Drug Trends in Two Forensic Populations within Strathclyde and a National Evaluation of the Field Impairment Test

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Summary

Drug Related Deaths

An investigation was carried out into all drug-related deaths that occurred within the Strathclyde Police region of Scotland over the 17-year period, 1985 – 2001. Deaths involving heroin, methadone, dihydrocodeine or cocaine were the focus of this thesis. In total, more than 1,000 cases were reviewed. By extracting data from the toxicology report and police sudden death report, changes in patterns and trends of drug misuse were highlighted which coincided with concurrent changes to legislation and medical care. This is a novel approach to the investigation of drug-related deaths within this jurisdiction.

Deaths involving heroin

Over the study period 869 heroin positive drug-related deaths were identified, in 95% of which that drug was the sole or the major contributory causal factor. The majority of these deaths involved males. The average age of all individuals increased slightly from 26 years to 29 years over the study period. The individual had a history of drug misuse in 95% of cases and of those, 92% were known to abuse drugs intravenously.

Approximately one quarter of individuals resided alone and over one-half resided with other people, primarily their parents or (common law) partners/spouses. The individual was homeless in 14% of cases. Of this group, 70% resided in a hostel. The remainder had no fixed abode. Of cases where the postal code was known, 74% resided within the Greater Glasgow Health Board area. In the last year of the study deaths of individuals residing in the Ayrshire and Arran Health Board area increased sharply compared to a decrease in deaths reported in all other areas. Approximately two-thirds of individuals resided in areas of high deprivation (categories 6 and 7). The locus where the body was found was primarily in a dwelling (73%), usually the individual's own home. From the circumstances surrounding the deaths it was ascertained that the individual was alone at the time of death in just under half the cases, highlighting the risk of taking drugs in isolation.

Attempts to revive the deceased prior to the arrival of paramedics occurred in only one fifth of cases where this information was available. An ambulance was summoned in approximately three-quarters of all cases where this information was available. Resuscitation attempts were more likely to be initiated by paramedics if witnesses were present at the locus.

A period of drug abstinence shortly before death was noted in one fifth of cases, the majority of which related to a period of incarceration. Of the deaths involving recently released prisoners, over half overdosed within one week of release highlighting the risk of reduced tolerance following a period of abstinence. The median blood morphine concentration detected amongst deaths where heroin was the sole cause of death was significantly higher than deaths where heroin was a contributory factor (0.33mg/l versus 0.23mg/l). Polydrug use accounted for 91% of cases and this was primarily a cocktail of two or three drugs. Benzodiazepines and alcohol were the most frequently detected drugs taken concurrently with heroin. Prior to 1996, the most frequently detected benzodiazepine was temazepam. However, a legislation change resulted in this drug being re-scheduled and consequently, the supply of temazepam decreased. As a result, the number of diazepam positive cases increased post 1996. Methadone was detected in 13% of polydrug cases. However, this had been obtained by the diversion of legitimate supplies in the majority of cases. Speedballing was noted in 3% of all polydrug cases, the majority of which occurred in the latter two years of the study.

Heroin remains the most frequently detected drug amongst drug-related deaths in the West of Scotland and at present, its incidence shows no signs of subsiding.

Deaths involving methadone

The methadone maintenance programme was introduced to Glasgow in 1994 and subsequent to this there was an increase in the number of deaths involving this drug. In 1996, a confidential enquiry was established to assess the clinical care provided in these deaths. The findings of this were reported in 1999 and showed that 93% of GPs interviewed "definitely" intended to change their future management of drug misusers. Supervised consumption was promoted heavily from 1996 and from this time deaths involving methadone were shown to decrease.

Methadone was detected in 271 drug-related deaths over the study period, 72% of which were due to methadone alone or in combination with other drugs. Between 1991 – 1995, 62% of methadone deaths in Strathclyde occurred in the Greater Glasgow Health Board area and this decreased to 45% between 1997 – 2001. This indicated that methadone deaths were occurring throughout the rest of the Strathclyde area. Methadone had been obtained by the diversion of legitimate supplies in over half the cases where this information was available. By calculating the number of patients enrolled on a methadone

programme within each health board area, a methadone death rate was obtained for each year. This was shown to fall sharply after 1996 and remained low thereafter. In 2001, the death rate calculated for individuals on a methadone programme in the Greater Glasgow Health board area was lower than the other three health board areas, but in general rates were low, indicating a good safety profile for the methadone programme.

A common observation in methadone deaths was that the deceased had been witnessed to be intoxicated prior to falling asleep. Witnesses then reported heavy uncharacteristic snoring in these cases. This suggests that some of these deaths may have been preventable had medical intervention been sought on first signs of overdose. The deceased was a recently released prisoner who overdosed within 2 weeks of release in 11% of cases. The median blood methadone concentration detected amongst deaths where methadone was the sole cause of death was significantly higher than deaths where methadone was a contributory factor (0.7mg/l versus 0.3mg/l). Polydrug use was evident in 85% of blood drug positive cases and the most frequently detected additional drug group was the benzodiazepines. The most frequently detected benzodiazepine up until the legislation change in 1996 was temazepam and from 1997 onwards this was replaced with diazepam. In 30% of heroin positive cases, the deceased had been prescribed methadone which suggests that they were being non-compliant with the methadone programme guidelines in that they continued to use illicit drugs. In general, over the study period, the proportion of all illicit overdose deaths where methadone was detected increased to 42% in 1996 and fell on a year-to year basis to 16% in 2000 and increased again slightly to 20% in 2001.

Despite initially receiving much criticism, this study has shown that with efficient patient management to establish the compliance with the guidelines of the programme, methadone can be a safe drug for substitution therapy.

Deaths involving Dihydrocodeine

During the period in which methadone deaths were decreasing, the number of dihydrocodeine (DHC) positive drug-related deaths increased. This drug is sometimes prescribed as a substitute for methadone for a number of reasons, one being that several days supply can be dispensed at the one time, owing to the short half-life of this drug. This can be problematic, however, as there is potential for diversion of legitimate supplies. DHC was found in 99 drug-related deaths over the study period, 59% of which were due wholly or partially to the effects of dihydrocodeine. Over two-thirds of cases involved

illicitly obtained dihydrocodeine and approximately one third involved the deceased being in an intoxicated state prior to falling asleep. The median blood DHC concentration detected amongst deaths where dihydrocodeine was the sole cause of death was significantly higher than deaths where dihydrocodeine was a contributory factor (3.8mg/l versus 0.9mg/l). Polydrug use was evident in all cases and this was primarily with diazepam or morphine (heroin).

Dihydrocodeine as a drug of misuse was highlighted and requires monitoring to establish whether this is a real trend or a fashionable phase.

Deaths involving Cocaine

Information relating to seizures, reported cocaine use within a population and individuals being registered for treatment as a result of cocaine and crack addiction have shown an increasing trend in the use of this drug. This has been corroborated by the number of cocaine positive cases detected amongst drug-related deaths in the Strathclyde region. The first cocaine positive case in Strathclyde was reported in 1993 and increased on a year-to-year basis. Cocaine was detected in 37 drug-related deaths, in 51% of which cocaine was the sole or a contributory factor in death. In approximately one third of cases where cocaine was the sole cause of death, the circumstances were uncharacteristic of a stimulant type death. Of the cocaine related deaths, heroin was a contributory factor in 80%. A median blood cocaine concentration of 5.23mg/l was recorded for deaths where cocaine was the sole cause of death and 0.17mg/l in cases where cocaine was a contributing factor in the death. Polydrug use was evident in 84% of all cocaine deaths and the most frequently detected drug in combination with cocaine was morphine, indicative of heroin use, followed by diazepam.

The occurrence of cocaine amongst drug-related deaths in the Strathclyde region is increasing, however it role in causing death remains negligible.

Drugs and Driving

A review of 1,195 biological samples received for the analyses of drugs obtained from drivers suspected of driving whilst under the influence of drugs was carried out between 1995 - 2001. The majority of samples were blood (84%). Drugs were detected in 82% of the blood samples and 94% of the urine samples. Polydrug use was prevalent amongst

these samples and the proportion of polydrug use cases increased over the years. The most frequently detected drug groups were initially the benzodiazepines, followed by cannabinoids and opioids. In later years, opioids superseded the cannabinoids. The proportion of drug positive blood samples that contained morphine (indicative of heroin) accounted for 12% of all drug positive cases in 1995 compared to 42% in 2001. The benzodiazepine most frequently detected was initially temazepam. However, following the legislation change in 1996, temazepam positive cases decreased and diazepam positive cases increased. Methadone positive cases were shown to decrease and dihydrocodeine cases to increase following 1996, the year when methadone supervision was heavily promoted. Drug combinations were similar to those found in drug-related deaths with the concurrent use of opioids and benzodiazepines being prevalent. The concurrent use of methadone and morphine (indicative of heroin) was confirmed in approximately one third of all methadone positive cases. However, no information was available regarding whether this had been prescribed to the individual. Cocaine had been taken in combination with heroin in 31% of all cocaine positive cases between 1999 and 2001. All drugs detected have impairing effects that can be detrimental to driving performance and the combinations of drugs detected in this study have been reported to enhance the disruptive effects of an individual drug.

The police officer's suspicion of drug induced impairment was confirmed in the majority of cases reviewed. The drugs detected paralleled the situation of drugs involved in drug-related deaths over the same time period.

As a result of the increasing prevalence of drugs detected amongst drivers, a pilot trial was initiated by police forces in the UK using the field impairment test. This battery of tests is based on those used in the United States and was modified for use in the United Kingdom. The Department for Transport commissioned a study to evaluate the use of these tests and the results obtained from eight Scottish police forces are presented. Of those drivers who were judged to be impaired, 95% were found to test positive for drugs. However, of those who were judged to be unimpaired, only 19% were found to be drug free. This could be explained by the driver's personal tolerance to the drugs detected. The drugs detected in all biological specimens were indicative of drugs being misused rather then the medicinal use of prescription drugs. Amongst the blood and urine samples (obtained from drivers who were judged to be impaired) the most frequently detected drug group was benzodiazepines and this was followed by opioids. The concurrent use of methadone with heroin was confirmed in 91% (n = 10) of methadone positive urine cases and in 38% (n =

5) of methadone positive blood cases. The next most frequently detected drug group was the cannabinoids. However the presence of the active component, THC, was confirmed in only 44% of these cases. Polydrug use was detected in 69% of drug positive blood and urine samples. Drugs detected in the saliva samples were indicative of drug misuse both in the actual drugs found to be present and drug combinations detected. Opioids were the most frequently detected drug group, followed by cannabinoids. The drug recognition skills of the police officer was generally shown to be very good, both in identifying the presence of a drug and the type of drug suspected to be causing impairment. Drug use was confirmed in 92% of cases and drugs suspected to be causing impairment were confirmed in 69% of cases where this information was available.

Within the battery of five tests (involving four divided attention tests), the sensitivity and specificity revealed that some tests contributed more diagnostic value than others. For example the pupillary examination had an overall accuracy of 48%, showing that it contributed little to the overall FIT, whereas both the one leg stand and the walk and turn test had an accuracy of 83%.

This study showed that the use of saliva is an effective and practical alternative to blood and preferable to urine as a biological specimen for the purposes of Section 4 of the Road Traffic Act. It also showed that the use of FIT is a useful adjunct to present procedures that are utilised by the police.

Abbreviations

A&C	Argyll and Clyde
A&A	Ayrshire and Arran
ACMD	The Advisory Council on the Misuse of Drugs
BE	benzoylecgonine
CNS	central nervous system
CO	cocaine only
CR	cocaine related
CoD	cause of death
DAT	drug action team
DHC	dihydrocodeine
DMD	drug misuse database
DOA	dead on arrival
DRD	drug related death
DR	drug recognition
DRE	drug recognition expert
DUID	driving under the influence of drugs
DVLA	driver and vehicle licensing agency
EMCDDA	European Monitoring Centre for Drugs and Drug Addiction
FIT	field impairment test
FMS	forensic medicine and science
GG	Greater Glasgow
GDPS	Glasgow drug problem service
GP	general practitioner
GROS	General register office for Scotland
L	Lanarkshire
mg/l	milligrammes per litre
mg/100ml	milligrammes per 100 millilitres
MDA	misuse of drugs act
MDMA	methylenedioxymethylamphetamine
ME	methylecgonine
MMP	methadone maintenance programme
MSIC	medically supervised injecting centre
NPV	negative predictive value
OD	overdose
PF	procurator fiscal

PM	post-mortem
PPV	positive predictive value
RTA	road traffic act
SDEA	Scottish drug enforcement agency
SDMD	Scottish drugs misuse database
SP	Strathclyde police
SPS	Scottish prison service
THC	tetrahydrocannabinol
THC-COOH	11-nor-delta-9-tetrahydrocannabinol-9- carboxylic acid
6-MAM	6-monoacetylmorphine

1 Introduction

Drug misuse refers to the improper use of drugs (both illicit and prescription type drugs) and is a pandemic affecting all levels of society in almost every country. From the recreational ecstasy user to the heavily addicted heroin addict it is estimated that approximately 200 million people abuse drugs throughout the world [1]. The United Nations Drug Control Programme estimated that the world trade in illicit drugs now stands at £250 billion per annum, accounting for 8% of international trade [2]. Addiction has been referred to as the biggest preventable killer in the United Kingdom resulting in over 150,000 deaths per annum [3]. Whilst the majority of these deaths are either tobacco or alcohol related the number of drug-related deaths should not be ignored. The latest Government funded research estimates that annual health and crime related costs arising from the most serious drug misusers alone are in excess of over £4 billion [4]. It has been estimated that the number of years of working life lost from drug misuse deaths is now approaching that of road traffic fatalities [5]. Alarming findings of a recent study involving secondary school children throughout Scotland revealed that approximately one in ten pupils, aged between 11-12 years, had already initiated illegal drug use. Whilst cannabis was the most widely reported drug used amongst this group, temazepam, magic mushrooms and amphetamines were also reported [6]. Drug addiction in the United Kingdom is clearly a problem and with the total number of seizures of controlled drugs having increased by 293% from 1985 to 1999, it appears to be an increasing problem that shows no signs of subsiding [7].

The number of seizures of controlled drugs throughout Scotland increased by 422% over the years 1985 to 1999 and the number of general acute hospital admissions for drug misuse and of drug-related deaths (DRDs) have continued to increase over the years. This increase in drug deaths has resulted in initiatives introduced by the Scottish Executive. A target set out by them, in 2000, was to reverse the upward trend of DRDs and reduce the number of DRDs throughout Scotland by 25% by the year 2005.

As drug misuse increases in society, it is necessary to have methods of recording and monitoring the situation at an international, national and local level. On a European level, information relating to drug misuse is collected and analysed by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA). This agency became fully operational in 1995 and was established in response to the escalating drug problem in Europe with the aim of providing an accurate picture of the extent of the drug problem in the European Union. The EU Action Plan on Drugs (2000 – 04) calls for member states to provide reliable and comparable information on five key indicators as proposed by the EMCCDA.

Therefore, in addition to a measure of drug use among the general population (population surveys), the prevalence of drug-related infectious diseases, incidence estimates and surveys among drug users, another key indicator is that of drug-related deaths and mortality of drug users. With respect to the latter, the EMCDDA have implemented "The DRD-Standard" which enables the harmonised collection of internationally comparable data [8]. On a national level, a record of all Scottish drug-related deaths is provided by the General Register Office for Scotland (GRO). However, both the definition of a DRD employed by the GRO and data collection methods have altered over the years and hence care must be taken when comparing trends in DRDs published by them. In addition, the GRO includes deaths in which a drug listed under the Misuse of Drugs Act (1971) was known to be present in the body at the time of death. The presence of a drug does not always infer that the drug was involved in causing death. Hence, in these instances, statistics relating to drugs involved in deaths can often be misleading. With the exception of the GRO procedure, there is at present no protocol for monitoring drug-related deaths at a local level. Therefore, one aim of this study was to analyse the DRDs that occurred in the Strathclyde region of Scotland with the intention of providing a chronological timeline of changing patterns and trends of drug misuse. For this purpose, the definition of a DRD and methods used for data collection were established and remained consistent throughout to provide data over a 17 year study period. Whilst DRD data can be used for estimating the extent of drug misuse in a population with respect to changing patterns of use, it has limitations. For example, the use of cannabis and stimulant type drugs, such as ecstasy, in a population cannot be extrapolated from DRD figures. Cannabis is reported to be the most commonly misused illicit substance[9] and yet it was mentioned as a substance causing death (concurrently with other drugs, mainly opioids or stimulants) in only approximately 3% of all "deaths by poisoning" as recorded by the GRO in 2000 [10]. Similarly, deaths due to ecstasy use are comparatively low when there is estimated to be in excess of 500,000 individuals consuming ecstasy in the UK every weekend [11, 12]. Hence, DRDs as an indicator of drug misuse in a community is more useful for frequent problematic drug use as opposed to drugs associated with recreational use.

The driving population is another group where drug misuse can be monitored. An increasing number of studies show that drug use is detrimental to traffic safety. Two recent studies in Scotland have focused on the nature and extent of driving and recreational drug use. The first, a household survey, aimed at estimating the prevalence of driving whilst under the influence of recreational drugs among 17 to 39 year old drivers revealed that 5% of the study sample had reported ever having driven under the influence of a drug

within the previous 12 months. Of these cases, the majority reported having driven under the influence of cannabis only. Less than one half of those who had reported drug driving within the previous twelve months also felt that the drugs had no effect on their driving [13]. Secondly, a qualitative study whereby 61 semi-structured interviews were conducted with individuals who had recently attended nightclubs at various locations throughout Scotland, revealed that 85% had driven after recreational drug use and 31% did so on a weekly basis. Cannabis use prior to driving was reported in 72% of cases and this was followed by ecstasy, in 43% of respondents [14]. Focusing on problematic illicit drug use, a recent study investigated the prevalence of drug driving amongst 585 new treatment clients in Scotland. This revealed that approximately 16% of clients had driven in the last 90 days. Of these cases, one fifth had been arrested for drug driving and despite drug driving being reported on numerous occasions an arrest had been reported on average only once [15]. These studies have all been conducted using data collated by survey and interview techniques. Whilst the information provided by these is of extreme importance, there is no way of corroborating alleged drug usage against that actually detected. A poor correlation between self-report data and laboratory testing has been shown in the past [16]. Another way of estimating the prevalence of drug driving is to analyse samples obtained from drivers of populations suspected to be "at risk". For this purpose, this study aimed to show the prevalence and extent of drug misuse amongst individuals who were suspected to be driving whilst under the influence of drugs in the Strathclyde region of Scotland. In addition to actual drugs and concentrations detected, the combinations of drugs consumed were summarised. As an adjunct to the drug driving section, an evaluation of the field impairment test in Scotland was given. It was not possible to provide an accurate evaluation of the Strathclyde area alone due to an insufficient number of cases. Nevertheless, this section monitors the use of the field impairment test by police officers and also establishes the nature and extent of drug use by both drivers who were judged to be impaired and those who were judged to be unimpaired.

In excess of 1000 DRD cases that occurred over a 17-year period were studied in order to ascertain the role of heroin, methadone, dihydrocodeine and cocaine in these deaths. In addition, approximately 1200 cases of drivers suspected to be driving whilst under the influence of drugs were studied between 1995 - 2001 to ascertain the nature and extent of drug use amongst this population. Finally, 736 cases involving an individual who participated in the field impairment test were studied in an effort to evaluate the use of this procedure when identifying the drugged driver and also to determine the extent of drug use by these drivers. Varying drug trends over the years were noted amongst both the DRD

cases and the drivers. These trends and possible reasons for the changes in demand and supply of the various drugs will be discussed.

2 Drug Misuse

2.1 A brief history of Drug Misuse

The most ancient drug known to man is probably opium with its use dating back to antiquity. An extract derivative of the seedpods from the opium poppy *Papaver somniferum*, opium was discovered in the lands of the eastern Mediterranean basin around the 16th century B.C. [17] and has been referred to as the "joy plant" [18]. It has been utilized by many civilisations and cultures from as far back as neanderthal man and Egyptian pharaohs [19]. Throughout time, the somnolent and medicinal properties of the opium poppy were noted in writings from the classical period of ancient Greece [20] and Homer referred to it as "*a drug to lull all pain and anger and bring forgetfulness to every sorrow*" [21]. Medically, it was used freely to allay not only the suffering of pain, but also diarrhoea, insomnia and neurological and psychiatric disorders [22] and was even used to calm children who cried excessively (Mrs Winslow's Soothing Syrup and Mother Bailey's Quieting Syrup) [23].

Pioneers of the medical world such as the Swiss physician, Philippus Aureolus Theophrastus Bombastas Von Hohenheim ‡ (1493 – 1541) and Thomas Sydenham † (1624 – 1689), the founder of clinical medicine and epidemiology, both have been viewed as having had promoted the medical use of opium. It was this duo who were responsible for the invention and introduction of laudanum, the alcohol tincture of opium, into the medical practice. In fact, it's use was so extensive and acceptable that vials of laudanum and raw opium could be purchased at any English pharmacy and grocery store up until the Pharmacy Act was passed in 1868 [24]. On the whole, opium's popularity was widespread and even Victorian authors were documenting their own experiences of the drug [25,26]. Limitations of its use were however noted and in the first half of the 19th century, medical textbooks were reporting on dissociation produced by the drugs[27].

> *"...here was the secret of happiness, about which philosophers had disputed for so many ages, at once discovered: happiness might now be bought for a penny and carried in the waistcoat pocket...."*
>
> **Extract from *Confessions of an English Opium Eater* by Thomas de Quincey** [25]

The 19th century marked some important and what were to become detrimental advances in terms of drug misuse. The isolation of morphine (so called after the Greek God of Dreams,

‡ Also known as Paracelsus

† Also known as the "English Hippocrates"

Morpheus) by the German pharmacist Sertűrner occurred in 1805. This was followed by the invention of the hypodermic needle (1857) to allow injection of pure morphine and whilst this was not believed to be addictive, it led to a rapid increase in the use of opium. The use of injecting morphine increased so much during the American Civil War that morphine addiction became known as the "soldiers disease" [28]. The synthesis of heroin occurred at St. Mary's Hospital in London in 1874 by the English pharmacist C.R. Wright who had been conducting studies on the naturally occurring alkaloids [29]. It wasn't until 1898 that it was synthesized and marketed by the German pharmaceutical company, Bayer. Heroin was initially believed to be a useful treatment for morphine and opium addiction, however, it soon became apparent that heroin itself was very addictive and it was not long before it was seen not as a cure but as "another curse" [30]. These "advances" could be regarded as the precursor of what was to become a major health problem and cause of otherwise preventable deaths on a world-wide scale.

Marijuana and cocaine, both naturally occurring psychoactive drugs have both been used for their recreational and medical properties. Medically, cocaine has been used in the treatment of depression and for a time, opiate withdrawal and was even heralded as the official remedy for "hay fever" by the American hay Fever Association due to its ability to shrink nasal mucous membranes and to drain sinuses [31]. Marijuana was utilised for its analgesic, hypnotic and anticonvulsant properties [21]. The presence of cocaine and marijuana have even been detected in the hair of Egyptian mummies (1072 BC – 395 AD)[32].

From the above it can be seen that the drugs which are widely misused today were originally applied in medical situations. However, mans ignorance as to the extent of their psychoactive properties was conducive to the phenomenon of addiction. As addiction of these drugs became more widespread, it became clear that something had to be done in an effort to control the use of drugs and unsocial behaviour associated with it.

2.2 Drug Legislation

In the United Kingdom there have been many statutes passed over the years in an attempt to regulate the supply and manufacture of both licit and illicit substances. The Pharmacy Act 1868 was passed in an effort to control the sale of opium to those who were knowledgeable of its properties. This Act stipulated that in order to retail, dispense or compound "poisons" the individual had to be registered by the Pharmaceutical Society [33].

Heroin, opiates and cocaine were made illegal in 1920 under the Dangerous Drugs Act. This Act was passed in order to implement the findings of the International Opium Convention 1912 (the Hague Convention) and required states party to it to limit the manufacture, trade and use of opiates and cocaine to medical purposes as well as prohibit the sale of opium to unauthorised users.

Presently there are two principal statutes which regulate the availability of drugs in the United Kingdom, they are (i) The Medicines Act 1968 and (ii) The Misuse of Drugs Act 1971. These two statutes govern the manufacture, licensing, prescription, supply and administration of medicinal products. The Medicines Act 1968 classifies medicinal drugs into one of three categories:-

- Prescription-Only Medicines: This is the most restricted category in that these medicines can only be dispensed from a pharmacist working for a registered pharmacy on instruction of an appropriate practitioner (doctor or dentist).
- Pharmacy-Only Medicines: These medicines can be purchased without a prescription provided a pharmacist working for a registered pharmacy supervises the sale.
- General Sale List Medicines: This is the least restricted category in that these medicines can be bought without supervision or a prescription from retail outlets.

Continued drug misuse resulted in the Misuse of Drugs Act (MDA) being passed in 1971. This is the major act controlling drugs and has brought together earlier legislation under one Act of Parliament and is the one that is most referred to today. It was established in response to the increasing trend of drug misuse in British Society and in order that the United Kingdom fulfils its obligation to control drugs in accordance with international agreements. The main aim of this Act is prohibition at all levels *i.e.* possession, supply, production (including cultivation) and trafficking of all drugs it controls. The MDA contains three classifications of drugs to which the Act applies and are defined according to the harm they impose on individuals at the time of inclusion. They are defined as Class A, B and C with Class A being thought to be the most harmful when misused and therefore carry the highest penalties through to Class C which includes drugs with the least potential harm to health and the lowest penalties. These penalties are outlined in Table 1.

Table 1: Maximum penalties incurred dependent on offence and where case contested

Offence	Court	Class of Drug under MDA 1971		
		A	B	C
Possession	***Magistrates***	6 months &/or £5000 fine	3 months &/or £2500	3 months &/or £1000 fine
	Crown	7 years &/or unlimited fine	5 years &/or unlimited fine	2 years &/or unlimited fine
Supply/ Trafficking	***Magistrates***	6 months &/or £5000 fine	6 months &/or £5000 fine	3 months &/or £2500 fine
	Crown	Life &/or unlimited fine	14 years &/or unlimited fine	5 years &/or unlimited fine

Exemptions to the general prohibition governed by the MDA do exist, for example, in cases where drugs are utilised for scientific and/or medical purposes. In these cases the Government is able to authorise a Home Office licence under the Misuse of Drugs Regulations 1985 which allow professionals to possess such drugs for research purposes in a controlled environment. These regulations are divided into five schedules with schedule 1 being the most stringently controlled and can only be supplied, possessed or administered in accordance with a Home Office licence. Schedule 5 lists preparations considered to pose minimal risk of abuse and those that can be bought over-the counter at a pharmacy without a prescription. The majority of controlled drugs available for medical use are included in schedules 2, 3 and 4. Table 2 illustrates the main types of controlled drugs abused in Strathclyde by schedule and class.

Due to the widespread misuse of Temazepam in the early nineties, this benzodiazepine was transferred from schedule 4 to schedule 3 in 1996. This meant that the possession of this drug without a prescription or other authority was illegal[34]. More recently owing to the increase in misuse, diazepam has been rescheduled from Schedule 4 part II (Misuse of Drugs Regulations 1985) to a revised Schedule 4 part I (Misuse of Drugs Regulations 2001) [35]. This now means that a person can be arrested and charged if found to be in the possession of just one tablet without a prescription. Most recently, on 10 July 2002, it was announced that cannabis would be reclassified from Class B to Class C, under the Misuse of Drugs Act 1971. Although this change was scheduled to take place by July 2003 [36], it actually took effect from 29th January 2004. Despite this declassification, production,

possession and distribution of cannabis is still illegal and persons found in possession of this drug are still liable to be arrested and charged under the Misuse of Drugs Act 1971.

Table 2: Commonly abused drugs in Strathclyde classified by schedule and class

Schedule	Class		
	A	B	C
1	MDMA (Ecstasy) Opium (Raw) Coca Leaf		Cannabis and cannabis resin
2	Heroin Methadone Cocaine	Amphetamine Dihydrocodeine (DF118)	Dextropropoxyphene
3		Barbiturates	Temazepam
4			Benzodiazepines (except Temazepam)
5	Preparations containing opium, morphine, certain opioids and cocaine	Non-injectable preparations containing codeine and other weak opiates and opioids	Preparations containing dextropropoxyphene to be taken by mouth

2.3 Drug Misuse in Scotland

The misuse of drugs has a detrimental effect both to the individual and to society as a whole and is an everyday problem encountered globally, Scotland being no exception. The use of drugs has always been present in society, albeit to a lesser extent some twenty years ago than in comparison with today. In the seventies, for example, drug use was mostly confined to bohemian groups experimenting with "love drugs" and other psychoactive drugs such as LSD and amphetamine. In those days there was little evidence of the hard core illicit drug injector that has emerged in today's society.

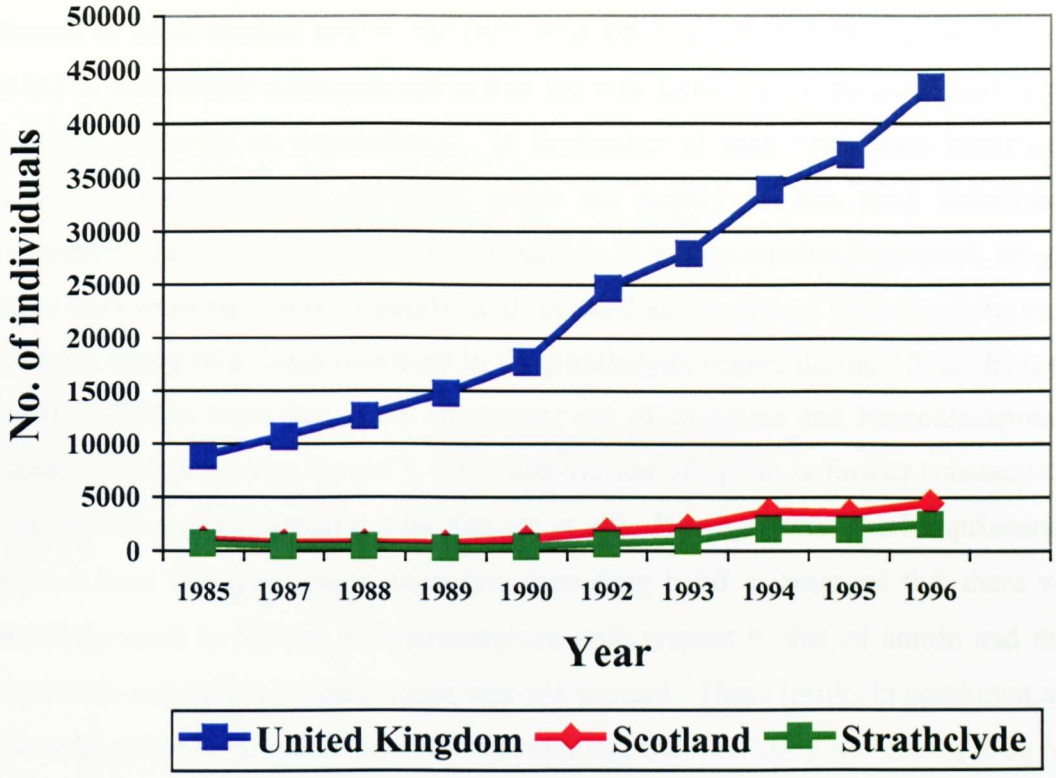
2.3.1 Number of Drug Addicts in Scotland

During 1968, it became statutory for general practitioners (GPs) to notify an individual to the Home Office addicts index if they were known to be addicted to any one of fourteen specific opiates and/or cocaine[†]. As well as monitoring the extent of drug misuse in the UK, this index acted as an extra source of intelligence to prevent double prescribing occurring [37]. In 1980, there was a total of 126 drug addicts notified to the Chief Medical Officer at the Home Office for the whole of Scotland (2 drug addicts per 100,000 population). Of these, 26 were from the Strathclyde region (1 drug addict per 100,000 population). Over the sixteen-year period the total number of drug addicts notified rose approximately 35 fold to 4516 for Scotland (89 drug addicts per 100,000 population), 2467 of which were in the Strathclyde region (107 drug addicts per 100,000) [38]. Since these figures relate to individuals who have voluntarily presented themselves for medical treatment at their GP, it can be assumed that the figures are an underestimate. For comparison, in terms of the national prevalence of problematic drug misuse, Hay et al have estimated that 55,800 individuals were misusing opiates and benzodiazepines in Scotland in the year 2000 and approximately 53% of problematic drug users were resident within the Strathclyde Police Force Area. [39].

Figure 1 shows the total number of drug addicts who had been notified to the Chief Medical Officer at the Home Office on a year to year basis (figures for 1986 and 1991 were not available) and include both new and re-notified drug addicts. Over the years shown, between 5% and 12% of all UK figures were from Scotland. The vast majority of Scottish drug addicts notified resided in the Strathclyde area and accounted for between 32% - 65% of all drug addicts notified in Scotland.

[†] Dextromoramide (Palfium), Diamorphine (Heroin), Dipipanone (Diconal), Hydrocodone (Dimotane DC), Hydromorphone, Levorphanol(Dromoran), Methadone, Morphine, Opium, Oxycodone, Pethidine, Phenazocine (Narphen), Piritramid (Dipidolor),Unspecified Opiates

Figure 1: Number of drug addicts notified to the Home Office Addicts Index (new and re-notified) for the United Kingdom, Scotland and Strathclyde



2.3.2 Trends and Patterns of Drug Misuse in Scotland

Trends and patterns of drug use in the West of Scotland have been well documented in the literature[40,41,42,43,44,45,46]. Drug abuse as a problem in the region dates from the early 1980s when the black market in heroin and trend of injecting drug use emerged in Edinburgh and Glasgow [47].

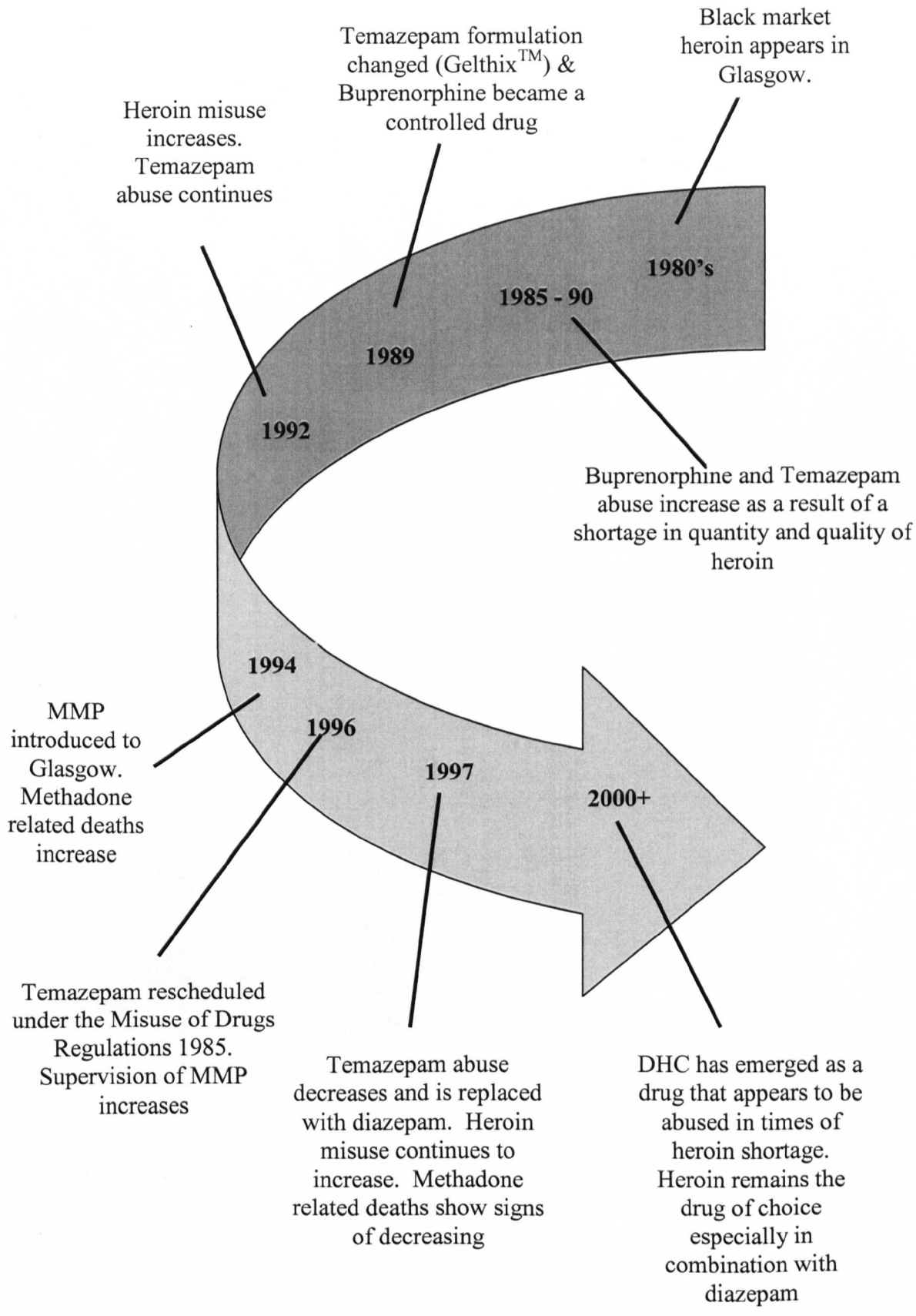
From 1985 to 1990, the abuse of buprenorphine (Temgesic™), an opioid analgesic, purported to be approximately 25 – 40 times more potent then morphine, spread throughout the Glasgow area. In addition, evidence pertaining to the abuse of temazepam, a benzodiazepine tranquiliser prescribed for the treatment of anxiety and insomnia, was present indicating that it was being misused throughout Glasgow[41]. This transition in drug use occurred as a result of a decrease in the quantity and quality of street heroin at that time. These two drugs were popular choices due to their ease of both availability and administration. Buprenorphine, at that time, was not a controlled drug and was easily available. As a consequence of solubility it became a preferred choice by the intravenous drug user. Temazepam, which once was the most widely prescribed hypnotic in the UK[48] and was initially manufactured in a liquid filled capsule, providing a "ready to inject" formula to the abuser. This era also saw the emergence of the opiate/benzodiazepine drug

cocktail that remains a popular choice with drug users in the West of Scotland today. In an attempt to decrease the abuse of temazepam, the manufacturers changed the formulation of the liquid filled capsule to one filled with wax (Gelthix™) in 1989. However, abuse continued as users applied heat to the capsule in order to melt the wax prior to injecting. This led to undesirable consequences in that the wax solidified in the individuals vein and in extreme cases led to amputations. In September of that same year, buprenorphine became a controlled drug and as a result the supply of this drug decreased and consequently, the price increased. As the supply of buprenorphine decreased, drug users resorted back to using heroin. Cassidy et al revealed an absence of buprenorphine amongst individuals dying of a drugs overdose in the Strathclyde region during 1992. Instead, the majority of deaths were due to the concurrent use of an opiate and benzodiazepine, with the opiate of choice being heroin[46]. This substitution of opiate is further substantiated by the results of a survey carried out by Forsyth et al[44]. Having interviewed imprisoned drug users at a local Glasgow prison regarding their drug habit, it emerged that there was an apparent decrease in the use of buprenorphine with respect to that of heroin and that the preference to mix this with temazepam was still present. These results in combination with an elevated presence of media attention surrounding the increasing number of drug related deaths (DRDs) at that time highlighted the danger of mixing these two potentially lethal drugs. In contrast, this trend of drug use was not noted in Edinburgh, a city not more than 48 miles East of Glasgow. A study of DRDs from 1989 – 1994 revealed that heroin was involved in very few deaths in the South-east of Scotland with heroin overdoses having peaked in this area in 1984 and fallen rapidly from 1986. The commonest drug implicated in causing death was methadone, which had been vigorously promoted since 1986 in response to the high prevalence of HIV experienced by the city [49]. These changes in drug misuse are summarised in Figure 2.

Methadone as a drug of misuse did not go unnoticed in Glasgow. An increase in the misuse of this drug became evident in the early 1990's following the introduction of the methadone maintenance programme (MMP). A substantial increase in the number of heroin addicts being prescribed this drug together with a lack of supervision of consumption were to blame for the initial increase in methadone deaths observed around that time. In the late 1990's an increase in the number of dihydrocodeine (DHC) positive drug related deaths was noted [50, 51]. Consumption of this drug has been reported in times of heroin deficit or when there is poor quality heroin on the streets [52]. It has been increasingly prescribed over the years and can be purchased very cheaply on the streets.

The increase in drug misuse has resulted in an increased workload at Forensic Medicine and Science at the University of Glasgow. During 1985, there was a total of 1005 post mortems carried out by pathologists within the department. By 2001 this figure had increased by approximately 107% to 2076. During this time period, the annual proportion of post mortems which were drug related increased from 0.9% to 8%. Of 758 biological samples received by the laboratory in 1985, 31% were Strathclyde cases requesting a drugs screen. The vast majority (91%) of these cases required a general drugs screen to detect the presence of prescription drugs, only a very small number were specifically analysed for heroin (3%). Over the years, an increasing number of samples were being sent to the laboratory and a drugs of abuse screening method was utilised due to the ever increasing requests for the analysis of street drugs. The screening and confirmation of drugs of misuse is now an essential part of all routine analyses in the laboratory.

Figure 2: Timeline of changing patterns of drug misuse in Glasgow



2.3.3 Drug Treatment Services Available to Drug Misusers

The widespread and preferred intravenous route of administration of drugs resulted in the spread of HIV infection becoming a major health issue in the late 1980's. The provision of sterile needles and syringes in order to discourage such behaviour was highlighted as an important part of the United Kingdom's strategy to prevent the spread of HIV infection[53]. As a result a pilot needle exchange was initiated in June 1987 in the Ruchill area of Glasgow. By 1992, there were 8 needle exchanges established in the city with attendances having risen approximately 32-fold from 880 in 1988 to 27, 990 in 1992 [54]. By 2001/02, a needle exchange service was provided by 4 key facilities namely pharmacy needle exchanges, the Glasgow Drug Problem Service, Base 75 and the Glasgow Drug Crisis Centre. The total number of attendances at these facilities in the Greater Glasgow area was 126,967, with over half of these involving the pharmacy needle exchanges [55].

The overall increase in drug misuse which had risen in epidemic proportions led to the Advisory Council for the Misuse of Drugs to conclude that general practitioners should participate more in the care of drug misusers[56]. In the early nineties, it became evident to the small group of Glasgow general practitioners who chose to prescribe the opiate substitute methadone that there was a need for a greater professional involvement in the care of drug misusers. As a result, the Glasgow Drug Problem Service and the General Practitioner Drug Misuse Clinic Scheme were established in 1994 whose objectives were to reduce drug-related harm to health [57]. The former was established in January 1994 with an aim to "*promote better management of drug injectors by general practitioners through a system of shared care*"[58]. A condition for receiving treatment at the GDPS is that the individual is referred by his/her GP, the GP agrees that the patient may receive methadone for a considerable time and that they will agree to share in the continuing care of the patient[59]. In addition to the shared care by staff in the GDPS and in general practice, community pharmacists were recruited to supervise the consumption of daily doses of methadone. In early 1994, approximately one fifth of all Glasgow community pharmacies had become involved [60] and this has increased to approximately two-thirds today [61]. In 1996, 99% of all methadone that had been prescribed by the GDPS involved supervised daily dispensing[58], a figure that remains unchanged[59].

2.3.3.1 Drug Action Teams

Drug Action Teams (DATs) in Scotland resulted from a recommendation of the Scottish Executive's Task Force Report in 1994. Each health board area was given the task of

establishing a DAT that would be responsible for planning action against drugs (and alcohol) misuse in their local area. They are multi-agency partnerships made up of local professionals who advise the DAT on policy and practice including medical, law enforcement and social work agencies. Some are involved with tackling issues on both drugs and alcohol and some are solely concerned with drug prevention and educational issues. There are 22 DATs in Scotland and four of these are encompassed by the Strathclyde Police region of Scotland:

Greater Glasgow DAT	Lanarkshire DAT
Ayrshire & Arran DAT	Argyll & Clyde DAT

Following the launch of the national drugs Strategy, "Tackling drugs in Scotland" in 1999 by the Scottish Office, a local strategy was agreed by the Greater Glasgow DAT which included five action plans:

- Understanding the drug problem
- Protecting young people
- Reducing drug related crime
- Treatment, support and rehabilitation
- Effective communications and co-operation

3 National Statistic Sources

There are various resources providing information on the extent of drug misuse within a community. Some examples are summarised below and include data pertaining to the number of drug-related deaths and the number of individuals who are known to be drug misusers within a population.

3.1 The Annual Report of the Registrar General for Scotland

Around 400 years ago, the General Assembly of the Church of Scotland, decreed that parish registers of baptisms, burials and marriages should be kept by every minister in Scotland. This was the responsibility of clergymen until 1854, when parliament passed an Act *"to provide for the better registration of births, deaths and marriages in Scotland"*. This meant that the responsibility was passed from the Church to the State and that it was a statutory obligation for individuals to register such vital events. Consequently, the General Registry was established and a Registrar General appointed, who was responsible for the compilation of an annual report which was to be laid before Parliament. The very first annual report produced by the General Register Office for Scotland (GROS) was produced in 1855 and has been published every year since then[62].

Presently, legislation requires that all deaths in Scotland be registered within 8 days of the event. Data included in the main register include personal details of the deceased such as name, occupation, marital status together with the certified cause of death. Once the cause of death has been established, the deaths are then coded in accordance with the International Classification of diseases.

3.1.1 International Classification of Diseases

To enable statistical comparison of morbidity and mortality, both nationally and internationally, the *first International Classification of Causes of Death* was devised in 1893. Since then it has been revised and published approximately every 10 years, latterly being co-ordinated by the World Health Organization (WHO), with the latest version (ICD-10) having been published in 1992. In order to encompass a broader range of disease and health issues and also to update in terms of medical advances in disease identification, the current version has been renamed as the *International Statistical Classification of Diseases and related Health Problems*. The ICD classification constitutes the means for

coding deaths depending on the cause of death issued on the deceased's death certificate, the codes being universal throughout the many countries which employ this system as a means of classifying both morbidity and mortality patterns and trends within that specific country. These codes are used as the means for listing the frequency of deaths in the annual report. Whilst the ICD-10 has been available since the early-nineties, it should be noted that the GROS converted to this version as recently as the year 2000.

3.2 The Home Office Addicts Index

Under the Dangerous Drugs Regulations of 1968, it became statutory for general practitioners (GPs) to notify an individual to the Chief Medical Officer at the Home Office if they were known to be addicted to any one of fourteen specific opiates and/or cocaine†. The results of all registered drug addicts were published in Statistical Bulletins to aid epidemiological research. However, certain limitations existed in that the list of drugs did not cover all drugs to which addiction is possible and hence did not reflect present day drug trends. In addition a person could only be notified if they presented themselves at their GP thereby omitting those who had approached other drug agencies directly. Finally, it had been noted that, despite the legal requirement, there was a significant number of addicts who, although identified by doctors, remained un-notified on the Home Office Index [63]. As a result of these factors together with the development of the regional Drug Misuse Databases, the Home Office Addicts Index was discontinued in April 1997. As of 1st May 1997, the legislation to remove the statutory duty of GPs to notify the Home Office of a known drug addict came into effect. From this date, the only information available as to the prevalence of known drug addicts seeking treatment is collated by the Department of Health's regional drug misuse databases (DMDs) and the Scottish drug misuse database.

3.3 The Scottish Drug Misuse Database (SDMD)

In 1982, the Advisory Council on the Misuse of Drugs (ACMD) published a report entitled "Treatment and rehabilitation" which highlighted the widespread misuse of drugs in the United Kingdom. It also drew attention to the fact that users' problems reached beyond present medical treatment available to them. Consequently, this promoted the

† Dextromoramide (Palfium), Diamorphine (Heroin), Dipipanone (Diconal), Hydrocodone (Dimotane DC), Hydromorphone, Levorphanol(Dromoran), Methadone, Morphine, Opium, Oxycodone, Pethidine, Phenazocine (Narphen), Piritramid (Dipidolor),Unspecified Opiates

development of multidisciplinary problem drug teams to be established locally within each Health Authority [64].

Following a request from the Department of Health and Social Security in 1984 asking the National Health Service to review the prevalence of drug misuse locally, a DMD was developed by the University of Manchester Drug Misuse Research Unit (DMRU) in 1986[64]. Consequently, the Department of Health funded the DMRU to develop a DMD to be utilised on a national level which in turn led to its distribution to all English regional health authorities around 1990, Scotland followed shortly after. The 1986 DMD was really the nucleus of something that was to become a valuable tool to monitor the nature and extent of drug misuse amongst individuals' who presented themselves to a wide range of drug services nation-wide. The Drug Misuse Information Strategy Team are part of The Information & Statistics Division Scotland within The National Health Service in Scotland and have managed the Scottish DMD since it formally began in August 1990. They are responsible for the production of an annual publication to disseminate the data to the public and in addition, contribute summary statistics for Great Britain in the Department of Health Statistical Bulletin[64].

The information of interest relates to new patients/clients whom present themselves at an agency with a drug-related problem of any kind, whether it be physically, legally or psychologically related. A new patient/client is defined as "*Any person who is attending the service for (a) the first time ever or (b) it has been at least six months since the last attendance at the service*"[7]. A form (SMR24) is completed by the agency/doctor and returned to the SDMD for collation, processing and analysis. Types of agencies returning forms include penal establishments, general practices, police surgeons and specialist drug services, with the latter being the main source of data by far.

In addition to the prevalence of new individuals presenting at various agencies, the SDMD bulletin also provides information on the extent of infectious disease, the number of drug seizures and other drug related crime figures for the whole of Scotland. All such data is broken down by individual health board and council areas.

3.4 The Scottish Drug Enforcement Agency (SDEA)

The SDEA is an organisation established and maintained by the Scottish Ministers under Section 36(1) of the Police (Scotland) Act 1967 (the 1967 Act). The Agency was launched

on 1 June 2000 by the then Deputy Minister for Justice, Angus MacKay, and formally established on 1 April 2001 on the basis of an Agreement of the 8 Scottish Chief Constables in terms of Section 12(1) of the 1967 Act.

By working together with all eight police force areas in Scotland, the SDEA publish a quarterly drug trends bulletin providing information regarding drug trends, seizures and enforcement issues at local levels. This is distributed to police forces, drug agencies and DATs. They also established a national drug related death database on behalf of the Scottish Police Service and in collaboration with Forensic Medicine and Science at the University of Glasgow produced a joint report on all drug-related deaths in Scotland during 2001[65]. The aim of this document was to enhance analysis of drug related deaths from a police perspective and to include accurate interpretation of pathology and toxicology findings and assist DATs, drug agencies as well as police and law enforcement agencies.

4 Methodology for Drug-Related Deaths

The area of study is the Strathclyde police district which encompasses a large portion of the Southwest of Scotland and has a population of approximately two and a quarter million [66] (Figure 3). There are four health board regions that fall within the boundaries of this geographical area, namely the Greater Glasgow Health Board, Lanarkshire Health Board, Argyll and Clyde Health Board and Ayrshire and Arran Health Board.

Figure 3: The Strathclyde Police Region of Scotland

The population and estimated number of problem drug users within each of these health board areas for the year 2000 are outlined in Table 3.

Table 3: Populations and estimated number of problem drug users in each health board area encompassed within the Strathclyde Police region, 2000

	Population [66]	Estimated number of problem drug users [39]
Greater Glasgow	~900K	~15,975
Lanarkshire	~560K	~5,076
Argyll and Clyde	~420K	~5,405
Ayrshire & Arran	~370K	~3,058

4.1 Investigation of a Drug Related Death

Following the event of a suspected drug related death the Police Service has an established duty to investigate the death on behalf of the Procurator Fiscal (PF)[67]. They are required to compile a death report summarising the deceased's background, their medical history and the circumstances of the death. This is then submitted to the PF who in turn instructs whether or not a post mortem examination is carried out. Approximately 90% of Strathclyde drug-related deaths are referred by the Procurator Fiscal to Forensic Medicine and Science at the University of Glasgow for post-mortem examination. The remaining 10% of suspected drug-related deaths are examined by hospital pathologists. All biological specimens procured at the post-mortem examination are submitted to Forensic Medicine and Science at the University of Glasgow for analyses. This department is responsible to the Crown Office (the department of the Scottish Executive which provides Scotland's death investigation service) for the provision of toxicology services throughout the West of Scotland. The information available in the police sudden death report can provide vital evidence and aid the pathologist and toxicologist when assigning the cause of death on completion of all post-mortem examinations.

4.1.1 Standardised medico-legal protocol of the investigation of a drug-related death

In response to recent guidelines published by The Royal College of Pathologists, a full post-mortem examination is carried out on all suspected drug-related deaths regardless of infectious status [68]. The guidelines note that "*a refusal to perform an autopsy purely because of perceived risk of exposure to a serious communicable disease would have to be*

justified". In previous years, it was generally accepted that in such infectious cases, an external examination would suffice.

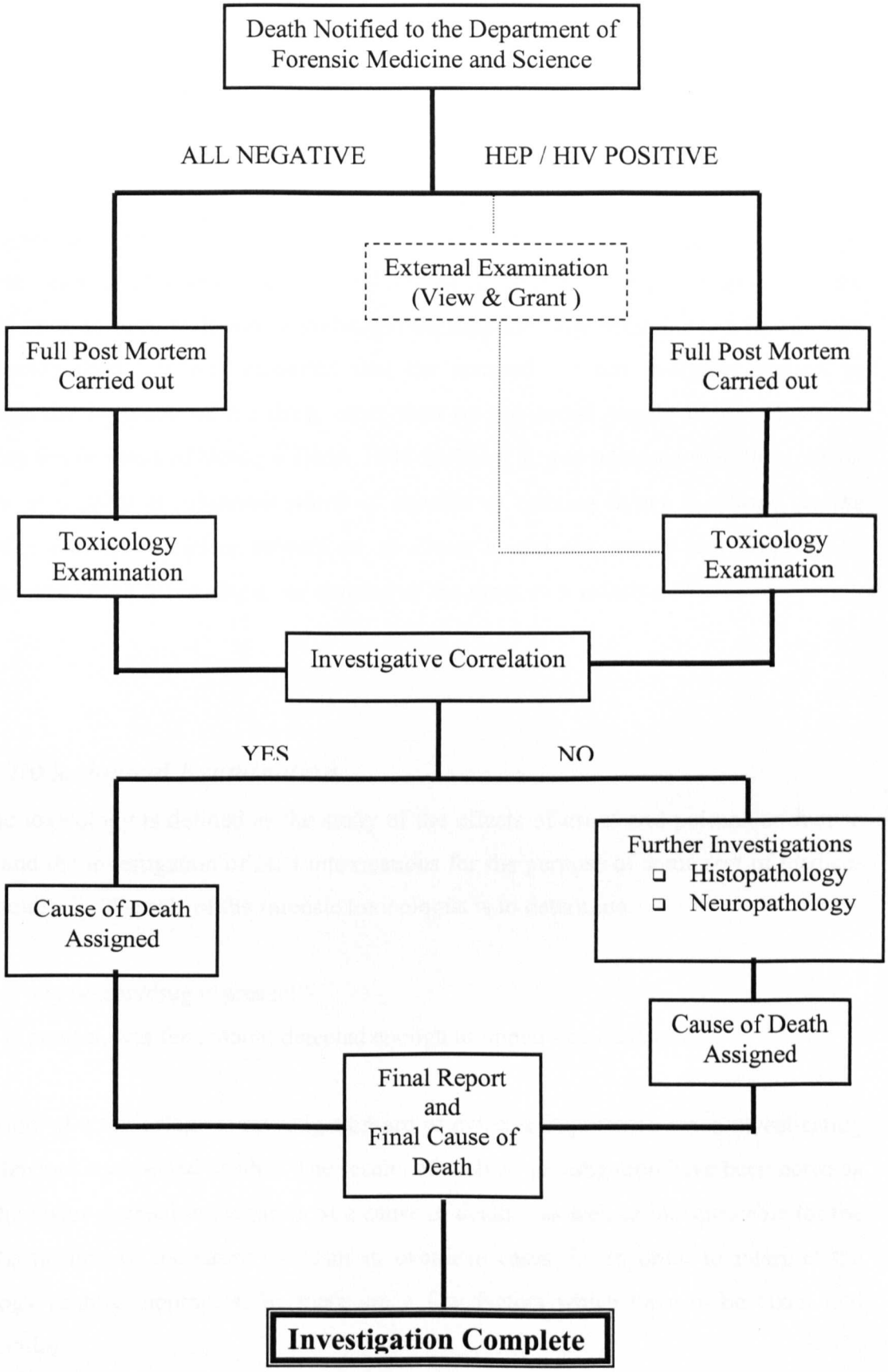
In addition, an agreed procedure has been established with the Procurator's Fiscal for sample retention with regards these deaths. Presently, the following samples are retained:

2 x Blood Samples (peripheral)	2 x Urine Samples
Small Tissue Samples for Histology	2 x Head Hair Pluckings

One of these duplicate samples is analysed on behalf of the Crown whilst the other is retained in the event that it may be required for analyses by future defendants.

On completion of the post-mortem examination, biological specimens are retained and submitted to Forensic Medicine and Science at the University of Glasgow for full toxicological and histopathological analysis. The current investigative procedures implemented by Forensic Medicine and Science are illustrated in Figure 4.

Figure 4: Overview of the Investigation of a Suspected Drugs Related Death.



A recent Crown Office recommendation in the procedure of investigating a DRD has resulted in the requirement for a full post-mortem examination to be carried out by two pathologists regardless of the infection status. Presently Crown Office is in agreement that this method of investigating drug related deaths is both thorough and concise and facilitates corroboration in the likelihood that a supplier may be charged for culpable homicide. However this practice is not consistent and can vary depending on the PF who instructs the post-mortem to be carried out.

The requirement for a double doctor post-mortem examination in possible culpable homicide cases came about following a Lord Advocate's reference in response to the acquittal of an accused male who was charged for supplying amphetamine to a female who subsequently died. It was contested that the accused did not instigate, suggest or encourage the ingestion of the drug, other than by the actual supply of it. However, following the decision of Ulhaq v HMA 1991 SLT614, it was accepted that "*if a person supplies to another a substance which is capable of causing injury if abused, in the knowledge that the recipient intends so to abuse it and the supply can properly be regarded as a cause of the abuse, the conduct of the supplier is criminal*" [69].

4.1.2 Toxicological Examination

Forensic toxicology is defined as the study of the effects of drugs and poisons on human beings and the investigation of fatal intoxications for the purpose of some sort of medico-legal enquiry [70]. The role of the forensic toxicologist is to determine:

- If any poison/drug is present?
- If present, was the amount detected enough to impair / cause death?

The results of a toxicological investigation are of extreme importance when investigating all sudden and unexpected deaths. The results of such an investigation have been noted as being the major element in diagnosis of a cause of death [71] as well as indispensable for the final clarification of the cause of death in overdose cases [72]. In order to interpret the toxicology findings appropriately, there are a few factors which have to be taken into consideration [73].

- The degree of tolerance the individual had developed
- The phase of absorption or elimination of the drug
- The additive or potentiating effect of the drug with other drugs and/or alcohol that may be present.

There are many biological matrices that can be utilised for the analyses of drugs today. However, blood remains the gold standard for detecting, quantifying and interpreting drug concentrations in post mortem toxicology. Blood is not always available, for example, in cases where the body is badly decomposed or the deceased has survived for a period of time in hospital and the admission sample has been disposed of. Post-mortem changes can profoundly alter the concentrations of many drugs and so blood taken from a peripheral site is preferred for estimating toxicity as these sites are usually less affected by post-mortem redistribution. In addition the common practice in forensic toxicology is to analyse whole blood compared with clinical cases where plasma is usually analysed. Other matrices used in forensic toxicology are outlined in Table 4.

Table 4: Alternative matrices used in the application of forensic toxicology

Urine	Has the greatest potential of any specimen to provide the toxicologist with qualitative ante-mortem drug exposure information. The accumulation of drugs and their metabolites result in relatively high concentrations which can facilitate the detection of an exposure to a particular drug. It should be noted, however, that this is only qualitative and not quantitative.
Hair	Provides a diary from which chronic drug use may be determined. Hair grows at a rate of approximately 1cm/month, therefore, hair samples can be sectioned allowing for each month to be analysed separately
Nails	Again can provide a diary of chronic drug exposure
Meconium	Principally used to assess in-utero drug exposure in newborn babies so that treatment may begin as early after birth as possible. Can also be used to determine drug exposure in stillborn infants
Stomach Contents	Sometimes analysed when an oral tablet overdose is suspected

All drugs of misuse (opiates, cocaine, buprenorphine, cannabinoids, benzodiazepines and methadone) are screened using enzyme immunoassay techniques. All positive samples are then confirmed and quantified. Analytical procedures remained consistent throughout the

study period and there were no major changes to the protocol that would radically change the sensitivity and specificity for a certain drug. Therefore, there were no analytical factors which would have a direct effect on the trends of drugs detected.

4.1.3 Retrieval of Cases

In order to identify a drug-related death several sources of departmental administration were searched. Initially, a search was made of the "post-mortem book". This book contains all cases investigated by pathologists within Forensic Medicine and Science and lists the deceased's name and their cause of death and was used to search for cases retrospectively. Prospectively, all completed toxicology reports were perused and cases that were positive for drugs of abuse were identified. Cross-reference was also made to the departmental diary which records the day and date for which a post-mortem is booked in. If the deceased is known to be a drug user, the details are highlighted accordingly. In the latter years of the study, all deaths were recorded on a departmental database which replaced the need for the "post-mortem book". This was used as a cross-reference source for any toxicology report that was positive for drugs of abuse. The criteria for identifying cases were consistent over the study period in that retrospectively, the cause of death was used and prospectively, the toxicology report and cause of death was used. All deaths which fell into one of the four categories highlighted in section 5.2 were included in the study.

As mentioned previously, a small number of PMs are carried out by NHS hospital pathologists. It was therefore necessary to identify these cases and locate the relevant documentation. Drugs of abuse positive cases were identified from the toxicology reports that also gave the name of the pathologist who requested the anlayses and the Fiscal instructing the analyses. It was necessary to liase with the various Procurators' Fiscal offices to access the relevant documentation, namely the police sudden death reports and post-mortem reports. In these cases, the cause of death was reported in a more general manner than was the practice used by pathologists based in Forensic Medicine and Science. For example, a common cause of death was "Toxic Effects of Drugs". In these instances, having reviewed the circumstances, the drugs involved in the death were determined and these were confirmed by a forensic toxicologist.

All information was stored in a Microsoft Excel spreadsheet which provided a departmental database of all drug related deaths within the Strathclyde police area. Information was extracted from each case relating to:

- Demographic information
- Medical history
- Circumstances of the death
- Toxicology Results
- Cause of Death

4.2 Statistics

The t-test was used to analyse continuous variables, except where data was highly skewed, in which case, medians were reported and analysed using the Mann-Whitney U test (a non-parametric analogue of the t-test). Categorical variables were analysed using the chi-squared test. For dichotomous categorical variables, Odds Ratios (OR) and 95% Confidence Intervals (95% CI) were reported. All statistical analyses required for the chi-squared test was carried out using MiniTab, Version 9.2 for Windows and all other statistical analyses was carried out using SPSS, Version 9.0 for Windows. Statistical significance was assumed when $p<0.05$.

5 Drug-related deaths

5.1 Why study Drug Related Deaths?

In addition to seizures, drug related criminal offences and the price and purity of a drug, the Pompidou Group classified drug-related deaths as a useful indicator in determining the extent and nature of drug abuse in a community[74]. This has been backed in the literature where mortality studies involving drug related deaths have been used in assessing the extent of drug abuse, changes in patterns of drug misuse and the efficacy of prevention treatment programmes and changes in clinical care within a population[71]. In addition to drug-related morbidity, drug consumption among the general population and service utilization for drug problems, drug-related mortality was listed as a core indicator of drug abuse at the Lisbon Consensus in 2000. This was in conjunction with the Global Assessment Programme which intends to harmonise global drug abuse data and was supported by the United Nations and hosted by the EMCDDA and involved experts in the field of epidemiology from key regional and international organisations [75].

5.2 What is a Drug Related Death?

The definition of a drug related death (DRD) varies greatly throughout the literature making it somewhat difficult to carry out comparative studies. Some studies include intentional overdoses of any drug, some include fatal accidents where a drug of misuse was involved and some include deaths of known drug users due to natural causes (Table 5).

In Scotland, there is presently two main data sources for DRD statistics, the General Register Office for Scotland (GROS) and individual police forces, although since 2001, all the police forces report their drug-death statistics via the Scottish Drug Enforcement Agency (SDEA). The GROS uses data obtained from death registrations which is supplemented by a Medical Enquiry form (ME4) that is sent to the investigating pathologist for completion. This highlights specific drugs involved in the death and, in particular, the ones which were considered to be responsible in causing death. The SDEA gathers its data from cases that have been reported to the police and sources of information include the police sudden death report, toxicology examination report and the post-mortem report.

Table 5: Examples of varying Definitions of a DRD

Author	Definition
Shai D. [76]	Deaths due to psychoactive drugs, legal or illegal through natural causes (chronic or acute narcotism) or accidental or purposive overdose
Püschel K.[71]	Deaths due to intentional or accidental overdose, the long term abuse of drugs, suicides connected with drug dependence or fatal accidents influenced by drugs
Risser D. and Schneider B.[77]	Deaths due to a narcotic overdose, long term effects of drug abuse, suicides in connection with drug abuse or withdrawal, violent deaths under the influence, deaths due to medication overdose whereby medication was used as a drug substitute or deaths of known drug users although actual CoD was not directly related to drug abuse

In order to disseminate statistics, the GROS produces an annual "occasional" paper [78] and the SDEA produced its first annual report in 2002 for DRDs that occurred in 2001[65]. There were however, discrepancies in the number of DRDs reported by both sources for the year 2001, where the GROS recorded 332 DRDs in Scotland compared with 223 confirmed DRDs by the SDEA. A possibility for the difference is that both agencies use quite different methods for case capture and more pertinently different definitions. The GROS definition was recently changed in 1998 and includes:

(a) deaths where the underlying cause of death has been coded to the following sub-categories of "mental and behavioural disorders due to pscychoactive substance use":

(i) opioids (F11);

(ii) cannabinoids (F12);

(iii) sedatives or hypnotics (F13);

(iv) cocaine (F14);

(v) other stimulants, including caffeine (F15);

(vi) hallucinogens (F16); and

(vii) multiple drug use and use of other psychoactive substances (F19).

(b) deaths coded to the following categories and where a drug listed under the Misuse of Drugs Act (1971) was known to be present in the body at the time of death:

(i) accidental poisoning (X40 – X44);

(ii) intentional self-poisoning by drugs, medicaments and biological substances (X60 – X64);

(iii) assault by drugs, medicaments and biological substances (X85);

(iv) event of undetermined intent, poisoning (Y10 – Y14).

The SDEA use the definition which is utilised by The Chief Association of Police Officers in Scotland (ACPOS) who adopted the definition which was defined in the 1994 Scottish Office 'Ministerial Drugs Task Force Report'. In this report, a DRD was defined as a death:

> *' where there is prima facie evidence of a fatal overdose of controlled drugs. Such evidence would be recent drug misuse, for example controlled drugs and/or a hypodermic syringe found in close proximity to the body and/or the person is known to the police as a drug misuser although not necessarily a notified addict.'*

With respect to published statistics, it is clear that discrepancies will arise due to the different definitions used. The GROS will, for example include all intentional self-poisoning cases and those whereby a drug governed by the Misuse of Drugs Act (1971) was known to be present in the body (accidental or intentional). The SDEA omit known suicides from their study and may also omit cases where the person was not known to be a drug user.

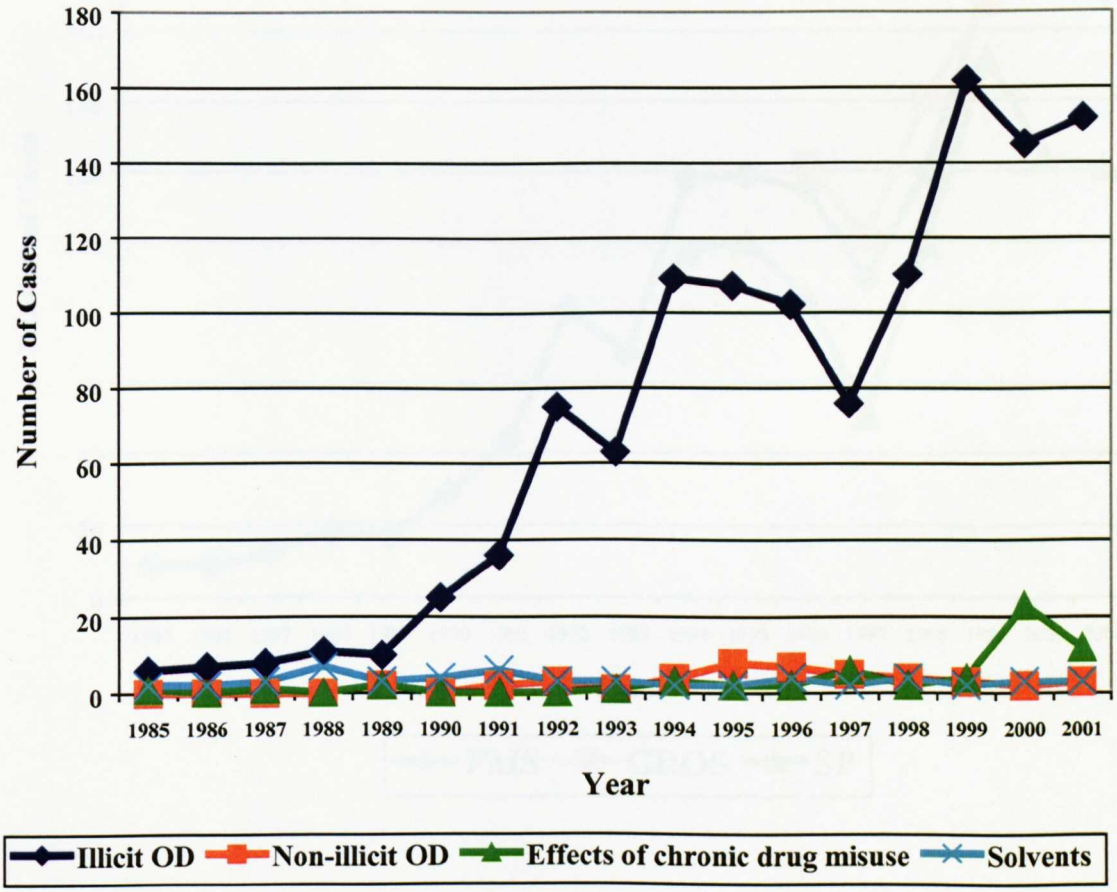
For the purposes of this study, all DRDs investigated by Forensic Medicine and Science that occurred in the Strathclyde Police Region were recorded on a database. If a drug

governed by the Misuse of Drugs Act 1971 was detected in a case following a toxicology examination and the death fell into one of the following four categories, that case was classed as a DRD.

- A sudden or unexpected death where drugs of misuse were implicated as a cause of death either through toxicology or circumstance
- Death as a result of chronic drug misuse (e.g. septicaemia)
- Death of a known drug user as a result of an overdose of non-illicit drugs
- Solvent abuse deaths

A death was only classed as a DRD once all investigations had been completed. Over the years there have been instances where the cause of death was amended and despite *"prima facie evidence of a fatal overdose of controlled drugs"*, was actually found to be not drug related (e.g. cause of death amended from suspected DRD to hypoglycaemic ketoacidosis). Drug related deaths have increased substantially over the study period and the majority of these deaths were due to the overdose of an illicit drug (Figure 5).

Figure 5: DRDs reported by Forensic Medicine and Science categorised by definition classes.



The incidence of DRDs in general in the Strathclyde Police Region as described by this definition has been previously reported [79].

5.3 Discrepancies between statistics published from three different sources

Figure 6 shows the total numbers of DRDs as reported annually, where available by:

- Forensic Medicine and Science, University of Glasgow **(FMS)**
- General Register Office for Scotland **(GROS)**
- Strathclyde Police Force **(SP)**

All data sources show an increasing trend for DRDs in the Strathclyde Police Region of Scotland

Figure 6: Total number of DRDs reported by three different data sources

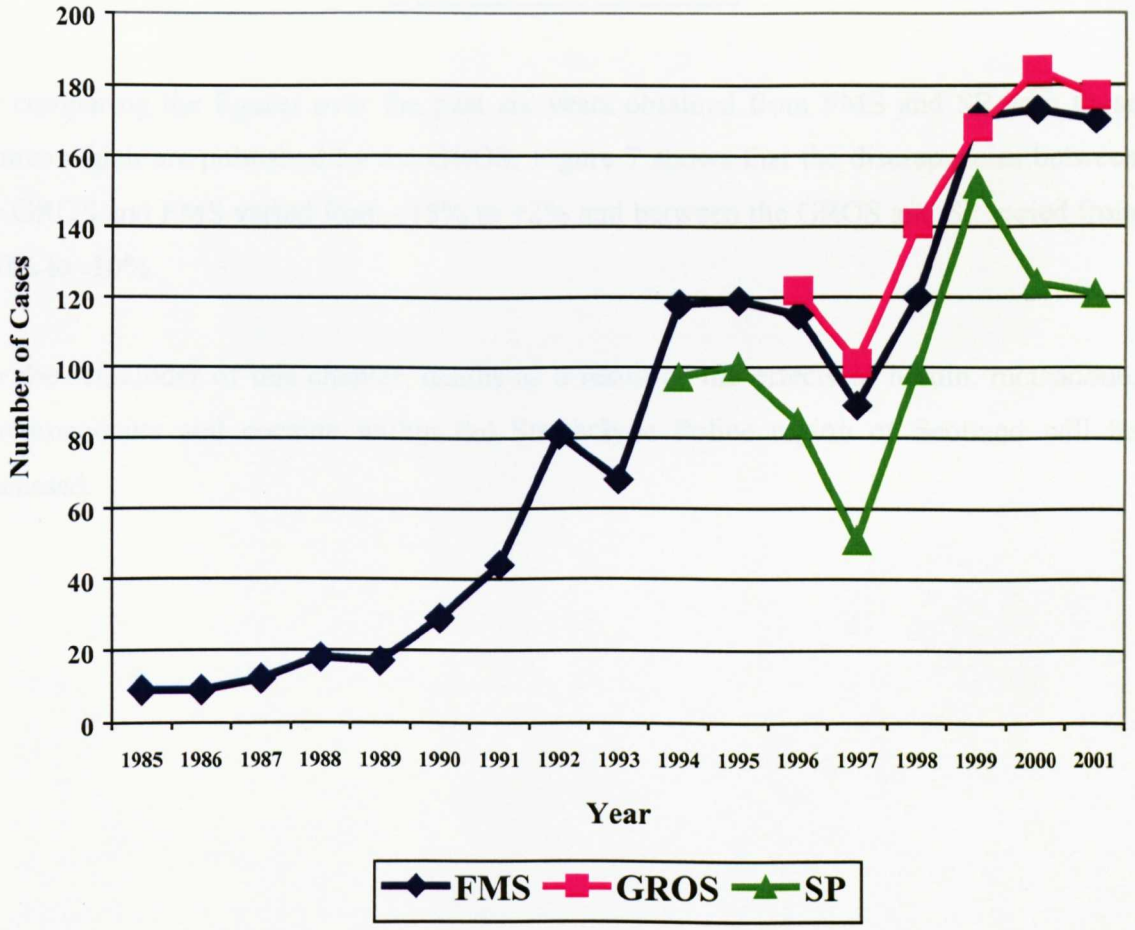
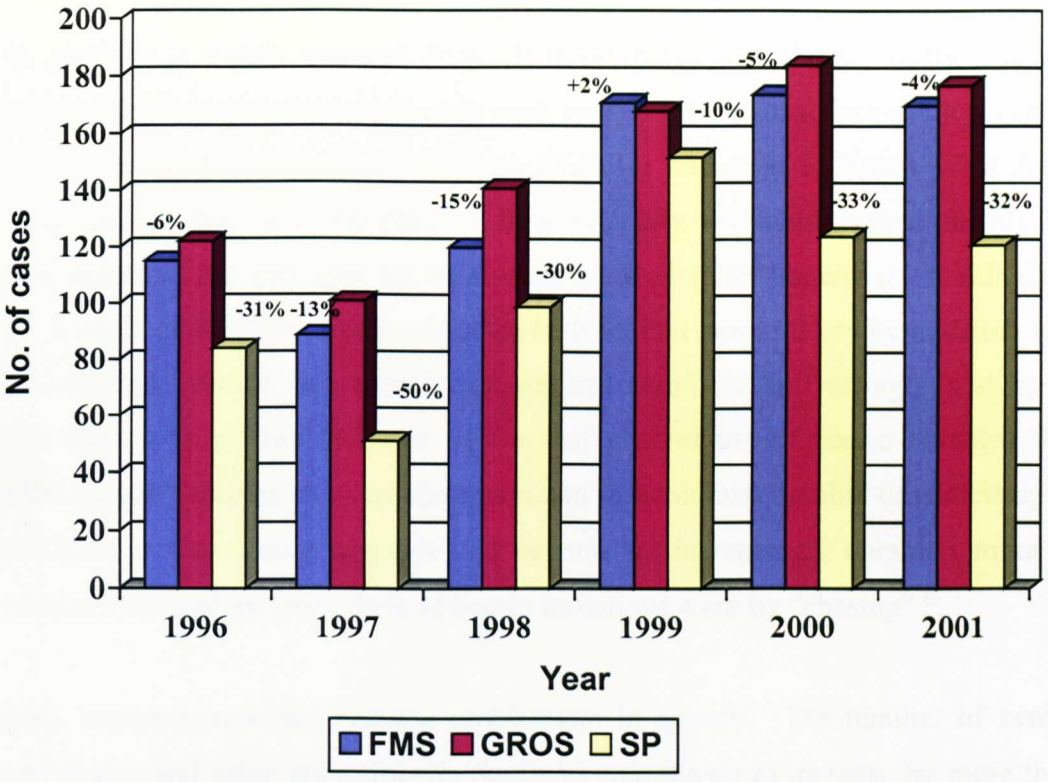


Figure 7: Percentage differences in figures published annually when GRO figures are taken as the baseline



By comparing the figures over the past six years obtained from FMS and SP with those figures which are published by the GROS, Figure 7 shows that the discrepancies between the GROS and FMS varied from –15% to +2% and between the GROS and SP varied from –50% to -10%.

For the remainder of this chapter, deaths as a result of the effects of heroin, methadone, dihydrocodeine and cocaine within the Strathclyde Police region of Scotland will be discussed.

5.4 Heroin

Street names: Brown, Junk, Smack, Scag, H

Heroin is, globally, a widely misused drug. It is estimated that about 8 million people (0.14% of the world's population) use heroin each year [80]. The main source of illegal street heroin in the United Kingdom is the *Golden Crescent* countries of South West Asia, mainly Afghanistan, Iran and Pakistan[81]. It is typically self-administered mainly by intravenous injection but can also be snorted or smoked (also known as "chasing the dragon"). A study of 200 heroin users reported in 1992 that heroin taken by injection was associated with more severe dependence than smoked heroin [82]. Interestingly, a study of 400 heroin users with a wide variation of the first year of use of heroin revealed that "chasing the dragon" was the route of administration in a minimal number of addicts up to the late 1970s. It was shown that this had become an increasingly common route of initiation since 1975 and by 1988, 94% of heroin initiations were by "chasing" [83].

In Scotland, heroin misuse has become problematic in society. The number of heroin seizures by Police and other authorities in Scotland was shown to increase by more than 540% over the years 1989 – 1999[84]. Heroin accounted for 39% and 52% of all Class A seizures carried out by Police and other authorities in the years 1989 and 1999 respectively.

Table 6: Number and Quantity of Heroin Seizures in Scotland, 1989 and 1999.

	1989	1999
Number of Seizures by Police & other authorities	2,320	14,950
Quantity of Seizures by Police & other authorities (kg)	20.8	1,493.7
Number of Seizures by HM Customs & Excise	408	158
Quantity of Seizures by HM Customs & Excise (kg)	330.6	848

5.4.1 Legal Status

Heroin is a Class A drug under the Misuse of Drugs Act 1971 (i.e. thought to be the most harmful when misused and hence carries the highest penalties). If convicted for possessing

or supplying/trafficking the drug carries a maximum penalty of 7 years imprisonment plus an unlimited fine or life imprisonment and an unlimited fine respectively. It is categorised as a schedule 2 drug under the Misuse of Drugs Regulations 1985, hence a Home Office licence is required to produce, import, export or supply it.

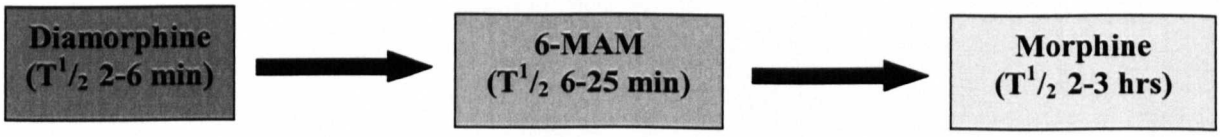
5.4.2 Prescribing

Following it's launch by the pharmaceutical company Bayer, heroin was initially thought to be an effective cure for morphine addiction. However, it soon became apparent that heroin itself was very addictive. Excessive prescribing by a small number of doctors together with the potential for abuse of the system resulted in prescribing restrictions which were enforced in 1968 [85]. This meant that only doctors with a special Home Office licence were allowed to prescribe heroin to addicts. Indeed, the prescribing of heroin to addicts is rarely exercised in the United Kingdom. Strang and Gossop reported that only approximately 100 doctors were entitled to do so in 1996 and at that time only approximately 300 addicts were in receipt of prescribed heroin[85].

Due to certain factors including addicts relapsing after detoxification or other drug treatments failing addicts, prescribed heroin as a treatment option has been considered in Switzerland. The Swiss study showed that it was feasible and politically and socially acceptable to establish a heroin injection clinic. It revealed that retention in treatment was reasonably good and no overdose deaths occurred among participants whilst they were receiving treatment. The outcome of the Swiss trials has encouraged proposals from other countries such as Australia, Denmark, Luxembourg and The Netherlands [86].

5.4.3 Identification in samples

Post-administration, heroin is rapidly hydrolysed in blood to an active metabolite, 6-monoacetylmorphine (6-MAM) which in turn is hydrolysed to morphine. However, the conversion to morphine occurs within minutes. It is believed that the two metabolites account for all or most of the narcotic activity of heroin.



$T^1/_2$ = half life of a drug, i.e. the time it takes for the concentration to fall by half the original value

Following toxicological analyses, heroin consumption can be ascertained by the presence of morphine and possibly codeine which is derived from acetylcodeine, a by-product from opium processing which is often carried over to the final heroin product. The presence of 6-MAM, the first breakdown product of heroin is indicative that death occurred either instantaneously or within a few minutes of administration. The metabolite 6-MAM is further broken down to two major metabolites morphine-3-glucuronide and morphine-6-glucuronide, both of which have found to be pharmacologically active. The action of the former is not entirely understood, however, morphine-6-glucoronide has been reported to be more potent than morphine in producing analgesia and in addition, its potency in depressing respiration has been reported to be greater than morphine [87]

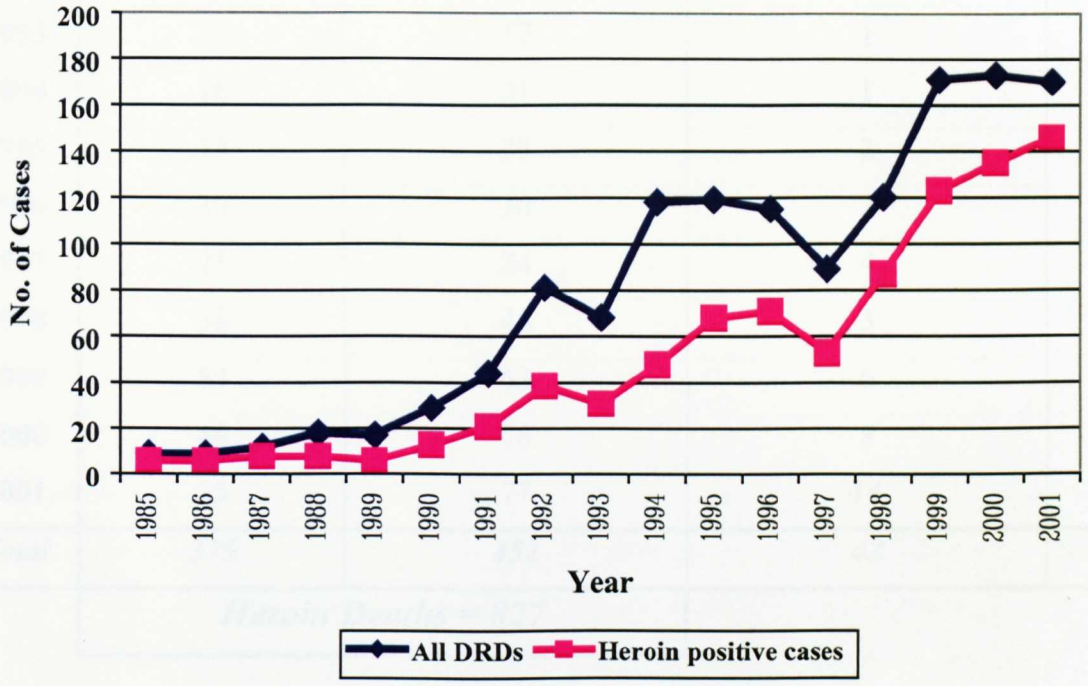
5.4.4 Toxicity

The concentrations of morphine in post-mortem fluid of individuals who have died from a heroin overdose are known to vary considerably depending on prior narcotic history. In addition, the levels measured in overdose deaths are known to overlap deaths where the presence of morphine was incidental. This is also the case between overdose levels and concentrations detected in living people. For example, a mean morphine concentration of 0.67mg/litre was measured in a study involving seven cases of suspected fatal heroin overdosage [88]. This compares to a mean concentration of 0.41mg/litre (range 0.01 – 2.8mg/litre) amongst a study of drivers killed in Australian road traffic crashes [89]. In the Strathclyde region, a level of 0.8mg/litre morphine was detected in a male who had been arrested for suspected drugged driving. Darke et al also showed that there was a substantial overlap between the blood morphine concentrations between those found in living users and those detected in overdose fatalities [90]. Hence, the interpretation of all morphine concentrations must be considered carefully and once all information regarding the case circumstances are known.

5.4.5 *The Incidence of Heroin in Drug Related Deaths in the Strathclyde Police Region of Scotland*

The incidence of heroin in drug related deaths investigated by Forensic Medicine and Science at the University of Glasgow has increased significantly and in a similar fashion to all drug-related deaths over the study period. On a year on year basis, heroin was found to be present in between 35% (1989) and 86% (2001) of all drug-related deaths that occurred within the Strathclyde Police region (Figure 8).

Figure 8: Number of morphine positive cases in relation to all drug-related deaths investigated over the study period, 1985 – 2001.



5.4.5.1 The Role of Heroin in Drug Related Deaths

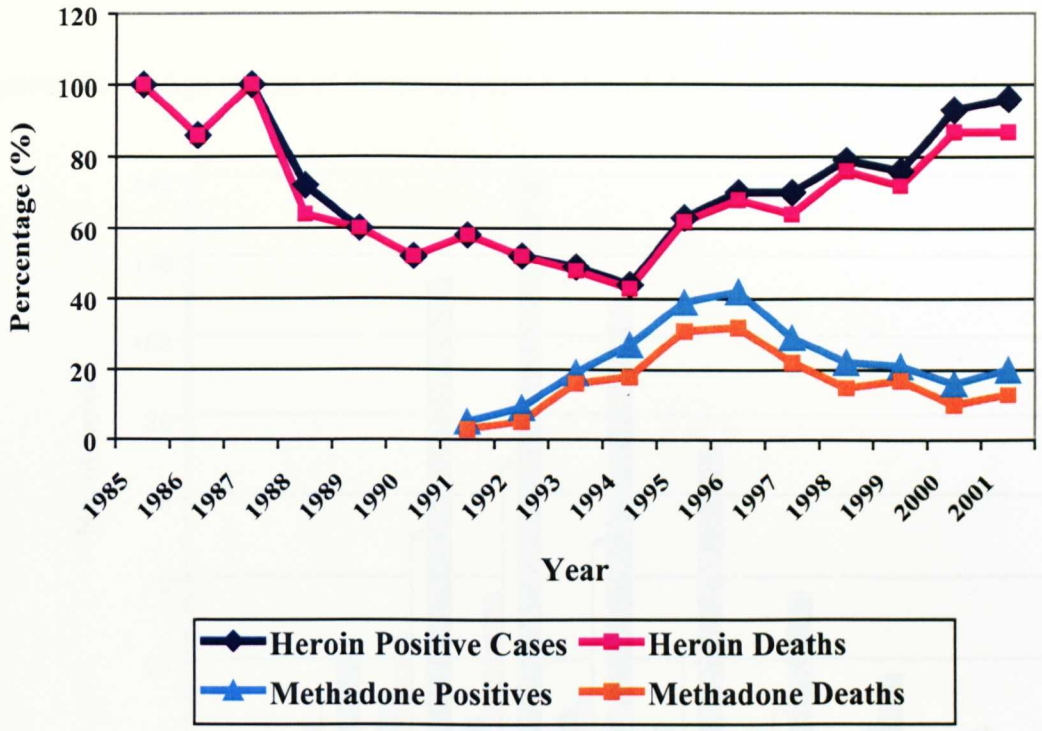
Over the study period, 1985 – 2001, a total of 869 heroin positive drug related deaths were identified. All heroin positive cases were classified into one of three groups according to the cause of death assigned by the investigating pathologist. Table 7 shows that 43% (n = 375) of cases were certified to be due solely to the effects of heroin, 52% (n = 452) were due to heroin in combination with other drugs and despite its presence in the biological sample, a further 5% (n = 42) were due to the effects of a drug other than heroin (n = 23) or due to the adverse effects of heroin injecting such as septicaemia, hepatitis or multiple organ failure (n = 19).

Table 7: Heroin positive cases classified according to cause of death as certified by the investigating pathologist

Year	Heroin Only	Heroin Related	Not Heroin Related	Total
1985	5	1	0	**6**
1986	5	1	0	**6**
1987	6	2	0	**8**
1988	5	2	1	**8**
1989	2	4	0	**6**
1990	5	8	0	**13**
1991	10	11	0	**21**
1992	15	24	0	**39**
1993	13	17	1	**31**
1994	16	31	1	**48**
1995	33	33	2	**68**
1996	39	30	2	**71**
1997	25	24	4	**53**
1998	38	46	3	**87**
1999	54	63	6	**123**
2000	49	78	8	**135**
2001	55	77	14	**146**
Total	***375***	***452***	***42***	***869***
	Heroin Deaths = 827			

The number of heroin positive cases and heroin deaths as a proportion of all accidental drug overdoses per annum is shown in Figure 9. This shows that between 1985 – 87, heroin misuse was accountable for 100% of all accidental illicit overdose cases. From 1988 – 1994, the proportion of heroin positive cases amongst all illicit overdoses was shown to decrease, however heroin, when present, was still a contributory factor either alone or in combination with other drugs in the vast majority of cases (88% - 100%). By 1994 less than half of all overdose deaths involved heroin, possibly due to the increased misuse of benzodiazepines at that time as well as the increasing use of methadone. This trend reversed post 1995 when heroin positive cases were shown to increase. In the vast majority of these cases heroin was considered to be the cause of death alone or as a contributory factor.

Figure 9: Heroin positive cases and heroin deaths as a percentage of all accidental illicit overdoses

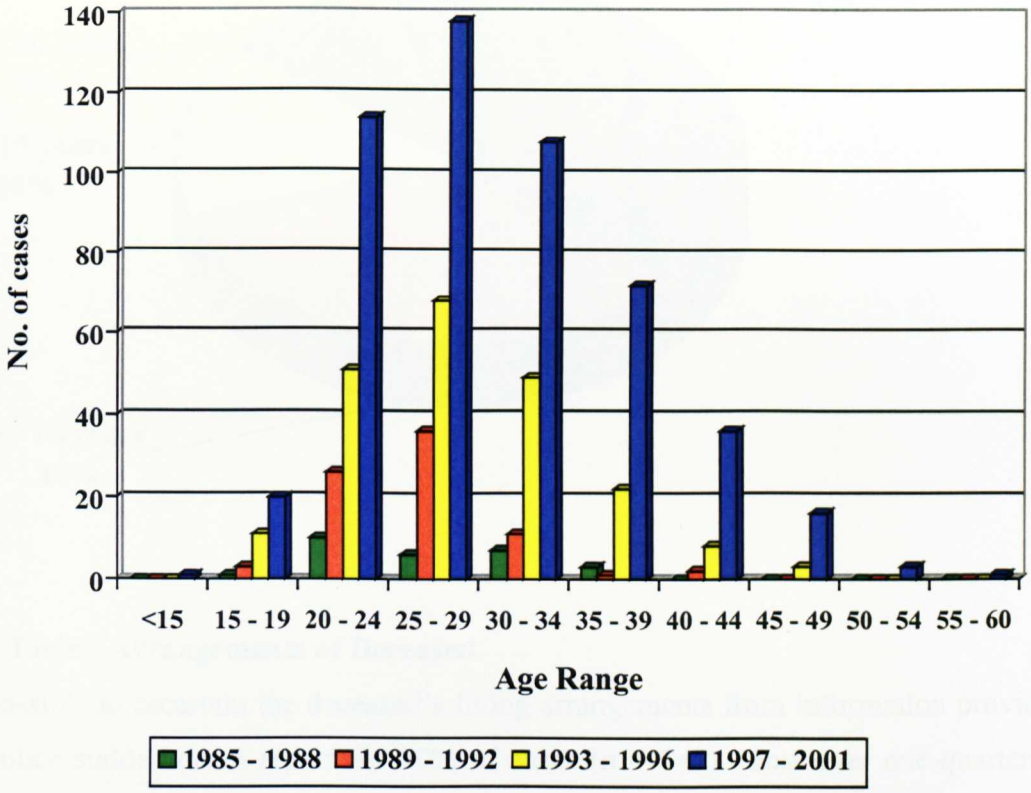


5.4.5.2 Heroin as a Cause of Death

In order to study deaths where heroin was considered to be the cause of death either alone or as a contributory factor in combination with other drugs, all deaths classed as "heroin only" or "heroin related" will collectively be referred to as "heroin deaths". The vast majority of all heroin positive drug related accidental overdose cases were found to be due wholly or partially to the effects of heroin (95%, n = 827). Of this group, males outnumbered females by a ratio of approximately 5 to 1. The mean male age was 29 years (14 – 39 years, std. dev. 6.9) and the mean female age was 27 years (15 - 42 years, std. dev. 6.6). This mean difference of 2 years was statistically significant (p = 0.004). The majority of individuals in each four/five year block were aged between 20 and 29 years where between 48% and 78% of individuals fell into that age category (Figure 10). Of all heroin deaths over the study period, 30% (n = 248) occurred amongst individuals who were aged between 25 and 29 years and this age group accounted for the highest proportion of males and females compared to the other age groups (29% of all males and 34% of all females). The next most common age group were people aged between 30 – 39 years and accounted for between 15% and 37% per four/five year block. From 1997 onwards, the number of individuals aged 40 years and older was shown to increase, although accounted for only 3%, 5% and 11% of all deaths between the years 1989 – 1992,

1993 – 1996 and 1997 – 2001 respectively. Over the study period, the annual average age observed increased significantly from 26 years in 1985 – 1888 to 29 years in 1997 – 2001 ($p = 0.02$).

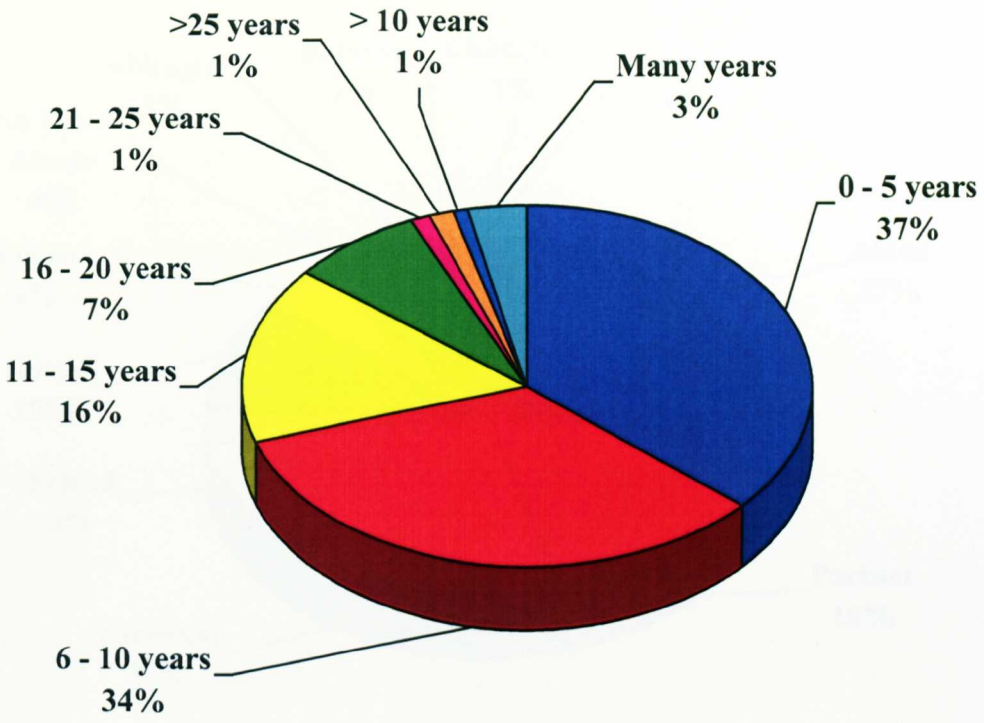
Figure 10: Age ranges of deceased persons whose death was heroin related



5.4.5.3 Drug history of deceased

The deceased was known to be an intravenous drug user at the time of their death in 92% (n = 762) of cases. A further 2% (n = 20) had a history of drug misuse, however drugs were administered by methods other than intravenous injection, such as smoking or snorting. There was no history of drug misuse noted in the police report for 44 cases (5%) and finally in one case it was noted that the deceased had injected heroin for the first time on the day they died. Information relating to the length of time the deceased had been known to inject drugs was available in 294 cases (39% of known drug injectors). In the majority of these cases, the deceased had been injecting for a considerable length of time and were by no means novice users (Figure 11). In fact, of these 294 cases, 97% (n = 286) had been injecting for 2 years or more. Of those that fell into the 0 – 5 years category (n = 106), only one individual was known to inject for less than one year.

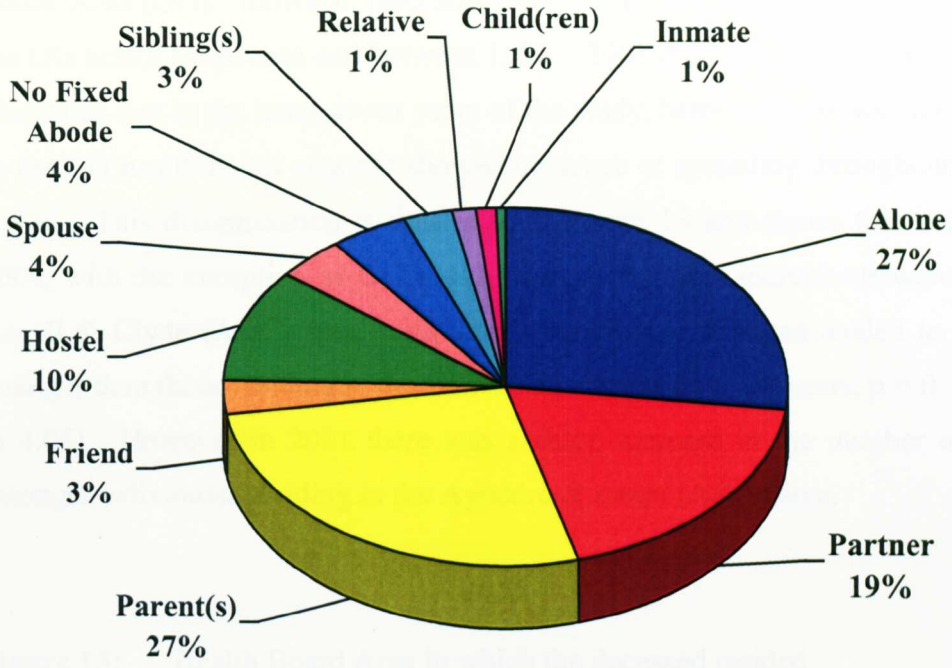
Figure 11: Length of time deceased was known to inject drugs



5.4.5.4 Living Arrangements of Deceased

It was possible to ascertain the deceased's living arrangements from information provided in the police sudden death report for 90% of cases (n = 745). Just over one-quarter of individuals lived alone (27%, n = 201). Over one-half (58%, n = 430) lived with other people and this was primarily their parents (n = 199) or (common law) partners /spouse (n = 169). In 14% (n = 108) of cases, the deceased was homeless at the time of death, 70% (n = 76) of whom resided in a hostel and the remainder were of no fixed abode. The deceased was a serving inmate at the time of death in 1% (n = 5) of cases. In one additional case the deceased was a long-term patient within a hospital but was allowed daily home visits. With the exception of this case, Figure 12 shows the distribution of living arrangements for the 744 cases where this was possible.

Figure 12: Living Arrangements of deceased



5.4.5.5 Health Board Area of Residence

Using the postal code of the address as a reference, it was possible to identify the health board area within Strathclyde in which the deceased resided in 93% of heroin deaths (n = 772). The reason why this was not achieved in the remaining 55 cases are as follows:

- 32 individuals were of no fixed abode at the time of their death (it is important to note that this does not include people who were residing in a hostel or care of an acquaintance, the postal code area of such an address would have been used to identify the health board area in such cases)

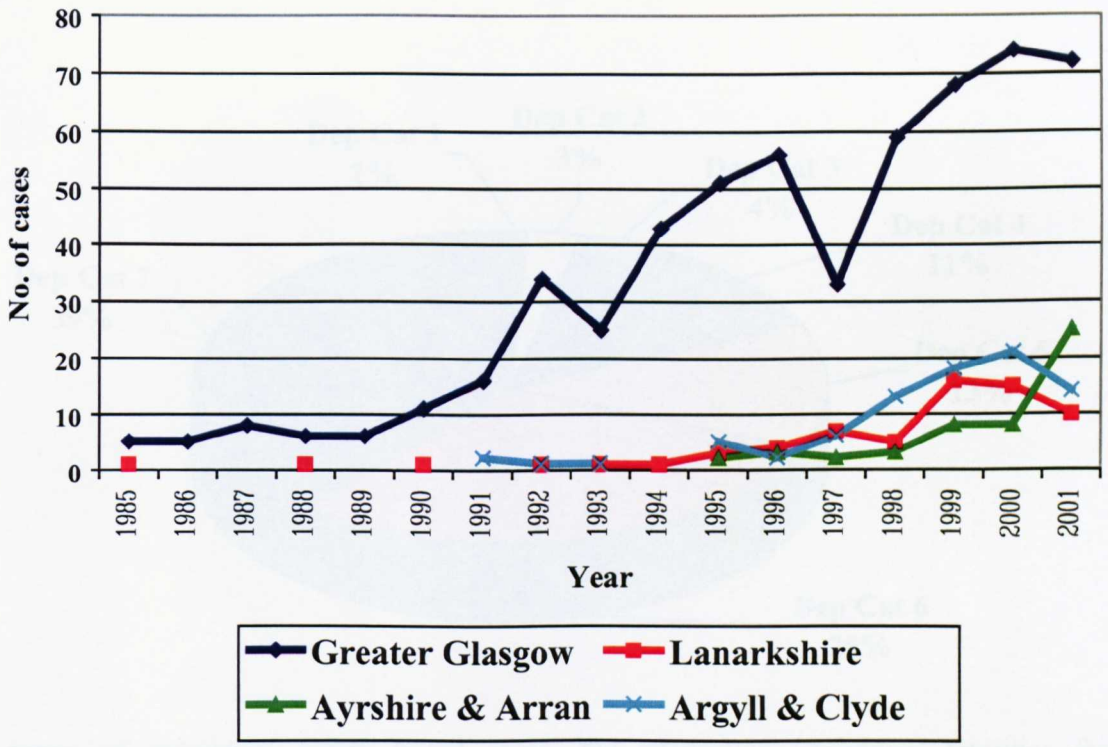
- In 11 cases, although the deceased died within the Strathclyde jurisdiction area, the deceased resided either in another Scottish health board area or in England or Ireland

- In five cases, the deceased was an inmate at the time of death.

- In seven cases, it was not possible to obtain a post code for the address given on the police sudden death report

Of the 772 cases where it was possible to identify the health board area, three quarters of cases (74%, n = 572) involved the deceased residing within the Greater Glasgow Health Board Area (GG). Between 1985 and 1994, 87% (n = 159) of individuals resided within the GG health board area and between 1995 – 2001 this decreased to 64% (n = 413). This illustrates that in the latter seven years of the study, heroin misuse was no longer confined to the GG health board area but showed evidence of spreading throughout the Strathclyde region. This dissemination is illustrated in Figure 13 and shows that between 1996 and 2000, with the exception of GG health board area, most individuals were residing in the Argyll & Clyde (A&C) area. Individuals residing in this area tended to be significantly younger than those residing in the GGHB area (31 years v. 28 years, p = 0.02, 95% CI 0.40 to 4.08). However in 2001 there was a sharp increase in the number of heroin deaths amongst individuals residing in the Ayrshire & Arran (A&A) area.

Figure 13: Health Board Area in which the deceased resided



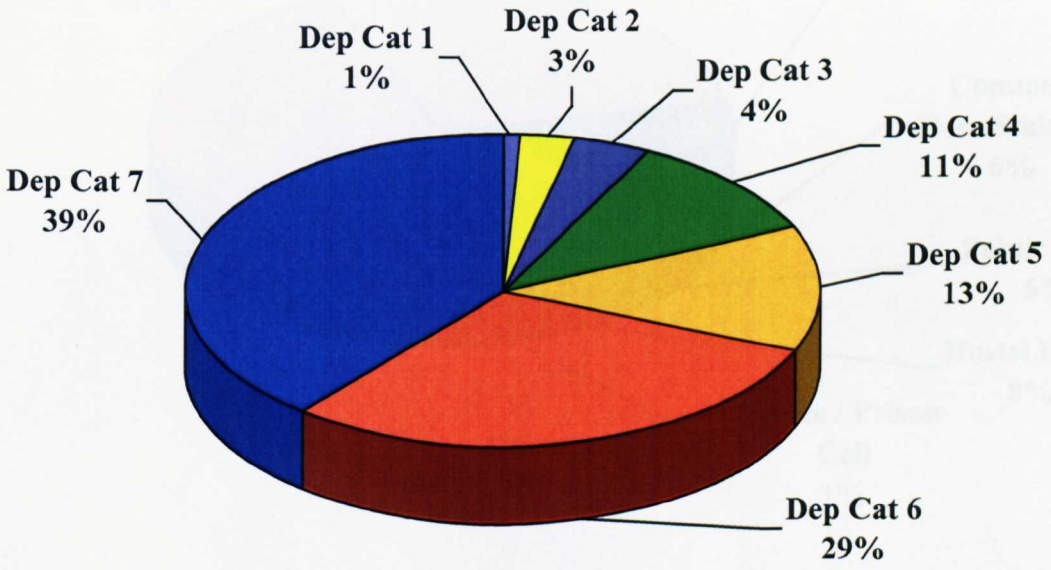
5.4.5.5.1 Deprivation Category

A measurement of deprivation was determined using the Carstairs & Morris Scottish Deprivation Sore Index 1991[91] which was developed for the analysis of Scottish health data and is the most widely used scoring system to measure deprivation in Scotland. The index

assigns postcodes within defined geographical areas into 7 categories, using a combination of four variables derived from the National Census (car ownership, overcrowding, male unemployment and proportion of people in social classes IV and V). These are judged to determine material disadvantage. Categories 1 and 2 represent the most affluent and 6 and 7 the most deprived.

It was possible to ascertain the deprivation category of residence in 92% of heroin deaths (n = 763). Of the remaining 64 cases, 32 were of no fixed abode and hence had no postal address and for another 32 cases, there was either no corresponding deprivation code available or it was not possible to obtain a sufficient postal code from the address given on the police report (in order to obtain a match, it is necessary to have the first part of the postal code in addition to the first number of the second part, e.g. G14 9). Figure 14 shows that in approximately two-thirds of cases (69%, n = 524), the individual resided in areas associated with high deprivation (i.e. categories 6 and 7).

Figure 14: Breakdown of deprivation categories of area where deceased resided

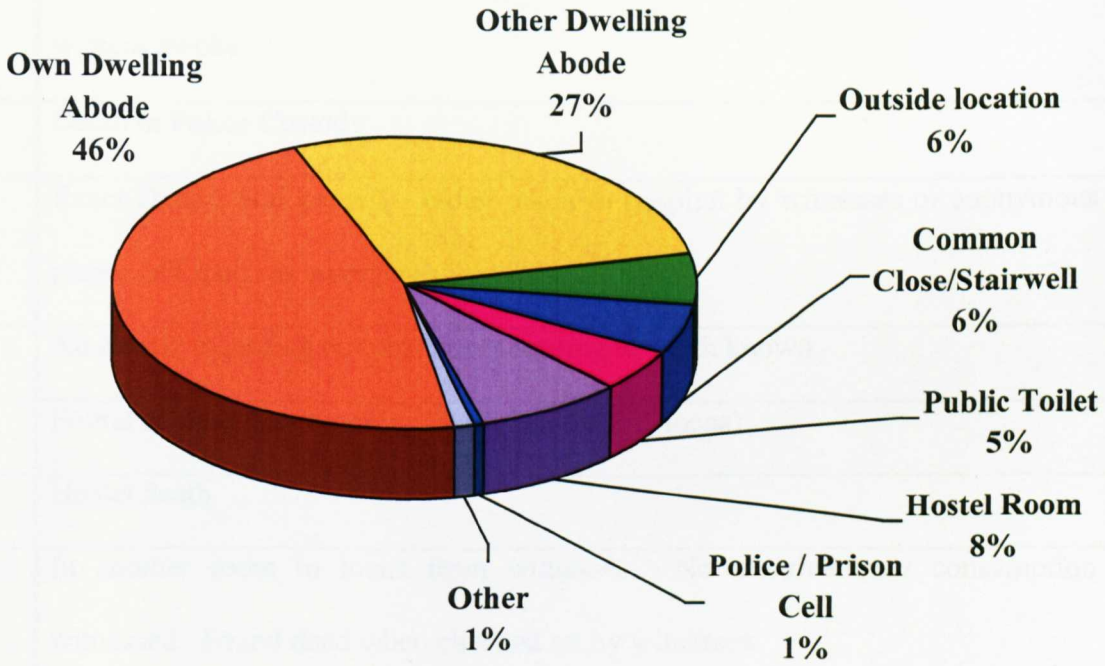


In terms of individual health board areas, the proportion individual fatalities from residences in deprivation categories 6 and 7 were higher than is estimated for the general population. That is, the distribution amongst the general population for Argyll & Clyde, Ayrshire and Arran, Lanarkshire and Greater Glasgow is estimated to be 19%, 13%, 21% and 50% of the total population respectively [91]. In this study, the proportion of fatalities from residences in deprivation categories 6 and 7 for Argyll & Clyde, Ayrshire and Arran, Lanarkshire and Greater Glasgow was 46%, 27%, 25% and 81% respectively.

5.4.5.6 Locus of Death

The locus where the deceased overdosed was established in 818 cases (99%), unfortunately there was no police report available in the remaining nine cases. The locus was a dwelling abode in approximately three-quarters of cases (74%, n = 605) and this was primarily the deceased's own dwelling abode (63%, n = 380). Figure 15 shows the other types of locus involved. The outside locations tended to be quiet inconspicuous places where it would be less likely to be disturbed, for example, under railway bridges, pathways. The public toilets included those found in railway stations, public houses and fast food restaurants. There were an additional two cases where the deceased had been admitted to hospital for unconnected reasons and died within, in one of these cases the deceased was suspected to have been using heroin whilst in the ward.

Figure 15: Distribution of locus where deceased fell unwell / found dead



Other: 3 cases whereby the deceased was taken to hospital, the circumstances leading up to the death were not known; 3 cases where the deceased was found within a disused / derelict flat, 2 cases where the deceased was found in a hotel room they had booked into the previous night; 1 case where the deceased was found within their car

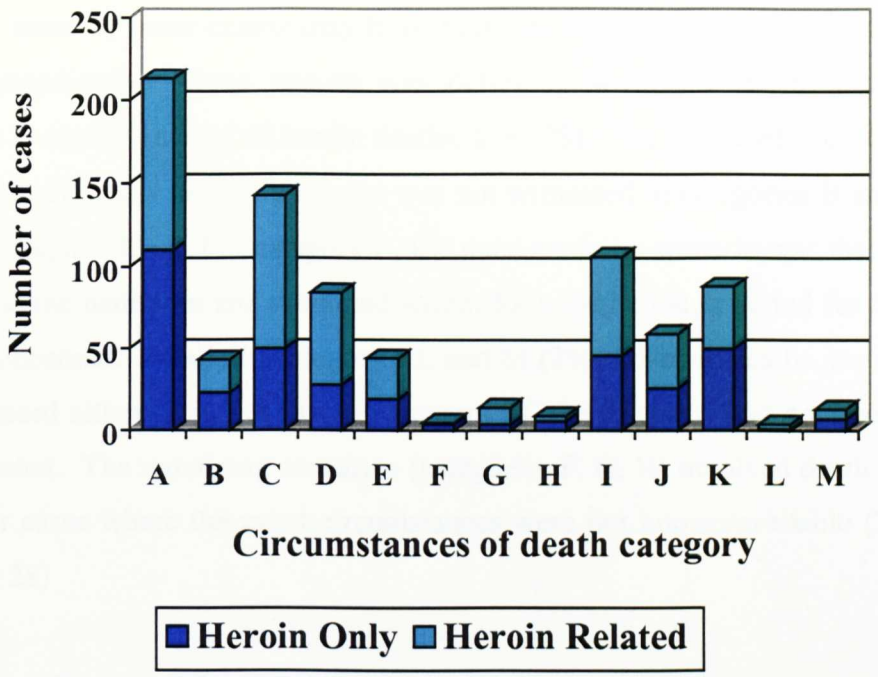
5.4.5.7 Circumstances of Death

From the police sudden death report, it was possible to ascertain the deceased's last movements prior to death and all deaths were grouped according to the categories outlined in Table 8 and these are summarised in Figure 16.

Table 8: Categories of Activities Prior to Death

A	Not seen for a while (long enough for relative/friend to become concerned) and found dead at locus
B	Gone elsewhere within locus long enough for witness to become concerned
C	Witnessed to be intoxicated prior to following asleep and never wakes up
D	Witnessed to take drugs prior to collapsing
E	Witnessed to take drugs and witness fell asleep. Deceased found dead when witness awoke
F	Death in Police Custody
G	Exact Details Not known – either taken to hospital by witnesses or anonymous phone call made to emergency services
H	No details regarding circumstances leading to death known
I	Found at locus (not dwelling abode but outside locus)
J	Hostel death
K	In another room in locus from witnesses. No intoxication / consumption witnessed. Found dead when checked on by witnesses
L	Witnessed to be intoxicated prior to collapse
M	No intoxication witnessed but deceased collapsed / feeling unwell

Figure 16: Number of cases classified by type of death and category of circumstance



(N.B. The above diagram excludes the two cases where the deceased was already within hospital for unconnected reasons.)

The most common scenario was where the deceased had not been seen or in contact with family/friends for a while (category A, 26% of heroin deaths, n = 213). More often than not, relatives/friends became concerned and after receiving no response by phone/knocking on door, access to their home was gained/forced. This scenario suggests that it was probable that the deceased was alone at the time of drug administration but one can not preclude the possibility that witnesses present panicked and left the locus. Other instances that are suggestive that the deceased may have been on their own at the time of ingestion are those that fell into circumstance category I and J (20% of heroin deaths, n = 165), i.e. those found at the locus by a witness who was passing by and those who died within a hostel setting. More often than not, the circumstances surrounding hostel deaths were very similar. Hostel staff have to carry out routine bed checks every morning, and it is at this time that the deceased is usually found. From close circuit television screens installed in the hostels, the deceased was last seen to enter their room alone the previous night. These types of deaths in the West of Scotland have been previously reported in the literature [92].

The deceased was definitely in the locus with other people at the time of collapse/death in categories B, C, D, E, K, L and M (51%, n = 419). The next most common scenario after category A were those that fell into category C (17% of all heroin deaths, n = 143).

Witnesses who allowed the individual to sleep whilst obviously intoxicated may think they are doing the right thing by allowing them to "sleep off" the effects of the drugs. However, some of these deaths may have been preventable had medical assistance been sought immediately. Drug misuse was definitely witnessed in those that fell into categories D and E (16% of all heroin deaths, n = 128). The deceased had been in another room within the locus and drug misuse was not witnessed in categories B and K (16% of heroin deaths, n = 131). For category B, the most common scenario was that the deceased had gone to the bathroom and remained within for a long enough period for the witness to become concerned. Finally in categories L and M (2% of heroin deaths, n = 17), collapse was witnessed although in the case of category M, the deceased had not been reported to be intoxicated. The remaining scenarios (categories F, G, H) involved death within police custody or cases where the exact circumstances were not known/available (3% of heroin death, n = 28)

In nine cases (8 male : 1 female) there was indication that death may have been intentional. The deceased had a history of drug misuse in seven of these cases, 86% (n = 6) of which was intravenous. A suicide note had been found at the locus in five cases and in the additional four cases the deceased had spoken to a relative or friend shortly prior to being found stating they had intention to take their own life.

5.4.5.8 Drug Paraphernalia

There was note of drug paraphernalia being found at the locus in three-quarters of all cases (75%, n = 624) and of these, 29% (n = 183) and 4% (n = 25) were found either adjacent to or under the body respectively. A needle and syringe had been found *in situ* in a further 16% (n = 100) and this was primarily in the arm or groin area (91%, n = 91). In an additional 42 cases (7%), the needle and syringe was found still grasped in the deceased's hand.

In one case six heroin deals wrapped in a cellophane package were found in the rectum of the deceased at autopsy. These were all found to be intact and the death was classed as a heroin only death.

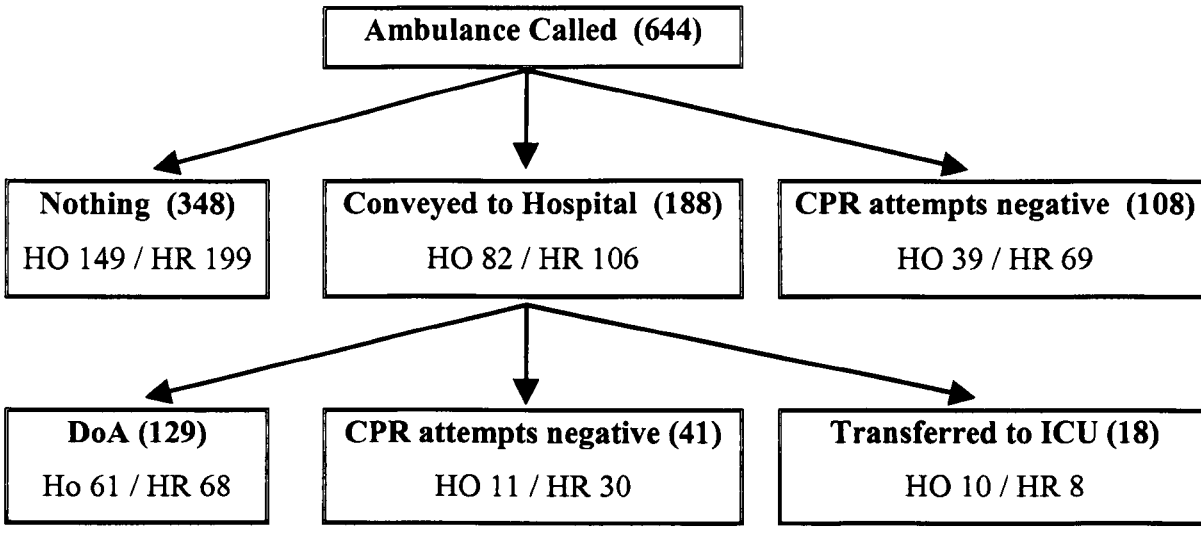
5.4.5.9 Medical Intervention

From the circumstances of death, it was possible to ascertain whether or not any medical intervention had been initiated on discovery of the body and prior to the arrival of the

emergency services in 815 cases (99%). In the vast majority of these cases, there was no effort to resuscitate the deceased (80%, n = 658), however, an attempt was made either on the witnesses own initiative or by instruction via the phone in 19% (n = 154) of cases. In the remaining 1% (n = 3) of cases the witness placed the deceased in the recovery position but there were no attempts at actual resuscitation. There was an association between being in the locus with people and resuscitation attempts being initiated prior to the arrival of paramedics (χ^2 = 47.4, p<0.001) in that this was more likely to be carried out if witnesses were present within the locus with the deceased (OR 3.74, 95% CI 2.5 to 5.47). In particular, there was an association between resuscitation being attempted and if drug consumption or actual collapse had been witnessed (χ^2 = 4.73, p = 0.03) whereby this was more likely to be carried out if witnessed as opposed to a witness merely being present at the locus (OR 1.67, 95% CI 1.04 to 2.66).

It was also possible to determine what form of action was taken upon discovery of the deceased in 99% (n = 815) of cases. Of these, only the police were summoned due to the deceased being obviously dead in 20% (n = 162) of cases. The deceased was either already in hospital, driven to hospital by the witness(es) or the deceased's GP called in 1% (n = 9) of cases and in the vast majority of instances, an ambulance was summoned (79%, n = 644). Of these, despite efforts of cardio-pulmonary resuscitation at the locus, the paramedics were unable to revive the deceased in 17% (n = 108) of cases and in a further 54% (n = 348), there were no attempts made to revive the deceased due to external indications of obvious mortality (e.g. colouration of skin and lips, rigor mortis established). The deceased was conveyed to hospital for further resuscitation in only 29% (n = 188) of cases. The deceased was pronounced dead on arrival (DoA) at hospital in 69% (n = 129) of these cases and despite further efforts at resuscitation, life was pronounced extinct in 22% (n = 41) of cases. The deceased was only transferred to either the intensive care unit or a ward in 9% (n = 18) of cases. There was an association between resuscitation being attempted by paramedics and whether or not a witness had been present within the locus (χ^2 = 14.7, p = 0.0001), in that this was more likely to happen if a witness was present and the paramedics were more likely to do nothing if the deceased had been alone and found some time later. A summary of medical intervention is shown in Figure 17.

Figure 17: Breakdown of cases where medical intervention was sought

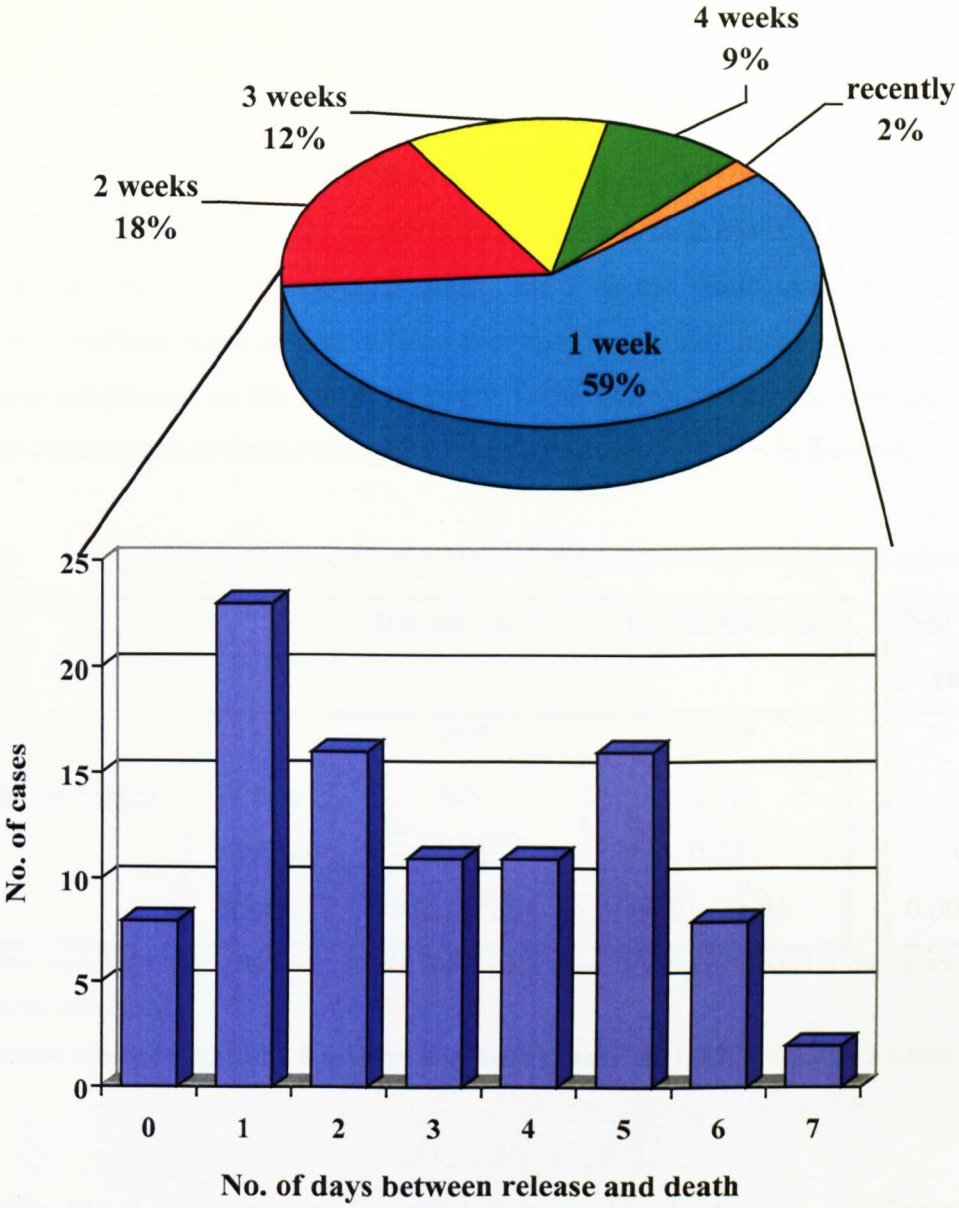


5.4.5.10 Recent Period of Abstinence

Information relating to the deceased having undergone a recent period of abstinence was available in 22% of cases (n = 178). This was in relation to release following a recent custodial sentence in 164 cases (92%), recent release from drug rehabilitation programme in nine cases (5%) and the individual being incarcerated at the time of death in five cases (3%). Of the drug rehabilitation cases, 56% (n = 5) of deaths occurred within one week of leaving and in two of these cases, the deceased had discharged themselves. Three of these five deaths were classed as heroin only deaths.

Of the 164 recently released prisoners, 95% (n = 156 (88 HO : 68 HR)) of deaths occurred within one month of the deceased's release date, of which 79% (n = 123) occurred within two weeks of release (68 HO : 55 HR). Figure 18 illustrates the time between release from prison and death. It can be seen that of those deaths occurring within one week of release (n = 95), just under one half occurred within the first two days of release (49%, n = 47) and were primarily heroin only deaths (28 HO: 19HR). Of these, 66% (n = 31) occurred either on the day of release itself or the day following release. During 1999, approximately three DRDs per month involved an individual who had been liberated within two weeks prior to their death.

Figure 18: Number of weeks (and days within one week) between release from prison and date of death



5.4.5.11 Methadone Maintenance Programmes

From the police sudden death report, information was available as to whether the deceased ever had been or was enrolled on a methadone maintenance programme (MMP) at the time of death. The deceased had been enrolled at the time of their death in only 7% of all cases (n = 60). There was one individual who had been enrolled on an MMP in 1989 and one in 1993. Hence the majority had been enrolled from 1994 onwards, the year the MMP was introduced into Glasgow (i.e. only 8% of deaths between the years 1994 – 2001). Of those apparently enrolled on an MMP at the time of death, methadone had been detected at toxicology in only 53% of cases. There was also evidence that the deceased had been enrolled on an MMP in the past in 5% of all heroin death cases (n = 38). The main reason

why this was no longer the case was that the deceased had defaulted from the programme by either continuing to use heroin or failing to keep appointments.

5.4.6 Results of Toxicological Analyses

A blood sample was obtained in 98% (n = 814) of cases, however, an alternative matrix was obtained in the remaining 13 cases (urine in 8 cases, liver blood in 2 cases and serum, plasma and pleural fluid in one case each). In 3 of the blood samples, there was no quantified morphine level available, however they were still included in this study as heroin was mentioned in the cause of death. Therefore a mean, median and range of morphine concentrations detected for 811 blood samples are shown in Table 9.

Table 9: Blood Concentrations of morphine detected in heroin positive cases

		Heroin Only	Heroin Related	Not Heroin related
	n	369*	442**	42
All Cases (n = 811)	**Mean**	0.5	0.33	0.11
	Median	0.33	0.23	0.07
	Range	0.01 – 12.3	0.01 – 4.04	0.002 - 0.96

*6 cases not included = 2 x urine, 1 x pleural fluid, 1 x plasma, 1 x liver blood, 1 x only a trace detected which was not quantified.

** 10 cases not included = 6 x urine, 2 x unknown quantity (cases from 1985), 1 x serum, 1 x liver blood

The median blood concentration detected in heroin only deaths was significantly higher than those found in heroin related deaths ($p < 0.001$, Mann Whitney). And similarly, the blood concentration for heroin related deaths was significantly higher than the not heroin related deaths ($p<0.001$, Mann Whitney). The median blood morphine concentration was significantly higher in females compared to males (0.39mg/litre v. 0.26mg/litre, $p<0.001$, Mann Whitney).

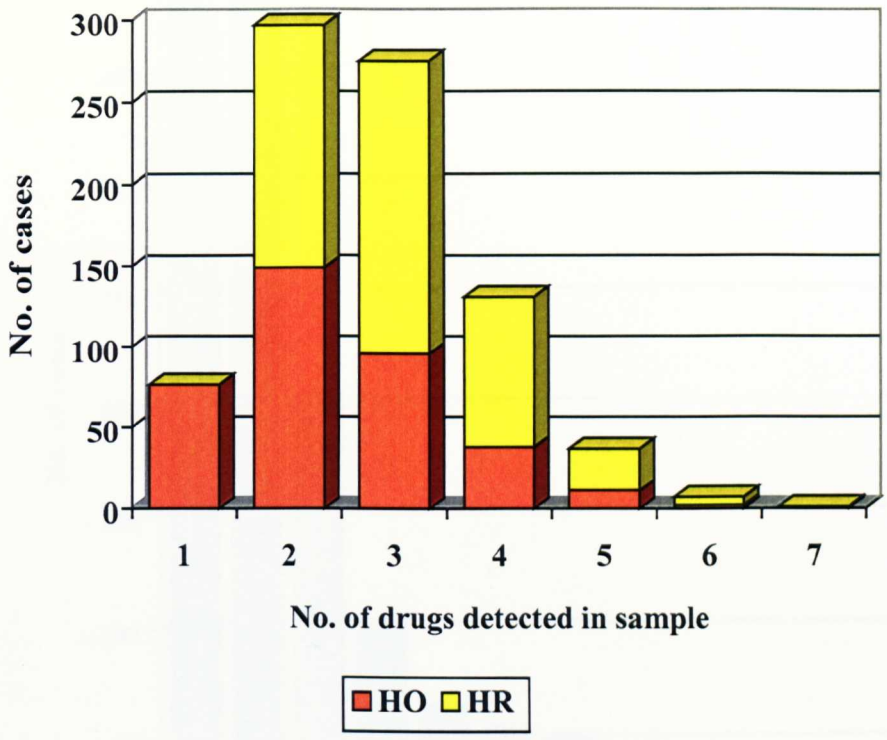
The identification of the first metabolic product of heroin 6-monoacetylmorphine (6-MAM) and also codeine, from the breakdown of monoacetylcodeine, an impurity in street heroin occurred in 1997. Prior to this, these were not routinely reported in toxicology reports. Codeine was detected in 316 heroin deaths between 1997 – 2001 (62% of deaths over that period). A mean codeine/morphine ratio of 0.2 was noted and this varied

between 0.03 to 1.52 (median 0.1). This is in keeping with a general finding that the ratio of monoacetylcodeine to heroin in street deals is approximately one to ten. A ratio of greater than 1.0 was noted in 10 cases suggesting the deceased had also taken codeine. The presumption that only codeine had been taken in these cases can be excluded due to the fact that the concentration of codeine exceeds that of morphine by a factor of approximately 19 when only codeine has been administered [93] in addition to the presence of drug paraphernalia which was found in all 10 cases. In seven cases this involved a needle and syringe either located adjacent to the deceased (3 cases), found still within the injection site (2 cases) or the deceased had been found earlier with the syringe held within their hand/in injection site a short time prior to unconsciousness (2 cases).

The presence of 6-monoacetylmorphine was noted in 62 cases and was indicative of a sudden death. A mean 6-MAM/morphine ratio of 0.08 was noted, ranging from 0.003 – 1.17 (median 0.04). The blood concentrations of free morphine and 6-MAM in these cases averaged 0.4 and 0.03mg/litre respectively which is similar to findings of a study where blood concentrations averaged 0.36 and 0.019mg/litre in eight individuals who died within 15 minutes of injecting heroin intravenously[94].

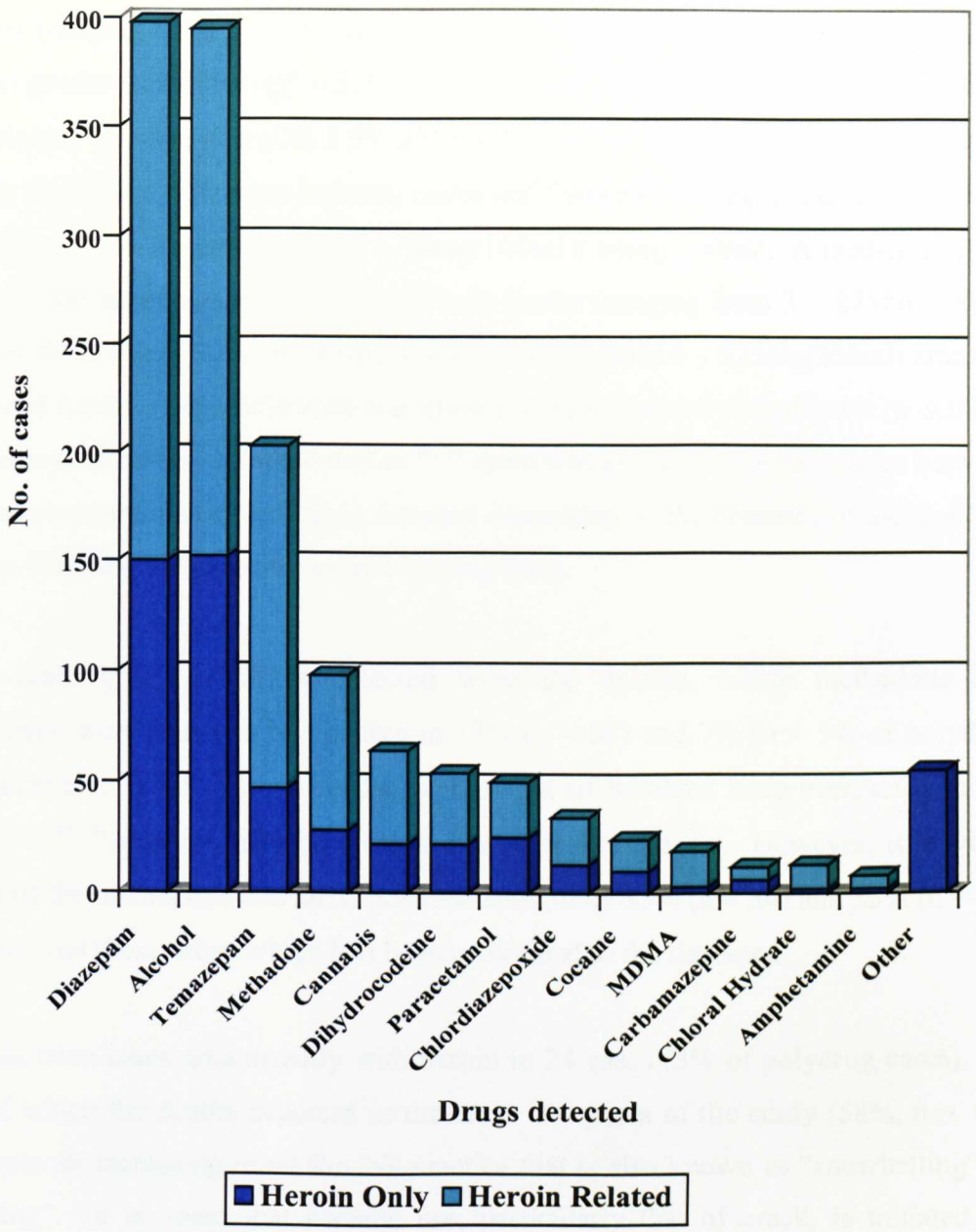
There was no toxicology report available in two cases. Of the remaining 825 heroin deaths, polydrug use was evident in 91% (n = 748) of cases (79% and 100% of heroin only and heroin related deaths respectively) and this involved the concurrent use of two or three drugs in three-quarters of all polydrug cases (76%, n = 572). Figure 19 shows that heroin was the only drug detected in 9% (n = 77) of heroin deaths and a cocktail containing as many as six or seven drugs had been consumed in eight cases.

Figure 19: Number of drugs detected in biological samples



There was a total of 2,254 drugs detected amongst all 825 cases. The frequency of drugs detected are shown in Figure 20. The benzodiazepines were the most frequently detected drug group and were found to be positive in over four fifths of polydrug cases where a toxicology report was available (85%, n = 638) and this was predominantly temazepam or diazepam (32% and 62% respectively). In fact, the prevalence of temazepam and diazepam were seen to significantly decrease and increase respectively from 1997 onwards ($p<0.001$, chi-squared). This was as a result of a legislation change in 1996 whereby temazepam was rescheduled from schedule four to three of the Misuse of Drugs Regulations 1985. There was no association between the presence of a benzodiazepine and gender and unlike other studies, females were not more likely than males to have benzodiazepines detected (OR 0.667, 95%CI: 0.44 to 1.01).

Figure 20: Drugs found to be positive in heroin deaths



Other: Phenobarbitone (6 cases); Fluoxetine (4 cases); Nitrazepam (3 cases); Paroxetine (3 cases); Citalopram (3 cases); Cyclizine (3 cases); Diconal (2 cases); Phenytoin (2 cases); Amylobarbitone (2 cases); Buprenorphine (2 cases); Propoxyphene (2 cases); Promethiazine (2 cases); Amitriptyline (2 cases); Dothiepin (1 case); Chlormethiazole (1 case); Prothiaden (1 case); Imipramine (1 case); Gammahydroxybutyric Acid (1 case); Quinalbarbitone (1 case); Solvents (1 case); Venlafaxine (1 case); Doxipin (1 case); Cyanide (1 case); Primidone (1 case); Butobarbitone (1 case); MDEA (1 case); Oxazepam (1 case); Sodium Valproate (1 case); Thioridazine (1 case); Co-proxamol (1 case); MDA (1 case); Procyclidine (1 case)

Alcohol was found to be present in just over one half of polydrug cases (53%, n = 397) where a mean and median BAC of 120mg/100ml and 85mg/100ml was measured respectively (ranging from 3 – 525 mg/100ml). An association between the presence of alcohol and gender was shown ($\chi^2 = 5.7$, p = 0.02) whereby males were more likely to have alcohol detected than females (OR 1.59, 95%CI 1.07 to 2.32). Despite this, there was no statistically significant difference between males and females with regards to median blood alcohol concentration observed (p = 0.14, 94mg/100ml v 64mg/100ml). A median BAC of 47mg/100ml was noted amongst the heroin only deaths (ranging from 3 – 275mg/100ml) compared with a median BAC of 143mg/100ml (ranging from 4 – 525mg/100ml) amongst heroin related deaths. This difference was shown to be statistically significant (p<0.0001, Mann-Whitney). Contrary to other studies [95, 96] there was no significant difference between the median concentrations of morphine detected depending on the presence of alcohol (p = 0.63, Mann-Whitney, 0.34mg/litre versus 0.36mg/litre).

The next main group of drugs detected were the opiates, where methadone and dihydrocodeine were found to be positive in 13% (n = 98) and 7% (n = 54) of polydrug cases respectively. Their role in deaths in the West of Scotland have been cited in the literature [50, 51, 97, 98] and will also be discussed later in this chapter. However, it is worth noting that of the methadone and DHC positive cases, only 35% (n = 34) and 33% (n = 18) of cases involved these drugs which had been prescribed to the deceased.

Cocaine had been taken concurrently with heroin in 24 cases (3% of polydrug cases), the majority of which the deaths occurred in the latter two years of the study (58%, n = 14). This indicates an increasing trend for this practice that is also known as "snowballing" or "speedballing". It is noted that cocaine use, particularly that of crack, is initiated by individuals who are already heavily using opiates and those whose primary drug of misuse is crack, often use opiates to counteract its unpleasant effects [99].

5.4.7 Contaminated heroin

In 2000, the total number of illicit overdoses was seen to decrease by 10%, although the total number of DRDs that year did not show signs of subsiding. That was because in the same year, the number of individuals dying from the adverse effects of drugs increased by 475%. In May 2000, the media reported the deaths of six addicts who all died in quick succession all of whom showed similar symptoms which were non characteristic of a usual DRD and seemed to occur only in skin and muscle poppers [100]. Initially, the problem was

thought to be localised, however, over a period of a few weeks, there was a total of 60 outbreaks in Scotland, 23 of which resulted in fatalities. There was also similar deaths in Dublin, England and Wales. At the time drug users were reporting having to use excess amounts of citric acid to dissolve the heroin and this along with presumed contaminated citric acid or heroin was originally thought to be the cause. All investigations, however, came back negative. Eventually it was found that the heroin had been contaminated with an anaerobic bacteria known as *Clostridium Novyi*. This was an anaerobic bacteria which grew in the absence of oxygen and released powerful toxins into the circulation leading to multiple organ failure and death. Whilst the bacteria was antibiotic sensitive, this form of intervention was effective only if initiated immediately and before the toxins were released into the circulation. In order to save those who were infected, surgical intervention was necessary. This ranged from incision of the affected area to extensive skin excision. These horrific deaths were not categorised as a DRD by the police or the GRO despite heroin being the obvious cause of death.

These deaths were not included in this study as the mechanism of death was not that of intoxication but rather due to the adverse effects of taking a drug. However, they constituted 15% of all DRDs in the year 2000. They were endemic to skin poppers and generated much media attention that it was felt they could not go unnoticed.

5.4.8 Discussion

Heroin misuse is a growing concern throughout the world. Numerous mortality studies have shown an increase in the number of premature overdose deaths as a result of this drug in Europe [77, 101, 102, 103], Australia[95], America [104] and elsewhere in the Untied Kingdom [105, 106]. These overdose deaths also remain the most common cause of death among heroin users [107]. In Scotland, statistics show that heroin is problematic to society and shows no signs of curtailing. For example, there has been a 625% increase in the number of heroin seizures in Scotland from 1985 - 2000, illustrating the sheer abundance of this drug. Despite increased efforts by law enforcement agencies, the number of individuals who are starting to take heroin is also escalating as the percentage of new individuals attending drug services, who are reported to be using heroin has risen over the years from 67% in 1997-98 to 79% in 2001-02 [108]. A possible reason for this could be that individuals are enticed into the heroin scene by means of smoking the drug, a route that is perceived to be less

addictive than if injected. This route of administration is particularly apparent in younger heroin users particularly in the last few years of this study. ISD Scotland reported that prior to 2001/02, heroin users aged under 20 years were more likely to inject, however, this trend has reversed and a preference for non injecting routes amongst this age group persists. This increase in heroin use is also corroborated by the results presented in this study where an increase in heroin death mortality rate throughout the Strathclyde Police region increased from 0.2 per 100,000 in 1985 to 5.9 per 100,000 in 2001.

Of all heroin positive cases identified over the study period, 95% were due to the effects of heroin either alone or in combination with other drugs. Also, these heroin deaths accounted for approximately two-thirds (69%) of all illicit overdoses that occurred within the Strathclyde police region of Scotland over the study period. In the early nineties, it was shown that heroin positive cases decreased, possibly due to changes in availability and costs of various drugs around that time. For example, between 1985 – 1992, temazepam abuse was shown to increase in the West of Scotland and indeed, most illicit overdose deaths were due to the effects of the illicit use of benzodiazepines. In addition, in the early nineties a trend was emerging for the use of methadone, the majority of which had been obtained by the diversion of legitimate supplies. Heroin began to play an increasing role in the majority of illicit overdose cases from 1995 onwards. This re-emerging trend was probably due to a lack of availability of both temazepam and methadone. A legislation change in 1996 resulted in the re-scheduling of temazepam which had a direct effect on its availability and methadone was being advocated as an opiate substitute around the same time with tighter controls on supervision of consumption being heavily promoted.

Between 1985 – 1988, approximately three-quarters of all heroin deaths (78%) were due to the effects of heroin alone. By 1997 – 2001, this proportion had decreased to 43% of all deaths during that time showing that a trend for polydrug had emerged. This increase in heroin related deaths over the years was shown to be statistically significant (χ^2 = 13.4, p=0.003).

When comparing individuals who died from a heroin overdose with other studies, the main factors in the death do not vary significantly. Our study showed that the majority of individuals were male and aged in their twenties, similar to studies of heroin deaths in France [109], Croatia [110] and Australia[95]. This over-representation of the male population has been noted to reflect the greater likelihood of opioid dependence among males compared to females [111] as well as greater risk taking among males than females [112]. There was also

evidence to show that the mean age of victims was slightly older in the latter years of the study compared to the mid-1980s. Certain risk factors may exist amongst the older drug using population such as pulmonary and hepatic dysfunction resulting from disease which may increase susceptibility to both fatal and non-fatal overdose. For example, hepatic disease may result in reduced metabolism of an opiate, decreased drug clearance and hence may prolong the period of heavy intoxication with a greater risk of respiratory depression [113]. The deceased was not a novice drug user in the majority of cases, which is reflected by the average age observed in addition to the length of time the deceased was known to abuse drugs. It has been noted that most deaths occur amongst those who have a definite dependency for heroin and have been using the drug for 5 – 10 years [114]. In this study, the average length of time that the deceased was noted to have abused drugs was 8.2 years. This was slightly lower than that recorded amongst heroin death victims over a similar study period by Quaglio et al where an average duration of addiction of 11.7 years was noted, however this study also included deaths due to AIDS and cases where the presence of heroin was incidental to death.[101].

The majority of individuals in this study lived with people whether it be relatives or partners (58%). Just over one-quarter (27%) lived alone and an additional 14% were classed as homeless (10% of all individuals lived in a hostel and 4% were of no fixed abode). Approximately 1% of deaths occurred whilst the individual was serving a prison sentence. Most people resided in the Greater Glasgow Health Board area of Strathclyde, however in the latter years of the study it was shown that drug deaths were spreading into the three other health board areas encompassed by the Strathclyde boundary. This was particularly evident in Argyll and Clyde which showed the second highest number of heroin deaths until the penultimate year of the study. Increasing drug misuse within this latter area is further supported by data on the percentage of new individual patients reporting the use of heroin which increased from 78% to 83% from 1997/98 to 2001/02. There was a 212% increase in the number of heroin deaths in Ayrshire and Arran in the latter year of the study. This was in contrast to all other health board areas where a decrease in numbers was noted ranging from a 3% decrease in the GGHB to a 33% decrease for both Lanarkshire and Argyll and Clyde. The reason for this increase is unexplained particularly since individuals commencing methadone prescriptions in the Ayrshire and Arran area was shown to increase on a year to year basis from 1999-00 to 2001 –02 [115]. The increase in deaths within this area did however result in a Drug Death Review Group being set up whose remit was to consider all DRDs, identifying potential for intervention and amending future practice for the benefit of others [116].

In addition to these geographical differences over the study period it was noted that approximately two-thirds of individuals resided in areas of high deprivation. This suggests high unemployment, low social class and high morbidity and mortality rates. This is supported by statistics from the Office of National Statistics that shows a strong positive relationship between deprivation and incidence of drug-related deaths by "accident" [117]. The ACMD has also stated that "*the rate of premature deaths among drug misusers is strongly and positively related to social deprivation*" [117]. People residing in these socially deprived areas may be more susceptible to dealers, pressure from peers or pressure to conform to groups where drugs are misused.

In the majority of cases (73%), the deceased was found to have overdosed within a dwelling abode and this was more often than not the deceased's own house. This is similar to heroin deaths in Australia [95, 118] and America [119]. In a further 17% of cases, the deceased was found in an external locus, mainly a public toilet, common stairwell, disused building or under railway bridges, pathways or cemeteries. Most of these locations would indicate that the deceased had chosen them as an inconspicuous place to inject their drugs. Whilst choosing such locations would suggest the need for "privacy", they are also making themselves vulnerable to overdose as they are less likely to be noticed and hence intervention is less likely to be initiated prior to death.

Various studies have reported on the circumstances leading up to a heroin death and note that the deceased was in the company of others in 58%[95], 61% [120] and 79% [121] of cases studied. These studies do not specify, however, whether the deceased was merely within the locus with other people or whether drug misuse had actually been witnessed. This study revealed that the deceased was definitely or most probably on their own at the time of death in 49% of cases as one cannot preclude the possibility that a third party was present and evaded the scene. Hence, a witness was present within the locus in the remaining 51% of cases of which there were basically three scenarios. Either the deceased was seen to be intoxicated prior to a period of sleep (34%); the deceased was physically segregated from the witness, the body being discovered when the witness went to check on the deceased some time later (31%), or drug consumption/physical collapse was witnessed (31% and 4% respectively). Of the cases where drug consumption was witnessed the toxic effects of the drugs were noticed by the witness in two-thirds of cases and in the remainder, the witness was under the influence of drugs and discovered the deceased once they themselves had "come round". In the cases where intoxication was witnessed prior to a period of sleep, the witness would probably think that allowing the deceased to "sleep

off" the effects of the drug was the right thing to do. However, it is feasible to suggest that some of these deaths may have been preventable had medical assistance been sought on the first signs of intoxication.

Evidence of drug paraphernalia was noted at the locus in three-quarters of all deaths. The location of a syringe and needle was indicative of a sudden death in 20% of all heroin deaths where paraphernalia was found. This consisted of a needle and syringe being found either in situ in the majority of these cases, suggesting that death was almost instantaneous (particularly since the syringe was noted to contain blood in most cases) or the needle and syringe being located under the body. In these cases it is possible that the deceased collapsed immediately after withdrawing the needle and hence landing on it or the needle and syringe were still *in situ* when the deceased collapsed, the fall causing them to dislodge. Nevertheless the finding that the majority of deaths did not appear to be instant following heroin administration is consistent with other studies[95].

Attempts to revive the deceased were made prior to the arrival of paramedics in only one fifth of cases where this information was available. However, this is still slightly higher than what was reported by Zador et al where resuscitation was attempted by an onlooker in only 11% of cases. The majority of instances were void of any efforts to revive the deceased by the witnesses own accord and this was despite a witness being present at the locus in just under one half of these cases. This is in agreement with findings of another study where no intervention occurred prior to death in similar circumstances [122]. As one might expect, intervention prior to the arrival of an ambulance was more likely to occur if witnesses were within the locus, particularly if drug consumption/collapse had been witnessed. This again highlights the risks of solitary heroin use.

In contrast to previous studies where witnesses appeared reluctant to seek assistance[107, 122] an ambulance was summoned in approximately three-quarters of all cases where this information was available. However, the deceased was obviously already dead in just over one half of these cases and no intervention occurred. In these cases the deceased was more likely to have been at the locus alone and found by a witness some time later. In the remaining cases, resuscitation attempts were initiated, but only a small proportion of these cases were revived and transferred to intensive care. It would appear, from the police sudden death report, that an ambulance was summoned shortly after the discovery of the body, however, as resuscitation attempts were initiated in less than one half of cases where an ambulance was called, this may not be entirely true. Resuscitation attempts were more

likely to be initiated by paramedics if the deceased had been in the locus with witnesses which suggests that intervention is perhaps sought more promptly when witnesses are present.

A period of abstinence was known to have occurred preceding death in one fifth of cases, the majority of which related to a period of incarceration. There were a few cases where the deceased had been involved with a residential rehabilitation programme. Over one half of these individuals overdosed within five days of leaving, two-fifths of whom had discharged themselves early. These findings that an individual is at risk of overdose following a rehabilitation programme is supported by Strang et al who followed up 137 opiate addicts who had been receiving opiate detoxification as part of a 28 day inpatient treatment programme. This study showed that patients who had "successfully" completed the programme were more likely to have died within the year following completion. In contrast there were no deaths amongst patients who failed to complete detoxification [123]. Of the cases involving a recently released prisoner, over one-half of overdoses occurred within one week of release, the vast majority of whom died within the first two days of liberation. In fact, of those dying within the first two days, one fifth overdosed on the day of release itself. The risk of resuming drug consumption following a period of abstinence in the Strathclyde area has been previously reported [124] where it was also highlighted that a breakdown in communication between prison doctors and general practitioners often resulted in methadone prescribing being discontinued upon imprisonment. Other studies of similar cases throughout Scotland showed that the risk of death from overdose was up to eight times higher in the two weeks after release than at other times at liberty [125, 126]. It has been noted by Glasgow GPs that the adverse consequences of imprisonment include resumption of heroin injecting and chaotic drug use both in prison and upon release [127]. Presently, the Scottish Prison Service (SPS) conduct "voluntary" drug testing and offer advice about the risks of overdose as a result of decreased tolerance. However, this study suggests that a large proportion of recently released prisoners resort back to quantities of drugs that they were previously accustomed to. Drug misuse within the prison system is clearly a problem. It's estimated that approximately 3 out of 4 people entering prison in Scotland test positive for drug misuse at the point of entry [128]. With nearly £8 million being spent on treatment and prevention initiatives, it was estimated that approximately 5,000 prisoners accessed treatment services in 2000, which is a 203% increase from 1997-98. The SPS has revised their drugs strategy which now has a prinicipal emphasis on harm reduction within prisons, an objective being to encourage drug misusing prisoners to present themselves for treatment and enter prison based drug interventions. A key

objective is also based on the continuity of care with the implementation of through care regimes [128]. However, whilst access to treatment services are scheduled for the individual, it has been shown that a large proportion fail to keep their appointments [129]. There are issues regarding the joint working between community and prison based services with respect to continuity and transfer of community based treatment plans on admission and similarly with consistency of pre and immediate post release services. Initiatives elsewhere in the UK have proved successful. For example, The Tower Project is a crime reduction initiative that has been operating in Blackpool and the Fylde since 1st January 2002. Its main aim is to target local persistent offenders either in prison or in the community and offer them immediate access to drug treatment and support with accommodation, benefits and employment. The project has been independently evaluated and has been shown to meet its 30% crime reduction targets. In addition, and most importantly, there have been no drug-related deaths amongst the client group [130]. This is an area which is in need of address and could begin with the evaluation of current strategies which are in place and identification of failings of these to meet specified targets.

In cases where a medical history was available, less than 10% of individuals had been enrolled on an MMP at the time of their death. It is possible to speculate that had more individuals been enrolled on an MMP, there may have been fewer deaths as a result of heroin overdose as methadone treatment is known to have a positive impact on reducing mortality amongst heroin-dependent individuals [131, 132]. This study also showed that there were a number of individuals who had had several previous attempts on an MMP, however were unsuccessful at completing them for one reason or another and that some individuals simply defaulted or failed to keep appointments. Another study reported that individuals who left treatment early had a higher risk of overdose than those still in treatment where an odds ratio of 3.55 (95%CI 1.82 to 6.90) was noted [133]. Of those who had been enrolled on an MMP at the time of their death, just over one-half were found to have methadone detected following toxicology. This finding together with a positive heroin result suggests that they were either selling their prescription in order to finance their heroin habit or "topping up" as a result of being prescribed too low a dose. To support the former, whilst much of the methadone prescribed by drug treatment services is supervised, some individuals may be prescribed methadone by a GP who is not involved in the shared care scheme, hence supervision of consumption would not be mandatory. In Glasgow, for example, over 50% of GPs participate in the shared care scheme and a main obstacle to GP involvement is lack of confidence and available training [134]. A possible explanation as to why an individual may have to "top-up" their dose may be due to genetic polymorphism

that results in varying degrees of methadone metabolism. For example, a study of 256 MMP patients showed that 89% were extensive metabolisers, 4% were ultrarapid metabolisers and 7% were poor metabolisers [135]. Drug clearance has also been noted to be significantly greater during pregnancy [136]. Due to a wide inter-individual variation of drug clearance, new research suggests that doses ranging from 120mg per day to more than 700mg per day may be optimal for many patients [137]. Interviews with drug addicts indicate that methadone is not a solution to their habit as some say that all it does is give them a kick start in the morning before going to get other "stuff" or that it made them feel lethargic, didn't give them a "buzz", was more addictive than heroin and was therefore harder to get off [138].

An important aim of any maintenance programme is to retain patients under medical supervision in order to reduce the health hazards associated with illicit drug consumption. Whilst methadone is the most frequently prescribed drug for opiate maintenance, concerns have been raised that GPs who prescribe the drug are not confident about doing so [139]. A possible explanation for this could be that the quality of treatment suffers because of a lack of training of the doctors [140]. There is scope for other treatments for heroin dependence such as buprenorphine. France was the first European country to legalize buprenorphine tablets for maintenance therapy and in the year 2000, there was estimated to be between 67,377 and 89,836 drug users being treated with this drug [141]. Kakko et al concluded that buprenorphine and intensive psychosocial treatment is a safe and highly efficacious treatment option for heroin dependent individuals [140].

As would be expected the median morphine concentrations in heroin only deaths was significantly higher than those where other drugs were considered to be a contributory factor in death. However, unlike other studies [95, 96], a significantly lower blood morphine level was not detected in those who were also found to be positive for alcohol. Nevertheless, the depressant effects of alcohol in combination with heroin has been reported to be synergistic in causing death, i.e. greater than if just additive [142].

Females were shown to have a significantly higher median blood morphine concentration compared to that of males. It is known that sex differences exist in drug pharmacokinetics and pharmacodynamics and it has been suggested that female-specific issues such as pregnancy, menopause and menstruation may also have profound effects on drug metabolism [143]. This could be one explanation for the difference in median blood

concentration but it is also probable that this difference was observed due to a larger distribution volume and hence faster clearance in men compared to women [144].

There is also scope for future work regarding the role of morphine metabolites in mediating respiratory depression of heroin. For example, the role of morphine-6-glucuronide needs to be further investigated as it is possible that there may be significant levels of this metabolite, which is known to be pharmacologically active, in cases where there are relatively low concentrations of morphine detected in the blood.

Certain theories exist as to why overdoses occur such as that the individual has taken a quantity of a drug which is in excess of their current tolerance. Another is that an increase in the purity of street heroin is conducive to an increase in heroin deaths. This theory, however, has not been supported by recent studies that showed either a moderate association between heroin purity and overdose fatalities [145] or no statistically significant relationship between the two [146]. In both these studies, other central nervous system depressants such as alcohol and benzodiazepines were detected in the samples in addition to morphine. A prominent finding of this study and one that is reported by various authors elsewhere [77, 95, 147, 148, 149] was that there was a very low number where solely morphine had been detected. In France, for instance, it has been reported that overdoses due to heroin alone have become "exceptional"[109]. In this study, a combination of either two or three drugs accounted for approximately three-quarters of all polydrug cases and benzodiazepines and alcohol were the most frequently detected drugs to have been taken concurrently with heroin which is similar to heroin deaths in Australia[118]. This drug combination has been reported to be a common practice among heroin users [107] and has been a favoured cocktail amongst Scottish drug users for many years [45, 46, 79]. A legislation change in temazepam prescribing was shown to have an impact on the availability of this drug and hence there was a trend change regarding the benzodiazepine of choice. However, regardless of what benzodiazepine was being taken concurrently with heroin, this mixture is potentially lethal. Heroin itself depresses the part of the brain that controls breathing, causing it to work at such a low level that it stops sending signals to the lungs to breathe. Benzodiazepines are also CNS depressants and the simultaneous administration of these drugs has a potentiating effect and can enhance and prolong the depressant effects of heroin. Despite polydrug use being prevalent, heroin was the only drug cited in the cause of death in 45% of all heroin deaths. In the remaining 55%, heroin was cited in the cause of death with other drugs. This was primarily with alcohol (107 cases), benzodiazepines (204 cases) or a cocktail of all three drugs (31 cases). It has been

suggested that concurrent intoxication may also make the heroin user more prone to risky behaviour and overdosing [150].

The concurrent use of heroin with any opiate is potentially fatal as both are respiratory depressants. Whenever methadone and dihydrocodeine had been detected, it was evident they had been obtained by the diversion of legitimate supplies in approximately two-thirds of each of the cases. These drugs are both prescribed for the management of opioid dependence, although DHC is not licensed for this purpose; it's main medical use is as an opioid analgesic. Therefore, there is a great concern as to why patients being prescribed these drugs are continuing to use heroin or indeed why prescription only drugs such as these are being abused by people who are obtaining them illicitly. Deaths involving these drugs will be discussed later in this chapter.

Cocaine was found to be present in 24 cases and these involved primarily males. There is a slow but increasing trend for cocaine as a drug of misuse in Scotland and it has only been in recent years that this drug has emerged in drug related overdoses. The combination of heroin and cocaine, usually by simultaneous injection, is a recognized phenomenon and referred to as "snowballing" or "speedballing", a practice which dates back to the 1930s. However, it became more well known as the cocktail that killed John Belushi in 1982 and River Pheonix in 1993. Whilst this combination was primarily used amongst heroin injectors who would add cocaine when they could afford it, there is evidence that it is now being used by those who snort cocaine. In these cases, whilst the heroin is snorted to bring them down, they still consider cocaine to be their main drug of use [151].

5.4.9 Conclusion

Heroin addiction remains a disturbing cause of premature death in Scotland. The demographical profile of such deaths has not changed dramatically over the study period, with the exception of a slight increase in mean age in the latter years of the study. Also, within the Strathclyde police region, the prevalence of heroin as a cause of death was shown to disseminate out to other health board regions. The availability of heroin, despite increased seizures over the years remains problematic to society. Various Government stratagems regarding drug use has varied from zero tolerance approaches to more educational based initiatives (e.g. Know the Score). However, drug misuse continues to increase regardless.

In an ideal world, the solution would be to restrict the supply of heroin on the streets and inhibit the initiation into drug misuse. This unfortunately is not feasible. As people will always abuse substances, it is better to concentrate on ways of preventing the outcome that is often a fatal overdose. This study has shown that in many cases, there is a possibility that death could have been prevented and has highlighted some potential risk factors which could form the basis of an educational campaign targeted at all drug users and their family/acquaintances. The misuse of drugs in isolation for example, is a precarious practice rendering any intervention almost impossible. Witnesses should be alerted to the possibility of respiratory failure in individuals that they witness to be obviously intoxicated prior to a period of sleep. They should be encouraged to be proactive in attempting to avoid overdose in these types of cases by promptly seeking medical attention. The issue of increased risk of overdose following a period of abstinence has substantial implications for public health prevention efforts. It is clear that current efforts with through care regimes are inadequate and need to be enhanced.

Another matter in need of address via education campaigns is the increased likelihood of overdose when drugs are taken concurrently, particularly multiple CNS depressants such as opiates, alcohol and benzodiazepines. It is clear that this is common practice amongst drug users in the Strathclyde Police region.

A lack of confidence by GPs prescribing maintenance therapy treatment due to a possible lack of training was mentioned earlier. Initiatives which aim to assess the medical care and patient management provided by GPs could be offered in an effort to maintain a level of clinical care which is considered adequate at retaining patients in treatment.

Perhaps by more education campaigns and encouragement aimed at the clinicians involved in drug misuse, heroin deaths will, one day, show signs of decreasing.

5.5 Methadone

Street Names: Meth, Phy, fairy Liquid, Green Death, Jungle Juice, Green Turtle

Methadone is a synthetic opioid agonist that was first synthesized in Germany during World War II. It was first used in opiate maintenance treatment by Vincent Dole and Marie Nyswander in the 1960s following failed attempts to maintain addicts on short-acting opiates. Despite being chemically different from morphine, it has clinically similar actions and analgesic effects[152]. Due to this it is used successfully for the treatment of heroin addiction. It has a slow onset (approx. 4 hours) and long duration of action (half-life 15 – 72 hours) thereby preventing the onset of withdrawal symptoms.

One of the first studies highlighting the benefits of methadone amongst heroin dependent individuals was carried out by Dole and Nyswander in the 1960's [153]. They showed that stabilization was possible with methadone and of 22 males aged between 19 – 37 years, all with several years drug history, only two individuals had been discharged from their study (the authors referring to them as "*uncooperative and disruptive psychopaths*"). It was concluded that methadone had contributed in a favourable way to this stabilization in that it relieved narcotic hunger and protected the individual against re-addiction to heroin by establishing a pharmacological block so as to induce sufficient tolerance to block the euphoric effects of an average dose of heroin. The authors supported the need for both the medication in addition to a supporting program as being key factors in succeeding to stabilize heroin dependent individuals.

Another study conducted by Dole and Nyswander reported on the success of methadone whereby the procedure was separated into three phases. The first phase begins with a six-week period of hospitalisation where the subjects receive a medical examination and are started on low levels of methadone (10 – 20mg daily) which are gradually increased to a blocking level (80 – 120mg daily). Phase two involved the subjects being transferred to an out patient clinic where they are in receipt of financial support.

> ***"Maintenance of patients with methadone is no more difficult than maintaining diabetics with oral hypoglycaemic agents and in both cases the patient should be able to live a normal life"***
>
> **Dole and Nyswander**

The final phase is when they are able to live a self-supporting lifestyle where no or little social assistance is required. The results revealed that of 120 patients admitted, only 13 failed to complete treatment. Of the remaining 107 patients, heroin use had stopped, drug-related crime had been eliminated and a substantial number were employed in a steady job [154]. Another study in Sweden showed a high rehabilitation rate of individuals who were enrolled on an MMP of 76% compared to 6% in a control group [155]. That said though, Dole reports that despite some patients doing well once treatment is terminated, the majority experience a return of symptoms after maintenance has stopped. Therefore, methadone as a treatment is "*corrective but not curative for severely addicted persons*" [156].

5.5.1 Legal Status

Like heroin methadone is a Class A drug under the Misuse of Drugs Act 1971. It is controlled under schedule 2 hence is considered to have medical therapeutic use and is legal to possess only if prescribed by a doctor, and then only if taken in accordance with the doctor's instructions. Presently, in the United Kingdom, any medical practitioner can prescribe methadone for the management of opiate dependence.

5.5.2 Prescribing

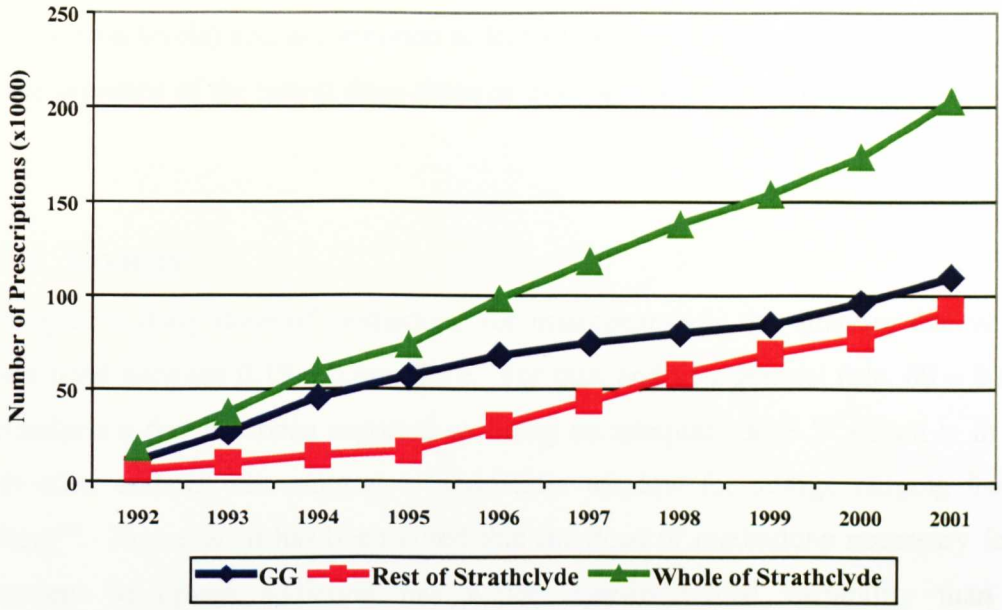
Methadone is presently the drug of choice in the United Kingdom for substitute prescribing in the treatment of heroin addiction [157, 158]. It has been estimated that there are presently 26,000 opiate addicts in methadone maintenance programmes in the United Kingdom, which is equivalent to 17% of the known opiate addict population[152]. The benefits of this drug are well documented and include a reduction in illicit drug use [159, 160], reduction in mortality rates [159] and a reduction in the level of criminal activity amongst opiate drug users [127, 160]. In addition this substitute drug appears to be more effective at keeping drug users in contact with health services compared to other interventions [161]. However, an increasing trend in the prescribing of this drug has also received concern with respect to the contribution it may have in drug related deaths both nationally [97, 162, 163] and internationally [164, 165]. In Scotland, a study investigating the views and experiences of drug users supported the notion that methadone is a useful, but controversial substitute drug. Whilst the drug users agreed that it had multiple advantages but simultaneously caused many problems for drug users, it was concluded that on the whole the respondents' comments were consistent with the views expressed by professionals in relation to reducing illicit drug use, decreasing drug-related harm and preventing drug-related crime [166].

5.5.2.1 Methadone prescribing in the Strathclyde area

In response to the increasing heroin epidemic in Strathclyde, various stratagems were devised to reduce the damage caused to opiate users and included the introduction of needle exchanges and substitute prescribing in communities. In the early nineties, it became evident to the small group of Glasgow general practitioners (GPs) who were prescribing methadone that it would be beneficial for drug misusers to attend clinics specifically designed for their care[57]. As a result, in 1994 both the Glasgow Drug Problem Service (GDPS) and a GP Drug Misuse Clinic Scheme were created to reduce drug related harm to health and "*promote better management of drug injectors in general practice through a system of shared care*"[58]. In addition to the shared care by staff in the GDPS and in general practice, community pharmacists were recruited to supervise the consumption of daily doses of methadone. In early 1994, approximately one fifth of all Glasgow community pharmacies had become involved [60] which increased to approximately two-thirds by 1999 [61]. In 1996, 99% of all methadone that had been prescribed by the GDPS involved supervised daily dispensing [58], a figure that remains unchanged [59].

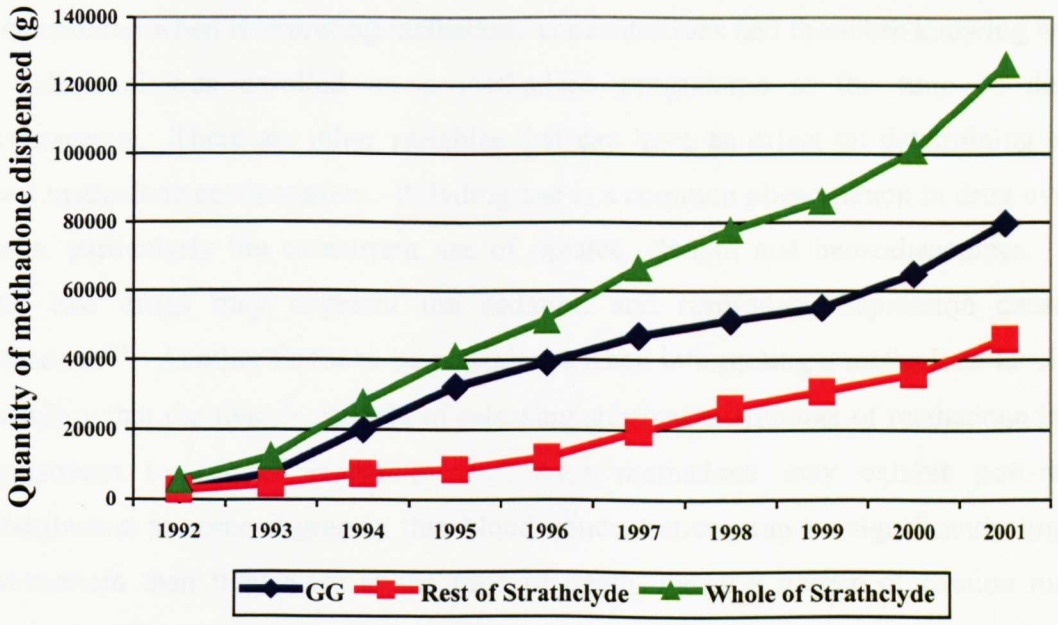
Figure 21 shows that the number of methadone prescriptions dispensed in the Strathclyde police region increased approximately 11-fold over the ten-year period 1992 to 2001 [167] with the majority of this methadone being dispensed in the Greater Glasgow Health board area. The proportion of methadone dispensed in the Greater Glasgow area compared to the whole of Strathclyde ranged from 63% in 1992 to 77% in 1995 and then decreased from 69% in 1996 to 54% in 2001. These figures suggest that although initially confined to the Greater Glasgow area, the establishment of methadone maintenance in the rest of the Strathclyde area has increased over the latter years.

Figure 21: Number of prescriptions dispensed in Strathclyde, 1992 – 2001.



Whilst it is not possible to decipher whether these prescriptions relate to those which are prescribed daily or monthly, an increasing trend for the quantity of methadone dispensed is shown in Figure 22. This shows that the quantity of methadone dispensed in the Greater Glasgow area compared to the whole of Strathclyde ranged from 47% in 1992 to 79% in 1995 and then decreased from 76% in 1996 to 63% in 2001, a trend which is similar to the one described above for prescriptions.

Figure 22: Quantity of Methadone Dispensed (g)



5.5.3 Identification of drugs in samples

Methadone is absorbed following oral administration (approximately 4 hours to achieve peak plasma levels) and is converted to EDDP. Exposure to methadone can be determined by the presence of the parent drug alone or in combination with its inactive metabolite.

5.5.4 Toxicity

The optimal daily dose of methadone for maintenance is the quantity that will hold the blood level between 0.15 – 0.6mg/litre. For this, and as a general rule, 60 – 80mg of oral methadone a day has been reported as being an adequate dose [168] which is in agreement with other authors who suggest a therapeutic window for dosage ranging from 50mg – 120mg[160]. However, it has been noted that the dose of methadone necessary for effective treatment of opiate addiction has wider inter-individual variability than has been previously acknowledged and that inadequate doses of methadone will result in patients supplementing their dose with illicit opiates, benzodiazepines and alcohol [169, 170].

The concentrations of methadone in maintenance patients are known to overlap those experienced in fatality cases. For example, a mean plasma methadone concentration of 0.45mg/l was noted in a study of 104 living addicts (range 0.02 – 1.3mg/l) [171]. This equates to approximately a mean blood methadone concentration of 0.34mg/l (average blood/plasma ratio for methadone is given as 0.75 [172]). However, mean blood methadone concentrations in drug fatalities have ranged from 0.28mg/litre amongst a study of 59 victims [173] to 0.56 in a study involving 18 victims [174]. And various studies have shown fatal concentrations to range from 0.1 – 4.5mg/litre [175]. Obviously tolerance is a major factor to be considered when interpreting methadone concentrations and therefore knowing whether an individual was enrolled on a methadone programme at the time of death is advantageous. There are other variables that can have an effect on determining a toxic blood methadone concentration. Polydrug use is a common phenomenon in drug overdose deaths, particularly the concurrent use of opiates, alcohol and benzodiazepines. These latter two drugs may augment the sedation and respiratory depression caused by methadone[176]. Another factor to be considered when interpreting a methadone level is the possibility that the liver is capable of releasing substantial amounts of methadone into the bloodstream long after ingestion [177]. Also methadone may exhibit post-mortem redistribution to some degree in that blood concentrations can be significantly higher at post-mortem than they were at the time of death, hence a degree of caution must be exercised with interpretation. This has been illustrated by Prouty and Anderson who found that heart/femoral blood concentrations averaged 1.1 (range 0.8 – 1.4), hence highlighting

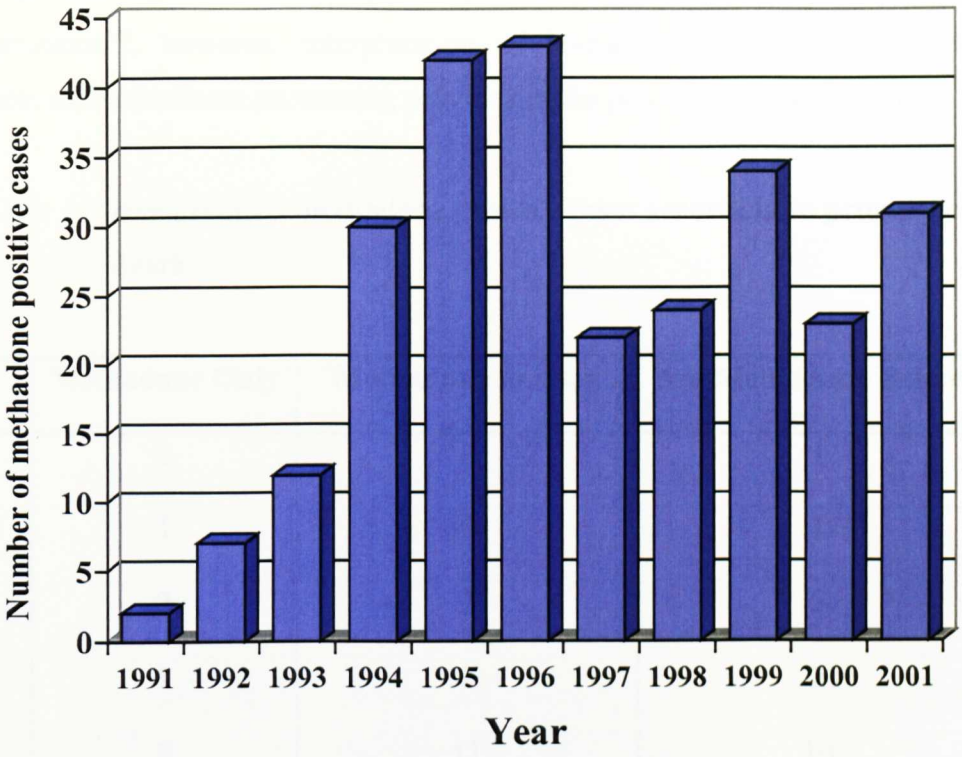
the importance of analysing peripheral blood before a definitive interpretation of post-mortem toxicological analyses is possible [178]. Therefore, obtaining as much information as to the background of the case being investigated is of utmost importance as post-mortem measurements of methadone cannot be used in isolation to determine toxicity [179].

5.5.5 The Incidence of Methadone in Drug Related Deaths in the Strathclyde Police Region of Scotland.

Methadone was first detected in a drug-related death in 1986, however, it appeared to play no part in the death as the pathologist certified the cause of death as being attributable to a heroin overdose. The next methadone positive case was recorded in 1991 after which its presence in drug related deaths investigated by Forensic Medicine and Science, increased dramatically up until 1997 (Figure 23). In 1994, the year the MMP was introduced into Glasgow, there was a 150% increase in methadone positive cases compared with the previous year. A continued increase resulted in media attention that called into question the efficacy of methadone as an opiate substitute [180, 181]. Consequently, in 1996, the GDPS co-ordinated a confidential enquiry into methadone-related deaths in Glasgow with a view to assessing the medical care provided by the clinicians who prescribed methadone [182]. It reported in 1999 and showed that medical services might have been deficient in 56% of the methadone deaths. Possible failures in clinical care were identified in 69% of cases and included, for example, prescribing too low or too high a dose of methadone or failing to examine a patient for continuing drug misuse. The response from the prescribing doctors was very positive with 93% "definitely" intending to change their future management of drug misusers. In order to disseminate the findings of this enquiry a booklet outlining the guidelines for safe methadone prescribing was distributed to all GPs in the Greater Glasgow area [183].

There was a 49% decrease in the number of methadone positive cases in 1997 which can possibly be explained by both the combination of increased supervision that was occurring at that time and also as a result of the ongoing confidential enquiry.

Figure 23: Number of methadone positive cases detected in drug related deaths



Over the 12-year study period, methadone was detected in 352 sudden, unexpected deaths in the West of Scotland. Of these, 271 cases (77%) were considered to be directly associated with the toxic effects of drugs either alone or in combination with alcohol. In the majority of cases, the deceased was male (79%, n = 213) and the average age was 27 years (range 15 – 58 years). A history of drug abuse was noted in 262 cases (97%), of which approximately two-thirds were known intravenous drug users (68%, n = 178).

5.5.5.1 The Role of Methadone in Drug Related Deaths

All drug related methadone positive cases (n = 271) were classified as "methadone only" deaths (e.g. methadone intoxication), "methadone-related" deaths (e.g. methadone and heroin intoxication) or "not methadone-related" deaths (e.g. heroin intoxication) in accordance with a previous study [97] and depending on the primary cause of death. Methadone in combination with other drugs accounted for 140 deaths (52%). Fifty-six or approximately one fifth of deaths (21%) resulted from the effects of methadone alone. In a further 75 deaths (27%) although methadone was found to be present, it was not considered to be at a high enough concentration to have caused or contributed to the death. In these 75 cases the interpretation of toxicological findings and the conclusion that methadone was not implicated in the death was stated by the pathologist on completion of

all post mortem investigations and having taken due notice of previous medical history. It is recognised that there is an overlap between therapeutic and fatal methadone concentrations[175], however, interpretation of levels is also based on circumstantial evidence, such as witness statements, provided in the police sudden death report.

Table 10: Drug related methadone positive cases according to primary cause of death.

Year	Methadone Only	Methadone Related	Not Methadone Related	Total
1986	0	0	1	**1**
1991	1	0	1	**2**
1992	2	2	3	**7**
1993	1	9	2	**12**
1994	9	11	10	**30**
1995	10	23	9	**42**
1996	9	24	10	**43**
1997	9	8	5	**22**
1998	4	13	7	**24**
1999	6	21	7	**34**
2000	1	13	9	**23**
2001	4	16	11	**31**
Total	***56***	***140***	***75***	***271***
	Methadone Deaths = 196			

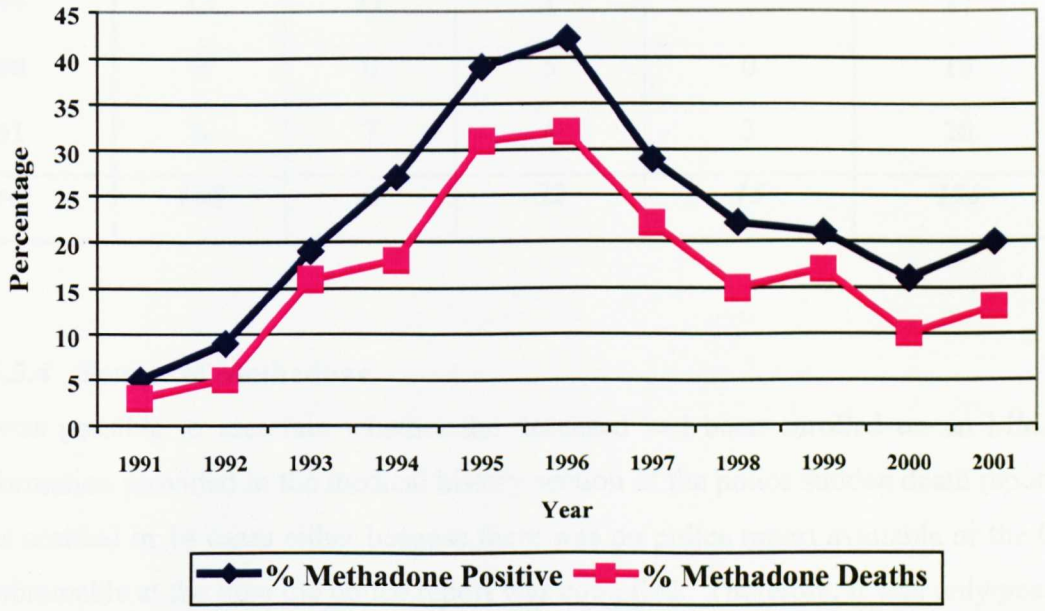
5.5.5.2 Methadone as a Cause of Death in Drug Related Deaths

In order to study deaths where methadone was considered the cause of death either alone or as a contributory factor in combination with other drugs, all deaths classed as

"methadone alone" or "methadone related" will be the focus of the remainder of this section. Collectively these two subgroups will be referred to as "methadone deaths". From Table 10, it can be seen that over the 12-year study period, there were 196 methadone deaths. The majority were male (80%) and the average age for both males and females was 26 years (range 15 - 38 years for females and 15 – 46 years for males).

Figure 24 illustrates that of all illicit overdose cases throughout the years, the presence of methadone increased from 5% of all cases in 1991 up to 42% in 1996. From 1997 onwards the number of methadone cases as a percentage of all illicit overdose cases has continued to decrease. Whilst approximately two fifths of all illicit overdose cases involved methadone in 1996, only one third were due to the effects of methadone alone or in combination with other drugs.

Figure 24: Methadone positive cases and methadone death cases as a percentage of all illicit drug overdoses over the years 1991 – 2001



5.5.5.3 Methadone Deaths by Health Board Area

Just over one half of all methadone deaths occurred within the Greater Glasgow Health Board Area (55%, n = 108). The corresponding figures for Ayrshire and Arran, Argyll and Clyde as well as Lanarkshire were 21% (n = 41), 16% (n = 32) and 8% (n = 15) of methadone deaths respectively. Between 1991 – 1995, 62% of methadone deaths over that 5-year period occurred in the GG health board area, this decreased between 1997 – 2001,

when less than one-half of all methadone deaths in this 5-year period occurred in the GG health board area. This difference was shown to be statistically significant ($p = 0.02$, $\chi^2 = 5.8$). This shows that as well as methadone prescribing disseminating throughout the rest of Strathclyde, so too were methadone deaths.

Table 11: **Methadone deaths defined by health board region**

	GGHB	A&A	A&C	L	Total
1991	1	0	0	0	**1**
1992	3	1	0	0	**4**
1993	6	2	0	2	**10**
1994	14	4	0	2	**20**
1995	18	6	8	1	**33**
1996	23	5	5	0	**33**
1997	7	3	5	2	**17**
1998	8	2	4	3	**17**
1999	13	11	1	2	**27**
2000	9	0	5	0	**14**
2001	6	7	4	3	**20**
Total	***108***	***41***	***32***	***15***	***196***

5.5.5.4 Source of Methadone

It was possible to ascertain whether the deceased had been enrolled on an MMP from information provided in the medical history section of the police sudden death report. This was omitted in 14 cases either because there was no police report available or the GP was unobtainable at the time the police report was compiled. Therefore, it was only possible to comment on the remaining 182 cases. Of these, the deceased had been in receipt of a methadone prescription in just under one half of cases (43%, n = 79), the majority of these cases were classed as a methadone related death (68%, n = 54). Therefore, methadone had been obtained by the diversion of legitimate supplies in 103 cases (57%).

The exact number of patients enrolled on a MMP within each health board area at any one time was unobtainable, but the following estimate was made in order to calculate the death rate. On the assumption that the average prescription for methadone is 50mg per day, a

patient will receive 18,250mg per annum (50mg x 365 days). Consequently, from the knowledge of the quantity of methadone prescribed in each health board area[184], it is possible to attain an indication of the number of patients in receipt of a methadone prescription.

Table 12 shows that, for individuals on an MMP, the methadone death rate fell sharply after 1996 and remained low thereafter. Following the distribution of the guidelines and changes in methadone dispensing there was a 0.38% absolute reduction in summary death rates from 0.53% per person year to 0.15% per person year. The numbers of methadone deaths for individuals not on an MMP decreased slightly from 54 deaths during the period 1991 – 1996 to 49 deaths during the years 1997 – 2001. This was despite a threefold increase in the amount of methadone being made available via the MMP. For 2001, Glasgow had a lower methadone death rate among individuals on an MMP than the three other health board areas (0.07% compared to 0.13%, 0.1% and 0.13%). In general, rates were low, indicating a good safety profile of the MMPs. A similar pattern was seen for those not on an MMP where Greater Glasgow had three deaths compared with a total of 11 from the three other health board areas (Lanarkshire: two deaths, Argyll & Clyde: three deaths, Ayrshire & Arran: six deaths). This was despite nearly twice as much methadone being prescribed in Glasgow via the MMP.

Table 12: Methadone Death Rates for Individuals on an MMP, 1991 – 2001

Year	Estimated number of MMP patients	Number of MMP deaths	MMP death rate
1991	Unknown:	1	unknown
1992	304	0	0.00%
1993	676	4	0.59%
1994	1512	9	0.60%
1995	2246	14	0.62%
1996	2815	13	0.46%
1997	3645	4	0.11%
1998	4252	10	0.24%
1999	4714	11	0.23%
2000	5519	7	0.13%
2001	6896	6	0.09%

Of the 79 cases involving prescribed methadone, it was noted that multiple doses had been prescribed in 21 of these cases (27%). This ranged from a single dose to one month's supply although the majority of cases were due to a forthcoming Sunday and/or bank holiday/long weekend closure of the pharmacy (52%, n = 11). In the remaining cases, the dispensing of multiple doses had been the decision of the GP. The reasons for multiple prescribing is shown in Table 13 below.

Table 13: Reasons why multiple doses were prescribed to the deceased

Number of Doses	Reason	Number of cases
1 day	Sunday Closure	6
2 days	Forthcoming Pharmacy Holiday	1
3 days	Forthcoming Pharmacy Holiday	3
5 days	Holiday Weekend Closure	1
Total No. of Cases due to a Pharmacy Holiday		***11***
4 days	Apparent holiday of patient	2
1 week	Decided by GP	3
1 week	Apparent holiday of patient	1
2 weeks	Decided by GP	2
1 months supply	Apparent holiday by patient	1
1 months supply	Decided by GP	1
Total No. of Cases due to Discretion of GP		***10***

In a further two cases involving prescribed methadone, while there was no mention of multiple prescriptions in the police report, the deceased was found to be in possession of two bottles of methadone prior to death in one case and an empty 200ml bottle was found at the locus in the other case.

5.5.5.5 Day of Death

Over half of the cases (n = 107, 55%) occurred over a weekend, Friday – Sunday with 80 deaths occurring on Saturday or Sunday (Table 14). Of these 107 cases, 46% (n = 49) were enrolled on an MMP which compares to 34% (n = 30) of deaths that occurred on a weekday. Despite this, there was no significant evidence of an association between the timing of the death (weekend or weekday) and MMP status (χ^2 = 2.411, p = 0.12; 14 individuals whose MMP status was unknown were excluded).

Table 14: Time of Week When Death Occurred and MMP Status of Deceased

MMP Status	Weekend Death	Weekday Death
Yes	49	30
No	52	51
Unknown	6	8
Total	***107***	***89***

5.5.5.6 Circumstances of Death

Each case was classified according to when the death occurred in relation to drug consumption. In 13 cases (7%) involving heroin, death was immediate as a needle and syringe were found still inserted into the injection site. In 36 cases (18%) the mode of death was undetermined as the deceased had been found dead at the locus and had not been seen for a prolonged period, hence circumstances directly prior to death could not be ascertained. The sequence of events prior to death in most cases (74%, n = 146) involved the deceased being seen to be intoxicated prior to falling asleep. Witnesses often reported heavy uncharacteristic snoring in these cases such as "gurgling" noises. In the final case, the deceased attended an Accident and Emergency department. Having been attended to, he was asked to sit in the waiting area. He was found dead in the toilet area approximately two hours later.

5.5.5.7 Recent Prison Release

Of all 196 methadone deaths, it was noted from the police sudden death report that 21 individuals (11%) had died with 2 weeks of release from prison, the majority of whom were male (76%, n = 16). Methadone had been prescribed in only 43% (n = 9) of these

cases. In these cases, methadone had been prescribed to the deceased between one and five days prior to death and dosages varied from 35ml daily to 90ml daily. Multiple doses had been prescribed in three cases, in one case a weeks supply was issued, in another case 4 days supply was dispensed and in a final case an extra dose for a Sunday pharmacy closure was given to the deceased. The majority of cases involving prescribed methadone were classed as methadone related (89%, n = 8) and in just over three fifths of these cases, heroin had been taken concurrently with the prescribed methadone (62%, = 5). In these five cases, a used syringe was found either next to or underneath the body (n = 4) or in one case, protruding from the groin. This shows that the guidelines of the methadone maintenance programme had been contravened.

The remaining 12 cases involved methadone which had been obtained by the diversion of legitimate supplies. Half of these cases were classed as methadone related with two thirds of these cases (67%, n = 4) testing positive for heroin.

5.5.6 Results of Toxicological Analyses

A blood sample was unobtainable in five cases because of decomposition, however, urine, liver and liver blood were used as alternative matrices. In an additional 4 instances, it was noted that the blood had been taken from a source other than the periphery. Of the remaining 187 cases, the post mortem blood methadone concentrations ranged from 0.01 – 3.84 mg/litre. Table 15 lists the mean, median and range of concentrations detected for each cause of death group and whether or not the deceased was enrolled on a MMP at the time of death. The mean concentrations for methadone only deaths were significantly higher than those for methadone related deaths (all deaths, two-sample t-test $p<0.0001$;methadone prescribed, $p=0.0001$; methadone not prescribed, $p<0.0001$).

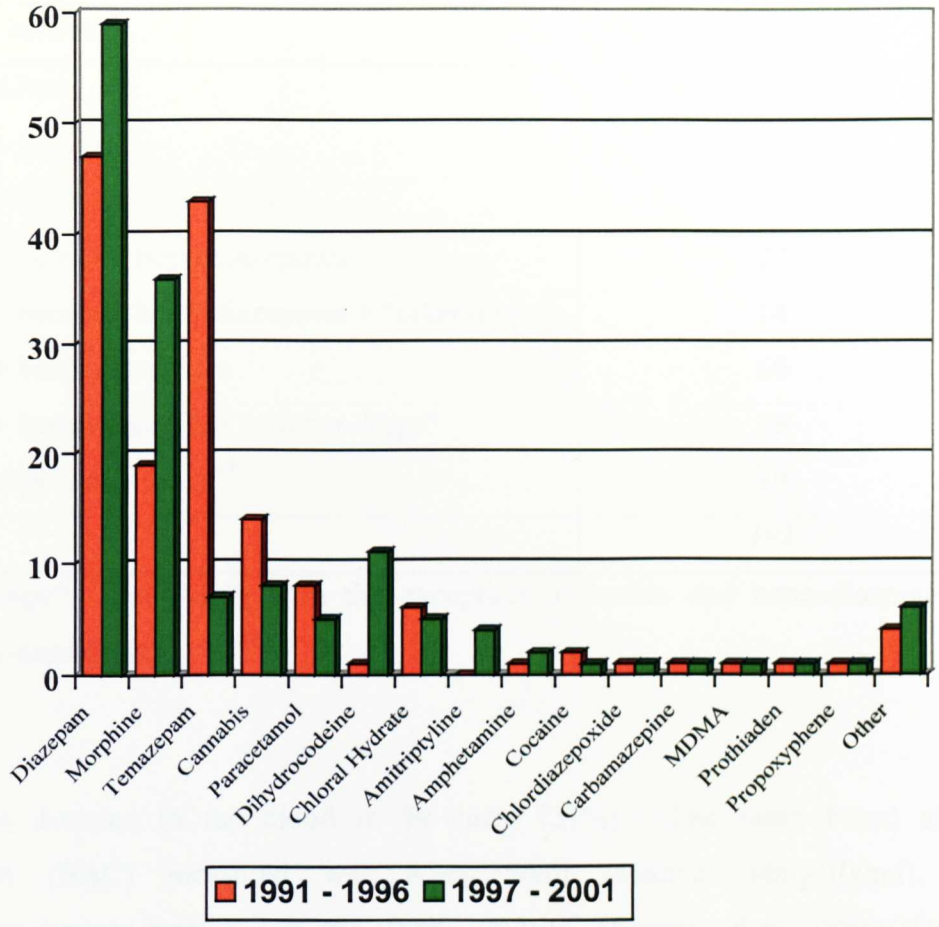
Table 15: Methadone Concentrations, Cause of Death and MMP Status.

		Methadone Only	Methadone Related
	n	52	135
All Cases (n = 187*)	**Mean**	0.8	0.4
	Median	0.7	0.3
	Range	0.08 – 2.63	0.01 – 3.84
	n	21	49
Prescribed	**Mean**	0.9	0.5
	Median	0.7	0.4
	Range	0.28 – 2.2	0.067 – 1.8
	n	25	78
Not Prescribed	**Mean**	0.7	0.3
	Median	0.5	0.2
	Range	0.08 – 2.63	0.01 – 3.84
	n	6	8
No Record	**Mean**	0.7	0.3
	Median	0.6	0.3
	Range	0.26 – 1.3	0.038 – 0.8

*In total the study period involved 196 MO and MR deaths, however, toxicology was carried out on the liver in 1 case, liver blood in 2 cases, urine in 2 cases. In a further 4 cases, the blood had been taken from a site which was other than the periphery.

Multiple drug use was prevalent with two or more drugs being detected in 163 cases (85% of blood drug positive cases). The most frequently detected additional drug group was the benzodiazepines with diazepam and temazepam being present in 65% (n = 106) and 31% (N = 50) of polydrug cases respectively. Heroin was found to be positive in 55 multiple drug cases (34%). In 16 of these cases (29%) the deceased was in receipt of a methadone prescription. Effectively, of all methadone patients in this study, one fifth (20%) were found to be non-compliant with the methadone programme guidelines in that they continued to use illicit drugs. The other drugs detected are shown in Figure 25.

Figure 25: Frequency of Drugs Detected



This graph also shows trends of drug misuse over the two-year blocks such as the decrease in temazepam following its legislation change and an emergence of dihydrocodeine. Of the 106 diazepam positive cases, prescribed diazepam accounted for only 28% (n = 27) of cases (NB no medical history was available in eight cases).

The cocktails of drugs consumed by the subjects of this study reflect the present pattern of drug misuse in Strathclyde which primarily involves the concurrent use of opiates and benzodiazepines[79]. All drug combinations in methadone deaths are summarised in Table 16 below. Methadone had been administered together with heroin (evident by the presence of morphine at toxicology) alone, or in combination with other drugs in seven (4%) and 48 (25%) of blood drug positive cases respectively. The other drugs involved were primarily benzodiazepines (85%, n = 41). Methadone in combination with benzodiazepines alone or together with other drugs other than heroin accounted for 60 (31%) and 29 cases (20%) respectively.

Table 16: Summary of Drug Combinations in Blood Samples (n = 191)

Drug Combination	Number of Cases
Methadone Alone	28
Methadone + heroin	7
Methadone + heroin + "other drugs"	7
Methadone + heroin + benzodiazepines	27
Methadone + heroin + benzodiazepines + "other drugs"	14
Methadone + benzodiazepines	60
Methadone + benzodiazepines + "other drugs"	29
Methadone plus "other drugs"†	19
Total	***191***

† "other drugs": any drug with the exception of heroin and benzodiazpines, for example anti-depressants

Alcohol was detected in the blood in 59 cases (31%). The mean blood alcohol concentration (BAC) measured was 85mg/100ml (median 44mg/100ml), with concentrations ranging from 4 – 462mg/100ml. A BAC of greater than 200mg/100ml (a level associated with probable coma in intolerant individuals) was noted in five individuals, and a history of chronic alcohol abuse was evident in all but one of these cases. Despite a level of tolerance in these four cases, the alcohol would have a possible potentiating effect on other respiratory depressants such as opiates leading to fatal respiratory depression.

5.5.7 Discussion

The proliferation of the methadone maintenance programme (MMP) throughout the Strathclyde area is evident from the annual increase in methadone prescriptions dispensed. Over the study period, 1986 – 2001, only 21% (n = 56) of drug related deaths where methadone was detected post-mortem were judged to be due to methadone alone.

This study revealed that fatalities from polydrug use involving other opiates and benzodiazepines were much more common than from methadone alone. This combination of drugs has previously been documented previously, not only in drug users in the West of Scotland[45, 46, 79] but also in Europe[109, 146]and Australia[118]. As both groups of drugs are respiratory depressants, at least an additive effect may result when taken in combination. Other illicit drugs (e.g. amphetamine, cocaine, ecstasy) and commonly abused medicinal drugs such as dihydrocodeine and chloral hydrate were also detected.

From the 182 cases where MMP status could be ascertained, less than one half of cases involved legitimately supplied methadone. This demonstrates the risk of diversion of legitimate supplies of methadone. Multiple "take home" doses was noted in 21 cases. Whilst permitting a patient to uplift multiple doses may be perceived as a "step forward", this practice should not be encouraged unless the patient has been on a stable dose for some significant period and tested negative for other drugs of abuse by urinalysis on several occasions. The prevalence of illicit methadone was also shown to be significant in a study of non-fatal overdoses in Glasgow and Dundee and was found to be particularly common amongst drug users already enrolled on an MMP [185].

There is concern that some MMP patients continue to use illicit opiates and there were a number of MMP patients who tested positive for continued heroin abuse. This was confirmed by the presence of morphine and either codeine from the breakdown of monoacetylcodeine, an impurity in street heroin and/or 6-monoacetylmorphine, the first metabolic product of heroin. A possible reason for this continued usage may be that the patient has to "top-up" as a result of being prescribed too low a dose of methadone. As discussed earlier, a therapeutic window ranging from 60mg – 120mg has been suggested [186] and in Glasgow, an average dose of 48mg was recorded, a dose regarded as being sub-optimal[187]. In difficult cases, blood/serum monitoring would be beneficial in achieving the optimal dose. This has been supported by work carried out in Austria where it was concluded that therapeutic drug monitoring should become routine amongst MMP patients in order to achieve optimal results by preventing relapse and intravenous drug use[171].

Another possible explanation for the concurrent use of heroin with prescribed methadone is that the latter was prescribed as part of a low-threshold programme. In these programmes, methadone is prescribed while continued drug use is tolerated, the aim being that drug users are retained in treatment with a main focus being harm reduction. They are targeted at disorganized clients, who are not reached by regular programmes or who are unable to sufficiently control their consumption, to follow regular treatment [188]. These programmes have shown benefits such as reaching a marginalized clientele exposed to the HIV virus through unsafe injecting practices. Or to those who would not have access to regular programmes that are characterised by restrictive selection criteria and limited availability [189]. Van Ameijden et al also showed that whilst methadone-assisted detoxification and high-dose methadone programmes are shown to reduce mortality, low-threshold programmes also reduce overdose mortality [190]. Torrens et al report on a study in Barcelona where of 370 opioid-dependent patients, the retention rate after 2 years was 72% which supports the efficacy of the low-threshold methadone program [191]. In Switzerland, a pilot project in Zurich in 1992 showed that of 800 clients, 450 were retained in treatment with many entering high-threshold programmes [192]. This "promotion" to high-threshold programmes has also been described in Amsterdam. Here, the offering of more favourable dispensing conditions and linking the low- and high-threshold programmes, is expected to stimulate the addict into regulating their own addiction and organize their life in a better way as a step towards rejecting the addiction on their own initiative [193].

From the circumstances of death it was ascertained that approximately three-quarters of deaths (74%, n = 146) occurred whilst the deceased was presumed to be sleeping, following a period of observed intoxication. Permitting a "sleep it off" period was considered to be beneficial by witnesses, presumably in order to allow the effects of the drugs to wear off. However, as reported in a previous study[97], had medical attention been summoned on the first indication of overdose, some of these deaths may have been preventable, a conclusion supported by Clark et al who found that the toxic effects of methadone are often delayed[174].

The source of methadone could not be ascertained in the majority of recently released prisoners in this study sample. A period of abstinence can result in a loss of tolerance for a drug and prisoners are made aware of these dangers prior to their release. Despite this, some individuals choose to revert back to quantities of drugs they were previously accustomed, hence increasing their risk of overdose. Whilst some of the recently released prisoners were enrolled on an MMP at the time of their death, their MMP status was

unobtainable prior to their term of imprisonment. The possibility of having been recently liberated should always be investigated by a GP when a patient is being prescribed methadone either for the first time or as an apparent "continuing" patient. If the latter case is applicable then the patient should be started on a dose lower than that previously prescribed. In addition, permitting multiple doses to be prescribed at the one time should be discouraged due to the obvious risks of overdose and/or leakage onto the black market.

Post 1996, deaths involving methadone have decreased despite both an increasing number of people being prescribed methadone and an overall increase in drug related deaths. This suggests a positive impact of both improved medical practice following 1996 and the dissemination of methadone programmes from Glasgow to Strathclyde. Supervision programmes did not become common practice in the rest of Strathclyde until 1997 onwards and presently the supervision scheme in the other three health board areas remains incomplete[5]. The death rates for 2001 in Glasgow are particularly encouraging, showing lower rates compared with the other health board areas despite this area having nearly double the amount of MMP patients than the other three health board areas combined. The figures presented in this paper reflect the success of the supervised programme in Glasgow. As the rest of Strathclyde becomes increasingly involved in the MMP it is essential that pharmacies are recruited to supervise daily doses of methadone. There are, however continuing concerns. For example, in all areas, a small proportion of patients continue to be issued either daily or weekly unsupervised scripts. Whilst this may be seen by GPs and other agencies as progress in building trust between the patient and GP, the potential for diversion should not be overlooked. In addition the Advisory Council on the Misuse of Drugs suggests that lax prescribing is responsible for a significant proportion of drug-deaths [5] and supports recent national guidelines on the management of drug misuse with an emphasis on the supervised consumption of controlled drugs [194].

Possible initiatives could target clinicians in an attempt to increase the participation and confidence of GPs involved in the methadone programme by continuous training and support in prescribing and supervision to avoid difficulties encountered with methadone dose assessment.

There may be other confounding factors aside from the introduction of the guidelines for improved patient management and clinical care together with increased supervision of consumption that resulted in a fall in the death rate. However, this observational study

showed that the death rate reduction did coincide with these changes in practice which indicates a possible positive effect on overall reduction of methadone deaths.

5.5.8 Conclusion

The use and effectiveness of methadone as a treatment for opiate addiction initially received much criticism. However, the findings of the confidential enquiry in addition to increased and widespread supervision implemented by pharmacists have been major factors in reducing deaths involving methadone. The argument that methadone is an unsafe alternative therapy for opiate addiction is not supported by the results of this study. What has been demonstrated in the West of Scotland is that methadone, if not sufficiently supervised can lead to otherwise preventable deaths by diversion of supply. In addition, regular monitoring should be adhered to as per the guidelines to ascertain the stability of the patient in order to establish the correct dosage is being prescribed. With efficient patient management to establish the compliance with the guidelines of the programme, methadone can be a safe drug for substitution therapy.

5.6 Dihydrocodeine (DHC)

Street Names: Diffs, DFs

Dihydrocodeine is a semi-synthetic opioid agonist derived from codeine. It's pharmacological action is almost purely analgesic and it is primarily prescribed for the relief of moderate pain, especially for terminal cancer patients. Other indications include that of an anti-tussive drug, being effective at doses lower than those employed for analgesia and as an anti-diaorrheal (DHC is the most constipating of all the opiates).

5.6.1 Legal Status

Dihydrocodeine is a Class B drug under the Misuse of Drugs Act 1971. Possession and supply of this drug carries a maximum penalty of 5 years and/or an unlimited fine and 14 years and/or an unlimited fine respectively.

5.6.2 Prescribing

DHC is available in the United Kingdom in oral and parenteral (50mg/ml injection) formulations. The oral preparations include an elixir syrup (10mg/5ml) and tablets of varying strengths (30mg, 40mg, 60mg, 90mg and 120mg). The 60mg – 120mg tablets are controlled release formulations allowing one tablet to be swallowed every twelve hours. In Strathclyde, the preferred formulation is the 30mg tablet which accounted for 75% of all DHC formulations prescribed over a five-year period[51]. For analgesia, the usual dose by mouth is 30mg or for severe pain up to 240mg daily whereas when prescribed as a cough suppressant, 10-30mg up to three times daily would suffice [195].

In the United Kingdom, DHC was first used in the treatment of narcotic addiction in the early 1970s. More recently there is evidence to suggest that it is emerging as an alternative to methadone in the management of drug misuse by some GPs [196, 197], even although DHC is unlicensed for the management of drug dependence [198]. This means that, unlike methadone, no rigorous research has been carried out into the effectiveness of this drug as a substitute for opiate addiction. In Scotland, for example, Matheson et al revealed that DHC was being dispensed for the management of drug misuse by 26% of pharmacists who participated in their study [157]. The prevalence of this drug in DRDs has been previously reported [50] and it's potential for abuse and caution on repeat prescriptions has been

publicised [199]. For those receiving DHC as an opiate substitute, the oral solution or controlled-release preparation is given in daily doses of up to 3000mg [200]. There are a few reasons as to why DHC prescribing is preferred by some GPs over methadone in the management of harm-reduction which include:

- It is perceived to be less addictive than methadone [201] with the manufacturers reporting that it has a "low addiction potential" [202].

- It may seem more favourable to GPs in that several days supply can be dispensed at the one time. (This can however, be perceived as problematic. The short half-life of this drug means that patients often have to consume very large numbers of tablets daily. This, in turn, may lead to diversion of legitimate supplies.)

- There is no need for patient follow up care or the administrative measures that are associated with methadone programmes.

- It is relatively insoluble and hence less likely to be injected.

- The supervision of DHC is not considered to be necessary (in any case, it would be a near impossible task to implement due to multiple doses having to be consumed daily owing to its short half-life).

DHC has been subject to virtually no media interest as a drug of misuse, despite, its abuse by drug addicts being widely reported [196, 202, 203, 204]. Due to this potential for misuse, it has been noted that a DHC detoxification programme should be managed just as carefully as that of methadone[198]. The presence of this drug as a contributory factor in deaths from narcotic overdoses has also been reported in Germany [205, 206].

5.6.3 Identification in biological samples

Dihydrocodeine is identified in biological samples by the presence of the parent drug itself. Metabolites such as dihydromorphine and nordihydrocodeine are not included as part of the routine analyses in the laboratory.

5.6.4 Toxicity

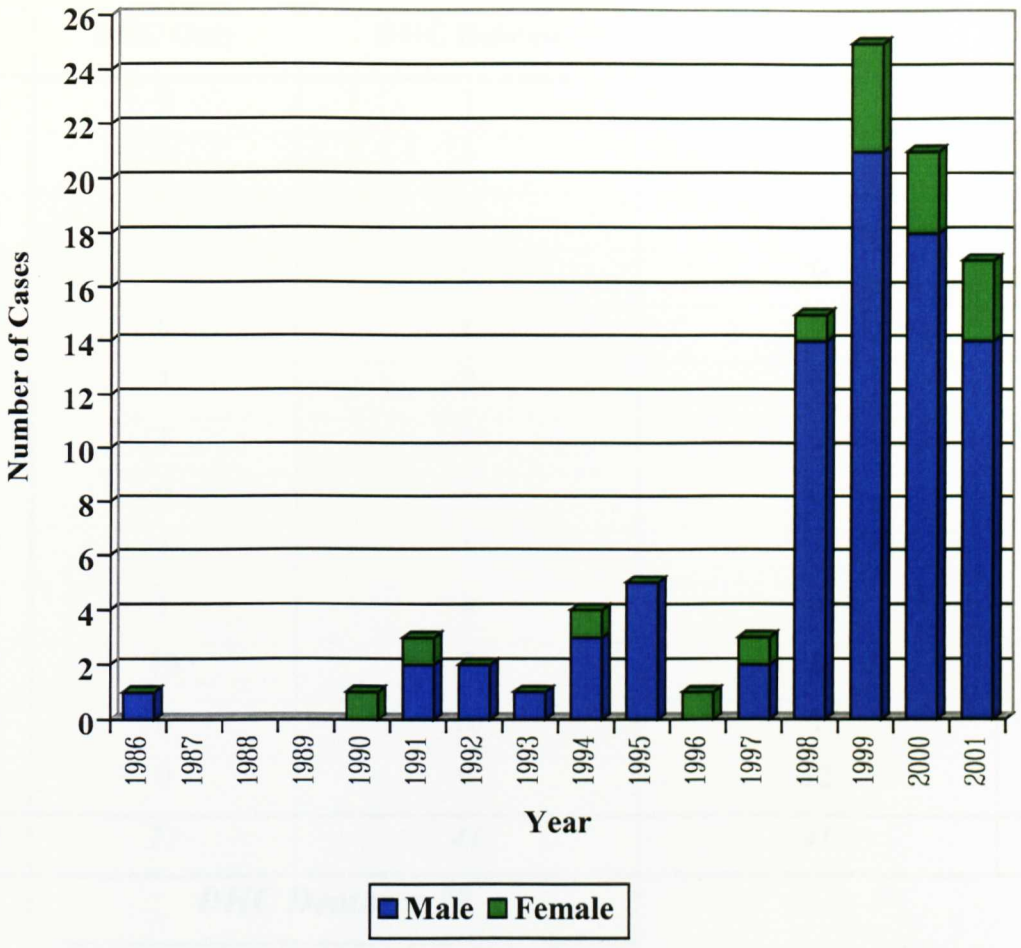
An overlap between levels of DHC detected in fatal and non-fatal cases have been reported in the literature. The blood concentration of DHC detected in a study of 36 fatalities ranged from 0.6 – 25.3 mg/litre [206] and in another study involving 4 self-poisoning cases ranged from 7.2 – 12.0 mg/litre [207]. In contrast, cases involving drivers suspected of driving whilst impaired have ranged from 0.1 – 3.3 mg/litre serum in one study [208] and 0.01 – 5.98mg/litre blood in another [209]. Efforts have been made to tabulate therapeutic, toxic and fatal levels, for example, Repetto and Repetto suggest a therapeutic window of 0.03 – 0.25 mg/litre in serum plasma and a fatal concentration of 0.8 mg/litre in blood [210]. These concentrations are in general agreement with Osselton who gives a therapeutic window of 0.07 – 0.13 mg/litre in serum plasma and a fatal range in blood of 0.8 – 1.7 mg/litre [211]. These are only guidelines for interpreting whether the drug has been conducive to death, however, and other information available must be considered such as the circumstances of death, other drugs detected and the tolerance of the individual.

5.6.5 The Incidence of Dihydrocodeine in Drug Related Deaths in the Strathclyde Police Region of Scotland.

The presence of dihydrocodeine was confirmed in 99 accidental drug related overdose deaths in the Strathclyde Police region over the years 1985 – 2001. The incidence of this drug increased from one case in 1986 to 25 cases in 1999 and decreased slightly to 18 cases by 2001 and accounted for between 1% and 15% of all accidental illicit drug overdoses throughout the study region over the study period. Figure 26 shows an emerging trend for this drug over the latter four years of the study which accounted for almost four fifths of all DHC positive drug death cases (79%, n = 78).

In the majority of cases, the deceased was male (84%, n = 83) with an average age of 28 years (ranging from 14 – 43 years, std dev. = 6.96). Females had an average age of 30 years (15 – 49 years, std dev. = 8.58). This difference of 2 years was shown not to be statistically significant (p = 0.28, 95% CI –6.09 to 1.76). The deceased was known to have a history of drug abuse in 95% (n = 94) of cases and in just under three-quarters of these cases, the deceased was known to be an intravenous drug user (73%, n = 69).

Figure 26: Number of dihydrocodeine positive illicit drug overdoses



5.6.5.1 The role of dihydrocodeine in causing death

All cases were classified into one of three groups depending on the cause of death assigned by the investigating pathologist and in a similar fashion to the way the methadone positive cases were classed. Table 17 shows that 18% (n = 17) of cases were certified to be due solely to the effects of dihydrocodeine, 41% (n = 41) were due to dihydrocodeine in combination with another drug and a further 41% (n = 41) were due to the effects of a drug other than DHC despite its presence in the biological sample.

Table 17: Dihydrocodeine cases classified according to cause of death as certified by the investigating pathologist

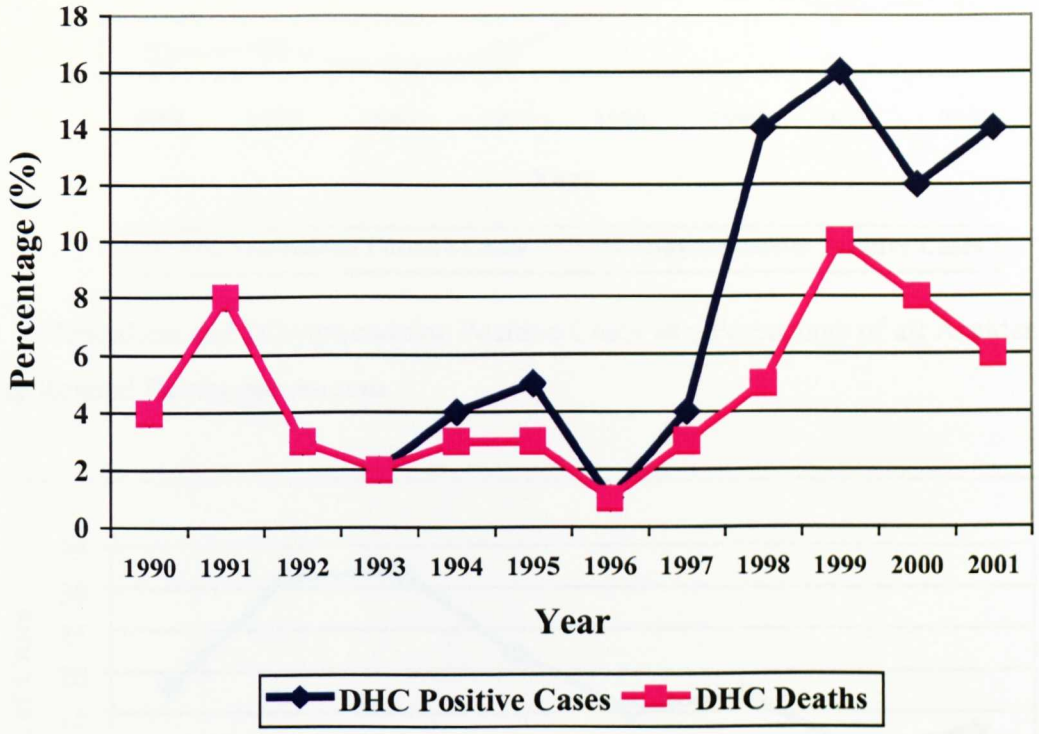
Year	DHC Only	DHC Related	Not DHC Related	Total
1986	0	1	0	**1**
1990	0	1	0	**1**
1991	1	2	0	**3**
1992	2	0	0	**2**
1993	0	1	0	**1**
1994	1	2	1	**4**
1995	1	2	2	**5**
1996	0	1	0	**1**
1997	1	1	1	**3**
1998	1	4	10	**15**
1999	10	7	8	**25**
2000	0	10	7	**17**
2001	0	9	12	**21**
Total	***17***	***41***	***41***	***99***
	DHC Deaths = 58			

5.6.5.2 Dihydrocodeine as a cause of death

In order to study deaths where dihydrocodeine was considered the cause of death either alone or as a contributory factor in combination with other drugs, all deaths classed as "DHC alone" or "DHC related" will collectively be referred to as "DHC deaths". More than half of all DHC positive drug related accidental overdose cases were found to be due wholly or partially to the effects of DHC (59%, n = 58). Males outnumbered females by a ratio of 5:1. Of this group, the mean male age was 26 years (14 – 39 years, std. dev. 6.71) and the mean female age was 28 years (15 - 42 years, std. dev. 7.50). There was no significant differences in age between males and females where a mean difference of 2 years was observed (p = 0.4, 95%CI –6.6 to 2.9). The number of DHC positive cases and DHC deaths as a proportion of all accidental drug overdoses is shown in Figure 27 with the exception of 1986. This shows that DHC was considered to play a role in causing death in all DHC positive cases between 1990 and 1993 only (as well as in 1986). From 1997 there was an emerging trend for DHC in overdose deaths and by 1999 it was found to be positive

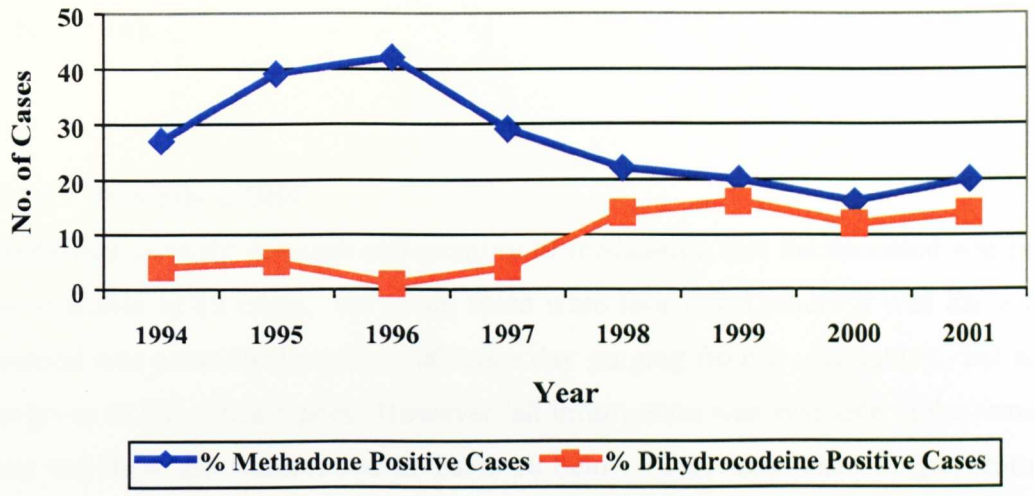
in up to 16% of all accidental drug overdoses. Despite this increase in positivity between 1997 - 2001, it was considered attributable to the death in between 33% - 68% of cases.

Figure 27: DHC positive cases and DHC deaths as a percentage of all accidental illicit overdoses

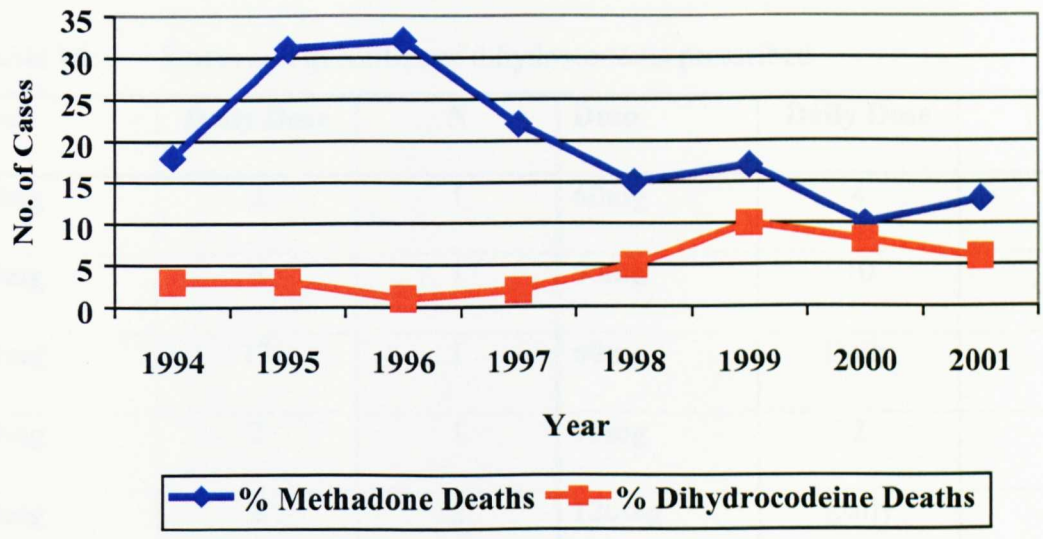


It is interesting to note the changes in trends between methadone and DHC when the number of methadone positive cases and methadone deaths as a percentage of all accidental drug overdoses are compared with the number of DHC positive cases and DHC deaths. Figure 28 shows this trend from 1994 onwards. When methadone positive cases started decreasing in 1996, the number of DHC positive cases detected in the laboratory were seen to increase. This could possibly be explained by the preference of some GPs to prescribed DHC in favour of methadone which at the time was being more strictly supervised. The defined daily dose (the typical adult daily maintenance dose of a drug) of DHC increased by 80% between 1992 and 2001. An increase in DHC prescribed could potentially result in an increase in DHC on the black market.

Figure 28: Prevalence of Dihydrocodeine and Methadone Amongst Drug-Related Deaths



A: Methadone and Dihydrocodeine Positive Cases as a Percentage of all Accidental Drug Related Deaths per Annum



B: Methadone and Dihydrocodeine Deaths as a Percentage of all Accidental Drug Related Deaths per Annum

5.6.5.3 Source of Dihydrocodeine

Of all 58 DHC deaths, it was possible to ascertain whether the deceased had been prescribed DHC from information provided in the medical history section of the police sudden death report. This was omitted in six cases either because there was no police report available or the GP was unobtainable at the time the police report was compiled. Of

the remaining 52 cases, approximately two-thirds involved DHC which had been obtained by the diversion of legitimate supplies (69%, n = 36) with the deceased having been in receipt of a DHC prescription at the time of their death in just over under one-third of cases (31%, n = 16).

5.6.5.4 Prescribed DHC

Information as to the strength and quantity of medication that the deceased was prescribed was available in 15 cases. Of these, there were four cases where it was known that the deceased was prescribed multiple tablets a day ranging from 2 – 13 tablets, but no dosage was given in the police report. However, all information was available in the remaining 11 cases and these are summarised in Table 18 below. The daily doses ranged from 60mg – 600mg daily. In two of these cases, the dose was in excess of that recommended for severe pain, suggesting that in the remaining cases, the DHC had been prescribed for the management of analgesia.

Table 18: Doses and quantities of dihydrocodeine prescribed

Dose	Daily Dose	N	Dose	Daily Dose	N
30mg	2	1	**60mg**	4	1
30mg	6	1	**60mg**	10	1
30mg	17	1	**60mg**	Daily	1
60mg	2	1	**90mg**	2	1
60mg	3	2	**120mg**	Daily	1

There was also note that in excess of the prescribed amount of medication had been consumed in three cases involving prescribed DHC. Details of these are summarised in Table 19.

Table 19: Details of cases where in excess of the prescribed dosage had been consumed.

	Date Prescribed	Amount Prescribed	Date of Death	Evidence to indicate an excess had been consumed	DHC Involvement
1	27/11/02	36	28/11/02	34 tablets missing from bottle	DHC Only
2	9/3/02	?	10/3/02	34 tablets missing from bottle	DHC related
3	7/1/00	56 tablets	10/1/00	Empty bottle at locus	DHC related

Information that the deceased had been on an MMP in the past but did not complete the programme for one reason or another was applicable to three cases where DHC had been prescribed (19% of prescribed cases). This involved one DHC only death and two DHC related deaths. In these instances it is probable that due to a failure to comply with an MMP, the GP decided to prescribe DHC as an alternative opiate substitute therapy.

5.6.5.5 Circumstances of Death

From the police sudden death report, it was possible to ascertain the deceased's last movements prior to death. From this all deaths were categorised according to the categories outlined in Table 20 and summarised in Figure 29:

Table 20: Categories of Activities Prior to Death

A	Not seen for a while (long enough for relative/friend to become concerned) and found dead at locus
B	Gone elsewhere within locus, witness becomes concerned and checks on deceased
C	Witnessed to be intoxicated prior to following asleep and never wakes up
D	Witnessed to take drugs prior to lapsing into unconsciousness
E	Anonymous phone call made to ambulance control and exact details unknown
F	Found dead at locus which was not a dwelling abode
G	Hostel Death – found dead whilst staff were carrying out routine checks
H	Death in Custody
I	No intoxication / drug consumption witnessed. Found dead in other part of locus to where witnesses were
J	Died in hospital having been admitted for suspected drugs overdose
K	Feeling unwell/ took a funny turn although no drug consumption witnessed
L	Exact details not known

Approximately one-third (36%, n = 21) of all DHC deaths fell into category C where intoxication was witnessed prior to a period of sleep (13 DHC related : 8 DHC only). In two-fifths of cases, (40%, n = 23), no intoxication or drug consumption had been witnessed. The circumstances surrounding these 23 cases included the deceased being found by a witness who:

- was within the same locus although physically segregated (categories B and I, n = 9),

- had not seen the deceased for a while and found them dead within their own abode (category A, n = 8),

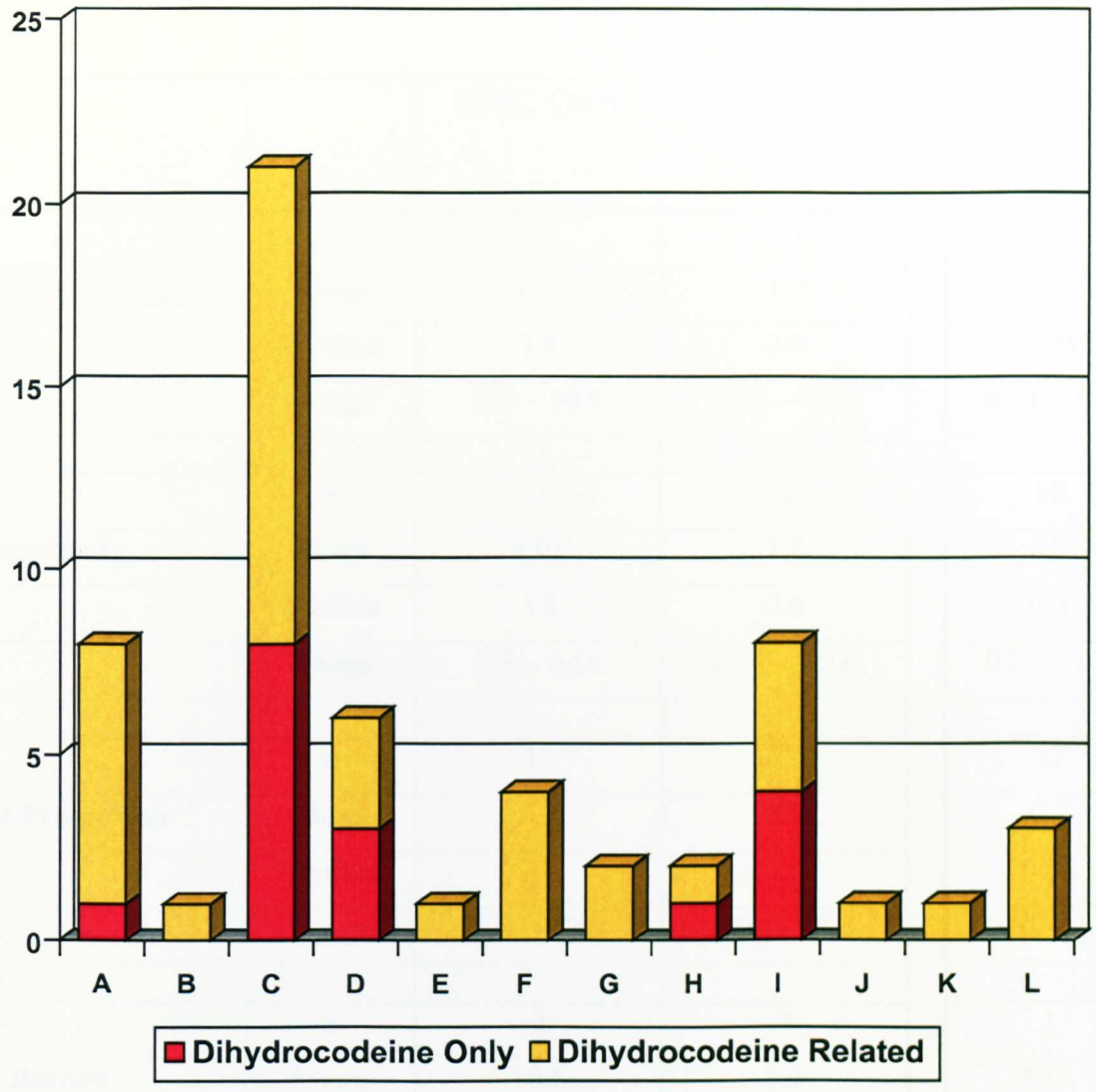
- was passing by the locus and found deceased (category F, n = 4)

- were hostel staff employees carrying out routine bed checks (category G, n = 2).

In the remaining 14 cases, drug use and/or collapse was witnessed in 7 cases (categories D and K); the exact details of overdose and witness accounts were unknown in 4 cases (categories E and L) and finally death occurred either within hospital or police custody in the remaing three cases (categories H and I).

In 13 cases (22%) a syringe and needle was found at the locus either in situ (n =5) or adjacent to the deceased (n = 8). These were all DHC related deaths and morphine, indicative of heroin misuse, was confirmed as being a contributory factor to death in all of these cases.

Figure 29: Number of cases classified by type of death and category of circumstance



5.6.6 Results of Toxicological Analyses

A blood sample was not obtained in six cases. However, urine and a liver sample were used as alternative matrices. Of the remaining 52 cases, the post mortem blood DHC concentrations ranged from 0.03 – 19.9 mg/litre. Table 21 lists the mean, median and range of DHC concentrations detected for each cause of death group and whether or not the DHC had been prescribed. The mean concentrations for DHC only deaths were significantly higher than those for DHC related deaths (p=0.01, 95% CI: 1.9 to 6.9) and a mean difference of 4.5mg/litre was observed.

Table 21: Mean concentrations of post-mortem DHC concentrations detected depending on cause of death

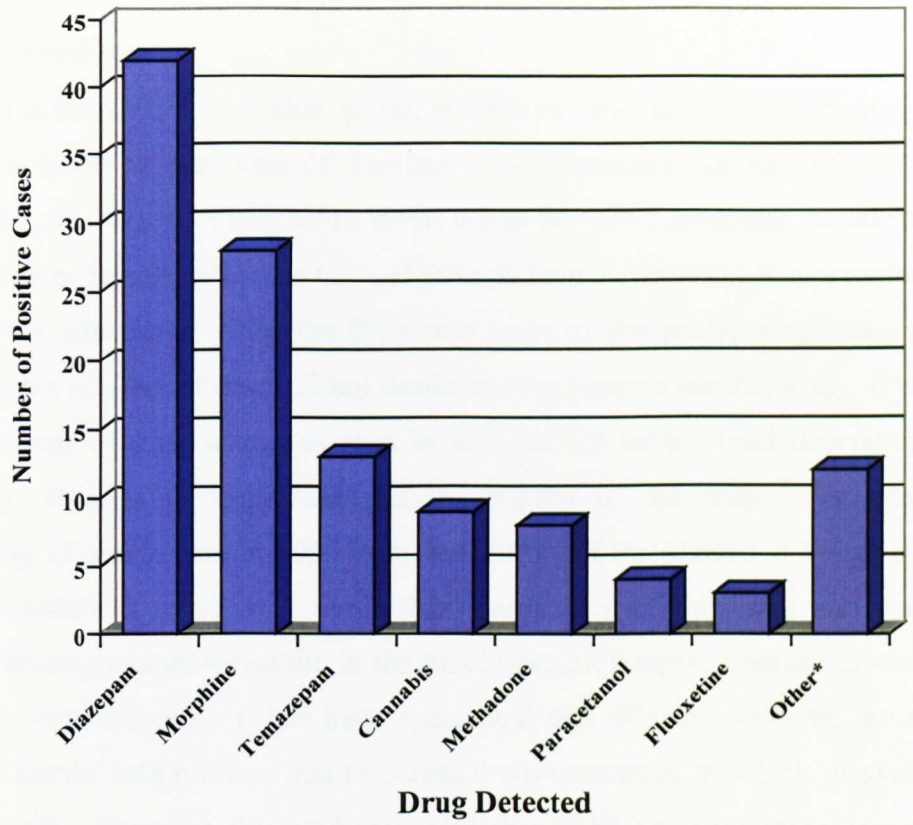
		DHC Only	DHC Related	Not DHC related
	n	16	36	41
All Cases (n = 52*)	**Mean**	6.2	1.7	0.3
	Median	3.8	0.9	0.05
	Range	0.9 – 19.9	0.03 – 17.5	0.01 – 1.6
	n	4	10	10
Prescribed	**Mean**	4.01	1.4	0.5
	Median	3.8	0.6	0.3
	Range	2.3 – 6.14	0.17 – 7.18	0.01 – 1.3
	n	10	23	27
Not Prescribed	**Mean**	6.2	1.8	0.2
	Median	3.8	1.0	0.04
	Range	0.9 – 17.6	0.03 – 17.5	0.01 – 1.6
	n	2	3	1
No Record	**Mean**	10.6	2.2	N/A
	Median	10.6	2.9	N/A
	Range	1.4 – 19.86	0.23 – 2.9	0.06

* In 6 cases it was not possible to collect a peripheral blood sample, however, liver blood or urine was available in 6 cases (5 DHC related, 1 DHC only)

Polydrug usage was evident in all 58 cases. DHC had been taken concurrently with another one drug in just over one-quarter of cases (28%, n = 16), together with another two drugs in 45% of cases (n = 26) and with another three drugs in 22% of cases (n = 13). As many as an additional four drugs had been detected three cases (5%). Diazepam was the most frequently detected additional drug closely followed by morphine which were found to be present in 42 (72%) and 28 (48%) of cases respectively. These two drugs had been consumed concurrently in 20 cases (48% of diazepam positive cases and 71% of morphine positive cases), 3 were DHC only deaths, 17 were DHC related deaths. In just over one-

third (39%, n = 11) of all morphine positive cases, the deceased had been prescribed DHC and indicates non-compliance with an opiate substitute programme in approximately two-thirds of all patients known to have been prescribed DHC throughout the study period (69%). Even if these individuals were not prescribed DHC as part of an opiate substitute programme, the dangers of polydrug use should have been highlighted by their GP. The other drugs detected are shown in Figure 30.

Figure 30: Other drugs detected in DHC positive cases



* **Other (one case each)** Amitriptyline, Chloral Hydrate, Diconal, Phenytoin, Chlorpromazine, Ibuprofen, Co-proxamol, Warfarin, Chlordiazepoxide, Diphenhydramine, Citaolpram, Venlafaxine

The frequency and types of drugs detected are consistent with the overall drug scene in the West of Scotland in that the opiate/benzodiazepine cocktail is preferred. This study shows that the type of opiate used may change or be taken concurrently with other opiates, therefore increasing the risk of overdose in an individual.

Alcohol was found to be positive in 24 (41%) cases (23 blood and 1 urine sample). An average BAC of 87mg/100ml was observed (3 – 364mg/100ml). Morphine was found to be positive in just over one-half of these cases (57%, n = 13). A median BAC of 74mg/100ml was observed in these cases compared to 28mg/100ml in cases where no morphine was detected, however there appeared to be no statistically significant association between BAC and presence of morphine (p = 0.06, Mann Whitney).

5.6.7 Discussion

In addition to heroin and benzodiazepines, the role of DHC as a significant drug of misuse has been detected in the West of Scotland. An increasing amount of DHC is being prescribed in this region. The reasons for its use as an opioid substitute include prescribing it to allow more flexibility for the GP and their patients in instances where methadone was not a suitable alternative. Over the latter four years of this study, there was a significant increase in the number of drug related deaths testing positive for this drug. Over the past decade patterns of drug taking as seen in drug deaths have varied depending on drug availability, changes in legislation and the quality of the drug. For example, the rescheduling of temazepam in 1996 from schedule 4 of the Misuse of Drugs Regulations 1985 to schedule 3 resulted in diminished availability of this drug and consequently diazepam emerged as its substitute in the heroin-benzodiazepine cocktail favoured by the Strathclyde drug misuser. It has been speculated that dihydrodocodeine is used during periods of heroin deficit either due to personal circumstances or a lack of availability of street heroin[204]. However, this study revealed that DHC had been taken in combination with heroin in one half of all cases.

Similar to all drug related deaths in the West of Scotland, the presence of a cocktail of drugs presents a problem. DHC, like other narcotics, interacts with other drugs to depress the central nervous system and consequently leads to acute respiratory depression and respiratory failure. This is recognised at post mortem by the presence of pulmonary congestion and oedema which is often the only significant autopsy finding in a drug related death. It should also be noted that the depressant effects of alcohol are enhanced by DHC.

The majority of DHC in this study had been obtained by the diversion of legitimate supplies. This is similar to findings of a study investigating methadone deaths in the same region where black market methadone accounted for the majority of the methadone

involved [97]. It is possible that the increased quantities of DHC prescribed over the study period have resulted in increased availability on the streets. This in turn makes DHC a low cost analgesic, which presently can be bought, on the streets of Glasgow for between 50 pence and £1.00 [212]. The pharmacokinetics of the most frequently prescribed 30mg DHC tablet render a supervised programme almost impossible to implement as the half-life is significantly shorter than that of methadone. This in combination with the fast acting properties of DHC means that often several doses have to be taken throughout the day. Seizures of DHC on the streets are relatively low and police tend not to consider this as a problematic drug[212].

From the circumstances of death, it was noted that of all DHC only and DHC related deaths, approximately one third of all cases involved the deceased falling asleep having been witnessed to being intoxicated. This is a similar scenario to that of methadone deaths and raises the point that some deaths may have been preventable had medical intervention been sought on initial contact as opposed to the witness allowing a period of sleep and ultimately unconsciousness.

The decreasing prevalence of methadone deaths with respect to the total number of accidental drug related deaths per annum reflects the positive impact of increased supervision of its consumption. What is of some concern is the fact that as the figures for methadone decrease, those for DHC are increasing, suggesting the possibility that as the supply for one opiate substitute on the streets decreases, the demand for another emerges.

5.6.8 Conclusion

DHC as a suitable, safer alternative to methadone prescribing is questionable. The increasing prevalence of DHC detected amongst drug related deaths and the consequent conclusion that it has attributed to death, particularly over the past two years of the study has been highlighted. The present situation reveals that the initial problems encountered with methadone dispensing, such as diverted methadone, have been resolved and is reflected in the decreasing numbers of methadone deaths per annum. However, an increase in DHC prescribing has resulted in an increase in DHC related deaths possibly due to this drug being more readily available and inexpensive to buy on the streets. Whilst in some aspects, DHC may appear to be a good alternative to that of methadone, its abuse potential should not be overlooked. The incidence of DHC detected in cases is a matter of concern and requires monitoring to establish if this is a "real trend" or "fashionable phase".

5.7 Cocaine

Street Names: Coke, Charlie, Snow, Base, Rock

Evidence of South American Indians chewing the leaves of the coca plant became apparent as early as AD500 where its ability to decrease fatigue, elevate mood and heighten alertness was known and was a practice they had been accustomed to for thousands of years [213]. It was in the mid 1800s that cocaine, an alkaloid substance present in the coca leaf was extracted by Albert Niemann who subsequently published his Ph.D thesis, "On a New Organic Base in the Coca Leaves" in 1860[214]. However it was not until 1880 that the drug's effects were recognized by the medical fraternity and in 1884 Sigmund Freud published "*Uber Coca*"[215] which documented his experiences of cocaine advocating that it was a tonic that could cure hunger, melancholy, asthma and morphine addiction[216]. Since this date, it's use in a number of products throughout the centuries have been well documented[20], for example, the psychostimulant has been used as a component in drinks (Coca-Cola®), patent medicines (e.g. Dr Tucker's Asthma Specific) and ophthalmic and dental procedures. However, like other psychotropic drugs it's abuse potential came to light and today the misuse of cocaine is dominant in the United States [217, 218] and conducive to a large proportion of drug related deaths [219,220]. That said, the prevalence of cocaine in other countries is becoming evident [221,222].

Cocaine is available in two illicit forms, the water-soluble white crystalline salt form cocaine hydrochloride ("snow") and a free base form referred to as "crack", so named due to the sound it makes when heated. The most common route of administration of cocaine is snorting, using the hydrochloride form where absorption occurs mainly through the nasal mucosa and euphoriant effects can last between 60 – 90 minutes due to slow and prolonged

Extract from Sigmund Freuds "Uber Coca" where he writes of cocaine inducing…

"...exhilaration and lasting euphoria, which in no way differs from the normal euphoria of the healthy person...You perceive an increase of self-control and possess more vitality and capacity for work....In other words, you are simply normal, and it is soon hard to believe you are under the influence of any drug....Long intensive physical work is performed without any fatigue...This result is enjoyed without any of the unpleasant after-effects that follow exhilaration brought about by alcohol....Absolutely no craving for the further use of cocaine appears after the first, or even after repeated taking of the drug..."

absorption. Inhaling the vapours produced when the rock form (crack) is heated produces a much more intense "high" compared to that of cocaine hydrochloride, however, in order to maintain the euphoriant effects, the process has to be repeated as frequently as every 20 minutes. Injection of cocaine hydrochloride has also been reported particularly when taken concurrently with heroin. The use of this bolus termed as a "speedball" has been reported in the literature [223,224].

In the mid eighties cocaine use tended to be restricted to small groups of upper class executives with disposable incomes residing mostly in the London area when it was used recreationally to enhance their party mood. In the past, due to it's relatively high price which acted as a natural deterrent, cocaine was not widely abused and was known on the streets as the "champagne of drugs"[225]. However, the prevalence of abuse and cocaine related deaths have risen over the past decade in Britain and this has been speculated to be due to a wider availability of the drug as a result of a depreciation in price [226]. It's availability in the United Kingdom is no longer limited to adults as a recent survey reported that of every 1000 children in the 10-12 year age group, 17 will have been offered cocaine [227]. National statistics relating to police seizures also suggest that cocaine is becoming problematic since the number of seizures in Scotland has increased over the years 1985 – 1998. In terms of quantity seized, 0.4kg was retrieved in 1985 compared with 22.8kg in 2001[228]. Whilst these figures do not differentiate between cocaine hydrochloride and "crack", anecdotal information suggests that the majority of cocaine circulating around the Strathclyde area is cocaine hydorchloride owing to a dearth in "cocaine houses" being identified. It is assumed that users attempt to produce their own crack in situ for their personal use. Cocaine use has not reached epidemic proportions compared to that of heroin, however, it is emerging as a drug of misuse with an increasing number of new clients presenting at drug agencies claiming to use the drug. In fact, between 1997 and 2001 there was a 307% increase in reported cocaine use amongst this population, the majority of whom resided in the Greater Glasgow area (64% of all reported cases in 2001)[229]. This together with the high number of recent seizures, are indicative of a higher demand and use of this drug in the West of Scotland.

5.7.1 Legal Status

Owing to the abuse and addiction potential of cocaine, possession and/or supply of this drug incur heavy penalties since it is controlled as a Class A drug under the Misuse of Drugs Act 1971.

5.7.2 Identification in Biological Samples

Cocaine has a relatively short half-life of approximately 40 – 60 minutes [230, 231]. The major metabolites in the blood are benzoylecgonine (BE) and methylecgonine (ME), the former having a much longer half-life to that of cocaine (5 – 7 hours). In addition nearly a dozen other metabolites have been identified such as cocaethylene [232], produced in the presence of alcohol and by-products such as anhydroecgonine methyl ester (also known as methylecgonidine) which is produced following the pyrolysis of cocaine as a result of heating in the smoking process and hence is indicative of the use of crack cocaine [233, 234]. For the purposes of this study, however, evidence that cocaine had been taken was determined by the identification of the parent drug, BE and/or ME.

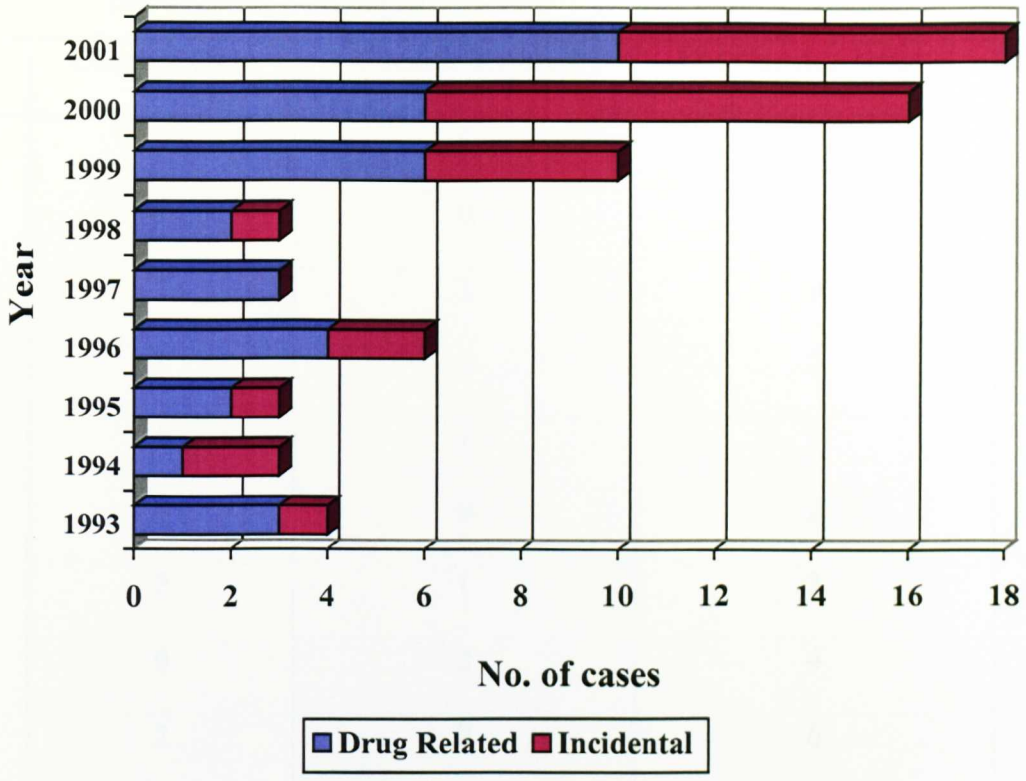
5.7.3 Toxicity

The ability to define a toxic level following the administration of cocaine is not so clear cut. For most other drugs the concentration of a drug detected in blood can be used to assess toxicity and lethality, however, cocaine would appear to be an exception to this rule [235]. Cocaine concentrations amongst deceased persons who have succumbed to the drug are known to vary greatly depending on the dosage, route of administration and period of survival. Excited delirium is a known syndrome related to cocaine use which is characterized by hyperthermia, delirium with agitation and respiratory arrest. A study of seven deaths whereby the deceased exhibited "excited delirium", prior to sudden collapse showed a mean PM blood cocaine concentration of 0.6mg/l (range, 0.1 – 0.9)[236]. Another study involving 2 patients who presented to the emergency department had cocaine concentrations that averaged 0.33mg/l [237]. These levels were significantly lower when compared to a study where the mean blood cocaine concentration measured in 48 males who died due to cocaine toxicity was 1.12mg/l (range, 0.001 – 18.1)[219]. Extremely high levels of cocaine and it's metabolites have been reported in cases, for example, a PM blood cocaine level of 51.7mg/l was recorded in a female who had reportedly ingested a large quantity of cocaine prior to suffering from a seizure[238]. The highest PM blood cocaine level recorded occurred in a female who died as a result of acute cocaine intoxication, a level of 330mg/litre was recorded even although the history suggested a series of recreational uses[239]. Also, Howell and Ezell report a case where a PM blood concentration of 30mg/l was recorded in a known chronic cocaine abuser, however, the presence of cocaine was merely incidental to death as the male died from a fatal gunshot wound [240]. Indeed the authors of this study report that "*a relationship between PM cocaine blood levels and toxicity has yet to be established and remains a matter of considerable debate*".

5.7.4 The Incidence of Cocaine in Drug Related Deaths in the Strathclyde Police Region of Scotland

Cocaine was first detected in a DRD in the Strathclyde Police region of Scotland in 1993 and since this date, evidence of its consumption in post-mortem samples has increased on a year to year basis. Over the study period, 66 cases showing exposure to cocaine were investigated in the Strathclyde region. For the purposes of this study, in order to show trends in drug misuse, the term "cocaine positive case" refers to a case where cocaine and/or metabolites were detected which would indicate consumption of the drug. In 1999 there was a 233% increase in cocaine positive cases compared with the previous year and by 2001 the number of cocaine positive cases had almost doubled compared to 1999. For all 66 cases, males outnumbered females by a ratio of 7:1. The mean age for both males and females was 30 years, ranging from 18- 46 years for males and 18 – 49 years for females. Figure 31 shows that just over one half of all cocaine positive cases were due to a drugs overdose (56%, n = 37) with the presence of the drug being considered as incidental to death in the remaining 29 cases. The mean age of males whose death was attributable to a drugs overdose was exactly the same as males where cocaine was regarded as being incidental to death (30years, S.D. 7.98 and 8.43 respectively). For females, the mean age of those who died of a DRD was 32 years (S.D. 11.28) and where cocaine was incidental to death, 30 years (S.D. 6.65). Of the 37 drug overdose deaths, the deceased was known to have a history of drug abuse in 33 cases (89%), 15 cases of which the deceased was known to abuse drugs intravenously. A history of cocaine abuse was noted on the police sudden death report in 10 cases, this being the only drug reported to be abused in 6 cases, misused in combination with other recreational drugs in two cases and misused by IVDA's in a further two cases.

Figure 31: Number of Cocaine Positive Cases Detected



5.7.4.1 The Role of Cocaine in Causing Death

From the causes of death certified by the investigating pathologist it was possible to ascertain the role of cocaine in the 37 overdose deaths and this is shown in Table 22 below. Just over one half were certified as being due to the effects of cocaine either alone (24%, n = 9) or in combination with other drugs (27%, n = 10). Just under one half were due to a drug other than cocaine (49%, n = 18). In these 18 deaths, heroin was certified as the cause of death in 12 cases either alone (9 cases) or in combination with other drugs (temazepam in 2 cases and diazepam in one case). The remaining six cases had a non-specific cause of death (e.g. inhalation of gastric contents, multiple drug intoxication), however, toxicology and circumstantial evidence indicated these were opiate related deaths, with heroin being positive in every case. This shows that the practice of concurrently injecting heroin and cocaine was prevalent amongst these cases.

Table 22: Cocaine cases classified according to cause of death certified by investigating pathologist

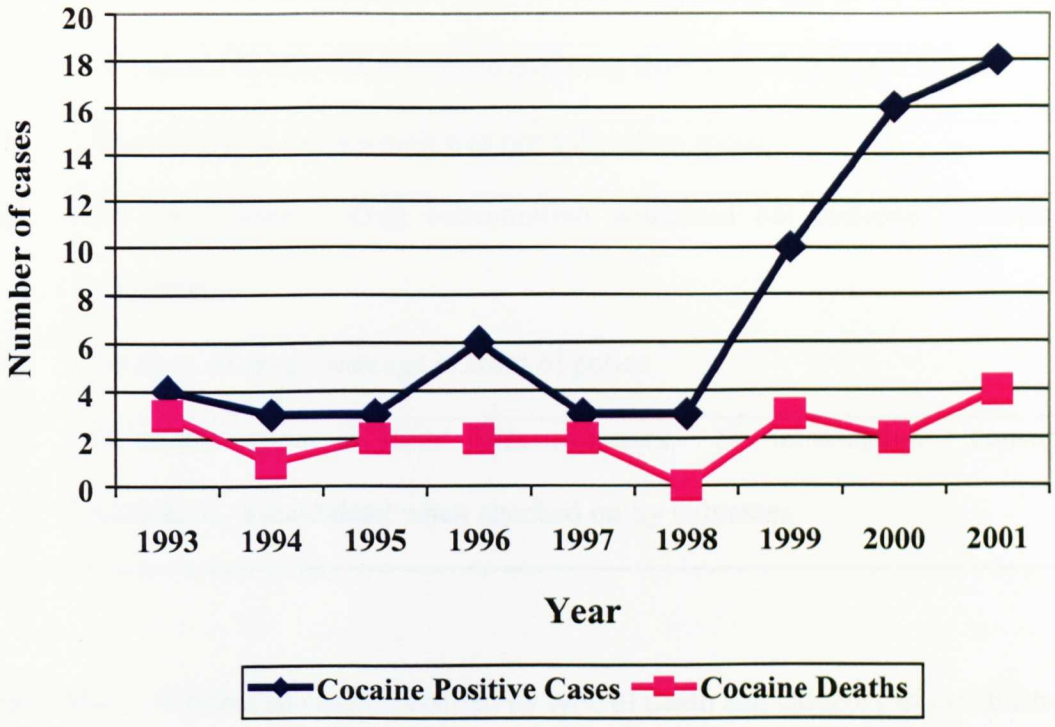
Year	Cocaine Only	Cocaine Related	Not Cocaine Related	Total
1993	1	2	0	**3**
1994	1	0	0	**1**
1995	1	1	0	**2**
1996	1	1	2	**4**
1997	1	1	1	**3**
1998	0	0	2	**2**
1999	2	1	3	**6**
2000	0	2	4	**6**
2001	2	2	6	**10**
Total	***9***	***10***	***18***	***37***
	Cocaine Deaths = 19			

5.7.4.2 Cocaine as a Cause of Death

In order to study deaths where cocaine was considered the cause of death either alone or as a contributory factor in combination with other drugs, all deaths classed as "Cocaine alone" or "Cocaine related" will collectively be referred to as "Cocaine deaths". Males accounted for all cocaine deaths with the exception of one case involving a 32 year old female, the mean male age was 30 years (19 – 44 years). Despite there being an increase in the number of cocaine positive cases reported in the laboratory, cocaine as a contributory factor to death in the West of Scotland remains negligible. (Figure 32). In fact in 1993, cocaine was attributable to death in 75% of all cocaine positive cases but by 2001, this fell to just over one fifth of all cocaine positive cases (22%, 4 cocaine deaths of a possible 18 cocaine positive cases). In relation to all accidental illicit overdoses over the study period and on an annual basis, cocaine was found to be positive, on average, in 4% of all cases between 1993 – 1999 and as a contributing factor to death in 2% of all overdoses. In 2000 and 2001, cocaine was found to be positive in 12% of all illicit

overdoses, however was considered to be contributory to death in only 2% of cases per annum.

Figure 32: Number of cocaine positive cases and of those the number of cases where cocaine was considered to be a contributing factor in the death



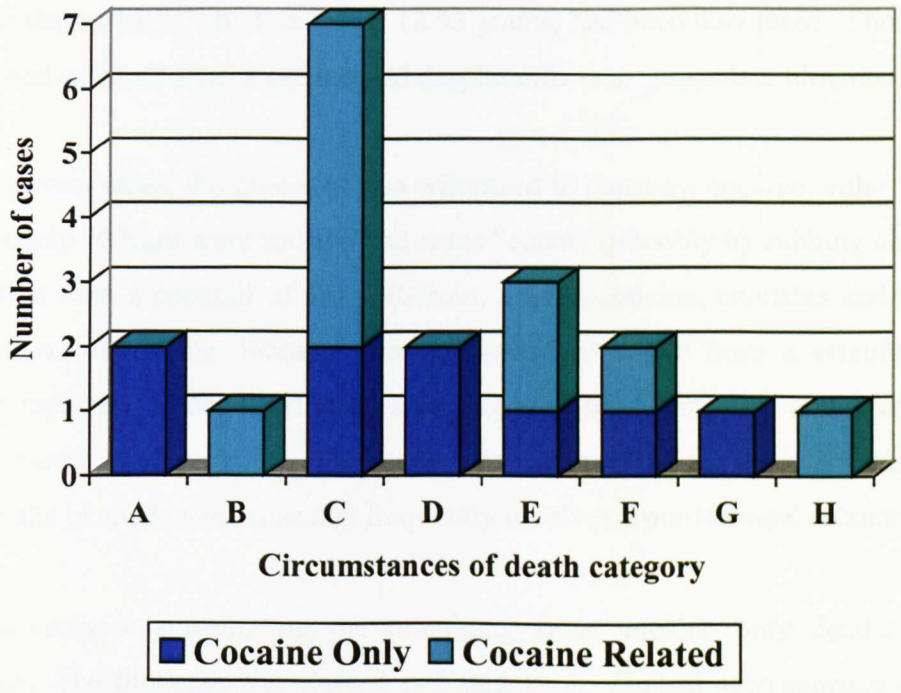
5.7.4.3 Circumstances of Death

From the police sudden death report, it was possible to ascertain the deceased's last movements prior to death and all deaths were grouped according to the categories outlined in Table 23 and these are summarised in Figure 33.

Table 23: Categories of Activities Prior to Death

A	Not seen for a while (long enough for relative/friend to become concerned) and found dead at locus
B	Gone elsewhere within locus, witness becomes concerned and checks on deceased
C	Witnessed to be intoxicated prior to following asleep and never wakes up
D	Witnessed to take drugs prior to suffering from a fit, foaming at mouth
E	Found dead at locus which was not a dwelling abode
F	No intoxication / drug consumption witnessed but collapse / reaction was witnessed
G	Swallowed drugs package in front of police
H	In another room in locus from witnesses. No intoxication / consumption witnessed. Found dead when checked on by witnesses

Figure 33: Number of cases classified by type of death and category of circumstance



5.7.4.3.1 Circumstances of Cocaine Only Deaths

In two cocaine only cases, death was intentional and this was ascertained by the presence of suicide notes at the locus. In the first case the deceased was a known drug user who took drugs both orally and nasally. He had been with friends earlier and was witnessed to smoke cannabis, prior to falling asleep, no indication of cocaine was evident from the police sudden death report apart from some empty paper folds with remnants of white powder (Category C). The second case involved a male who had no known drug history of note and was found in his works van along with a bag containing white powder. Despite paramedics conveying the deceased to hospital, he was pronounced dead on arrival (Category E).

In another two cocaine only cases, the deceased had swallowed or attempted to swallow a package containing cocaine respectively. In the former case, the deceased had not been seen for a while (Category A), however at post-mortem, a plastic bag containing white powder was found within the stomach and this showed evidence of having ruptured. A blood PM cocaine concentration of 8.4mg/litre was measured, a level consistent with levels found in similar cases [241]. In the second case, the deceased attempted to swallow a drug package when confronted by police (Category G). He refused to open his mouth which was firmly clenched shut and the package was retained within. At hospital diazepam was administered as a muscle relaxant in an attempt to open the mouth. On retrieval it was noted that the package, which weighed 12.93 grams, had been punctured. Shortly after this the deceased suffered from a seizure and despite efforts to resuscitate him, died.

In a further two cases, the deceased was witnessed to consume cocaine, either alone where approximately 10 lines were snorted and some "eaten" (possibly by rubbing on gums) or in combination with a cocktail of drugs (heroin, dihydrocodeine, cannabis and alcohol). In both of these cases, the deceased was witnessed to suffer from a seizure, where the witnesses reported the deceased to be sweating profusely, foam was also seen to emanate from the mouth (Category D). These cases are classical of the typical cocaine overdose which results in sudden collapse and frequently involves a pre-terminal seizure[236].

The circumstances surrounding the remaining three cocaine only deaths are a little ambiguous. The first case was classed as Category A. He had been snorting cocaine with friends who left the deceased alone for a period of time. When they returned to his house some hours later he was found to be dead. Despite being conveyed to hospital, he was

pronounced dead on arrival. The second case (Category F) involved a male who was working although feeling unwell and complaining of a sore head. Whilst in a car being driven by a witness, he vomited, got out the car, stumbled and fell over banging his head. The witness also reported foam emanating from the deceased's mouth. He too was pronounced dead on arrival at hospital. In the third case, the deceased (who was witnessed to be intoxicated) admitted to having snorted a couple of lines of cocaine. He was later seen apparently sleeping on his bed, but was later unrousable (category C). Paramedics efforts to revive the deceased at the locus were fruitless.

5.7.4.3.2 Circumstances of Cocaine Related Deaths

Heroin was a contributing factor to death in 80% (n = 8) of the cocaine related deaths. In five of these eight cases, the deceased was witnessed to be intoxicated prior to falling asleep (Category C). In another two cases involving heroin as a cause of death, the deceased was found dead at the locus (public toilet and common landing) and a syringe and needle was found close to the body (Category E). In the final case involving heroin, no intoxication or consumption of drugs had been witnessed, the deceased was in another room at the locus from witnesses, however was found to be dead when witnesses looked in. Syringes and pieces of foil were adjacent to the deceased (Category H).

One CR death was classed as Category B, the deceased was found with a syringe inserted into the groin area. Temazepam was a contributing factor in death in this instance. In the death classed as Category F the deceased had been talking to friends when he fell over, banging his head. Initially friends thought he was fooling around but they noticed his lips turned blue. Methadone was a contributing factor in the cause of death and this had been prescribed to the deceased.

5.7.5 Results of Toxicological Investigation

A blood sample was obtained in all but two of the 19 cases, in these two cocaine-related cases a urine sample was analysed due to an insufficient blood sample being provided for a full toxicological examination. Despite cocaine being mentioned in the cause of death in all these cases, the presence of cocaine itself was identified in 14 cases as shown in Table 24 (8 cocaine only deaths, 6 cocaine-related deaths). The mean, median and range of cocaine concentrations are summarised in Table 25.

Table 24: Cocaine and metabolites detected in cocaine deaths

	N	Cocaine	BE	ME
Cocaine Only	9	8	9	6
Cocaine Related	10	5 (+ 1 urine)	6 (+ 2 urine)	5 (+ 2 urine)

Table 25: Blood Concentrations of cocaine and metabolites detected in cocaine positive cases

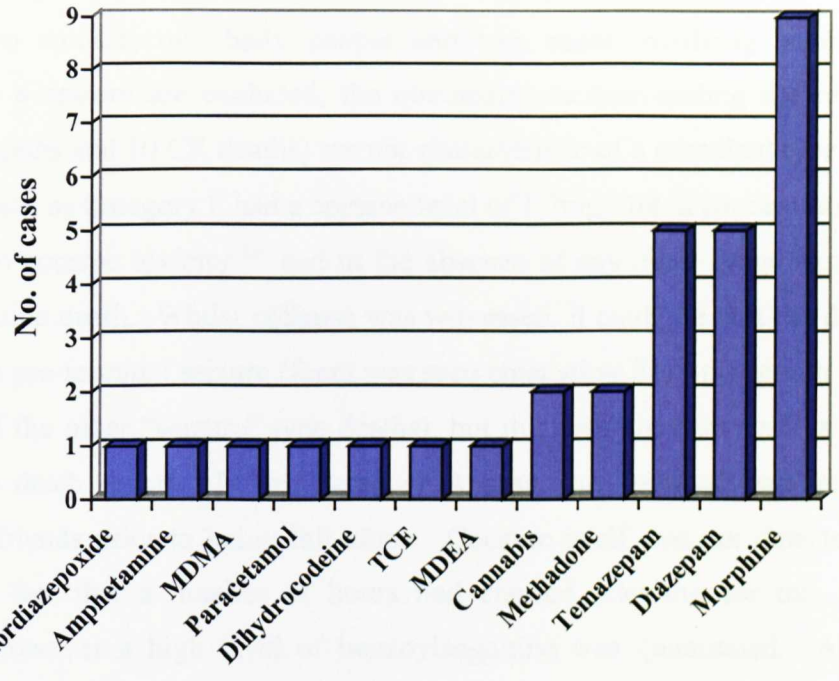
		Cocaine Only	Cocaine Related	*Not Cocaine related*
	Cocaine			
	n	8	5 (+ 1 urine)	*8*
All Cases (n = 19)	**Mean**	6.52	0.33	*0.04*
	Median	5.23	0.17	*0.03*
	Range	0.005 – 16.8	0.01 – 0.8	*0.007 – 0.09*
	Benzoylecgonine			
	n	9	6 (+2 urine)	*15 (+3 urine)*
	Mean	10.4	1.6	*0.4*
	Median	9.64	0.46	*0.14*
	Range	0.03 – 30.3	0.31 – 7.1	*0.016 – 1.26*
	Methylecgonine			
	n	6	5 (+ 2 urine)	*13 (+2 urine)*
	Mean	5.5	0.14	*0.09*
	Median	4.2	0.12	*0.04*
	Range	0.007 – 14.3	0.006 – 0.31	*0.005 – 0.45*

The mean cocaine blood concentration for cocaine only deaths was significantly higher than those found in cocaine related deaths ($p = 0.03$) where a mean difference of 6.2mg/litre was observed (95% CI: 0.7 to 11.7).

Cocaine was the only drug detected in three cases (16% of all cocaine deaths). Polydrug use was evident in 67% (n = 6) and 100% (n = 10) of cocaine only and cocaine related deaths respectively. For the blood samples, this varied from one additional drug (5 CO

deaths, 2 CR deaths) up to three additional drugs (1 CO death), but in the majority of cases cocaine in combination with two other drugs were detected (6 CR deaths). Polydrug use involving two and six additional drugs was evident in the urine samples. The drugs detected for both blood and urine are shown in Figure 34. Opiates were detected in only two CO deaths, morphine in one instance and unprescribed methadone in the other.

Figure 34: Other drugs detected in cocaine deaths



Heroin identified by the presence of morphine was the most frequently detected drug taken in combination with cocaine, this pattern of drug taking is referred to as "snowballing" or "speedballing", a cocktail used by drug users for many years. The drugs are taken in conjunction to allow the user to achieve the brief exhilarating high from the cocaine combined with the longer lasting effects of heroin which dissipate the crash[242].

Alcohol was found to be present in only 5 cases (4 x CO, 1 x CR) and in every case the BAC was below the legal limit as stipulated in the Road Traffic Act 1988. The mean BAC was 40mg/100ml ranging from 16 – 70mg/100ml (median 41mg/100ml).

5.7.5.1 Should Cocaine be mentioned in the cause of Death?

When ascertaining whether cocaine has attributed either wholly or partly to a death, it is vital to know the circumstances surrounding the case as well as whether the individual had a history of cocaine abuse. Karch and Stephens report that the quantitation of cocaine blood levels is not required for actual decision making when determining a cause of death. They highlight that "*if there is a strong history of cocaine abuse and typical myocardial pathology is observed, the case should be certified as cocaine induced sudden death, even in the face of negative toxicology testing*"[243]. Indeed cocaine levels cannot be used to explain the cause of death as cocaine-associated sudden death is not dose-related and some chronic users may have alterations in their hearts [243] and possibly their brains[244].

When the two suicide, two body packer and two cases involving sudden collapse subsequent to a seizure are excluded, the circumstances surrounding the remaining 13 cases (3 CO deaths and 10 CR deaths) are not characteristic of a stimulant type death. The CO death classed as Category F had a cocaine level of 1.7mg/litre, a concentration reported to be linked to cocaine toxicity [219] and in the absence of any other drugs would strongly indicate a cocaine death. Whilst collapse was witnessed, it could be that the deceased did in fact suffer a pre-terminal seizure (foam was seen emanating from the mouth as had been seen in one of the other "seizure" type deaths), but this was not conveyed as such in the police sudden death report. In the Category A case, the deceased had been snorting cocaine with friends prior to being left alone. Cocaine itself was not detected, possibly owing to the fact that a number of hours had elapsed allowing for this to be fully metabolised, however a high level of benzoylecgonine was quantitated. Again in the absence of any other drugs, this would strongly suggest cocaine as the main drug in causing death. In addition, Coronary Artery Atheroma was noted as being an underlying cause of death, a risk factor associated with cocaine misuse[245, 246]. However, for the final CO death, the circumstances and toxicology do not fully support the cause of death as certified by the pathologist. Despite a very low level of cocaine and metabolites being quantitated, this Category C death may have been due to an overdose of methadone which would appear to have been obtained illegitimately. The level of 0.13mg/litre of methadone detected falls into the lower end of the range detected in methadone only deaths amongst illicit users [98].

The circumstances surrounding five of the CR deaths are not characteristic of a stimulant death as the deceased was seen to fall asleep whilst clearly intoxicated (category C). In two of these cases the deceased was seen to either snort (in addition to consuming "jellies") or smoke cocaine. Cocaine itself was detected in the blood in one instance and

urine in another case. In all five instances, heroin was a contributing factor to death, either alone or in combination with an additional respiratory depressant. In four other CR deaths where neither drug consumption nor intoxication had been witnessed (2 x category E, 1 x category B, 1 x category H), a syringe was found adjacent to the deceased's body. Heroin was a contributing factor to death in three of these cases and in the remaining case, death was due to cocaine and temazepam, it is possible the cocaine had been administered intravenously in this case. In the final CR case, no drug consumption or intoxication was apparently witnessed although the deceased was seen to fall over. Cocaine was detected at autopsy at the highest cocaine concentration amongst all CR deaths in this study (0.8mg/litre) and is consistent with a study where cocaine was purported to precipitate sudden death in individuals with undiagnosed cardiovascular disease [247]. It cannot be precluded that the deceased died of a sudden death due to cocaine consumption which the witnesses failed to divulge. Methadone was also a contributory factor, however, this methadone had been prescribed and was not an excessive amount for the dosage he was receiving, hence it's role in causing this death could in fact be subsidiary.

5.7.6 Discussion

The increase in recent seizures of cocaine, drug users admitting to using this drug when presenting themselves to drug clinics and the increase in cocaine positive cases amongst deceased persons investigated by FMS are evidence that cocaine is emerging as a drug of misuse in the West of Scotland. The wider availability of this drug owes itself to the decreased price where, today, a gram of cocaine hydrochloride and a rock of crack can be purchased in the Strathclyde region for approximately £50 and £20 - £50 respectively. This compares to 10 years ago where a gram of cocaine hydrochloride would cost in the region of £100 [212]. In addition recent research indicates that the dramatic increase in the use of cocaine in Scotland could be related to the methadone programme. With an increasing number of people being initiated on a methadone maintenance programme and the demand for heroin diminishing, the article reported that drug dealers were merely diversifying their product line by targeting patients on a methadone programme. The study group suggested that as many as one quarter of addicts coming forward for treatment have used cocaine in the last three months and not only were most using heroin in combination with cocaine, around one-third were also using methadone[248].

Although there has been a substantial increase in cocaine positive cases investigated by FMS, it should be noted that the majority of cases were not as a result of a drugs overdose and the presence of cocaine was merely incidental. In the majority of CO deaths, the decision of the pathologist to certify death as cocaine only was aided by the circumstances surrounding the death, namely intentional overdosage, sudden collapse subsequent to a pre-terminal seizure or death due to concealing drug packages, the dangers of which have been well documented [249, 250, 251]. Of those, where cocaine was a contributory factor in causing death, some ambiguity exists as to the actual role of cocaine in causing death, especially since the circumstances surrounding the majority of deaths together with the presence of an opiate would be indicative of an opiate induced death. Indeed, it may be that the presence of cocaine in some of these CR deaths may have been incidental and the fact that they were mentioned in the cause of death due solely to the discretion of the investigating pathologist. There was one CR death whereby respiratory depression subsequent to a collapse, and with no other information available, led the pathologist to certify the death as due to the intoxicating effects of cocaine and methadone, despite the methadone having been prescribed. It is not impossible to suggest that had more information been available, this may have been a CO death.

Due to the usually brief "rush" that is experienced with cocaine which is often followed by a dysphoric "crash", the use of longer-acting drugs and alcohol is common[252]. Alcohol in combination with cocaine, despite being the most frequent cause for drug-related emergency room visits in the United States [253] was more the exception than the norm in this study. This outcome is similar to findings of a study that concluded that the concomitant use of ethanol and cocaine does not appear to be nearly as common as suggested by epidemiological studies[254].

Variables exist which can hinder the interpretation of PM blood cocaine and metabolite findings when trying to extrapolate levels back to perimortem drug concentrations. Firstly, cocaine continues to deteriorate in the post-mortem state if specimens are not properly preserved [255]. This *in vitro* instability must be taken into consideration when interpreting PM blood cocaine concentrations especially in unpreserved blood that has been maintained at room temperature for any length of time [256].

All samples investigated by FMS are stored at optimal temperatures whilst awaiting analyses. Blood concentrations of cocaine have also reported to be site-dependent in a study where cocaine concentration in subclavian vein blood was shown to decrease whilst

that from heart, aorta and femoral vein blood increased during the interval between death and autopsy[257]. A further study noted that there were no consistent patterns of site-specific differences for cocaine, benzoylecgonine or cocaethylene and that the central compartment showed both higher and lower concentrations than the peripheral[258]. This illustrates the difficulties encountered by a toxicologist when interpreting a PM blood cocaine level and highlights that caution should prevail when determining whether cocaine has been conducive to death.

5.7.7 Conclusion

Over the past decade, cocaine use in the West of Scotland has increased and is receiving a lot of attention from the media, law enforcement and harm reduction agencies. It's occurrence in deaths in the Strathclyde Police region is relatively new but is now increasing. It may be somewhat premature to start comparing local experiences of cocaine related deaths to other studies due to the relatively small incidence of cases and lack of deaths where only cocaine was detected, an issue raised by Karch et al [219]. From the experience in the West of Scotland, it was noted that there are some cases where the role of cocaine in deaths is somewhat ambiguous. It is accepted that the concentration of cocaine and/or metabolites, in isolation, is not sufficient enough to determine a cause of death but that other sources of evidence must be taken into consideration, for example, results of the autopsy and in particular the circumstances surrounding the death. Hence, the pathologist can only certify a death on the information available to them. In the absence of significant PM findings, a trivial toxicology level and lack of circumstantial evidence, an accurate determination of cocaine as a causative factor may not be possible.

5.8 Chapter Conclusions

It is clear from this chapter that drug related deaths remain a problem in the Strathclyde Police region of Scotland and one that is shared internationally. The main drug groups involved in deaths within this study has been the opioids, heroin in particular. Similar scenarios were prevalent throughout this chapter. For example, in a substantial number of cases, the deceased was witnessed to be intoxicated prior to falling asleep. Education initiatives to target drug users and acquaintances into recognizing signs and symptoms of overdose as well as simple cardiopulmonary resuscitation skills may have a positive impact on reducing some of these otherwise preventable deaths. However, an obvious obstacle with this is obtaining funding to implement it. In the early nineties, safety campaigns to discourage drug users from sharing needles together with the implementation of needle exchange schemes all had an encouraging outcome in that the prevalence of HIV in the West of Scotland remained low. This method of campaigning would have incurred a substantial sum. However, it may be viewed that the necessity to finance this particular health promotion was justified due to the potential risk of infection to the community at large and not just drug users as is the case for education to prevent fatal overdoses.

Other strategies for prevention of fatal overdoses may be the implementation of trials to assess the efficacy of naloxone and naltrexone amongst the drug using fraternity in the Strathclyde Police district. These are opioid antagonists that in the absence of opioids have no pharmacological activity and when used therapeutically have no impairing effect on respiration. The only adverse effect may be the rapid onset of opioid withdrawal symptoms in opioid-tolerant individuals. This may be seen as a positive aspect, however, in that it may allay fears that heroin users would be likely to inject more heroin if naloxone was available in the knowledge that an overdose could be reversed [259]. This view has also been reported elsewhere where it was noted that an "*addict's extreme distaste for the withdrawal caused by naloxone may make them reluctant to use it even if it is available*" [260]. Despite the positive aspects of these antagonistic drugs, there are possible limitations of their use. For example, naloxone has a relatively short half-life and hence may be ineffective if administered in cases of methadone overdose, an opioid agonist with a longer half-life, in that the effects of the full agonist may return after the naloxone has been cleared. That said, the advantage of administering naloxone in methadone related cases is that the reverse effects will permit a sufficient period of time to summon an ambulance and convey the individual to hospital where medical intervention can commence. Naltrexone has a longer half-life and may precipitate a longer lasting withdrawal syndrome in opioid-dependent individuals [261]. Further it should be noted that specific opioid antagonists will

only block the respiratory depressant effects of an opioid and hence has no effect on respiratory depression which is caused by the concurrent use of alcohol and benzodiazepines[261]. A pre-launch study into the acceptability of these drugs as possible intervention strategies concluded that it is appropriate to proceed to a carefully constructed trial of naloxone distribution as it was estimated that at least two-thirds of witnessed fatal overdoses could have been prevented had naloxone been available by witnesses[262]. An early report on the provision of naloxone to drug users revealed that 10% of distributed naloxone had saved lives [263]. Despite lives having been saved, this study raised concerns as to the amount of naloxone which remained unaccounted for. This highlights the need to fully assess the extent of possible harm caused by this manner of intervention [264]. There may be scope for the use of these antagonists but only in cases where overdose has been obviously witnessed, the opioid used is known and polydrug use is absent (e.g. they will not be effective in cases where opiates have been taken concurrently with alcohol and/or benzodiazepines).

Another strategy, which is not new to the United Kingdom, is that of heroin prescribing. Prior to 1968 any doctor was able to prescribe pharmaceutical diamorphine to opioid-dependent individuals. Concern as to the diversion of prescribed drugs to the black market due to prescriptions of these drugs remaining freely available coincided with a change in the sub-culture associated with drug misuse which saw the number of heroin and cocaine addicts increasing sharply [265]. In London, an illicit market in pharmaceutical cocaine and heroin was thought to originate from the prescribing procedures of Lady Isabella Frankau who was reported to be the mainstay of the flourishing illicit heroin market [266]. However, today heroin and cocaine prescribing is strictly controlled. There are approximately 100 doctors, mainly specialist psychiatrists, who have a Home Office licence to permit this practice and encompass prescriptions for about 500 patients, most of whom are in receipt of diamorphine [267]. A study to determine the scale and practice of diamorphine prescribing showed that the majority of doctors who were prescribing had not initiated a prescription but rather inherited patients who were already receiving a prescription. However, they reported that prescribed heroin provided an opportunity for clinical improvement and a few reported their reasons for prescribing it as being to help them attract and retain hard-to-reach drug users. Reasons for not prescribing heroin, despite holding a licence ranged from the doctors concern regarding diversion of supplies, lack of evidence for it superiority over oral methadone to the high costs compared to methadone and also that it was considered not to be good clinical practice. In addition there was a great variation in the doses prescribed (ranging from 5 – 1500mg/day) and an agreement regarding the daily

dose-equivalent of 100mg of methadone (ranging from 50 – 900mg) [268]. In 1994, a heroin prescribing project was initiated in Zurich, Switzerland, however this was accompanied by medical, psychiatric and social assessments. Between 1994 and 1996, a total of 1000 patients were treated, 800 of whom had asked for heroin prescription. The results were promising and showed that the physical health state of the individual improved, as did their mental health state which showed a clear regression in co-morbidity related issues linked to drug misuse such as depression and anxiety. Concurrent use of benzodiazepines also decreased, as did drug-related criminal behaviour. Social integration greatly improved and permanent employment was more than doubled. A conclusion from this study was that heroin prescription can be recommended for a designated target group, i.e. heavily addicted persons who have failed attempts in other treatments. In addition, a vital element of treatment was the health and social support made available. That said, the United Nations remain concerned about the treatment and were reported to state that they were not convinced that the limited positive effects were solely due to the heroin prescribing but that other factors such as the support made available could have been involved[269]. This highlights the varying views of doctors who are able to prescribe heroin as well as the inconsistencies of treatment protocols and prescribing practices throughout the UK. A limitation of this treatment is the cost incurred which is estimated to be approximately £3000 – 6000 per patient-year [268]. The success of the Swiss trials could well be down to the simultaneous assistance offered both on a health/ counselling and welfare basis which together with prescribing may assist in retaining individuals in treatment.

A risk factor associated with fatal overdoses is injecting alone which denies the individual of imminent medial intervention. Over the past few years, injecting rooms have been established in several European cities in Holland, Germany and Switzerland. Australia has experimented with a "medically supervised injecting centre" (MSIC) which aims to reduce the risk of morbidity and mortality associated with drug use. In addition to reducing the spread of blood borne viruses, another aim of the MSIC is to provide access for drug users to drug treatment, health welfare and social services. As well as providing sterile injecting equipment, staff are on site to advise on safe injecting practices and observe the "clients" until they are ready to leave. While this would seem a likely alternative initiative in preventing fatal drug overdoses, their place in Scottish society is improbable at present. These facilities need to be legally sanctioned, and even though Scottish legislation would allow this, the Government seems unwilling to embrace the idea as a possible solution. However, this may change as did the legislation governing the supply of specific items such as swabs, citric acid, filters, sterile water ampoules for safe injecting practice. In

August 2003 there was an amendment to Section 9(a) of the Misuse of Drugs Act (MDA) 1971 to allow the supply of the aforementioned items to drug users by medical practitioners, pharmacists and drug treatment service providers. Prior to this date, this section created an offence "*for any person who supplies, or offers to supply, any article, which may be used to prepare a controlled drug for administration, by any person, to himself or another, believing that the article is to be used in circumstances where the administration is unlawful*". This section was inserted into the MDA (1971) in 1986 and excluded the supply of a hypodermic syringe and needle in order to reduce the spread of blood borne viruses such as HIV. However, this section was regarded by Drug Action Teams to obstruct harm reduction activities and hinder service provision via the needle exchanges and was highlighted to the Scottish Executive. In response the Scottish Executive advised that a Letter of Comfort be issued by regional Procurators Fiscal stating that prosecution would not be contemplated for the supply of drug paraphernalia as mentioned above. In any case, it was considered that prosecution in such cases would not be in the public interest [270]. So, amendments to drug legislation have occurred over the years in response to the magnitude of the problem and has resulted in a decrease in supply of some drugs and the lawful provision of drug paraphernalia to permit safe injecting and promote harm reduction. Government attitudes to the provision of a "safe haven" for drug misusers to inject may change in the future particularly if positive research findings regarding this issue continue to be promoted from areas where these are already operational.

As well as education initiatives for drug users and acquaintances, there is a need for training of GPs in the management of narcotic addiction. A study involving inner city London GPs revealed that they were not taking on an active role in drug misuse treatment that was being encouraged by the Department of Health. Less than one-half of GPs responded to a questionnaire which was sent in order to assess the proportion of GPs who were seeing narcotic users and what methods of treatment were being employed. Inadequate training in the management of narcotic addiction was noted amongst the GPs although they were interested in partaking in small group training to improve their skills [271]. Although drug misuse management has come a long way in the West of Scotland particularly with the initiation of the Glasgow Drug Problem Service and methadone prescribing, there is still scope to assess GPs views on this issue, similar to the study carried out in London. This would identify if there is a need for further training for GPs which may even increase the participation from GPs who have opted out of shared care

schemes already in practice. This may even increase the accessibility for drug users to enter into drug treatment services.

Another theory regarding drug overdoses is that there may be a greater number of cases whereby the deceased overdosed intentionally. Usually, the manner of death is ascertained as suicidal in the presence of a note or if the deceased was exhibiting strong suicidal intent shortly prior to death. A connection between suicide and overdose amongst drug users has been identified elsewhere in the literature[272, 273]. Neale reports on a study involving 76 drug users who had recently experienced a non-fatal overdose[185]. Interviews took place within the hospital setting which meant that the respondents accounts were not clouded by time or subsequent events and also allowed for a higher level of reliability and a greater degree of insight into the event. It was concluded that non-fatal overdoses are often motivated by suicidal intent especially since approximately one-half of interviewees reported suicidal thoughts or feelings prior to the overdose they had just experienced. Initiatives to offer counselling and support for drug users, via both primary and secondary care may help to reduce these suicidal tendencies experienced by drug users and hence potentially safe lives.

Despite efforts at reducing the supply of illegal drugs, their misuse will always be prevalent in society be it because of their abundance and/or because peoples attitudes will not change. The major task for government and health care providers, therefore, is to prevent fatal overdoses occurring. This can be done by encouraging drug users to access treatment by making this readily available as well as providing support and counselling as part of the package. Continued monitoring of patients to ensure cessation of illegal drug use and compliance with the treatment is also required and hence clinicians may have to undergo training to ensure they are competent in this. Education programmes to encompass drug users and those close to them would help by encouraging safe injecting practice and highlight the dangers of concurrent consumption of drugs.

There is no shortage of strategies that can be implemented in order to reduce drug-related deaths. However, additional research is required into the efficacy of some that were mentioned earlier particularly in the West of Scotland society. The need for medical treatment, counselling, social welfare support and continued education is the vital equation in the fight against drug misuse. A multi-disciplinary approach is required in an effort to reduce drug-related deaths in Scotland.

6 Drugs and Driving

Driving is a multi-factorial task requiring precision and alertness where the driver is continuously receiving information (visual), processing and analysing it (decision making) and consequently reacting accordingly to it (possible risk taking). All of these tasks are controlled by the cognitive and psychomotor functions of the central nervous system (CNS) which when working unimpeded will allow the driver to react efficiently. Therefore, any substance, which affects the CNS in such a way as to cause significant alterations to these functions, has a potentially impairing effect on the ability to drive safely.

In 2001, there were approximately 33 million persons holding a full driver's license in the United Kingdom [274], 63% of whom are aged between 17 – 50 years of age, a range deemed sufficiently large enough to include distributions of both recreational and dependent drug users [275]. With an increase in drug misuse throughout society in general, it is of no surprise that drug misuse amongst the driving population is also an issue in need of address. In a study of samples obtained from suspected drugged drivers received by the Forensic Science Service in 1997, drugs were detected in 89% of cases. The drugs detected were primarily drugs of abuse and polydrug use accounted for over one half of the samples received [276]. In addition, the experience in the West of Scotland shows that driving under the influence of drugs rarely involves individuals who are taking prescription medicines. In reality, those who are suspected of contravening section 4 of the Road Traffic Act 1988 are using drugs of abuse including commonly abused prescription drugs that have been obtained illegally (e.g. benzodiazepines, opioid analgesics) or, particularly in the West of Scotland, a combination of both[209, 277]

The Driver and Vehicle Licensing Agency (DVLA) treat drug addiction in the same as any other medical condition. If a driver is deemed unfit to drive due to a medical condition, which they are obliged to notify to the DVLA, the Secretary of State for Transport has the power to revoke their license. In reality, however, the likelihood that a person will divulge this "medical condition" is remote. Recently, the British Medical Association recommended that the Government develop a campaign to highlight that taking drugs (licit or illicit) can have an impairing effect on driving ability similar to that of alcohol [278]. The proposed initiative would be aimed at educating the public to the dangers of driving whilst under the influence of drugs.

6.1 DUID: A world-wide problem

The problem of driving under the influence of drugs (DUID) is by no means restricted to the United Kingdom. Studies have shown that driving whilst impaired through drugs is increasing in epidemic proportions all over the world. Smink et al reported that 80% of their study group of impaired drivers in the Netherlands tested positive for drugs, 42% of whom were polydrug users [279]. A study in Austria revealed that over a three-year study period, 94% of urine samples obtained from drivers suspected of DUID tested positive for drugs thereby confirming the police officers suspicions. Cannabis was the most commonly abused drug followed by morphine [280]. An indication of widespread consumption of alcohol and drugs was reported by Alvarez et al in Spain, following the distribution of questionnaires to drivers who were due to undergo a medical examination prior to obtaining or renewing their driving licence [281]. In addition, Lillsunde et al showed that the number of positive drug findings and drug abuse has steadily increased among drivers suspected of DUID in Finland. These results followed the comparison of two one-week study periods, one in 1979 and one in 1993. Drugs classed as hazardous to traffic safety were detected in 7% of the samples in 1979 compared to 26.8% of those in 1993. In both years, benzodiazepines were the most commonly detected drug group and illegal drugs were found in 4% of cases in 1993, primarily cannabis and amphetamine. Polydrug use was also a common finding in the samples [282]. Polydrug use was also a finding of a study conducted by Augsburger and Rivier. Their retrospective study of suspected DUID drivers in Canton de Vaud (Switzerland) showed a very high correlation between police suspicion and positive results for drug analyses where one or more psychoactive drug was found to be present in 92.8% of samples over a 13-year period. The most commonly detected drug group was the cannabinoids followed by opiates, benzodiazepines, cocaine, methadone and amphetamines [283]. Findings from other European studies are outlined in Table 26 below.

Table 26: Abstract Findings of European Studies into Drivers suspected of DUID.

Author(s)	Country of Study	Study Period	Major drug group detected	Other notes
Christensen et al [284]	Denmark	1981 – 1985	Benzodiazepines	Polydrug use prevalent
Gjerde and Kinn [285]	Norway	June 1989 – June 1990	THC	Polydrug was prevalent
Cosbey S.H. [286]	Northern Ireland	1982 - 1985	Benzodiazepines	
Bjørneboe et al [287]	Norway	1978 and 1983	1978: Benzodiazepines 1983: THC	

Alarmingly, a study investigating the perceptions and behaviours of drivers who use illicit substances revealed that the participants were aware of many drug effects which may lead to impairment. However, they believed the risk of accidents whilst drug-driving were smaller than the risk of being caught for a traffic offence or in possession of drugs. This was despite reports of "alarming attitudes and behaviour" amongst the amphetamine users and "drug-induced tiredness" amongst the heroin users in the study group [288].

6.2 DUID: The Procedure in the UK

In 1997, the Transport Research Laboratory (TRL) carried out research for the Department of Transport, Local Government and the Regions (DTLR) and reported that illicit drug consumption by fatally injured drivers showed a six-fold increase compared with a comparable study carried out 10 years previously [289]. Drugs and driving is, without a doubt, an increasing crime in the United Kingdom.

Alcohol as an impairing agent in relation to driving was first addressed in the Criminal Justice Act 1925 which made it an offence to be a person "*drunk while in charge on any highway or any public of any mechanically propelled vehicle*". Over the next few years the Road Traffic Act 1930 made it an offence to drive, attempt to drive or to be in charge of a vehicle on a road or other public place when "*under the influence of drink or drug to such an extent as to be incapable of having proper control of the vehicle*".

The 1962 Road Traffic Act allowed a police constable to request a blood or urine sample from an individual and required the Courts to have regard for the proportion of alcohol or drugs in the body as evidenced by blood or urine levels. With regards driving under the influence of alcohol, a statutory limit did not come into effect until the 1967 Road Safety Act was passed. In addition, this Act introduced the Breathalyser as a screening test, and if a positive result was obtained from this, it had to be followed up by an evidential blood or urine test. This made it an offence to drive a vehicle on a road or public place whilst the proportion of alcohol in the blood, ascertained by laboratory procedures, exceeded a prescribed limit (which in the UK is 80mg/100ml). Prior to this, an individual suspected of driving whilst intoxicated was liable to be charged under the Criminal Justice Act 1925. The definition of "drunk" was however open to interpretation and only those who were obviously drunk were prosecuted. The Road Transport Act 1981, introduced a fixed limit for alcohol in breath which facilitated the police officer with a rapid means of dealing with suspected drink driving cases through the introduction of the evidential breath testing device. The existence of statutory limits is advantageous for the purposes of prosecution which in the United Kingdom can be enforced if the person is above the following defined alcohol limits:

Blood 80mg/100ml
Urine 107mg/100ml
Breath 35µg/ml

To date, there are no defined limits with respect to drugs, despite it being an offence to drive whilst under the influence of drugs. In the United Kingdom, the statutory offence relating to drugs and driving is contained under Section 3A and 4 of the Road Traffic Act 1988 (as amended by S4 of the Road Traffic Act 1991).
Section 3A RTA 1988 as amended states:

"If a person causes death of another person by driving a mechanically propelled vehicle on a road or other public place without due care and attention, or without reasonable consideration for other persons using the road or place, and –
(a) He is, at the time when he is driving, unfit to drive through drink or drugs.....he is guilty of an offence."

Section 4(1) RTA 1988 as amended states that:

"A person who, when driving or attempting to drive a motor vehicle on a road or other public place, is unfit to drive through drink or drugs shall be guilty of an offence".

The problem with this existing legislation is the ability to prove that a person is unfit to drive. The Appeal court has said that, *"For the purposes of this section, a person shall be taken to be unfit to drive if his ability to drive properly is for the time being impaired".* Presently, there is no categorical definition of "impairment" in the Road Traffic Act.

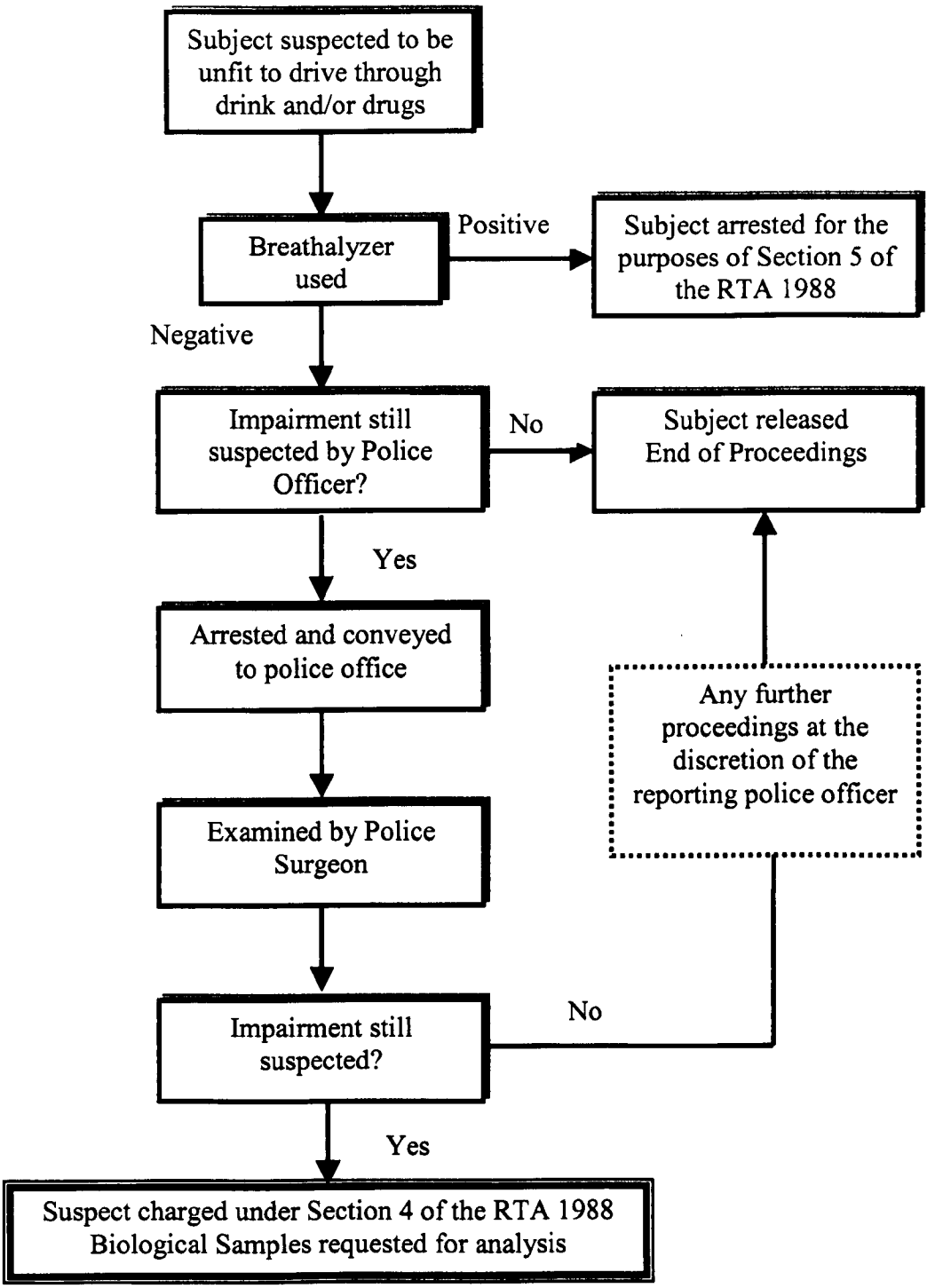
A police officer must have due cause to arrest a person on suspicion of driving whilst impaired. In the majority of cases, if a positive breath test is obtained, the person will be charged under Section 5 of the RTA 1988, the fixed level alcohol offence. However, if the police officer still suspects the person to be impaired after providing a negative breath test, the person should be charged under Section 4. In such instances, the person is taken to a police office where they are required to undergo a medical examination. If the police surgeon agrees that the person's condition may be due to the effects of drug(s), a blood/urine sample is obtained and submitted to a laboratory for analyses. It is an offence, at this stage for the person to refuse to provide a sample. If the police surgeon disagrees that the person's condition may be due to the effects of drug(s) further prosecution is at the discretion of the reporting police officer (Figure 35).

The objective of the Police Surgeon's examination is to establish that the individual is fit to be detained in the police station and to exclude any conditions, illnesses or injury which may mimic intoxication. They are then required to determine whether there is a condition that might be due to a drug. The police surgeon therefore carries out their own series of tests, within which are tests equivalent to those used in the field impairment tests (e.g. finger to nose, walk in a straight line). For this purpose a Pro Forma (F97) is used. There is no obligation for the driver to undertake these tests and the tests themselves are not exhaustive. In order for a specimen to be obtained, the Police Surgeon has to advise the police officer that the condition of the person might be due to a drug.

The decision as to whether a person is impaired must be reached by a Court following evidence received from police officers involved, witnesses, the Police surgeon and the forensic analyst. A conviction is not weighted solely towards the evidence of the police surgeon. Convictions have been successful going on evidence obtained from only the police officer and the forensic analyst [290].

The problem of proving impairment has led some countries to introduce a *per se* type law. For example, Germany introduced a new law in 1998 which sanctioned drivers suspected of being under the influence of any of the following banned drugs: amphetamine, MDMA, MDE, cannabis, cocaine, heroin and morphine [291]. If any of these analytes are identified in a blood sample, this, according to the law, is *prima facie* evidence of impairment. In such cases where there has been a violation of the analytical zero-tolerance limit, the individual is subject to an "administrative sanction" whereby they are fined. However a violation of the impairment "limit" is a "criminal sanction" [292]. In addition following a multi-disciplinary approach, a similar per se law was made applicable in April 1999 in Belgium and is being enforced at police check points and areas where drug driving may be common, e.g. roads to and from nightclubs [293].

Figure 35: Simplified Diagram of the current procedure for dealing with a driver suspected of DUID in the United Kingdom



6.3 Improvements to the Present Procedure

In Scotland, over the years 1995 – 2001, the police prosecuted 52,592 persons under Section 5 compared to only 5,963 persons under Section 4 of the RTA (Tables 27 and 28) [294]. A possible explanation for this vast difference may be that a significant number of drugged drivers go undetected as a consequence of two factors. Firstly, police officers are not trained in relation to drug recognition. It has been suggested that due to the success of the roadside breath screening and evidential breath testing devices, observational skills of police officers in identifying otherwise impaired drivers have been lost [295]. Secondly, there is no readily available roadside screening devices similar in principal to the breathalyser.

Table 27: Number of Crimes Recorded under Section 4 of the Road Traffic Act 1988 in Scotland and the Strathclyde Region.

	Driving		In Charge of Vehicle	
Year	**Scotland**	**Strathclyde (%)**	**Scotland**	**Strathclyde (%)**
1995	597	359 (60%)	113	55 (49%)
1996	921	485 (53%)	112	70 (63%)
1997	899	561 (62%)	225	137 (61%)
1998	987	658 (67%)	131	70 (53%)
1999	825	479 (58%)	111	46 (41%)
2000	793	429 (54%)	125	40 (32%)
2001	941	498 (53%)	119	39 (33%)
Total	***5,963***	***3,469 (58%)***	***936***	***457 (49%)***

Table 28: Number of Crimes Recorded under Section 5 of the Road Traffic Act 1988 in Scotland and the Strathclyde Region.

	Driving		In Charge of Vehicle	
Year	**Scotland**	**Strathclyde (%)**	**Scotland**	**Strathclyde (%)**
1995	7,450	3,042 (41%)	248	96 (39%)
1996	7,987	3,238 (41%)	277	99 (36%)
1997	7,686	2,989 (39%)	274	75 (27%)
1998	7,246	2,772 (38%)	265	59 (22%)
1999	7,397	3,078 (42%)	277	98 (35%)
2000	7,139	2,955 (41%)	349	146 (42%)
2001	7,687	3,187 (41%)	411	124 (30%)
Total	***52,592***	***21,261 (40%)***	***2,101***	***697 (33%)***

This deficiency in training of police officers in addition to growing concerns surrounding an increased prevalence of DUID inspired two Strathclyde police officers (Inspector Paul Fleming and Chief Inspector Davey Stewart) to pursue a study of existing drug recognition procedures utilised by police. Following a visit to the United States in 1997, they made a recommendation that a new procedure be initiated in the United Kingdom based on the standardised Drug Evaluation and Classification (DEC) programme being utilised in California. Previous adaptations of the DEC programme are being successfully put into practice in other countries. Saarland in Germany, for example, has had a training programme available to police officers since 1997, which is practised by police officers in 10 of the 16 German states [291].

6.3.1 The DEC programme

In response to the increase in substance misuse in the 1970s and the lack of experience of drug-driving recognition together with a necessity to legally document DUID cases, the Drug Evaluation and Classification (DEC) program was developed by the Los Angeles Police Department and introduced in 1979. The development was aided by other experts in the drug field, such as scientists and physicians [296]. The programme enables specially trained police officers (Drug Recognition Experts, DRE) to evaluate the situation and conclude (a) whether a subject is impaired, (b) if impaired, that impairment is or is not due to a drug and (c) if due to a drug, identify the specific drug category involved. The programme comprises a systematic and standardized series of events starting with examination of the subject through to evaluating the subject's performance in a number of field sobriety tests. The DRE works through 12 steps which are outlined in Table 29 below. It should be noted that at no point is there a requirement for a medically qualified person to examine the subject.

Laboratory validation of this procedure was initially conducted in 1984 co-operatively by the National Highway Traffic Safety Administration (NHTSA) and the National Institute on Drug Abuse (NIDA). Results were very encouraging showing that the DRE's were able to identify correctly 95% of drug-free subjects as "unimpaired" and classify 98.7% of high-dose subjects as "impaired". In addition they were able to identify the category of drug for approximately 92% of high-dose subjects [297]. Following this controlled laboratory study, NHTSA proceeded with a field validation of the DRE procedure. Again results were promising and revealed that when a DRE claimed drugs other than alcohol were present, this was the case in 94% of cases [298]. Over the years a highly standardized training and certification programme evolved with the co-operation of NHTSA and the International Association of Chiefs of Police (IACP). This DEC program is now operational in 40 states and the District of Colombia [299].

Table 29: The 12 components of the DRE procedure.

	Test	Purpose of test
1	Breath alcohol test	Precedes involvement of DRE
2	Consultation with arresting officer	DRE discusses circumstances of arrest with arresting officer
3	Preliminary examination and first pulse	Purpose is to determine that there is sufficient reason to suspect drug influence
4	Eye examinations	Conducts 3 separate eye movement examinations *
5	Divided attention tests	The Romberg Test The Walk and Turn test The One-Leg Stand Test The Finger to Nose Test
6	Vital signs and second pulse	DRE takes blood pressure, body temperature and pulse
7	Dark room examination and ingestion examination	Responsiveness of eye pupils to light and dark conditions
8	Muscle tone check	Certain drugs cause muscle rigidity and some cause muscle flaccidity
9	Injection site search and third pulse	To ascertain IV usage
10	Further interview and observations	DRE conducts a structured interview with arrestee and asks questions about drug use
11	Expert opinion of evaluator	Based on totality of all tests outlined above and is in their opinion to a "reasonable degree of certainty"
12	Toxicological sample	To allow corroboration which is required for a successful prosecution

* Horizontal gaze nystagmus, vertical gaze nystagmus and eye convergence examination

In the United States, the DRE is only called to conduct a thorough examination as outlined above if the arresting officer suspects impairment through drugs. At the roadside, the arresting officer carries out the Standardised Field Sobriety Tests (SFST) which are used irrespective of whether drugs or alcohol are suspected. These consist of psychomotor and

divided attention tests which have been validated using scientific techniques [300]. The SFSTs consist of

- The Walk and Turn Test
- The One Leg Stand
- Horizontal Gaze Nystagmus

} Administered to detect for alcohol

- The Romberg Test

} Administered to detect for drugs

Some of these tests are repeated by the DRE once in the controlled environment of the police station, however in a slightly different order as outlined in Step 5 of Table 4.

The general principles and techniques utilised in America formed the basis for the development of a programme adapted for use in the United Kingdom. The SFST battery used by the arresting officer at the roadside was the initial starting point for a suitable procedure to be adopted in the United Kingdom. However, it was felt that the horizontal gaze nystagmus may be construed as being too medical and it was decided to include an alternative eye test which would be easier to conduct and possibly more informative in terms of drug symptom recognition, i.e. the examination of the pupil size. In addition, the Finger to nose test utilised by the DRE would be included as an additional test to be conducted at the roadside.

Essentially the training package for use in the UK is comprised of the Drug Influence Recognition Training (DIRT) and the Field Impairment Testing (FIT). Having trained 209 selected police officers from across 6 police forces throughout the United Kingdom, an evaluation of the adapted programme was carried out in 1999 which was commissioned by both DETR and TRL. This showed that the correlation between the drug suspected by the police officer and the drug identified following toxicological analyses was generally very good. It transpired that the presence of a drug was confirmed in 92% of cases. In addition, police officers considered the training very worthwhile and enhanced their ability to recognise drug impairment and the drug that may be causing it [301].

The proposed FIT procedure has, however, received criticism from some members of the medical profession. Results of a questionnaire distributed to police surgeons following a

full day training programme in respect to "Drugs and Driving" showed that whilst 54% were happy to accept the tests, concerns did exist with the Walk and Turn Test and the One Leg Stand Test [302]. In addition, a female police surgeon has publicly expressed her concerns with the tests rating them as "totally hopeless" and marking them "0 out of 10" [303].

Fleming and Stewart showed that there seems to be no compulsory rigorous training available for police surgeons with regards impairment testing or symptom recognition in relation to drug driving [300]. Whilst some police forces do offer courses, others are reliant on the police surgeons experience and professionalism. Further, they distributed a questionnaire to 250 police surgeons asking them about training issues regarding drug impairment. Only 61 forms were returned, however showed that 87% of police surgeons thought it would be beneficial for them to receive specific training to assist in identifying symptoms of drug usage in drivers, 89% felt this type of training would be beneficial for police officers also. The majority also thought that the reason for disagreement between the police officer and police surgeon with respect to whether a person was impaired was not down to lack of knowledge or training but due to the effects of a drug having worn off (58%). Rogers and Stark noted that there was uncertainty amongst some forensic medical examiners as to whether a blood sample can be lawfully requested in the absence of evidence of impairment at the time of their examination [304]. This resulted in correspondence from two eminent lawyers who stated that "*the effect that the condition (of impairment) referred to in the road Traffic Act 1988 related to when the offence was allegedly being committed, i.e. when the person was driving, attempting to drive or in charge of a vehicle*". Hence, if sufficient evidence was available from police officers at the time of the offence despite an absence of evidence at the time of medical examination, it is lawful that a blood sample be obtained for drug analysis [305].

The proposed FIT procedure in the United Kingdom is not regarded as a duplicate of the American system. In order for that to happen there would need to be a change in the legislation, as under current UK law the driver must be examined by a police surgeon, who is regarded as an impartial witness. The FIT is being proposed as an extra "diagnostic tool" for the police officer which will increase their confidence in dealing with the suspected drugged driver. The results of Fleming and Stewart's questionnaire highlights that a high proportion of police surgeons felt that training would be beneficial to both parties whose corroboration is vital in requesting a biological sample and ultimately the fight against drugs and driving in society.

6.4 The FIT Procedure in the United Kingdom

If a subject provides a negative breath test but the police officer still suspects impairment then the subject is obviously exhibiting signs and/or symptoms indicative of recent drug misuse. For example, reddened eyes, loss of co-ordination, slurred speech or drowsiness. As part of the new FIT procedure, the police officer is trained to identify these various signs and/or symptoms and is implementing his/her drug recognition skills. At this point, the subject is asked to participate, on a voluntary basis, in a series of four divided attention tests (Field Impairment Tests, FIT). If the individual declines to participate in the FIT, the normal procedures for a Section 4 offence are applied in that they are arrested and accompanied back to the police office. In Scotland, FIT is, presently, regarded as part of the investigation process. If the subject agrees and carries out the tests to the satisfaction of the police officer, they will be permitted to carry on their way and no further proceedings will ensue. If, however, the police officer is not satisfied with the way in which they have been carried out, the subject is arrested and the normal procedures for a Section 4 offence proceed from this point forward (Figure 36).

6.4.1 Symptoms of Recent Drug Misuse (Drug Recognition Phase)

The police officers are trained to identify signs and symptoms of six drug groups:

- Opiates
- CNS Stimulants
- CNS Depressants
- Cannabis
- Hallucinogens
- Solvents

Table 30 shows some of the clues and symptoms which can be exhibited by a user of a specific drug group. As part of their training, the police officers are trained to recognise these clues when in contact with a suspected drugged driver.

Figure 36: The current procedure for dealing with a driver suspected of DUID in the United Kingdom implementing the voluntary FIT

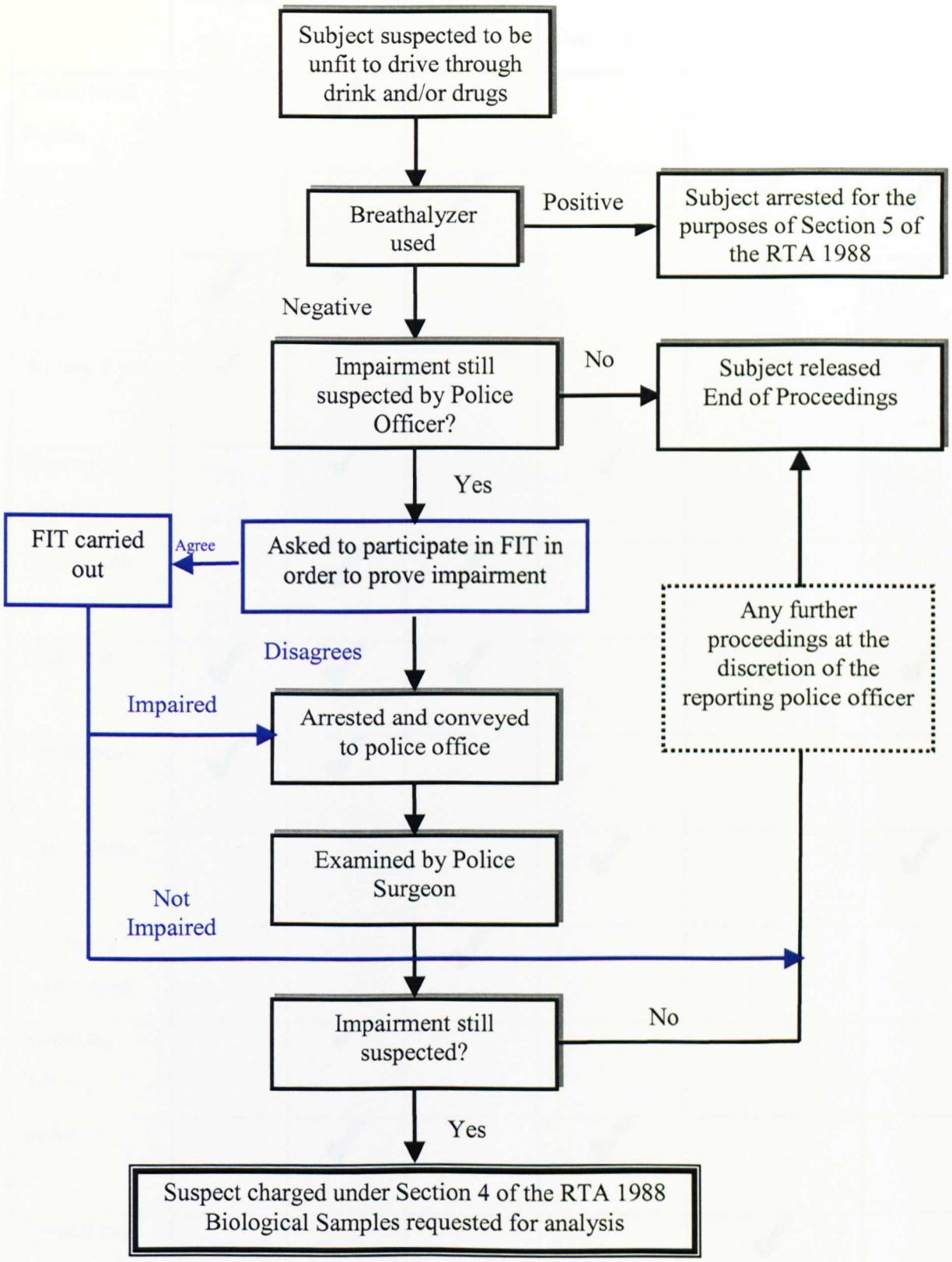


Table 30: Signs and symptoms which are indicative of drug use

✔ **Probable sign/symptom** ✓ **Possible sign/symptom:**

	Cannabis	Opiates	CNS Stimulants	CNS Depressants	Hallucinogens	Inhalants
Constricted Pupils		✔				
Dilated Pupils			✔		✓	✔
Reddened Eyes	✔	✓			✓	✓
Watery Eyes	✓				✓	✓
Slurred Speech		✓		✓		
Dry Mouth		✔	✔			
Euphoria	✔	✔	✔		✔	✔
Relaxation	✔	✔				
Drowsiness				✔		✔
Increased confidence			✔			
Sweating / Itching		✓				
Sedation		✔		✔		
Synesthesia					✔	

6.4.2 The Field Impairment Tests

If the subject agrees to participate in FIT, the police officer initially notes the condition of the eyes (glazed, watery, reddened) and also estimates the size of the pupil by using a chart which is held adjacent to the eye. The police officer then reads out the instructions for each test and demonstrates where necessary. The four divided attention tests consist of:

- **The Romberg Test:** The subject is asked to stand with his/her heels and toes together and arms by their sides. They are asked to tilt their head back, close their eyes and maintain that position whilst estimating the passage of 30 seconds. Once they suspect the passage of 30 seconds they raise their head and say "Stop". The subjects ability to balance during the instruction phase, maintain the required stance and also estimate the passage of 30 seconds is assessed.

- **The One Leg Stand:** The subject is asked to stand with his/her heels and toes together and arms by their sides. When instructed they have to raise their right foot approximately six inches off the ground, keep their leg straight and toes pointing forward and count in the fashion "1001, 1002, 1003" etc until told to stop. This is repeated for the left leg. The subjects ability to balance during the instruction phase, carry out instructions and count correctly are assessed.

- **The Walk and Turn Test:** The subject is asked to walk along a line making sure their feet touch heel to toe on every step. Having walked nine steps they leave their front foot on the line and use a series of small steps to turn thereby facing the opposite direction. They then walk a further nine steps. At all times, their arms are required to stay by their side. The subjects ability to balance during the instruction phase, carry out the required instructions and count correctly are assessed.

- **The Finger to Nose Test:** The subject is asked to stand with his/her heels and toes together and arms by their sides. They are instructed to extend both arms, palm side up, make fists and extend both index fingers. They are then required to touch the tip of their nose with the tip of their index finger as instructed. The ability of the subject to balance during the instruction phase, stand as instructed, count and carry out required instructions are assessed.

Throughout the series of tests, the ability to understand and follow each instruction are observed and any mistakes, excessive body sway and loss of balance noted. The outcome is not regarded as a "pass" or a "fail". These tests are regarded as an extra implement for the police as an evidence-gathering tool and the suspicion that the subject is impaired is reached on the totality of all observations, *i.e.* the reason for stopping the subject, the behaviour of the subject and the performance in FIT. At no point can these tests be used as the sole reason for arresting a subject and likewise the subject is not noted as "failing" any one particular test.

6.4.3 The Public Reaction to FIT and Drugs and Driving

During the summer of 2002, a drug driving advert was developed by Faulds Advertising on behalf of the Scottish Road Safety Campaign's Drug Drive Working Group. This consisted of American police video footage of intoxicated individuals participating in the various tests and came across to the public as amusing. However, the advert then shows a man at a police check point in Scotland failing a test. A message that these tests are being carried out in Scotland flashes on the screen and leaves the viewer with the hard hitting slogan "Who's laughing now?" The Scottish Executive and the Scottish Road Safety Campaign commissioned NFO Social Research to evaluate this advert and there was a particular focus on its impact on young drivers aged 17 – 24 years. In general, young people did not consider drug driving to be as dangerous or likely to lead to a prosecution than drink driving. That said, the key messages of the advert were well understood and general awareness of advertising and publicity on drugs and driving was high following the advert. However, there was some criticism as to the lack of actual legal consequences of drug driving and NFO Social Research felt that including confirmed high-profile successes may strengthen the credibility of the enforcement message [306].

In order that the FIT can be used in evidence in a court of law, it has to be validated to show that it is a reliable evidence gathering tool which can be utilised by the police officer. The results of a national study commissioned by the Department for Transport in collaboration with the University of Glasgow aiming to do just that will be discussed later in this chapter and following an evaluation of the prevalence of DUID in the Strathclyde Police district of Scotland.

6.5 Methodology for Drugs and Driving

6.5.1 Drivers Suspected of DUID

Forensic Medicine and Science receive biological samples from drivers suspected of DUID from all Police Forces throughout Scotland with the exception of Lothian and Borders. All biological samples obtained from subjects who are charged under Section 5 of the RTA 1988 are conveyed to the relevant regional Police Laboratories. The results of toxicological analyses from samples obtained from drivers suspected of DUID were retrieved from archive records retrospectively and from the department database prospectively and were reviewed to determine the number which were found to be drug positive and of those, the drugs which were detected. Unfortunately, there was no information available relating to any prescribed medication that the individual may have been in receipt of at the time the sample was obtained. It was therefore not possible, to ascertain if, for example, methadone had been prescribed or obtained illicitly.

The same analytical procedures applied as per the drug-related death cases in that all samples were routinely screened for all illicit and prescription-type drugs and any tentative positive drugs / drug groups were confirmed. There was no significant changes to these procedures which would affect the sensitivity or specificity over the study period.

6.5.2 Field Impairment Test

Nation-wide, some police officers had been trained on the use of FIT to detect the drug impaired driver. As a result, Forensic Medicine and Science was commissioned by the Department for Transport to evaluate the use of FIT. Whilst having no control over the design of the incorporation of FIT into present police procedures, a protocol was developed to ensure delivery of all toxicological results and the voluntary provision of a saliva sample. That is, in addition to obtaining blood/urine samples from individuals who were judged to be impaired at the roadside, those who were judged to be unimpaired were asked to donate a specimen of saliva to detect any "missed" drugs and to confirm drug free drivers. The use of saliva over other alternative matrices has been shown to be preferable due to it's collection being rapid, non-invasive and relatively easy to obtain [307], i.e. it does not require special facilities and close supervision of private functions of the subject [308]. A project known as the Roadside Testing Assessment (ROSITA) was set up in 1999, part of which was to investigate the use of oral fluid in road-side testing. This demonstrated that driver response to providing saliva specimens has been favourable and also that, in the

absence of blood, saliva provides the best indicator for the drugs in circulation in the body [309]. Saliva is an ultrafiltrate of interstitial fluid and contains the free component of drugs (i.e. the physiologically active fraction). Therefore, measurement of drug concentrations in saliva provides an estimate of the actual amount of drug in circulation and the results can therefore be used to indicate possible drug impairment [308].

A liaison officer was appointed for each police force in Scotland who would be the main point of contact between the department and their operational officers. In order to document results of the field impairment test (FIT), a five-page form was devised in order that mistakes and/or clues of impairment could be easily recorded by the police officer for each element of the test (Form 1). Forensic Medicine and Science were involved with the design and layout of these forms. In addition an extra form was included in order that the police officers drug recognition skills may be monitored (Form 2).

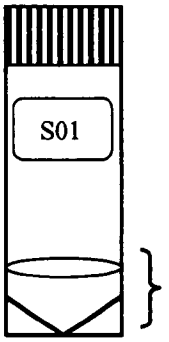
Prior to an individual agreeing to carry out the test, they were informed by the police officer that participation was on a voluntary basis and if found to be not impaired and a saliva sample obtained, that anonymity would prevail at all times. This was read from the reverse side of the information sheet (Form 3) that was within the saliva kit and given to individuals for their information. A phone number was provided should the individual have any questions or concerns regarding their participation.

In cases where the individual was presumed to be impaired, they were taken back to the police station for a medical examination by a police surgeon and the usual procedures for a Section 4 offence carried out. All samples taken by police surgeons from accused persons suspected of contravening Section 4 of the Road Traffic Act 1988 are submitted to the laboratory of Forensic Medicine and Science for toxicological investigation. This is the case for all police forces throughout Scotland with the exception of Lothian and Borders who have their own Forensic Laboratory. The samples are subjected to the same analytical procedures as the post-mortem samples. In order for a full investigation to be carried out and in duplicate, it is a requirement that a quantity of 10ml of blood be submitted. In some cases, confirmation of drugs which screened positive is not possible due to an insufficient blood sample being obtained by the police surgeon. All toxicological results from these cases are held on the department database allowing for retrospective and prospective analyses. This study did not impinge on the normal Police - Forensic Laboratory arrangements for the analysis of blood or urine samples taken for the purposes of Section 4 of the Road Traffic Act.

For the purpose of this study, a saliva kit was produced and batches sent to each of the eight police forces. The kit contained the following:

- Information sheet
- Labelled universal container
- Stamped, addressed jiffy bag
- Disposable gloves
- Extra label corresponding to that on universal which was attached to DRE form

The driver was requested to expectorate into the plastic universal enough to cover the convex bottom (as illustrated below). Disposable gloves are supplied with the kit if required. The universal was then placed in the stamped addressed envelope and posted by the police officer or if necessary, the individual.



Recommended quantity of saliva (~2ml)

The following protocols were put into place:

In EVERY case, the paperwork was received as follows:

The police officer was required to complete a FIT form for EVERY person who participated to take part. In addition a DRE form was also completed

- Both forms were forwarded to the appointed force liaison officer
- Both forms were photocopied, the FIT form was made anonymous and they were attached together and forwarded to the department

For impaired drivers where sample was obtained

- Completion of forms as above
- The liaison officer noted on the FIT form whether a blood or urine sample was obtained

- The department database was searched in order to find a sample that had been obtained by the specific police force round about the date the FIT was carried out. The match was verified by checking the arresting police officer noted on the FIT form matched that on the database
- For cases from Lothian and Borders, it was necessary to contact the liaison officer who in turn received the results from their laboratory

For impaired driver where no sample was obtained

- Completion of forms as above
- Reason why sample not obtained noted accordingly on the DRE form

For drivers found to be not impaired who agreed to provide a saliva sample

- Completion of forms as above
- Driver asked to provide saliva sample
- This was placed in the envelope provided and posted as soon as possible (N.B. No paperwork accompanied the sample)

6.5.2.1 Measuring Impairment

FIT was used to identify drug-induced impairment. A key concept in the design of this study was the use of an available objective indicator of probable drug-related impairment, which was drug analyses of biological specimens. There is at present, no other recognised reference or standard method for measuring impairment or indeed an absolute definition of impairment. Hence whilst it is recognised that the mere presence of a drug in blood or saliva does not indicate impairment *per se.* However, in the absence of any other objective indicator, the occurrence of toxicologically significant concentrations of drugs supports the presumption of impairment.

6.5.3 Statistics

In order to assess the ability of the FIT to diagnose impairment the sensitivity, specificity and accuracy of each test was calculated.

The sensitivity is defined as the proportion of drug positive cases that are correctly identified by the test (i.e. the probability that a driver with drugs in their system was identified as impaired) and is calculated as:

TPx100/(TP+FN)

The specificity is defined as the proportion of drug negative cases that are correctly identified by the test (i.e. the probability that a driver with no drugs in their system was identified as not impaired)and is calculated as:

TNx100/(TN+FP)

The accuracy can be defined as the proportion of cases that were correctly diagnosed in the study sample and is calculated as:

(TP+TN)x100/(TP+TN+FP+FN)

The positive and negative predictive values were also calculated. The Positive Predictive Value (PPV) is defined as the proportion of drivers with positive test results (i.e who are suspected to be impaired) that are correctly diagnosed and is calculated as:

TPx100/(TP+FP)

The Negative Predictive Value (NPV) is defined as the proportion of drivers with negative test results (i.e who are suspected to be not impaired) that are correctly diagnosed and is calculated as:

TNx100/(FN+TN)

Where TP, FP, TN and FN are defined as follows:

TP (True Positive) the number of drivers who were suspected to be impaired / displayed clues and who tested positive for drugs (drug positive blood samples)

FP (False Positives) the number of drivers who were suspected to be impaired / displayed clues but were drug free (drug negative blood samples)

TN (True Negatives) the number of drivers who were not suspected to be impaired / did not display clues and were drug free (in saliva)

FN (False Negatives) the number of drivers who were not suspected to be impaired / did not display clues but drugs were detected (in saliva)

Form 1: The FIT form

IMPAIRMENT ASSESSMENT
Section 3A/4 RTA 1988

INTRODUCTION AND GENERAL GUIDANCE

Note: This form is for use by authorised police officers during the application of Field Impairment Tests on a subject who has voluntarily agreed to participate. Where a test is abandoned the reasons should be recorded in additional particulars. If the questions are read from a laminated card, the wording must be identical to those in this form and the card must remain available for court purposes.

REQUEST AND CAUTION

"In order to assess whether your ability to drive is impaired, I would like you to perform a series of tests. The tests are simple and will enable me to make a judgement as to whether your ability to drive is impaired. I must caution you that you are not required to participate; if you do, the results of the tests may be used in evidence. Part of the evaluation is based on your ability to follow my instructions. If you do not understand any of the instructions, please tell me so that I can clarify them.

'Do you understand' YES / NO

'Do you agree to participate in the tests' YES / NO

RELEVANT DETAILS

BRIEF CIRCUMSTANCES OF INCIDENT / DEMEANOUR / BEHAVIOUR OF SUSPECT

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

. . . . . .

NAME _____ **D.O.B.** _____ **SEX: MALE** ☐ **FEMALE** ☐

ADDRESS _____

DAY/DATE _____ **TIME STARTED** _____

LOCATION _____

WEATHER	FINE ☐	RAIN ☐	SNOW ☐	WIND ☐
LIGHTING CONDITION	DAYLIGHT ☐	TWILIGHT ☐	DARKNESS ☐
STREET LIGHTING	LIT ☐	UNLIT ☐	NIL ☐
ROAD SURFACE	WET ☐	DRY ☐	
FOOTWEAR	SUITABLE ☐	UNSUITABLE ☐	REMOVED ☐

If unsuitable state reason: . . . . . .

. . . . . .

. . . . . .

. . . . . .

PUPILLARY EXAMINATION

'I am going to examine the size of your pupils, comparing them to this gauge, which I will hold up at the side of your face. All I require you to do is look straight ahead and keep your eyes open'.

'Do you understand?' YES / NO

'Are you wearing contact lenses?' YES / NO

PUPIL SIZE LEFT: CONSTRICTED / NORMAL / DILATED Approx Size: ☐

PUPIL SIZE RIGHT CONSTRICTED / NORMAL / DILATED Approx Size: ☐

NOTE CONDITION OF EYES: WATERY **YES / NO** REDDENING **YES / NO**

Additional Comments

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. . . . . .

ROMBERG TEST

'Please stand with your heels and toes together with your arms down by your sides. (Demonstrate). Maintain that position while I give you the remaining instructions. Do not begin until I tell you. When I tell you, tilt your head back slightly, close your eyes (Demonstrate - do not close your eyes). When you think that 30 seconds have elapsed, bring your head forward, open your eyes and say "stop".'

'Do you understand?' **YES / NO**

'Do you have a disability or medical condition that prevents you from participating in this test?' **YES / NO**

'Tilt you head back, close your eyes - begin'

ABLE TO BALANCE DURING INSTRUCTIONS? YES / NO

IF NO STEPS ☐ SWAYS ☐ RAISE ARMS ☐

COMPLIED WITH INSTRUCTIONS? YES / NO

IF NO TIME (secs)	EYES OPEN	HEAD RAISED	STEPS	SWAYS	RAISE ARMS

ESTIMATION OF 30 SECS ⊕ ☐

Additional Comments

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WALK AND TURN TEST

'Please put your left foot on the line, place your right foot in front of your left foot, touching heel to toe with your arms down by your side. (Demonstrate). Maintain that position while I give you the remaining instructions. Do not begin until I tell you.'

"When I tell you, take nine heel to toe steps along the line, on each step, the heel of the foot must be placed against the toe of the other foot (Demonstrate). On the ninth step, leave the front foot on the line and turn round using a series of small steps with the other foot (Demonstrate). After turning, take another nine heel to toe steps along the line. During the test, keep your arms by your sides, watch your feet, count the steps out loud and don't stop walking until the test is complete'.

'Do you understand?' **YES / NO**

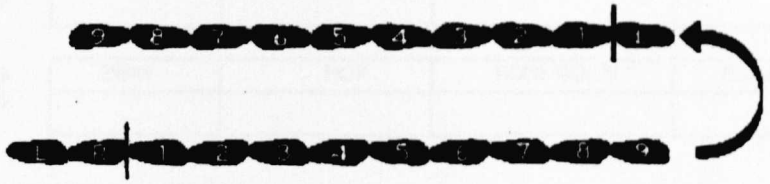
Do you have a disability or medical condition that prevents you from participating in this test? **YES / NO**

ABLE TO BALANCE DURING INSTRUCTION? YES / NO

IF NO STEPS ☐ SWAYS ☐ RAISE ARMS ☐ STARTS TOO SOON ☐

ABLE TO BALANCE DURING INSTRUCTION? YES / NO

COMPLIED WITH INSTRUCTIONS? YES / NO IF NO:



Any deviation from the instructions should be indicated below and on the diagram above.

STOPS WALKING [1] MISS HEEL/TOE [2] RAISE ARMS [3] STEP OFF LINE [4]

CORRECT TURN? YES / NO IF NO STATE REASON:

_____

_____

COUNTS OUT LOUD YES / NO

CORRECT STEP COUNT? YES / NO

If no: TO TURN ☐ **FROM TURN** ☐

Additional Comments

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ONE LEG STAND

'Please stand with your heels and toes together with your arms down by your sides (Demonstrate). Maintain that position while I give you the remaining instructions. Do not begin until I tell you'.

'When I tell you, raise your right foot approximately six inches off the ground, keeping your legs straight and your toes pointing forward (demonstrate). Keep your arms by your sides, look at your elevated foot and count out loud "1001,1002,1003" and so on until I tell you to stop.'

Do you understand?' **YES / NO**

Do you have a disability or medical condition that prevents you from participating in this test?' **YES / NO**
(Time 30 seconds)

REPEAT FOR OTHER FOOT.

ABLE TO BALANCE DURING INSTRUCTION? **YES / NO**

IF NO: **STEPS** ☐ **SWAYS** ☐ **RAISE ARMS** ☐

COMPLIED WITH INSTRUCTIONS? **YES / NO**

LEFT LEG TIME (secs)	SWAY	HOP	FOOT DOWN	RAISE ARMS

RIGHT LEG TIME (secs)	SWAY	HOP	FOOT DOWN	RAISE ARMS

COUNTED CORRECTLY? **YES / NO**

Additional Comments

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FINGER TO NOSE TEST

Please stand with your heels and toes together with your arms down by your sides. (Demonstrate). Extend both arms forward, palm side up, make fists and extend both index fingers. Lower your arms to the side. Maintain that position while I give you the remaining instructions. Do not begin until I tell you. When I tell you, tilt your head back slightly, close your eyes and lift your arms slightly in front of you (Demonstrate). I will say either left or right, at which time lift the relevant hand directly in front and touch the tip of your nose with the tip of the index finger. After touching the nose lower the hand until I tell you the next hand to use (Demonstrate).

Do you understand' **YES / NO**

Do you have a disability or medical condition that prevents you from participating in this test? **YES / NO**

ABLE TO BALANCE DURING INSTRUCTION? **YES / NO**

IF NO: SWAYS ☐ STEPS ☐ RAISES ARM ☐

Tilt your head back, close your eyes and bring your hands slightly forward

Call out the hands in the following order: left, right, left, right, right, left.

TOUCH	CORRECT	WRONG HAND	MISSED NOSE
1			
2			
3			
4			
5			
6			

COMPLIED WITH INSTRUCTIONS? **YES / NO**

IF NO SWAYS ☐ STEPS ☐ RAISES ARM ☐

ADDITIONAL COMMENTS

. . . . . .

. . . . . .

. . . . . .

TIME TEST COMPLETED ☐

TEST RESULTS: **SUSPECT IMPAIRED/NOT IMPAIRED**

OFFICER CONDUCTING TEST
(Print name and sign) ☐

OFFICER CORROBORATING TEST
(Print name and sign) ☐

ARRESTING OFFICERS ☐

Form 2: The Drug Recognition Form

Drug Recognition Form

[please tick √as appropriate]

Please use this form for ALL F.I.T. participants - ALL sections to be completed

Section A – Initial Stage

Reason For Stopping:
- Suspicion of Impairment ☐
- Involvement in RTA ☐
- Moving Traffic Offence ☐ Specify:_____
- Other ☐ Specify:_____

Results of Roadside Breath Alcohol Test:
- Positive ☐
- Not requested ☐
- Negative ☐
- Refused ☐
- Alcohol Present ☐

Reasons for suspicion of drug consumption:
- Dilated pupils ☐
- Constricted pupils ☐
- Slurred speech ☐
- Drowsiness ☐
- Reddening of eyes ☐
- Slumped position at wheel ☐
- Poor co-ordination/balance ☐
- Nervous/agitated demeanour ☐
- Sweating ☐
- Other:_____

Section B – Field Impairment Test

Build: ☐ Underweight ☐ Slim ☐ Normal ☐ Overweight ☐ Obese

F.I.T. Result

Impaired

Does police surgeon believe condition is due to the effects of a drug(s)? Yes ☐ No ☐

If *yes*, sample obtained: Blood ☐ Urine ☐ Sample Refused ☐

Other:_____

If *no*, saliva sample obtained: Yes ☐ No ☐

Not impaired

Was a saliva sample obtained? Yes ☐ No ☐

If *yes*, saliva kit reference number: Stick label *here*

Sample forwarded to University by: Police ☐ Subject ☐

Drug groups suspected:

Opiates ☐ Cannabis ☐ CNS Depressants ☐ CNS Stimulants ☐

Hallucinogens ☐ Inhalants ☐ Polydrug Use ☐ Unknown ☐

This form to be forwarded with impairment assessment form to force liaison officer

Label provided in saliva kit S01 - 0001

Form 3: Information sheet supplied to individuals who agreed to provide an anonymous saliva sample

(a) Front of sheet

University of Glasgow

Road Safety Project

(1) **You have been tested to ascertain if your ability to drive is impaired. It has been concluded that you are NOT UNFIT to drive and no PROCEEDINGS WILL BE TAKEN in respect of offences under the Road Traffic Act 1988, Section 3A or 4.**

(2) **The project you have agreed to participate in is designed to ascertain the TRUE USAGE OF DRUGS (illicit and prescribed) by drivers.**

(3) **Your participation in this project is strictly VOLUNTARY and ANONYMOUS.**

(4) **Consequently, at no time can your identification be linked to the saliva sample that has been taken for RESEARCH PURPOSES ONLY.**

(5) **Should you have any QUESTIONS regarding this research you can contact the University of Glasgow, Tel: 0141-330-2464**

Thank you for your co-operation

(b) Reverse side of sheet

Statement by police to subject

I have to advise you that the tests that you have been subjected to have been concluded and I can advise that there were no signs of impairment and consequently no prosecution will follow in respect of the offences under the Road Traffic Act 1988, Section 3A or 4.

I would now ask whether you would agree to participate in a research project, which is being conducted by an independent body. The purpose of this research is to ascertain the true usage of drugs in drivers. Your participation in the research is on a strictly voluntary and anonymous basis.

Your name and address will not be disclosed to the researchers and any samples obtained will be used for research purposes only. You are under no obligation to participate in the research and may withdraw at any time.

The research consists of taking a saliva sample and will take no more than a few minutes. The samples will be collected using sterile equipment (show kit) and once obtained, will be sealed in this tamper proof envelope. The Police will thereafter post the envelope to the researchers unless you specifically request to do this yourself.

Do you agree to participate in this research?

6.5.4 Storage of Data

On receipt of a FIT form, information was extracted and entered onto a database that had been devised specifically using the Microsoft Access 2000 package. This consisted of an eight page tabbed form with each tab representing a different test or stage of the process:

- General Information
- Pupillary Examination
- Romberg Test
- Walk and Turn Test
- One Leg Stand
- Finger to Nose Test
- DR Form
- Toxicology Results

Each tabbed page was designed using the outline of the FIT form.

6.5.5 Analysing Data in Access

Manipulation of data was achieved using the system query function in Access that enables data corresponding to specific criteria to be retrieved.

An example of each page of the form are shown in Figures 37 – 44.

Figure 37: General Information Screen

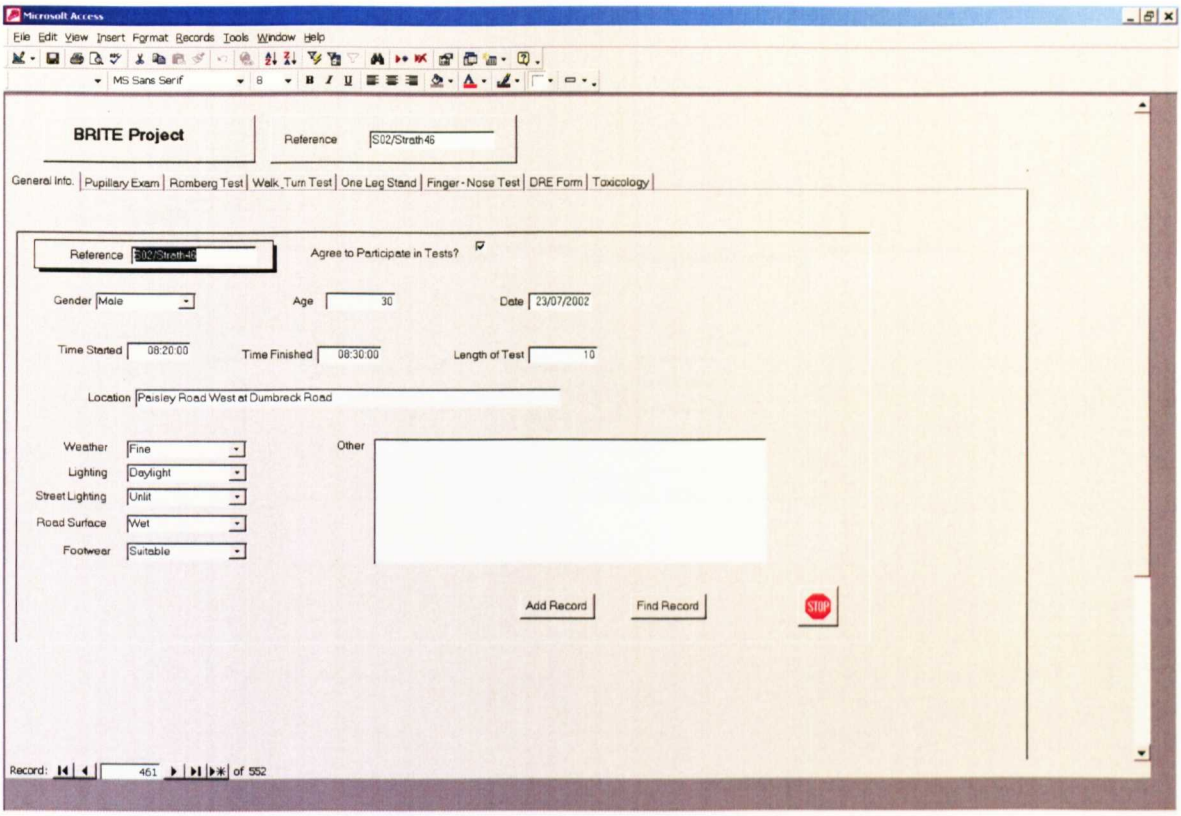


Figure 38: Pupillary Examination Screen

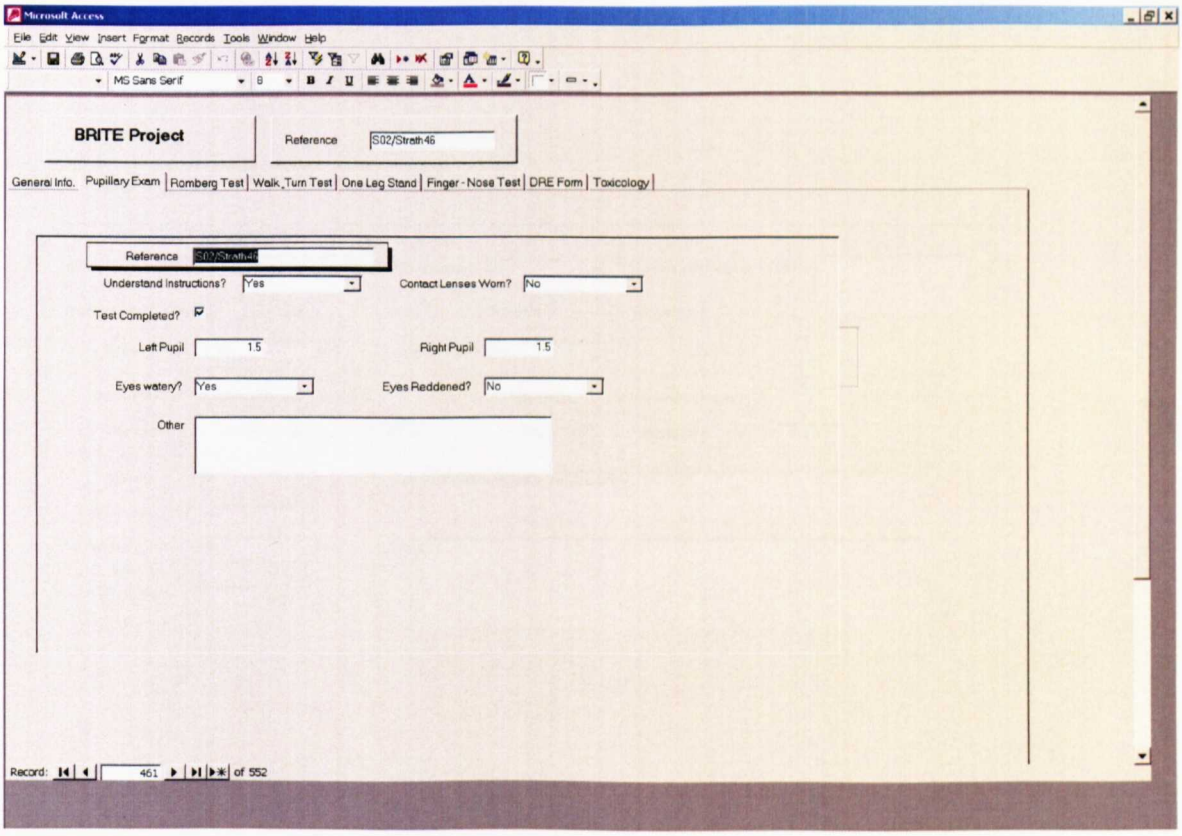


Figure 39: Romberg Test Screen

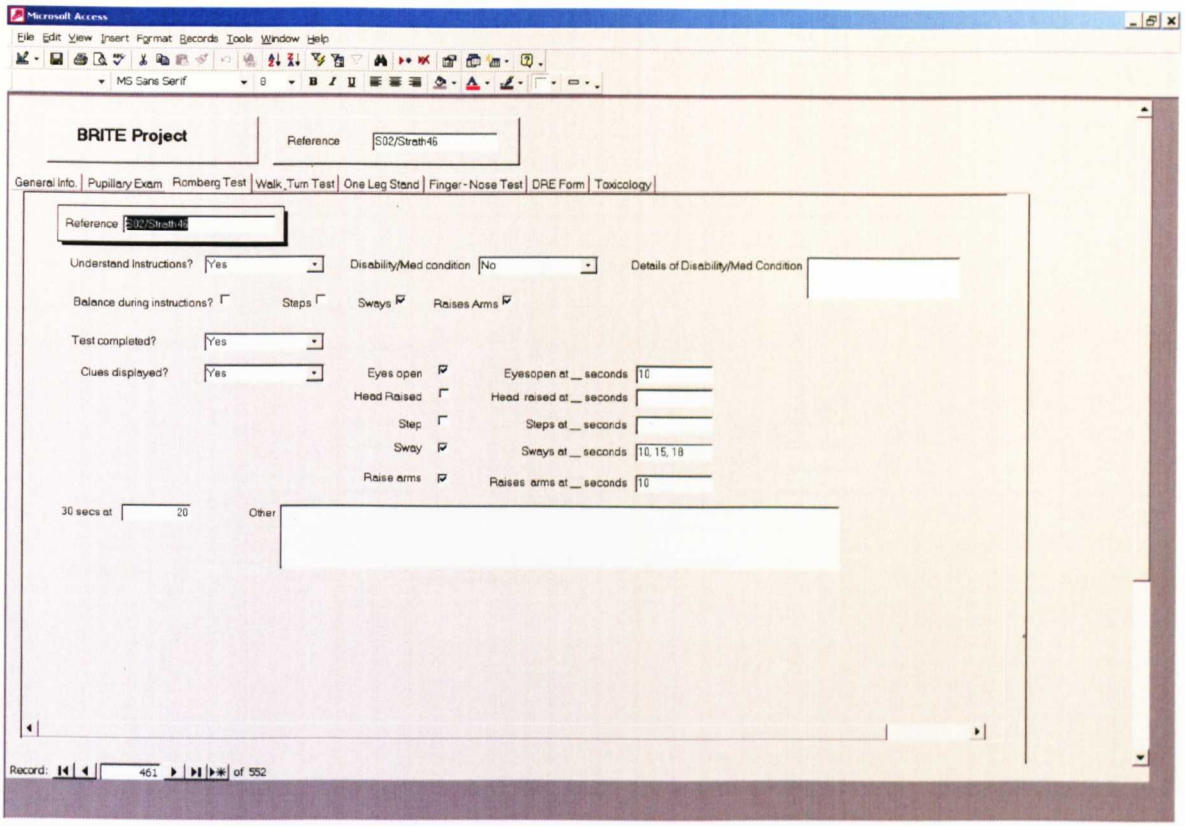


Figure 40: Walk and Turn Test Screen

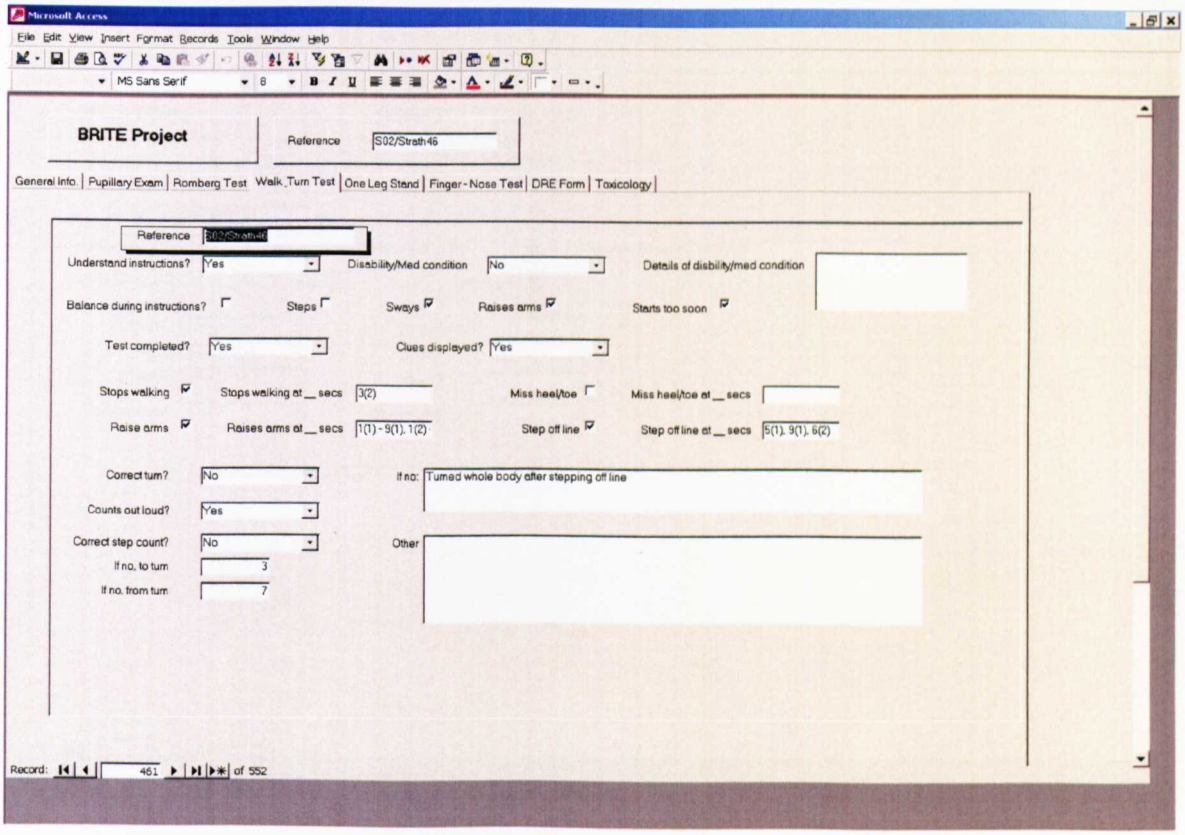


Figure 41: One Leg Stand Test Screen

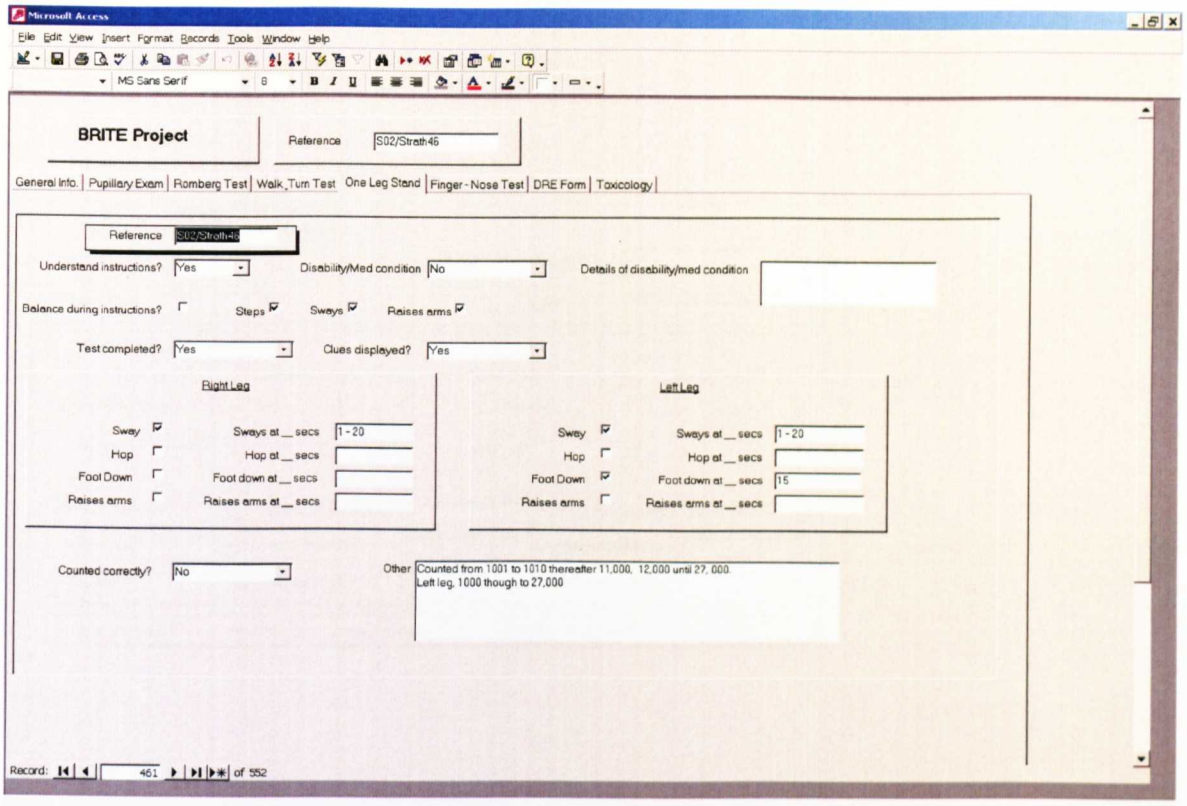


Figure 42: Finger to Nose Test Screen

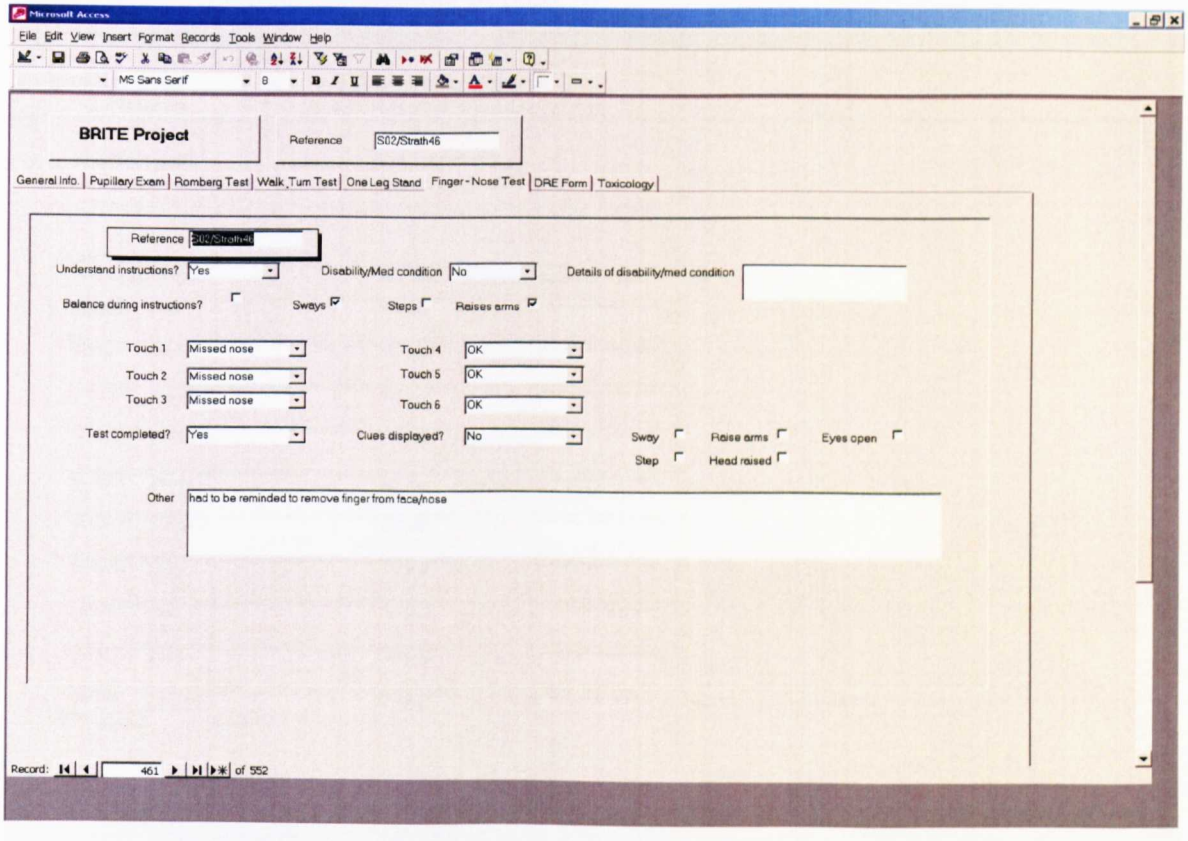


Figure 43: DR Form Screen

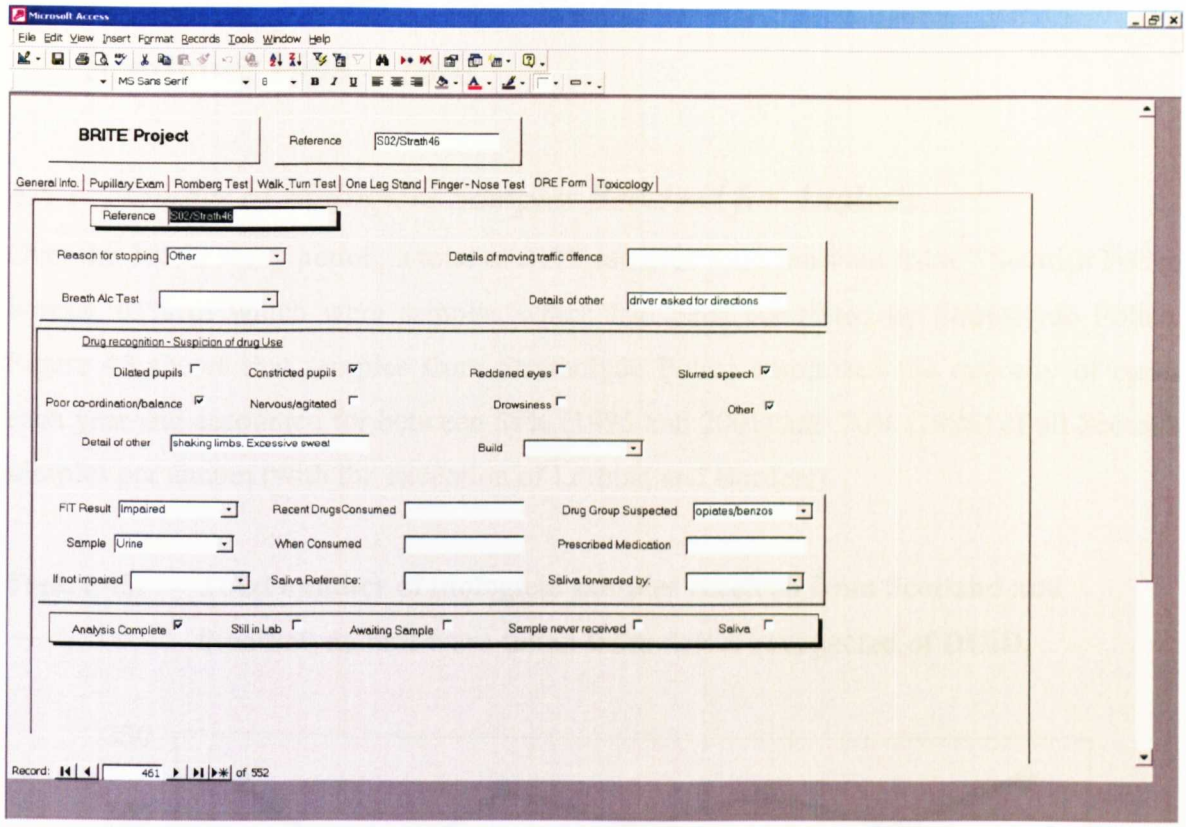
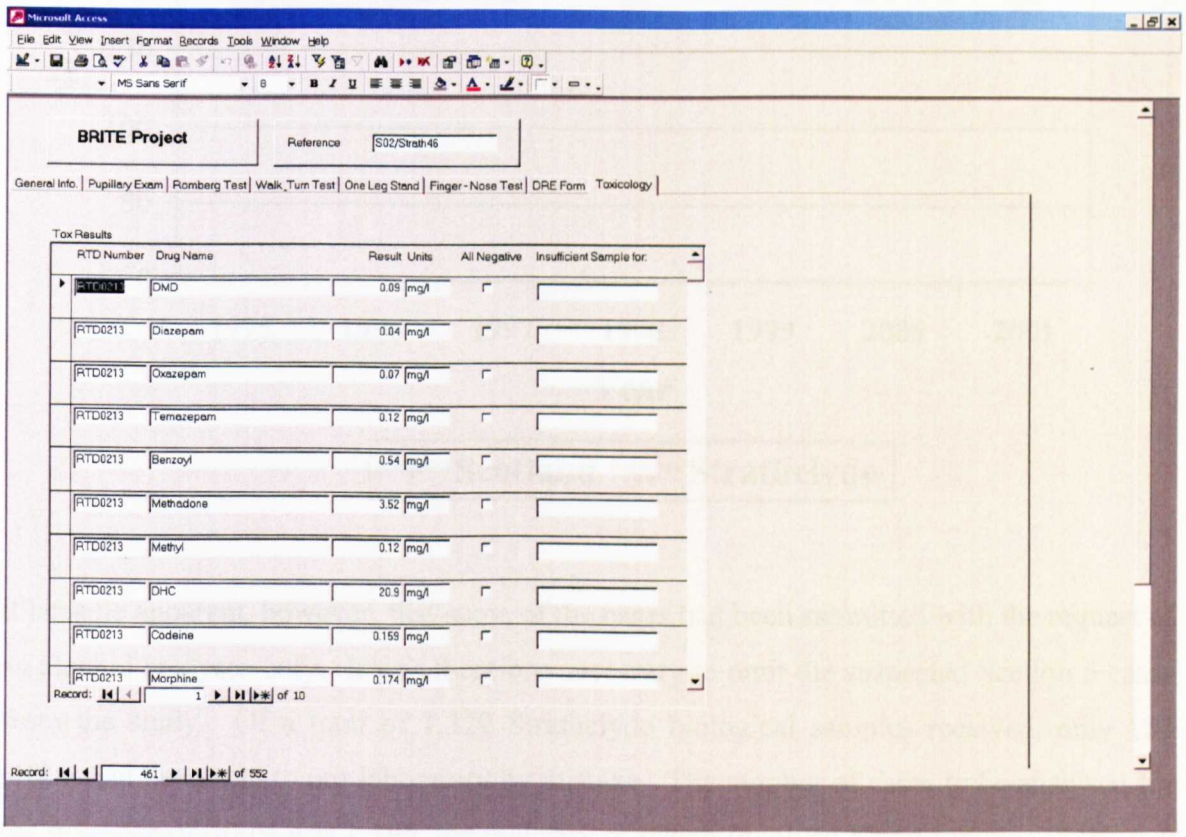


Figure 44: Toxicology Results Screen

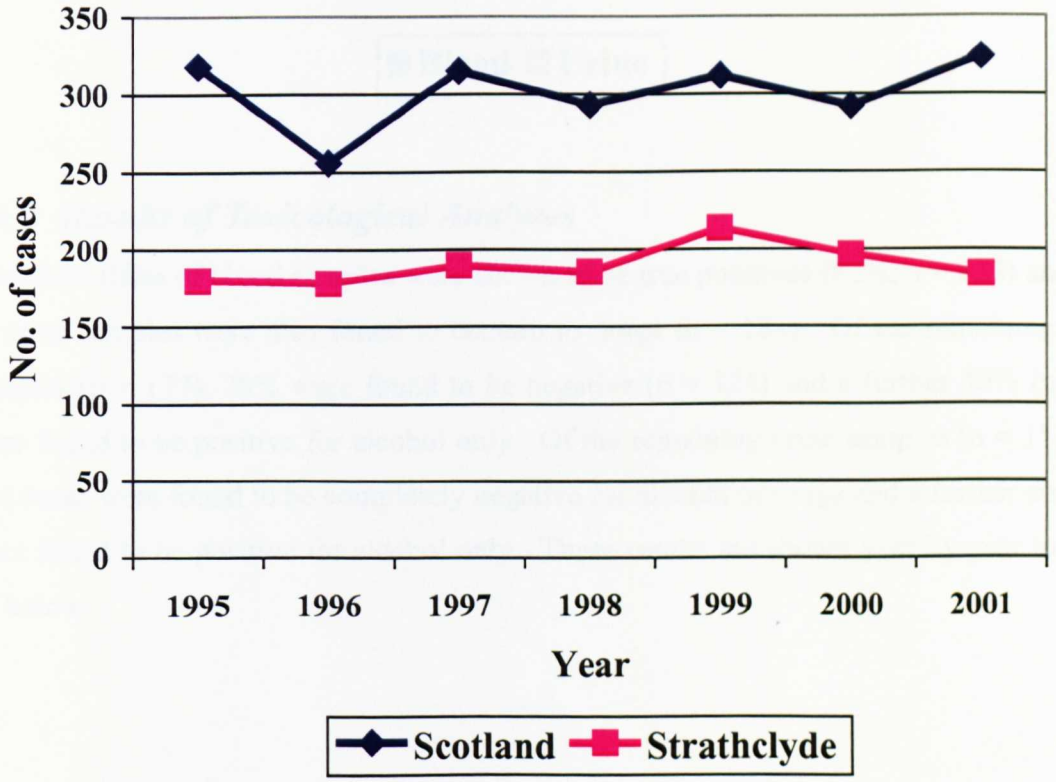


6.6 An Evaluation of Drug Consumption amongst Suspected Drugged Drivers in the Strathclyde Police District of Scotland, 1995 – 2001

6.6.1 Number of Biological Samples Received for Analysis

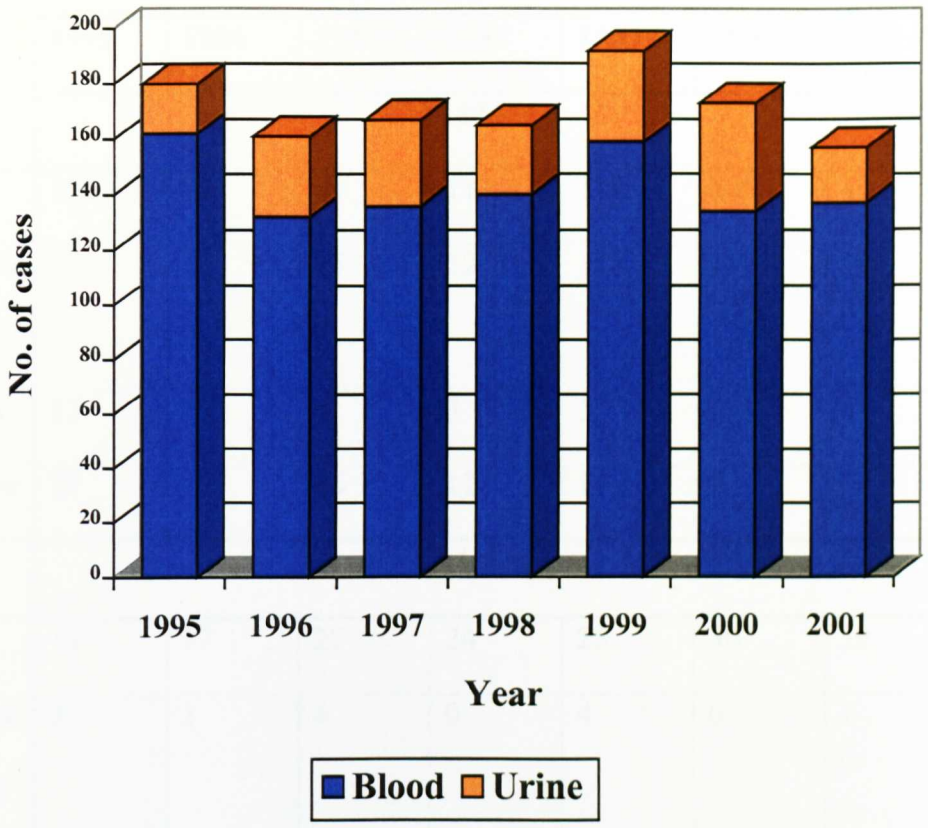
Over the 7-year study period, a total of 2110 samples were received from 7 Scottish Police Forces, 63% of which were samples which had been submitted by Strathclyde Police. Figure 45 shows that samples from Strathclyde Police comprised the majority of cases each year and accounted for between 57% (1995 and 2001) and 70% (1996) of all Scottish samples per annum (with the exception of Lothian and Borders).

Figure 45: Total number of biological samples received from Scotland and Strathclyde that were taken from drivers suspected of DUID.



It became apparent, however, that some of the cases had been submitted with the request of an alcohol analyses only. It was therefore necessary to omit the suspected Section 5 cases from the study. Of a total of 1,329 Strathclyde biological samples received, only 134 (10%) had been sent to our laboratory by mistake. The number of cases to be analysed for the presence of drugs was 1,195, the majority of which involved blood samples (84%, n = 1,000) as is shown in Figure 46.

Figure 46: Breakdown of Strathclyde Section 4 Cases by Sample Type.



6.6.2 Results of Toxicological Analyses

Over four fifths of blood samples were shown to be true positives (82%, n = 823) and 94% of urine samples were also found to contain to drugs (n = 184). Of the remaining blood samples (n = 177), 70% were found to be negative (n = 124) and a further 30% (n = 53) were found to be positive for alcohol only. Of the remaining urine samples (n = 11), only five cases were found to be completely negative for alcohol or drugs and a further six cases were found to be positive for alcohol only. These results are shown year by year in Table 31 below.

Table 31: Breakdown of Blood and Urine Samples per Year

	1995	1996	1997	1998	1999	2000	2001	*Total*
	Blood							
Drugs	102	73	89	113	128	106	112	***723***
Drugs & Alcohol	20	13	15	12	11	15	14	***100***
Alcohol	13	19	6	3	3	5	4	***53***
Negative	27	27	26	12	17	8	7	***124***
	Urine							
Drugs	13	27	27	24	25	30	19	***165***
Drugs & Alcohol	3	1	4	0	4	6	1	***19***
Alcohol	0	0	0	1	4	1	0	***6***
Negative	2	1	0	0	0	2	0	***5***

6.6.3 Number of Drugs Detected in Blood Samples

Figure 47 shows that polydrug use was evident in the majority of drug positive blood cases (61%, n = 501), with the presence of either two or three drugs being confirmed in 91% (n = 457) of polydrug cases.

Figure 47: Number of drugs detected in drug positive blood samples

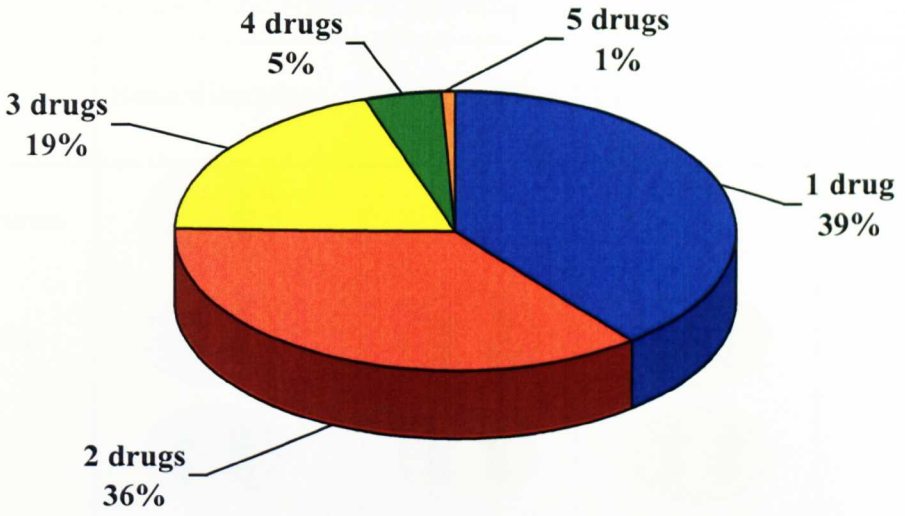
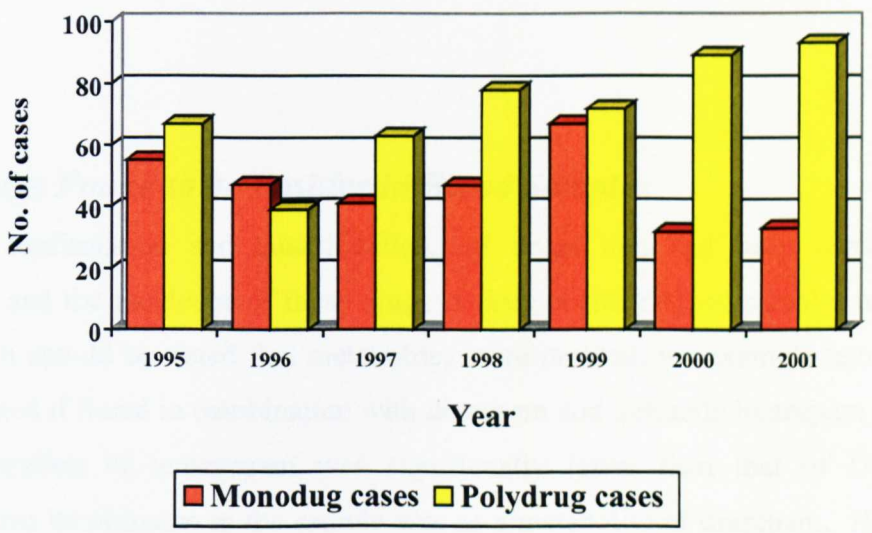


Figure 48 shows that over the study period, the number of cases where only one drug was confirmed has decreased and the number of cases involving polydrug use has increased. In 1995, monodrug cases accounted for 45% of all drug positive cases and in 1996, over half of all drug positive blood cases tested positive for only one drug (55%). However, by 2001 approximately one quarter of drug positive cases involved the presence of one drug (26%).

Figure 48: Changes in frequency of monodrug and polydrug cases over the study period, 1995 – 2001.



The effects of polydrug use are summarised in Table 32 below.

Table 32: Overview of the effects of polydrug use[310]

	Benzodiazepines	Amphetamine	Cannabinoids	Cocaine
Amphetamines				
Cannabinoids				
Cocaine				
Opiates				

 Unpredictable effects

 Additively stimulating effects

 Additively / Potentiating depressant effects

6.6.4 Drugs Found to be Positive in Blood Samples

Following confirmation and quantification, all drugs that had been consumed were ascertained and the incidence of these drugs in drug positive blood samples are shown in Table 33. It should be noted that metabolites were omitted, for example temazepam has not been noted if found in combination with diazepam and desmethyldiazepam (DMD) and the concentration of temazepam was significantly lower than that of DMD, hence indicating that its presence in the sample was as a metabolite of diazepam. However, the presence of benzoylecgonine and methylecgonine either alone or in combination was indicative of cocaine usage.

The average number of drugs detected amongst all drug blood positive cases was shown to increase slightly over the years illustrating that polydrug was evident.

Table 33: Number of drugs detected per annum

	1995	1996	1997	1998	1999	2000	2001	Total
Cannabis (THC-COOH)	46	26	41	60	22	32	41	**268**
THC	6	1	6	16	6	14	11	**60**
Morphine	15	10	33	38	34	54	53	**237**
Methadone	12	13	8	2	10	12	24	**81**
Dihydrocodeine	0	0	10	16	5	13	5	**49**
Diazepam	41	42	64	93	118	101	108	**567**
Temazepam	95	40	20	41	28	11	7	**242**
Cocaine	2	5	1	1	7	6	19	**41**
Amphetamine	0	1	2	0	1	1	3	**8**
MDMA	0	1	1	6	3	8	13	**32**
Other*	4	6	14	6	6	9	8	**53**
Total no. of drugs detected	**215**	**144**	**194**	**263**	**234**	**247**	**281**	**1578**
Drug Positive cases	**122**	**86**	**104**	**125**	**139**	**121**	**126**	**823**
Average no. of drugs per sample	**1.8**	**1.7**	**1.9**	**2.1**	**1.7**	**2.0**	**2.2**	**1.9**

THC-COOH: Tetrahydrocannabinol carboxylic acid

THC: Tetrahydrocannabinol

* **Table 32a:** Other Drugs present per annum

	1995	1996	1997	1998	1999	2000	2001	Total
Carbamazepine	2	2	1	1	0	2	2	10
Chlordiazepoxide	1	1	5	2	4	2	1	16
Caffeine	1	0	0	0	0	0	0	1
Fluoxetine	0	1	2	0	0	0	0	3
Naproxen	0	1	0	0	0	0	0	1
Nitrazepam	0	0	2	0	0	3	0	5
Chloral Hydrate	0	0	1	0	0	0	0	1
Phenobarbitone	0	0	1	0	0	0	0	1
Paracetamol	0	0	1	0	0	1	0	2
Ketamine	0	0	1	0	0	0	0	1
Codeine	0	0	0	2	0	1	0	3
Thioridazine	0	0	0	1	0	0	0	1
Gammahydroxybutyric Acid	0	0	0	0	1	0	0	1
Phenytoin	0	0	0	0	1	0	0	1
Methyldioxyamphetamine	0	0	0	0	0	0	1	1
Amitriptyline	0	0	0	0	0	0	1	1
Sodium Valproate	0	0	0	0	0	0	1	1
Mefenamic Acid	0	1	0	0	0	0	0	1
Oxazepam	0	0	0	0	0	0	1	1
Tramadol	0	0	0	0	0	0	1	1

Figure 49: Most frequently detected benzodiazepines and stimulants as a percentage of all blood drug positive cases per annum

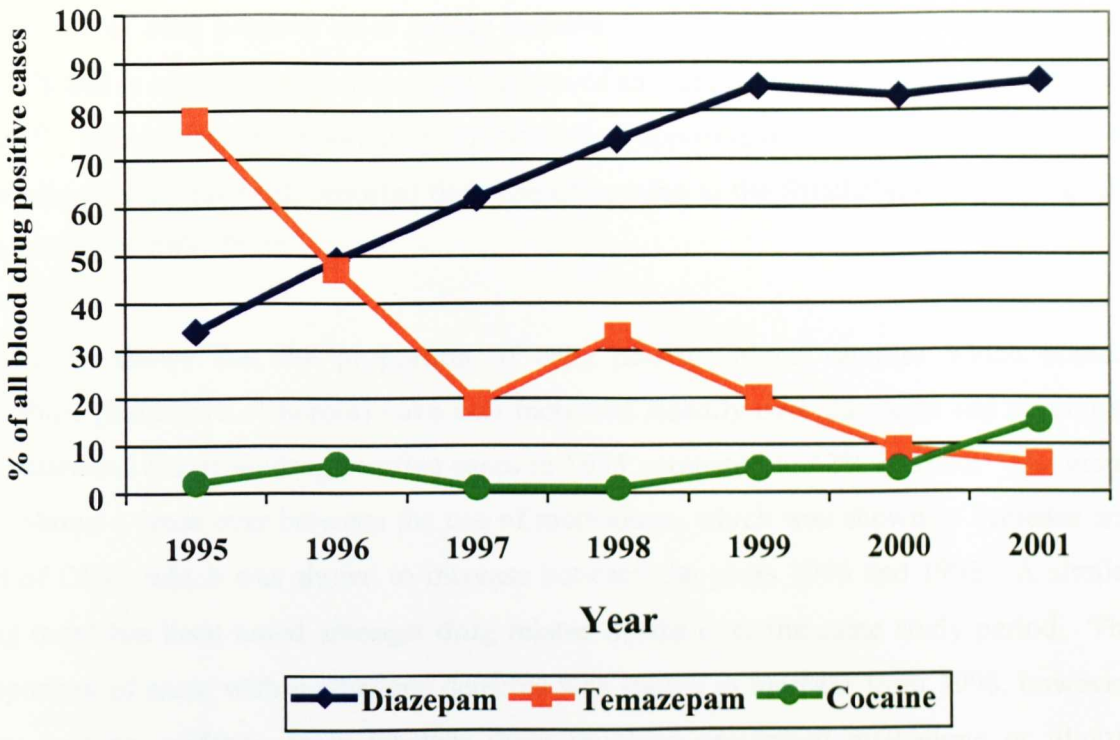
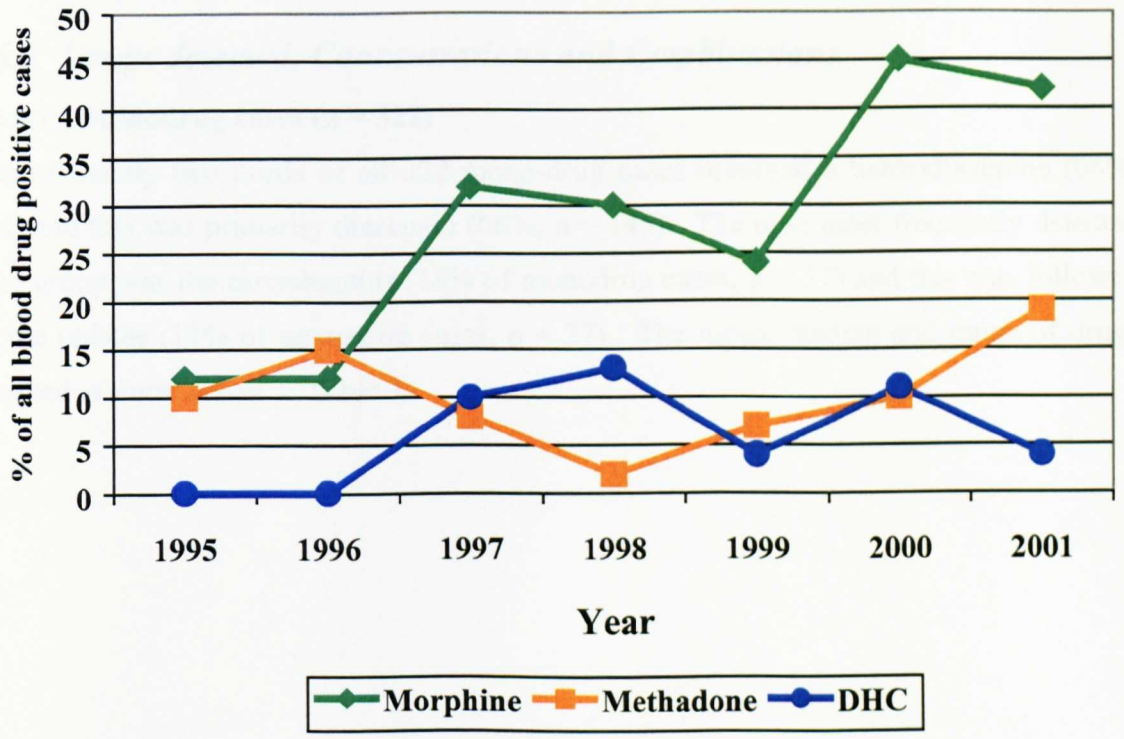


Figure 50: Most frequently detected opioids as a percentage of all blood drug positive cases per annum



The legislation change regarding temazepam in 1996 and the subsequent substitution for diazepam was also evident amongst DUID cases in the Strathclyde Police Region as is shown in Figure 49. This figure also shows that in the latter two years of the study, the proportion of drug positive cases testing positive for cocaine was also shown to increase slightly and is consistent with anecdotal reports of an increase usage of this drug within the area [311]. This is further supported by an increase of approximately 136% in the number of new clients who have self reported their use of cocaine in the Strathclyde region over the years 1999 to 2001 [108, 312].

Figure 50 shows that the proportion of drug positive blood samples which contain morphine (indicative of heroin) have also increased steadily over the years and accounted for between 12% of all drug positive cases in 1995 compared to 42% in 2001. The graph also shows a cross over between the use of methadone, which was shown to decrease and that of DHC, which was shown to increase between the years 1996 and 1998. A similar drug trend has been noted amongst drug related deaths over the same study period. The proportion of cases with methadone detected was shown to increase from 1998, however, there was no evidence as to whether these involved prescribed methadone or illicitly obtained prescriptions.

6.6.5 Drugs detected, Concentrations and Combinations

6.6.5.1 Monodrug cases (n = 322)

Approximately two thirds of all 322 mono-drug cases involved a benzodiazepine (66%, 214) and this was primarily diazepam (68%, n = 145). The next most frequently detected drug group was the cannabinoids (18% of monodrug cases, n = 57) and this was followed by the opiates (11% of monodrug cases, n = 37). The mean, median and range of drugs detected is summarised in Table 34.

Table 34: Mean, median and range of concentrations for drugs detected in Monodrug Cases

	N	Mean (Range) mg/litre	Median mg/litre	Therapeutic Levels mg/litre[313]
Diazepam	142†	0.83 (0.01 – 5.2)	0.51	0.05 – 2.0
Temazepam	66	2.81 (0.13 – 23.14)	1.45	0.36 – 0.85
THC-COOH	57	27.6 (2.0 – 117)‡	22.0‡	
THC	*21*	*4.3 (2 – 15)‡*	*4‡*	
Morphine	26	0.08 (0.01 – 0.3)	0.06	0.04 – 0.5
Methadone	6	0.13 (0.06 – 0.23)	0.11	0.05 – 1.0
Cocaine	5	0.15 (0.01 – 0.6)	0.03	
Benzoylecgonine	5	0.62 (0.085 – 1.8)	0.2	
Methylecgonine	3	0.24 (0.009 – 0.67)	0.04	
Dihydrocodeine	5	0.64 (0.11 – 1.22)	0.77	0.8 – 1.7[211]
MDMA	3	0.9 (0.67 – 1.2)	0.83	
Nitrazepam	2	0.5 (0.3 – 0.69)	0.5	
Other	7	GHB (41.4), Fluoxetine (0.09), Phenobarbitone (34.1), Carbamazepine (0.71), Naproxen (2.62), Caffeine (0.17), CDP (0.23)		

† There were three cases where diazepam was confirmed by the presence of desmethyldiazepam, but no diazepam was detected.

‡ ng/ml

A mean concentration of 0.83mg/litre of diazepam was detected ranging from 0.01 – 5.2mg/litre, approaching levels associated with toxicity. Morphine, indicative of heroin misuse was noted in 26 cases and a mean morphine concentration of 0.08mg/litre was

measured, ranging from 0.01 – 0.3mg/litre. While these are in keeping with a therapeutic dosage, the presence of codeine and 6-MAM in a large number of these cases suggest that heroin was being misused. Of 66 cases testing positive for temazepam, it can be seen that over one half of these cases involved a concentration which is above that recommended as a concentration used in therapy and which is associated with fatal overdose cases. Cocaine use was confirmed in five cases, all of which can be assumed that the individual was still under the influence of this drug as cocaine itself was detected. Use of cannabis was confirmed in 57 cases, however the presence of the active component, THC, was noted in only 37% (n = 21) of these. This indicates that although the person had consumed cannabis at some point prior to confrontation with the police (which could have been as long ago as 4 weeks), the likelihood that they were under the influence of cannabis in the absence of THC, the principal active constituent, is improbable. Methadone was detected in only six cases and all concentrations were within the therapeutic range associated with maintenance therapy. However, it was not possible to ascertain whether this involved prescribed methadone. Five cases involved DHC with a median concentration approaching that associated with toxicity. MDMA was detected in three cases and in one case a level associated with fatal overdose was noted [314, 315]. Gammahydroxybutyrate, an anaesthetic and hypnotic agent which has nowadays been encountered as a drug of misuse was detected in one case at a level which has been shown to be associated with death [316]. The remaining cases involved mainly medicinal drugs such as anti-depressants, anti-inflammatories and anti-convulsants all at levels associated with therapeutic usage.

6.6.5.2 Two Drug Polydrug Cases (n = 297)

Benzodiazepines were confirmed either alone or in combination with another drug in 19% (n = 56) and 77% (n = 228) of cases where two drugs were detected. In cases where another drug was present in combination with a benzodiazepine, this was primarily either cannabis (42%) or an opiate (42%). In total, 340 benzodiazepines were detected in this group and the most frequently detected benzodiazepine accounted for just over two thirds of these cases and was diazepam (69%, n = 233). Table 35 summarises the combinations of drugs encountered and Table 36 summarises all drugs detected in this group together with a breakdown of concentrations detected.

Table 35: Combinations of drug groups in cases where two drugs were confirmed

	Benzodiazepine	**Opiate**	**Cannabinoid**
Benzodiazepine	56		
Opiate	95	5	
Cannabinoid	96	4	
Cocaine	12	1	
Amphetamine	1		1
MDMA	9		2
Other	15		

Table 36: Mean, Median and Range of Concentrations for drugs detected in cases where the presence of two drugs was confirmed.

	n	Mean (Range) mg/litre	Median mg/litre	Therapeutic levels[313]
Diazepam	222†	0.91(0.03 – 5.5)	0.61	0.05 – 2.0
Temazepam	97	2.03 (0.11 – 11.7)	1.24	0.36 – 0.85
THC-COOH	101**	44.7 (4.0 – 248)‡	29.0‡	
THC	*20*	*12.4 (1 – 96)‡*	*4‡*	
Morphine	81	0.06 (0.004 – 0.65)	0.05	0.04 – 0.5
Methadone	19	0.13 (0.01 – 0.4)	0.11	0.05 – 1.0
Cocaine*	10	0.14 (0.004 – 0.9)	0.04	
Benzoylecgonine	11	0.5 (0.011 – 1.95)	0.225	
Methylecgonine	12	0.44 (0.01 – 3.6)	0.05	
Dihydrocodeine	10	1.06 (0.02 – 7.79)	0.33	0.8 – 1.7[211]
MDMA	11	0.46 (0.01 – 2.3)	0.3	
CDP	9	1.65 (0.17 – 4.62)	1.2	
Carbamazepine	5	9.1 (1.5 – 20.4)	9.8	
Fluoxetine	2	0.12 (0.001 – 0.24)		
Amphetamine	2	0.66 (0.6 – 0.71)		
Other	9	Mefenamic Acid (0.56), Chloral Hydrate (14.2), Paracetamol (145), Thioridazine (0.64), Phenytoin (2.01), Codeine (0.01), MDA (0.01), Tramadol (0.19), Oxazepam (1.83)		

† Plus 10 cases that had only DMD and 1 case only a trace of diazepam was identified.

* Cocaine was present in 13 cases: 9 cases with cocaine, ME and BE, 2 cases with ME and BE, 1 case with cocaine only and 1 case with ME only

** 83 cases only THC-COOH, 18 cases THC-COOH and THC, 2 cases only THC

‡ ng/ml

With respect to the levels encountered, a similar pattern exists for cases with two drugs present as it does for the monodrug cases. That is, the levels of morphine and methadone detected tended to be within the therapeutic ranges and the mean concentration of diazepam and DHC were those associated with therapy, although ranged up to levels related to toxicity and that the mean concentration for temazepam was outwith therapeutic usage. However, the combinations of drugs mainly suggest drug misuse. The vast majority of opiates had been taken concurrently with benzodiazepines (90%), a cocktail of drugs favoured for many years in the West of Scotland. The concurrent use of methadone and morphine was evident in three cases which equates to 60% of the cases where two opiates were detected or 16% of all methadone positive cases in this group. Exposure to cannabis was noted in 103 cases, however the active constituent, THC was noted in only 20 of these cases. Nevertheless, the majority of cases where exposure to cannabis was confirmed involved primarily benzodiazepines but also opiates, amphetamine and MDMA. Exposure to cocaine was noted in 13 cases and the presence of the parent drug was confirmed in 10 of these cases, implying that the person was most probably under the influence of the drug at the time of arrest. Whilst determining the effect that one drug may have on a person can prove difficult, the fact that drugs are often taken in combination suggests that in some cases, the effects of one drug may be augmented by that of another.

6.6.5.3 Three Drug Polydrug Cases (n = 160)

Benzodiazepines were found to be present in 99% (n = 158) of cases where the presence of three drugs was confirmed. This comprised of two benzodiazepines in combination with one other drug in 31% (n = 50) of benzodiazepine positive cases in this group. The concurrent use of benzodiazepines and opiates accounted for 72% (n = 115) of all cases within this group and comprised of two opiates and one benzodiazepine in 35 cases; two benzodiazepines and one opiate in 25 cases and one of each in combination with another drug in 55 cases. The combinations of all 160 cases are summarised in Table 37 below.

Table 37: Combinations of drug groups in cases where three drugs were confirmed

	Benzo	Benzo & Opiates	Benzo & Cannabinoid	Benzo & Cocaine	Benzo & Amphet	Opiates
MDMA	1	1	4	2	3	
Cannabinoid	24	41				2
Cocaine		10	6			
Other		3	2		1	
Opiate	60					

Table 38 below summarises all drugs detected together with mean concentrations detected and ranges.

Table 38: Mean, Median and Range of Concentrations for drugs detected in cases where the presence of three drugs was confirmed.

	n	Mean (Range) mg/litre	Median mg/litre	Therapeutic levels[313]
Diazepam	139*	0.81 (0.01 – 6.7)	0.42	0.05 – 2.0
Temazepam	57	2.4 (0.1 – 9.9)	1.9	0.36 – 0.85
THC-COOH	78	31.3 (3 – 273)	20	
THC	*15*	*4.2 (1 – 11)*	*4*	
Morphine	96	0.06 (0.01 – 0.5)	0.04	0.04 – 0.5
Methadone	38	0.13 (0.02 – 0.87)	0.09	0.05 – 1.0
Cocaine**	8	0.05 (0.007 – 0.18)	0.04	
Benzoylecgonine	18	0.49 (0.008 – 2.16)	0.195	
Methylecgonine	10	0.12 (0.02 – 0.9)	0.03	
Dihydrocodeine	20	0.54 (0.01 – 5.98)	0.19	0.8 – 1.7[211]
MDMA	11	0.47 (0.01 – 1.4)	0.14	
CDP	3	0.60 (0.41 – 0.97)	0.44	
Carbamazepine	3	7.84 (1.3 – 15)	7.24	
Amphetamine	4	0.25 (0.01 – 0.71)	0.14	
Nitrazepam	2	0.06 (0.03 – 0.08)		
Other	3	Paracetamol (20.9), Amitriptyline (0.33), Sodium Valproate (44)		

* Plus 8 cases where only DMD was detected

** 8 cases with cocaine, BE and ME; 2 cases with BE and ME; 8 cases with only BE

Again, with respect to levels of drugs detected, and drug combinations a similar pattern was observed as detailed above. The concurrent use of methadone and morphine was

noted in 21 cases which equates to 57% of cases in this group with two opiates confirmed (n = 37) or 55% of all methadone positive cases in this group.

6.6.5.4 Four Drug Polydrug Cases (n = 38)

Benzodiazepines were found to be present in 97% (n = 37) of cases in this group. Eight cases were found to be positive for only benzodiazepines and opiates, seven of which involved two benzodiazepines and two opiates. This duo drug group combination was also found, together with other drugs, in 26 cases in this group (68%), 12 cases involved two benzodiazepines, one opiate and another drug; another 10 cases involved two opiates, one benzodiazepine and another drug and finally four cases involved one benzodiazepine, one opiate and two other drugs. The combinations of drugs are summarised in Table 39 and the mean, median and ranges of concentrations are shown in Table 40 below.

The concurrent use of methadone and morphine was confirmed in 11 cases and is equivalent to 61% of cases where more than one opiate was positive and 79% of all methadone positive cases in this group.

Table 39: Combinations of drug groups in cases where four drugs were confirmed

	Benzo & Opiates	**Benzo & Cannabinoid**	**Opiate**	**Benzodiazepine**
MDMA	2			
Cannabinoid	19			
Cocaine	1			
Other		1		
Opiate				8
Cannabinoids & MDMA	1			
Amphetamine & MDMA		2		
Cannabinoid & Cocaine	2		1	
MDMA & Cocaine	1			

Table 40: Mean, Median and Range of Concentrations for drugs detected in cases where the presence of four drugs was confirmed.

	n	Mean (Range) mg/litre	Median mg/litre	Therapeutic levels[313]
Diazepam	33*	0.90 (0.04 – 4.29)	0.51	0.05 – 2.0
Temazepam	19	2.1 (0.08 – 9.1)	1.64	0.36 – 0.85
THC-COOH	26	37.5 (0.001 – 190)	23.5	
THC	*2*	*4 (3 – 5)*		
Morphine	28	0.04 (0.007 – 0.12)	0.03	0.04 – 0.5
Methadone	14	0.10 (0.01 – 0.26)	0.08	0.05 – 1.0
Cocaine**	2	0.02 (0.003 – 0.03)		
Benzoylecgonine	4	0.05 (0.007 – 0.1)	0.05	
Methylecgonine	1	0.001		
Dihydrocodeine	9	0.75 (0.02 – 3.03)	0.25	0.8 – 1.7[211]
MDMA	6	0.22 (0.11 – 0.29)	0.24	
CDP	3	0.27 (0.05 – 0.44)	0.31	
Codeine	2	0.06 (0.05 – 0.07)		
Amphetamine	2	0.19 (0.18 – 0.21)		
Other	2	Nitrazepam (1.0), Ketamine (0.03)		

* Plus 3 cases with DMD only

** 1 case with cocaine and BE, 1 case with ME and BE, 1 case with cocaine only and 2 cases with BE only

6.6.5.5 Five Drug Polydrug Cases (n = 6)

Each case involved a combination of benzodiazepines and opiates either alone (n = 1) or in combination with other drugs (n = 5). The combinations of drugs are summarised in Table 41 and the concentrations outlined in Table 42.

Table 41: Combinations of drug groups in cases where five drugs were confirmed

	Benzo & Opiates	Benzo
Cannabinoid	3	
Other	1	
Opiate		1
Cannabinoids & MDMA	1	

Table 42: Mean, Median and Range of Concentrations for drugs detected in cases where the presence of five drugs was confirmed.

	n	Mean (Range) mg/litre	Median mg/litre	Therapeutic levels[313]
Diazepam	6	0.59 (0.13 – 1.79)	0.43	0.05 – 2.0
Temazepam	3	1.63 (1.07 – 2.0)	1.81	0.36 – 0.85
THC-COOH	4	25.5 (6 – 54)	21	
THC	*2*	*9.5 (4 – 15)*		
Morphine	6	0.12 (0.01 – 0.28)	0.105	0.04 – 0.5
Methadone	4	0.76 (0.01 – 2.95)	0.05	0.05 – 1.0
Dihydrocodeine	5	0.22 (0.002 – 0.63)	0.13	0.8 – 1.7[211]
Other	2	Carbamazepine (0.85), MDMA (0.18)		

The concurrent use of methadone and morphine was confirmed in four cases and is equivalent to 67% of cases where more than one opiate was positive and 100% of all methadone positive cases in this group.

6.6.5.6 Cannabis Levels

Tetrahydrocannabinol is the active component of cannabis and is detectable in blood up to 4 hours after consumption. It's presence at toxicology is thus indicative of recent usage. In fact a level of between 10 – 15ng/ml has been noted as an indicator of recent consumption. Also, consumption can be estimated to have occurred within 20 – 40 minutes of the sample being obtained if similar concentrations of both THC and THC-COOH are detected and THC-COOH when found in concentrations in excess of 40ng/ml can be an indicator of chronic usage [317]. However, over the study period, of all THC positive cases (n = 60), the vast majority had a concentration of less than 10ng/ml (83%, n = 50). Also, the THC/THC-COOH ratio in these cases averaged 0.2 and similar concentrations, indicative of usage within the past 20-40 minutes was only noted in three cases where an average ration of 1.23 was noted. Hence, in these three cases the levels would suggest a high probability of intoxication. Finally, THC-COOH concentrations detected were consistent with those found in chronic users in 28% (n = 76) of cannabis positive cases.

6.6.6 Drugs Found to be Positive in Urine Samples

The table below summarises drugs that were found to be positive in the 184 drug positive urine samples submitted for analyses.

	1995	1996	1997	1998	1999	2000	2001
THC-COOH	11	19	20	17	16	19	14
Morphine	12	21	17	14	19	29	18
Methadone	4	14	12	1	10	14	6
Dihydrocodeine	2	2	3	2	8	8	2
Diazepam	7	10	7	11	19	30	15
Temazepam	10	16	9	15	19	23	15
Cocaine	1	1	2	1	7	14	6
Amphetamine	4	2	5	5	6	2	1
MDMA	1	0	5	1	1	7	7
MDEA	1	0	2	0	0	0	0
Chlordiazepoxide	2	3	0	1	1	0	0
Carbamazepine	1	0	0	1	1	0	1
Nitrazepam	1	0	1	1	0	3	0
Other*	0	2	1	2	4	7	1

***Other Drugs**

	1995	1996	1997	1998	1999	2000	2001
Co-proxamol	0	1	0	0	0	2	0
Paracetamol	0	1	1	0	2	1	0
Ibuprofen	0	0	0	1	0	0	0
Amitriptyline	0	0	0	1	0	0	0
Citalopram	0	0	0	0	1	0	0
Trimetheprim	0	0	0	0	1	0	0
Methamphetamine	0	0	0	0	0	2	1
Prothiaden	0	0	0	0	0	1	0
Promethiazine	0	0	0	0	0	1	0
Drug positive urine cases	16	28	31	24	29	36	20
Total Drugs detected	57	90	84	72	111	156	86
Average number of drugs per sample	3.6	3.2	2.7	3.0	3.8	4.3	4.3

The number and type of drugs detected in urine reveal similar patterns that were noted in the blood drug positive cases. No concentrations have been noted as the presence of a drug in urine can only be used as evidence that the person has consumed the drug. The amount detected cannot be related to the concentration of drugs circulating in the body. However, polydrug was prevalent and similar trends noted in the blood samples was evident.

6.7 Discussion

The problem of increasing drug misuse amongst drivers is evident from the number of drug positive cases investigated in the West of Scotland. Of all cases of drivers suspected of DUID, the results of toxicological analyses show that there is a high correlation between police observations/suspicions and drugs confirmed. Of all samples submitted for analyses, DUID was corroborated in 82% and 94% of the results from the blood and urine samples respectively. On a year to year basis, this correlation varied from 71% (1996) to 93%(2001). The latter two years of the study showed the highest correlation and is possibly a result of increased training and awareness of drug driving by police officers through the introduction of FIT. The results of this study show that the majority of drugs involved were those associated with misuse in the Strathclyde Police region of Scotland and the incidence of purely medicinal drugs amongst drivers suspected of DUID was minimal. Benzodiazepines were the most frequently encountered legal drug group, particularly diazepam and temazepam, a finding shared by other studies of drivers suspected of DUID[282, 284, 318, 319]. This group of drugs is frequently prescribed for the treatment of anxiety and insomnia and is the most widely used psychoactive medicine in the world. In Scotland, the number of diazepam prescriptions per 1000 population increased from 98 to 144 between the years 1992 and 2001[108]. Despite benzodiazepine use generally increasing with age and being about twice as high among females than males[320, 321] the presence of benzodiazepines in this study was suggestive of drug misuse particularly since the concurrent use of benzodiazepines and opiates accounted for one half (50%) of all polydrug cases. The most frequently encountered drug of misuse group was the cannabinoids, which was found to be positive in approximately one-third of all drug positive cases and is similar to findings in other countries [322, 323, 324]. However, that said, the majority of cases that were positive for cannabinoids were shown to contain only the inactive carboxylic acid and therefore an indication that cannabis had been consumed in the past. The presence of the active component of cannabis was present in only approximately one fifth of cannabis positive cases. Opiates were the second most frequently detected illegal drug group and primarily involved morphine, indicative of heroin misuse and this was followed by methadone. It was not possible to ascertain whether the methadone had been prescribed to the individual or whether it had been obtained by the diversion of legitimate supplies. However, the concurrent use of methadone and morphine was confirmed in approximately one third of all methadone positive cases which suggests that even if the methadone had been prescribed, the individual was "topping-up" their prescription with heroin and hence not complying with the guidelines of the methadone programme. A possible reason for this may be due to sub-

therapeutic doses being administered. Albery et al reported that illicit drug use and driving behaviour is common among out-of treatment drug users [325]. An emerging trend for the use of stimulants was observed in this study and in particular cocaine and MDMA. Cocaine use was also noted to have been consumed as part of a cocktail involving heroin, a mixture that accounted for 31% of all cocaine positive cases between the years 1999 and 2001.

All these drugs have impairing effects that can be detrimental to an individuals driving performance. Benzodiazepines for example, produce sedation when administered at low doses and hypnosis when the dose is increased. It is these sedative effects which are purported to be conducive to impairment of driving skills by decreasing alertness, slowing reaction times, reducing visual function and degrading decision-making capacity [326]. More importantly they may also potentiate other CNS depressants when taken concurrently. A higher accident risk associated with benzodiazepine use has been noted to be higher among drivers aged less than 30 years and decrease with increasing age, it was also greater when the breath alcohol test was positive [327]. Laboratory studies have shown that diazepam, the most commonly prescribed benzodiazepine, causes prolonged reaction times, impaired tracking and divided attention [328, 329].

The "high" associated with cannabis use can vary a great deal depending on the user, the surroundings the drug is taken in and the company. The use of cannabis results in co-ordination, tracking, perception and alertness being impaired. A study carried out in Memphis, USA in 1993 showed that of 50 subjects who screened positive for only marijuana, 84% (n = 42) were considered to be moderately or extremely intoxicated. This ranged from the subjects being described as "paranoid, argumentative or cocky", "co-operative, carefree and happy" to "slow and sleepy" [330]. It has also been shown that older long-term cannabis users perform badly in short-term memory tests and divided attention tasks associated with working memory [331]. The effects of cannabis have reported to increase variability of longitudinal (speed and headway) and lateral control (lane position), increase decision times to evaluate a situation and hence determine an appropriate response and cause the driver to adopt a more cautious style of driving performance. It appears that drivers who consume cannabis retain insight in their performance and will compensate where they can, for example, by slowing down or increasing effort [332]. Another study whereby subjects were administered with doses of cannabis varying from 10mg (low dose) to 20mg (high dose) revealed a reduction of average speed on the motorway when both low and high dosed participants undertook simulator tests. The high dose population were unable to control their steering and suggests that cannabis adversely affects drivers'

tracking ability. That said though, there was a failure to produce significant results on various driving performance measurements when compared to alcohol which indicates that a variability of drug effects on individuals exists with cannabis [333].

Controlled studies investigating the effects of heroin on driving impairment are impossible due to ethical reasons of administering this drug. However, the "high" experienced with heroin is quickly induced and leads to relaxation, euphoria and sedation. This can effect driving performance as the individuals concentration is greatly reduced and reaction time is therefore increased. A known physiological effect of heroin is miosis (constricted pupils) which results in a negative influence of the eyes to accommodate darkness. Hence driving at night would present a problem for someone under the influence of heroin.

Varying opinions as to the effects of methadone on driving performance exist in the literature. For example, a study involving 34 methadone substitution patients who were subjected to 10 individual performance tests to assess essential functions with regard their driving ability, showed that they achieved rather lower results in almost all variables when compared to a control group. However those who tested negative for the presence of any other psychotropic substances performed better than the methadone group as a whole and achieved practically the same results as the corresponding control group. It concluded that, long term methadone maintenance under strict supervision does not have any significant unfavourable impact on the driving ability [334]. This finding was similar to that of Dittert et al who, after studying 28 methadone patients concluded that in general methadone substitution does not implicate driving inability although it was noted that the majority of subjects showed some reduction of their psychomotor skills [335]. Friedel et al, on the other hand, noted that heroin addicts treated with methadone are generally not fit to drive. Exceptions to this being those patients who show evidence of therapy compliance whereby they have been in treatment for more than a year and show evidence of cessation of the consumption of additional psychotropic substances [336]. A stronger viewpoint is that any person receiving regular methadone is *ipso facto* unfit to hold a drivers licence as it can be construed as being comparable to an uncontrolled epileptic [337]. It has been agreed by experts with practical experience with methadone treatment that some patient's psychological condition reaches a state of normality after prolonged use and that they should be considered fit to drive. However it was also stressed that driver fitness be checked and verified and that criteria to be applied in assessment should include length of treatment, cessation of other psychotropic drugs, regular psychosocial therapy and psychosocial integration [338]. The present legislation in the UK with respect to driving

whilst receiving methadone is somewhat ambiguous. In July 1996 the European Union licence directive included drug abuse and dependency as a prescribed disability. This means that physicians who prescribe methadone should advise their patients that the patient has a duty to inform the DVLA that they are in receipt of treatment [339]. However, having to divulge this information may deter some individuals from seeking access to treatment.

Cocaine, unlike the CNS depressants leads to increased alertness, self-confidence and a loss of inhibitions, the latter two variables may be detrimental when driving as this could lead to increased risk taking. Controlled experimental research is practically impossible with cocaine due to ethical reasons. Although studies of the effects of cocaine on psychomotor performance are scarce, one study showed that together with impaired judgement of distance, volunteers partaking in co-ordination tests were shown to drive in a considerably more aggressive manner whilst under the influence of cocaine [340]. In European countries, the prevalence of cocaine among drivers is amongst the lowest compared with other illicit substances [341].

Methylenedioxymethylamphetamine (MDMA) has both stimulant and hallucinogenic properties with sympathomimetic effects. The composition of the tablets is very variable and often there are many adulterants added in the manufacturing process such as caffeine, paracetamol, testosterone and quinine. The main effects of this drug include increased awareness, suppression of tiredness and hunger, increased performance, rise in blood pressure and heart beat, euphoric rushes and increased empathy between users. In addition, it increases self-confidence. However, negative effects experienced include muscle tension, blurred vision, nausea, confusion, apathy, hyperthermia and hallucinations. Both these positive and negative effects would have detrimental outcomes to ones ability to drive a motor vehicle safely. During the high there is a danger of increased self confidence and hence risk taking, in addition users have reported the effects of MDMA as a "separation of mind and body" [342]. Physiologically, the user may have dilated pupils and hence be sensitive to blinding light. The exhaustion and overexertion resulting from the stimulation can also lead to impaired driving. Memory deficits [343] and elevated impulsivity [344] have been reported amongst MDMA users and various studies reviewed by Logan and Couper revealed that reckless driving, the ability to drive being heavily compromised and impaired judgement and decision making were all cited as detrimental effects of MDMA consumption on driving [345].

Most studies of the effects of a drug on the ability to drive safely have been carried out when only that sole drug has been administered and at controlled concentrations. In reality, among the drug using population, this practice is very seldom the case. Polydrug use is an increasing problem in society and the effects of mixing drugs can be additive or potentiating. The number of cases where polydrug use was confirmed was shown to increase over the study period and the drugs detected paralleled the situation of drug misuse in general. Polydrug use amongst drivers is not a new phenomenon and has been reported in other countries such as Finland [346], Norway [347] and Switzerland[283]. However, the concomitant use of various drugs have been reported to enhance the disruptive effects of an individual drug or condition [348] and are often highly unpredictable leading to the inability to drive safely. The most commonly encountered cocktail in the west of Scotland was benzodiazepines and opiates, which has been a favoured combination in this area for some time [79].

At present it is not possible to define a critical body fluid concentration above which all individuals would show impairment and below which all would lack impairment. There are also many variables that have to be taken into consideration when interpreting the effects of a specific level of drug in an individual. These include, age, state of health, other drugs that had been consumed and the individual's tolerance to the drug.

Drug misuse amongst the driving population is, without a doubt, a cause for concern. A step forward in tackling the problem is to equip law enforcement agencies with the facilities to recognise drug misuse amongst drivers, particularly those who may provide a negative breath test but where the police officer may still suspect impairment. One such way is the use of roadside testing devices, an avenue which has been extensively researched by the Rosita Project (www.rosita.org) who reported their findings in 2001. The main objectives of this research were to identify the requirements for roadside testing equipment and to make an international comparative assessment of existing devices and prototypes. At the time the report was published, roadside drug testing devices were being routinely used in only two European countries, namely, Belgium and Germany. In the Untied Kingdom, there is at present no viable device available to allow roadside testing for drugs. Another way of facilitating officers with the ability to recognise drug misuse is by training officers in the use of FIT. The background to FIT has been discussed above and the following section will concentrate on a study which was used to monitor the effectiveness of FIT in detecting impairment and differentiating between those who were impaired through drug use and others who were not impaired.

Even recent toxicological advances have been used in the fight against drugs and driving. For example, the use of hair as an alternative matrix has been used in Italy as a means of proving drug abstinence in drivers whose licence has been refused, revoked or suspended as a result of their drug addiction [349]. Hair analysis forms part of the overall process of confirming abstinence in addition to a clinical test and urinalysis which is used to investigate approximately 700 subjects per year [350].

6.8 Conclusion

Despite possible limitations of descriptive epidemiological studies [351], analytical procedures in place eliminated such restrictions occurring in this study. That is, all cases of drivers suspected of DUID in the Strathclyde region of Scotland were analysed in the same laboratory. All matrices were subjected to a full drugs screen for both drugs of abuse and medicinal drugs and all drugs which screened positive were confirmed.

The data presented in this section provides descriptive information regarding the frequency of drug use amongst drivers suspected of impaired driving. It gives an indication of the magnitude of the problem of drug misuse as well as changes in patterns and trends of drugs experienced over the years in the West of Scotland. These changes have paralleled those found amongst drug related deaths in the same region, the majority of which have shown to be possibly associated with concurrent changes to legislation and clinical practices.

6.9 Monitoring the Effectiveness of the Field Impairment Test

6.9.1 Study Design

The aim of the project was to evaluate the use of field impairment testing as a diagnostic tool for use by police officers. This was achieved by collating data from drivers who had participated in the field impairment test throughout Scotland. This data consisted of clues displayed throughout the battery of tests. The clues were noted on a specially designed form by the police officer at the time of the test. The data collected also included toxicological results obtained from biological samples for two groups. Firstly, a blood /urine specimen (or the laboratory report in the case of Lothian and Borders Police) was requested in cases where, following completion of FIT by the police officer, impairment was suspected and the police surgeon agreed that the driver's condition might have been due to the effects of a drug(s). Cases that were drug positive were considered to be supportive of the police and medical examiner's opinion and were treated as true positives in the data analysis. Secondly, a saliva sample was requested in cases where the individual completed FIT and did not show clues. This specimen was analysed to confirm that these drivers were in fact drug free (or to detect "missed" drug-related impairment). For this purpose, insignificant drug levels in saliva, therefore unlikely to cause impairment, were considered to be negative. The project continued over a 24-month period from August 2001 until July 2003.

6.9.2 Force Participation

All eight police forces in Scotland agreed to participate in the project. Enthusiasm was initially very high and in the first 6 months, the number of FIT evaluation forms received averaged 33 forms per month. At the end of the 24-month study period, a total of 736 FIT evaluation forms had been received. Table 43 below shows the distribution of these forms by each force area.

Table 43: Forms received from Scottish Police Forces

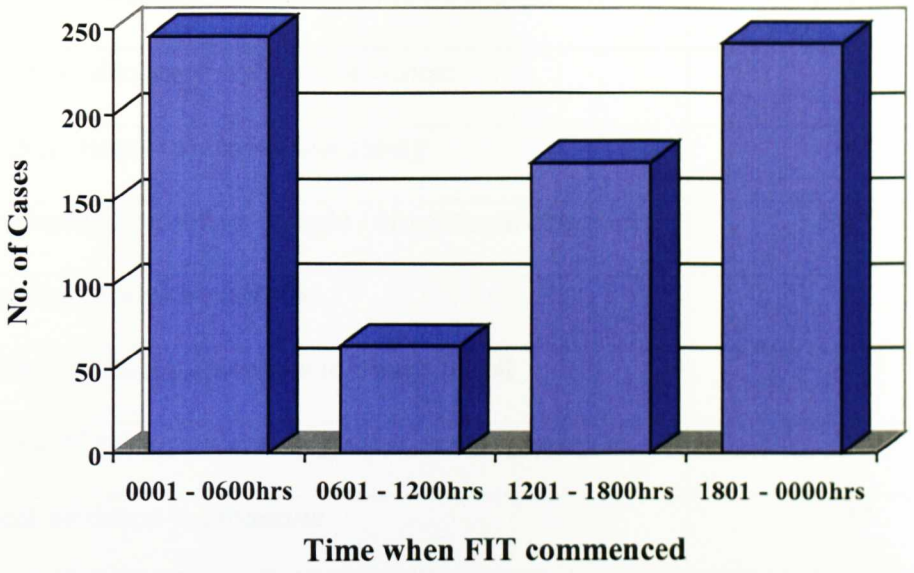
Force Area	No. of forms	**% of Scotland**
Central Scotland Police	17	2%
Dumfries & Galloway Constabulary	17	2%
Fife Constabulary	122	17%
Grampian Police	43	6%
Lothian & Borders Police	208	29%
Northern Constabulary	8	1%
Strathclyde Police	201	27%
Tayside Police	120	16%
Total	**736**	**100%**

6.9.3 Demographic information

In summary, of all 736 forms received, information regarding gender and age of the subject was available in 733 and 714 cases respectively. Of these, the majority involved the male population (89%). An average age of 27 years (range 15–61 years) and 28 years (range 16–64 years) was noted for males and females respectively.

The time at which the test was started was available in 724 cases. Approximately two-thirds of these cases (67%, n = 488) occurred between the hours of 1801 and 0600 (Figure 51). There was no statistically significant association between the time of day the test was carried out and whether impairment was suspected ($\chi^2 = 0.608$, $p = 0.43$).

Figure 51: Time of day at which field impairment test commenced



6.9.4 Study Sample

In 10 cases, the individual refused to carry out the FIT. The extent of refusals, however, is unascertainable, as there may have been a failure to send forms in some instances, despite initial requests made to the police asking them to submit a form for every individual who was asked to participate regardless of the outcome. Therefore a decision as to the presence or absence of impairment could only be made in 726 cases. The majority were found to be unimpaired (58%, n = 419) and in the remaining 42% (n = 307), the police officer suspected impairment. A breakdown of cases is summarised in Figure 54.

6.9.4.1 Cases Where Individual was Judged to be Impaired at the Roadside (n = 307)

A biological sample was received in the laboratory in only 51% (n = 158) of all impaired cases. Of the remaining 149 cases, the police surgeon disagreed with the police officer that the effects exhibited may be due to the effects of drugs in 66 cases and in a further 8 cases, a medical condition was confirmed. No biological sample was obtained in 35 cases and finally although a sample was obtained in the remaining 40 cases, it was not sent to the laboratory for analyses. This is summarised in Table 44 below.

Table 44: Samples not submitted to the laboratory

Reason why no sample submitted to laboratory	No. of samples
Police surgeon disagreed with police officer	74
Sample taken but never sent to laboratory	33*
Subject refused to provide a sample / No consent obtained	30**
Drink/Driving procedure pursued	4*
No vein located therefore unable to obtain blood	3**
Subject died of a drugs overdose prior to sending sample	2*
Insufficient evidence to prosecute	1**
No police surgeon available	1**
Sent to wrong laboratory, sample never retrieved	1*
Total	**149**

* denotes those where a sample was taken although never submitted for analyses

** denotes cases where no sample was obtained

6.9.4.2 Cases Where Individual was Judged to be Unimpaired at the Roadside (n = 419)

The DRE form indicated that the individual refused to donate a saliva sample in 104 cases (25%). In a further 211 cases (50%) it was not known if a saliva sample had been requested, due to the absence of the DRE form. Consequently, a total of 104 saliva samples were received from all eight force areas (25%). However, 20 of these samples were not matched to the FIT paperwork as the DRE form had been sent in the envelope with the saliva sample. The unimpaired population therefore consisted of the 84 saliva samples for which analytical results were available.

6.9.4.3 Nature and extent of drug usage observed

Of the 158 samples submitted to the laboratory from impaired drivers, 89% (n = 140) were blood and 11% (n = 18) were urine. Unfortunately in 9 cases involving blood, there was an insufficient quantity of sample to allow analyses.

6.9.4.3.1 Completed Blood Samples (n = 131)

In 7 cases, there were no drugs detected. Of the remaining 124 blood samples, polydrug use was evident in 65% (n = 80) of cases comprising the presence of two, three or four drugs in 45, 29 and six cases respectively. In total, 245 drugs were detected amongst all blood samples. Figure 52 below shows all drugs detected in drug positive samples.

Figure 52: Frequency of drugs detected in blood drug positive cases

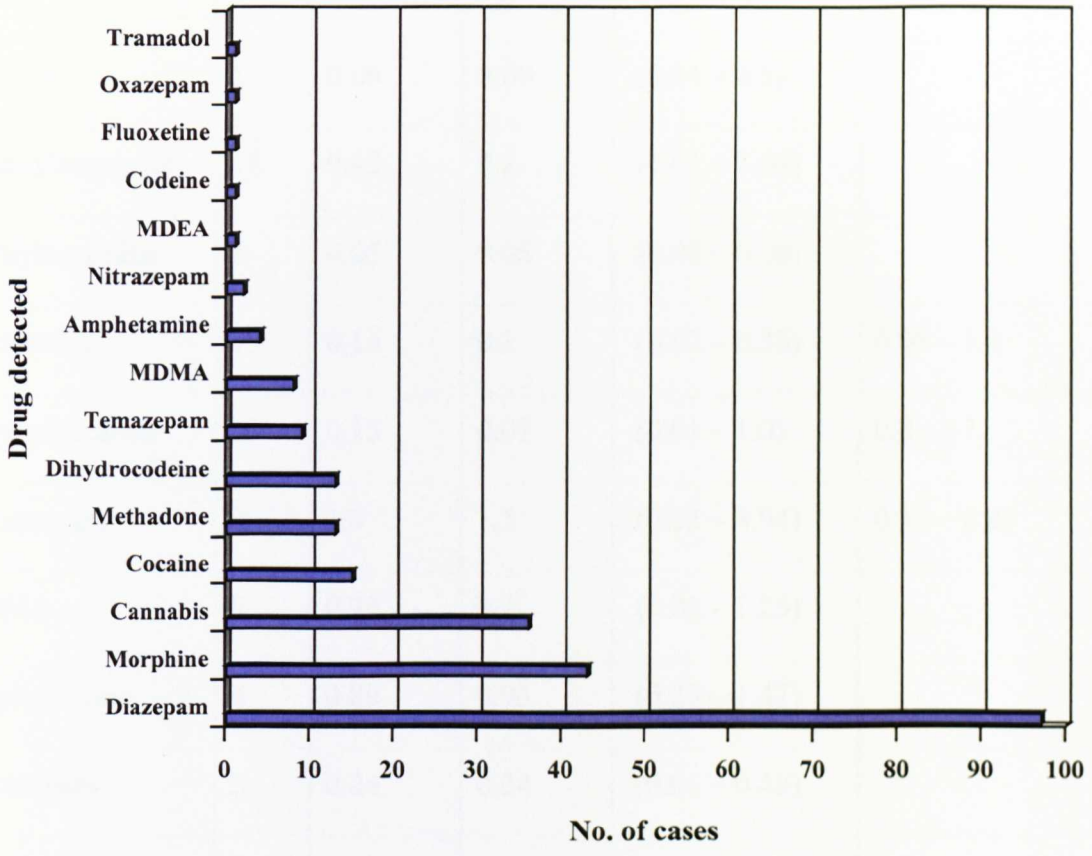


Table 45 below shows the mean, median and ranges of drug concentrations detected in all drug positive cases.

Table 45: Drug concentrations detected in blood samples

Drug	n	Mean	Median	Range	Therapeutic [352]
Diazepam	97	0.92	0.7	(0.02 – 5.5)	0.05 – 2.0
Morphine	43	0.05	0.05	(0.002 – 0.12)	0.04 – 0.5
THC	16	4.3	4.0	(0.1 – 13)	
THC-COOH	36	35.3	27.5	(4 – 121)	
Cocaine	5	0.06	0.09	(0.01 – 0.1)	
Benzoylecgonine	15	0.42	0.2	(0.01 – 1.44)	
Methylecgonine	6	0.05	0.05	(0.03 – 0.08)	
Methadone	13	0.16	0.1	(0.02 – 0.38)	0.05 – 1.0
Dihydrocodeine	13	0.15	0.07	(0.01 – 1.0)	0.8 – 17
Temazepam	9	1.8	1.5	(0.02 – 4.94)	0.36 – 0.85
MDMA	8	0.33	0.2	(0.01 – 1.25)	
Amphetamine	4	0.89	0.93	(0.23 – 1.47)	
Nitrazepam	2	0.24	0.24	(0.01 – 0.48)	
Tramadol	1			0.19	
Oxazepam	1			1.83	
Fluoxetine	1			0.04	
Codeine	1			0.007	
MDEA	1			0.02	

(ii) Monodrug Cases

The presence of one drug was detected in 44 cases and this was primarily diazepam (59%. n = 26). A mean concentration of 1.06mg of diazepam per litre blood was detected ranging from 0.2 – 2.67mg/litre, approaching levels associated with toxicity. Morphine, indicative of heroin misuse was noted in five cases and a mean morphine concentration of 0.05mg/litre was measured. In two cases the presence of 6-monoacetylmorphine (6-MAM) was also detected which suggested recent usage. There were two cases that tested positive for temazepam and in one case a therapeutic level of 0.02mg/litre was recorded, however in the other a level of 2.1mg/litre was noted which is potentially toxic. Although cocaine use was confirmed in three cases by the presence of the inactive metabolites, cocaine itself was detected in only one instance. Use of cannabis was confirmed in seven cases, however the presence of the active component, THC, was noted in only one case. Finally there was one case where MDMA was detected at a level of 0.01mg/litre.

(iii) Polydrug cases

Polydrug use was confirmed in 80 cases and involved primarily diazepam which had been taken concurrently with at least one other drug (89%, n = 71). A mean concentration of 0.87mg/litre was detected, ranging from 0.02 – 5.5mg/litre, the upper scale of which is associated with toxicity. Temazepam was found in seven cases where a mean concentration of 1.98mg/litre was detected, ranging from 0.05 – 4.94mg/litre, both the mean and upper range are potentially toxic. Morphine, indicative of heroin usage was detected in 38 cases, however the presence of 6-MAM was confirmed in only five of these cases. Cannabis use was detected in 29 cases, the presence of THC was confirmed in 42% (n = 15) of these cases. Cocaine use was detected in 12 cases, although the parent drug was only confirmed in four of these cases. The remaining prescribed drugs all fell within the therapeutic ranges, however, the drug combinations detected were similar to those found amongst drug related deaths in the West of Scotland [79]. The benzodiazepine and opiate cocktail was found in over one half of polydrug cases (64%, n = 51). Of these, an additional drug group was present in 15 cases notably cannabinoids (n = 10), cocaine (n = 4) or MDMA (n = 1). Table 46 shows the various cocktails of drug groups detected in the blood samples.

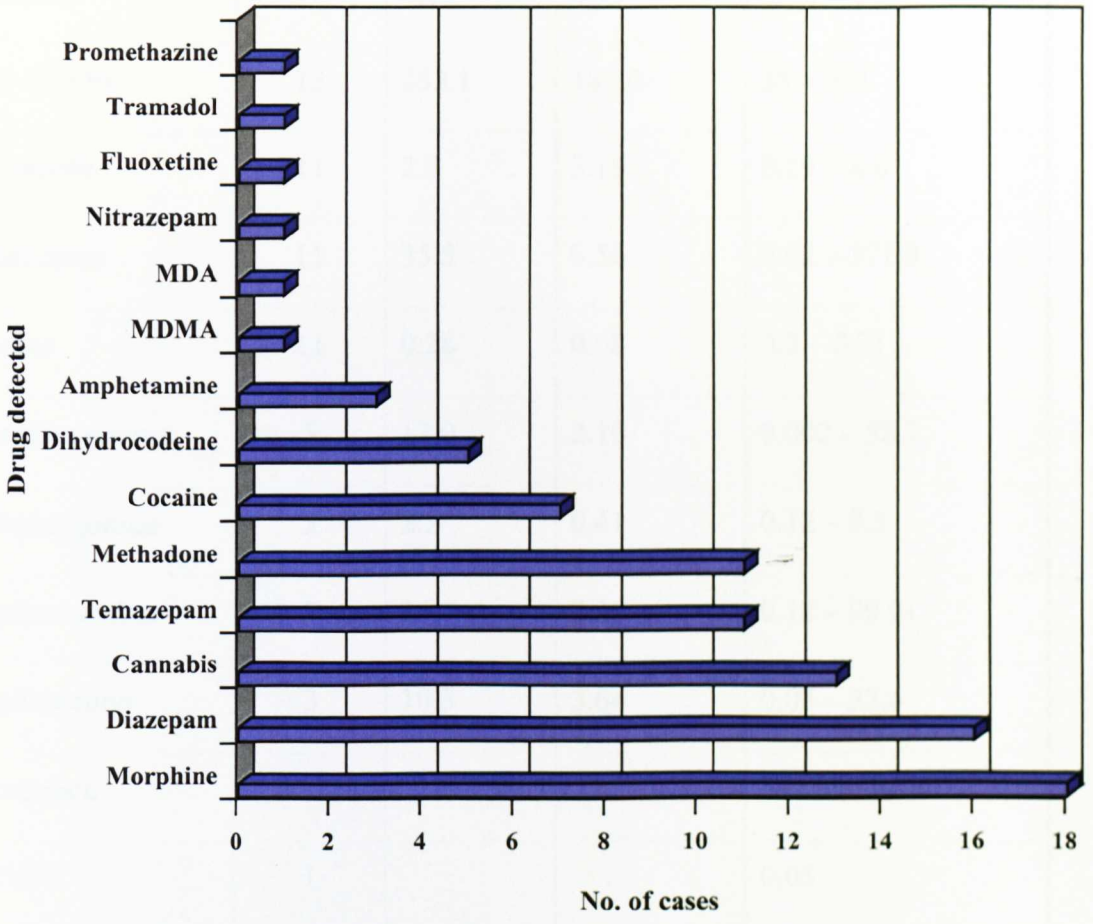
Table 46: Drug combinations in the blood of polydrug users

Drug combination	n	% of polydrug cases
Benzodiazepines & Opiates	36	45%
Benzodiazepines & Cannabinoids	12	15%
Benzodiazepines, Opiates & Cannabinoids	10	13%
Benzodiazepines, Opiates & Cocaine	4	5%
Benzodiazepines, Cannabinoids & Cocaine	3	4%
Benzodiazepines & Cocaine	2	2%
Benzodiazepines	2	2%
Benzodiazepines, Cocaine & MDMA	1	
Benzodiazepines, Amphetamine & MDMA	1	
Benzodiazepines, Amphetamine & Cocaine	1	
Benzodiazepines, Cannabinoids & MDMA	1	
Benzodiazepines, Opiates & MDMA	1	
Benzodiazepines, Cannabinoids, Cocaine & MDMA	1	14%
Opiates, Cannabinoids & Amphetamine	1	
Opiates & Tricyclic depressant	1	
Opiates & MDMA	1	
Cannabinoids & MDMA	1	
Amphetamines & MDMA	1	

(v) Completed Urine Samples (n = 18)

Polydrug use was confirmed in all 18 urine samples, ranging from two drugs up to seven drugs. The drugs found to be positive are detailed in Figure 53 below.

Figure 53: Frequency of drugs detected in urine drug positive cases



The detection of drugs in urine provides evidence that the person has consumed the drug and does not relate to the concentration of drugs circulating in the body at the time when the urine sample was collected, and therefore cannot be used to infer impairment. However, Table 47 shows the mean, median and range of concentrations of drugs detected. The concurrent use of benzodiazepines and opiates was confirmed in all 18 urine samples.

Table 47: Drug concentrations detected in urine samples

Drug	n	Concentration (mg/l)		
		Mean	**Median**	**Range**
Morphine	18	16	8.6	0.17 – 50.0
Diazepam	16	0.12	0.13	0.02 – 0.35
THC-COOH	13	253.1	180.0	35 – 581
Methadone	11	2.9	3.19	0.19 – 8.0
Temazepam	11	35.5	0.56	0.02 – 371.9
Cocaine	11	0.28	0.08	0.7 – 0.71
Benzoylecgonine	5	13.0	2.19	0.002 – 58.2
Methylecgonine	5	2.2	0.41	0.12 – 9.3
Dihydrocodeine	5	24.7	2.2	0.18 – 99.0)
Amphetamine	3	10.3	3.64	0.03 – 27.4
Nitrazepam	1			Not available
MDMA	1			0.05
MDA	1			0.04
Promethazine	1			0.96
Tramadol	1			0.26
Fluoxetine	1			0.26

(vi) Completed Saliva Samples (n = 84)

Of all saliva samples obtained from individuals where no impairment was suspected, 81% (n = 68) were found to be drug positive. Polydrug use was found in 47 cases (69% of drug positive cases). The presence of 2, 3, or 4 drugs was shown in 21, 13 and 11 cases respectively. The remaining two cases each tested positive for five and six drugs. A total of 157 drug positive results was detected in the 68 drug positive saliva samples. Figure 54 shows all the drugs detected in the drug positive samples and Table 48 shows concentrations measured.

Figure 54: Frequency of drugs detected in saliva samples

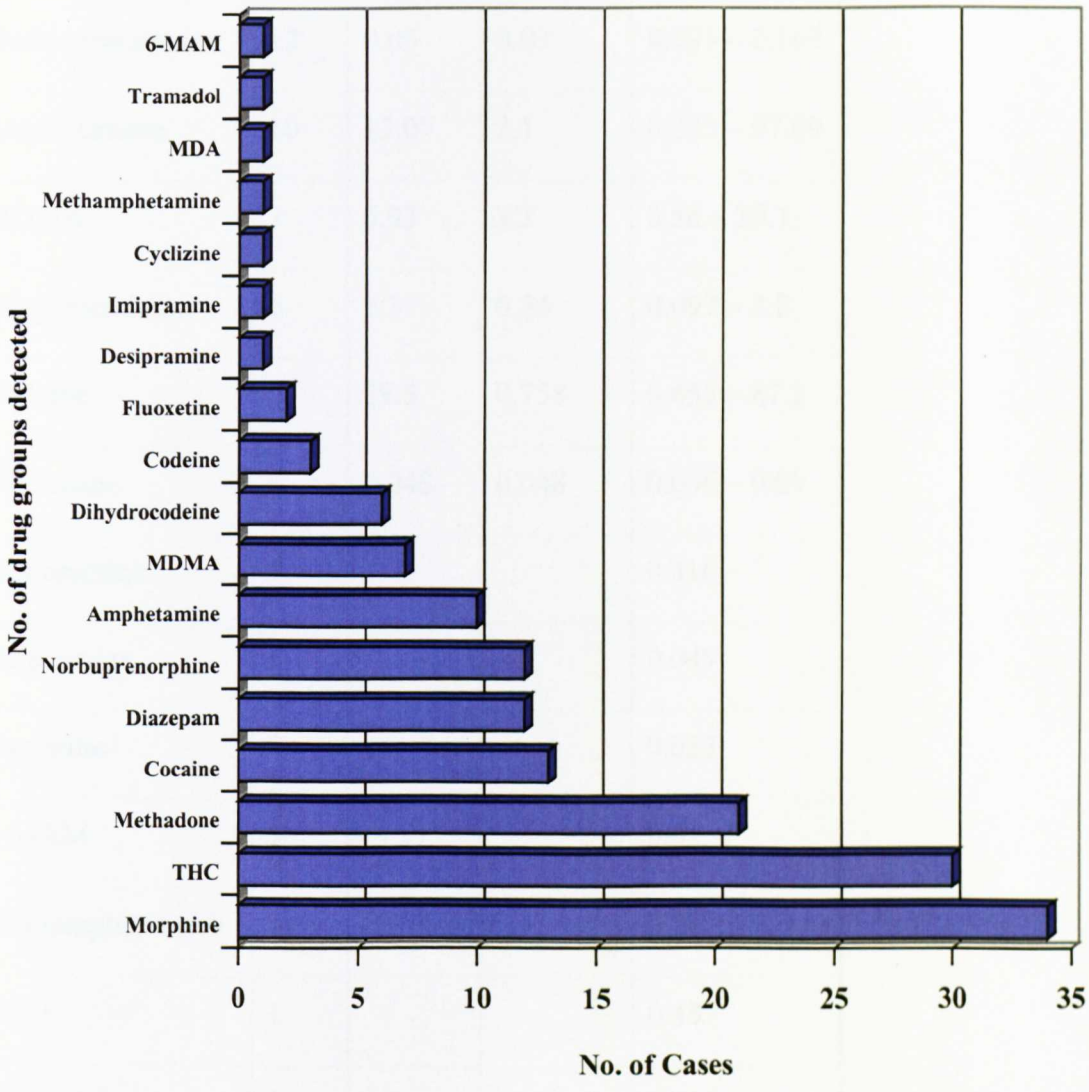


Table 48: Drug concentrations detected in saliva samples

Drug	n	Concentration (mg/l)		
		Mean	Median	Range
Morphine	34	4.04	0.86	0.04 – 77.1
THC**	30	2.42	0.28	0.01 – 49.3
Methadone	21	1.13	0.09	0.025 – 16.7
Cocaine	13	0.83	0.33	0.007 – 2.9
Diazepam	12	2.32	0.74	0.107 – 14.0
Norbuprenorphine	12	0.06	0.03	0.001 – 0.169
Amphetamine	10	13.07	2.1	0.325 – 97.09
MDMA	7	6.93	3.3	0.56 – 29.1
Dihydrocodeine	6	1.37	0.54	0.097 – 4.8
Codeine	3	29.5	0.758	0.655 – 87.2
Fluoxetine	2	0.048	0.048	0.006 – 0.09
Desipramine	1			0.316
Imipramine	1			0.049
Cyclizine	1			0.033
6-MAM	1			0.01
Methamphetamine	1			0.21
MDA	1			0.48
Tramadol	1			0.116

** Results in ng/ml.

(vii) Monodrug groups detected (n = 21)

Tetrahydrocannabinol (THC) was detected in the majority of cases involving the presence of one drug (13 cases, 62%) and was followed by opiates which were detected in 5 cases (24%). The presence of cocaine, MDMA and an anti-depressant accounted for the remaining 3 cases.

(viii) Polydrug drug groups (n = 47)

The combinations of drugs detected in saliva samples differed from those detected in blood samples in that the most frequently detected drugs were the opiates, which were found either alone or in combination with other drugs in 9 and 29 cases respectively (19% and 62% of polydrug cases respectively). The opiates and benzodiazepine cocktail was confirmed in 10 cases (34% of cases where opiates had been taken concurrently with another drug group). Opiates had been used with cocaine in 10 cases. Of these, an additional drug group was present in 4 cases. The drugs detected were MDMA (2 cases), diazepam (1 case) or amphetamine (1 case). THC was detected with stimulants in 7 cases (15% of polydrug cases). Table 49 shows the drug combinations detected in saliva samples collected in Scotland.

Table 49: Drug combinations detected in saliva samples

Combination	Cases	% of polydrug cases
Opiates	9	19.1%
Opiates & Cannabinoids	6	12.7%
Opiates & Cocaine	6	12.7%
Opiates & Benzodiazepines	4	8.5%
Opiates, Benzodiazepines & Cannabinoids	2	4.2%
Opiates, Cocaine & MDMA	2	4.2%
Opiates, Benzodiazepines & Cocaine	1	2.15%
Opiates, Benzodiazepines & Cyclizine	1	2.15%
Opiates & Anti-depressants	1	2.15%
Opiates, Amphetamine & MDMA	1	2.15%
Opiates, Benzodiazepines, Cannabinoids & Amphetamine	1	2.15%
Opiates & MDMA	1	2.15%
Opiates, Amphetamine & MDMA	1	2.15%
Opiates, Cocaine & Amphetamine	1	2.15%
Opiates, Cannabinoids, Benzodiazepines & Anti-depressants	1	2.15%
Cannabinoids & Amphetamine	2	4.2%
Cannabinoids, Benzodiazepines & Amphetamine	1	2.15%
Cannabinoids & Cocaine	1	2.15%
Cannabinoids & Methamphetamine	1	2.15%
Cannabinoids & MDMA	1	2.15%
Cannabinoids, Cocaine & Amphetamine	1	2.15%
Benzodiazepines, Amphetamine & Methamphetamine	1	2.15%
Amphetamine & Anti-depressants	1	2.15%

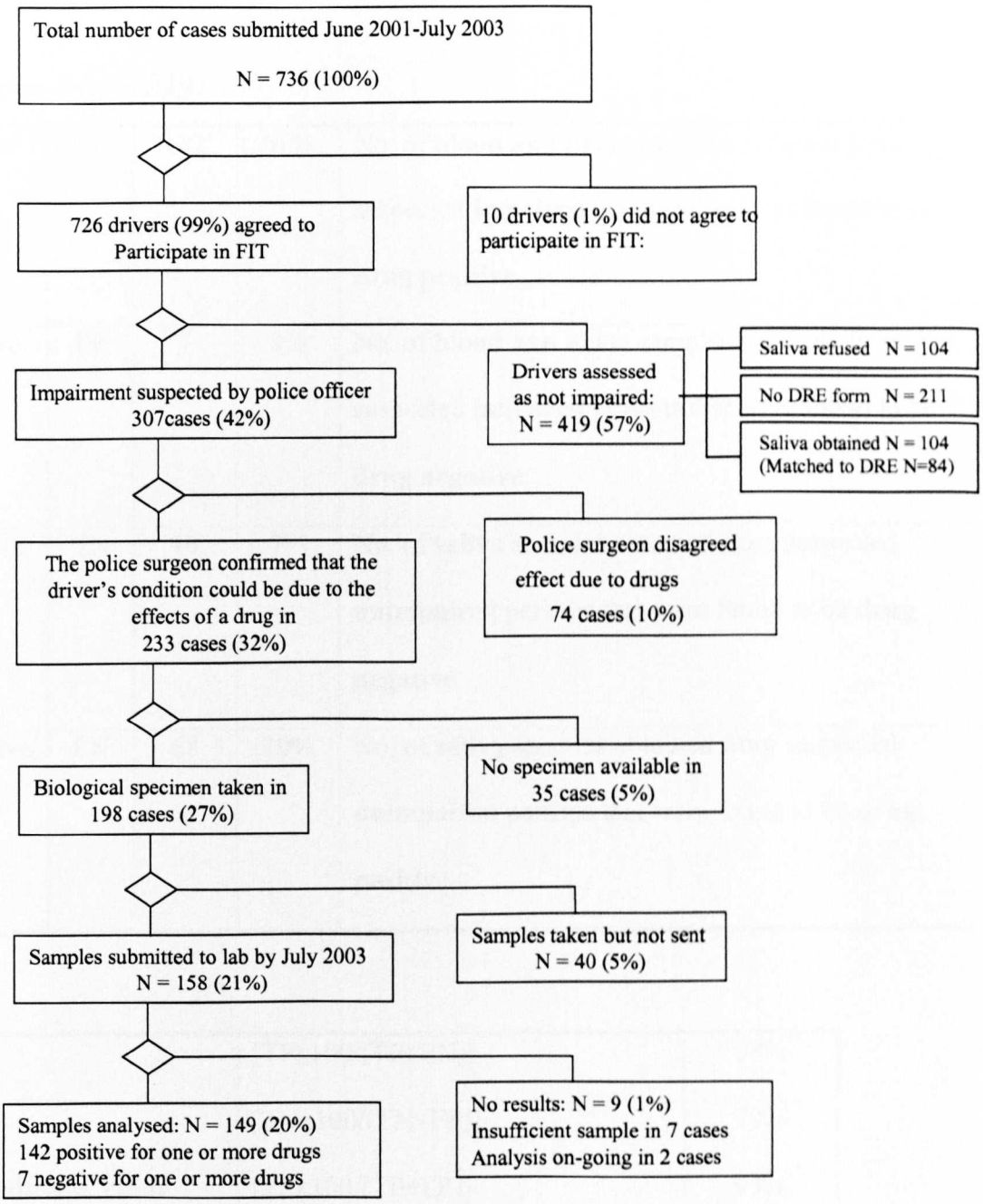
6.9.4.4 Summary

Benzodiazepines were the most frequently encountered drugs, a finding shared by other studies of drivers suspected of DUID[282, 284, 318,319]. Opiates were the second most frequently detected drug group and involved primarily morphine, indicative of heroin use, followed by methadone. It was not possible to ascertain whether methadone had been prescribed in the majority of methadone positive cases. Its concurrent use with heroin was confirmed in 56% (n = 10) of urine polydrug cases and in 38% (n = 5) of methadone positive blood cases. This is suggestive of either the illicit use of methadone or of a driver who was prescribed methadone "topping-up" with heroin. The next most frequently detected drug group was the cannabinoids; however the presence of the active component, THC, was confirmed in only 44% of all cases where cannabis was present. This is in contrast to other studies where the most frequently detected drug was cannabis[323,324].

Polydrug use was evident amongst drivers suspected of DUID in Scotland. This is in common with studies reported in other countries such as Finland,[346] Norway[347] and Switzerland [283]. The concomitant use of various drugs has been reported to enhance the impairing effects of an individual drug or condition [348] and hence can be detrimental to the ability to drive safely. The most commonly encountered cocktail was that of benzodiazepines and opiates, which is also a favoured combination in the West of Scotland [209]. This combination of drugs was found either alone or with other drugs in 64% and 100% of blood and urine polydrug samples respectively.

In general, the drugs detected in this study for Scotland as a whole, were similar to those recorded in the latter years of the study in the Strathclyde Police region alone in that benzodiazepines were the most frequently detected drug group which was followed by opiates and cannabis.

Figure 55: Breakdown of cases received from Scottish Police Forces



6.10 Statistical Summary of Field Impairment Testing Procedure

A blood or urine sample was obtained and analysed for 149 individuals who were suspected to be impaired and a saliva sample was obtained and analysed for 84 individuals who were suspected to be not impaired.

6.10.1Scotland (n = 233)

True Positive	TP	142	61%	No. of **blood and urine** samples obtained from suspected **impaired** persons that were found to be **drug positive**
False Positive	FP	7	3%	No. of **blood and urine** samples obtained from suspected **impaired** persons that were found to be **drug negative**
True Negative	TN	16	7%	No. of **saliva** samples obtained from suspected **unimpaired** persons that were found to be **drug negative**
False Negative	FN	68	29%	No. of **saliva** samples obtained from suspected **unimpaired** persons that were found to be **drug positive**

Sensitivity	[TPx100/(TP+FN)]	68%
Specificity	[TNx100/(TN+FP)]	70%
Positive Predictive Value	[TPx100/(TP+FP)]	95%
Negative Predictive Value	[TNx100/(FN+TN)]	19%
Accuracy	[(TP+TN)x100/(TP+TN+FP+FN)]	68%

6.11 The Pupillary Examination

Aim: To examine the pupils of the eyes in order to determine if constriction or dilatation is present. This may give an indication that drugs such as opiates, which are known to cause pupil constriction, or cannabis, hallucinogens or stimulants which are known to cause pupil dilatation may be present. Therefore the purpose was to evaluate the number of cases where drugs detected corresponded with an effect on pupil size. A pupil size of between 3 and 6.5mm in diameter was considered to be normal.

TP cases where pupil size was either <3mm or >6.5mm and drugs known to cause constriction or dilatation were present respectively

FP cases where pupil size was either <3mm or >6.5mm and drugs known to cause constriction or dilatation were absent respectively

TN cases where pupil size was >=3mm and <=6.5mm and drugs known to cause dilation or constriction were absent

FN cases where pupil size was >=3mm and <=6.5mm and drugs known to cause dilatation or constriction were present

This test was completed in 229 cases (98%) out of the 233 total included in the study. In the remaining four cases, the test was not carried out in three cases due to lighting restrictions and in the remaining case because the individual complained of having a sore head and was unable to keep his eyes open.

Table 50: Pupil size recorded by police, Scotland

Pupillary size		FIT outcome		
Eye 1	**Eye 2**	**Impaired**	**Not impaired**	**Total**
Constricted	Constricted	52	22	74
Dilated	Dilated	29	14	43
Normal	Normal	56	43	99
Normal	Constricted	11	0	11
Dilated	Normal	0	2	2
Total		**148**	**81**	**229**

Both pupils were considered to be of normal size in 99 cases (43% of cases in which the test was completed) and these included 56 (38%) and 43 (53%) of the impaired and not impaired cases respectively. However, drugs which are suspected to cause dilatation (i.e.

stimulants, hallucinogens, cannabis) or constriction of the pupils (i.e. opiates) were present in 70 of the cases (71%) with normal pupil sizes.

Table 51: Pupillary Examination Overall Statistical Summary, Scotland

	Drugs causing constriction / dilatation		Row Total
	Present	Absent	
Pupils constricted or dilated	80	50	**130**
Pupils normal	70	29	**99**
Column Total	**150**	**79**	**229**

Sensitivity	[TPx100/(TP+FN)]	53%
Specificity	[TNx100/(TN+FP)]	37%
Positive Predictive Value	[TPx100/(TP+FP)]	61%
Negative Predictive Value	[TNx100/(FN+TN)]	29%
Accuracy	[(TP+TN)x100/(TP+TN+FP+FN)]	48%

6.11.1 Summary

It is difficult to obtain reproducible conditions for this test in the field. Local variations in lighting conditions are outwith the control of the police officer. Overall, the accuracy of the pupillary examination in identifying subjects correctly was low. The sensitivity (53%) showed that, of all drivers who tested positive for a drug known to cause constriction or dilatation, the relevant signs were exhibited in only just over one half of the cases. Similarly, the specificity (37%) showed that in the majority of cases clues were exhibited even when no drugs known to cause constriction or dilatation were present. These results demonstrate that this test added little to the overall predictive value of the field impairment test.

6.12 The Romberg Test

The performance phase can be broken down into the ability to stand as instructed and the ability to estimate the passage of 30 seconds as instructed. If the passage of 30 seconds is estimated to be less than 20 seconds, this may be indicative of a stimulant type drug whereas if it is greater than 40 seconds it may be indicative of a CNS depressant or hallucinogen.

The test was attempted by 233 subjects. It was completed by 98% (n = 229) of the drivers. For the remainder, in three cases, the driver was unable to comply with the instruction and in the fourth case the test was aborted for safety reasons as the driver was swaying excessively.

A clue was displayed if the driver was seen to sway, step, raise arm(s), raise their head, open their eyes and/or was unable to estimate the passage of 30 seconds within the pre-set limits.

(1) Clues whilst standing

Clues Displayed		Drugs Present	All Negative	Total
	Yes	94	8	102
	No	112	15	127
	Total	***206***	***23***	***229***

(2) Clues whilst standing plus internal body clock

Clues Displayed		Drugs Present	All Negative	Total
	Yes	120	13	133
	No	86	10	96
	Total	***206***	***23***	***229***

Table 52: Overall Statistical Analysis for the Performance Phase of the Romberg Test

		Balance clues	Balance clues & Internal Clock
Sensitivity	[TPx100/(TP+FN)]	46%	58%
Specificity	[TNx100/(TN+FP)]	65%	43%
Positive Predictive Value	[TPx100/(TP+FP)]	92%	90%
Negative Predictive Value	[TNx100/(FN+TN)]	12%	10%
Accuracy	[(TP+TN)x100/(TP+TN+FP+FN)]	48%	57%

Drugs found to be positive in those cases where the passage of 30 seconds was estimated to be either less than 20 seconds (indicative of a stimulant type drug) or greater than 40 seconds (indicative of a CNS depressant) are summarised below:

Drivers estimating time at less than 20 seconds (n = 41)

Of the 41 cases where the driver estimated the passage of 30 seconds to be less than 20 seconds, no drugs were found in 8 cases (20%) and stimulants were found to be present in 11 cases (27%) with the remaining 22 cases involving CNS depressants and/or cannabinoids. The stimulant positive cases are tabulated below:

Stimulant	No. of cases	Concurrently with..
Amphetamine	1	1 x CNS Depressants
Cocaine metabolites	3	3 x CNS Depressants
Cocaine	2	1 x CNS Depressants
MDMA & Cocaine	2	2 x CNS Depressants
MDMA	2	2 x CNS Depressants
Amphetamine & Cocaine	1	1 x CNS Depressants

Drivers estimating time at more than 40 seconds (n = 27)

In this group, only one case was found to be negative for drugs. Of the remaining 26 cases, 25 were found to be positive for CNS depressants (primarily benzodiazepines and opiates) and one case was positive for MDMA.

6.12.1 Summary

Overall, the accuracy of the test was higher when both balance and time estimation clues were taken into consideration. The sensitivity during this performance stage was higher than specificity (58% versus 43%). This shows that the majority of drug positive cases displayed one or more clues whereas just over half of the drug negative cases displayed clues. A high PPV was obtained, illustrating that the majority of cases displaying clues were positive for drugs. The low NPV showed that, despite showing no clues, a large proportion of drivers were found to be positive for drugs. This shows that the predictive value of the test in identifying drug negative subjects is poor, since drivers shown to be drug positive are able to carry out the test in a satisfactory manner, possibly as a result of their personal tolerance to the drug(s).

There was no correlation between the estimation of 30 seconds to be outwith the accepted time range (20 – 40 seconds) and the presence of drugs which might be expected to induce this effect. This could be due, in the majority of these cases, to polydrug use involving both stimulants and CNS depressants. In these instances, the pharmacological effects of drug combinations are usually unpredictable and one type of drug may cancel out the effects of another, i.e. the drugs behave as agonist/antagonist combinations.

6.13 The Walk and Turn Test

This test was completed in 97% (n = 227) of the study sample cases. Of the remaining six cases, four drivers were unable to comply with the instructions, one individual refused to continue with the FIT and in the last case the form relating to the walk and turn test was missing from the paperwork.

A clue was displayed if during the test: the individual stopped walking, missed heel/toe, raised arms, stepped off the line, did not turn as instructed, did not count out loud as instructed and/or did not take nine steps in each direction

(1) Walking in a line

Clues Displayed	Drugs Present	All Negative	Total
Yes	142	9	151
No	63	13	76
Total	***205***	***22***	***227***

(2) Walking in a line and turning

Clues Displayed	Drugs Present	All Negative	Total
Yes	172	14	186
No	33	8	41
Total	***205***	***22***	***227***

(3) Walking in a line, turning and counting

Clues Displayed	Drugs Present	All Negative	Total
Yes	178	15	193
No	27	7	34
Total	***205***	***22***	***227***

(4) Walking in a line, turning, counting and number of steps

Clues Displayed	Drugs Present	All Negative	Total
Yes	181	15	196
No	24	7	31
Total	***205***	***22***	***227***

Table 53: Overall Statistical Analysis of the Performance Stage of the Walk and Turn Test

	Walking only	Walking and turning	Walking, turning and counting	Walking, turning, counting and correct no. of steps
Sensitivity	69%	84%	87%	88%
Specificity	59%	36%	32%	32%
Positive Predictive Value	94%	92%	92%	92%
Negative Predictive Value	17%	20%	21%	23%
Accuracy	68%	79%	81%	83%

6.13.1 Summary

The sensitivity of this test was seen to increase as more tasks were added, meaning that more and more drug positive drivers displayed clues and were correctly identified. Simultaneously, the specificity decreased, meaning that more drivers who were drug negative also displayed clues. Taking the clues exhibited during the walking task alone shows that the sensitivity and specificity are moderately high. The addition of tasks, hence making the test more difficult, will obviously detect more of those drivers who are under the influence of a drug. However it should be noted that those who were drug free also found the test more difficult and displayed clues. The positive predictive value was high throughout, meaning that approximately 90% of drivers displaying clues were drug positive. The overall accuracy of this particular test was the highest encountered of all the tests so far.

6.14 The One Leg Stand

This test was completed in 96% (n = 223) of the study sample. In the remaining 10 cases the individual was unable to comply with the instructions (two cases), was stopped for safety reasons due to the inability to balance properly (six cases), refused to comply with the test (one case) or refused to complete the test as a result of being bored with the process (one case).

A clue was displayed if, during the test, the individual swayed, hopped, put a foot down, raised his/her arms and/or did not count as instructed.

(1) Standing on one leg

Clues Displayed		Drugs Present	All Negative	Total
	Yes	167	9	176
	No	35	12	47
	Total	***202***	***21***	***223***

(2) Standing on one leg and counting

Clues Displayed		Drugs Present	All Negative	Total
	Yes	175	10	185
	No	27	11	38
	Total	***202***	***21***	***223***

Table 54: Overall Statistical Analysis for the Performance Phase of the One Leg Stand Test

	Standing on one leg	Standing on one leg and counting
Sensitivity	83%	87%
Specificity	57%	52%
Positive Predictive Value	95%	95%
Negative Predictive Value	26%	29%
Accuracy	80%	83%

6.14.1 Summary

The sensitivity for one leg stand task was high, showing that a high proportion of drivers who were found to be drug positive also displayed clues and this increased slightly when the second task (counting) was taken into account. The specificity was moderate indicating that most drug-free subjects did not show any clues. However, this decreased slightly with the addition of the second task. It should be noted that this increase was due to only one individual. The accuracy of this test was high showing that approximately eight out of ten subjects were correctly identified.

6.15 The Finger to Nose Test

This test was completed in 98% (n = 229) of the study sample cases. In the remaining four cases the individual was unable to carry out the test (three cases) or the test was not done due to adverse weather conditions (one case).

A clue was displayed if, during the test, the individual was unable to touch his/her nose as instructed and/or swayed, stepped, raised arms, raised head, opened eyes whilst standing.

(1) Unable to touch nose as instructed

Clues Displayed		Drugs Present	All Negative	Total
	Yes	150	12	162
	No	56	11	67
	Total	***206***	***23***	***229***

(2) Unable to touch nose and stand as instructed

Clues Displayed		Drugs Present	All Negative	Total
	Yes	155	12	167
	No	51	11	62
	Total	***206***	***23***	***229***

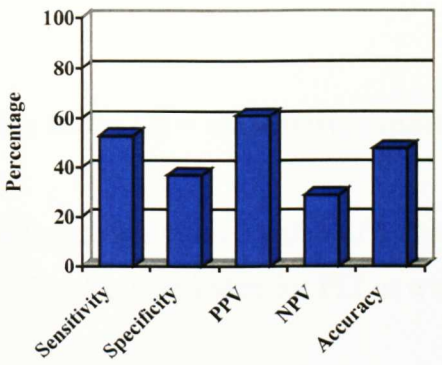
Table 55: Overall Statistical Analysis for the Performance Phase of the Finger to Nose Test

	Clues associated with touching nose	**Clues associated with touching nose and standing as instructed**
Sensitivity	73%	75%
Specificity	48%	48%
Positive Predictive Value	93%	93%
Negative Predictive Value	16%	18%
Accuracy	70%	72%

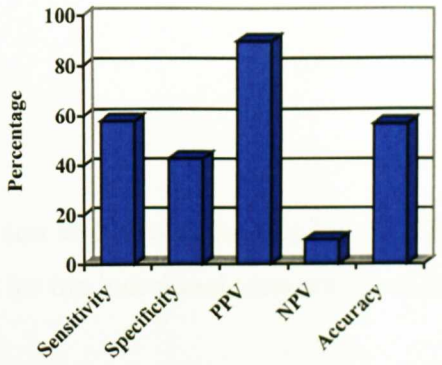
6.15.1 Summary

The sensitivity for this test was high showing that a high proportion of drug positive drivers also displayed clues and the sensitivity increased slightly when both tasks were taken into account. The specificity showed that, amongst drivers who were drug free, approximately one half did not show any clues and one half did display clues. Overall the diagnostic accuracy of this test was good in that high proportions of true positive and true negative cases were correctly identified.

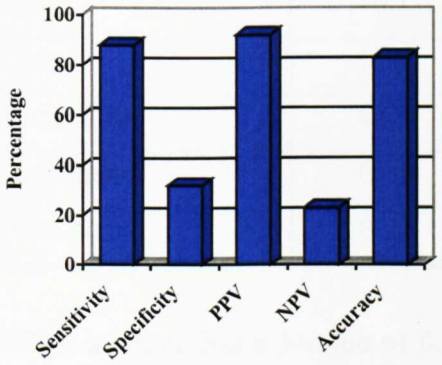
Figure 56: Summary of Statistical Analyses for Each Test



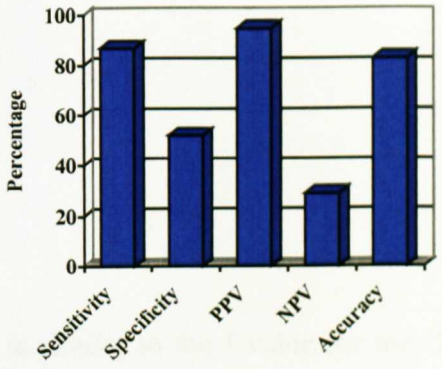
The Pupillary Test



The Romberg Test

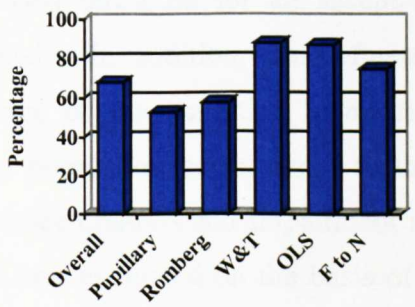


The Walk and Turn test

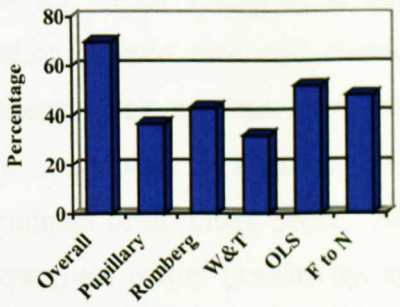


The One Leg Stand Test

Figure 57: Sensitivity and Specificity of Each Test



Sensitivity of tests



Specificity of tests

6.15.2 Statistical Evaluation

Statistical methods can be used to compare the reliability of diagnostic tests such as those in the field impairment test. One of these methods uses the Youden Index[353] which is given by:

Youden Index (J) = sensitivity + specificity – 1

The index ranges from a value of 1 for a perfect test to 0 where the test has no diagnostic value. The Youden Index for FIT as a whole and for the individual tests are given below:

Table 56: Youden Indices for FIT and the individual tests

Test	Scotland
FIT overall	0.38
Pupillary	-0.1
Romberg	0.01
Walk and Turn	0.20
One Leg Stand	0.39
Finger to Nose	0.23

The FIT as a whole has a J-value of 0.38 which is similar to the J-value for the One Leg Stand. This indicates that a reduced set of tests might give the same degree of sensitivity and specificity as FIT. The indices given in the table are lower than would be desirable for a diagnostic test. However, this type of statistical evaluation as a measure of a test's efficiency was primarily developed for medical diagnostic tests, which require a higher level of accuracy than might be acceptable for the purpose of driver screening. For example, a higher proportion of false positives and false negatives in FIT will not have the same effect as if it were screening for a disease state. There is no internationally recognised threshold for an acceptable test index for which a diagnostic test can be approved. In addition, the influence of population sample size and characteristics, incidence of the condition being tested (impairment), lack of knowledge concerning normal population performance in the test and the uncertainty in relationships between drug concentrations and impairment affect the usefulness of an Index Score. At present, FIT is best evaluated on the basis of the parameters given earlier (sensitivity, specificity etc.). Validation of a scoring system/index is required to establish its usefulness in this context. However, in order for this to be achieved the performance of individuals from a control group must first be established.

6.16 Drug Recognition Skills

From the 158 cases where impairment was suspected and a sample had been analysed, information about the drug(s) suspected by the police officer was available for 75 cases (47%). This information was provided from the DRE sheet:

Drug groups suspected:

Opiates ☐	Cannabis ☐	CNS Depressants ☐	CNS Stimulants ☐
Hallucinogens ☐	Inhalants ☐	Polydrug Use ☐	Unknown ☐

Figures 58 and 59 summarise the performance of police officers with respect to their drug recognition skills. Overall, drug use was confirmed in 92% (n = 69) of the 75 cases where impairment was suspected. In 68 cases, the police officer had noted the drug they suspected was causing the condition and of these, 69% (n = 47) were correctly confirmed by toxicological investigations, either wholly or partially. This suggests that the DRE skills of police officers are generally good. Drugs tentatively identified by the police officer were confirmed in 30 out of the 45 cases in which a single drug was suspected. Within these 30 cases, 24 tested positive for another drug group which had not been suspected. Polydrug use was confirmed in 19 out of 30 cases in which polydrug use was suspected. Of these 19 cases, specific drugs were mentioned in 16 cases and toxicology confirmed the presence of all or some of the suspected drugs in 9 and 6 cases respectively. In the remaining case, drugs were detected which had not been suspected.

This shows that drug use was confirmed in the majority of cases where impairment was suspected. Drug class decisions were also consistent with results of toxicological investigations, either partially or wholly, in approximately two-thirds of cases. This suggests that the DRE skills of police officers in Scotland are generally good. The implementation of refresher courses may aid the officers with their DRE skills and encourage them to utilise them.

Figure 58: Cases where a single drug group was suspected to be causing impairment

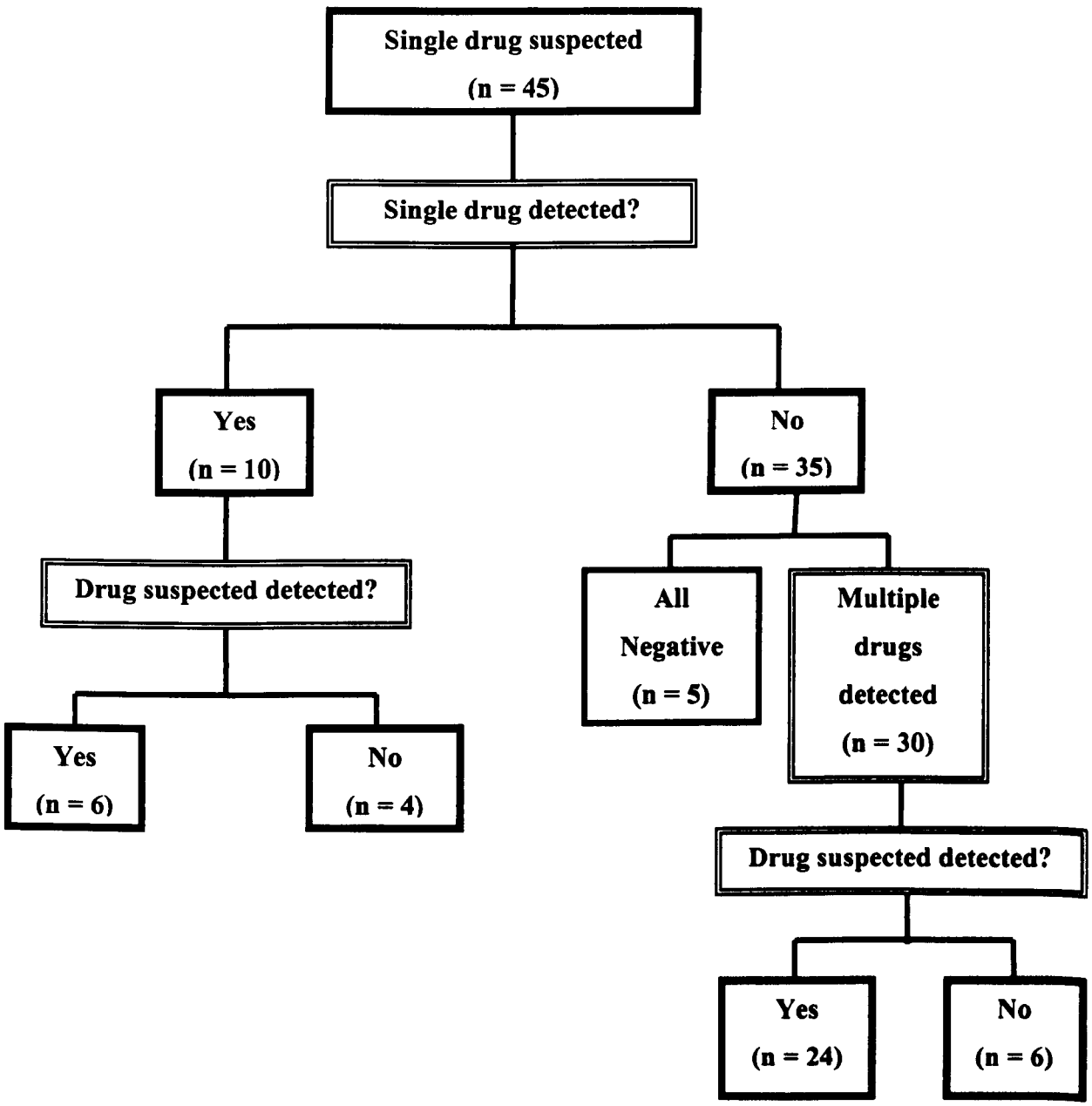
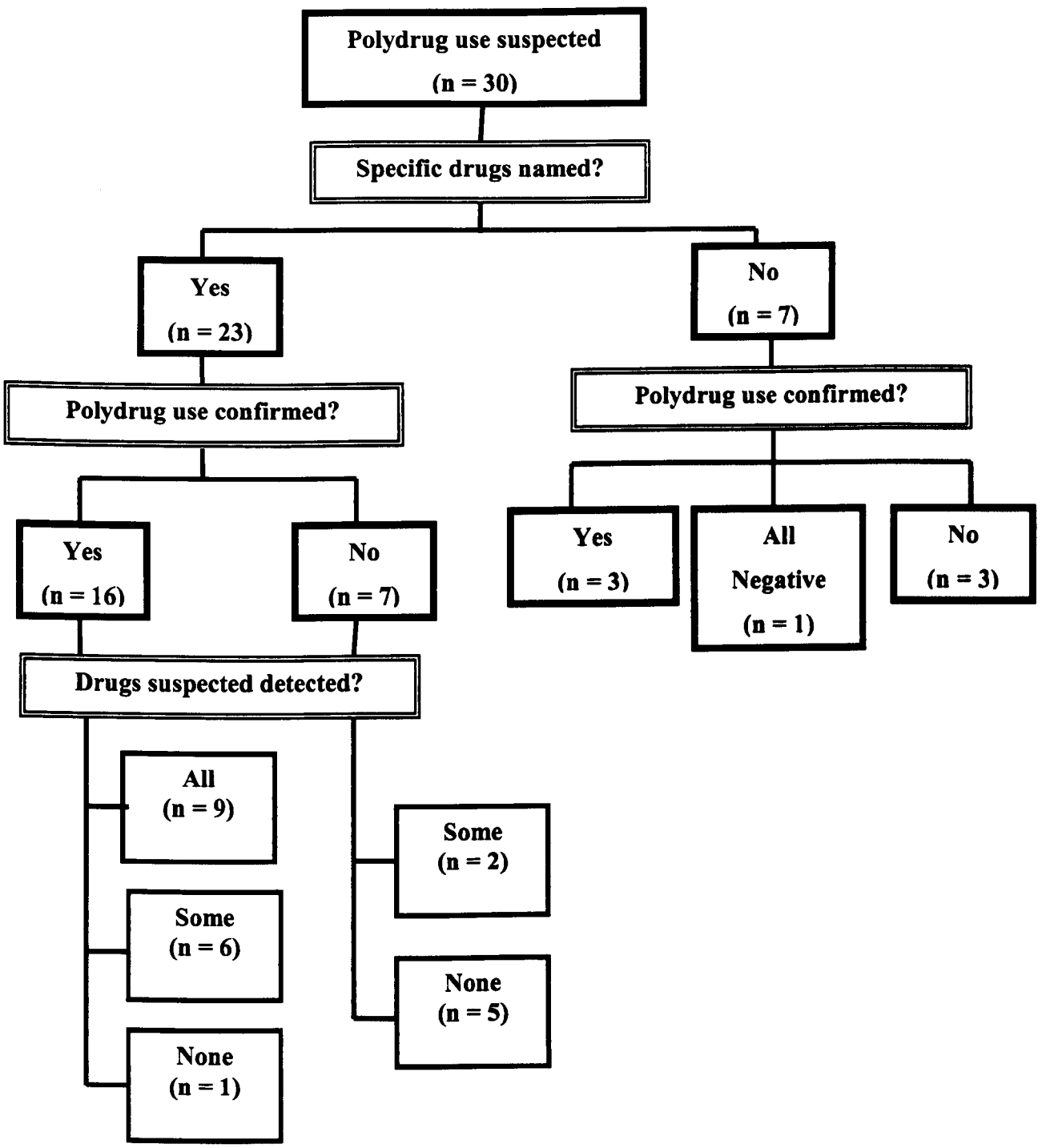


Figure 59: Cases where multiple drug groups were suspected to be causing impairment



6.17 Discussion

Despite the collation of 736 FIT evaluation forms, a biological sample was received in only 32% (n = 233) of these cases allowing for the evaluation of the effectiveness of FIT with respect to diagnosing impairment. In the majority of cases where no impairment was suspected, a saliva sample had not been obtained. Due to erroneous delivery of documentation, it was not possible to establish whether the driver had refused to provide a sample or whether they were not asked to donate a saliva sample. Unfortunately, a biological sample was not received in a large number of cases whereby the police surgeon did not suspect the condition exhibited was due to the effect of a drug(s). This population remains a concern as it could be that the effects of drugs may have worn off between time of arrest and clinical examination. A study showed that, generally, the police surgeon arrives at the station within 30 minutes of being requested by police to attend but that this could be greatly extended if a police surgeon was not available and the time lag was reported to be up to 3 hours [354]. This study also showed that the time delay between a blood sample being obtained and the time that the driver was observed driving could be as mush as 7 hours. These time delays are sufficient for the effects of some drugs to wear off.

Drugs were found to be positive in 95% of all cases where impairment was suspected. The most frequently detected drugs were diazepam, morphine and cannabis. Polydrug use was evident in approximately two thirds of cases, primarily involving the concurrent use of benzodiazepines and opiates, a cocktail favoured among drug users in Scotland. It is not possible to infer the specific effects that drug levels measured would have on each particular driver but what is of interest is that the types and levels of drugs detected are indicative of drugs being misused. It is improbable that an impairing effect would result in the cases involving only cocaine and cannabis, in the absence of the active component of the drug. However, THC has a very short plasma half-life and is undetectable after approximately four hours of consumption. This time interval may easily pass before a police surgeon is contacted and arrives at the police station. Drugs were present in 81% of drivers who were thought to be unimpaired by the police officer. Polydrug use was evident in approximately two thirds of saliva samples. The most frequently detected drugs in saliva samples were morphine and cannabis.

The overall analysis showed that that the use of FIT when dealing with the drugged driver is effective. This was demonstrated by the sensitivity (proportion of drug positive drivers who were suspected to be impaired) and the specificity (proportion of drug negative drivers who were suspected to be not impaired), which were both found to be moderate.

This shows that satisfactory proportions of true positive cases were identified. A high positive predictive value was also noted and overall, the accuracy of FIT showed that approximately seven out of ten individuals were correctly identified.

When evaluating the tests individually, there was no information available on whether or not the driver had passed or failed any one particular test. This would be contrary to the ethos of FIT, whereby a decision on impairment is concluded on the totality of the tests. Therefore, individual tests were evaluated on clues which had been displayed and whether or not drugs were present.

Inclusion of more tasks in the tests resulted in the possibility of more clues being displayed. This in turn resulted in more drug positive drivers displaying clues. However, simultaneously a higher proportion of drug free drivers displayed clues. The normal FIT performance for an unimpaired population has yet to be determined but it is likely to exhibit some clues. In order for a "measurement" of impairment to be established, the performance of known drug free individuals in FIT must be evaluated.

The sensitivity of the individual tests ranged from 53% for the pupillary examination to 88% for the walk and turn test. While there is no standard to which these tests must conform, these results would be unsatisfactory if obtained for a medical diagnostic test, which typically would require sensitivity and specificity to be above 90%. For a field test, these results were acceptable in that a high proportion of true positive cases were identified by the use of FIT. However, the specificities were lower, showing that a significant proportion of drug-free/unimpaired drivers also displayed clues, underlying the future need to characterise the population norm for these tests. The negative predictive values were also low. As the aim of FIT is to identify impairment, it is possible that drug positive drivers who were "not impaired" were sufficiently tolerant to the effects of the drug(s) present to avoid showing clues, the presence of a drug in the system does not necessarily infer impairment. It is also true that FIT comprises only one factor of a series of events which leads to the police officers decision on impairment. Within the battery of tests, the Walk and Turn test and the One Leg Stand test were the most effective. A lack of correlation between drugs detected and pupil size illustrates that the pupillary examination contributed very little to FIT.

From the 158 drivers where impairment was suspected, information as to the drugs suspected to be causing impairment was available in just under one half of these cases

(47%, n = 75). The drug recognition skills of the police officers were very good. Drug use was confirmed in 92% of cases where this information was available. The drugs consumed were correctly identified either wholly or partially in 69% of cases.

6.18 Conclusion

Driving under the influence of drugs is without a doubt an increasing problem in society and may only be reduced by a multi-disciplinary approach involving both police and other agencies. One way of tackling the problem is by equipping law enforcement personnel with adequate resources, equipment and training. A deficiency in the ability to recognise drug impairment at the roadside has been previously highlighted. This study has shown that Field Impairment Testing is a useful adjunct to earlier assessment procedures used to detect impairment but could be improved in order to increase sensitivity and specificity. If nothing else, at present, the use of FIT increases the police officers confidence in recognising drug misuse and hence increases the capture of drivers who may otherwise go undetected in the event of passing the evidential breath test. Additonal or alternative, tests might be included in FIT or roadside instrumental tests could be introduced. An alternative to an improved FIT would be to change the existing legislation and create prescribed limits for drugs, as for alcohol.

It would appear that there is definitely a place for FIT in the fight against drugs and driving. In July 2003, an amendment to the Railway and Transport Act was announced which empowers a police officer to administer preliminary tests [355]. It states that :

"*A constable shall have the right to require any driver whom he reasonably suspects of committing a moving traffic offence to take a field impairment test or require a blood or other bodily sample for analysis, or both, for the purpose of establishing whether or not that driver is under the influence of any drug.*"

Although the drug testing device to be used has not yet been confirmed, the use of non-invasive matrices such as saliva or sweat seem probable. Whilst the legislation enabling mandatory FIT has been passed, the code of practice to implement these operationally has yet to be established.

7 Conclusions

This study focused on two areas of forensic interest; drug-related deaths (DRD) and drivers suspected of driving whilst under the influence of drugs (DUID). For the first group, the aim of this study was to analyse the DRDs that occurred in the Strathclyde Police region of Scotland with intent to provide a timeline of changing patterns and trends of drug misuse. To do this, a protocol and a definition of a DRD were established and data was collected in a consistent manner throughout the study period. For the second group, the aim was to show the prevalence and extent of drug misuse amongst individuals who were suspected to be driving whilst under the influence of drugs in the Strathclyde police force region of Scotland. As an adjunct, an evaluation of the field impairment test was carried out. This technique was recently introduced to aid the Scottish Police Officer in the detection of the drugged driver. The aim was to establish the nature and extent of drug use by both drivers who were judged to be impaired and those who were judged to be unimpaired.

Drug-related deaths in the Strathclyde police region of Scotland increased on a year-to-year basis over the study period 1985 – 2001, the majority of which involved death due to the overdose of an illicit drug. Deaths due to each of four main drugs were the focus of this study and each section highlighted various risk factors associated with drug related deaths. These include the risks of consuming drugs in isolation, decreased tolerance following a period of abstinence, the dangers of consuming a cocktail of drugs and the risks of allowing an intoxicated individual to "fall asleep". Some of these deaths may have been preventable had medical intervention been sought on the first indication of overdose.

Heroin was detected in 72% of all illicit drug overdoses and of these, heroin was the sole or a contributory factor to death in 95% of cases. When heroin was abused with other drugs, this was primarily with a benzodiazepine. This combination of drugs was shown to be favoured in the Strathclyde police region throughout the study period. The benzodiazepine of choice was temazepam up until a legislation change in 1996 which resulted in this drug being re-scheduled. This meant that possession of the drug without the appropriate authority (e.g. a prescription) was illegal. However, whilst the prevalence of temazepam positive cases decreased subsequent to this, there was an increase in diazepam positive cases detected in the laboratory. Hence, the heroin/benzodiazepine cocktail was still being consumed, but a replacement had occurred for the benzodiazepine of choice, mainly due to a decrease in supply for temazepam.

Due to an increase in heroin misuse, opiate substitute prescribing was introduced in an effort to reduce deaths due to heroin. Following the promotion of the methadone maintenance programme in 1994 in Glasgow there was a sharp increase in deaths involving methadone, calling into question the efficacy of this drug. Consequently, a national confidential enquiry was established to investigate the medical care provided by clinicians prescribing methadone. At this time, there was also an increase in supervised administration of consumption. This resulted in the number of methadone related deaths decreasing in the area despite a continued increase in the amount of methadone being prescribed. This observation indicated that good practice had a positive effect on overall reduction of methadone deaths.

As methadone positive cases amongst deaths in the laboratory were shown to decrease, an increase in the number of dihydrocodeine positive cases was highlighted. This observation suggested that as the supply for one opioid decreases as a result of better clinical practice, the demand for another emerges. The majority of dihydrocodeine had been obtained by the diversion of legitimate supplies, a similar situation to that involving methadone in drug-related deaths.

Finally, the prevalence of cocaine amongst drug-related deaths was shown to increase in the latter years of the study confirming data obtained from other sources that suggested cocaine use is on the increase. However, cocaine as the sole cause of death was reported in only 24% of all cocaine positive drug-related deaths. Heroin was detected in a high proportion of all cocaine positive drug-related deaths, however, in almost one half of these cases, cocaine was not considered to be a contributory factor in death. This in addition to the relatively small number of cases and lack of deaths involving cocaine alone highlights that it is somewhat premature to start comparing local experiences of cocaine deaths to other international studies.

For the drivers suspected of driving whilst under the influence of drugs, between 65% and 92% were found to be drug positive on a year-to-year basis. Initially benzodiazepines were the most frequently encountered legal drug group and cannabinoids were the most frequently encountered illicit drug group followed by opioids. In the latter years of the study opioids were more frequently detected than cannabinoids. Over the 7-year study period, the prevalence of polydrug use was shown to increase and the patterns and trends of drugs detected were similar to those found in drug-related deaths. That is, a decrease in temazepam positives was replaced with an increase in diazepam positive cases, methadone

positive cases increased up until 1996. A decrease in methadone positive cases subsequent to this overlapped an increase in the number of dihydrocodeine positive cases and finally there was an increase in the number of cases testing positive for cocaine in the latter years of the study.

The evaluation of the field impairment test revealed a high positive predictive value which demonstrates the effectiveness of the test when dealing with the drugged driver. Following of the technique, a high proportion of drivers suspected to be impaired through drugs, tested positive for drugs. Since there is no absolute definition of impairment and since it was not possible to carry out a parallel study on a drug free normal driver population to use as a control group, it was not possible to achieve an absolute measure of impairment. Consequently, the test in its current form is only suitable for screening purposes. It requires confirmation by a suitably qualified medical examiner prior to the collection of a biological sample. Further testing of this procedure is required in order to improve the low negative predictive value that was found in this study. That is there was a high percentage of drivers who were suspected to be unimpaired that tested positive for drugs. The drugs detected in saliva by type, concentrations and combinations were indicative of drug misuse and similarly, on the whole for all biological specimens, the nature and extent of drug use by the drivers reflected drug misuse rather than the medicinal use of prescribed drugs. It was concluded that whilst there is still scope for future work to be carried out to improve the accuracy of the field impairment test, it is a useful adjunct to earlier assessment procedures used to detect impairment by the police officer.

8 Further Work

Drug-related deaths in the Strathclyde Police region will continue to be collated and monitored to identify emerging patterns and trends of drug misuse. Further collaboration with multidisciplinary agencies including the Scottish Prison Service, Clinical Medicine and Social Care would be beneficial for a complete and thorough investigation into these otherwise preventable deaths, particularly at a local level, for example by DAT regions. An area in need of more research is that of recently released prisoners. It is necessary to ascertain the actual extent of treatment intervention, if any, that the individual had prior to, during and following release of a custodial sentence as this information is often omitted from the police sudden death report. Particular attention should be made to cases whereby the individual had been on a methadone programme prior to imprisonment to ascertain whether this was continued during and following release from prison. Similarly, if the individual commenced a methadone programme whilst in prison, the extent to which this was continued following release must also be established. In cases where this did not happen, the reasons why there was an inconsistency in care should be investigated. Corroboration with ISD, Edinburgh could determine the extent, if any, of service contact by the deceased prior to death. In addition, the retrieval of medical records would allow the clinical care provided by any treatment programmes to be assessed or indeed, ascertain if the deceased was known to drug services and if not, the reason why. By plotting the loci of death or the individual's area of residence, geographical "black spots" may be identified. From this it would be possible to ascertain the availability and quality of drug treatment services within specific areas which may identify areas which need to be targeted by local authorities.

With respect to the drugs and driving cases, again all drugs detected will be monitored to establish changes in patterns and trends of drug use. In order to validate the use of FIT, it is necessary to compile data relating to the performance of a drug free population as a control group. This would involve a control population of individuals of varying ages and abilities to be tested using FIT possibly conducted in various weather conditions and at various times of the day and night. This will facilitate the future development of FIT in an effort to refine the battery of tests to improve sensitivity and specificity. This would enable the development of a "scoring system" which would allow FIT to be considered as a more objective indicator for detecting impairment and allow its results to be used as evidence in a court of law for the prosecuting of the drugged driver.

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10 Publications in Support of this Thesis

Drug Related Deaths Among Recently Released Prisoners in the Strathclyde Region of Scotland. Alison Seymour, John S. Oliver and Marjorie Black. Journal of Forensic Sciences, (2000), 45 (3), 649 – 654.

Drug related deaths amongst Glasgow city hostel dwellers. Alison Seymour, Marjorie Black, Kenneth Simpson and John S.Oliver. Journal of Clinical Forensic Medicine, (2000), 7, 183 - 187.

A Study of Alcohol and Drugs in Impaired and fatally Injured Drivers in the West of Scotland. Alison Seymour and John S. Oliver. Journal of Traffic Medicine, (2000), 28(3 – 4), 32 – 37.

Drug Related Deaths in the Strathclyde Region of Scotland, 1995 – 1998. Alison Seymour, Marjorie Black and John S. Oliver. Forensic Science International, (2001), 122, 52 – 59.

The Role of Dihydrocodeine in causing Death Among Drug Users in the West of Scotland. Alison Seymour, Marjorie Black, Jane Jay and John S. Oliver. The Scottish Medical Journal (2001), 46 (5), 143 – 146.

Dihydrocodeine – Drug of use or misuse? Alison Seymour, Marjorie Black, Jane Jay and John S. Oliver. The British Journal of General Practice, (2001), 51(466), 404 – 405.

Recent contact with health and social services by drug misusers in Glasgow who died of a fatal overdose in 1999. Russell Jones, Laurence Gruer, Gail Gilchrist, Alison Seymour, Marjorie Black, John Oliver. Addiction (2002), 97, 1517 – 1522.

Death by Obstruction – Sudden Death Resulting from Impromptu Ingestion of Drugs. Alison Seymour BSc (Hons), Marjorie Black M.B., Ch.B., Jeanette H. McFarlane BSc (Hons) M.B. Ch.B. and John S. Oliver Ph.D. The American Journal of Forensic Medicine and Pathology, (2003) 24(1), 17 - 21.

The Role of Methadone in Drug Related Deaths in the West of Scotland. Alison Seymour, Marjorie Black, Jane Jay, Gail A.A. Cooper, Christopher J. Weir and John S. Oliver. Addiction (2003), 98(7), 995 – 1002.

Alison Seymour,[1] *B.S. (Hons); John S. Oliver,*[1] *Ph.D.; and Marjorie Black, M.B., Ch.B.*

Drug-Related Deaths Among Recently Released Prisoners in the Strathclyde Region of Scotland*

Authorized Reprint from Journal of Forensic Sciences, May 2000

REFERENCE: Seymour A, Oliver JS, Black M. Drug-related deaths among recently released prisoners in the Strathclyde Region of Scotland. J Forensic Sci 2000;45(3):649–654.

ABSTRACT: Drug abuse and its consequences are everyday problems encountered globally, and Scotland is no exception. During a study of drug-related deaths in the Strathclyde region of Scotland it was noted that known drug users who had recently been released from prison were at high risk of dying from a drug overdose. The majority of deaths occurred within one week of the release date and polydrug use was prevalent. Morphine was the most frequently encountered drug and this was found in combination with benzodiazepines in a significant number of cases. This paper highlights the dangers of resuming drug consumption following a period of abstinence.

KEYWORDS: forensic science, drug-related deaths, Strathclyde, recently released prisoners, tolerance

Drug abuse and consequently drug-related fatalities are recognized problems in the West of Scotland. While the incidence of both has risen dramatically since the eighties, that of the latter has risen approximately 13-fold. The Forensic Medicine and Science Department, University of Glasgow, is responsible to the Crown Office for the provision of pathology and toxicology services in the Strathclyde Region of Scotland. This area encompasses most of the Southwest of Scotland and has a population of approximately two and a quarter million (Fig. 1). During a retrospective study on drug-related deaths (DRDs) in Strathclyde, it became evident that a population at high risk of dying from drug misuse were recently released prisoners. This paper presents the results of epidemiological and toxicological analyses of all DRDs among recently released prisoners over the eight-year study period, 1990 to 1997.

Methods

At the postmortem examination, blood samples are obtained from peripheral veins (subclavicle or femoral) and sent to the Department of Forensic Medicine and Science for routine analysis for the presence of alcohol and drugs using immunoassay, gas liquid chromatography and high-pressure liquid chromatography. All positive samples are confirmed and quantified by gas chromatography/mass spectrometry following extraction from a nonhydrolyzed sample. Data relating to age, sex, cause of death and results of toxicological analysis were obtained from the postmortem and toxicology reports, respectively. Information regarding medical history and circumstances surrounding the death was extracted from the sudden-death report issued by Strathclyde Police. For the purpose of this study, a drug-related death was defined as an unexpected death where drugs were implicated as a cause of death either through circumstance or toxicology.

Results

Throughout Strathclyde, from 1990 to 1997, a total of 670 DRDs were identified of which 87 (13%) involved a drug user who died within one month of release from prison. These deaths accounted for between 3.4 and 20.1% of the total number of DRDs per annum (Table 1). The deceased was known to be an intravenous drug abuser in 95% ($n = 83$) of cases. The majority of deaths occurred in the male population (76%) and the male:female ratio over the study period was approximately 3:1. The average age observed was 27 years (19 to 44 years).

Mode of Death

The majority of deaths (93%) were unexpected as a result of an acute fatal overdose. There were a small number of cases ($n = 4$) where the cause of death was recorded as "unascertained." In all four cases, the deceased was a known drug user; however, toxicology analysis was impossible in two cases as the bodies were in an advanced state of decomposition, making the procurement of a suitable blood sample impossible. In both instances, drug paraphernalia was found at the locus, a used syringe near the body in one case and a syringe and needle protruding from the deceased's left arm in the other. In the other two cases, toxicological analysis did not reveal any trace of drugs. However, in one of these instances, the presence of a used syringe and needle near the body and fresh needle puncture marks present in both groins strongly suggested that the death was drug related. In the fourth case, no sign of natural disease was identified and no real explanation could be found.

The circumstances surrounding two cases where death followed a significant period of survival are as follows. In the first case, the deceased was witnessed to be heavily under the influence of drugs, unsteady on his feet and had slurred speech. He fell asleep on a sofa and was found dead 14 hours later. Methadone and diazepam were detected at levels within the therapeutic range. The cause of death was certified as bronchopneumonia. The other case involved an inebriated individual who was thought to have consumed his week's quota of methadone. He collapsed outside his parent's house and was taken to hospital where he was

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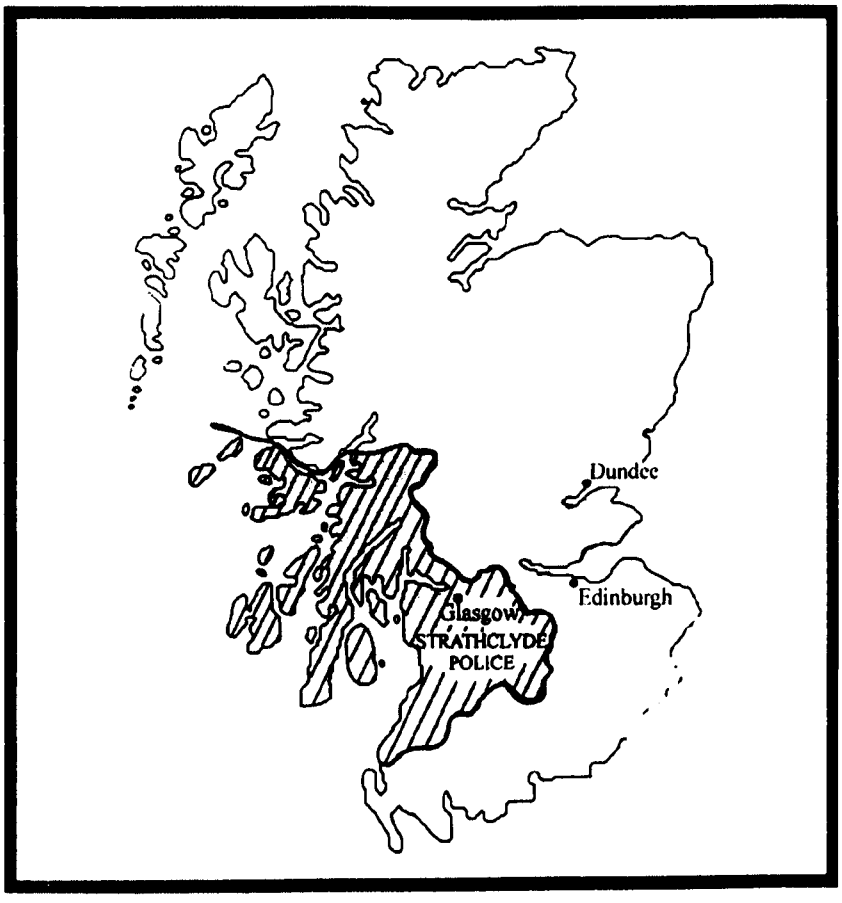

FIG. 1—*The Strathclyde region of Scotland*

TABLE 1—*Recently released prisoners (RRPs) as a percentage of the total number of drug-related deaths (DRDs) per annum in Strathclyde.*

Year	DRDs in Strathclyde	DRDs in RRPs in Strathclyde	Percentage (%)
1990	29	1	3.4
1991	45	6	13.3
1992	81	6	7.4
1993	73	6	8.2
1994	117	17	14.5
1995	119	24	20.1
1996	116	18	15.5
1997	90	9	10.0

declared brain dead. He died three days later with cause of death being recorded as cerebral oedema due to anoxia following drugs and alcohol intoxication.

Time Period Between Release from Prison and Death

Figure 2*a* shows that the majority of deaths occurred within one week of release from prison (62%), with approximately one third of these deaths occurring on the day of release or the day following release from prison (Fig. 2*b*). Of the 19 deaths occurring on either of these two days, 47% ($n = 9$) were due to heroin intoxication and four (21%) were due to temazepam and morphine intoxication. The causes of death for the remaining six cases were recorded as follows:

Temazepam, morphine and chlordiazepoxide intoxication
Methadone and morphine intoxication
Pulmonary congestion and oedema (morphine detected in blood)
Methadone intoxication
Morphine and diazepam intoxication
Temazepam poisoning

Toxicology

There were three cases where no blood sample was obtained. In two of these cases the bodies were in an advanced state of decomposition. In the third, the deceased survived for a period of time in hospital and the admission sample was disposed of prior to seizure. A total of 84 blood samples were received for toxicological analysis. In two cases, no drugs were detected and only alcohol was detected in another two cases; however, these deaths were still considered to be drug related due to circumstantial evidence.

Of the blood samples that tested positive for drugs (n 80), 29% (n 23) were positive for one drug, primarily morphine presumed to be as a result of the misuse of heroin (74%) generally supported by circumstantial evidence. In the remaining 71% of cases, two or more drugs were detected demonstrating the prevalence of poly drug use (Fig. 3).

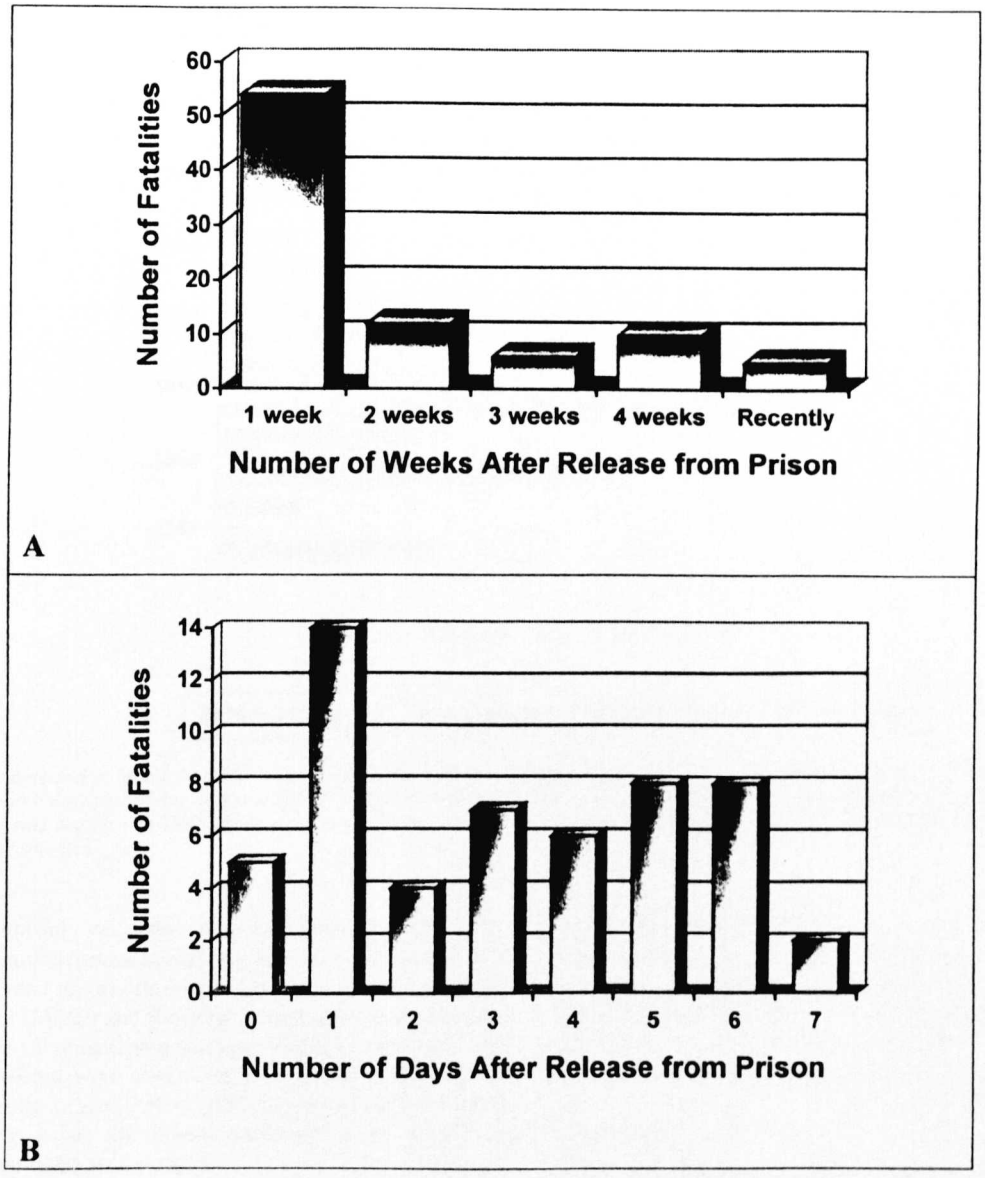

FIG. 2—*Time between release from prison and date of death in weeks* (A) *and days* (B).

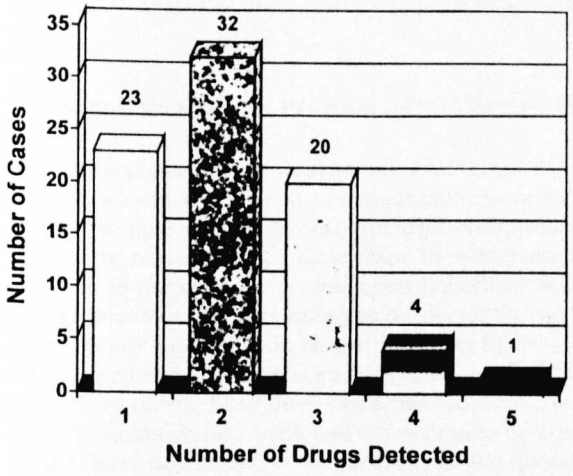

FIG. 3—*Number of drugs detected in blood samples.*

Figure 4 shows the distribution of drugs detected. Morphine was the most frequently encountered drug (n = 62, 78%), next was temazepam (n = 38, 48%) followed by methadone (n = 23, 29%) and diazepam (n = 23, 29%). The most frequently encountered combination of drugs was morphine (heroin) mixed with benzodiazepines, particularly temazepam. Temazepam was replaced by diazepam as the benzodiazepine of choice in the latter years following a drop in the availability of the former as a result of a legislation change in 1996.

Drug Concentrations

Morphine and methadone were mainly detected at levels that fall into the therapeutic range for tolerant individuals (0.04 to 0.5 and 0.05 to 1.0 mg/L, respectively) (1). They were found at significantly higher levels in 26 and 12.5%, respectively (Figs. 5*a* and *b*). The average morphine concentration was shown to be above the therapeutic level in cases where morphine alone or in

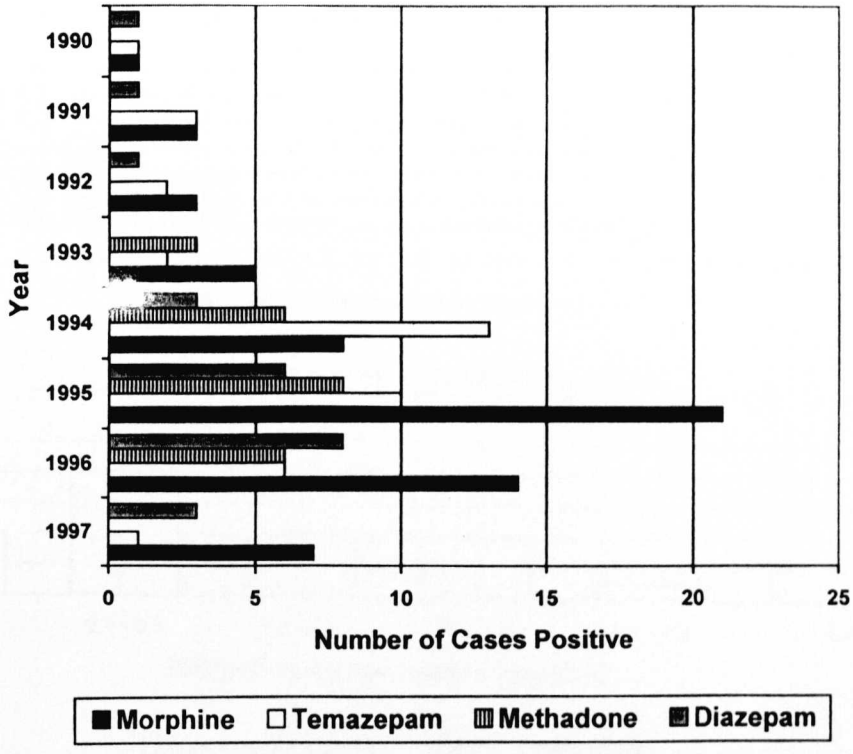

FIG. 4—*Drugs detected in blood samples. Note—Other drugs detected in blood: alcohol (23 cases), cannabis (8 cases), paracetamol (6 cases), chlordiazepoxide (2 cases), dihydrocodeine, buprenorphine and trichloroethanol (1 case each). NB: Morphine was detected in urine in one case in 1994 as was methadone. There was one case in 1997 where temazepam, morphine, diazepam, and chlordiazepoxide were all detected in the urine sample. Alcohol was detected in 7 urine samples.*

combination with only one other drug had been detected. There were no significant differences with regard to the concentration of methadone detected among those enrolled in a methadone maintenance program (MMP) and those who were consuming the drug illicitly. In 51% of temazepam positive blood samples the concentrations measured were consistent with levels reported in fatalities (therapeutic range: 0.36 to 0.85 mg/L) (1) and in all diazepam positive cases the levels measured were within the therapeutic range (0.05 to 2.0 mg/L).

Alcohol was found at relatively modest levels. The average blood alcohol concentration of all 23 alcohol positive cases was 70 mg/100 mL (range: 8 to 214 mg/100 mL). Morphine was detected in 21 (91%) of these cases and temazepam in 11 (48%) cases.

Methadone Maintenance Program (MMP) Involvement

From the police sudden death reports it was noted that nine decedents (37%) who tested positive for methadone were enrolled in an MMP at the time of death. Seven of these cases occurred within one week of the release date. Of these cases, three had recently started an MMP. In one case, the deceased was prescribed methadone on the day prior to death after stating to his doctor that he had developed a heroin habit while in prison. The other two cases involved the deceased being prescribed methadone on the day they were released from prison. In all three cases, the decendents were to pick up the prescription on a daily basis; however, in one case, the deceased was issued 320 mL of methadone (four-day quota), two days prior to death, due to a forthcoming holiday. Prescribing was resumed in three of the remaining four cases. In one instance, the deceased was prescribed methadone at a lower dosage than he had received prior to imprisonment and in another instance the deceased was given a week's supply of methadone two days prior to death. Of all the decedents in this study who were known to be enrolled in an MMP at time of death (n = 16), 69% tested positive for morphine, confirming the misuse of heroin.

Discussion

There has been an increase in the number of drug-related deaths occurring in the Strathclyde region of Scotland over the study period and, coincidentally, a rise in the number of prisoners dying from DRD within one month of their release date was observed. The majority of these deaths involved the male population who were aged in their mid-twenties. Although the overall numbers identified may appear relatively low with respect to the duration of the study, they represent one drug-related death occurring approximately once per month.

Over half the cases (62%) occurred within one week of release from prison and a substantial number of these occurred either on the day of release or the day after release. This highlights the situation that an enforced period of abstinence can lead to a reduction in an individual's tolerance for a specific drug of abuse.

Approximately three-quarters of the deaths were heroin-related and toxicological analysis revealed that polydrug use was prevalent, with the heroin-benzodiazepine combination reported by Cassidy et al. (2) remaining a popular choice for the West of Scotland drug user. These findings are not significantly different to the findings in the study of all drug-related deaths in the Strathclyde region. The preference for diazepam as a mixer in the latter years owes itself to the wider availability of this drug. In 1996, Glasgow

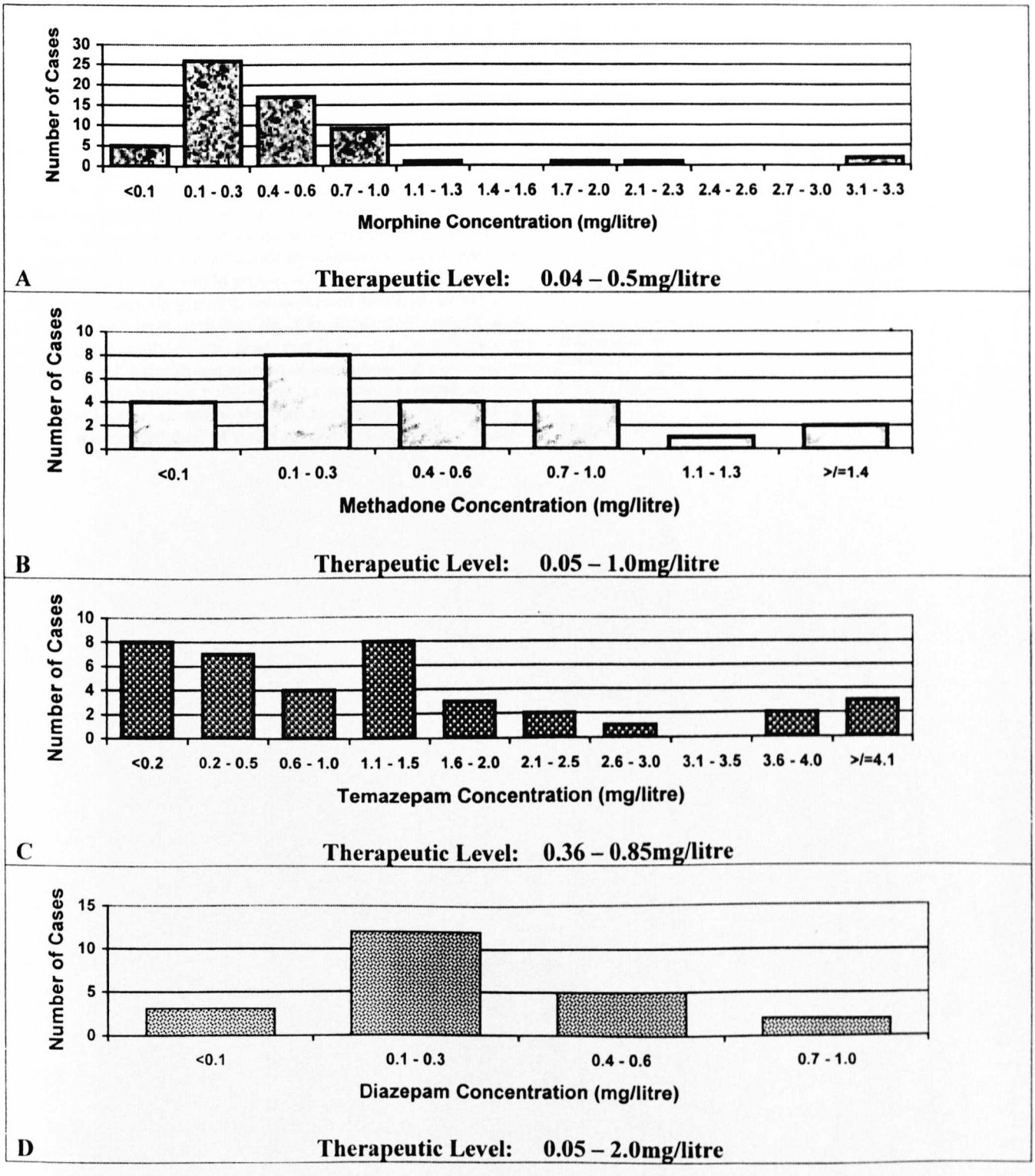

FIG. 5—*Concentrations of morphine* (A), *methadone* (B), *temazepam* (C), *and diazepam* (D) *detected in blood.*

general practitioners regarded the prescribing of temazepam as "not good practice" following the transfer of this fast acting benzodiazepine from schedule 4 of the Misuse of Drugs Act 1985 to schedule 3 (3). Alcohol was detected in approximately one quarter of all cases, albeit at relatively modest concentrations, unlikely to cause death alone. Morphine was the primary drug found in all alcohol positive-drug positive combinations, followed by temazepam. Alcohol, opiates and benzodiazepines are all known to have an emetic effect and when taken in combination, this effect is additive. In the majority of methadone positive cases, the deceased had not been enrolled in an MMP (63%) and the methadone was obtained by diversion of legitimate supplies. This

was similar to the findings of a study on all deaths involving methadone in Strathclyde (4). These studies underline the need for tighter controls on methadone dispensing. For example, a requirement for the drug to be consumed under strict supervision on a daily basis. A substantial number of decedents who were in an MMP at the time of death tested positive for morphine and were apparently continuing to abuse heroin.

There appears to be a breakdown in communication between prison doctors and general practitioners and as a consequence methadone prescribing is often discontinued upon imprisonment. Glasgow general practitioners have reported that the adverse consequences of imprisonment include resumption of heroin injecting and chaotic drug use both in prison and upon release (5).

When a known drug user is released from prison in the West of Scotland, he or she is advised of the risks of overdose and is issued with helpline numbers. This study highlights that, in spite of this advice offered, a significant number of individuals clearly resort to their old habits without building up a tolerance. Comparison between the level of morphine detected in relation to the period of time of release and date of death revealed no significant differences. There is, however, insufficient data available on a day-to-day basis to draw any real conclusions regarding the level of drug misuse by the individual.

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ORIGINAL COMMUNICATION

Drug related deaths amongst Glasgow city hostel dwellers

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SUMMARY. The problems of homelessness and drug misuse are every day issues encountered in today's society. Over the past 2 years the number of hostel residents overdosing within their rooms in the city of Glasgow was shown to increase. Approximately three-quarters of deaths involved heroin, of which 56% also involved at least one benzodiazepine. This paper demonstrates a dearth in the literature relating to drug misuse amongst the homeless population, highlighting an area in need of address by the appropriate authorities.

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INTRODUCTION

Homelessness and drug abuse are two escalating problems in society today and are often associated with each other. In Glasgow, UK, with a population of some 650 000 people, there are estimated to be approximately 8000 single homeless people, of which roughtly 60% are believed to use drugs.[1] Whilst there are numerous causes which lead to a person adopting a nomadic existence, a contributory factor may take the form of an individual's untreated addictive disorder. The exacerbation of drug addiction and consequential associated debilitating issues may be the catalyst that impels residential instability. In Glasgow, there has been a marked increase in the number of single homeless individuals with a history of drug/alcohol abuse who present themselves to homeless units.[2] A study in the USA revealed that approximately 45% of a sample of homeless people were abusing drugs,[3] whilst in London, 39% of subjects involved in a long term drug management programme were or had been homeless.[4]

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During a study involving drug related deaths in the Strathclyde region of Scotland, it became evident that a significant number of deaths were occurring within the homeless hostels situated throughout the city of Glasgow. To date, there is virtually no literature on the prevalence of drug related deaths within such loci. This paper investigates all drug-related deaths that occurred in hostels for the homeless over the 10-year study period 1990–1999.

There are various homeless hostel facilities throughout the Glasgow area. Eight are owned by the Glasgow city council and managed by the Hamish Allan Centre who operate as an emergency-receiving unit for homeless people in Glasgow and provide a 24 h, 365-day service. Four of these hostels accommodate males aged 18 years and over, one is for females, one is for both sexes, one provides an emergency and assessment hostel housing 16–18 year olds and one is an emergency assessment hostel for the more vulnerable homeless adult. Jointly, these hostels provide over 1155 bed spaces that are constantly occupied at full capacity. All give precedence to individuals of Glasgow origin and are located within or near to the city centre providing easy access. Other privately run hostels exist and these predominantly provide accommodation for individuals from outwith the Glasgow area. Also, in situations whereby an individual has been expelled from a council hostel due to violence or contravening guidelines, the assistance of private hostels is called upon to re-house these offenders.[5]

MATERIAL AND METHODS

The protocol for a drug-related death in the Strathclyde region of Scotland is for an initial report to be prepared by Strathclyde Police prior to the Procurator Fiscal instructing a post mortem examination. Biological samples taken for toxicological investigation are routinely analysed for the presence of alcohol and drugs using immunoassay, gas liquid chromatography and high-pressure liquid chromatography. Positive samples are confirmed and quantified by gas chromatography mass spectrometry. The results of the pathological and toxicological investigations are used to establish the cause of death. For this study, all cases relating to homeless hostels at the time of their death were identified. All information pertaining to these cases were extracted from the police sudden death report, the toxicology report and the post mortem report.

RESULTS

During the period 1990–1999, there were 957 drug-related deaths identified in the Strathclyde region of Scotland. Of these, 61 involved a hostel dweller (47 resided within a council hostel and 14 within a private hostel). The locus of death was the deceased's hostel room in 49 (80%) cases (38 in a council hostel and 11 in a private hostel). Approximately four-fifths of all cases (79%, $n = 48$) occurred in the last 5 years of the study, 46% of these cases ($n = 22$) within the latter 2 years (Fig. 1). The final year accounted for 25% ($n = 15$) of the cases over the study period. As with most drug-related deaths in the region, the majority of subjects were male (84%, $n = 51$) and aged in their late twenties (average age: 29 years (21–44 years)). The deceased was known to be an intravenous drug abuser in all but two cases. Unemployment prevailed in all cases except in one instance where it was noted the deceased had been employed as an upholsterer at the time of his death.

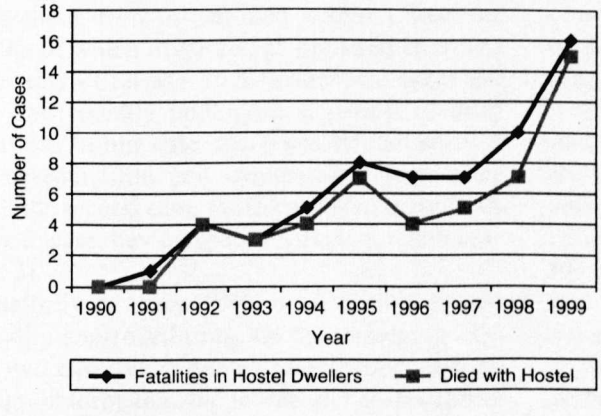

Fig. 1 Number of hostel deaths per annum

Of the 49 cases where death occurred within the hostel, the circumstances surrounding 47% ($n = 23$) of these involved the deceased being discovered following routine bed checks carried out by the hostel attendants. The majority of checks took place before 0945 hours (83%, $n = 19$) with just over two-thirds of these taking place before 0900 hours (68%, $n = 13$). Of these 23 cases, the deceased was witnessed to enter their room the previous evening by other residents and hostel staff in seven and six cases respectively. In a further seven cases, entry to the room was verified by access card (two cases) or close circuit television (five cases). The deceased's demeanour was noted in six of the 13 cases where the last movements of the deceased had been physically witnessed. Drug consumption was admitted in two cases and the deceased appeared in good spirits in another two cases. One case involved a member of staff helping the deceased to bed due to his inebriated state and in the final case the deceased was witnessed to have injected drugs. No mention of the deceased's state of health was made in the remaining seven cases.

The circumstances for the remaining 26 cases whereby the deceased was found within the hostel premises are as follows. Another witness associated with the hostel discovered the deceased in their room in 10 cases. Discovery within the hallway, dayroom and an unoccupied bedroom accounted for one case each and the hostel toilet was the locus in a further three deaths. The deceased was witnessed to be intoxicated either through drink or drugs and was left alone for a short period of time in four cases, on return of the witness the deceased was dead. Two cases involved the deceased falling asleep in the presence of a witness following the consumption of drugs, a period of time later they were found to be dead. The deceased collapsed immediately following drug injection in three cases and in one case an anonymous phone call was made to ambulance control stating that a male had overdosed in his hostel room.

For the remaining 12 cases where death occurred outwith the hostel, the loci are as follows. In four cases, the deceased died within a friend's house. Drug consumption had been witnessed in these cases, the deceased left alone for a period of time and later found to be dead. The deceased was discovered within a common close and public toilet area in two cases each. The loci for the remaining four cases were within hospital grounds, a street, a lane or waste ground.

Drug paraphernalia was recovered from the locus in 85% ($n = 52$) of all cases. Used syringes were retrieved in the majority of these cases (87%, $n = 45$). The location of the syringes in one third (33%, $n = 15$)

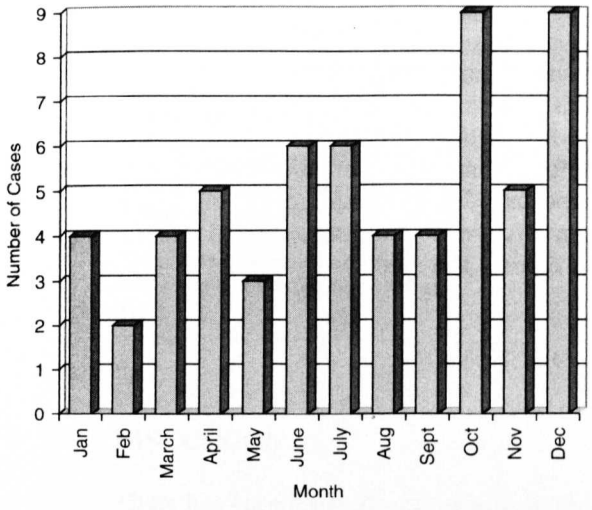

Fig. 2 Time scale of when death occurred by month

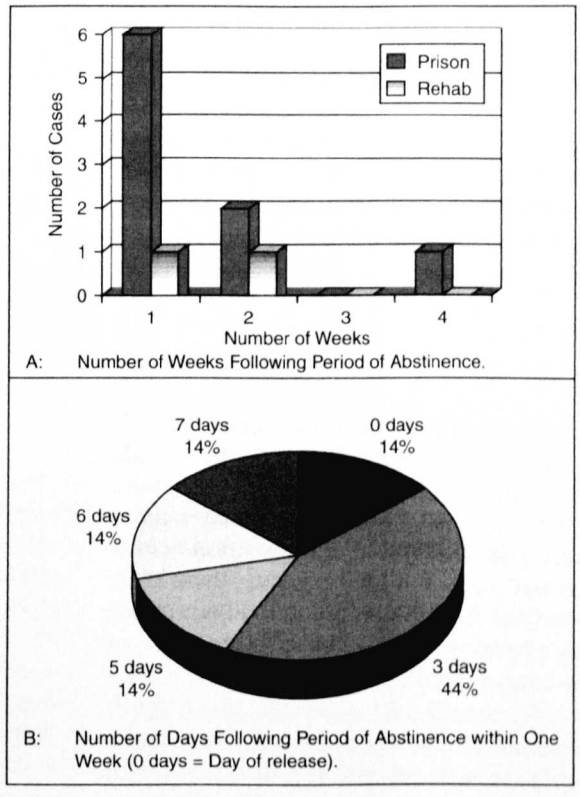

Fig. 3 Number of days between release from prison or rehab and death in weeks and days

of these was strongly indicative of a sudden death. A needle and syringe was found in situ in 10 cases, a used syringe was found clenched in the deceased's hand in two cases and a used syringe was located under the subjects body in three cases. Sudden death could not be presumed in the remaining 30 cases as the police report stated merely that a used syringe was found either adjacent to the body or within the vicinity of the body in 24 and six cases respectively. Drugs (either in powder or tablet/capsule form) were recovered in six cases, one of which involved a body packer with six heroin deals concealed in his rectum (all of which were found to be intact).

The month in which the death occurred was noted, the results of which can be seen in Figure 2. Just over half of the cases (54%, $n = 33$) had occurred either in the first ($n = 10$) or last quarter ($n = 23$) of the year.

Nine cases (15%) involved an individual who had been released from prison within 1 month prior to death. Of these, 67% ($n = 6$) died within 1 week of release, one of which involved the deceased overdosing on the day of release. In a further two cases the deceased had recently undergone a period of drug rehabilitation. In one case, the deceased had spent 3 days in rehabilitation and overdosed 7 days after release. In the second case, the deceased overdosed 11 days after release, having spent 23 days in rehabilitation (Fig. 3).

The majority of cases (79%, $n = 48$) involved the overdose of a controlled drug. Of the remaining 21% ($n = 13$), two cases were due to intoxication of non-illicit drugs, chlormethiazole in one and co-proxamol in the other. Two individuals died as a result of the adverse effects of their drug abuse, haemorrhage and shock resulting from a bleeding leg ulcer accounted for one case and bacterial endocarditis, an infection caused by intravenous drug abuse, was responsible for the other case. The cause of death in seven cases was certified as drug related death. Due to the risk of infection, a full post mortem examination was not carried out in five of these cases, the cause of death was assigned following a full external examination and toxicological investigation. Finally, two cases were considered to be drug related due to circumstantial evidence however, the underlying cause of death was unascertained.

Heroin prevailed as the drug which either alone or in combination with other drugs led to death amongst the controlled drugs overdoses. Heroin intoxication was assigned as the cause of death in 20 cases. The concurrent use of heroin with other drugs accounted for 25 cases, 64% ($n = 16$) of which involved at least one benzodiazepine. The various combinations of drugs that were considered to be involved in the death are listed in Table 1. Mono-intoxication was responsible for three cases, temazepam and methadone in two cases and one respectively.

Table 1 Combination of drugs in heroin related deaths.

Heroin plus	Number of cases
Alcohol	9
Temazepam	8
Diazepam	1
Chlordiazepoxide	1
Temazepam and diazepam	2
Temazepam and alcohol	1
Temazepam and methadone	1
Temazepam, diazepam and methadone	1
Temazepam, diazepam and alcohol	1
Total	**25**

DISCUSSION

There has been a significant increase in the number of drug related fatalities in the West of Scotland over the study period. Within this group, there has also been an increase in the number of individuals overdosing within various homeless hostels throughout the city of Glasgow, particularly in the latter 2 years. The demographic synopsis of this study reflects all known cases of drug fatalities in the Strathclyde region with respect to sex, age and employment status, drug history of the individual as well as the specific drugs that were considered responsible for the death. Heroin either alone or in conjunction with other drugs, in particular benzodiazepines was the most prevalent.

The circumstances surrounding a large number of these deaths indicated that the deceased was alone prior to drug administration. In the absence of a letter or note of some kind, it was impossible to establish whether the death was suicidal or accidental. A study investigating suicidal intent in non-fatal illicit drug overdoses revealed that almost one half of respondents reported to have suicidal thoughts or feelings prior to overdosing.[6]

The presence of a needle and syringe in situ, grasped in the deceased's hand or located under the body, strongly suggests that death occurred almost immediately following or during drug injection. This applied to 25% of all cases in this study ($n = 15$).

Over half of the deaths had occurred in the first and last quarter of the year, particularly in the months October–December. In terms of all drug-related deaths throughout the study period, the distribution of deaths over the months was constant and showed no significant variations from month to month. Therefore, the increased numbers of hostel deaths occurring in the months October–December, although not statistically significant, suggests that hostel dwellers may be at a slightly higher risk from overdosing during this period. This time of year can prove to be a difficult period to cope with for many people, in particular those who are emotionally or psychologically unstable, such as drug misusers. The feeling of isolation associated with hostel dwelling may only enhance this melancholy.

Reduced drug tolerance and increased deaths resulting from a period of abstinence has been previously reported.[7] Recent prison release or termination of recent drug rehabilitation accounted for a small number of cases in this study.

CONCLUSION

To date, there is a dearth of literature pertaining to the extent of drug misuse within homeless hostels. However, this study highlighted an increase in drug related fatalities occurring within hostels revealing that there is indeed a problem with illicit drugs in such establishments. Drug misuse that is brought to the attention of hostel staff is not tolerated; however, in reality many drug users are granted a room and are able, to a certain extent, to buy, consume and even deal drugs freely. The only surveillance takes the form of close circuit television systems or electronic key tagging systems that record the time of entry and exit to each room. What goes on behind closed doors is at the resident's own discretion.

It has been postulated that due to drug dealers being moved from their customary vicinity due to policing or the installation of close circuit television systems, they are targeting hostels as a means of continuing their business. This is an area presently being addressed by the appropriate law enforcement agencies.

The Government has recently addressed the problem of homelessness, not only from the aspect of accommodation deficiency but also highlighted a need to treat those with mental health, drug and alcohol problems. As part of a pledge of £25 million, not only will impersonal dilapidated homeless hostels be eradicated making way for modern accommodation, but health-related projects will also be financed.[8]

The results of this study highlight a need to investigate fully and monitor the number of drug users abusing the hostel system. The number of deaths presents a problem in need of address by the relevant authorities.

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Journal of Traffic Medicine (2000), 28:3-4

A STUDY OF ALCOHOL AND DRUGS IN IMPAIRED AND FATALLY INJURED DRIVERS IN THE WEST OF SCOTLAND

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ABSTRACT

Objective: To ascertain the prevalence of drugs (both licit and illicit) and alcohol amongst both drivers suspected of impairment and fatally injured drivers.

Methods: All 214 relevant cases were identified and results of toxicological investigation retrieved using the departmental database.

Results: The prevalence of illicit drugs amongst living drivers is increasing, in particular the concurrent use of morphine and benzodiazepines. Alcohol was found to be present in approximately one fifth of living drivers at quite significant concentrations. Drug and alcohol use amongst fatally injured drivers was shown to be minimal.

Conclusions: The incidence of illicit drugs amongst drivers suspected of impairment is increasing in the Strathclyde region and remains a problem for the authorities.

INTRODUCTION

The misuse of drugs in the West of Scotland has increased dramatically over the years and at present shows no signs of subsiding (Seymour, Black, Oliver 2000). Consequently and in addition to an increase in the number of drug related deaths occurring in the area, this problem is reflected in the drugs and driving scene. A recent study highlighted an increased number of samples received by the Department of Forensic Medicine and Science, University of Glasgow requiring analysis of drugs (Seymour and Oliver, 1999). These samples had been obtained from drivers who were suspected of impairment. This paper presents the results of the toxicological investigation of biological samples obtained from drivers charged under Section 4 of the Road Traffic Act 1988 for the year 1999. For comparison purposes, the results of toxicology carried out on samples taken from fatally injured drivers that same year are also included.

MATERIAL AND METHODS

Following arrest, an individual suspected of driving whilst under the influence of drink and/or drugs is accompanied to the police station where a police surgeon is summoned to examine the driver and ascertain the extent (if any) of impairment. In the event of diagnosed impairment, two 10 millilitre blood samples are obtained. One of these is given to the driver should they want to pursue independent analysis and the other sample is given to the police, who submit the sample for analysis to the Department of Forensic Medicine and Science, University of Glasgow. Under the Road Traffic Act 1988, it is an offence for an individual to refuse the assessment and /or refuse to provide a sample of either blood or urine.

In the cases of fatally injured drivers, biological samples are sent to the aforementioned department for analysis following completion of a post mortem examination.

All samples were routinely analysed for the presence of alcohol and drugs. Benzodiazepines,

opiates, LSD, cannabinoids, amphetamines, buprenorphine and methadone were analysed using enzyme-immunoassay. Blood was screened for acidic, basic and neutral drugs using gas liquid chromatography and high performance liquid chromatography. All positive samples were confirmed and quantified by gas chromatography mass spectrometry. Drug levels were measured using stable isotope reference materials where available or by internal standard procedures.

RESULTS

Drivers Suspected of Impairment

Over the study period 1999, the department received 312 biological samples from various police forces throughout Scotland. The majority of these (69%, n = 214) were submitted by Strathclyde Police force and were primarily blood samples (85%, n = 181). The majority of drivers were male (187male:27 female). Following toxicological analyses of the blood samples, drugs were found to be present in 139 cases (77%), 11 of which also tested positive for alcohol. Alcohol alone was detected in 23 blood samples and the remaining 19 cases tested negative for both drugs and alcohol. Of the 33 urine samples, the majority (88%, n = 29) were positive for drugs, alcohol also being detected in three of these cases. The presence of alcohol alone was detected in four urine samples. This is summarised in Table 1.

Drug Involvement

Blood Samples: Polydrug use was evident in just over one half of drug positive blood samples (53%, n = 73). Table 2 lists all drugs detected. It can be seen that benzodiazepines were the most frequently encountered medicinal drug with diazepam and temazepam found to be present in 83% and 55% of drug positive cases respectively. Morphine was the most frequently detected illegal drug followed by cannabis. The co-administration of morphine and benzodiazpines accounted for 41% (n = 30) of all polydrug blood samples and 88% of all morphine positive cases. The concurrent use of morphine with diazepam or temazepam was detected in 15 cases and one case respectively. Morphine in combination with diazepam and one other drug[†] were detected in seven cases and one case involved morphine, temazepam and methadone. Both benzodiazepines, diazepam and temazepam were found in a cocktail with morphine in three cases and finally all three drugs together with dihydrocodeine accounted for three cases. The co-administration of diazepam and temazepam alone accounted for 13 cases. The remaining 30 combinations of drugs detected are summarised in Table 3, all of which involved diazepam and/or temazepam. Sixty-six cases involved the presence of one drug and this was primarily diazepam (74%, n = 49). Temazepam alone was found to be present in six cases, morphine and cannabis in four cases each and finally methadone, cocaine and gammahydroxybutyric acid were detected in one case each.

From Table 2 it can be seen that whilst the average concentration of most drugs fell within the expected therapeutic level, concentrations associated with death amongst intolerant individuals were noted. In particular, morphine and diazepam were found to be present at concentrations approximately double that of the upper therapeutic range level and a temazepam concentration more than four and a half times that was detected. Whilst no medical history of the deceased was made available, these ranges of concentrations suggest a potential for impairment.

Urine Samples: The presence of drugs were noted in the majority of urine samples (88%, n = 29) and are listed in Table 4. Again, polydrug use was evident with one drug being detected in only two cases (amphetamine and cannabis). The concentration of a drug in urine can only be used as an indication that the individual has been exposed to that drug. Whilst the concentrations of drugs in urine can not be equated to a level of impairment, the number of drugs detected per sample was rather alarming. Four drugs accounted for 10 cases, two, three and five drugs for four cases each and finally five cases involved the presence of as many as six different drugs. Morphine was detected in 19 polydrug cases (70%), with the presence of both diazepam and temazepam accounting for approximately two thirds (68%, n = 13) of morphine positive cases. Again, no medical history was available, however, the variety of drugs and combinations is indicative of drug misuse.

Alcohol Involvement

Alcohol was detected in 34 blood samples, of which 11 cases (32%) also tested positive for drugs. The average blood alcohol concentration (BAC) measured in the 23 alcohol only positive cases was 148mg/100ml (Median: 136mg/100ml, Range: 41 – 333mg/100ml), which is almost double the legal driving limit of 80mg/100ml. In one case a BAC of 333mg/100ml blood was detected, a level associated with coma and impaired respiration in an intolerant individual. The average BAC (52mg/100ml) observed in the drug-alcohol positive cases was considerably lower than when alcohol alone was detected. Only one of the 11 drug positive cases had a BAC greater than the legal

[†] cannabis (3 cases), cocaine (2 cases), methadone (1 case), dihydrocodeine (1 case)

driving limit. This level of 217mg/100ml would most certainly cause a marked degree of impairment.

Time Sample was Obtained

In accordance with a previous study carried out in the region (Seymour and Oliver, 1999), the majority of samples were obtained between 2100 hours and 0600 hours (56%, n = 120). A further breakdown shows that 68% (n = 81) of these samples were taken between midnight and 0600 hours. The distribution of time when the sample was obtained is illustrated in Figure 1.

Fatally Injured Drivers

In 1999, there were 26 drivers who were fatally injured in a road traffic accident. Again, the majority were male (24 male: 2 female). Following completion of a post mortem examination, a blood/urine sample was collected and analysed for the presence of alcohol and drugs. The majority of samples were void of both alcohol and drugs (19 cases, 73%). Only two samples were found to be positive for drugs. One sample revealed codeine (0.023mg/litre) and the other methylenedioxyamphetamine (0.006mg/litre). Alcohol was detected in five cases, the average BAC measured being 104mg/100 millilitre (Range: 5 – 231mg/100 millilitre). Only two of the five blood samples were under the legal driving limit.

DISCUSSION AND CONCLUSION

The number of samples submitted to the department of Forensic Medicine and Science in 1999 requesting drug analysis for individuals suspected of impaired driving was the highest ever recorded. The findings of toxicological investigations were similar to previous years in that polydrug use was prevalent in particular the concurrent use of morphine and benzodiazepines. This combination of drugs has previously been reported to be the major causative factor conducive to drug related deaths within the region (Cassidy, Curtis, Muir and Oliver, 1995) in the early nineties and remains to be the favoured cocktail of abuse today. Benzodiazepines remained the most common legal drug amongst suspected impaired drivers. However, morphine was the most frequently encountered illegal drug followed by cannabis, which is in contrast to previous years where the latter drug was the most common (Seymour and Oliver, 1999). Overall, the findings are similar to that of other countries who seem to experience the same trends as Scotland (Lillsunde, 1998). The average drug concentrations measured in blood were all within the therapeutic range level except for dihydrocodeine. The frequency of this drug amongst drug related deaths in the region was seen to increase over the latter two years and appears to be emerging as a drug of misuse amongst known drug users (Seymour, Black, Oliver, In Press). In a few cases, drugs were found to be present at concentrations associated with fatalities in non-tolerant individuals, most notably morphine, diazepam and temazepam. Whilst no information was available with respect to any prescribed medication the individual may have been receiving, the combination of drugs, in particular, the concurrent use of morphine and benzodiazepines is indicative of drug misuse. For future research it would be useful if a synopsis of the individuals age and medical history were documented at the time of sample procurement in order to distinguish between legitimate drug consumption and drug misuse. Alcohol detected in living drivers was measured at significant concentrations when enountered alone. The median concentration of 136mg/100ml in this study is associated with a marked loss of co-ordination and would undoubtedly have an effect on an individuals driving ability.

With respect to fatally injured drivers, drugs were not considered to be a causative factor in the accident. Drugs were found to be present in only two cases, one involving codeine in a 62 year old male, presumably prescribed and a metabolite of ecstasy in another case although at a very low concentration. Alcohol was suspected of being conducive to the fatal accident in only two cases where BACs of 231mg/100ml and 169mg/100ml were measured. These concentrations are associated with considerable impairment. In order to bring the United Kingdom in line with the majority of member states in the European Union, the proposal of lowering the legal driving limit to 50mg/100ml has been brought to the publics attention (Sunday Mail, 2000). However, a high profile publicity campaign will have to be initiated prior to a change in existing legislation. Should this go ahead, this would be a good opportunity to warn the public of the risks associated with drugs and driving and to highlight that it is a major problem on Scottish roads - one which the police are currently addressing. The implementation of a training programme for police officers in the West of Scotland in 1999 has heightened their awareness of drugs and their effect on driving ability.

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Table 1 : Breakdown of Toxicological Investigation of Biological Samples Received by the Department of Forensic Medicine and Science.

	Blood	Urine
Drugs Only	128	26
Alcohol Only	23	4
Drugs and Alcohol	11	3
All Negative	19	0
Total	**181**	**33**

Table 2: Drugs detected in Blood Samples.

Drug Detected	No. of cases	Level Measured (mg/l) Ave (low-high)	Therapeutic Level (mg/l) (Stead and Moffat, 1983)
THC [a]	6	3.5 (1.65 – 7.0)[c]	
THC-COOH [b]	22	61.1 (10 – 190)[c]	
Amphetamine	1	0.05	0.05 – 2.0
Chlordiazepoxide	4	0.66 (0.05 – 1.2)	1.0 – 8.0
Desmethyldiazepam	111	1.1 (0.02 – 8.53)	
Diazepam	115	0.91 (0.04 – 3.37)	0.05 – 2.0
Temazepam	76	0.76 (0.05 – 4.02)	0.36 – 0.85
Morphine	34	0.05 (0.01 – 1.0)	0.04 – 0.5
Methadone	9	0.13 (0.024 – 0.26)	0.05 – 1.0
Dihydrocodeine	5	0.3 (0.18 – 0.52)	0.03 – 0.25 (Repetto and Repetto, 1997)
Other [d]	25		
Positive Drug Samples	**139**		
Total Drugs Detected	**408**		

[a] Delta-9-tetrahydrocannabinol

[b] 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid

[c] nanogrammes per millitre

[d] Other drugs included: Benzoylecgonine (7), Methylecgonine (7), cocaine (6), Gammahydroxybutyric acid (1), Phenytoin (1), Methylenedioxymethylamphetamine (3).

Table 3: Drug Combinations of 30 drug positive cases Comprising of Benzodiazepines and other drugs.

Drug Combinations (Number of Cases)		
Diazepam Plus	***Temazepam Plus***	***Diazepam + Temazepam Plus***
Cannabis (11)	Phenytoin (1)	Cannabis (1)
Methadone (5)	Cannabis (1)	Chlordiazepoxide + Methadone (1)
Cocaine (3)		
Chlordiazepoxide (3)		
MDMA (1)		
Cannabis + Cocaine (1)		
Methadone, MDMA + Cannabis (1)		
Amphetamine +MDMA (1)		
Total = 26	**Total = 2**	**Total = 2**

Table 4: Drugs Detected in Urine Samples.

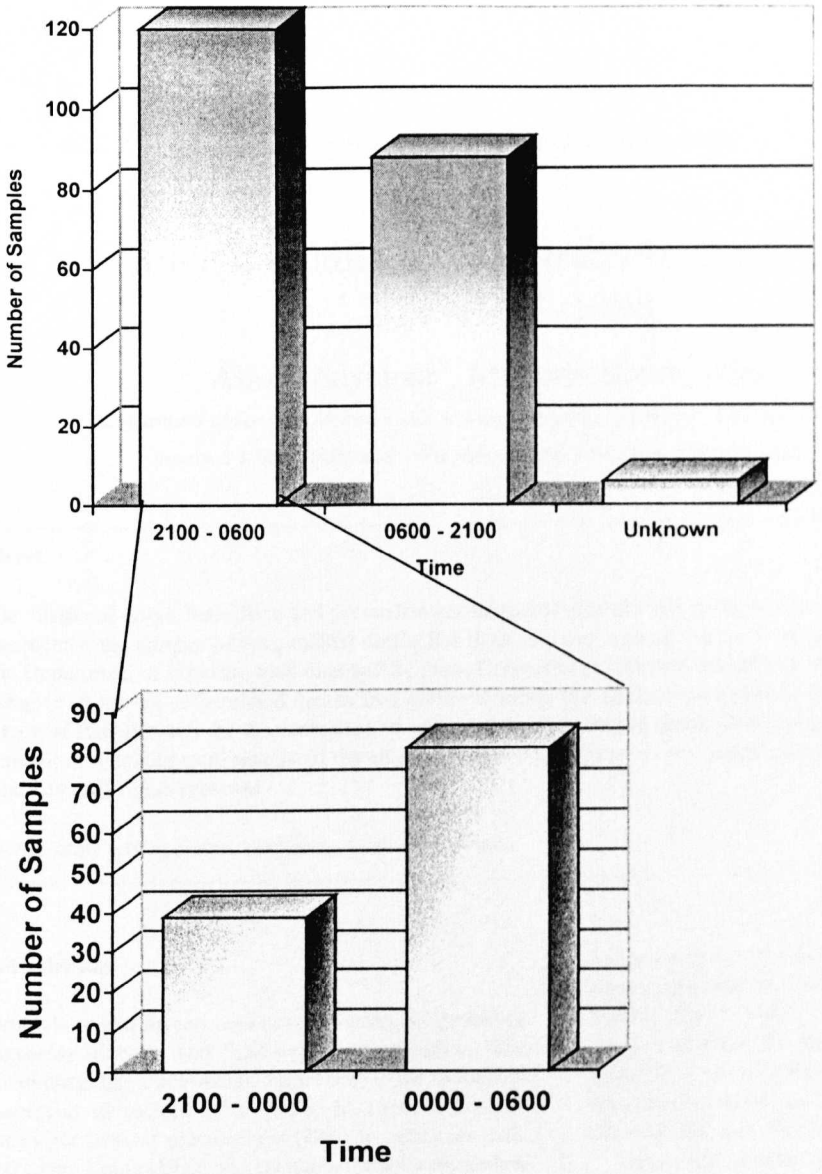
Drug Detected	No. of cases
THC[a]	0
THC-COOH[b]	16
Amphetamine	6
Chlordiazepoxide	1
Desmethyldiazepam	18
Diazepam	10
Temazepam	19
Morphine	19
Methadone	10
Dihydrocodeine	8
Other[c]	20
Positive Drug Samples	**29**
Total Drugs Detected	**127**

[a] Delta-9-tetrahydrocannabinol

[b] 11-nor-delat-9-tetrahydrocannabinol-9-carboxylic acid

[c] Other drugs included: Benzoylecgonine (6), Methylecgonine (6), Cocaine (4), Paracetamol (1), Citalopram (1), Methylenedioxymethylamphetamine (1), Trimethoprim (1).

Figure 1: Time When Sample was Taken.



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Drug related deaths in the Strathclyde region of Scotland, 1995–1998

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Abstract

The misuse of drugs, both illicit and prescribed has increased dramatically in the west of Scotland over the last few decades. Consequently, the number of drug related deaths has risen as a direct result. Since, discrepancies exist between data collected by the Department of Forensic Medicine and Science, University of Glasgow and official statistics, this project, was funded to investigate all known drug related deaths that occurred within the Strathclyde region of Scotland in an effort to improve the accuracy of statistics and the dissemination of information pertaining to them. Changes in medical treatment, legislation and patterns of drug taking were noted and the effects of these on the year-by-year death tolls evaluated. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Drug related deaths; Strathclyde; Methadone; Heroin

1. Introduction

Drug abuse and its consequences are everyday problems encountered globally and Scotland is no exception. The abuse of drugs has a detrimental effect both to the individual misuser and to society as a whole. In 1968, it became statutory for general practitioners (GPs) to notify an individual to the Home Office addicts index if they were known to be addicted to any 1 of 14 specific opiates[1] and/or cocaine. As well as monitoring the extent of drug misuse in the UK, this index acted as an extra source of intelligence to prevent double prescribing occurring [1]. The number of drug addicts notified to the Chief Medical Officer at the Home Office rose from 126 for the whole of Scotland in 1980 to 4516 in 1996 [2]. Given that these figures relate to individuals who have voluntarily presented themselves for treatment, it can be assumed that they are an underestimate. For comparison, there are estimated to be between approximately 12,000–15,000 adults with a serious drug problem in the greater Glasgow area alone. Since mortality is a contingency of an individuals drug abuse, the number of people who died directly as a result of their drug abuse rose dramatically over the above time period.

Trends and patterns of drug use in the west of Scotland have been well documented in the literature [3–9]. Drug abuse as a problem in the region dates from the early 1980s when black market heroin and the trend of injecting emerged in Edinburgh and Glasgow [10]. Preferences for buprenorphine, heroin and the concurrent use of heroin with benzodiazepines have all existed over certain time scales in the Strathclyde region. Usually, preferences are dictated by availability and cost. For example, initially buprenorphine and temazepam were favoured drugs as a result of widespread availability due to prescribing practices. Changes in legislation led to the availability of these drugs diminishing and the street value increasing. As a result, the popularity of heroin recovered and the scarcity of temazepam led to diazepam being used as a substitute.

During the decade 1983–1993, there has been a considerable expansion in the number and range of services available to drug users in Glasgow. The Glasgow drug problem service

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[1] Dextromoramide (palfium), diamorphine (heroin), dipipanone (diconal), hydrocodone (dimotane DC), hydromorphone, levorphanol (dromoran), methadone, morphine, opium, oxycodone, pethidine, phenazocine (narphen), piritramid (dipidolor) and unspecified opiates.

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was established in 1993, followed by the General Practitioner Drug Misuse Clinic Scheme in 1994 whose objective was to reduce drug related harm to health [11]. The Methadone Maintenance Programme (MMP) was introduced into Glasgow in October 1993 in order to wean addicts off heroin.

This paper reports on the trends and patterns of drug taking as found in the drug related deaths of Strathclyde. In particular, the effects of the MMP, legislation changes and periods of abstinence are discussed.

2. Methods

The Strathclyde police district encompasses a large portion of the southwest of Scotland with a population of approximately two and a quarter million. Any sudden, unexpected death or one with suspicious circumstances occurring within this region is reported to the appropriate Procurator Fiscal. Over the study period, 94% of Strathclyde drug related deaths were referred to the Department of Forensic Medicine and Science, University of Glasgow for post-mortem examination. The remaining 6% were examined by pathologists from hospitals within one of the four Strathclyde health board areas. Post-mortem toxicological samples obtained from all drug related deaths within the region are investigated at the Department of Forensic Medicine and Science Laboratory. For toxicological investigation, qualitative analyses is routinely carried out to detect the presence of alcohol, acidic drugs, basic drugs, benzodiazepines, opiates and methadone using immunoassay, gas liquid chromatography and high-pressure liquid chromatography. All positive samples are then confirmed and quantified by gas chromatography–mass spectrometry.

Data relating to age, sex, cause of death and results of toxicological analysis were obtained from the post-mortem and toxicology reports. Information on medical history and circumstances surrounding the death was extracted from the police sudden death report. For the purpose of this study, a drug related death was defined as a sudden or unexpected death:

- where illicit drugs were implicated as a cause of death either through circumstance or toxicology;
- as a result of long-term drug abuse;
- of a known drug abuser as a result of an overdose of non-illicit drugs;
- due to solvent abuse.

3. Results

3.1. Demographics

A total of 443 DRDs were identified over the study period, 360 (81%) involved males and 83 (19%) involved females. The average age of the subjects was 28 years (range 13–49 years). Although the number of deaths resulting annually remained relatively consistent at approximately 120 deaths, a decrease was recorded in 1997. The majority of deaths resulted from an overdose of illicit drugs (89%, $n = 395$). Known drug users who overdosed on non-illicit drugs, such anti-depressants and distalgesics accounted for 5% ($n = 24$) of deaths. Deaths due to the adverse effects of drug abuse such as septic shock syndrome and other complications of chronic intravenous drug abuse accounted for 3% ($n = 12$), a further 3% ($n = 12$) of deaths were due to solvent abuse (Fig. 1). The majority of subjects were unemployed (51%), employment status unknown in 42% and most had a history of drug abuse (97%, $n = 428$), of which 77% were known intravenous drug users.

3.2. Virology status

Virology results were obtained for 84% of all cases ($n = 370$) cases and are shown in Table 1. Hepatitis C was not routinely analysed for until the latter months of 1997, explaining the increase in hepatitis C positive cases in 1998. Only 2% ($n = 7$) of cases were shown to be HIV positive, which is in sharp contrast to the situation in Edinburgh [12].

3.3. Circumstances of death

Approximately four-fifths of subjects (82%, $n = 363$) were found dead within a dwelling abode, two-thirds (66%, $n = 239$) of which involved the deceased's own residence (house or hostel room). The various locations where the deceased was discovered are shown in Fig. 2. Only 4% ($n = 17$) of subjects died in hospital having been admitted for medical intervention. The remaining cases (14%, $n = 63$) were discovered in fairly public loci. It should be noted that, although found in a public place, the locus was, generally, inconspicuous. For example, the rear of a shop, cubicles within a public toilet or stairwell/common close within a block of flats. The location of death in each case was recorded using the postal code. The majority of deaths occurred within the city of Glasgow (65%, $n = 288$). Of these 17% ($n = 48$) occurred within the city centre and 26% ($n = 74$) in the north side of the city, notably Possilpark, Springburn, Milton and Ruchill, all of which are less affluent areas of Glasgow known locally to be areas of drug supply/abuse, high unemployment and social deprivation.

In just under one-third of cases over the study period (30%, $n = 133$), the deceased was seen to be intoxicated prior to falling asleep and later reported to be unrousable. In some cases, due to the intoxicated state of the individual, regular checks were made to establish that the deceased was still alive. Reports of the deceased "groaning", "grunting" and "gurgling" were not uncommon in these instances. In contrast, there were 122 cases (28%) which were considered to be sudden deaths, due to either a syringe being found in

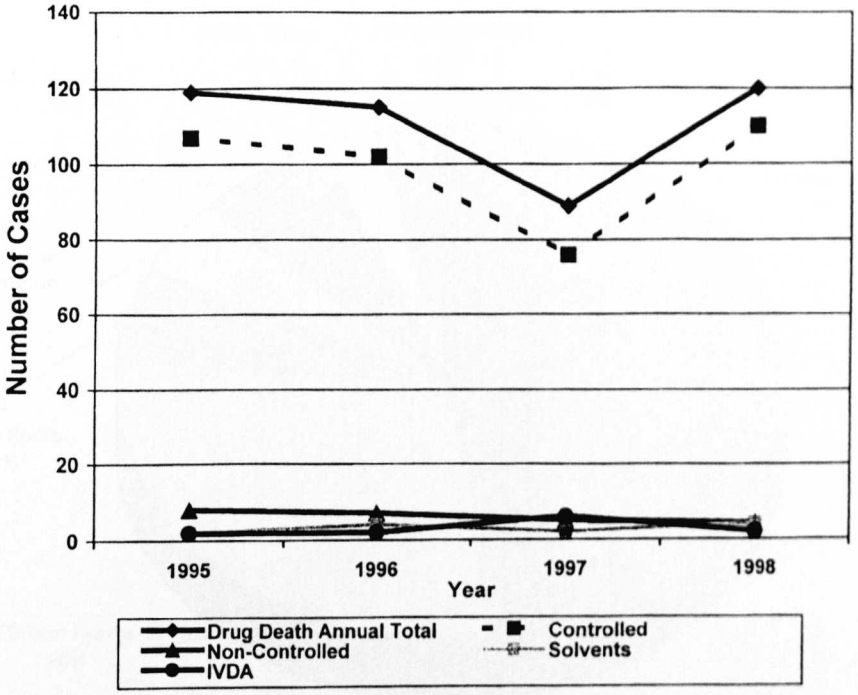

Fig. 1. Drug related deaths categorised on an annual basis according to the definition used for the purpose of this study (1995–1998).

situ (32 cases), needle and syringe still grasped in the deceased's hand (10 cases) or syringe found adjacent to or underneath the deceased's body (80 cases).

3.4. Toxicology

There were 10 cases where no toxicological analysis was carried out. This was due to the body being badly decomposed in three cases, making the procurement of a suitable sample infeasible. In a further seven cases, the deceased died in hospital after a period of survival and it was not possible to obtain the relevant admission blood samples. Toxicological analysis was carried out on 433 cases of which 429 (99%) tested positive for drugs. No drugs were detected in four cases. In two cases there was insufficient sample obtained to make a comprehensive analysis. Despite the absence of drugs, these cases were considered to be drug related due to circumstantial evidence such as the drug use history of the deceased, activities of the deceased prior to death and/or drug paraphernalia being located at the locus indicating recent drug administration.

Of the 429 drug positive cases, toxicological analysis revealed that mono-intoxication accounted for only 29% ($n = 124$) of cases over the study period and this was

Table 1
Virology results of 370 drug related deaths, 1995–1998

Results	1995	1996	1997	1998	Total
All negative	77	74	45	47	243
HIV positive	1	1	1	1	4
HIV positive/hepatitis C positive	0	1	0	1	2
HIV positive/hepatitis B uninterpretable	1	0	0	0	1
Hepatitis B positive	10	11	0	1	22
Hepatitis B uninterpretable	9	2	11	0	22
Hepatitis B positive/hepatitis C positive	1	2	0	1	4
Hepatitis C positive	2	0	10	46	58
Sample unsuitable for analysis	0	0	5	1	6
Results uninterpretable	2	6	0	0	8
No virology results	16	18	17	22	73
Total	119	115	89	120	443

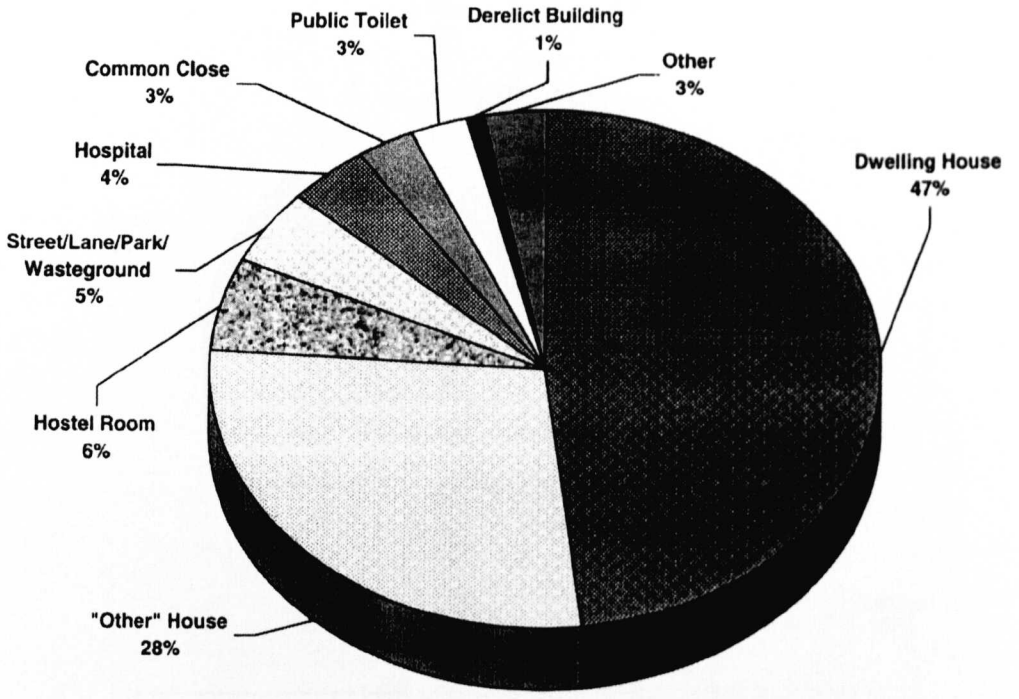

Fig. 2. Locus of body — place of discovery, 1995–1998.

primarily due to the consumption of morphine which in combination with the circumstances surrounding the death was indicative of heroin abuse. The presence of two or more drugs was found in 71% ($n = 305$) of cases. There were three cases where as many as six drugs (1%) were detected at autopsy (Fig. 3). As in similar studies in other countries [13–15], the drug of abuse most commonly encountered was morphine, which was identified in 281 (66%) drug positive samples. The prevalence of this drug increased from 59 to 75% of all drug positive samples between 1995 and 1998 (Fig. 4A). Diazepam (45%, $n = 191$) and temazepam (33%, $n = 143$) were the next most frequently encountered drugs. The prevalence of temazepam almost halved between 1995 and 1996 and again in 1997 (Fig. 4C). In 1998, however, temazepam related cases increased by 111%. In contrast, as temazepam positives decreased, there was an increased incidence of diazepam. Between 1995 and 1996 there was a 38% increase in diazepam numbers and a further 64% increase over the period 1997–1998 (Fig. 4D). Methadone was detected in 132 (31%) of all drug positive cases. Its incidence decreased by 47% between 1995 and 1997, and was at a similar level in 1998 (Fig. 4B). No medical history was obtained in 19 of these cases. Of the remaining 113 cases, methadone had been obtained by the diversion of legitimate supplies in 62 of the cases (55%). Cocaine, ecstasy and amphetamine were found to be present in 12 cases each. It should be noted that not one death involved the presence of buprenorphine over the study period.

From Table 2 it can be seen that the average concentrations of morphine, methadone and diazepam detected each year were all within the therapeutic range for tolerant individuals [16]. However, that of temazepam was consistent with concentrations associated with fatalities [16].

Alcohol was detected in 184 samples (43%), 160 in males and 24 in females. The concentrations found ranged from 5 to 462 mg/100 ml blood, approximately six times the legal driving limit (80 mg/100 ml) and a concentration associated with fatalities in most individuals. A BAC greater than 200 mg/100 ml blood was detected in just under one quarter of cases (23%, $n = 43$), a level that would result in severe intoxication in intolerant individuals. Medical history notes available for 33 (77%) of these cases revealed that the deceased had a known history of alcohol misuse in 73% ($n = 24$) of cases. Heroin was detected in just over two-thirds of alcohol positive cases (67%).

3.5. Recently released prisoners

Of the 443 drug deaths identified over the study period, 62 occurred in known drug users who had been released from prison within 1 month prior to their death. Cause of death was drug related in 61 cases with one case being certified as unascertained. Morphine (heroin) was implicated as a cause of death in 44 cases (72%). Fig. 5 shows that over half the cases (63%, $n = 39$) occurred within 1 week of release from prison, the majority of these deaths occurred either on the day of release (8%, $n = 3$) or the day following release (31%, $n = 12$).

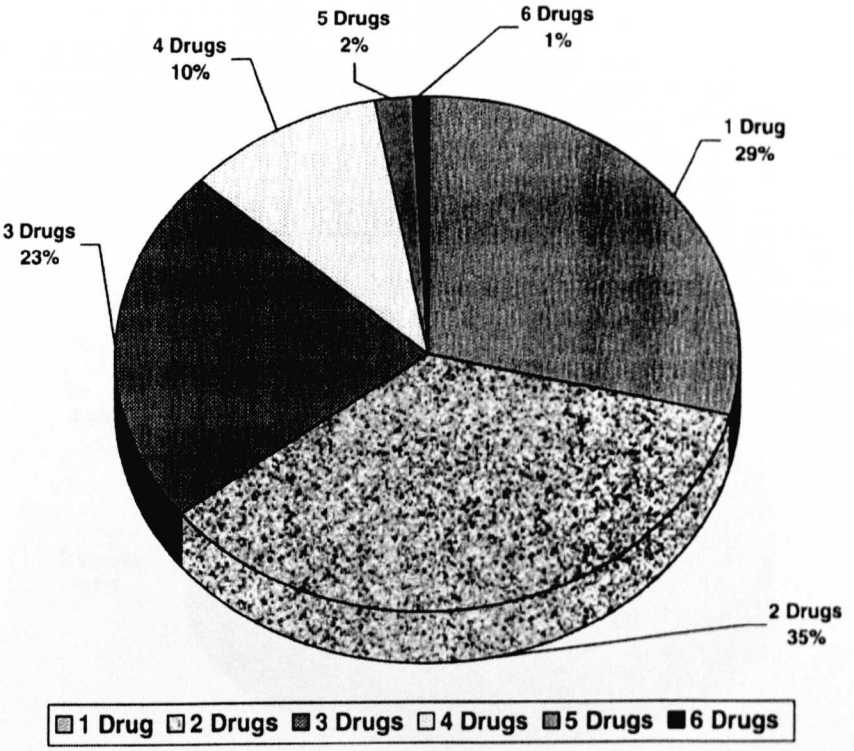

Fig. 3. Number of drugs detected in each drug positive case, 1995–1998.

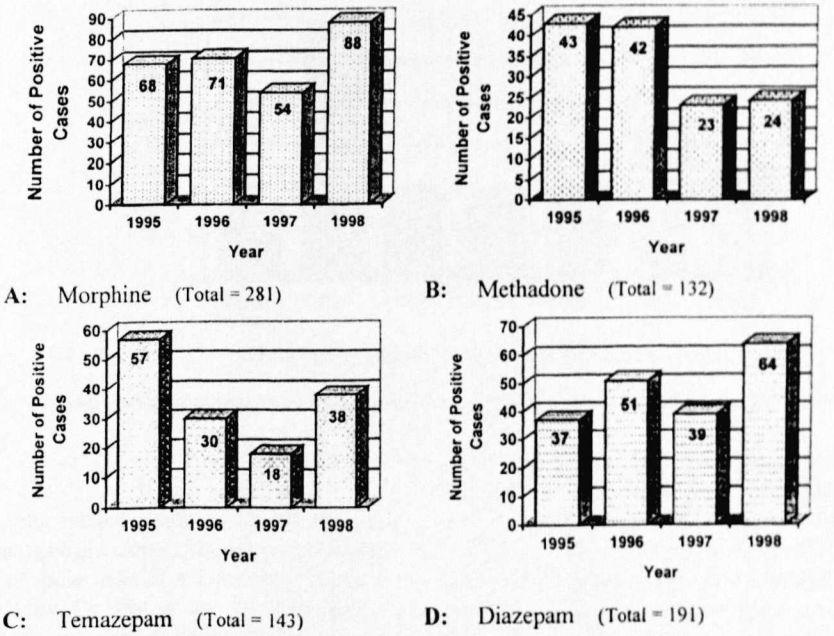

Fig. 4. Prevalence of morphine (A), methadone (B), temazepam (C) and diazepam (D) in positive blood samples, 1995–1998.

Table 2
Blood concentrations of opiates and benzodiazepines

Year	Morphine range (mg/l)	Methadone range (mg/l)	Temazepam range (mg/l)	Diazepam range (mg/l)
1995	0.45 (0.002–3.1)	0.6 (0.04–5.6)	2.1 (0.05–29.9)	0.37 (0.04–2.64)
1996	0.36 (0.015–1.16)	0.8 (0.013–4.59)	0.92 (0.02–4.23)	0.37 (0.031–1.6)
1997	0.25 (0.014–0.9)	0.55 (0.003–2.11)	0.85 (0.05–6.85)	0.45 (0.03–1.6)
1998	0.32 (0.025–1.26)	0.29 (0.05–0.96)	0.87 (0.03–9.2)	0.39 (0.06–1.76)

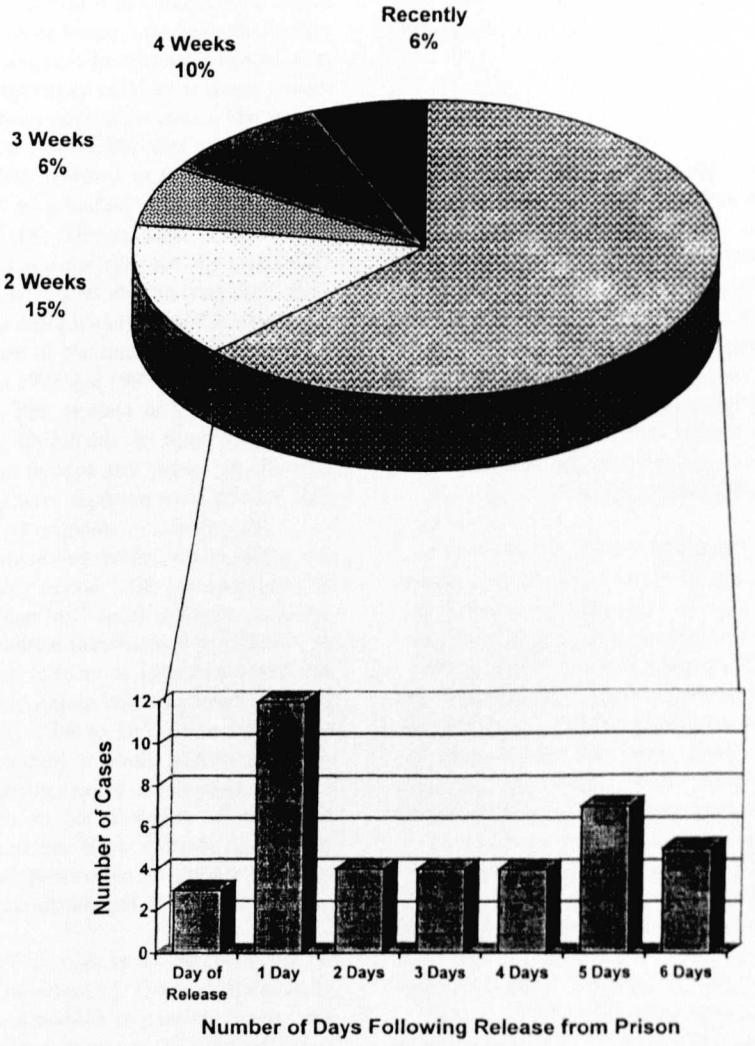

Fig. 5. Time period between release from prison and death in weeks (A) and days (B), 1995–1998.

4. Discussion

The number of drug related deaths in the Strathclyde region of Scotland has risen dramatically since the mid-1980s. The characteristics of those most at risk have not changed since first described by Cassidy et al. [9]. The deaths occurred predominantly in young unemployed males, aged between 20 and 30 years. With respect to the epidemiology of infectious diseases, the incidence of HIV was shown to be very low in the west of Scotland. The low frequency of HIV is attributable to the efficacy of needle and syringe exchange services which were established in Glasgow in 1993 enabling drug users access to sterile injecting equipment hence reducing the necessity for drug users to share [17]. However, the frequency of hepatitis C positive cases show that Glasgow and the surrounding area is by no means

void of blood borne infectious diseases and this disease remains a problem for the individual and society.

Whilst some deaths are obviously sudden, the circumstances surrounding a number of deaths suggest that had prompt medical attention been sought at the first indication of intoxication, death may possibly have been prevented.

Polydrug abuse was prevalent amongst this study sample with over two-thirds (71%) of all deaths testing positive for two or more drugs. Approximately two-thirds of the deaths were heroin related predominantly in combination with a benzodiazepine drug. As both heroin and benzodiazepines cause respiratory depression, co-administration results in an additive effect and the possibility of death is much greater than if either drug had been consumed alone. The benzodiazepine of choice in the early 1990s was temazepam. A legislation change in 1996 resulted in temazepam being moved from schedule 4 to schedule 3 of the Misuse of Drugs Regulations 1985 [18]. This resulted in tighter controls of its prescribing and as a consequence, the availability of temazepam decreased which resulted in drug users turning to the alternative and more widely available diazepam. This explains the decrease in the number of cases testing positive for temazepam in 1996 and 1997 and the increase in diazepam positive cases. The increase in temazepam positive cases in 1998 was attributable to illicit supplies of temazepam capsules that flooded the streets of Glasgow that year. These capsules were reported to be of very high quality and were known to originate in Europe [19].

The number of deaths involving methadone has decreased substantially over the study period. This is encouraging as the frequency of methadone implicated in deaths since the introduction of the methadone maintenance programme in Glasgow was initially seen to increase [20]. Since then, the number of methadone prescriptions issued in Strathclyde has risen from 76,391 in 1995–1996 to 123,166 in 1997–1998 [21]. Despite this, the decrease in deaths involving methadone demonstrates the effectiveness of increased supervision of dispensing in relation to the diversion of legitimate supplies of this drug onto the black market. At present, approximately 68% of all pharmacies in greater Glasgow provide supervision of the consumption of methadone on the premises [22].

In 1997 there was a 23% decrease in the number of deaths investigated. This figure increased by 35% to 120 deaths in 1998. Although there are a number of possible reasons for this, it was most likely due to a change in the purity of heroin in 1998. In 1997, the average purity of a street deal was reported to be between 15 and 30%. The purity increased to between 20 and 60% in 1998 to cater for a cohort of novice heroin users whose preferred method of administration was smoking. As a result, intravenous drug users were exposed to higher strength deals [19]. Many would inject their usual quantity of heroin unaware of its possible high and potentially lethal purity.

Alcohol was detected in approximately two-fifths (41%) of all deceased. On its own, the level of alcohol was insufficient to explain death in the majority of the cases. However, the additive effect with opiates and/or benzodiazepines increases the risk of overdosing.

As previously reported, a small proportion of deaths was shown to have resulted after recent release from a penal establishment [23]. The predominant drug involved in these deaths was heroin. In the majority of these deaths, the deceased overdosed within the first week of release, particularly on the day of release or day following release, highlighting the dangers of initiating old drug habits following a prolonged period of abstinence.

5. Conclusions

Drug deaths have significantly increased in the west of Scotland. This presents a challenge for the health and law enforcement agencies. Areas that require to be targeted include the availability of heroin and the illicit supply of all drugs, benzodiazepines and methadone in particular. Stricter controls on the latter within the Glasgow city area have resulted in a significant decrease in the cases involving methadone. However, bank holidays and closure of pharmacies on Sundays still remains a problem that is in need of address from the authorities. This study has highlighted that whilst a change in legislation may decrease the availability of one drug, it does not take long before it is merely replaced by another.

Individuals who have been recently liberated from prison remain a vulnerable cohort. The requirement for an improved prisoner through care regime is an area in need of assessment by the relevant authorities.

We have demonstrated a high incidence of hepatitis C in the fatalities investigated suggesting a possible major residual health problem for individuals who successfully manage to overcome their drug abuse. In view of this it is surprising to have such a low incidence of HIV when the figures are compared to those in the east of Scotland.

An education programme for relatives and friends of known drug users to highlight the basic techniques of first aid would be advantageous. This could include the placing of an individual in the recovery position whilst in a drugged state. An area to be addressed includes the necessity to summon medical assistance if the individual is unrousable.

Despite significant numbers and quantities of drug seizures in the west of Scotland by Strathclyde police, the drug problem in the west of Scotland, at present, shows no signs of subsiding.

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THE ROLE OF DIHYDROCODEINE IN CAUSING DEATH AMONG DRUG USERS IN THE WEST OF SCOTLAND

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Abstract: *There has been a wealth of information relating to the role of methadone in fatalities over the past decade. However, a dearth exists in the literature of deaths involving dihydrocodeine, a substitute that is being increasingly prescribed by general practitioners for drug harm reduction purposes. Over the past five years in the Strathclyde region of Scotland there has been an increase in the number of drug related deaths involving dihydrocodeine with the largest increase occurring in the latter two years. This in combination with a general acceptance for this drug as a substitute for methadone amongst general practitioners highlights its potential abuse factor which is addressed in this paper. As the number of methadone deaths in relation to the total number of accidental drug related deaths per annum decrease, those related to dihydrocodeine are shown to be increasing.*

Key words: Dihydrocodeine, drug-abuse, Strathclyde

Introduction

The increase in drug misuse in the United Kingdom over the past decade has resulted in an expansion of services for drug misusers. Consequently there has been an increase in substitute prescribing by general practitioners (GPs). Whilst methadone appears to be the most frequently prescribed substitute for the management of heroin misuse in Scotland,[1] the preference for dihydrocodeine (DHC) by a number of general practitioners is becoming evident.[2,3] This opioid analgesic, which is closely related to codeine, is primarily prescribed for the relief of moderate pain, especially for terminal cancer patients. Other indications include that of an antitussive drug, being effective at doses lower than those employed for analgesia and as an antidiaorrheal (one of the side effects of DHC being constipation). GPs who regard DHC as a safe alternative to methadone in detoxification programmes, may prescribe DHC to patients whose drug dependence is less severe than those in receipt of methadone. The acceptance of DHC by many GPs in the United Kingdom as a substitute is of some concern particularly since DHC is unlicensed for the management of drug dependence.[4]

There are a few reasons as to why DHC prescribing is preferred by some GPs over methadone in the management of harm reduction. A major factor is that DHC is perceived to be less addictive than methadone with the manufacturers reporting that it has a "low addiction potential".[5] The prescription policy associated with this Class B drug may seem more favourable to GPs in that several days supply can be dispensed at the one time. In addition, there is no need for patient follow up care or the administrative measures that are associated with methadone programmes.

Over the years, there has been a certain amount of unfavourable publicity surrounding methadone and its potential as a drug of abuse, particularly, in relation to the diversion of legitimate supplies.[6] As a result of an increase in black market methadone subsequent to the introduction of the methadone maintenance programme in Glasgow, the supervision of its consumption was enforced and is common practice in a substantial number of pharmacies in the Greater Glasgow area today.[7] The supervision of DHC is not considered to be necessary, mainly due to this being a near impossible task to implement due to multiple doses having to be consumed daily owing to its short half-life. DHC has been subject to virtually no media interest as a drug of misuse, despite, its abuse by drug addicts being widely reported.[2,5,8,9] Due to this potential for misuse, it has been noted that a DHC detoxification programme should be managed just as carefully as that of methadone.[4] The presence of this drug as a contributory factor in deaths from narcotic overdoses has also been reported in Germany.[10,11]

The purpose of this research was to ascertain the contribution of DHC in drug related deaths in the West of Scotland. Previous work showed that changing trends in drug taking had occurred over a number of years with the use of specific drugs being influenced by their availability and quality.[12-17] Data for the years 1995 - 1999 (in the Strathclyde region of Scotland) demonstrated an increasing use of DHC.

Material and methods

A retrospective search of all DHC positive cases investigated by the Department of Forensic Medicine and Science, over the five-year study period, 1995 - 1999 was carried out. Each case was classified according to the manner of death as either accidental or suicidal. The investigation of all accidental overdose deaths was instigated, the relevant information being obtained from police, post mortem and toxicology reports.

In Strathclyde, following a suspected drug related death, the Department of Forensic Medicine and Science is responsible to the Crown for the full forensic medical investigation of the death. On completion of a post mortem examination, all biological samples taken for toxicological purposes are routinely analysed for the presence of alcohol and drugs using immunoassay, gas liquid chromatography and high-pressure liquid chromatography. Positive results are confirmed and quantified by gas chromatography, mass spectrometry.

In all cases a full police report was available. This provided information pertaining to the extent of the individuals probable drug misuse and the identity of any medication that had been

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prescribed at the time of death as well as the sequence of events prior to the overdose.

Results

Over the five-year study period, 89 cases involving DHC were identified, increasing from 12 cases in 1995 to 42 cases in 1999. Males accounted for 80% (n = 71) and females, 20% (n = 18). Death as a result of an accidental drug intoxication accounted for 58% (n =51) of cases, followed by death due to suicide, homicide or natural causes (22%, n = 20). Only a small number of deaths were considered to be deliberate suicidal overdoses (20%, n = 18) (Table I). Of all 51 accidental overdose cases, there were only two cases that were not known drug users. In the remaining 49 cases the deceased had a history of drug abuse, 69% (n = 34) of whom were known to be intravenous drug injectors. The majority were male (86%, n = 42) and the average age was 27 years (15 -42 years). Most of the cases occurred over the two-year period, 1998 - 1999 (Figure 1).

Toxicological analysis revealed that no deaths involved DHC alone. The concurrent use of DHC and alcohol was detected in one case and polydrug use was evident in the remaining cases. The number of drugs detected in samples is summarised in Figure 2. It can be seen that approximately two thirds of samples (65%, n = 32) were found to contain three or four drugs. The most frequently detected drug was diazepam (80%, n = 39) followed by morphine (59%, n = 29), a breakdown product of heroin. Of all morphine positive cases, 83% (n = 24) were also found to contain at least one benzodiazepine. Morphine in combination with diazepam, temazepam or both accounted for 16, two and six cases respectively. All drug combinations are summarised in Table 2. The average blood concentration of DHC was 1.9mg/litre (Median: 0.7mg/litre, Range: 0.01 - 19.86mg/litre).

In just under two thirds of cases (65%, n = 32) DHC had been illicitly obtained. DHC had been prescribed to the deceased in only 12 cases (24%) and no medical history was included in the police sudden death report for the remaining five cases. Of those that had been prescribed the drug, 83% (n = 10) were intravenous drug users. Of those who had obtained the drug by diversion of legitimate supplies, 69% (n = 22) were known to be intravenous drug users. From the police report it was ascertained that in one case involving illicit DHC the deceased was attempting self-rehabilitation.

When interpreting the results of the toxicological investigation both the pathologist and toxicologist have to consider the individuals tolerance and past history of exposure to the drugs detected as well as the concentration of drug measured. The provisional cause of death is amended to incorporate those drugs that were considered to cause/contribute to death.

Of all 49 cases, DHC was implicated in the cause of death either alone or in combination with other drugs in 11 cases (22%) and eight cases (16%) respectively. Of these cases, the vast majority had occurred in the latter two years. A cause of death involving DHC alone accounted for one case and eight cases in 1998 and 1999 respectively and a cause of death involving other drugs for two and five cases respectively.

The authors then reviewed the cases and divided the deaths into three categories depending on the history of the case, drugs detected and concentration of drugs. Death where DHC was considered the sole factor in causing death irrespective of other drugs present were classified as "DHC only" deaths. "DHC related" deaths were those where the concurrent use of DHC and other drugs resulted in death and finally cases where a drug other than DHC was attributed to death were classed as "non DHC related".

Table I
Breakdown of dihydrocodeine posotive cases

Dihydrocodeine posotive cases (n = 89)	
Suicidal overdose	18
Suicide/homicide/Natural causes	20
Accidental overdose	51

Fig.1: Accidental overdoses of known drug users involving dihydrocodeine 1995-1999

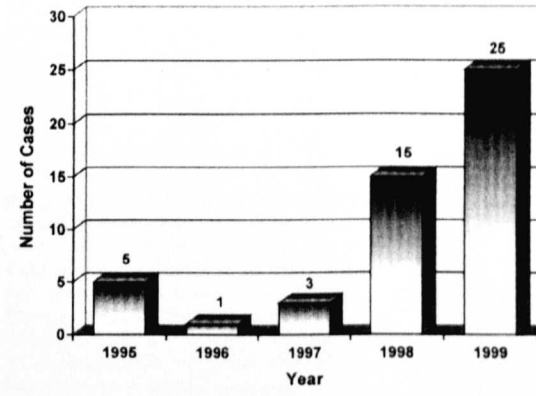


Fig.2: Number of drugs detected per sample

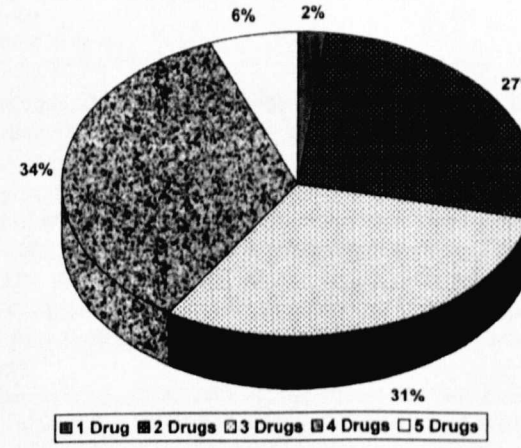


Fig.3: Number of prescriptions by Health Board area

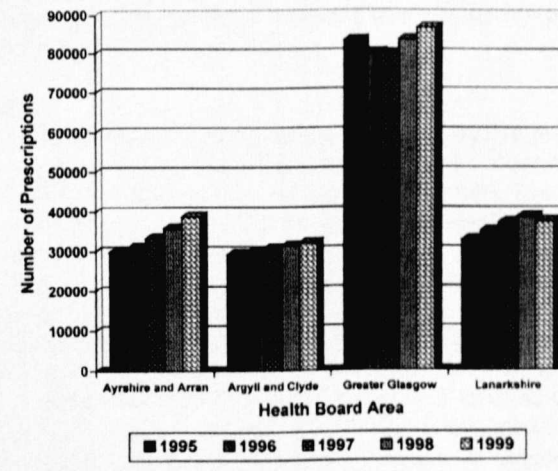


Fig.4: Number of oral tablet formulations prescribed

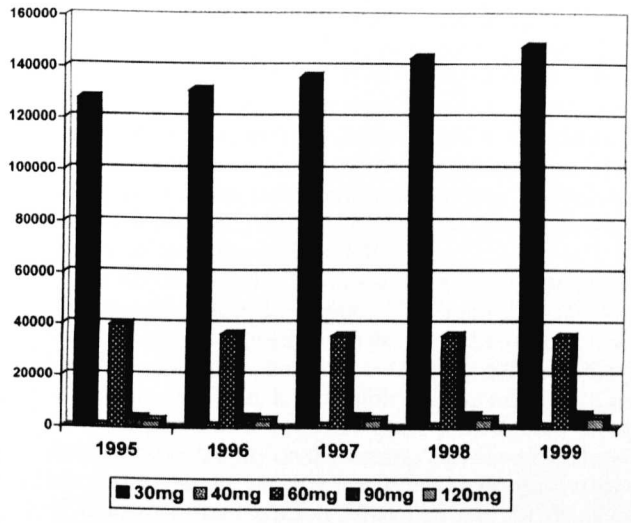
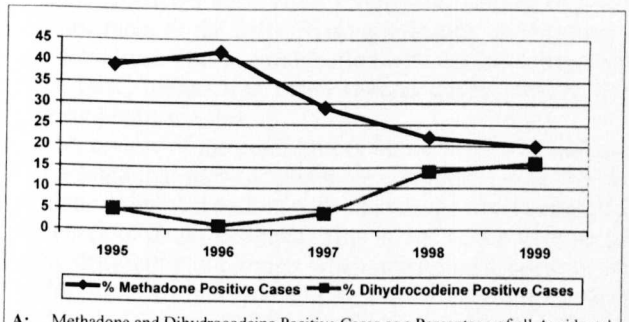
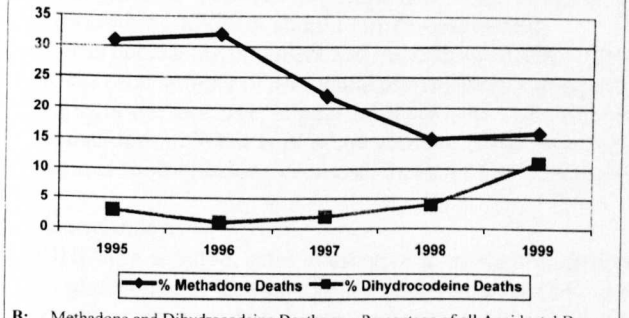


Fig.5: Dihydrocodeine versus methadone



A: Methadone and Dihydrocodeine Positive Cases as a Percentage of all Accidental Drug Related Deaths per Annum



B: Methadone and Dihydrocodeine Deaths as a Percentage of all Accidental Drug Related Deaths per Annum

The results revealed that over half of cases were either classed as DHC only (22%, n = 11) or DHC related (35%, n = 17). Alcohol was found to be present in 19 cases (39%). The average blood alcohol concentration (BAC) measured was 110mg/ 100ml (Median: 69mg/100ml, Range: 5-400mg/100ml). In over one half of these alcohol positive cases (63%, n = 12), morphine was also detected, 42% (n = 5) of which were also found to contain benzodiazepines.

DHC is available in the United Kingdom in oral and parenteral (50mg/ml injection) formulations. The oral preparations include an elixir syrup (10mg/5ml) and tablets of varying strengths (30mg, 40mg, 60mg, 90mg and 120mg). The 60mg - 120mg tablets are controlled release formulations allowing one tablet to be swallowed every twelve hours. Figure 3 shows that the majority

Table II
List of drugs detected in samples

No of drugs	Combination of drugs	No of cases
1	Dihydrocodeine (1*)	1
The following relate to dihydrocodeine plus:		
2	Fluoxetine	1
	Methadone (1*)	1
	Diazepam (3*)	8
	Morphine (2*)	3
3	Morphine+methadone (1*)	1
	Morphine+diazepam (3*)	10
	Morphine+temazepam (1*)	1
	Diazepam+temazepam	1
	Diazepam+diphenhydramine (1*)	1
	Diazepam+Fluoxetine	1
4	Morphine+diazepam+temazepam (2*)	6
	Morphine+diazepam+chlordiazepoxide	2
	Morphine+diazepam+cannabis	1
	Morphine+diazepam+methadone (1*)	2
	Morphine+temazepam+cannabis (1*)	1
	Morphine+methadone+cocaine (1*)	1
	Diazepam+methadone+co-proxamol (1*)	2
	Diazepam+methadone+temazepam	1
	Diazepam+temazepam+warfarin	1
5	Morphine+diazepam+cannabis+paracetamol	1
	Diazepam+methadone+cyclizine+prothiaden	1
	Diazepam+amitriptyline+diconal+nortriptyline	1
	Total	**49**

* *Alcohol detected*

of prescriptions dispensed within the Strathclyde area occurred in the Greater Glasgow region. There was an overall 11% increase in the number of prescriptions dispensed between 1995 and 1999. Figure 4 illustrates that the formulation of choice appeared to be that of the 30mg tablet which accounted for three-quarters (75%, n = 687,736) of all DHC formulations prescribed. This was followed by the 60mg tablet (20%, n = 183,746), the 90 and 120mg tablet (each 2%). The 40mg tablet, the elixir syrup and injection preparations jointly comprised 1% of the total amount prescribed.[18]

DHC positive cases and DHC deaths (those deaths classified as DHC alone and DHC related) were compared with all methadone positive cases and methadone deaths as a percentage of all accidental drug related deaths over the study period. Figures 5A and B shows that on a year to year basis, the frequency of methadone positive cases and methadone deaths have been decreasing in contrast to those involving DHC which were shown to increase.

Discussion

In addition to heroin and benzodiazepines, the role of DHC as a significant drug of misuse has been detected in the West of Scotland. Over the latter two years of this study, there was a significant increase in the number of drug related death cases testing positive for this drug.

Over the past decade patterns of drug taking as seen in drug deaths have varied depending on drug availability, changes in legislation and the quality of the drug. For example, the rescheduling of temazepam in 1996 from schedule 4 of the Misuse of Drugs Regulations 1985 to schedule 3 resulted in diminished availability of this drug[19] and consequently diazepam emerged as its substitute in the heroin-benzodiazepine cocktail favoured by the Strathclyde drug misuser.[20]

It has been speculated that dihydrodocodeine is used during periods of heroin deficit either due to personal circumstances or a lack of availability of street heroin.[9] However, this study revealed that DHC had been taken in combination with heroin

in over half of all cases. Of all heroin positive cases, 90% were known to be intravenous drug users.

Similar to all drug related deaths in the West of Scotland, the presence of a cocktail of drugs presents a problem. DHC like other narcotics, interacts with other drugs to depress the central nervous system and consequently leads to acute respiratory depression and respiratory failure. This is recognised at post mortem by the presence of pulmonary congestion and oedema which is often the only significant autopsy finding in a drug related death. It should also be noted that the depressant effects of alcohol are enhanced by DHC.

The majority of DHC in this study had been obtained by the diversion of legitimate supplies. This is similar to findings of a study investigating methadone deaths in the same region where black market methadone accounted for the majority of the methadone involved. It is possible that the increased quantities of DHC prescribed over the study period have resulted in increased availability on the streets. This in turn makes DHC a low cost analgesic, which presently can be bought, on the streets of Glasgow for between 50 pence and £1.00 (Personal communication with Strathclyde Police Drug Squad). The pharmacokinetics of the most frequently prescribed 30mg DHC tablet render a supervised programme almost impossible to implement as the half-life is significantly shorter than that of methadone. This in combination with the fast acting properties of DHC means that often several doses have to be taken throughout the day.

A review of the contributory factor that DHC had in deaths revealed that more deaths were considered to be due to DHC alone or in combination with other drugs when compared to the causes of death assigned. This is due to the varying practice by different pathologists when amending a cause of death in that some will include all drugs detected going on the theory that they have an additive effect on each other. However, in other cases, a drug that is detected at low levels may simply be disregarded. This review highlights that DHC as a drug contributing to death should not be overlooked.

The decreasing prevalence of methadone deaths with respect to the total number of accidental drug related deaths per annum reflects the positive impact of increased supervision of its consumption. What is of some concern is the fact that as the figures for methadone decrease, those for DHC increase.

Conclusion

DHC as a suitable, safer alternative to methadone prescribing is questionable. The increasing prevalence of DHC detected amongst drug related deaths and the consequent conclusion that it has attributed to death, particularly over the past two years has been highlighted. The present situation reveals that the initial problems encountered with methadone dispensing, such as diverted methadone, has been resolved and is reflected in the decreasing numbers of methadone deaths per annum. However, an increase in DHC prescribing has resulted in an increase in DHC related deaths possibly due to this drug being more readily available and inexpensive to buy on the streets. Whilst in some aspects, DHC may appear to be a good alternative to that of methadone, its abuse potential should not be overlooked. The incidence of DHC detected in cases is a matter of concern and requires monitoring to establish if this is a "real trend" or "fashionable phase".

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LETTERS

Note to authors of letters: Letters submitted for publication should not exceed 400 words. All letters are subject to editing and may be shortened. Letters should be sent to the *BJGP* office by e-mail in the first instance, addressed to **journal@rcgp.org.uk** (please include your postal address). Alternatively, they may be sent by post (please use double spacing and, if possible, include a MS Word or plain text version on an IBM PC-formatted disk). We regret that we cannot notify authors regarding publication.

Asymptomatic peripheral arterial occlusive disease and erection problems

We would like to report the association between peripheral arterial occlusive disease (PAOD) and perceived erection problems found in the Limburg PAOD study.[1]

Intermittent claudication (IC), the first symptomatic stage of PAOD, is a common atherosclerotic condition among mostly elderly subjects. However, the majority of PAOD cases are asymptomatic.[1] Symptomatic PAOD is associated with organic impotence, particularly when the occlusion involves the aortoiliac vascular bed.[2] Data on the prevalence of erectile impairment in asymptomatic PAOD subjects are non-existent.

Our study population consisted of 3649 male subjects (47%) with a mean age of 59 years (range = 40 to 78 years), who were selected out of a group of 26 620 subjects from 18 general practice centres by means of a stratified sampling procedure. Strata were formed on the basis of the number of positive answers on a short postal screening questionnaire, concerning complaints on walking and cardiovascular risk.[1] PAOD was defined as an ankle–brachial pressure index (ABPI) <0.95, measured twice in the same leg with a one-week interval. The ABPI was calculated as the ratio of ankle systolic blood pressure to the highest arm systolic blood pressure, using a Doppler device. Reproducibility and diagnostic accuracy of Doppler ABPI measurements have been shown to be adequate.[3,4] IC was assessed according to a modified version of the Rose questionnaire.[1,5] Asymptomatic PAOD was defined as an ABPI <0.95 without IC complaints. In addition, data were collected on experienced erection problems, smoking habits, hypertension, diabetes, and hypercholesterolaemia.[1]

Among male asymptomatic PAOD subjects, 44% (66 out of 150) reported erection problems compared with 25% (358 out of 1405) among male subjects without PAOD. For claudicants, this number was 47% (41 out of 87).

Logistic regression analysis showed that experienced erection problems were significantly associated with asymptomatic PAOD (odds ratio = 1.6, 95% confidence interval 1.1–2.4), as well as with symptomatic PAOD (odds ratio = 1.6, 95% confidence interval 1.2–2.9), adjusted for higher age, smoking, diabetes, hypercholesterolaemia, and hypertension.

Our findings are consistent with the notion that subclinical atherosclerosis of the aorta and distal arteries (aortoiliac, penile, and testicular arteries) may result in penile ischaemia. In case of a patient complaining of erection problems, the general practitioner could perform a vascular physical examination including ABPI measurements and assessment of atherosclerotic risk factors. Positive findings raise the possibility of organic impotence. Conversely, in male subjects with asymptomatic or symptomatic PAOD, attention could be paid to the possible presence of erection problems.

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Dihydrocodeine — drug of use or misuse?

An increase in drug misuse in the United Kingdom has resulted in an increase in substitute prescribing by GPs. While methadone appears to be the most frequently prescribed substitute for the management of heroin misuse in Scotland,[1] there is evidence of a growing preference for dihydrocodeine (DHC) by general practitioners (GPs).[2,3] GPs, who regard DHC as a safe alternative to methadone, may prescribe DHC to patients whose drug dependence is considered to be less severe than those in receipt of methadone. Another factor affecting their choice is the perception that DHC is less addictive than methadone.[4] In addition, the prescription policy associated with this Class B drug may seem more favourable in that several days supply can be dispensed at the one time without supervision. There is no need for patient follow-up care or the administrative measures that are associated with methadone programmes.

The deaths we investigated revealed that over the years 1998 to 1999, there was an increase in the number of drug-related deaths involving primarily illicitly obtained dihydrocodeine and this is in contrast to a decline in deaths involving methadone. Dihydrocodeine-positive cases have risen from 4% of all accidental drug overdose cases in 1997 to 15% between 1998 and 1999. There was an observed decline in methadone-related

deaths, from 29% to 21%, over the same time period. Polydrug use was prevalent, with the most frequently detected drug being diazepam (80%) which was followed by morphine (59%), a breakdown product of heroin. Of all morphine-positive cases, 83% were also found to contain at least one benzodiazepine, making for a potentially lethal combination leading to acute respiratory depression and respiratory failure.

It can be speculated that an increase in DHC prescribing over the study period has resulted in increased availability on the streets. This, in turn, makes DHC a low cost analgesic which presently can be purchased on the streets of Glasgow for between 50 pence and £1.00 (personal communication, Strathclyde Police, 2000). Its use during periods of heroin deficit has been highlighted[5] and confirmed during the spate of contaminated heroin deaths in Glasgow during the year 2000 (personal communication, Glasgow Drug Problem Service, 2000).

While in some aspects, DHC may appear to be a good alternative to that of methadone, its abuse potential should not be overlooked. The incidence of DHC detected in cases is a matter of concern and requires monitoring to establish if this is a 'real trend' or 'fashionable phase'.

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A comparison between patient consultation satisfaction scores from a trainer and registrar in a Nottinghamshire practice

Patients' agendas are often not fully addressed during the consultation.[1] This may lead to low levels of patient satisfaction with consultations, poor compliance, and poor outcome.[2] With experience, general practitioners (GPs) may be expected to become more adept at addressing these patient agendas and general practice registrars may be expected to demonstrate a lower level of patient satisfaction than their trainers.

We measured patient satisfaction with their consultations with a general practice registrar and trainer in a rural Nottinghamshire practice in 1996, using the Consultation Satisfaction Questionnaire (CSQ, Eli Lilly National Clinical Audit Centre).[3] The practice had six-and-one-half partners and a list size of 12 000. A personal list system was not used, although patients were encouraged to see the same doctor for a single episode. The registrar was in the third training month and the trainer was a principal with over 10 years' experience.

The criteria were defined with reference to a large study of CSQ results in 126 GPs.[4] The CSQ has four sub-scales and the audit standards were defined as an 80% general satisfaction with the quality of consultations, 82% with professional care, 73% with depth of relationship, and 72% with perceived time.

Consecutive adult patients and younger patients accompanied by adults were asked to complete the CSQ immediately after their consultation until 75 questionnaires were available for each doctor, and to give freetext comments.

The trainer and trainee differed significantly only in respect of general satisfaction (Table 1). However, the range of satisfaction scores was greater for the trainee. These findings suggest that patients may not discriminate between doctors on the basis of clinical skill. Instead, they may value characteristics such as empathy, the ability to listen, and an appreciation of their point of view. The free text comments suggested that longer consultations and shorter waiting times were important to patients.

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Table 1. CSQ satisfaction scores for the GP trainer and GP registrar compared with the audit standard (standard deviation in brackets).

	Mean score for GP registrar (%)	Mean score for GP trainer (%)	Student's t-test/ANOVA *P*-value (trainer/trainee comparison)
General satisfaction	75.6 (16.9)	82.2 (13.5)	0.022
Professional care	79.6 (13.6)	79.3 (10.5)	0.910
Depth of relationship	63.6 (15.5)	68.7 (13.9)	0.072
Perceived time	66.5 (20.2)	71.1 (17.0)	0.180

Natural history of lower respiratory tract illness

Holmes *et al*[1] present pertinent observational data on the prolonged natural history of lower respiratory tract illness (LRTi) in the community, with or without antibiotic treatment, an important message for all general practitioners (GPs). The paper and the accompanying editorial[2] assume that antibiotics are inappropriate for many patients presenting in this way, although both recognise the dif-

Recent contact with health and social services by drug misusers in Glasgow who died of a fatal overdose in 1999

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ABSTRACT

Aim To explore the recent contact with health and social services by drug misusers who died of a fatal overdose and identify opportunities for preventive intervention.

Design Retrospective case analysis.

Subjects Eighty-seven residents of the Greater Glasgow area who died of a drug misuse-related overdose in 1999.

Methods Analysis of matched data from several sources: Strathclyde Police; University of Glasgow Department of Forensic Medicine and Science; the Scottish Prison Service; general practitioners' medical notes, including records of accident and emergency attendances and psychiatric assessments; and five specialist agencies for drug misusers or the homeless.

Findings Most of those who died of an overdose were males, long-standing heroin injectors and resident in a deprived area. Heroin caused most deaths, either alone or with other drugs. Twenty-three per cent died within 2 weeks of release from prison. For the 77 whose medical records were available, 90% had seen their general practitioner (32% in the month before death), 48% had attended accident and emergency services and 22% had received a psychiatric assessment in the year before death. Over 40% of the 87 used a drug agency in the year before death and 20% had used more than one agency.

Conclusions Previous suicidal ideation, attempted suicide and depression were common among those who died of an overdose, as was recent release from prison. Almost all had been in contact with and several were receiving specific treatment from health or specialist addiction services in their last weeks or months. The findings highlight both the numerous opportunities for intervention and the challenge of using them to prevent death.

KEYWORDS Drug misuse, fatal overdose, mental health, service use.

INTRODUCTION

Deaths due to drug-misuse related overdose are on the rise in many countries (ACMD 1998). Increases have been noted in Australia (Hall & Darke 1998; Hall *et al.* 2000), continental Europe (Risser & Schneider 1994; Davoli *et al.* 1997; Seidler *et al.* 2000), the United Kingdom (Hall *et al.* 2000; Neeleman & Farrell 1997) and the United States (CDC 2000). A recent report from the UK Advisory Council on the Misuse of Drugs concluded that health and social services could play a role in reducing drug misuse-related deaths by engaging more actively with vulnerable individuals (ACMD 2000).

Studies of both fatal and non-fatal overdoses have provided information about the correlates and circumstances of drug overdoses. Most fatal overdoses occur among men with a long history of heroin misuse (Darke & Zador 1996; Hall & Darke 1998; Risser *et al.* 2000) who tend to be unemployed (Cassidy *et al.* 1995) or socially deprived (ACMD 2000). Fatal overdoses are often the result of drug interactions, particularly heroin in combination with alcohol or benzodiazepines (Davoli

et al. 1993; Hammersley *et al.* 1995; Darke & Zador 1996; Gossop *et al.* 1996; Zador *et al.* 1996; Frischer *et al.* 1997; Hall & Darke 1998; Powis *et al.* 1999; White & Irvine 1999; Risser *et al.* 2000; Zador & Sunjic 2000; Seymour *et al.* 2001). There is an increased risk of overdose when tolerance is reduced after a period of abstinence, such as those recently discharged from treatment or released from prison (Davoli *et al.* 1993; Darke, Ross & Hall 1996; Strang *et al.* 1996; Groenemeyer 1997; McGregor *et al.* 1998; Seaman *et al.* 1998; Zanis & Woody 1998; Seymour *et al.* 2000). However, little is known about the use of general medical or specialist services in the year before death. In this paper, we describe the residents of an urban area with a high prevalence of drug misuse who died of a drug-related overdose in 1999 and their use of services in the year before their death. We then consider the potential for the involvement of these and other services in preventing further deaths.

METHODS

With the consent of the Regional Procurator Fiscal (the prosecuting authority in Scotland), Strathclyde Police provided demographic information on all 87 sudden deaths among drug misusers in the Greater Glasgow area in 1999 where the cause of death was found to be a drug overdose. These were defined as deaths with 'prima facie evidence of a fatal overdose of controlled drugs. Such evidence would be recent drug misuse, for example, controlled drugs and or a hypodermic syringe found in close proximity to the body and/or the person is known to the police as a drug misuser, although not necessarily a notified addict' (Ministerial Drugs Task Force 1994). The overdose must have been of an apparently accidental nature without evidence of suicidal intent. All pathological and toxicological investigations to establish a cause of death and the drugs implicated were carried out by the University of Glasgow Department of Forensic Medicine and Science. Information on recent imprisonment was obtained from the Scottish Prison Service.

Carstairs deprivation categories (Carstairs & Morris 1991) were assigned to the postcodes of residence of the deceased. The Carstairs index is a summary measure of relative deprivation or affluence applied to populations contained within small geographical areas. These are ranked using a combination of socio-economic variables from the 1991 census (percentage of households with no car ownership, male unemployment, overcrowding and social class IV and V). Scores from 1 (most affluent) to 7 (most deprived) are then produced for each postcode sector.

The names and dates of birth of the 87 individuals were used to obtain general practitioners' medical records for 77 (89%) cases. Ten records were unavailable because they were subject to legal proceedings or the individual had recently moved to Greater Glasgow and had not yet registered with a general practitioner in the area. Psychiatric diagnoses and attendances at accident and emergency departments were all verified by a letter from the service in the medical records.

Names and dates of birth were also used to match the deaths with five databases held by agencies providing services in Glasgow: Glasgow City Council Social Work Addiction Services, who manage most of the community drug services in the city; the Glasgow GP Drug Misuse Clinic Scheme, a shared-care scheme enabling general practitioners to prescribe methadone to opiate-dependent patients; the Glasgow Drug Problem Service, a specialist medically led service assessing and treating opiate dependent patients referred by general practitioners; the Glasgow Drug Crisis Centre, a 24-hour service that provides assessments, needle exchange, in-patient residential treatment, out-patient methadone treatment and referrals; and the Hamish Allan Centre, a 'one-door' 24-hour emergency service for all homeless individuals and families in Glasgow. Contact information was obtained from each of the five agencies for the 12 months before death.

RESULTS

Most of the 87 Glasgow residents who died of a drug-related overdose were single (80%), unemployed (94%) and male (83%), with a mean age of 29 years; 83% lived in deprived areas with a Carstairs deprivation score of either 6 or 7 and 29% had been homeless at some time in the year before death.

Sixty-nine per cent died in a private home—their own (26%), a friend's (25%) or a relative's (18%). Fifteen per cent died in a hostel and 11% died in a public place, such as a hotel (3%), public toilet (5%) or on the streets or in a disused building (4%). Five per cent died in a hospital or on their way to a hospital. Over a third (36%) died alone, but most died in the presence of other people, who were either in the house but not the same room (34%) or in the same room (25%). In only 16% of cases did those present say they were aware that there was a potential problem. In only five cases was an ambulance called while the deceased was still alive, and in one of these the person was dead when the ambulance arrived.

Almost half (49%) had been in prison in the year before death. Nine per cent died within a week of leaving prison and another 14% died within 2 weeks of being released. Only four individuals (5%) had been in residential rehabilitation in the year before death and half of those died within 10 days of release.

The route of administration of the drug(s) was recorded for 74 of the 87 deaths. Of these, the drugs had been taken by injection in 72%, orally in 16%, smoked in 3%, snorted in 3% and by unknown means in 7%. Figure 1 shows the drugs considered by the pathologist to have played a part in causing death. A single drug was implicated in 53% of the deaths and more than one in 43%. Four cases were unascertained. Heroin was implicated in 74% of deaths, either alone (37%) or in combination with other drugs (37%). Diazepam (28%) and temazepam (17%) were frequently involved. Alcohol and methadone were each implicated in nine deaths (10%).

Recorded contacts with general practitioners, accident and emergency (A&E) departments, psychiatric services and specialist services for the treatment of drug misuse and dependence are presented in Table 1. All recorded attendances at A&E departments, psychiatric services and specialist services and those in the last year are shown, the latter as an indicator of the extent of serious health problems and service contacts leading up to the death. Over 90% of the deceased had seen their general practitioner at least once in the year before death and almost 60% more than six times. Thirty-two per cent had been seen within a month of their death. In the year before death, 48% had gone to an A&E department at least once, most often for an assault or overdose. Over half had ever attended for an assault and a quarter after attempted suicide. Twenty-two per cent had been assessed by a psychiatrist in the previous year and 45% ever. Suicidal ideation, depression and anxiety-related disorder were the most common psychiatric diagnoses. Those assessed by a psychiatrist in the year before death were much more likely than the others to have attended an accident and emergency department for a drug overdose in the past year (44% and 17%, respectively). Twenty-seven per cent of all cases had received drug counselling and 38% had been prescribed substitute drugs in the previous year, of which the most common was methadone. Six per cent had seen their GP in the month before death for a prescription of substitute drugs.

Over 40% of those who died of a drug overdose in 1999 had used at least one of the four specialist drug agencies in the year before death (Table 2). Twenty-three per cent used only one service, while 14% and 6% had used two or at least three drug services, respectively. A higher proportion of women had used services than men (73% versus 36%). The Glasgow City Council Social Work Services were used most by both men and women, followed by the Drug Crisis Centre. Only 2% had been in contact with a service in the month before death.

The overlap between use of drug services, accident and emergency departments and psychiatrists in the year before death is shown in Fig. 2. Three-quarters of those who had had a psychiatric assessment in the year had also used other services. Half of those using specialist drug services had also attended accident and emergency departments. Five people had used all three types of service.

DISCUSSION

The majority of the deceased in this study were similar to those described in previous studies of fatal drug misuse-related overdose: experienced heroin users, usually men in their 20s or 30s who were resident in socially deprived

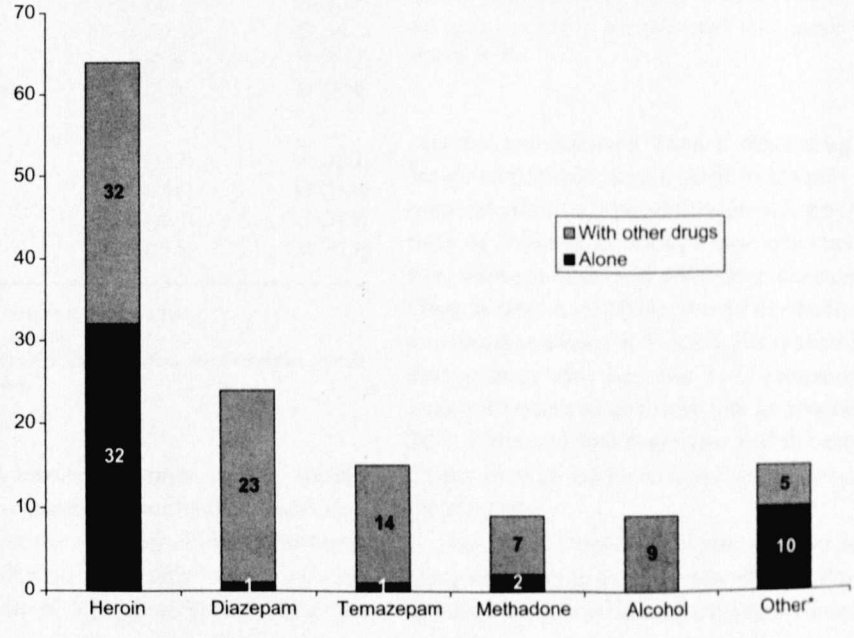

Figure 1 Drugs implicated in 87 fatal drug misuse-related overdoses in Glasgow in 1999 (total exceeds 87 as many deaths were due to more than one drug). *Other drugs include dihydrocodeine, ecstasy, cocaine, gamma hydroxybutyrate, chloral hydrate, DMD, and amitryptyline.

Table 1 Drug-related medical histories of 77 Glasgow residents who died of a drug-misuse-related overdose in 1999.

	Number (valid %)	
No. of GP visits in year before death		
0	7 (9)	
1–5	26 (35)	
6–15	23 (31)	
>15	19 (28)	
missing	2	
Time between death and last GP visit		
<1 week	13 (17)	
1 week–1 month	11 (15)	
>1 and <3 months	15 (20)	
3–6 months	17 (23)	
6–12 months	12 (16)	
>1 year	7 (9)	
missing	2	
	Year before death	**Ever**
A&E attendances[a]		
All	37 (48)	59 (77)
Assaults	17 (23)	41 (53)
Suicide attempts	7 (9)	20 (26)
Drug overdoses[b]	17 (22)	29 (38)
Injection-related problems[c]	11 (15)	22 (29)
Psychiatric diagnoses[a]		
All	17 (22)	35 (46)
Suicidal ideation	8 (10)	13 (17)
Depression	7 (9)	15 (20)
Anxiety-related disorders	8 (10)	14 (18)
Schizophrenic-related disorders	4 (5)	4 (5)
Personality disorders	4 (5)	6 (8)
History of abuse	2 (3)	6 (8)
Drug counselling or treatment[a]		
All	27 (35.1)	51 (66.2)
Counselling	21 (27.3)	39 (50.6)
Detoxification	1 (1.3)	9 (11.7)
Residential rehabilitation	4 (5.2)	16 (20.8)
Drug replacement[a]		
All	29 (37.7)	58 (75.3)
Methadone	22 (28.6)	43 (55.8)
Dihydrocodeine	8 (10.4)	21 (27.3)
Benzodiazepines	15 (19.5)	33 (42.9)

[a]Patients may be included in more than one category.
[b]Does not include suicide attempts.
[c]Injection-related problems include abscesses, deep vein thrombosis, cellulitis and needles broken off in skin.

areas. Heroin was involved in most deaths, usually injected and often in combination with other drugs. Most died at home, often in the company of others. However, the police reports indicated that in only 16% of cases was anyone present aware of a potential problem once the overdose had occurred. Thus, if other drug users, their family and friends were trained to identify the signs of overdose and offer intervention, drug deaths could potentially be reduced. In 2000, it was estimated that there were between 6000 and 8600 drug injectors in Greater Glasgow (Hay *et al.* 2001). The 87 deaths thus represent an annual incidence of 1–1.5%. The male to female ratio among those who died was 5 : 1, compared with 2 : 1 among Greater Glasgow injectors in general (Hay *et al.* 2001). The overdose death rate and the excess of male deaths are both similar to those reported in other studies (ACMD 2000).

One of the limitations of this study is the lack of a comparison group to determine whether those who died attended services or received treatment more or less often

Table 2 Number of drug agencies contacted in the year before death by Glasgow residents who died of drug misuse-related overdose in 1999.

	Male	*Female*	*Total*
Number of services			
None	46 (64%)	4 (27%)	50 (58%)
One	16 (22%)	4 (27%)	20 (23%)
Two	7 (10%)	5 (33%)	12 (14%)
Three or more	3 (4%)	2 (13%)	5 (6%)
Type of service			
Specialist social work services	14 (19%)	6 (40%)	20 (23%)
GP drug misuse clinic scheme	4 (6%)	4 (27%)	8 (9%)
Drug problem service	9 (13%)	4 (27%)	13 (15%)
Drug crisis centre	12 (17%)	7 (47%)	19 (22%)

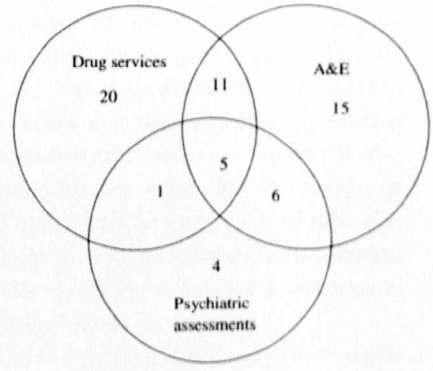

Figure 2 Number of individuals attending drug services, accident and emergency (A&E) departments and psychiatric services in the year before death. *Twenty-five of the 87 who died from a drug overdose in 1999 do not appear on this diagram. For 10, records were not available for A&E and psychiatric assessments, therefore this may be an undercount. Fifteen of the 87 (17%) had not attended a drug service, A&E or received a psychiatric assessment in the year before death.

than those who did not fatally overdose. However, it was beyond the scope of the study to obtain relevant information from a representative community-based sample of living drug misusers, which could be the subject of future research. We were also aware of the variable quality of the medical notes and service databases. It is highly likely that some service contacts were not recorded; therefore, our data represents the minimum number. We also did not have access to certain categories of information, such as the circumstances of previous overdoses.

Despite these limitations, our study offers new insights into the extent of contact by the deceased with services in the weeks and months before death. We found that almost all the 77 individuals with available medical records had seen their general practitioner in the year before death, often on numerous occasions. Many had attended an accident and emergency department in the past year, most often following an assault or overdose. Over 20% had been seen by a psychiatrist in the previous year who typically diagnosed suicidal ideation, depression or anxiety disorder. As we only recorded diagnoses verified by a mental health professional, the true prevalence of mental disorder is likely to be greater. Those assessed by a psychiatrist in the previous year were also more likely to have had a non-fatal overdose during the same period. The depression and suicidal ideation and the large number of recorded previous suicide attempts make it unlikely that all the deaths were entirely accidental. In a recent study in two cities in Scotland, suicidal intent was expressed by about half of those who had overdosed but survived and was associated with a history of mental health problems (Neale 2000). Therefore, drug users expressing suicidal ideation should be seen as at a particularly high risk of death from overdose.

Contact with specialist drug services was also common. Over 40% had used at least one of four specialist drug agencies in the year before death and 20% more than one. Drug counselling had been given to at least 50% ever and 25% within the previous year. Substitute prescribing was common, with over 75% receiving a prescribed opiate or a benzodiazepine at some time and almost 40% in the past year.

Despite all these contacts with helping services, the individuals in this study died. Could their deaths have been prevented? We do not know enough about the circumstances of the deceased and the type and quality of the services they received to be certain. However, we would agree with the UK Advisory Council on the Misuse of Drugs (2000) that careful risk assessment should always be carried out by specialist drug services and intensive support given, whenever appropriate. That should include simple and accurate information about overdose risk and how to recognize and respond to the danger signs in others (Strang *et al.* 1999). General practitioners can play a major role in treating drug misusers themselves and coordinating care with specialist services (Gruer *et al.* 1997; Hutchison *et al.* 2000). A&E departments clearly often see drug users in crisis and thus have an opportunity to provide help. Enabling them to do so represents a major training challenge. Coexisting drug dependence and other mental health disorders can be a very complex combination. Do we have enough staff with the expertise to perform an adequate assessment and offer the most appropriate treatment? A specialist 'comorbidity team' was established in Glasgow in 2000 to begin to fill this gap.

A loss of drug tolerance was a probable contributing factor in at least 25% of the deaths. Twenty people died within 2 weeks of release from prison and two within 10 days of leaving residential rehabilitation. The Scottish Prison Service has recently recognized this problem and has implemented new strategies designed to help reduce drug deaths. These include providing known drug users with pre-release information about the risks of overdose and arranging for continued support to be provided by community drug services after release. However, it is too early to say how widely and effectively this approach is being implemented across the prison service. In particular, drug misusers who are remanded in custody or released at short notice may be more likely to miss out. Managers of services providing residential rehabilitation also need to be aware of the risks of loss of tolerance and advise their departing clients accordingly.

In conclusion, this study has shown that, in Glasgow in 1999, the weeks and months before drug misusers died of an overdose were often characterized by numerous contacts with services. The overall picture that emerges is largely one of disturbed people leading chaotic lives who die despite the help they may have received. This underlines the difficulties in preventing death, but also highlights the opportunities that may exist for effective help to be given.

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Death by Obstruction

Sudden Death Resulting from Impromptu Ingestion of Drugs

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Over an 18-month period, the department of Forensic Medicine and Science at the University of Glasgow investigated four rather unusual drug-related deaths. In all cases, death was due to the obstruction of the airway by a foreign body after an attempt to evade arrest. In all cases, the obstruction was drug packages of various shapes and sizes. Results of toxicology revealed levels of drugs that may have had a significant respiratory effect on the deceased in three of the cases. Rupturing of the packages and hence leakage of drugs being conducive to death was obvious in only one case.
Key Words: Drug death—Choking—Obstruction—Foreign body.

Choking on a foreign body is not an uncommon cause of sudden death and has been well documented among young children (1–3). In these cases, the aspirated object is usually a small toy, a balloon, or sweets. In addition, accidental aspiration of poorly masticated food is well recognized (4). This article reports four cases involving drug users who died as a result of obstruction of the airway by a foreign body. In these instances, the blockage was caused by packages of illicit drugs. The practice of swallowing drugs or concealing them in body cavities to avoid detection by law enforcement agencies is not new (5–9). The use of drug couriers—also known as body-packers, higher angels, and mules—presents a problem for both law enforcement and customs and excise authorities. Whereas the concealment of drugs in this manner conjures up an image of a contrabander involved in the trafficking of illegal drugs over national or international boundaries, the cases described here involved drug users who attempted to quickly conceal their drugs during an approach by police. Such individuals have also been referred to as mini-packers (7). The circumstances of death and the pathologic and toxicologic findings in the deaths of four mini-packers investigated over an 18-month period are described.

MATERIALS AND METHODS

After a sudden unexpected death, a police report is compiled and submitted to the Procurator Fiscal (whose service provides Scotland's independent public prosecution and death investigation service), who in turn instructs a forensic pathologist to investigate the death and conclude the cause of death.

Between August 1998 and March 2000, four deaths of known drug users were investigated wherein death was caused by obstruction of the airways by a foreign body. The findings are reported here.

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CASE REPORTS

Case 1

In 1998, a 31-year-old man was in a friend's house abusing illegal drugs. The police arrived at the flat in relation to an unconnected inquiry. Having seen the police, the deceased ran into another room and was seen to stuff something into his mouth. Thereafter the police attempted unsuccessfully to persuade him to spit it out. After a struggle, the deceased was handcuffed but collapsed shortly after. He was witnessed to be choking, and he was released from his handcuffs. Resuscitation was commenced, and an ambulance was summoned.

On the arrival of the paramedics, the deceased was in cardiorespiratory arrest. On attempting to insert an airway, the paramedics identified a blockage in the deceased's airway: a white powdery substance at the top of the larynx. An endotracheal intubation was performed. He was taken to hospital but was found to be dead on arrival.

At postmortem examination, scattered fine petechial hemorrhages were present in the conjunctivae, inside the mouth, and on the eyelids. There were a few small superficial abrasions on the neck, consistent with resuscitation attempts, and minor blunt force injuries in keeping with the described scenario, which included the use of handcuffs. A foreign body was identified at the tracheal bifurcation, which was obstructing the airway. The foreign body was a crumpled mass of plastic-like material containing a brown paste. It formed a Y shape, molding to the configuration of the tracheal bifurcation. From its end to the top of its bifurcation, the stem of the Y was 4.5 cm long and ≤2 cm wide. It divided into two branches, one measuring 4 cm × ≤1.4 cm and the other 3.5 cm × ≤1.5 cm (Fig. 1).

The results of toxicologic analysis, as shown in Table 1, revealed the presence of significant levels of morphine, Valium, and metabolites. The low level of codeine was indicative of the use of heroin rather than morphine. The levels measured, on their own, were consistent with those in fatalities from the concurrent use of valium and heroin. The contents of the package were analyzed and were found to contain heroin, noscapine, papaverine, and acetyl codeine.

The cause of death was determined to be asphyxia due to impaction of foreign body in the trachea.

Case 2

In 1999, a 20-year-old woman had been arrested for shoplifting. She was being searched in police custody when she attempted to swallow a plastic bag, which had been partly concealed in her underwear. During this procedure, the bag was observed to burst open, emitting some powder. Shortly afterward, the woman began to choke and became unable to breathe. She bit a police officer who went to her assistance. Police attempted resuscitation and summoned an ambulance.

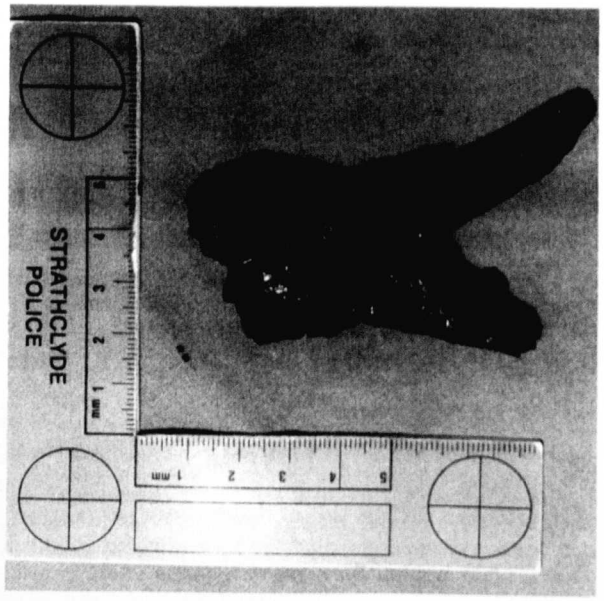

FIG. 1. Y-shaped foreign body obstructing the tracheal bifurcation.

On the arrival of the ambulance technicians approximately 9 minutes later, she was cyanotic and pulseless. Attempts to clear her airway with a hand-held aspirator resulted in an effusion of white fluid from the airway. An oropharyngeal airway was inserted, and cardiopulmonary resuscitation was attempted; however, it was thought that the airway was blocked and that no air was entering the lungs. Life was pronounced extinct at the locus.

At postmortem examination, no petechial hemorrhages were identified. The decedent's face and neck had minor abrasions consistent with resuscitation, and scattered bruises were seen on her arms and wrists, related to the restraint including handcuffs. A foreign body was present at the back of the mouth extending down to the upper trachea. The foreign body, a crumpled, folded material resembling cling film, measured 10 cm × 1.1 cm × 1 cm and contained a white semisolid pastelike material.

TABLE 1. *Results of toxicologic analysis of blood samples (mg/litre)*

	Case 1	Case 2	Case 3	Case 4
Morphine	0.44	0.09	0.1	ND
Diazepam	0.87	ND	0.6	0.1
Desmethyldiazepam	0.35	ND	0.7	1.1
Temazepam	0.72	5.61	ND	0.1
Codeine	0.05	0.03	0.1	ND
Cocaine	ND	ND	ND	0.1
Benzoylecgonine	ND	ND	ND	7.5
Methylecgonine	ND	ND	ND	1.4
Propoxyphene	ND	ND	ND	trace

ND, not detected.

Toxicology

The results of toxicologic examination are shown in Table 1. The levels of morphine and codeine detected were consistent with the use of street heroin. A significant level of temazepam could have had a considerable respiratory depressant effect on the deceased. This high level could have been due to the rupture of the package. Analysis of the white powder confirmed the substance to be temazepam.

The cause of death was established as choking due to impaction of foreign body in the larynx and a contributing factor was temazepam intoxication.

Case 3

In 1999, a 36-year-old man was known to be a drug abuser and dealer, with a history of swallowing/concealing drugs in his mouth. While police were searching his room, the man became agitated, and he was handcuffed. Shortly afterward he collapsed. The handcuffs were removed, he was placed in the recovery position, and an ambulance was summoned.

Cardiopulmonary resuscitation was administered, and the man was conveyed to the hospital. En route, the paramedic discovered a foreign body in the air passages and removed it with the aid of a laryngoscope. The man was pronounced dead on arrival at the hospital.

At postmortem examination, a few tiny petechiae were identified in the mouth. The decedent had several minor blunt force injuries, which had not contributed to his death. There was superficial bruising of tongue and congestion and petechiae in the larynx, just below the vocal cords. The foreign body had been removed during resuscitation. It was a crumpled piece of plastic-type material measuring 8.5 cm × 5 cm × 0.5 cm and contained a lump of soft brown material.

Toxicologic analysis showed the presence of morphine, codeine, diazepam, and metabolite. These drugs were evidence of the use of heroin and valium. The soft brown material was not made available for analysis.

The cause of death was determined to be obstruction of the air passages by foreign body.

Case 4

In 2000, during the execution of a search warrant, a 46-year-old man was witnessed to force something into his mouth and to put his face into the bed in an effort to prevent its retrieval. A struggle ensued, during which time, because the man refused to spit out the contents of his mouth, he was handcuffed. An ambulance was summoned. Shortly afterward the man became pale and appeared to be losing consciousness. He was placed in the recovery position, and his handcuffs were removed.

Paramedics commenced resuscitation efforts, during which time two packages were removed from the man's upper airways; however, other packages could be seen below this and could not be retrieved. A doctor arrived, and after further attempts at resuscitation and the administration of an opiate antagonist, life was pronounced extinct at the locus.

At postmortem examination, the face and neck were congested, with a few fine petechiae of the conjunctivae. The only significant injuries were a few minor scratches on the lower part of the face, consistent with resuscita-

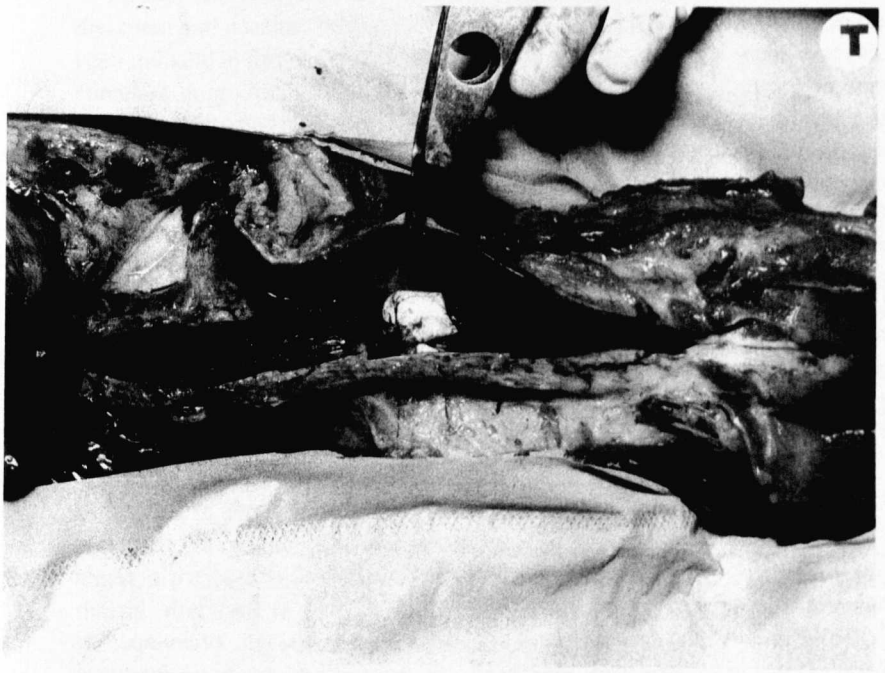

FIG. 2. Two packages present within the lower trachea.

FIG. 3. Eighteen packages found within the esophagus.

tion, and bruising and abrasions to both wrists resulting from the struggle while handcuffs were applied.

Two packages made of material resembling cling film, at least one of which contained a white substance, completely occluded the lower part of the trachea, the lower one extending into the right main bronchus (Fig. 2). The esophagus was filled from the level of the thyroid cartilage to the stomach by 18 similar packages (Fig. 3). A further 8 packages were retrieved from the stomach.

Toxicologic analysis confirmed the concurrent use of diazepam and cocaine. Respiratory depression would have been unlikely in this case, particularly because cocaine is a stimulant drug. Analysis of the contents of the retrieved packages identified cocaine. The blood levels, however, gave evidence of the use of cocaine before the packages were swallowed, particularly because the concentrations of the metabolites were significant.

The cause of death was determined to be choking on a foreign body.

DISCUSSION

During an 18-month period, four known drug users died in the west of Scotland as a result of the unpremeditated ingestion of drugs. In each case the deceased was attempting to avoid detection of the drugs because of the proximity of police. The deceased was witnessed to ingest a package in three cases, and choking followed shortly afterward in two of these cases. Collapse was subsequent to ingestion in all cases. This initiated the summoning of an ambulance. Resuscitation was attempted in all cases; however, life was pronounced extinct either at the locus or on arrival at the hospital (two cases each). The recovery of all obstructions at the locus was accomplished in only one case (Case 3); in the remaining cases it was not possible to reach the obstruction before death. In Case 1, endotracheal intubation resulted in the package being pushed further down the air passages, below the tip of the tube.

In addition to the potential dangers of drug toxicity resulting from the rupture of packaging, the issue of airway obstruction by the package itself has been previously reported (10–12). This article has highlighted cases wherein sudden death occurred after the deliberate, impromptu ingestion of drug packages in individuals who were attempting to evade arrest. In all cases collapse was very rapid. We can only emphasize that in such cases medical intervention should be sought immediately and efforts to clear the individual's airway initiated. However, it is also important to emphasize that resuscitation attempts may carry a significant infection risk to police officers and other staff, especially if the individual is already struggling in an arrest situation. When known drug users are being confronted, the possibility that they will swallow a drug package must always be considered.

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The role of methadone in drug-related deaths in the west of Scotland

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ABSTRACT

Aims To determine the incidence of methadone as either the principal cause of death or as a contributing factor in drug related deaths in the Strathclyde Police region of Scotland and to assess the impact of supervised consumption of methadone on the number of deaths that occurred within each health board area within this region.

Design Retrospective analysis of records held within the Department of Forensic Medicine and Science based at the University of Glasgow over the 11-year period 1991–2001.

Setting The Strathclyde Police region of Scotland (population approximately 2.25 million).

Findings In 1991, there was one death recorded which was attributable to methadone. Following the introduction of the methadone maintenance programme (MMP) in Glasgow during 1994, there was a 100% increase in these deaths compared to the previous year, a trend which continued over the subsequent 2 years. Following a confidential enquiry into these deaths and a greater compliance from pharmacies supervising methadone consumption, deaths involving methadone had decreased by 48% in 1997. This was particularly evident in the Greater Glasgow Health Board Area, where methadone prescribing has continued to rise annually. However, some difficulties still exist. Multiple take home doses are sometimes prescribed when a pharmacy is closed, which may lead to inadvertent overdose or facilitate diversion of legitimate supplies. In addition, continued use of heroin was found in approximately one-fifth of MMP patients, suggesting possible underdosing.

Conclusions A growing prevalence of heroin misuse has resulted in an increase in the number of individuals entering the MMP. Despite a continuing increase in the amount of methadone prescribed, methadone deaths in Strathclyde have decreased since 1996 due possibly to changes in both prescribing and clinical care. With efficient management to establish that the patient is complying with the guidelines of the programme and has stopped heroin misuse, methadone can be a safe drug for substitution therapy.

KEYWORDS Drug deaths, methadone, Strathclyde.

INTRODUCTION

Heroin addiction has acquired the proportions of an international epidemic. The associated premature mortality caused by the overdose of opiates has been reported previously in Europe [1–3], Australia [4–6] and the United States [7,8]. The United Kingdom is no exception [9,10]. Illicit heroin appeared in Scotland in the early

1980s [11] and since then illegal drug use has become widespread. In response to this problem, various stratagems have been devised to reduce the damage caused to opiate users. These include needle exchanges and substitute prescribing. Presently in the United Kingdom, the standard substitute drug of choice is methadone [12–15] and there are reported to be approximately 26 000 opiate addicts in MMPs in the United Kingdom, comprising almost one-fifth of all known opiate addicts [14]. The benefits of this drug are well documented and as well as reducing illicit drug use [16,17] and mortality rates [13], a reduction in the level of criminal activity among opiate drug users [14,18] has also been reported. In addition, this substitute drug appears to be more effective at keeping drug users in contact with health services compared with other interventions [19]. In the early 1990s, it became evident to the small group of Glasgow general practitioners (GPs) who were prescribing methadone that it would be beneficial for drug misusers to attend clinics designed specifically for their care [20]. As a result, in 1994 both the Glasgow Drug Problem Service (GDPS) and a GP Drug Misuse Clinic Scheme were created to reduce drug-related harm to health and 'promote better management of drug injectors in general practice through a system of shared care' [21]. In addition to the shared care between staff in the GDPS and in general practice, community pharmacists were recruited to supervise the consumption of daily doses of methadone. In early 1994, approximately one-fifth of all Glasgow community pharmacies had become involved [22] and this has increased to approximately two-thirds today [23]. In 1996, 99% of all methadone that had been prescribed by the GDPS involved supervised daily dispensing [21], a figure that remains unchanged [24].

The number of methadone prescriptions dispensed in the Strathclyde police region increased approximately 11-fold over the 10-year period 1992–2001 (personal communication, Primary Care Information Unit, Information and Statistics Division, NHS in Scotland) with the majority of this methadone being dispensed in the Greater Glasgow Health board area. The proportion of methadone prescriptions dispensed in the Greater Glasgow area compared with the whole of Strathclyde increased from 63% in 1992 to 77% in 1995 and then decreased from 69% in 1996 to 54% in 2001 (personal communication, Primary Care Information Unit, Information and Statistics Division, NHS in Scotland). These figures suggest that although confined initially to the Greater Glasgow area, the establishment of methadone maintenance in the rest of the Strathclyde area has increased over the latter years.

Initially, the increase in prescribed methadone was accompanied by an escalation in methadone-related deaths which was subject to much public and media attention. Consequently, in 1996 the GDPS co-ordinated a confidential enquiry into methadone-related deaths in Glasgow in order to assess the medical care provided by the clinicians who prescribed methadone [25]. It reported in 1999 and showed that medical services might have been deficient in 56% of the methadone deaths. Possible failures in clinical care were identified in 69% of cases and included, for example, prescribing too low or too high a dose of methadone or failing to examine a patient for continuing drug misuse. The response from the prescribing doctors was very positive, with 93% 'definitely' intending to change their future management of drug misusers. In order to disseminate the findings of this enquiry a booklet outlining the guidelines for safe methadone prescribing was distributed to all GPs in the Greater Glasgow area [26]. A separate study in 1999 revealed that the increase in methadone-related deaths in the Strathclyde region coincided with the introduction of the methadone maintenance programme (MMP) in Glasgow [27]. It was also revealed that illegal diversion of legitimate supplies of methadone was found to account for the majority of deaths and in addition it was noted that many deaths might have been prevented had the signs of intoxication been identified and immediate medical assistance sought.

This paper studies deaths involving methadone which occurred in the Strathclyde Police region of Scotland over the 11-year study period, 1991–2001, and investigates changes in death rates subsequent to improved prescribing and clinical care procedures.

MATERIALS AND METHODS

The Strathclyde Police region encompasses a large proportion of the South-west of Scotland and has a population of approximately 2.25 million [28]. There are four health board areas that fall within the boundaries of this geographical region. The population and estimated number of problem drug users for 2000 within each of these health board areas are outlined in Table 1.

Current policy is that following a suspected drug-related death, a report is submitted to the Procurator Fiscal who in turn instructs a post-mortem examination. On its completion, biological specimens are submitted for full toxicological analysis and histopathological examination.

All methadone-positive cases in 1991–2001 were identified from the records held at the Department of Forensic Medicine and Science, University of Glasgow. Information regarding circumstances of the death was obtained from the police report which includes the medical history of the deceased, the sequence of events leading up to the death and any recent custodial sentences that may have been incurred. Once identified, the relevant cases were classified as 'methadone only' deaths,

	Approximate population [28]	*Estimated number of problem drug users [29]*	%
Greater Glasgow	900 000	15 975	2%
Lanarkshire	560 000	5076	1%
Argyll and Clyde	420 000	5405	1%
Ayrshire and Arran	370 000	3058	1%

Table 1 Approximate populations and estimated numbers of problem drug users in each health board area in the Strathclyde Police region, 2000.

'methadone-related' deaths or 'not methadone-related' deaths in accordance with a previous study [27] and depending on the primary cause of death.

RESULTS

Over the 11-year study period, methadone was detected in 352 sudden, unexpected deaths in the west of Scotland. Of these, 270 cases (77%) were considered to be associated directly with the toxic effects of drugs either alone or in combination with alcohol. In the majority of cases, the deceased was male (79%, $n = 213$) and the average age was 27 years (range 15–58 years). A history of drug abuse was noted in 262 cases (97%); approximately two-thirds were known intravenous drug users (68%, $n = 178$).

The drug-related methadone-positive cases ($n = 270$) were then divided into one of three groups depending on the cause of death. Methadone in combination with other drugs accounted for 140 deaths (52%). Fifty-six or approximately one-fifth of deaths (21%) resulted from the effects of methadone alone. In a further 74 deaths (27%), although methadone was found to be present it was not considered to be at a high enough concentration to have caused or contributed to the death. In these 74 cases the interpretation of toxicological findings and the conclusion that methadone was not implicated in the death was stated by the pathologist on completion of all post-mortem investigations and having taken due notice of previous medical history. It is recognized that there is an overlap between therapeutic and fatal methadone concentrations [14]; however, interpretation of levels is also based on circumstantial evidence, such as witness statements, provided in the police sudden death report.

Because this report aims to study drug-related deaths where methadone was a cause of death either alone or as a contributory factor in combination with other drugs, all information that follows will focus on those deaths which were classed as methadone-only or methadone-related deaths. Collectively, these two subgroups will be referred to as 'methadone deaths' ($n = 196$).

Over the study period, there has been an overall increase in the number of drug-related deaths occurring in the Strathclyde Police region. Figure 1 shows that the number of methadone-positive cases increased in a similar fashion to all drug-related deaths in the years 1991–96. Following 1997, when methadone-positive cases decreased by almost one-half, all drug-related deaths continued to increase substantially from 1998 onwards; however, the number of methadone-positive cases and 'methadone deaths' remained relatively stable over the last 5 years of the study.

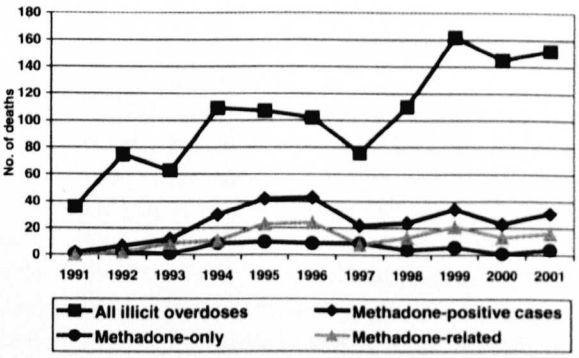

Figure 1 Methadone-positive cases and methadone deaths, 1991–2001

Just over one-half of all methadone deaths occurred within the Greater Glasgow Health Board Area (55%, $n = 108$), representing seven deaths per 1000 population of estimated problem drug users in this area [29]. The corresponding figures for Ayrshire and Arran, Argyll and Clyde and Lanarkshire were 21% ($n = 41$), 16% ($n = 32$) and 8% ($n = 15$) of methadone deaths, respectively. These figures correspond to 13 deaths, six deaths and three deaths per 1000 population within each health board area, respectively.

The medical history section of the police sudden death report was used to ascertain whether or not the deceased was enrolled on an MMP. This was not available in 14 cases. Of the remaining 182 cases, 103 (57%) appeared to have used methadone which had been obtained illegally.

The exact number of patients enrolled on a MMP within each health board area at any one time was unobtainable, but the following estimate was made in order to calculate the death rate. On the assumption that the average prescription for methadone is 50 mg per day, a patient

Table 2 Methadone death rates 1991–2001.

Year	*Estimated number of MMP patients*	*Number of MMP deaths*	*MMP death rate*
1991	unknown	1	unknown
1992	304	0	0.00%
1993	676	4	0.59%
1994	1512	9	0.60%
1995	2246	14	0.62%
1996	2815	13	0.46%
1997	3645	4	0.11%
1998	4252	10	0.24%
1999	4714	11	0.23%
2000	5519	7	0.13%
2001	6896	6	0.09%

will receive 18 250 mg per annum (50 mg × 365 days). Consequently, from the knowledge of the amount of methadone prescribed in each health board area (personal communication, Primary Care Information Unit, Information and Statistics Division, NHS in Scotland), it is possible to attain an indication of the number of patients in receipt of a methadone prescription.

Table 2 shows that, for individuals on an MMP, the methadone death rate fell sharply after 1996 and remained low thereafter. Following the distribution of the guidelines and changes in methadone dispensing there was a 0.38% absolute reduction in summary death rates from 0.53% per person-year to 0.15% per person-year. The numbers of methadone deaths for individuals not on an MMP decreased slightly from 54 deaths during the period 1991–96 to 49 deaths during the period 1997–2001. This was despite a threefold increase in the amount of methadone being made available via the MMP. For 2001, Glasgow had a lower methadone death rate among individuals on an MMP than the three other health board areas (0.07% compared to 0.13%, 0.1% and 0.13%). In general, rates were low, indicating a good safety profile of the MMP. A similar pattern was seen for those not on an MMP where Greater Glasgow had three deaths compared with a total of 11 from the three other health board areas (Lanarkshire: two deaths, Argyll and Clyde: three deaths, Ayrshire and Arran: six deaths). This was despite nearly twice as much methadone being prescribed in Glasgow via the MMP.

Over half the cases ($n = 107$, 55%) occurred over a weekend, Friday–Sunday, with 80 deaths occurring on Saturday or Sunday. Of these 107 cases, 46% were enrolled on an MMP, which compares to 34% of deaths that occurred on a weekday. Despite this, there was no significant evidence of an association between the timing of the death (weekend or weekday) and MMP status (Fisher's exact test, $P = 0.13$; 14 individuals whose MMP status was unknown were excluded).

Multiple doses to take home (e.g. due to pharmacy closure) were known to be prescribed in 21 cases and ranged from a single extra dose to 1 month's supply. In the majority of cases (55%, $n = 11$) this was due to the forthcoming Sunday and/or Bank Holiday closure of the pharmacy. In the remaining cases, the dispensing of multiple doses had been the decision of the general practitioner. In a further two cases, while there was no mention of multiple prescribing in the police report, the deceased was found to be in possession of two bottles of methadone prior to death in one case and an empty 200 ml bottle was found at the locus in the other case.

Each case was classified according to when the death occurred in relation to drug consumption. In 13 cases (7%) involving heroin, death was immediate because a needle and syringe were present with the body. In 36 (18%) cases the mode of death was undetermined as the deceased had been found dead at the locus and had not been seen for a prolonged period, hence circumstances directly prior to death could not be ascertained. The sequence of events prior to death in most cases (74%, $n = 146$) involved the deceased being seen to be intoxicated prior to falling asleep. Witnesses often reported heavy uncharacteristic snoring in these cases. In the final case, the deceased attended an accident and emergency department. Having been attended to, he was asked to sit in the waiting area. He was found dead in the toilet area approximately 2 hours later.

Of the 196 methadone deaths, 21 individuals (11%) had died within 2 weeks of being released from prison. Methadone was known to have been prescribed in only 10 cases.

A blood sample was unobtainable in five cases because of decomposition. However, urine, liver and liver blood were used as alternative matrices. Of the remaining 191 cases, the post-mortem blood methadone concentrations ranged from 0.01 to 3.84 mg/l. Table 3 lists the average and range of concentrations detected for each cause of death group and whether or not the deceased was enrolled on a MMP at the time of death. The mean concentrations for methadone-only deaths were significantly higher than those for methadone-related deaths (all deaths, two-sample t-test, $P < 0.0001$; methadone prescribed, $P = 0.0001$; methadone not prescribed, $P < 0.0001$).

Multiple drug use was prevalent, with two or more drugs being detected in 163 cases (85% of blood drug-positive cases). The most frequently detected additional drug group was the benzodiazepines, with diazepam and temazepam being present in 106 (65%) and 50 (31%) of these cases, respectively. Heroin was found to be positive in 55 multiple drug cases (34%). In 16 (29%) of these cases the deceased was in receipt of a methadone pre-

Table 3 Methadone concentrations, cause of death category and MMP status.

		Methadone-only	*Methadone-related*
All cases ($n = 187$[a])	n	52	135
	Mean	0.8	0.4
	Median	0.7	0.3
	Range	0.08–2.63	0.01–3.84
Prescribed	n	21	49
	Mean	0.9	0.5
	Median	0.7	0.4
	Range	0.28–2.2	0.067–1.8
Not prescribed	n	25	78
	Mean	0.7	0.3
	Median	0.5	0.2
	Range	0.08–2.63	0.01–3.84
No record	n	6	8
	Mean	0.7	0.3
	Median	0.6	0.3
	Range	0.26–1.3	0.038–0.8

[a]In total, the study period involved 196 MO and MR deaths; however, toxicology was carried out on the liver in one case, liver blood in two cases, urine in two cases and no post-mortem examination was carried out in four cases. In these four instances, the concentrations were high enough to indicate that the blood had been taken from a source other than the periphery. These concentrations were 11.3, 0.83, 5.6 and 1.9 mg/l blood.

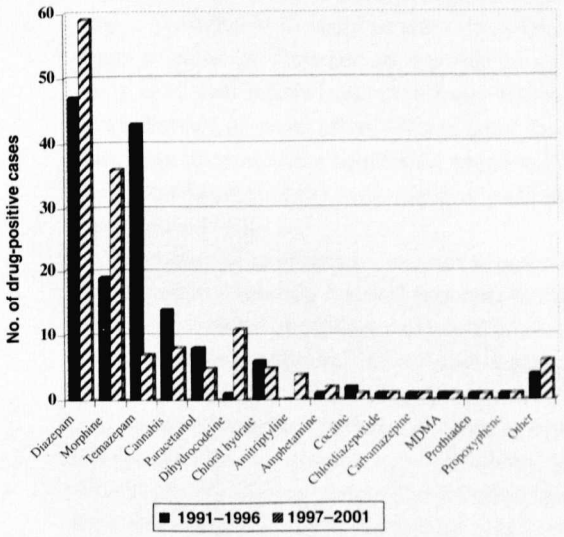

Figure 2 Frequency of drugs detected

scription. Effectively, of all methadone patients in this study, one-fifth (20%) were found to be non-compliant with the methadone programme guidelines in that they continued to use illicit drugs. The other drugs detected are shown in Fig. 2.

The cocktails of drugs consumed by the subjects of this study reflect the present pattern of drug misuse in Strathclyde, which involves primarily the concurrent use of opiates and benzodiazepines [30].

Alcohol was detected in the blood in 59 cases with mean blood alcohol concentrations ranging from 4 to 462 mg/100 ml. This could have a possible additive effect on other respiratory depressant drugs.

DISCUSSION

The proliferation of the methadone maintenance programme (MMP) throughout the Strathclyde area is evident from the annual increase in methadone prescriptions dispensed. Over the study period, 1991–2001, only 29% ($n = 56$) of drug-related deaths where methadone was detected post-mortem were judged to be due to methadone alone.

This study revealed that fatalities from polydrug use involving other opiates and benzodiazepines were much more common than from methadone alone. This combination of drugs has been documented previously, not only in drug users in the west of Scotland [30–32], but also in Europe [33,34] and Australia [35], and the increased risk of overdose from this combination of drugs has been reported by Darke *et al.* [36]. As both groups of drugs are respiratory depressants, at least an additive effect may result when taken in combination. Other illicit drugs (e.g. amphetamine, cocaine, ecstasy) and commonly abused medicinal drugs such as dihydrocodeine and chloral hydrate were also detected.

From the 182 cases where MMP status could be ascertained, less than one-half of cases involved legitimately supplied methadone. This demonstrates the risk of diversion of legitimate supplies of methadone. Multiple 'take-home' doses were noted in 21 cases. While permitting a patient to uplift multiple doses may be perceived as a 'step forward', this practice should not be encouraged unless the patient has been on a stable dose for some significant period and tested negative for other drugs of abuse by urinalysis on several occasions.

There is concern that some MMP patients continue to use illicit opiates and there were a number of MMP patients who tested positive for continued heroin abuse. This was confirmed by the presence of morphine and either codeine from the breakdown of monoacetylcodeine, an impurity in street heroin and/or 6-monoacetylmorphine, the first metabolic product of heroin. A possible reason for this continued usage may be that the patient has to 'top-up' as a result of being prescribed too low a dose of methadone. A recommended serum therapeutic range of between 0.15 and 0.6 mg/l has been reported when monitoring methadone maintenance patients [37] and a therapeutic window for dosage ranging from 60 mg to 120 mg suggested [38]. In Glasgow, an average dose of 48 mg was recorded, a dose regarded as being suboptimal [39]. In difficult cases, blood/serum monitoring would be beneficial in achieving the optimal dose.

From the circumstances of death it was ascertained that over three-quarters of deaths (74%, $n = 146$) occurred while the deceased was presumed to be sleeping, following a period of observed intoxication. Permitting a 'sleep-it-off' period was considered to be beneficial by witnesses, presumably in order to allow the effects of the drugs to wear off. However, as reported in a previous study [27], had medical attention been summoned on first indication of intoxication, some of these deaths may have been preventable: a conclusion supported by Clark *et al.*, who found that the toxic effects of methadone are often delayed [40].

The source of methadone could not be ascertained in the majority of recently released prisoners in this study sample. A period of abstinence can result in a loss of tolerance for a drug and prisoners are made aware of these dangers prior to their release. Despite this, some individuals choose to revert to quantities of drugs to which they were previously accustomed, hence increasing their risk of overdose. While some of the recently released prisoners were enrolled on an MMP at the time of their death, their MMP status was unobtainable prior to their term of imprisonment. However, a recent study has highlighted the adverse effects of the interruption of methadone treatment by imprisonment where a number of general practitioners reported chaotic drug use following release from prison [41].

After 1996, deaths involving methadone have decreased despite both an increasing number of people being prescribed methadone and an overall increase in drug-related deaths. This suggests a positive impact of both improved medical practice following 1996 and the dissemination of methadone programmes from Glasgow to Strathclyde. Supervision programmes did not become common practice in the rest of Strathclyde until 1997 onwards and currently the supervision scheme in the other three health board areas remains incomplete [42]. The death rates for 2001 in Glasgow are particularly encouraging, showing lower rates compared with the other health board areas despite this area having nearly double the amount of MMP patients than the other three health board areas combined. The figures presented in this paper reflect the success of the supervised programme in Glasgow. As the rest of Strathclyde becomes increasingly involved in the MMP it is essential that pharmacies are recruited to supervise daily doses of methadone. There are, however, continuing concerns. For example, in all areas a small proportion of patients continue to be issued either daily or weekly unsupervised scripts. While this may be seen by GPs and other agencies as progress in building trust between the patient and GP, the potential for diversion should not be overlooked.

Because this was an observational study, and due to the potential confounding effect of other factors, we cannot conclude that the introduction of the guidelines for improved patient management and clinical care together with increased supervision of consumption were the only causes of the fall in death rate. However, the death rate reduction was seen to coincide with these changes, indicating a possible positive effect on reducing deaths.

CONCLUSIONS

Heroin addiction remains a disturbing cause of premature death in Scotland. The effectiveness of methadone as a treatment for opiate addiction received much criticism initially. However, the findings of the confidential enquiry in addition to increased and widespread supervision implemented by pharmacists have been major factors in decreasing deaths involving methadone. The argument that methadone is an unsafe alternative therapy for opiate addiction is not supported by the results of this study. What has been demonstrated in the west of Scotland is that methadone, if not sufficiently supervised, can lead to otherwise preventable deaths by diversion of supply. In addition, regular monitoring should be adhered to as per the guidelines to ascertain the stability of the patient in order to establish the correct dosage is being prescribed. With efficient patient management to establish compliance with the guidelines of the programme, methadone can be a safe drug for substitution therapy.

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