A Comparison of the Relative Values of Chloroform and Ether in General Anaesthesia with special reference to their influence on the Blood-Pressure.

:: THESIS for DEGREE of M.D. ::

Presented by

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In taking up the subject of the relative values of chloroform and ether for general anaesthesia, I am fully aware of the fact that it is one which has already received very thorough discussion. At the same time, when one studies the recent literature on the subject it is seen that very considerable differences of opinion still exist.

For some years past there has been a marked swing of the pendulum of medical opinion in favour of ether, particularly since its administration by an open method, and without re-breathing, has been proved to be practicable as a means of maintaining anaesthesia for a major surgical operation. This method first found favour in America, and to-day comparatively little use is made in that country of any other anaesthetic. In England ether has become more and more the routine anaesthetic, while in Scotland and on the Continent of Europe there has been a tendency in the same direction, although to a less extent.

The reason for this is undoubtedly to be found in the fact that during anaesthesia chloroform is more dangerous than ether, that deaths under chloroform are of more frequent occurrence than deaths under ether. Sir Frederic Hewitt has collected statistics in this connection and on analysing them comes to the conclusion that ether is about six times as safe as chloroform. He says:- "With the above statistics before

"us we shall probably not be far wrong in assuming that "under the circumstances mentioned, ether is about six times "as safe as chloroform; in other words, with a heterogeneous "assortment of anaesthetists, patients, and operations, and "with ether and chloroform as the anaesthetics, the risk to "life is about one-sixth as great with the former as with the "latter agent" (1)

The statistics on which his conclusion is based are taken from a very mixed assortment of cases and with no reference to whether the administrations were conducted by a practised anaesthetist or not. I am sure that, as Sir Frederic Hewitt suggests, the preponderance in favour of ether would not be nearly as great in statistics of administrations in skilled hands. Further, those statistics ignore altogether the relative incidence of serious after effects and of deaths subsequent to anaesthesia with the two anaesthetics. It would indeed be exceedingly difficult to prepare reliable figures bearing on this aspect, so many factors, apart altogether from the effect of the anaesthetic, come into play in the causation of death soon after operation.

Then the question as to which is the more efficient anaesthetic must be considered. Whether does ether or chloroform produce the more satisfactory anaesthesia? In this connection Prof. A.D.Waller has done very valuable work. In comparing the relative molecular toxicity of alcohol, ether, and chloroform, on muscle he gives the following figures:-

Chloroform	6
Ether	0.72
Alcohol	0.06

Alcohol as an anaesthetic in modern surgery he, of course, rules out of count; but in discussing the other two substances he says :-

"A drachm of chloroform is physiologically equivalent "to 15 drachms of ether. Experience proves that ether is "above all the safe anaesthetic, chloroform the powerful "anaesthetic".

"The margin between anaesthesia and death is relatively "narrow for chloroform, because chloroform is a most powerful "drug, with which it is easy to overcharge the blood.

"The margin between anaesthesia and death is relatively "broad for ether, because ether is a less powerful drug, with "which therefore it is difficult to overcharge the blood.

"This is not to say that we should reject chloroform "anaesthesia in favour of ether anaesthesia".

"What are we to think, and what shall we do? Should we "take chloroform or ether for ourselves and for our children?.. "My answer to the question, couched in this its most search- "ing form, is as follows:-

"If I had to undergo anaesthesia unexpectedly at the "hands of an unknown administrator, I should take ether. If "I had to undergo anaesthesia after due warning, I should take "chloroform/

"chloroform, but only at the hand of an administrator of known "skill and experience". (2)

The implication from those sentences of Professor Waller's is, that, although he considers chloroform the more dangerous agent, at the same time he admits that it is the more efficient.

The object of this thesis is to show that, while ether has a field of undoubted value as a general anaesthetic in surgery, chloroform, as well as being more efficient is "par excellence" the anaesthetic for those operations where surgical shock is likely to be severe, while its exhibition is less fraught with the danger of serious after effects.

Most important in proof of this conclusion are the observations of the behaviour of the blood-pressure with respect to the two anaesthetics but a number of other considerations seem to me to be of value and I propose to deal briefly with them before taking up the subject of the blood-pressure.

The general observations to which I am first going to refer are taken from a series of 1,400 cases, 850 of which are chloroform cases, and 550 ether.

Before going further it will be well if I make a few preliminary observations on two points:- firstly, the methods of administering the two anaesthetics which I have employed;

and/

and, secondly, the stages of anaesthesia.

By so doing I hope to avoid unnecessary repetition.

METHODS OF ADMINISTRATION ADOPTED.

Chloroform has in all cases been used either by the drop-method with a Skinner's lint mask or by means of the Vernon-Harcourt inhaler which gives a definite percentage (up to 2%) of chloroform vapour in air.

The latter method is after all only a refinement, though a very valuable one, of the former, and the effects produced are identical in both cases.

Ether has been administered either by means of Clover's inhaler, or by the open method, as with chloroform, on a Skinner's lint mask, with the slight difference that steps have been taken with ether to prevent unduly rapid evaporation of the agent by covering the lint, after the administration of each dose, with eight or ten layers of gauze.

In this case there is a distinction between the two methods. Administration by means of Clover's inhaler, which is a closed method, involves the repeated rebreathing of air; or, in other words, the patient, in addition to the ether vapour breathes air with a relatively high carbon-dioxide percentage. However, in using Clover's inhaler, the great art is to have this carbon-dioxide percentage as low as possible, as indicated by/

by absence of cyanosis, and if this point be carefully watched, the effects of ether administered in this way are practically identical with those produced when the open method is employed.

In many of the cases ether administered by means of Clover's inhaler has been preceded by nitrous oxide gas, the object being to induce unconsciousness by means of this non-irritating and easily respirable gas and thus to avoid the unpleasantness caused by the inhalation of ether vapour during consciousness. But this in no way affects the action of ether, as nitrous-oxide is only used during the first two or three minutes of anaesthesia.

STAGES OF ANAESTHESIA.

I shall have occasion to refer many times to the different stages of anaesthesia, and, as different definitions of these stages are in use, it would be better for me to clear the way by indicating the definitions I employ. Although there are a number of signs of value in ascertaining in what stage of anaesthesia a patient is, the best guides are the eye reflexes and it will be sufficient if I base my definitions on them. Any such division must be to some extent arbitrary as one stage merges gradually into another.

I make a division into four stages -

(1) Stage/

(1) Stage of Excitement.

Conjunctival reflex brisk.

Pupil dilated, active to light.

(2) State of Light anaesthesia.

Conjunctival reflex present but less active,

Pupil smaller, active to light.

(3) Stage of Deep Anaesthesia.

Conjunctival reflex absent.

Pupil small, inactive to light.

(4) Stage of Paralysis.

Conjunctival reflex absent.

Pupil dilated, inactive to light.

As illustrations of the preliminary series of observations I shall make use of copies of the charts on which I take notes during anaesthesia; and, for the blood-pressure observations, of Lewis's blood-pressure charts.

The preliminary observations deal with (1) The pulse; (2) the respiration; (3) the muscles; and (4) some of the after-effects.

(1) PULSE.

(a) Chloroform.

In the first stage the pulse rate becomes more rapid/

rapid and this is accompanied by an increase in volume, while along with this circulatory stimulation the face is flushed.

In the second stage the beat slows down to about the patient's normal or below it, the pulse remaining of good volume; the flushing of the face disappears.

In the third stage further slowing down occurs usually with diminution in volume, and, as this stage merges into the fourth, irregular rythym may commence. Very often there is a slight degree of pallor.

In the fourth stage the rate usually slows down; but sometimes there is acceleration. The volume is diminished and there is irregularity both in force and rythym. There is marked pallor.

After the administration is discontinued the pulse rate increases along with an improvement in the volume.

The character of the pulse is, of course, very much affected by the degree of surgical shock. Where this is a prominent factor the volume of the pulse is diminished and this often, though not always, accompanied by acceleration, and in extreme cases by irregularity.

This element of shock plays such an important part in anaesthesia in general and on the circulatory system in particular, that it is almost impossible to generalize about it. Where shock occurs, a smaller amount of chloroform is required/

required to maintain the necessary depth of anaesthesia. There are three other factors which very materially complicate chloroform anaesthesia and give rise to difficulty, (1) violent struggling in the first stage; (2) initial nervousness on the part of the patient, and (3) false anaesthesia.

In the first of these danger arises towards the cessation of struggling when the patient may take several deep breaths then suddenly goes into an advanced third or even into the fourth stage, with a small, rapid, and irregular pulse. This complication can only be overcome by care during and immediately after the excitement stage. It is most troublesome in muscular men and in alcoholic subjects.

The second difficulty, however, is one which may very seriously complicate an entire chloroform anaesthesia. The patient at the commencement does not give him-or her-self properly into the control of the anaesthetist; i.e. there is an attempt to maintain voluntary control. The result of this is that the breathing is shallow and irregular and the pulse usually small and rapid. It is with great difficulty that a good anaesthesia in the second or third stages can be induced. Those stages are inclined to be very transitory, the patient going suddenly into the fourth stage. Throughout the entire operation there are quick changes from too light to too/

too deep anaesthesia, and the pulse always unsatisfactory. Frequent accompaniments are a tendency to vomiting and increased secretion of saliva and mucus, which cause further complication.

Women are particularly prone to give trouble in this way.

The third difficulty arises from some operative manipulation during too light anaesthesia, it may be the skin incision before anaesthesia is properly established. This is specially liable to occur in children who often go early into a state of false anaesthesia, a condition resembling sleep, which so simulates the third stage that the distinction is often impossible until some such stimulus as the incision is given. The patient then wakes up and very frequently a degree of syncope ensues with a small rapid pulse. The difficulty may also arise during some such process as manipulation of the abdominal viscera while the anaesthesia is insufficient.

The following charts will illustrate these remarks.

I

Date 7:10:09. Case Tuberculous Hip. Excision of joint. No. 285

Name Mrs. B. Age 34 Alcohol Abstainer

Heart Normal Lungs Normal Anxiety None.

Anaesthetic Chloroform :- Skinner's Mask — 8½ drachms.

First Stage—Resistance None

Pulse 92, 112 88. Excitement

Duration 4½ minutes. 3rd Stage at 5½ minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
6 Incision.	$CHCl_3$	88 Regular Good Volume	34 Regular Deep.	Corneal reflex absent. Pupil small & fixed. (3rd Stage)	Good.	
10		86 Regular Good Volume				
15		78 Regular Good vol.	44 Regular Deep.	3rd Stage	"	
20						
30		70 Regular Good vol.	40 Regular Deep	2nd Stage.	"	
34	Anaesthetic discontinued.					
45						
60						
75						

Stimulants, etc.

After effects Vomited three times during the 10 hours immediately after operation.

Remarks Uneventful anaesthesia. Good recovery.

Case 1.

In the first case the pulse rate, before the administration was commenced, was 92. A count during the first stage showed acceleration to 112. From that time onward, during the anaesthesia, the pulse gradually slowed down, the patient's condition remaining good.

II

Date 15·10·09 Case Varicose Veins No. 302

Name Wm. A. Age 31 Alcohol Heavy drinker.

Heart Normal Lungs Normal Anxiety None

Anaesthetic Chloroform. Skinner's Mask.

First Stage—Resistance Considerable.

Pulse 72, 96, 60. Excitement

Duration 6½ minutes

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$					
7		60 Regular Good volume	24 Regular Deep.	Corneal reflex present. Pupil small, active. (2nd Stage)	Good.	
10						
Incision 14.						
15		58. Reg. Good vol.	28. Reg. Deep.	2nd stage.	"	
20						
30		52 Reg. Good vol.	"	3rd Stage	"	
45						
53	Anaesthetic discontinued	52 Reg. Good vol.	"	2nd Stage	"	
60						
75						

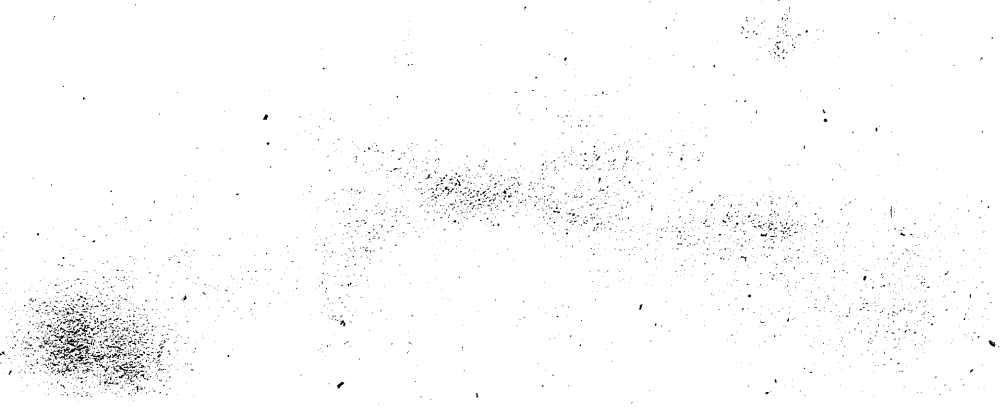
Stimulants, etc.

After effects No vomiting.

Remarks Uneventful anaesthesia.

Case 11.

Also illustrates the typical behaviour of the pulse in an operation where the element of shock is trivial. An acceleration again took place in the first stgge which was accompanied by struggling. Then a gradual slowing down in the second and third stages, the pulse remaining of good volume.



III

Date 26·5·09 Case Excision of Epithelioma of Lip No. 133

Name Wm. F. Age 46 Alcohol Heavy drinker

Heart Normal. Lungs Normal. Anxiety None.

Anaesthetic Chloroform:- Skinner's Mask. (2½ ounces.)

First Stage—Resistance Violent Struggling

Pulse 64, 82. Excitement Marked.

Duration 4½ minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$	80 Irregular Small.	36 Irregular.	2nd Stage. Coughing	Cyanosed.	
7						
10		40 Thready	36 Shallow	Dilated fixed pupil (4th Stage)	Livid.	Tongue pulled forward Head lowered.
11			Ceased.			
Incision 15		68 Regular Much improved	Resumed 40. Reg. Shallow.	3rd Stage	Much better.	
20	For remainder of detailed	Anaesthesia impossible to make observations.				
30						
45						
60						
75						
80	Anaesthetic discontinued.					

Stimulants, etc.

After effects No vomiting.

Remarks Anaesthetic badly taken at first Violent struggling and coughing during induction. Immediately after cessation of struggling patient went into fourth stage. By lowering the head and pulling out the tongue his condition at once improved and no further trouble occurred, the pulse remaining satisfactory till the end of the operation.

Case 111.

A muscular well-built man who drank heavily. Probably owing to the presence of chronic bronchitis, chloroform caused coughing. The patient struggled violently, then very soon after its cessation went into the fourth stage with momentary stoppage of respiration. His head was lowered and his tongue pulled forward with immediate benefit. The pulse, at first rapid then irregular and slow, began to improve soon after breathing was re-established and remained satisfactory during the rest of the operation.

As well as an illustration of the pulse in the fourth stage this case shows the difficulty which is very liable to occur immediately after the struggling of alcoholic subjects.

IV 18/10 (In Ward) Pulse 82
Blood-pressure 124.

Date 21:1:10 Case Ventral Hernia. No. 452

Name J. S. (Male) Age 25 Alcohol Abstainer

Heart Normal Lungs Normal Anxiety None

Anaesthetic Chloroform:- Skinner's Mask (15 drachms)

First Stage—Resistance None

Pulse 84, 100
80
Blood-pressure 130
110
Excitement

Duration 8 minutes (3rd stage at 10 minutes)

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	~~Sickness~~ Blood-pressure
4	$CHCl_3$	100				
5						
Incision 10		80 Regular Good volume	36 Regular Deep.	3rd Stage	Good.	110.
Intra-abdominal Manipulation 15		"	"	2nd Stage	"	115.
20		60 Reg. Fair vol.	"	3rd Stage	Slight pallor.	80
30		68. Reg. Fair vol.	"	" "	"	104
45		64 Reg. Small.	48 Reg. Deep.	" "	Pale	90.
60		72 Improved	40 Reg Deep.	" "	Improved	104
75		64 Reg Small.	36 Reg. Deep.	" "	Pale	
100	Anaesthetic discontinued	80. Reg. Small.	"	2nd Stage	Improved	108.

Stimulants, etc.

After effects Vomited three times between 12 and 18 hours after operation.

Remarks Good regulin anaesthesia. Operation prolonged owing to dense adhesions.

After effects.

After operation	Pulse	Blood-pressure
1 hour	100 Reg. Fair vol.	115.
4 hours.	112 Reg Fair vol.	112
12 "	96 Reg. Good vol.	118.
24 "	90 Reg.	118.

Case IV.

The gradual slowing of the pulse is again observed. With the shock produced by the intra-abdominal manipulation the pulse volume was diminished. During the latter half of the operation a tendency to acceleration accompanied this.

The pulse readings taken after the operation show a pulse, at first rapid, gradually slowing down and improving in volume.

V.

Date 6.7.11 Case Appendix abscess opened Appendectomy No. 1214

Name Alec. T. Age 15. Alcohol

Heart Normal. Lungs Normal. Anxiety Slight.

Anaesthetic Chloroform. Skinner's mask for 6 minutes, then Vernon-Harcourt Inhaler.

First Stage—Resistance Slight.

Pulse 88, 96, 88. Excitement

Duration 6 minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$					
6	Vernon Harcourt 2%	88 Regular Good volume		2nd Stage	Good.	
Incision 9						
10	1·8%	82 Reg. Good Vol.	36 Regular Deep.	3rd Stage	"	
15	"	80. Reg. Good Vol.	32. Reg. Deep.	" "	"	
Manipulation of Intestine. 20	"	100 Reg. Smaller.	40 Reg. Shallow.	4th Stage	Slight pallor.	
	0					
24	1·4%	100 Reg. Improved	36 Reg. Deep.	2nd Stage		
30						
31	Anaesthetic discontinued	88. Reg Fair Vol.			Improved.	
45						
After operation. 1 hour ~~60~~		104 Reg. Fair vol.				
12 hours		100				
24 " ~~75~~		90 Reg. Good vol				

Stimulants, etc.

After effects No vomiting.

Remarks Vernon-Harcourt Inhaler maintained deep anaesthesia.

Case V.

In this case the initial slowing down of the pulse was slight. During the intra-abdominal manipulation, and the shock caused thereby, the patient was for a brief period in the fourth stage. On withdrawal of the chloroform vapour he at once improved and anaesthesia in the second stage was maintained. The bahaviour of the pulse after operation was very similar to that observed in the previous case.

VI.

Date 18:8:10 Case Carcinoma of Uterus Hysterectomy No. 764

Name Miss C. W. Age 43 Alcohol Abstainer

Heart Weak action Mx murmur Lungs Normal Anxiety Slight

Anaesthetic Chloroform:- Skinner's Mask for 5 minutes; then Vernon-Harcourt Inhaler.

First Stage—Resistance Very slight

Pulse 100 72 Excitement

Duration 4½ minutes

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$ Vernon Harcourt 2%	72 Regular Good volume	24 Regular Deep.	2nd Stage	Good.	
10		64 Reg. Good Vol.		3rd Stage	"	
Incision of Peritoneum 14 Incision						
15	1·8%	64 Reg. Fair Vol.	36 Reg. Deep.	" "	"	
20	1·6%					
25	2%	80. Reg. Small.	44 Reg. Shallow.	2nd Stage Slight Straining	Slight Pallor.	
30		78 Reg. Good Vol.	40 Reg. Deep.	3rd Stage.	Good.	
40	Anaesthetic					
45	discontinued	64 Reg. Good vol.	36 Reg. Deep.	" "	"	
60						
75						

Stimulants, etc.

After effects Immediate vomiting and twice during four hours subsequent to operation.

Remarks Vernon-Harcourt Inhaler maintained level anaesthesia except when chloroform percentage reduced to 1·6, when slight straining occurred.

Case VI.

The pulse rate when the patient was brought into the theatre was 100. With the induction of the second stage it fell to 72, and with the third to 64. Twenty minutes after the commencement of anaesthesia the percentage of chloroform vapour was reduced to 1.6% but this proved to be insufficient, with the result that five minutes later the anaesthesia became too light and, along with this, the pulse became quicker and smaller. On increasing the dose of chloroform improvement soon showed itself - a slower and fuller pulse.

VII.

Date 24.9.09. Case Appendicitis with Adhesions Appendectomy. No. 271.

Name Wm M. Age 26. Alcohol Abstainer.

Heart Normal. Lungs Normal. Anxiety Marked.

Anaesthetic Chloroform:- Skinner's mask.

First Stage—Resistance Slight.

Pulse 120 96. Excitement Talking and weeping.

Duration 14 minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$					
10						
14	- - - -	- - - -	. . . .	Corneal reflex present	Good.	
Incision 15				3rd Stage		
16		96 Irreg. Small.	48 Regular Shallow.	Advanced 3rd Stage	Pale	
20		92 Reg. Fair Volume	4	3rd Stage	Improved.	
25		"	"	Early 2nd Stage	Pale	Slight straining.
30				3rd Stage		
40		88 Reg.	44 Reg.	" "	Improved.	
45		Fair Vol.	Better			
50.	Anaesthetic discontinued	92. Reg Fair Vol.	48 Reg Shallow	Early 2nd Stage.	Pale.	Vomiting.
60						
75						

Stimulants, etc.

After effects Vomiting of bile-stained fluid at intervals for 48 hours.

Remarks Very nervous patient. Prolonged induction with shallow unsatisfactory breathing. Irregular anaesthesia varying from early second to advanced third stage.

Chart VII.

Although the complication is commoner in women, the above chart shows very well the behaviour of the pulse as influenced by nervousness, but in a male patient, It might be said that the anaesthesia in this case was never satisfactory.

The patient, a muscular man, was very nervous on entering the theatre. Before the administration was commenced the pulse rate was 120 per minute. After induction, the anaesthesia varying from a light second to an advanced third stage, the pulse rate was from 96 to 88 per minute. Immediately after the incision it was irregular and thready, and throughout the operation of small volume.

VIII.

Genu valgum.

Date 30:10:09 Case Osteotomy No. 329

Name David A. Age 9 Alcohol —

Heart Normal Lungs Normal Anxiety —

Anaesthetic Chloroform:- Skinner's Mask

First Stage—Resistance None.

Pulse 98 / 84. Excitement

Duration 4½ minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	$CHCl_3$	84 Regular Good volume	34 Regular Deep.	Corneal reflex absent. Pupil small. Inactive.	Good.	
Incision 9.						
10		96. Reg. Small	48 Reg Shallow.	Corneal reflex brisk Pupil large, active.	"	
14	- - - - -	- - - - -	- - - - -	3rd Stage.	Slight Pallor.	
15		92 Reg. Fair vol	44 Reg. Shallow.	2nd Stage	Good.	
20		88 Reg Good vol.	36 Reg. Deep.	3rd Stage	"	
30		"	40 Reg Deep.	" " "	"	
40	Anaesthetic discontinued.	86 Reg. Good.	"	2nd Stage.	"	
~~45~~						
60						
75						

Stimulants, etc.

After effects No vomiting.

Remarks False anaesthesia at five minutes the patient waking up on the incision being made. For some time after this (till 20 minutes) anaesthesia irregular, good after 20 minutes.

Case VIII.

A Rachitic child. Five minutes after the commencement of administration he went into what appeared to be a good third stage. However, when the incision was made four minutes later, it was evident that anaesthesia had not been induced, the patient "coming out" to the first stage. During the next ten minutes the anaesthesia was slightly irregular; and the pulse, which had become more rapid and smaller immediately after the incision, began to steady down. From twenty minutes till the end of the operation the anaesthesia was satisfactory and the pulse good. The apparent third stage early in this anaesthesia is an illustration of false anaesthesia.

(b) Ether.

The effect produced by ether on the pulse varies to some extent with the method of administration adopted, whether the closed or the open method. If the former method be employed, however, with precaution against causing much limitation of air, there is very little difference from the open method.

In the first stage of anaesthesia the pulse is greatly accelerated and of a full bounding character. Where there is limitation of air this acceleration is accentuated, while the face is cyanosed. In presence of free air supply the face is flushed.

In the second stage the pulse slows down slightly but remains quicker than the normal. It is of full volume. The face is somewhat flushed, and cut arteries bleed very freely.

In the third stage there may be further slowing down but still not to the normal, the volume remaining good. There is usually slight flushing of the face at first.

Any degree of air limitation supervening at any stage of operation is accompanied by acceleration of the pulse and by cyanosis. In the early stages of ether anaesthesia circulatory trouble is of exceedingly rare occurrence, the pulse therefore remains good until a very deep anaesthesia is produced.

The/

The fourth stage never occurs under ether while the air passages are kept free, unless one pushes the anaesthesia with the object of producing it.

The effect of surgical shock during ether anaesthesia is very similar to that observed with chloroform; a pulse of diminished volume, usually slower and sometimes irregular.

Although it is exceedingly uncommon to have trouble from circulatory failure early in an ether anaesthesia, very much more so than with chloroform, towards the end of a prolonged ether administration, especially if there has been a considerable degree of shock, the pulse fails very decidedly in volume, may become irregular, and, after the operation, does not exhibit the same rapidity in recovery which is observed in a chloroform case.

The difficulties produced by nervousness and by the condition of false anaesthesia are rarely very troublesome. There may be considerable trouble, however, from operative manipulation during too light anaesthesia, the pulse then becoming small, rapid, and perhaps irregular. It is often only with very great difficulty that a sufficient anaesthesia can be maintained by means of ether in alcoholic and in very muscular subjects, and in some cases altogether impossible.

IX 27.5.09 Pulse 84.

Date 29.5.09 Case Varicocele No. 139

Name Karl K. Age 19 Alcohol Abstainer

Heart Normal Lungs Normal Anxiety None

Anaesthetic Ether :— Clover's Inhaler.

First Stage—Resistance Nil.

Pulse 90 120 100 Excitement

Duration 5 minutes

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	Ether.	100 Regular Bounding	32 Regular Deep.	2nd Stage.	Good. Face flushed	
Incision 10		"	36 Reg. Deep.	3rd Stage	"	
15		105 Reg. Good volume	32. Reg. Deep.	" "	Good.	
20		100 Reg. Good vol.	36 Reg Deep.	2nd Stage	"	
30						
32	Anaesthetic discontinued	120 Reg. Good vol.	40 Reg. Shallow.	" "	"	
45						
60						
75						

Stimulants, etc.

After effects No vomiting.

Remarks Quiet uneventful anaesthesia. When the patient began to come out the pulse rate increased and the respiration became shallower and more rapid.

Case IX.

Is intended to show the ether pulse in a short anaesthesia and one in which there is little complication by surgical shock. The pulse rate taken two days before operation was 84 per minute.

During the first stage there was marked acceleration to 120 per minute, then in the second and third stages a slight slowing occurred. The pulse remained about 100 per minute until the patient began to"come out", when the rate again went up to 120. It remained of good volume and regular throughout the anaesthesia.

X. 17·4·10 Pulse 82.

Date 18:4:10 Case Varicose Veins No. 588

Name Kate M. Age 22. Alcohol Abstainer.

Heart Normal Lungs Normal Anxiety None.

Anaesthetic Ether: Clover Inhaler for 17 minutes, then open method.

First Stage—Resistance None.

Pulse 100 120 Excitement

Duration 4 minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	Ether (Clover)	120 Regular Good volume	36 Regular Deep.	2nd Stage	Good.	
7	" " "	" "	" "	3rd Stage		
10						
Incision 13.						
15		116 Reg. Full.	48 Reg Deep.	" "	"	Excessive Mucus secretion
17	" Open Method.					
20		"	40 Reg. Deep.	" "	"	
30		120. slight Irregular Fair Vol.	38 Reg Shallow.	2nd Stage	Slight Pallor.	
45		120. Irreg.	40 Reg Shallow.	3rd Stage.	"	
50	Anaesthetic discontinued	120 Irreg Small.	"	" "	"	
60						
75						

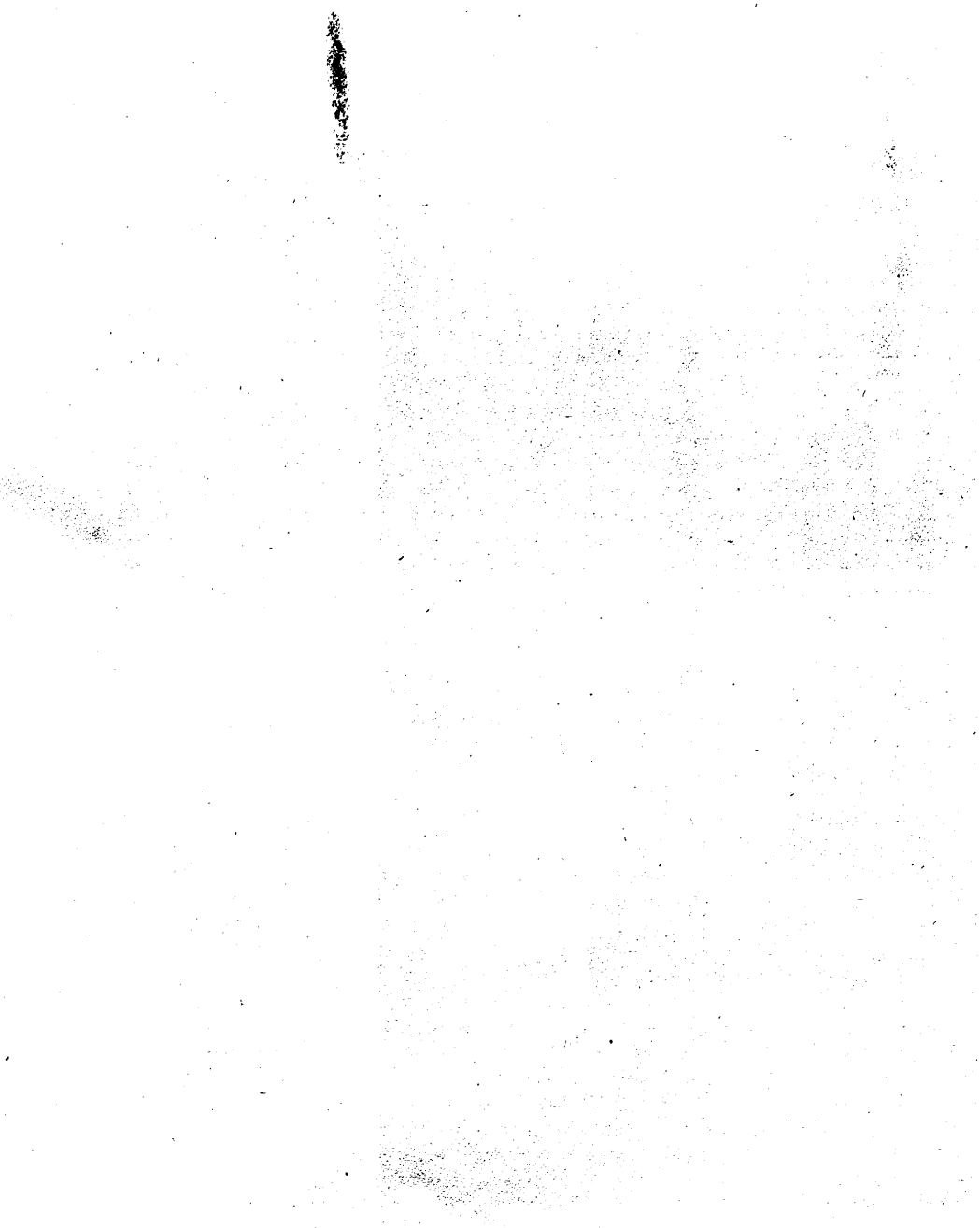
Stimulants, etc.

After effects Frequent vomiting during the 20 hours following operation.

Remarks Quiet induction. Excessive mucus secretion with Clover administration, ceasing after change to the open method. Pulse failure from thirty minutes onwards.

Case X.

The pulse again exhibits the acceleration and improvement in volume which ether causes in the early stages of administration. In this case although the operation was not one involving much shock there is evidence of circulatory failure during the latter part of the operation, commencing at 30 minutes.



XI 6·6·11 Pulse 100, Regular, Fair volume.

Date 7·6·11 Case Gastric Ulcer Gastro-enterostomy No. 1190

Name Mrs. S Age 42 Alcohol Abstainer.

Heart Normal Lungs Normal Anxiety Marked

Anaesthetic Nitrous Oxide (4 minutes) Ether:- Clover Inhaler till 20 minutes then open method.

First Stage—Resistance None

Pulse 100 144. Excitement

Duration 6 minutes

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	Ether (Clover)	148.		2nd Stage	Slight Cyanosis	
8	"	144 Regular Full.	28 Regular Deep.	3rd Stage.	Good.	
Incision 10						
Manipulation in Abdomen. 12		112 Reg. Good Vol.	36 Reg. Deep.	Advanced 3rd stage.	"	
15		116 Reg. Good Vol.	32 Reg. Deep.	3rd Stage	"	
20	" Open Method.	128 Reg. Good Vol.	"	" "	"	
25		132 Reg. Fair Vol.	36 Reg. Deep.	" "	Slight Pallor.	
30						
Stitching Wound. 40		124 Reg. Fair Vol.	28 Reg. Deep.	" "	"	
45						
50	Anaesthetic discontinued	104 Reg. Small.	28 Reg. Shallow	2nd Stage	Pale.	
60						
After operation						
2 hours		132 Reg Small				
12 "		128 Reg Fair Vol				
24 hours		102 Reg Fair Vol.				

Stimulants, etc.

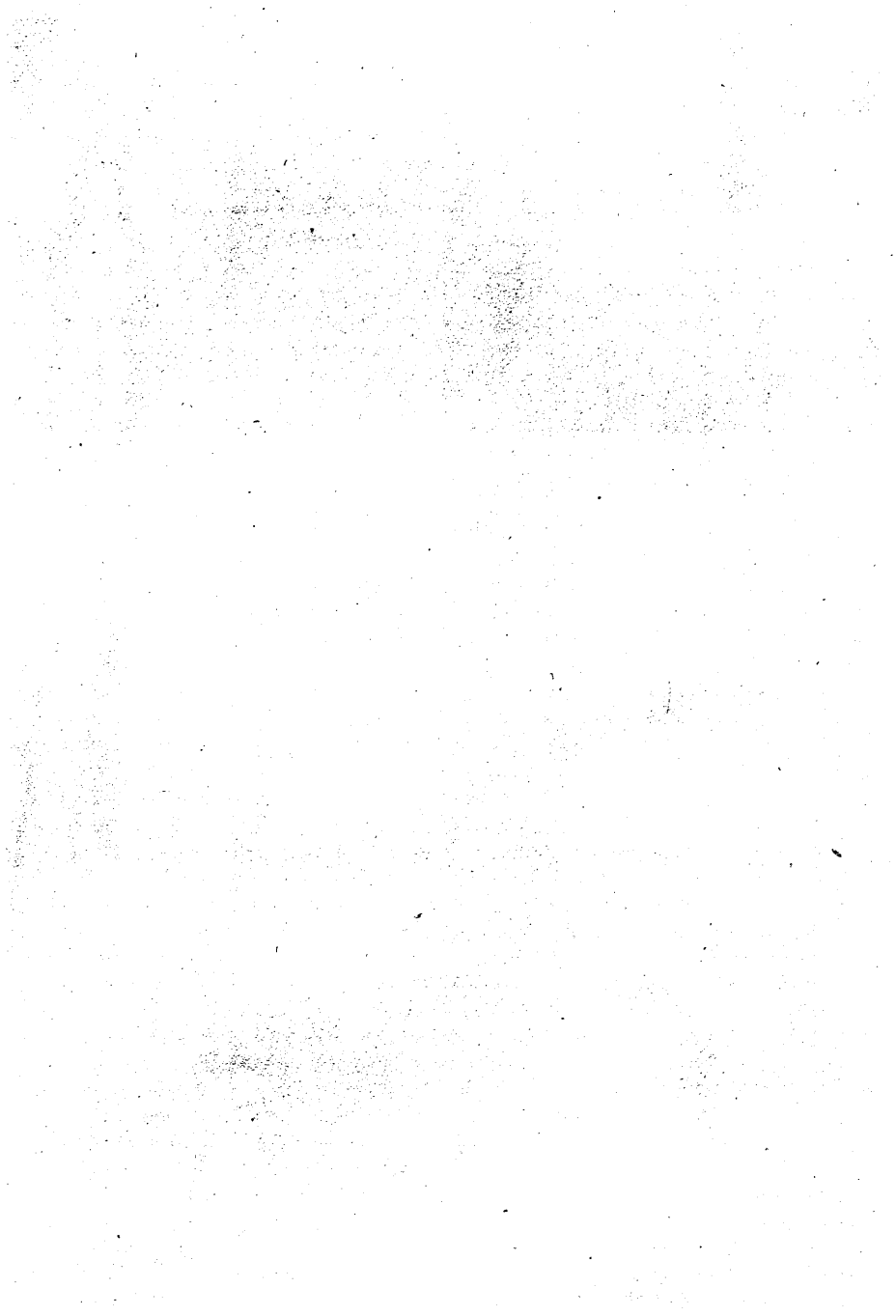
After effects Vomiting at long intervals during first 48 hours. Some haematemesis.

Remarks Nervous patient. Quiet easy induction. Uneventful anaesthesia.

Case XII.

Although the patient was very nervous, induction of anaesthesia with nitrous oxide and ether was easy and a good level anaesthesia easily maintained. Under nitrous oxide the pulse was greatly accelerated but after its withdrawal gradually slowed down from 148 per minute to 112. It again became quicker at 20 minutes showing no marked slowing till the finish of the operation. The volume diminished from 20 minutes onwards.

After the operation the pulse continued of small volume and began to improve decidedly at twenty four hours.



XII. 10·8·11 Pulse 72.

Date 11:8:11 Case Double Inguinal Hernia Radical Cure No. 1291

Name G.M. (Male) Age 27 Alcohol Abstainer.

Heart Normal Lungs Normal Anxiety Slight

Anaesthetic Nitrous Oxide (4 minutes) Ether—Clover Inhaler for 14 minutes, then open method, then Chloroform.

First Stage—Resistance Slight.

Pulse 80, 132, 108 Excitement

Duration 8 minutes.

Second Stage—

Time	Anaesthetic	Pulse	Resp.	Reflexes	Colour of Lips, &c.	Sickness
5	Ether (Clover)			1st Stage	Cranosed.	
8				2nd Stage		
9 (1st Incision) 10		108 Regular Good Volume	28 Regular Deep. Stridor.	3rd Stage	Slight Cranosis	Mucus secretion.
15	" Open Method	112 Reg. Good Vol.	26 Reg. Deep. Stridor.	2nd Stage	Good	Profuse Mucus.
20				3rd Stage	Slight lividity	Less Mucus.
25						
~~30~~ 26 (2nd Incision) 28	Chloroform.	108 Reg Fair Vol	22 Reg Deep. Stridor.	1st Stage	" "	Profuse Mucus.
~~45~~		96 Reg Fair Vol	24 Reg. Deep. Stridor	3rd Stage	Improved	
35 ~~60~~		64 Reg. Good Vol.	24 Reg. Quiet.	2nd Stage		Slight Mucus.
42 75	Anaesthetic discontinued.	60 Reg Fair Vol.	"	3rd Stage	Slight Pallor	

Stimulants, etc.

After effects Vomiting during first six hours.

Remarks Difficult induction with mucus secretion and cough; and difficult anaesthesia until change made to Chloroform. Patient tended to "come out" very quickly until chloroform was adopted.

Case XII.

The induction was troublesome owing to cyanosis and accompanying mucus secretion and coughing. The pulse which, during the nitrous-oxide administration beat 132 per minute, during the ether anaesthesia remained from 108 to 112 per minute, the volume diminishing slightly. As the excessive mucus secretion persisted, and later began to be accompanied by a smaller pulse and slight lividity, a change was made to chloroform. After the change improvement set in and along with slowing of the pulse the volume increased, while the mucus secretion was soon stopped. Eleven minutes after the change to chloroform the pulse rate fell from 108 to 64 per minute.

The patient made a good recovery without bronchial complication.

The above charts are sufficient to illustrate the effects of the two anaesthetics on the pulse. Later, when dealing with their effects on blood pressure, the charts used will show pulse readings as well as blood-pressure readings

2. Respiration.

Very little requires to be said on the subject of the effects on respiration of chloroform and ether as they differ only in a few details. The charts used in illustration of the pulse changes indicate also the effects on respiration. In the first stage there is no regular course followed. Some patients breathe quietly in their normal manner. With others there is shallow breathing, holding of the breath, and irregularity. Toward the end of this stage there is usually acceleration.

In the second stage the respirations become quicker and deeper and this continues into the early part of the third stage.

In an advanced third stage and in the fourth stage they become slower and shallower until finally ceasing. Air limitation at first produces acceleration.

In this connection it may be pointed out that, whereas ether may be given in presence of air-limitation, chloroform should never be so administered, i.e. no closed method of administration is allowable with chloroform. A very great proportion of chloroform difficulties arise through want of attention to the free passage of air to and from the lungs. If there be obstruction to this passage and if this obstruction be allowed to continue, the blood not being properly oxygenated, the dose of chloroform necessary to produce/

produce a fatal result by circulatory depression is relatively small.

The recent Chloroform Commission emphasises this point. In its report it is stated that:- "As has been "indicated again and again, the dangers of chloroform ..... "arise in part through direct overdosage, and in part "through intercurrent conditions often themselves determined "by the extended influence of the chloroform. Of these "asphyxia is the most important .....The grave danger of "allowing any interference with respiration during inhalation "of chloroform is too well known to need emphasis" (3)

Ether has, in a much greater degree than chloroform, an irritant action on the bronchial mucous membrane. This action is emphasised by air limitation which of itself tends to produce congestion.

In susceptible patients, particularly in those with bronchial affections, there is excessive bronchial secretion, which causes obstruction to respiration, sufficient sometimes to be dangerous, because in the later part of the second stage, and in any anaesthesia deeper than this, the cough reflex is abolished, so that mucus is allowed to collect in the air passages and is inhaled.

In Case XIII there is an illustration of this excessive bronchial secretion. In this case a change to chloroform was productive of prompt relief.

3. The Muscles.

(a) Chloroform causes very thorough relaxation of the muscles if a sufficiently strong vapour is administered. In most cases, after the first fifteen minutes of anaesthesia, the two per cent maximum of the Vernon Harcourt apparatus is sufficient to achieve this. In very muscular and in alcoholic subjects, however, this percentage may not be sufficient.

(b) With ether there may be difficulty in obtaining thorough relaxation, and if the operation be a laparotony this is a serious drawback. But again this difficulty, like so many of the others experienced in the administration of ether, may be due to excessive air limitation. It is often found that a change from the closed to the open method of administration is productive of more satisfactory relaxation. At the same time there are cases in which ether, however administered, does not produce a sufficient relaxation of the muscles. The difficulty, just as with a weak chloroform vapour is most liable to occur in muscular and alcoholic patients.

4. Some After-effects.

There are only three of the sequelae of anaesthesia with which I wish to deal at this point. They are:- (i) Vomiting. (ii) Acidosis, and (iii) Lung complications.

(i) Post anaesthetic vomiting is unfortunately of frequent occurrence both with chloroform and ether. In a number of cases in which it occurs it is of trifling account, lasting only during the two hours subsequent to anaesthesia; before the patient has properly regained consciousness; but in others it is a serious complication. The figures given in illustration of the incidence of vomiting are divided into three classes:-

(1) those in which no vomiting occurs.

(2) those in which there is only slight vomiting or at infrequent intervals.

(3) those in which there is violent or prolonged vomiting.

(a) Chloroform.

(1) No vomiting 50%

(2) Slight vomiting, 35%

(3) Violent or prolonged vomiting. 15%.

(b) Ether.

(1) No vomiting. 42.5%

(2) Slight " 47.5%.

(3) Violent or prolonged vomiting, 10%.

So that as regards the percentage of vomiting in all cases there is a balance in favour of chloroform; whereas, as regards serious vomiting the balance is against it.

(ii) Acidosis.

This condition is very commonly called delayed chloroform poisoning and is attributed by almost all who have written on the subject to the effects of chloroform. Although of very rare occurrence its existence is undoubted and it has been reported on by several careful observers. Leonard Gurhrie was the first in Great Britain to call particular attention to it.(4) Since then many writers have reported the condition. Of particular interest is an article by Stiles & Macdonald (5) and a series of articles which appeared in one number of "The Lancet".(6)

The condition ensues about forty eight hours after chloroform anaesthesia and is ushered in by violent and continued vomiting with progressive asthenia, followed almost invariably by death, which usually occurs about the fifth day.

The chief post-mortem change is fatty degeneration, particularly of the liver.

The condition is most often observed to occur after anaesthesia in septic conditions and especially in children.

In my own experience no case has occurred, but those who write on the subject all attribute it to chloroform, with the exception of Low & Stone, two American writers, who

observed/

observed the symptoms after ether anaesthesia and found post-mortem fatty degeration of liver and muscles. (7)

Professor Noel Paton (8) found, in experimenting on rabbits, that extensive fatty degeneration of the liver cells could be produced by large doses of chloroform given by respiration, by the mouth, or by hypodermic injection.

(iii) Lung Complications.

The most important of these is bronchitis. In a small percentage of cases pleurisy and pneumonia occur.

In my experience they follow ether more frequently than chloroform anaesthesia. In giving figures I am comparing chloroform with ether as administered by the open method, because I think that the irritant action of ether on the respiratory mucous membrane is emphasised, if in addition to ether vapour the patient rebreathes for a long period by a closed inhaler, the same air, gradually becoming charged with bacteria, carbon-dioxide, and other waste products.

Some writers are now stating that ether as given by the open method is not more productive of respiratory affections than is chloroform. Dr. W. Pasteur in a paper on "Post-Operative Lung Complications" (9) says:- "By way of summing up the share of the anaesthetic we may, I think, conclude that ether "per se," is probably not a direct cause of pulmonary inflammation".

The/

The figures showing the incidence of lung complications after operation in my cases are:-

Bronchitis,	Chloroform,	1.3%.
	Ether,	3.2%.

Pleurisy accompanied two of the bronchitis cases after ether. Pneumonia occurred once, after chloroform administration, in a girl of 18, for appendectomy in an abscess case.

Those figures are taken from cases in which no lung complication existed before operation.

In those cases in which an anaesthetic has been given to a patient suffering from bronchitis I have almost invariably given chloroform, because, in the few cases in which I have used ether, it has occasioned decided aggravation of the trouble, whereas chloroform, of itself, does not seem to have had this effect.

Before going further I shall briefly sum up the relative advantages and disadvantages of the two anaesthetics as regards the points so far dealt with.

Chloroform.

In favour of chloroform:- During anaesthesia it establishes a thorough anaesthesia with complete muscular relaxation/

relaxation in the great majority of cases. It acts to a very slight extent if at all as a respiratory irritant.

While immediately subsequent to anaesthesia it tends less to the production of vomiting and of lung complications, and causes less aggravation of the latter where they already exist.

Against chloroform:- During anaesthesia it produces circulatory depression which, to some extent an advantage in so far as it diminishes haemorrhage, is very liable to be of danger, particularly in nervous patients.

Immediately subsequent to anaesthesia in a very small number of cases it produces delayed poisoning which when it does occur is often fatal.

Ether.

In favour of ether:- During anaesthesia. It acts as a circulatory stimulant at any rate during the first thirty minutes of its administration and rarely with it does serious circulatory failure occur - it is relatively safe.

Immediately subsequent to anaesthesia. It very rarely if ever causes delayed poisoning.

Against Ether.

During anaesthesia. In many cases it fails to produce thorough muscular relaxation. It acts as a respiratory irritant sometimes causing troublesome secretion of mucus/

mucus. Immediately subsequent to anaesthesia it causes vomiting and lung complications more frequently than chloroform. Where lung trouble is already present it frequently aggravates it.

Those remarks conclude what I have called the preliminary part of my paper and I now come to the subject of:-

The Blood-Pressure.

In taking it up I shall first deal briefly with some of the experimental work which has been done.

It is a rather singular fact that, since soon after its discovery as a general anaesthetic, ether seems to have received little attention in experiment; whereas the effects of chloroform have been carefully studied by trial on the lower animals, and frequently written about. It is exceedingly difficult to find any literature referring to ether in this connection.

Based on this experimental work there is complete unanimity of opinion as to the action of chloroform on the blood-pressure. It produces a fall. But, when one examines the opinions as to the cause of this, considerable differences are discovered. The following quotations taken from some of the best known literature on the subject give some indication of this.

Among/

Among the first to do experimental work in this direction were the members of the Hyderabad Commission. Although discredit has fallen on them on account of the prejudiced attitude they took in favour of chloroform, much of their work is very valuable.

The following conclusions were based on this experimental work:-

"Chloroform when given continuously by any means which ensures "its free dilution with air, causes a gradual fall in the "mean blood-pressure, provided the animal's respiration is not "impeded in any way, and it continues to breathe quietly "without struggling or involuntary holding of the breath. As "this fall continues the animal becomes insensible, the "respiration gradually ceases, and, lastly, the heart stops "beating".(10)

In summing up they say:-

"I.A general fall of blood-pressure, whether sudden or gradual "is not in itself dangerous".

"II. The fall of blood-pressure which occurs in chloroformisa-"tion with regular breathing is due solely to narcosis of the vaso "-motor system, and is, if not a safe-guard, absolutely "harmless.

"III. The fall of blood-pressure under chloroform is not due "to weakening of the heart. The heart has nothing to do with "producing it, unless the vagus is stimulated, or unless its "nutrition/

"nutrition falls from imperfect oxygenation of the blood "due to abnormal breathing, or from stoppage of the "respiration from over-dosing" (11)

McWilliam, whose excellent work on the subject has often been quoted, took a somewhat different view, holding that the fall in blood-pressure caused by chloroform while, in great part due to the action on the vaso-motor centre, was to some extent also caused by direct action on the heart. "The fall of blood-pressure caused by chloroform is due "primarily to the depressing influence of the drug on the "vaso-motor centre, leading to arterial relaxation..... "at the same time to a more or less marked dilatation of "the heart".

"Ether can abolish the conjunctival reflex and "induce profound anaesthesia with no appreciable direct "effect on the heart; while chloroform in causing less deep "anaesthesia - in which the conjunctival reflex is not "abolished -- may directly cause marked dilatation of the "whole heart" (12)

Gaskell and Shore adopted a more extreme attitude attributing the fall in blood-pressure which chloroform causes primarily to dilatation of the heart and only in a secondary degree, if at all, to its action on the vaso-motor centre (13)

But the theory which finds most general acceptance today, backed by the careful experiments of McWilliam, and later of Leonard Hill [14] is that the fall of blood-pressure caused by chloroform is partly due to the action of the vaso-motor centre and partly to dilatation of the heart.

As regards the action of ether on the blood pressure different opinions prevail. McWilliam's experiments led him to the view that it causes a very slight fall. Kemp, on the other hand states that ether causes a slight rise in the general blood-pressure. [15] But neither claims any large variation from the normal.

So much for the experimental side of the question, I shall now turn to the clinical aspect illustrating my remarks with observations I have made on the behaviour of the blood-pressure during anaesthesia in surgical operations. It is necessary to preface those remarks by pointing out that causes other than the anaesthetic employed are at work as influences on the blood-pressure. The principal of these are shock and collapse.

Crile [16] in dealing with the subject defines shock as "A condition resulting from a fall in general blood-pressure due to exhaustion of the vaso-motor centres". and/

and collapse as "A condition resulting from a fall in "general blood-pressure due to inhibition of the vaso-motor "centres or a loss of the circulating fluids".
Lockhart Mummery[17] in his Hunterian Lecture speaking on the subject of shock said that "Shock may be produced in two "main ways (1) by injury to important nerve paths; and "(2) by exposure or injury of the abdominal viscera". He further points out that the former of those two causes may at first cause a rise in blood-pressure, due to stimulation of the pressor fibres which sensory nerves contain, on those becoming exhausted, but later a fall, due to stimulation of the depressor fibres; and also that no structural changes accompany shock as evident from the fact that no lesions are found in persons dying from shock, and that when recovery takes place, it is complete.

In writing on this subject previously I stated that in presence of severe shock chloroform anaesthesia is preferable to ether[18] Since that contribution I have continued to make observations of which, as well as of those made previously, I shall now make use.

The number of cases on which observations of the blood-pressure have been made is 211, of which 120 are chloroform anaesthesia, 91 in ether.

Wherever practicable I have made one or two readings on the day previous to operation, one reading on/

on the patient's arrival in the operating theatre, and as frequent readings as possible during the operation. It has frequently been a difficulty to obtain readings in the early part of the administration, because, as well as the disturbing effect on the patient, during struggling it was not possible.

Latterly in addition to those reading I have continued observations for some time after operation -- forty-eight hours or in some cases longer.

I have been greatly indebted for help to several students who have taken an interest in the work and who have made it possible to make observations during anaesthesia.

The instrument which I have used in estimating the blood-pressure is Martin's Modification of the Riva Rocci sphygmomanometer.

I have divided the illustrations into three classes showing:-

(1) The early influence of the anaesthetic.

(2) Cases in which the operation involved a slight degree of shock.

(3) Cases in which the operation involved a severe degree of shock.

(1) The early influence of the anaesthetic.

(a) Chloroform.

This drug causes a steady fall of blood-pressure. With the induction of the second stage this fall usually amounts to from 10 to 20 mms. Beyond the second stage a progressive fall continues and in deep anaesthesia it may be extensive.

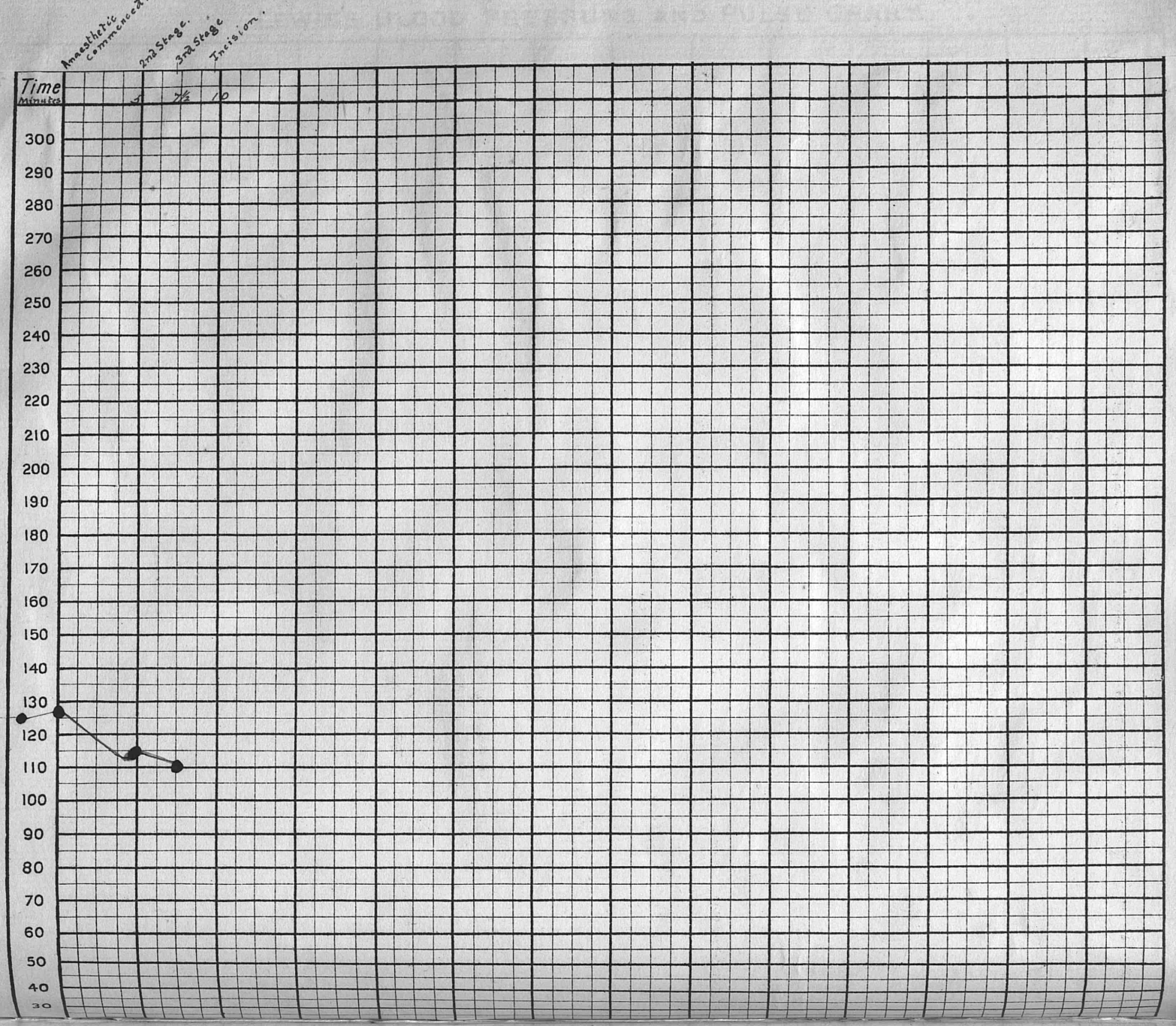
I

Name
Jno Orr.

Age 14

Disease
Tubercular Elbow.
Operation 14. 3. 10

Notes
Anaesthetic :-
Chloroform-Skinner Mask
13. 3. 10. B.P. 124



Case 1.

The above chart is from a boy of 14 years of age with healthy heart and lungs.

The anaesthesia was uneventful and requires no special comment.

On the day before operation his blood-pressure was 124 mm. (as marked to the left of the chart) On coming into the operating theatre a higher pressure was recorded, as is so often the case. This is probably due to the mental state. Janeway finds that "mental excitement is the most powerful "cause of increased pressure in the normal man".(99)

With the arrival of the second stage a fall of 12 mms. was recorded, then immediately after the commencement of the third stage a further fall of 5 mm's.

II

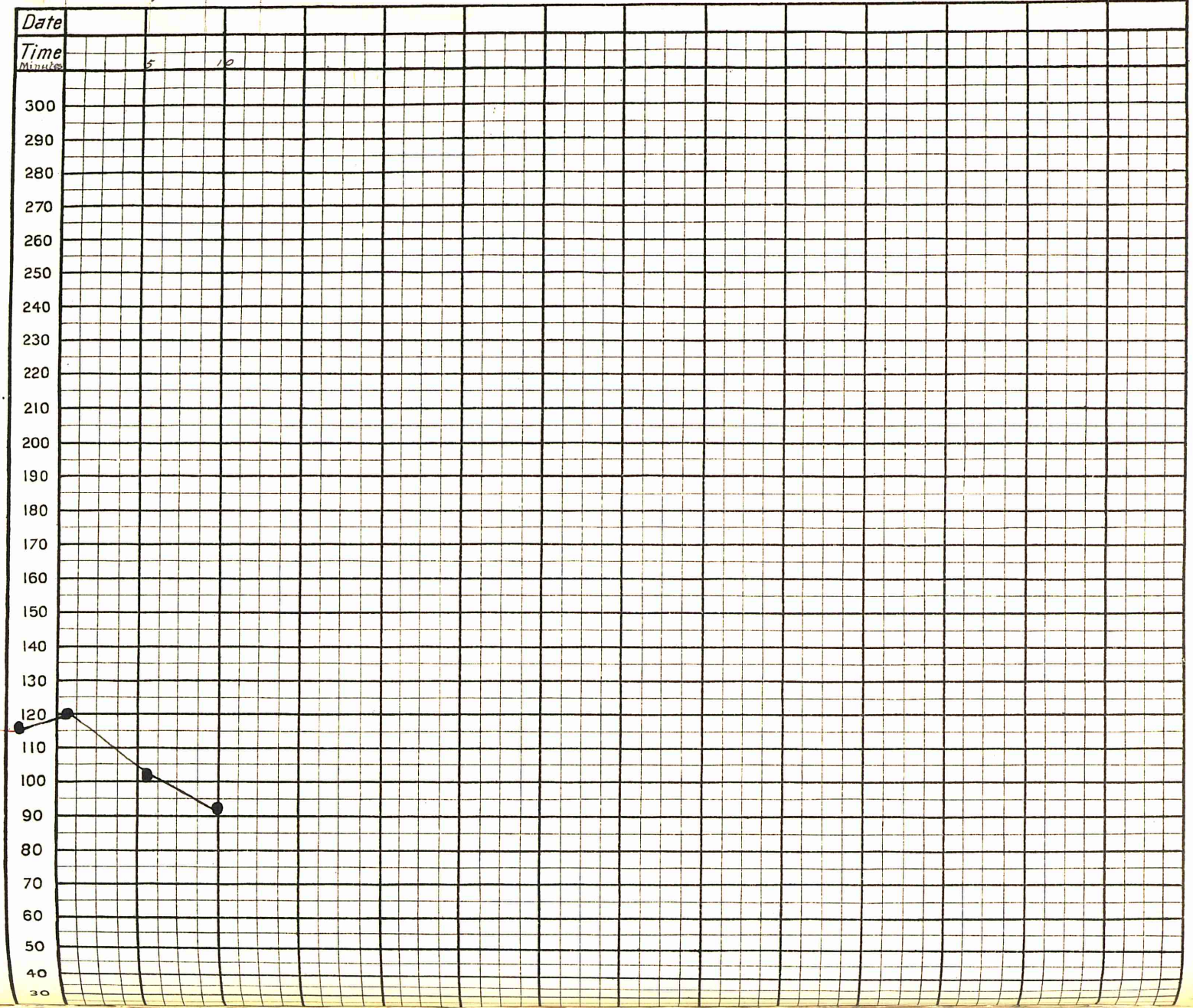
Name
Mrs Whyte

Age 30

Disease
Floating kidney
Operation 19. 1. 10.

Notes
Anaesthetic:-
Chloroform, Skinners mask.

19. 1. 10. B.P. = 118



Case 11.

In this case the blood-pressure on the day before operation was 118 m.m. On arrival in the theatre the reading was 120 mm's. Early in the second stage a fall of 11 mm's was recorded and in a light third stage a further fall of 8 mm's.

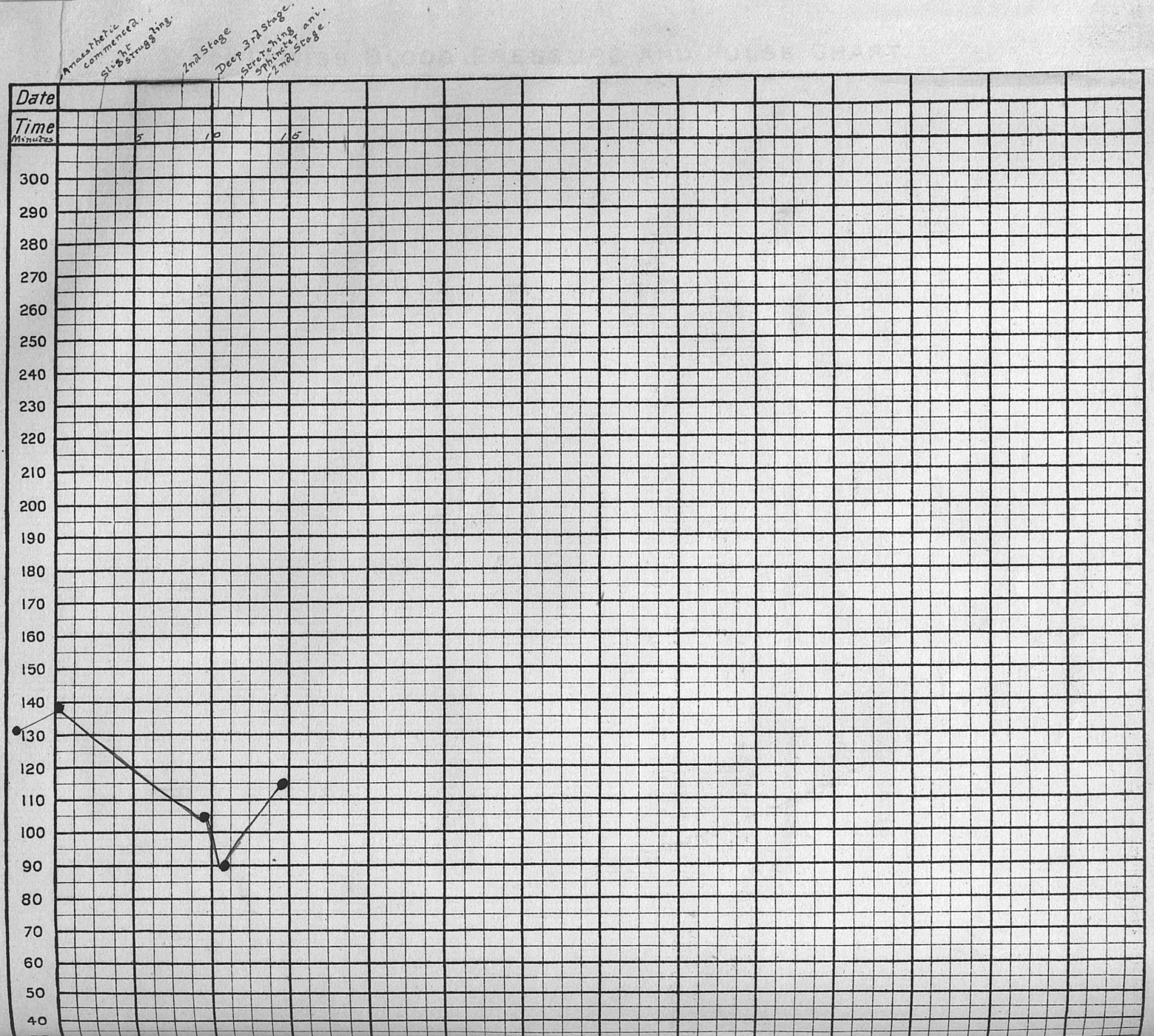
III

Name
James McArlan

Age 29.

Disease
Haemorrhoids.
Operation 26-4-12.

Notes
Anaesthetic :-
Chloroform, Skinner Mask.
26-4-12. B. P. +132.



Case III.

A healthy man well developed, a heavy drinker. The blood-pressure reading on the day before operation was 132 mm's. On being placed on the operating table the reading was 6 mm's higher than this. The induction of anaesthesia took nine minutes to the beginning of the second stage and was accompanied by very slight struggling. The third stage commenced at ten minutes and the anaesthesia was pushed until a deep third stage was induced. Accompanying this a marked fall in blood pressure took place to 105 mm's in the second stage, and to 90 mms. in the deep third stage. The patient was then allowed to "come out" to a light second stage and a reading taken just after the sphincter ani had been dilated, the pressure then stood at 115 mm's

(b) Ether.

With ether there is some variation in the behaviour of the blood pressure but as a rule no marked difference from the normal is caused. There may be a slight rise or a slight fall.

IV.

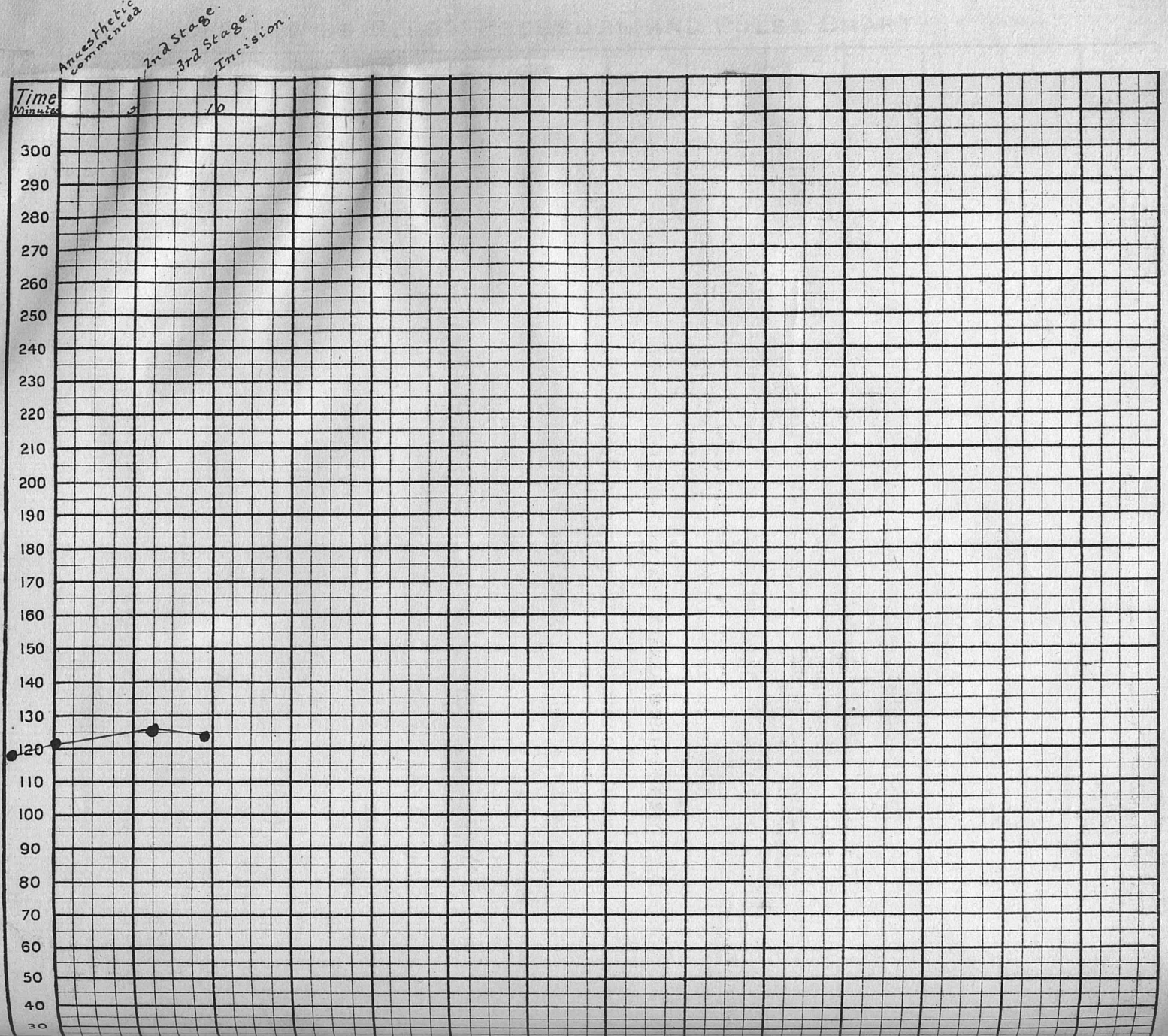
Name
Dante Equi

Age 18

Disease
Hernia.
Operation 22·12·11.

Notes
Anaesthetic:-
Ether, Clover's Inhaler.

21·12·11 B.P.= 119



Case IV.

A somewhat excitable Italian, aged 18. (Male). On the day before operation the blood-pressure was 119 mm's. Immediately before the anaesthetic was commenced it was 122 mm's. During the induction of the second stage, which was accompanied by some excitement with talking and slight struggling, the pressure rose to 126 mm's. With the arrival of the third stage it fell to 124; i.e. with full anaesthesia there was a slight mean rise above the patient's normal.

V

Name

Hannah Bryan.

Age 17.

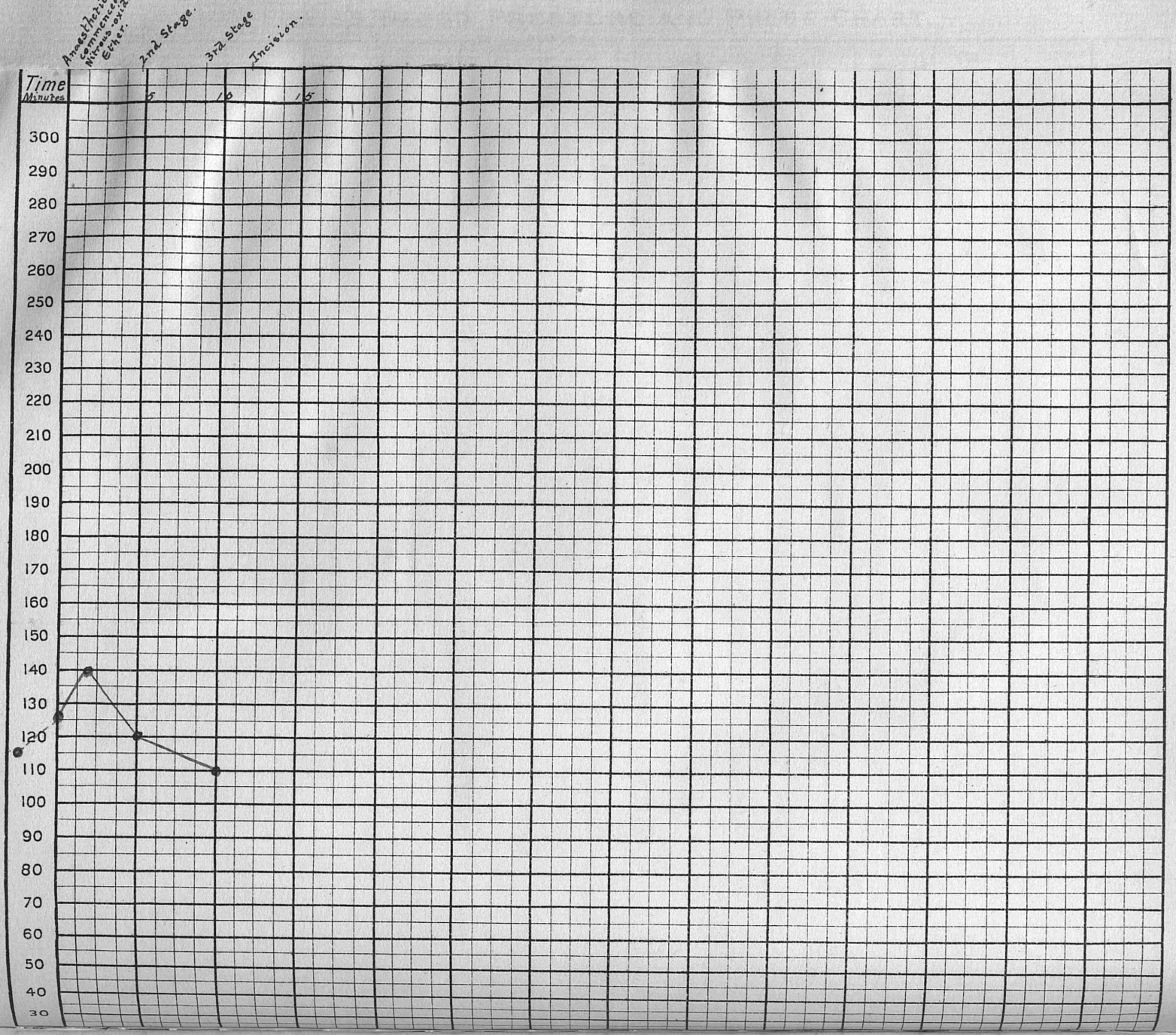
Disease

Renal Calculus
Operation 19.2.10

Notes

Anaesthetic:-
Nitrous-oxide – Ether,
(Clover Inhaler)

18.2.10 B.P. = 115.



Case V.

A girl of 17 with healthy heart and lungs, very nervous on coming into the operating room when the pressure was 11 mm's higher than on the previous day.

Anaesthesia was induced by means of nitrous oxide and ether and during the administration of the former the pressure rose 14 mm's. After its withdrawal and with the arrival of the second stage a fall of 20 mm's took place and a further fall of 10 mm's with the third stage. The final reading of 110 mm's was just below the patient's normal level.

The following case is interesting as an illustration of the effect on the blood-pressure of a change from ether to chloroform anaesthesia. This change is productive of a fall in blood-pressure from the patient's notmal but not usually so extensive as is caused by the induction of anaesthesia by means of chloroform.

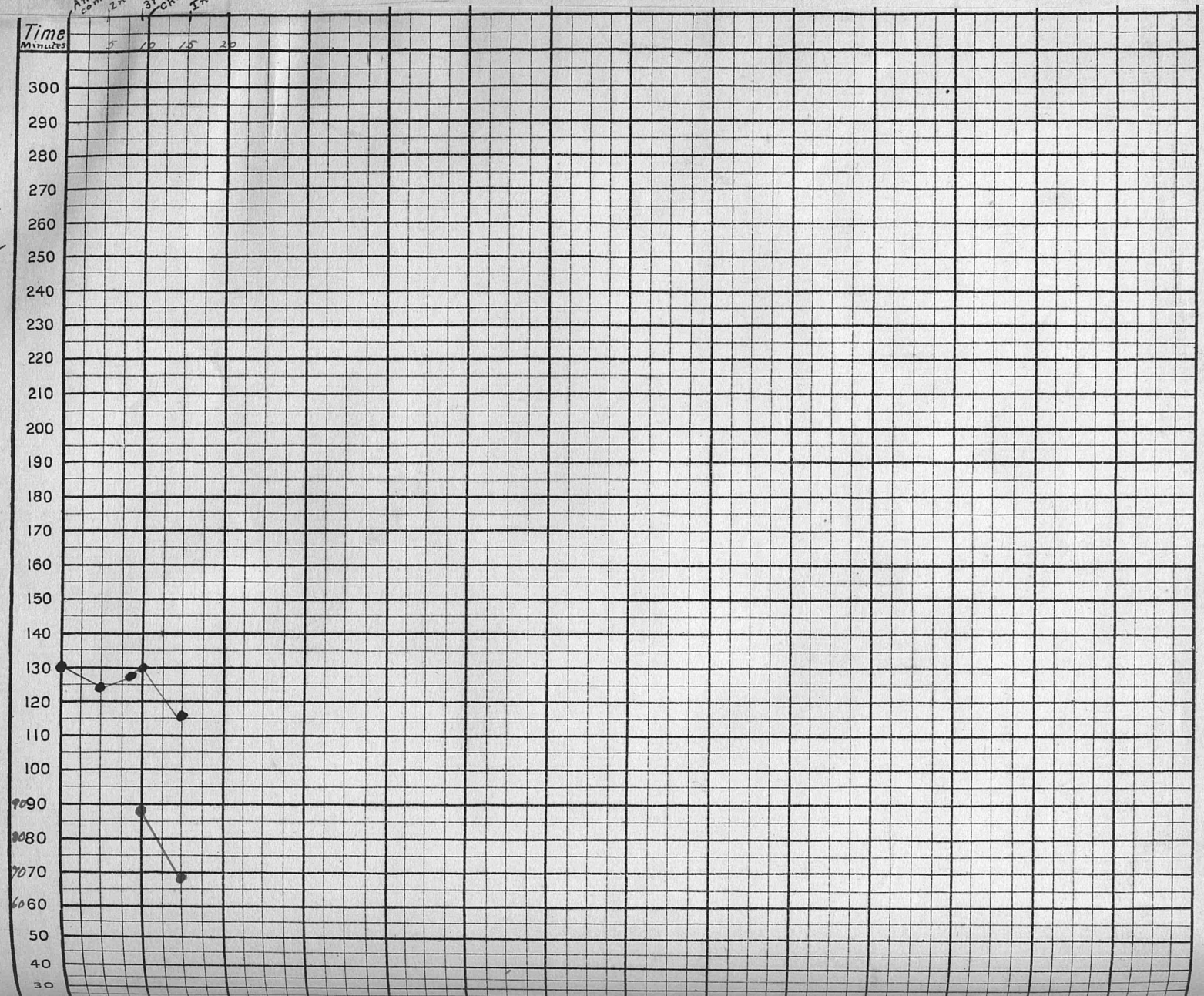
VI

Name
D. W.

Age 47.

Disease
Carcinoma of Stomach
Operation:- Exploratory laparotomy.

Notes
Anaesthetic:-
Nitrous oxide – ether – chloroform.



Case VI.

Well built man age 47.

Operation :- Exploratory laparotomy.

Anaesthesia was induced by the nitrous oxide - ether sequence. No blood-pressure reading was taken during the nitrous oxide stage. At five minutes a fall of 6 mm's was recorded, then during the third stage the pressure rose to the same level as at the commencement of anaesthesia. At eleven minutes a change was made to chloroform (Skinner's mask and drop method), and five minutes later the blood-pressure had fallen 15 mm's. The pulse-rate which was 88 per minute during the ether anaesthesia fell to 68 under chloroform.

The following charts give blood-pressure and pulse readings during and after operation. A division has been made between the readings taken during operation and those taken afterwards by a red line drawn across the chart.

(2) Cases in which the operation involved a slight degree of shock.

(a) Chloroform.

In this class the blood-pressure, after the fall which accompanies the induction of anaesthesia, remains at about the same level until the latter part of the operation, when, along with a less deep anaesthesia, it begind to rise again.

For some hours after the operation there is usually a slight drop followed by a rise to a point a little below the patient's normal.

1121

VII.

Minutes during Operation

Hours after Operation.

Anaes. commenced. 2nd Stage Incision. 3rd Stage Scraping Cyst. Anaes. discontd.

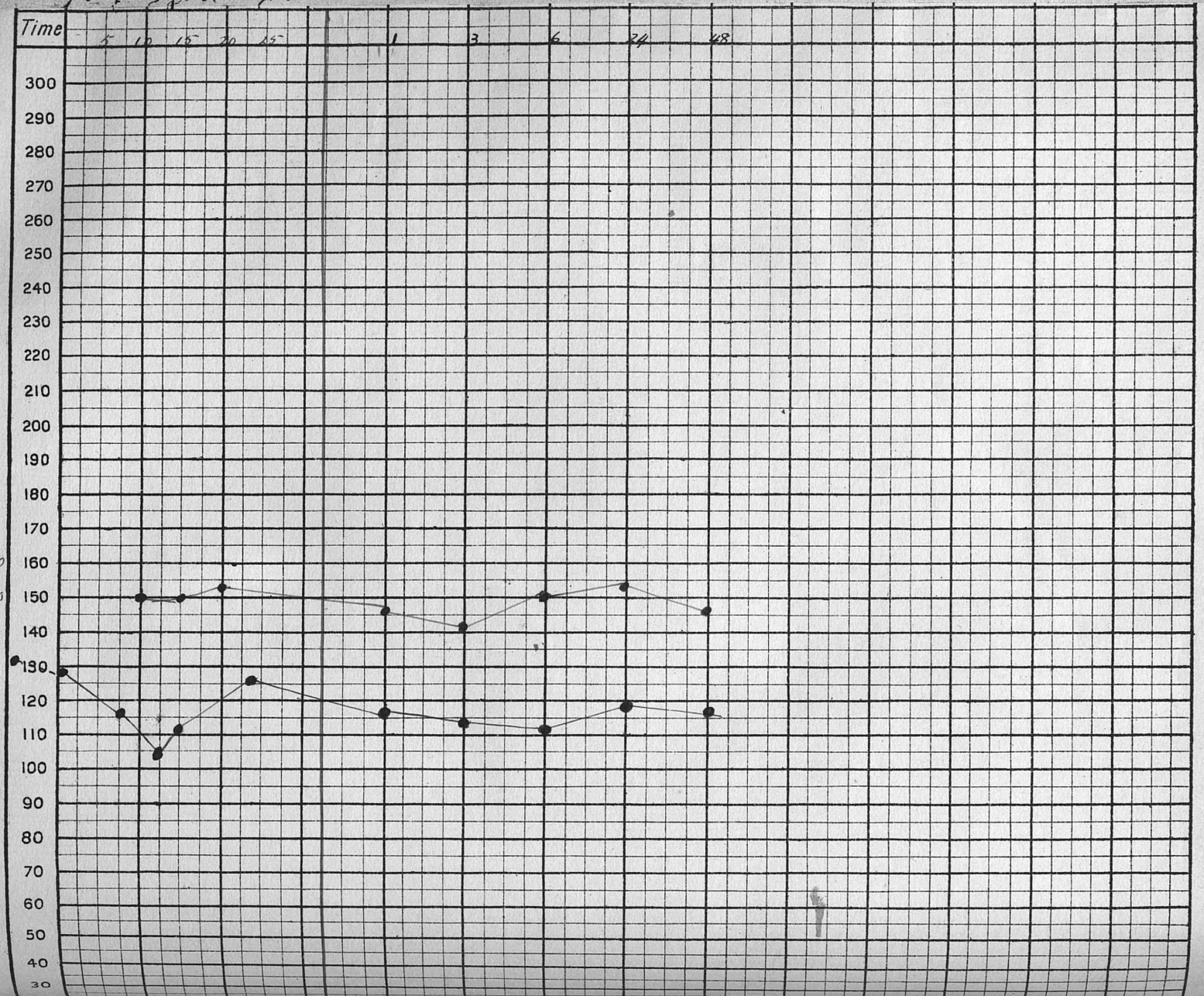
Name
A. Robertson

Age 39

Disease
Hydatid Cyst (Hepatic) scraping 3.5.11

Notes
anaesthetic - Chloroform

B.P. 132 - 2.5.11



Case VII.

A man of 39 years of age, a heavy drinker.

Heart normal. Slight chronic bronchitis.

The operation involved the opening and scraping of a hydatid cyst of the liver. Anaesthetic for 23 minutes.

The cyst was superficial and the peritoneal cavity was not opened.

The blood pressure fell, with the induction of anaesthesia, 23 mm's. The reading for the third stage was taken at twelve minutes just after the incision had been made. After this a lighter anaesthesia was allowed and the next reading showed a rise of 7 mm's. The last reading taken during anaesthesia was 2 mm's below the one taken at the commencement.

Afterwards, at first a fall was recorded; then, at twenty four hours, a slight rise had taken place.

The variations in the pulse rate were small.

1480

VIII.

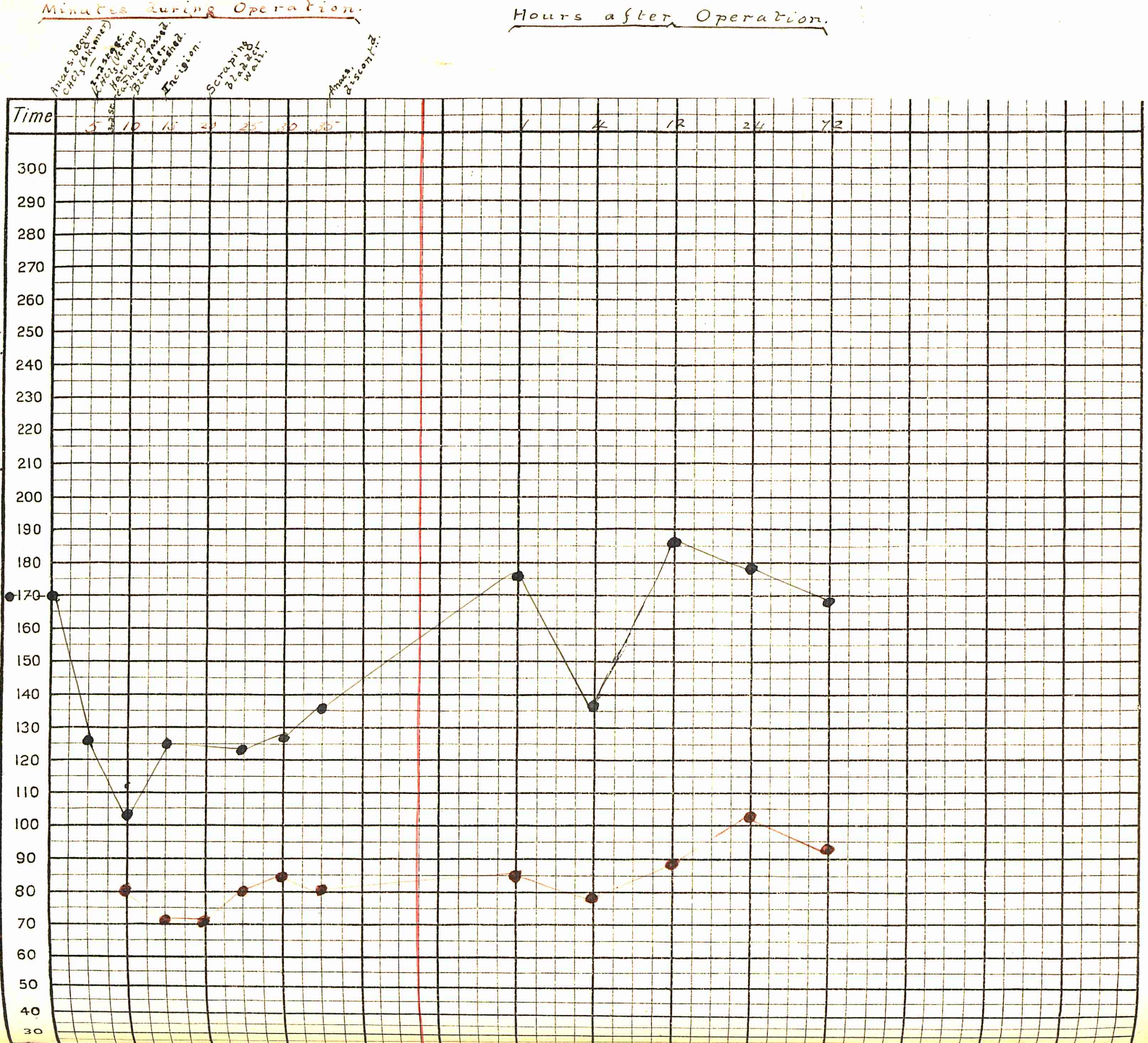
Name
Ebenezer Gordon

Age 56

Disease
Papilloma of Bladder.
Op:- Removal of tumour & scraping of bladder wall. 13.12.11.

Notes
Anaesthetic:-
Chloroform (Vernon Harcourt after induction by Skinner's mask)

11.12.11 B.P. = 170
P = 84.



Case VIII.

A man aged 56. Moderate drinker.

Heart loud 2nd.sound at aortic area.

No murmurs. Arterio sclerosis.

Chronic bronchitis.

Operation :- Opening bladder, removal of papillonia.

Anaesthetic, 35 minutes.

Violent struggling took place during induction and the patient thereafter went into a deep third stage. The pressure fell 68 mm's. A much lighter anaesthesia was then allowed and the next reading, taken just after the incision, was 23 mm's higher. Towards the end of the operation a further rise took place.

An hour after the operation the pressure had risen to a point about the patient's normal. Then, four hours after the end of the operation, a considerable fall took place followed by another rise. There was some haemorrhage following on the operation.

In this case the pulse slowed down with falling blood-pressure.

(b) Ether.

The early part of the operation usually causes a slight fall, after this the pressure remaining fairly constant during the operation. Afterwards the pressure rises to a level near the patient's normal.

1163

IX.

Minutes during Operation.

Hours after Operation

Anaes. began. | 2nd stage 3rd stage Excision | Stitching Sut. Stitching Wound | Anaes. ceased.

Date

Time 5 10 15 20 25 | 1 | 3 | 6 | 12 | 24 | 48 | 72 | 120

Name

Jas. Brownlie

Age 24.

Disease

Inguinal Hernia.
Opn:- Radical Cure.
29.5.11.

Notes

Anaesthetic:-
-Ether (Clover)

27.5.11
Pulse 56.
B.P. 124.

Pulse Rate. 120 110 100 90 80 70 60

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

Case IX.

A man aged 24.

Heart and lungs normal.

Operation :- Radical cure of Inguinal Hermia.

Anaesthetic, 26 minutes.

The pressure fell slightly during induction and again 7 mm's early in the operation then rising slightly towards the end of anaesthesia.

Afterwards the readings were a little lower until at twelve hours a rise was recorded to a point slightly below the normal level.

The pulse rate fell very decidedly during anaesthesia much more than is usual with ether.

1111

X

24 hours before Opr.

Minutes during Operation

Nitrous Ethyl Oxide — 2nd Stage — Incision — Anaes discontd.

Hours after Operation

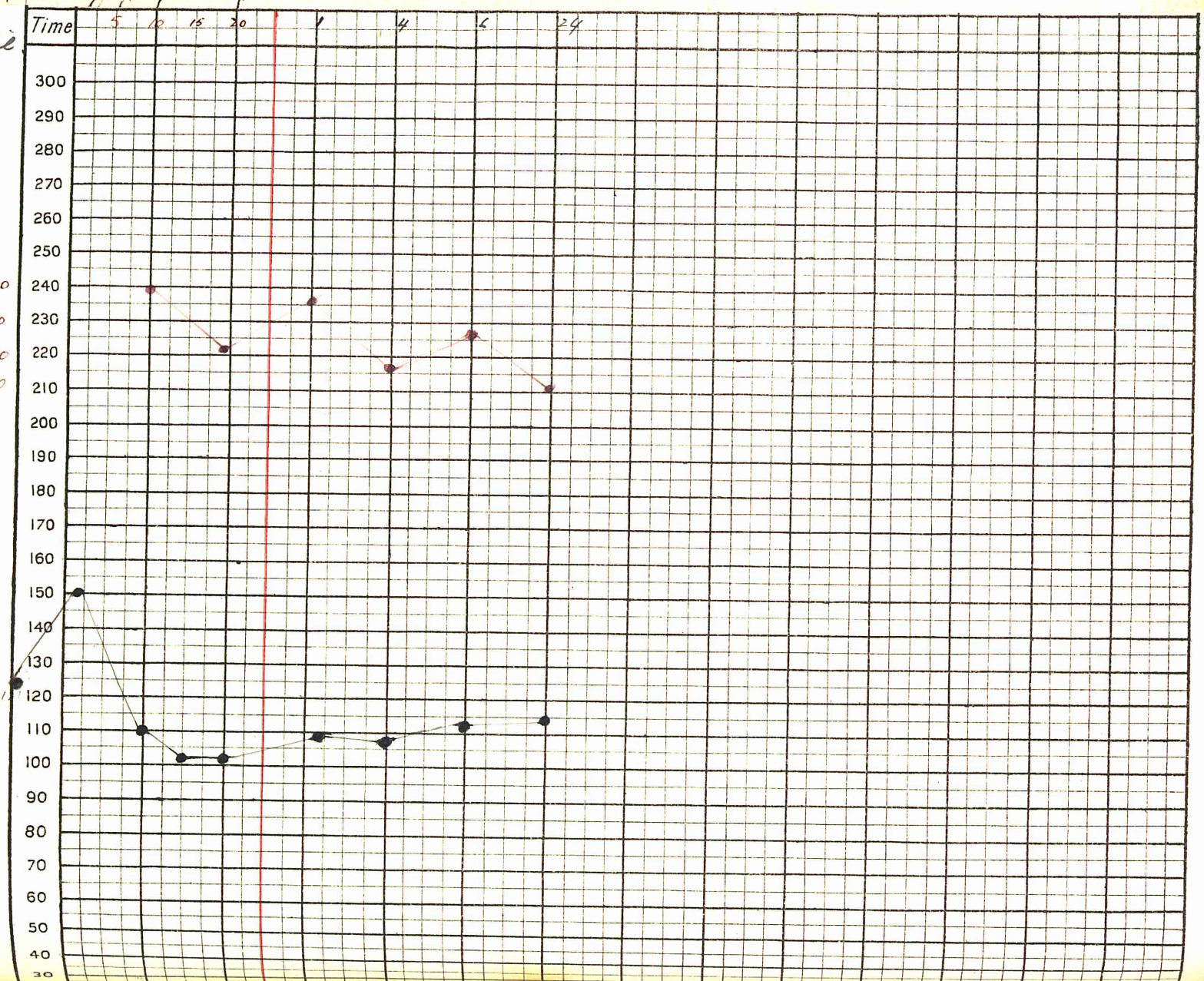
Name
Isabella McCreadie

Age 18.

Disease
Tubercular Glands of neck:- Abscess. Scraping 29/4/11

Notes
Pulse rate: 120, 110, 100, 90
Immediate.
Nitrous oxide & Ether (Clover)
B.P. 28·4·11 = 121

Blood pressure (m m's. Hg)



Case X.

A stout girl aged 18.

Heart and lungs normal.

Operation :- For Tubercular glands of neck.

Anaesthetic, 18 minutes.

Unfortunately no blood-pressure reading was obtained on the patient's arrival in the theatre before the commencement of anaesthesia, but on the day before operation it was 121 mm's.

During nitrous oxide administration it was 150 mm's; thereafter with the arrival of full anaesthesia a fall of 40 mm's took place, the level then being 11 mm's below the patient's normal, and during the operation a further fall of 8 mm's.

After the operation a progressive rise was recorded until at the end of twenty four hours it had reached 115 mm's.

(3) Cases in which the operation involved a severe degree of shock.

The best illustrations of this class of cases are abdominal sections as any intra-abdominal manipulation is productive of shock. Most of the following charts will be taken from this class, but in addition there are other useful illustrations such as :- some herniae, the degree of shock depending to a great extent on the amount of manipulation of the sac, and possibly on its contents; operations involving manipulation of the testicle; Halsted's operation for removal of the breast and axillary glands where in addition to considerable haemorrhage the large exposed subcutaneous area with injury to afferent nerves is productive of severe shock.

(a) Chloroform.

After the initial fall in blood-pressure which accompanies the induction of anaesthesia any surgical procedure causing shock produces a second fall. The pressure usually remains low during the early part of the operation, beginning to rise with the stitching up of the wound. The early readings after operation usually show a slight fall below the level reached at the end of operation then a gradual rise takes place.

1214

XI

Name

Alec Johnston.

Age 15

Disease

appendix abscess.

Operation:- abscess opened; appendix removed. 6.7.11

Notes

Anaesthetic:- Chloroform, (Skinner's Mask)

5.7.11. B.P = 116.

Minutes during operation.

Anaesthetic begun. | 2nd Stage | 3rd Stage. | Incision | Peritoneal Incision. | Abscess opened | Manipulation of Bowel. | Appendix removed. | Anaesthetic discontinued.

Hours after Operation.

Time: 5' 10' 15' 20' 25' 30' 35' 1 6 12 24 48 72 96

Pulse Rate: 100 90 80 70 60 50 40

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

Case XI.

A spare lad of 15.

Heart and lungs normal.

Operation:- Appendix abscess opened and appendix removed.

Anaesthetic, 32 minutes.

During a quiet induction of anaesthesia the blood pressure fell 25 mm's then remained almost constant until immediately after the opening of the peritoneal cavity when a fall of 9 mm's occurred. The readings continued to be low till the discontinuance of the anaesthetic after the intra-abdominal manipulation had ceased when a rise of 7 mm's was recorded. One hour after the patient's return to bed a further slight rise had occurred but not until twenty four hours after did any distinct rise occur. At that time the pressure recorded was 2 mm's lower than the reading taken on the day before operation.

1117.
X XII.

Minutes during Operation

Hours after Operation.

Anaes. begun
2nd Stage
3rd Stage
Incision
Peritoneum opened
Manipulation of bowel
Stitching
Anaes. discontd

Name
Mary Connal

Age 12.

Disease
appendicitis
Op. for appendectomy
3/5/11

Notes
Anaesthetic
$CHCl_3$
(Skinner's mask)
B.P. 1/5/11 = 113

Date
Time 5 10 15 20 25 30 1 2 7 24 48

Pulse Rate

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

120 110 100 90 80 70

Case XII.

A well built girl 12 years of age.

Heart and lungs normal.

Operation:- Appendectomy.

Anaesthetic, 28 minutes.

No struggling took place during the induction which was accompanied by a fall in blood-pressure of 22 mm's. During a somewhat lighter anaesthesia it rose 6 mm's, then just after the peritoneal incision the reading showed a drop of 22 mm's. The readings towards the end of the anaesthesia again indicated a rise, continuing at two hours after the finish of the operation. Thereafter a gradual fall took place, while at twenty four hours the temperature rose to 103.2°.

1127.

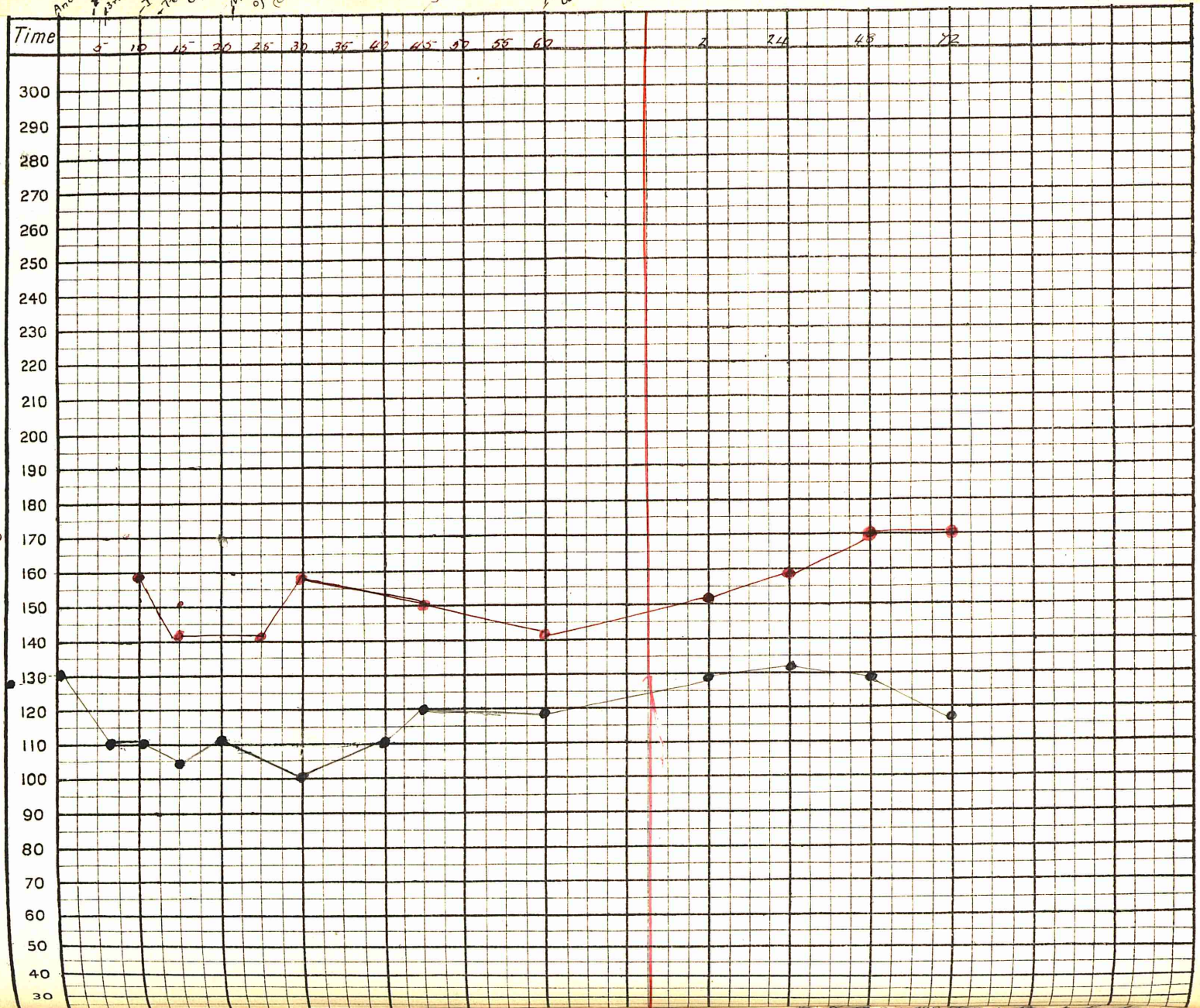
XIII.

Name
Mary Doherty

Age 24

Disease
Ventral Hernia.
Op.n
Radical Cure.
6·5·11

Notes
anaesthetic.
$CHCl_3$
(Shriner's mask)
4·5·11 BP = 127



Case XIII.

A stout girl. Age 25. Very nervous.

Heart and lungs normal.

Operation:- For ventral hernia.

Anaesthetic, one hour.

Excitement stage, accompanied by struggling and screaming. The fall in blood-pressure after the peritoneal incision was small and not until a later stage, during the manipulation of the viscera, was a decided fall observed. During this manipulation the lowest reading was taken and thereafter a progressive rise followed.

Unfortunately very few readings could be obtained after operation, none being taken between two and twenty-four hours. Both indicated a progressive rise.

120

XIV

Name

John McWilliams.

(Heavy drinker)

Age 38.

Disease

Hydrocele.

Uni:-

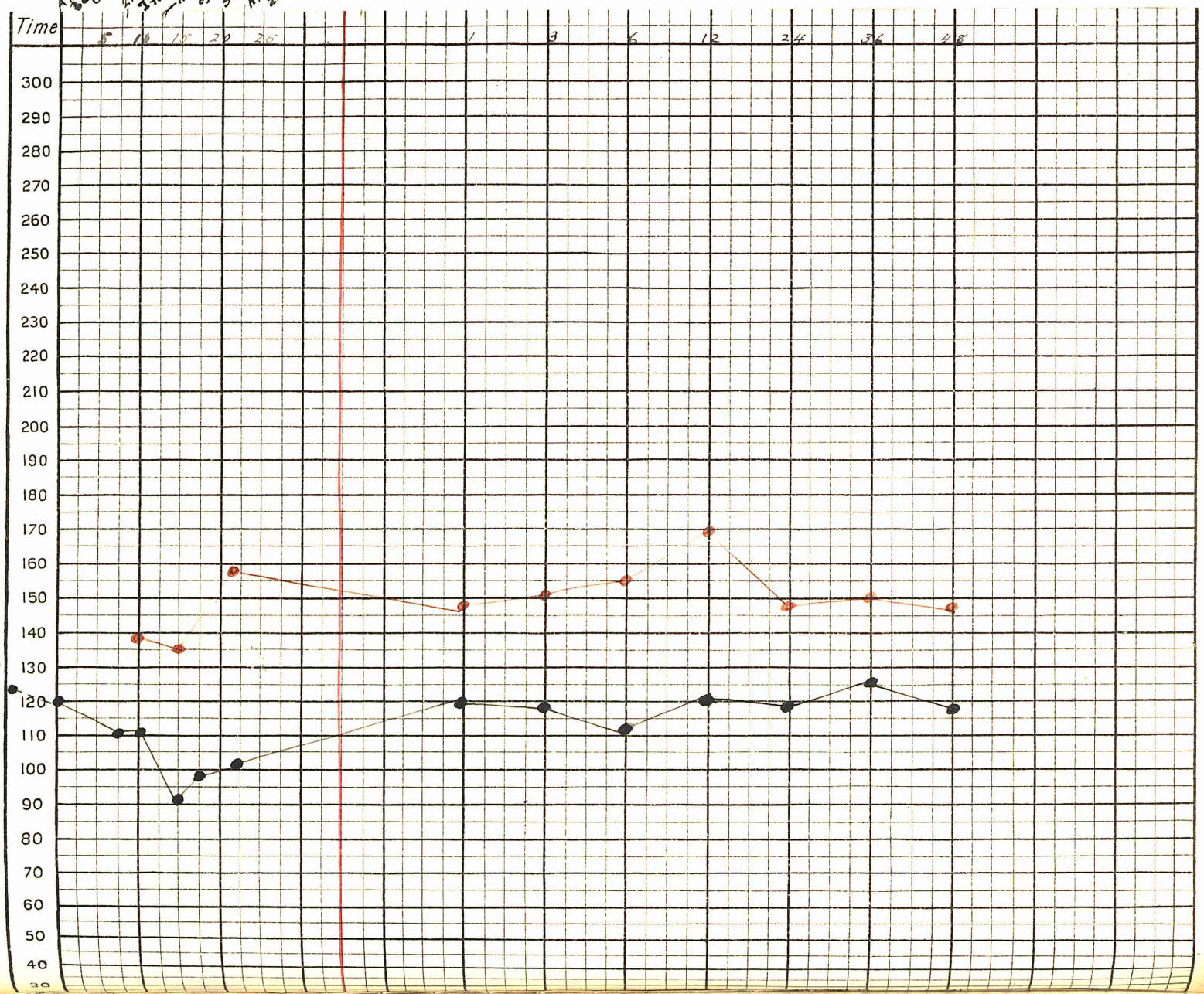
Radical Cure.

Notes

Anaesthetic.

Chloroform (Skinner)

2·5·11. B.P. = 122.



Case XIV.

A muscular man. Aged 38. Heavy drinker.
Heart normal. Slight chronic bronchitis.
Operation:- Radical Cure of Hydrocele.
Anaesthetic, 22 minutes.

The induction was attended by violent struggling but was not accompanied by so marked a fall in blood-pressure as is usual. On the arrival of the third stage the pressure had fallen 10 mm's. A fall of 20 mm's took place however during the manipulation of the testicle. Then, with the finish of the anaesthesia, a rise of 12 mm's, and one hour afterwards of 20 mm's more. After this a slight fall and a second rise at twelve hours, this time being well maintained.

427

XV.

Name

Mrs Mc Bride

Age 25

Disease

Pyosalpinx.

Double Salpingectomy.

10·1·10

Notes

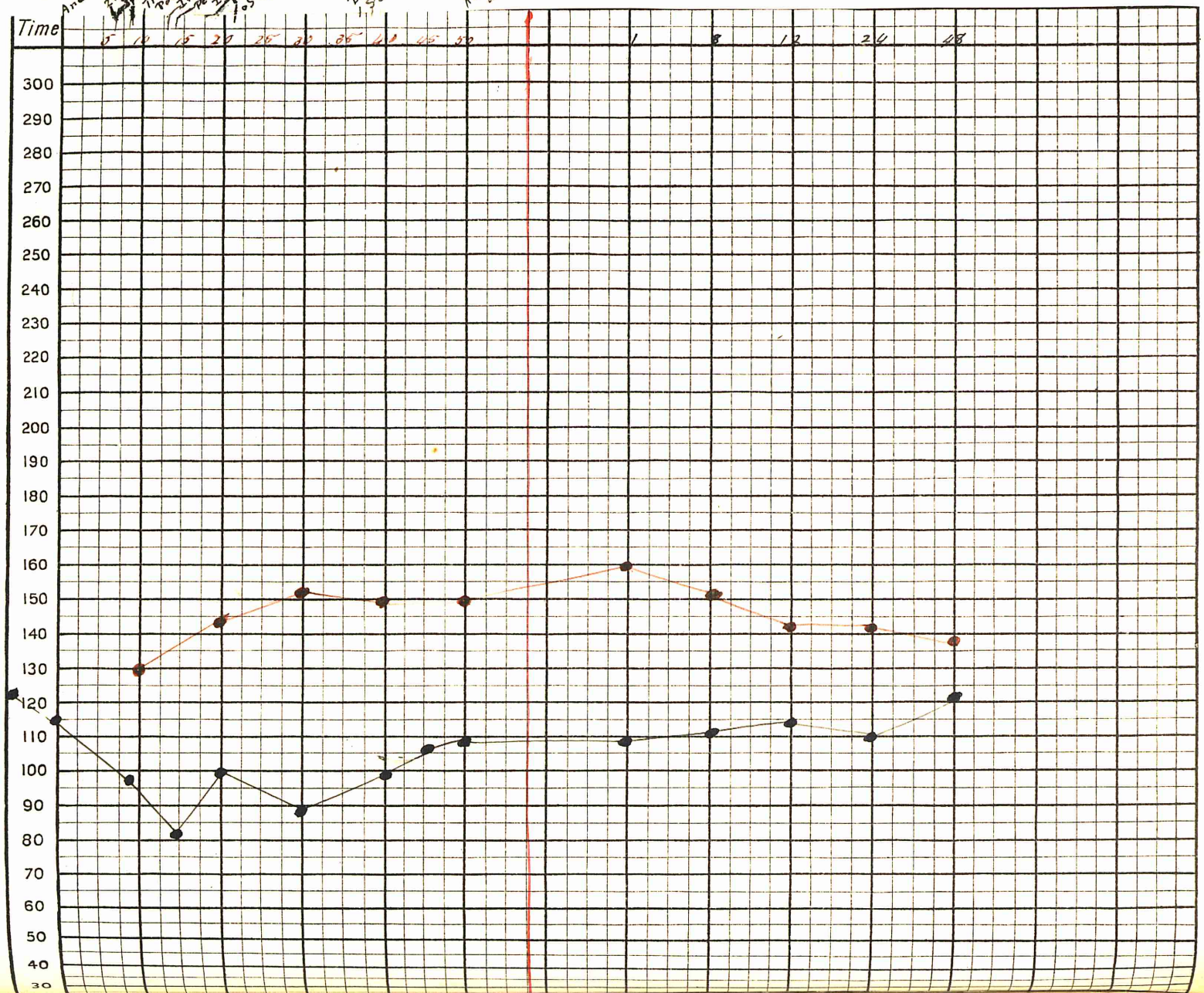
Anaesthetic:-

Chloroform (Skinner)

8·1·10 BP = 121

Minutes during Operation.

Hours after Operation



Case XV.

A thin anaemic woman. Age 25.

Heart and lungs normal.

Operation:- Double Salpingectomy for Pyosalpinx with adhesions.

Anaesthetic, 50 minutes.

The induction was quiet, the blood pressure falling 18 mm's, and after the peritoneum was opened 15 mm's. Then during too light anaesthesia with some muscular rigidity it rose 19 mm's accompanied by a quicker pulse. The anaesthetic was pushed to the induction of a good third stage, and during manipulations involving the freeing of the Fallopian tubes a fall again took place. Then with the superficial part of the operation - the stitching of the parietes - a rise commenced which was well maintained after the operation.

406

XVI

Name

A. Milree

Age 30

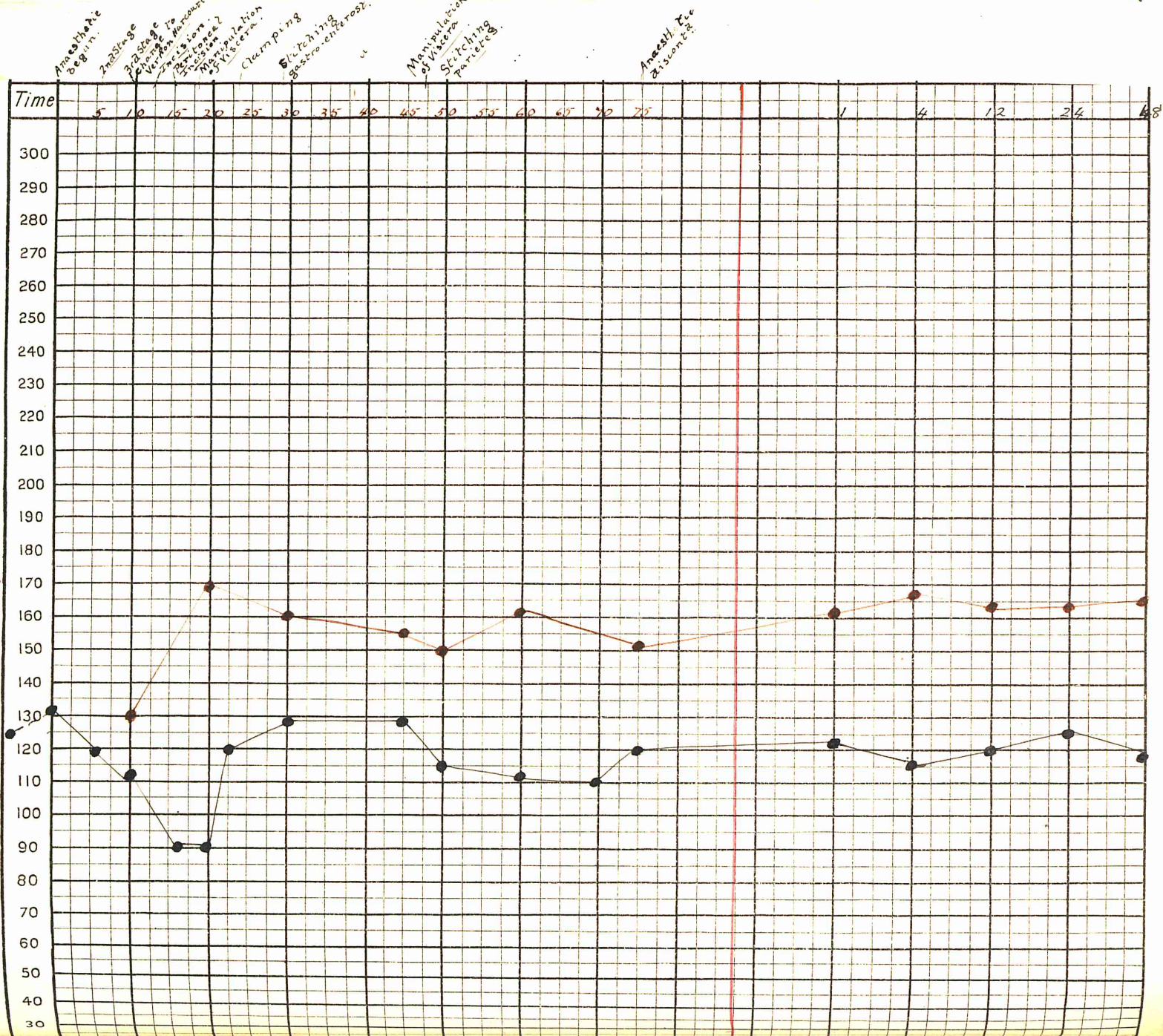
Disease

Duodenal Ulcer.
Operation:—
Gastro-enterostomy.

Notes

Anaesthetic.—
Chloroform
Skinner's Mask &
Vernon-Harcourt.

17·12·09 B.P. = 125.



Case XVI.

Man age 30. Abstainer.

Heart and lungs normal.

Operation:- Gastro-enterostomy for duodenal ulcer.

Anaesthetic, 75 minutes.

Induction by the drop method without struggling, then the Vernon Harcourt inhaler employed maintaining a satisfactory anaesthesia.

The fall in blood-pressure which accompanied the opening of, and the early manipulations in, the abdomen was followed during the clamping and stitching of the stomach, and jejunum, by a decided rise continuing until the manipulation which accompanied the returning of the organs to the abdominal cavity, when a fall of 14 mm's. took place. I am unable to explain this rise but have observed it, though never so marked, at the same period in other gastro-enterostomy cases. It was accompanied by slowing of the pulse.

The pressure at the end of, and subsequent to, operation again had an upward tendency.

1748

XVII

Name

Mrs Wallace.

Age 63.

Disease

Cancer of Breast.

Operation:—

Excision.

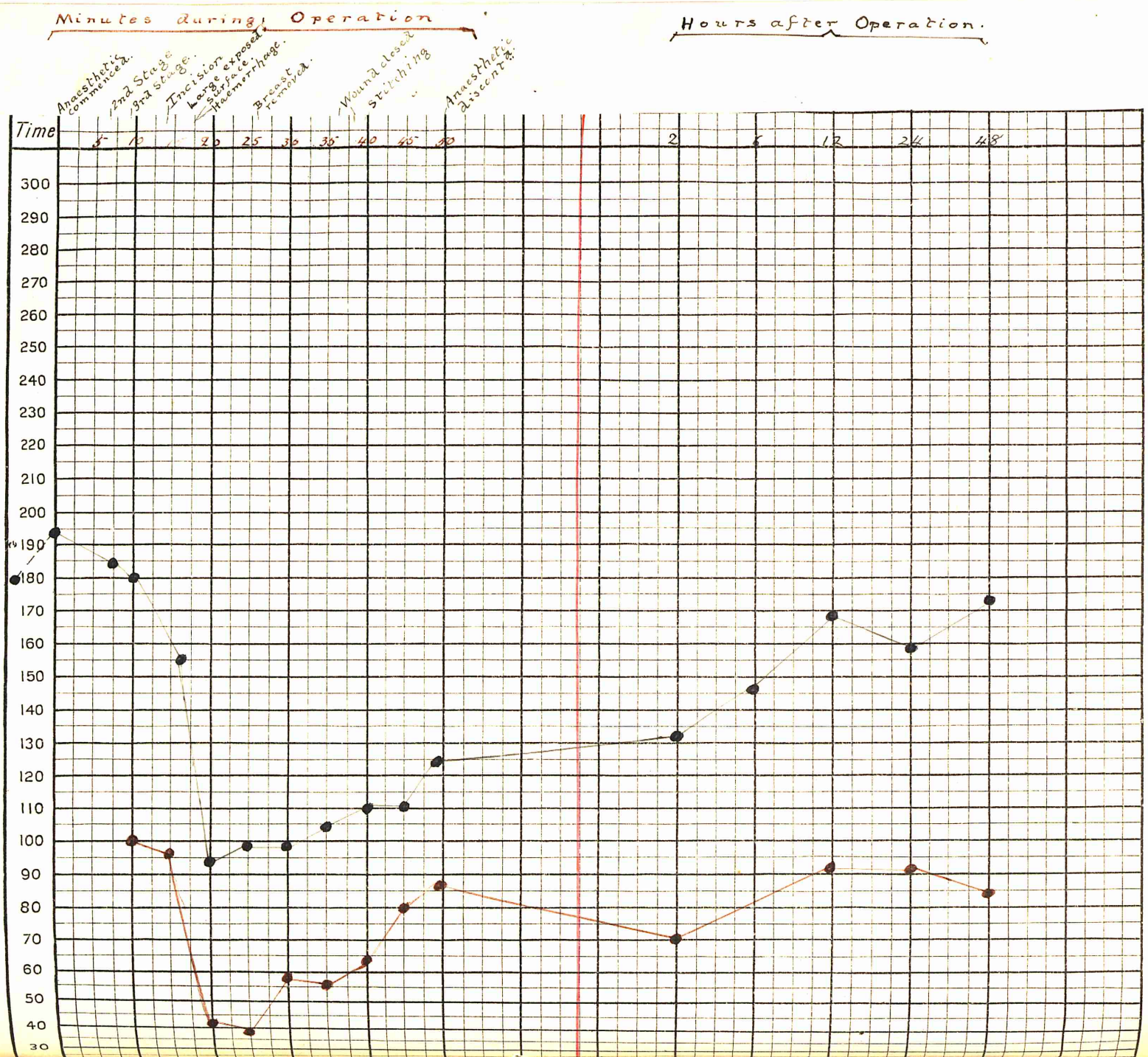
19.4.12.

Notes

Anaesthetic:-

Chloroform, Skinner's Mask.

19.4.12 BP = 180.



Case XVII.

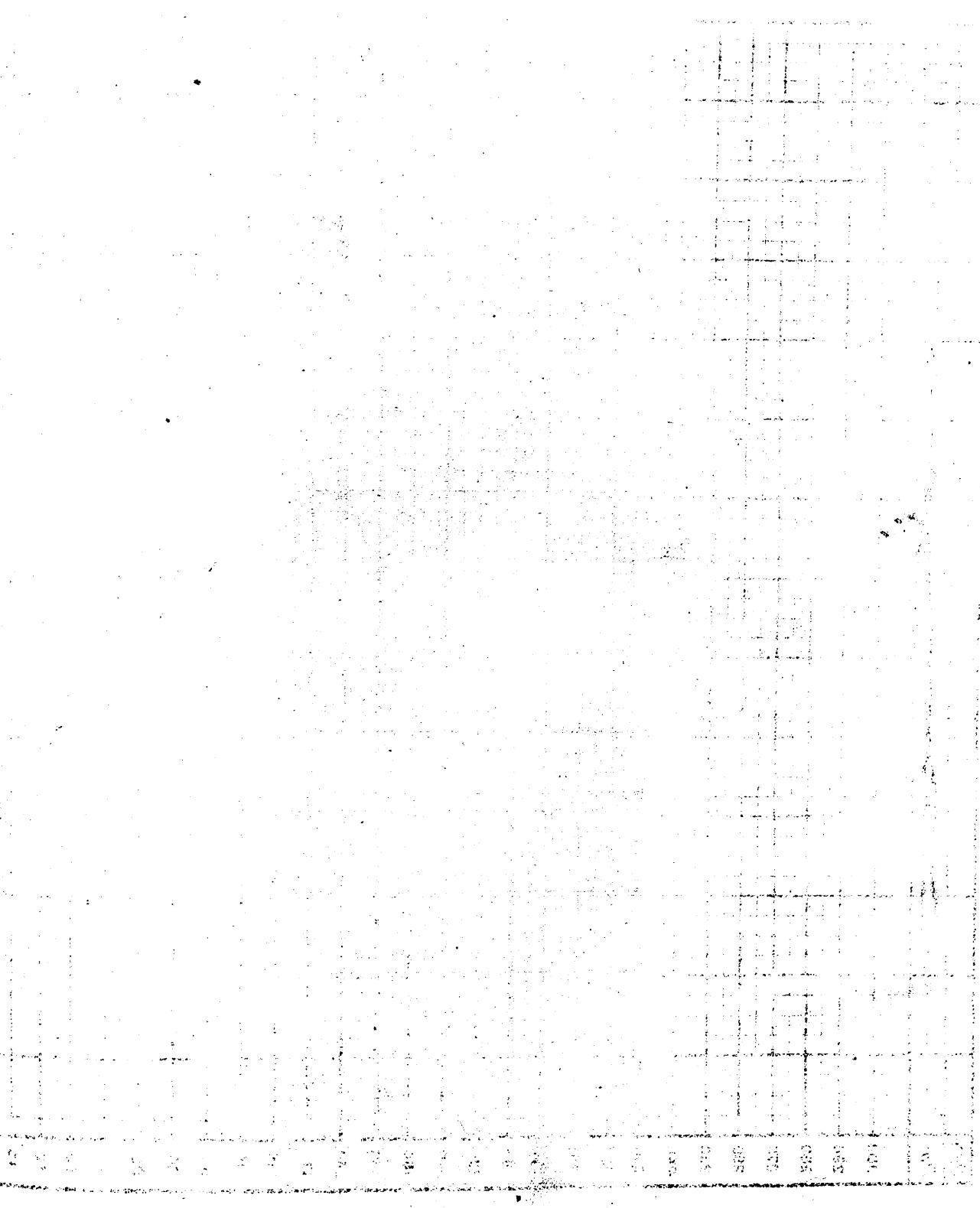
A very stout woman, aged 63. An abstainer.
Heart normal. Arteries thickened.
Chronic bronchitis.
Operation:- Halsted's excision of the breast and axillary glands.
Anaesthetic, 50 minutes.

The induction was accompanied by slight struggling and by a fall in blood-pressure of 14 mm's. From the time of the incision the pressure began to fall decidedly, and with the exposure of a large area of chest muscle and fascia a drop from 180 mm's to 94 mm's occurred, the largest I have seen recorded during any operation. Accompanying this there was very marked slowing of the pulse which at one time was beating 38 per minute. With the removal of the breast and even more with the closing of the wound by forceps the pressure began to rise and the pulse rate to increase, and by the time the stitching was finished the former had gone up to 124 mm's. and the latter to 86 per minute.

There was a steady rise in blood-pressure after the operation until at twelve hours it was 11 mm's below the reading taken the day before operation.

(b) Ether.

As a rule the level reached by the blood pressure in the early stages of surgical shock during ether anaesthesia is not so low as during cholorform anaesthesia. But as the operation advances, and towards its finish, there is a tendency for the pressure to remain low or even to go lower; and during the early hours after the patients' return to bed this downward tendency is usually still in evidence, there being often an interval of twelve hours or more before a rise commences.



1509. XVIII.

Minutes during Operation.

Hours after Operation

Anaes. begun. | 2nd Stage. | Peritoneal Incision | Manipulation of Viscera. | Stitching | Anaes. discont.

Time: 5 | 10 | 15 | 20 | 2 | 4 | 12 | 24 | 48 | 72 | 96

Name
Owen Reehill

Age 43

Disease
Cancer of intestine & liver.
Op: Exploratory Laparotomy.
30.12.11

Notes
Anaesthetic:-
Ether (Cloves)

Ship patient
Alcoholic

29.12.11
Pulse 88
B.P. 122

Pulse Rate.

120	170
110	160
100	150
90	140
80	130
70	120
60	110
	100
	90
	80
	70
	60
	50
	40
	30
	300
	290
	280
	270
	260
	250
	240
	230
	220
	210
	200
	190
	180

Case XVIII.

A spare man, aged 43, heavy drinker,
heart and lungs normal.
Operation:- Exploratory laparotomy for
Carcinoma of the Liver and Intestine.
Anaesthetic, twenty-one minutes.
Violent struggling during the first stage.

With the arrival of the second stage the blood-pressure had risen 13 mm's. The next reading was taken after the peritoneal incision when a fall of 25 mm's had occurred, and later during the intra abdominal manipulation, another of 14 mm's. At the end of the administration a further fall of 8 mm's. the reading being then 92 mm's. The reading two hours after operation was 108 mm's. After which lower readings were recorded until twenty four hours after when the pressure reached 110 mm's.

Three days after his operation a transitory low blood pressure was observed. Readings extending over three hours were all about the same level, 80 mm's. There was nothing in the patient's condition to account for it. He made a good recovery so far as the operation was concerned. The progress of his disease was not arrested.

1158 XIX.

Minutes during Operation — Hours after Operation.

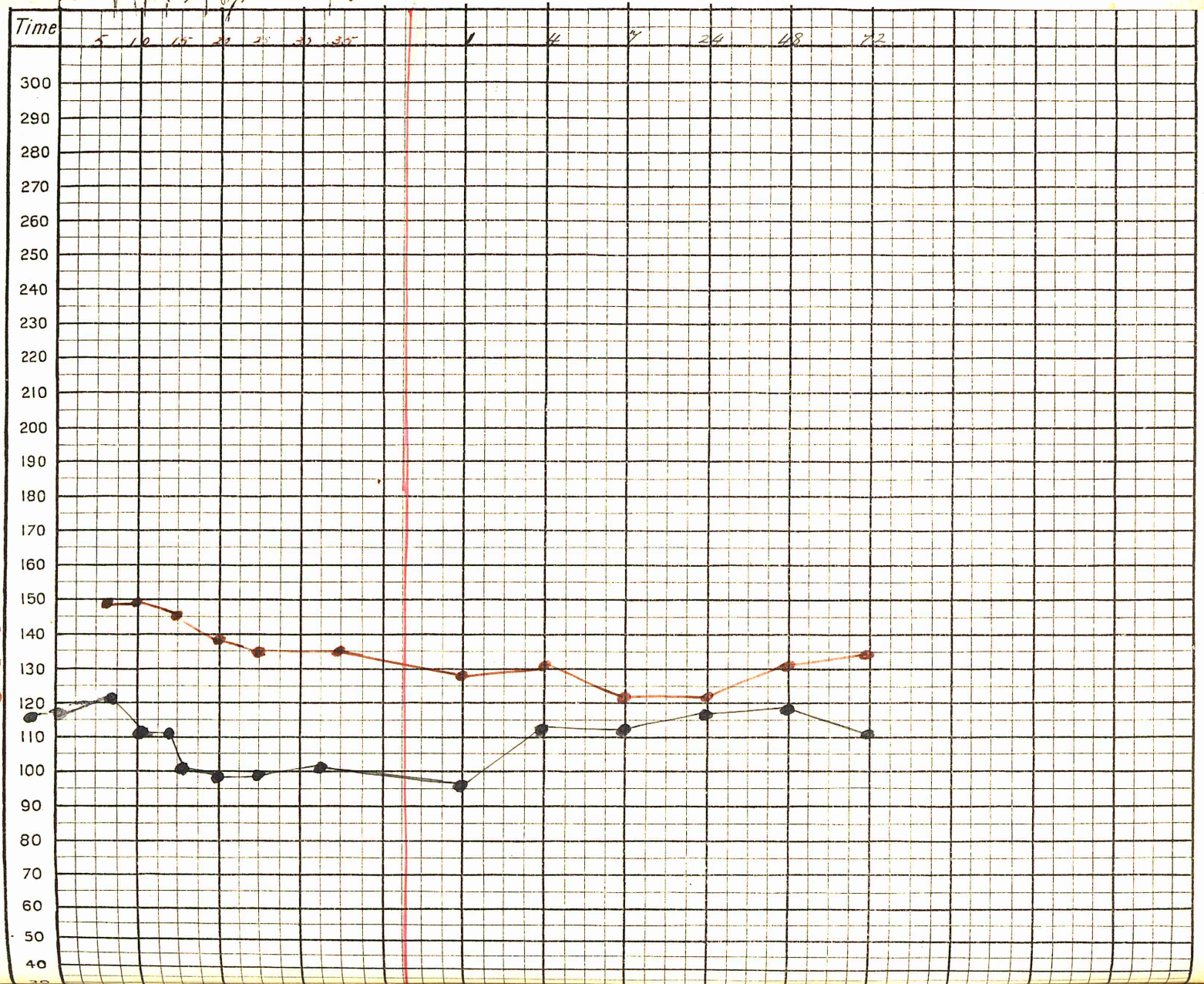
Anaes begun. 2nd Stage 3rd Stage Incision Peritoneal Incision Manipulation of Intestine Stitching Anaes discont'd

Name Mrs Arnold

Age 46

Disease appendicitis. Opn:- appendicectomy. 26.5.11.

Notes Anaesthetic:- Ether. Clover. 25.5.11. Pulse 80 BP 116



Case XIX.

A stout woman. Age 46. Abstainer.

Heart and lungs normal.

Operation :- Appendectomy.

Anaesthetic, 33 minutes.

Quiet first stage with a rise of blood-pressure of 6 mm's at the beginning of the second stage and a fall of 10 mm's at the beginning of the third.

During the early manipulation in the abdomen a fall of 12 mm's occurred and the pressure remained in the neighbourhood of 100 mm's during the remainder of the operation, and at the first subsequent reading, taken an hour after. The later readings showed a progressive rise.

1104

XX

Name

A. Scott.

Age 22.

Disease

Inguinal Hernia.

Operation:- Radical Cure.

28·4·11

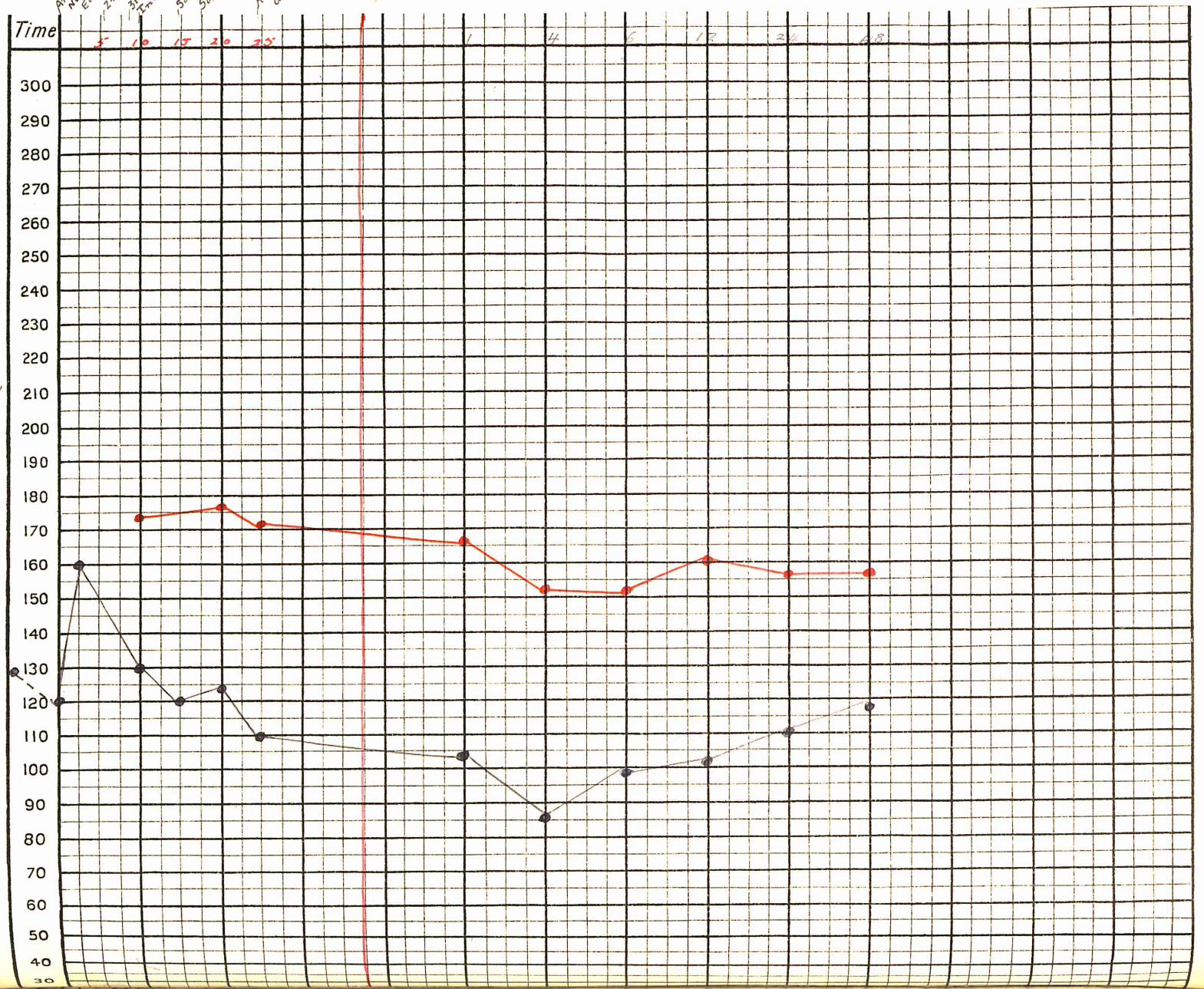
Notes

Anaesthetic

Nitrous oxide — Ether,

(Clover inhaler)

27·4·11 B.P. = 128.



Case XX

A well built muscular lad of 22.

Heart and lungs normal.

Operation :- Radical Cure of Inguinal Hernia.

Anaesthetic, 25 minutes.

A considerable amount of cyanosis and congestion was incurred during the induction of anaesthesia which was unaccompanied by struggling. This congestion persisted to some extent throughout the anaesthesia and there was free secretion of bronchial mucus. It continued for a few hours after the operation then cleared up entirely. The blood pressure rose considerably during the nitrous-oxide administration, then fell with induction of full ether anaesthesia to 130 mins. which was near the normal for the patient. During the manipulation of the hernial sac there was a drop of 10 mm's and finally with the conclusion of anaesthesia the pressure fell to 110 mm's. Subsequently during the early hours a very pronounced fall took place, four hours after operation the reading being as low as 85 mm's. Intense nausea accompanied this and the pulse although not rapid was of small volume. The subsequent rise in pressure was gradual and at forty eight hours 116 mins. was indicated.

1164

XXI.

Name

Maggie Law.

Age 20

Disease

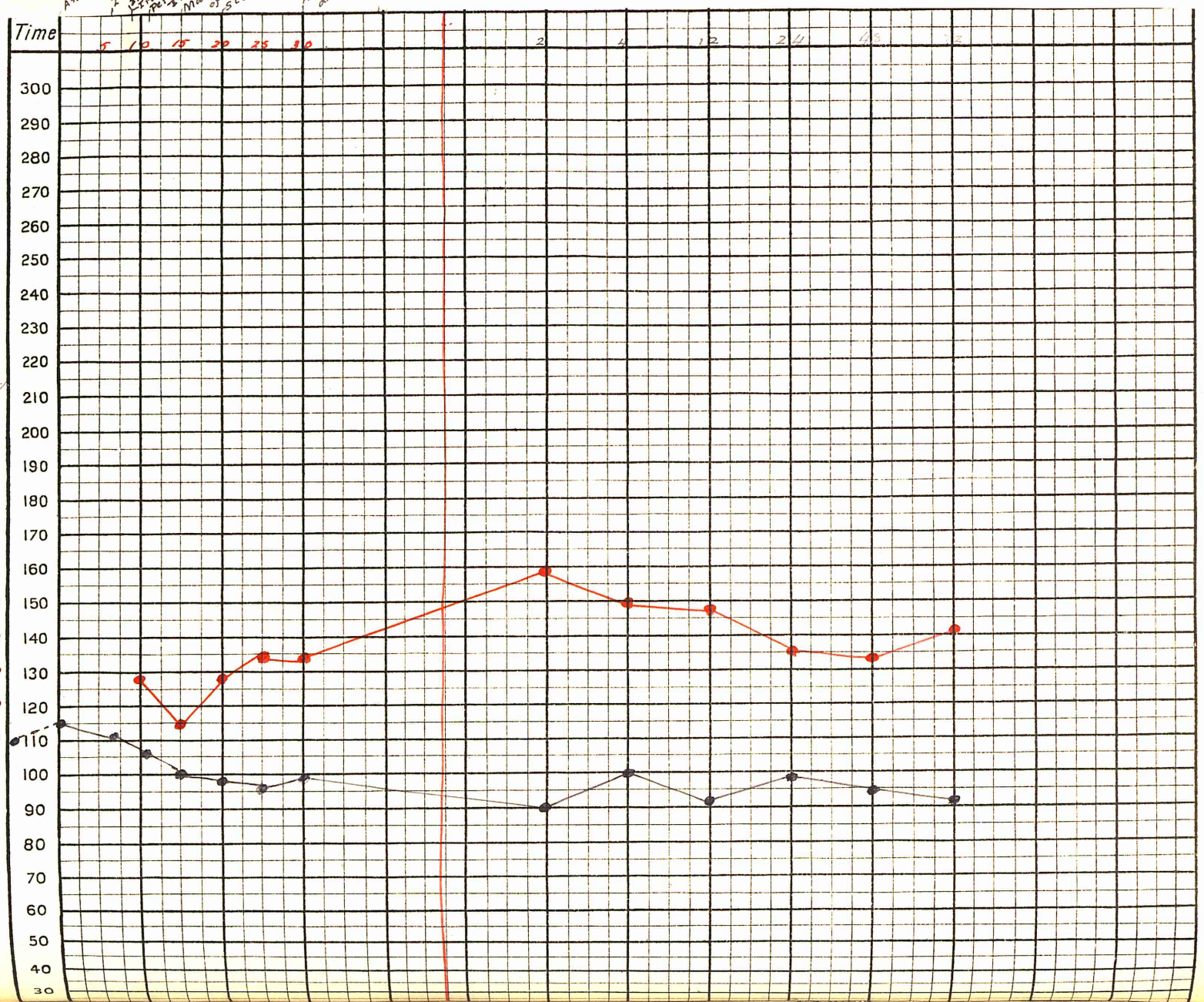
appendicitis.

Operation:-
appendicectomy
27.5.11.

Notes

Anaesthetic:-
Ether (Clover's inhaler)

26.5.11 Pulse 72
BP 110.



Case XXI.

A thin girl, age 20. Heart and lungs normal. Operation:- Removal of appendix and Meckels diverticulum. Anaesthetic, 30 minutes.

The blood pressure just after the establishment of full ether anaesthesia and after the incision was 4 mins. below the patient's normal. From this point until five minutes before the finish of the administration of ether a progressive fall occurred.

Subsequent to the operation, the pressure remained low, two hours afterwards being only 88, and twelve afterwards 92 mms.. Only once in the first three days did it reach 100 mms.. This was accompanied by an accelerated pulse.

1506

XXII

Name

Mrs McLellan

Age 45.

Disease

Cancer of Caecum.
Operation:-
Lateral Anastomosis.
29.12.11.

Notes

Anaesthetic:-
Ether; Clover inhaler for 36 minutes, then open method.

27.12.11 Pulse 108
B.P. 114

Minutes during Operation

Hours after Operation.

Anaes. begun (clover)
2nd Stage.
3rd Stage.
Incision.
Peritoneum opened.
Manipulation of Intestine.
Clamp applied.
Opening Stitched.
Open Method Ether
Stitching Wound.
Anaesthetic discontd.

Time

5 10 15 20 25 30 35 40 45 50 55 1 4 20 24 48 72 96

Pulse Rate

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

110 100 90 80

Case XXII.

An emaciated jaundiced woman, aged 45. Heart normal. Slight chronic bronchitis. Operation:- Lateral anastomosis of the intestine for carcinoma of the caecum. Anaesthetic, 55 minutes.

The patient was nervous on being placed on the operating table and a pressure considerably above her normal was recorded. The anaesthetic was well taken throughout. The early part of the operation produced a fall in pressure to 108 mms. and after this the level remained fairly constant, the last reading on the table being 104 mm's. One hour later there was a drop of 6 mm's, then a gradual rise till 24 hours. The pressure then fell very low and as an accompaniment the pulse became more rapid. The patient was lethargic and had a temperature of 101°. She made a good recovery from the operation.

1035

~~XXIII~~.

Name

Edward Gorman

Age 32

Disease

Dilated Stomach

Op^n. Gastro-enterostomy.

10·5·11.

Notes

Anaesthetic:-

Ether. Clover for

10 minutes then per

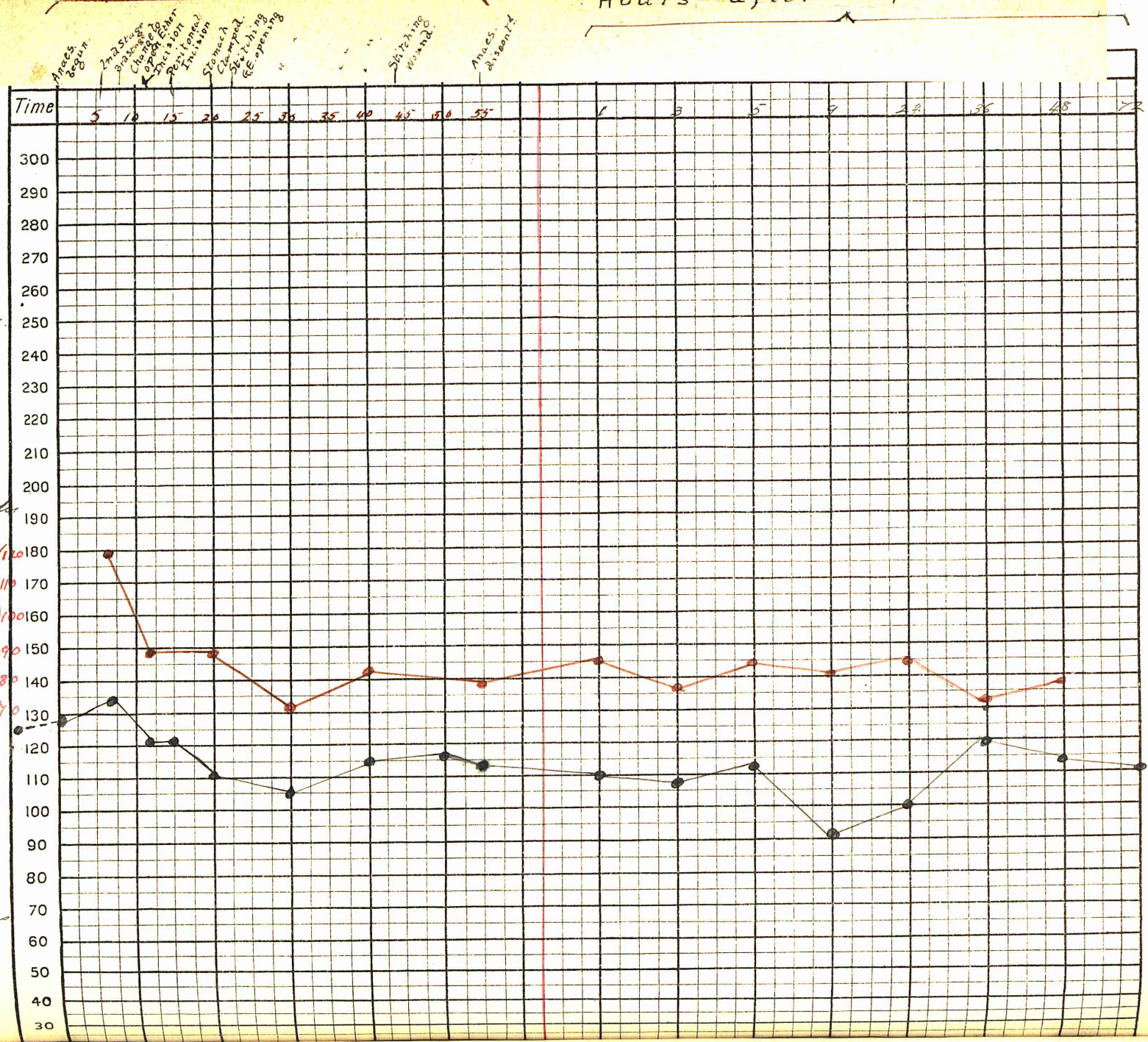
method during remainder

of operation.

9·5·11 BP=126.

Alcoholic, sometimes

to excess.



Case XXIII.

A well built but somewhat ill-nourished man, age 32. A moderately heavy drinker. Heart and lungs normal.

Operation:- Gastro-enterostomy for dilated stomach.

Anaesthetic, 55 minutes.

Good anaesthesia; the induction lasting 8 minutes, accompanied by slight struggling. At eleven minutes just before the incision the blood-pressure had fallen 8 mm's., (after a preliminary rise). During the first part of the operation there was a fall of 15 mm's; then, during the latter part of the stitching of the gastro-enterostomy opening, a rise of 10 mm's, the level then reached being maintained till five minutes before the finish of the operation. The last reading in the theatre indicated a slight fall and this was continued afterwards. Nine hours after the operation a very decided fall to 90 mm's occured. From this point there was a rise.

1188

XXIV.

Name

Mrs Carey

Age 40

Disease

Traumatic Stricture of oesophagus (Irritant poison)

Opn:- Gastrostomy.
5.6.11

Notes

Anaesthetic:-
Nitrous oxide & Ether Clover, then open Ether.

3.6.11
Pulse 96.
B.P. 98.

Minutes during Operation.

Hours after Operation.

Anaes. began
Ether (Clover)
2nd Stage
3rd Stage
Change to Ether
Open Method.
Incision
Peritoneal Incision
Manipulation of Stomach.
Stitching
Gastrostomy Opening
Stitching Wound.
Anaes. discont'd.

Time

4 10 15 20 25 30 35 40 45 50 1 4 8 48 72

Pulse Rate.

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

140 130 120 110 100

Case XXIV.

An emaciated woman. Age 40.

Heart and lungs normal.

Operation:-Gastrostomy for stricture of oesophagus caused by irritant poison.

Anaesthetic, 50 minutes.

The patient's normal blood pressure was 95 mm's. No reading was obtained on the patient's arrival in the theatre. She was very nervous, but the anaesthetic was well taken, there being only slight excitement in the first stage.

Owing to want of assistance early in the anaesthesia, few pressure readings were obtained but in the second stage the pressure was 112 mm's and just after the peritoneum was opened 96 mm's. Thereafter there was a progressive fall during the operation, and one hour after its completion the reading was 60 mm's and at four and eight hours 70 and 68 mm's. Unfortunately no further observations were made for forty hours and by that time the pressure had risen to 100mm's. An uninterrupted recovery followed.

During most of the operation and for the eight hours following the pulse was rapid and small in volume. When the pressure fell to 60 mm's it was irregular and thready.

XXV

Name

J.T. (Male)

Age 36

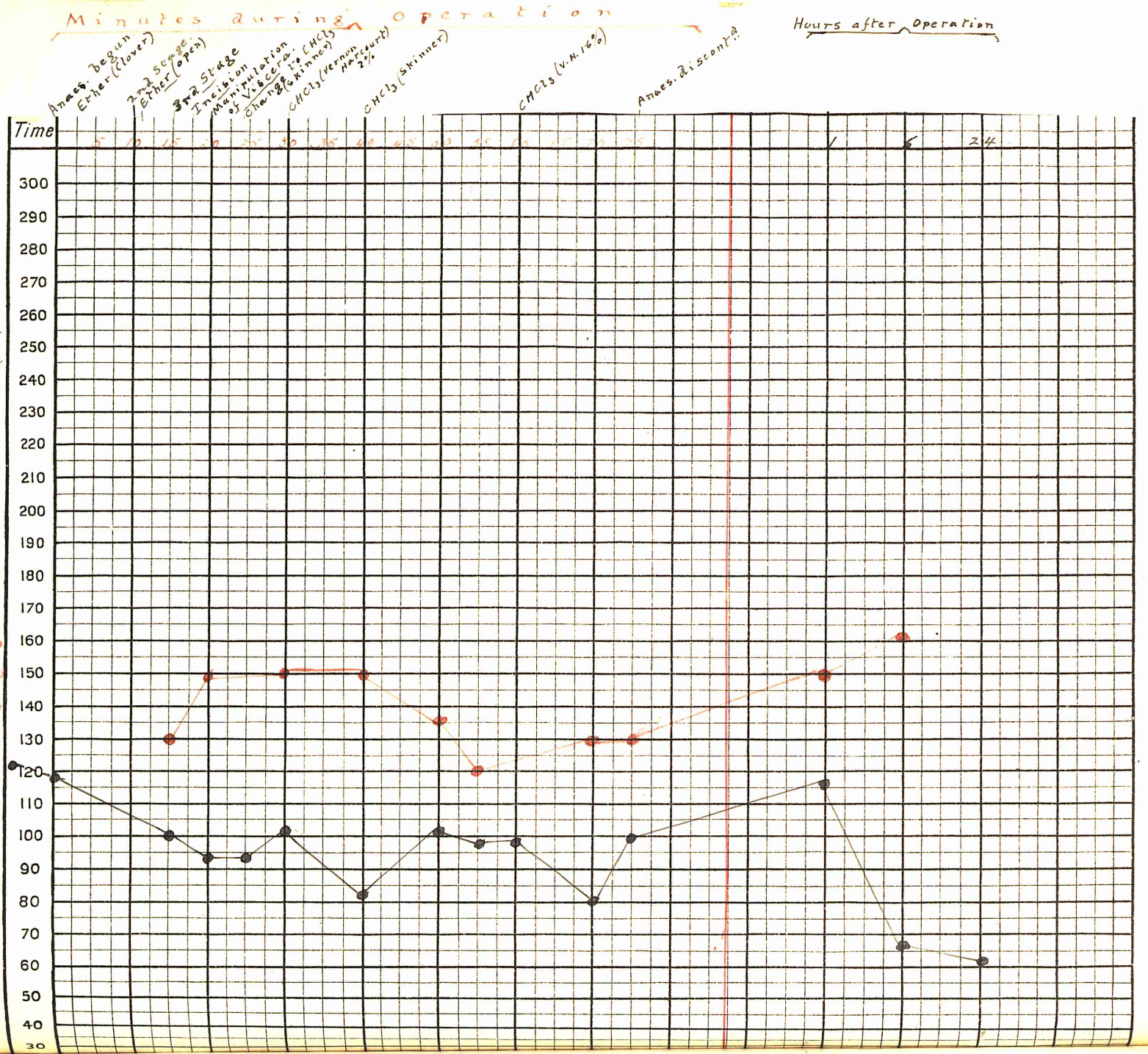
Disease

appendicitis.
Operation:- Exploratory Laparotomy, Appendectomy

Notes

Anaesthetic:-
Ether:- Clover (open method)
Chloroform:- Skinner & Vernon-Harcourt.

25.9.11:- B.P. 123.



Case XXV.

As will be seen from the above chart this case is a nondescript one - the anaesthetic during the early part of the operation being ether, and, during the later, chloroform.

The patient was a well-built and fairly well nourished man, an abstainer. He was admitted to the surgical ward with a diagnosis of dilated stomach.

At the operation, during which the abdominal organs were thoroughly examined, this involving a considerable amount of manipulation, nothing abnormal was found except signs of old inflammatory trouble in the appendix, which was removed. Ether was first used by Clovers inhaler, and later by the open method. The induction was prolonged. Even after the arrival of the third stage the anaesthesia was not satisfactory it being impossible with any concentration of ether vapour to overcome some rigidity of the abdominal muscles and straining during the early intra-abdominal manipulation. I have already referred to the difficulty in establishing satisfactory anaesthesia after trouble of this kind, which is particularly serious in abdominal operations. It was impossible during the subsequent procedure in this case to obtain a continuous even third stage. The patient went from one extreme to another - at one time too lightly under, at another too deeply. A change to chloroform failed to help very materially although it was possible to obtain muscular relaxation. Subsequent to the change of anaesthetic on two occasions/

occasions during deep manipulation in the abdomen the pressure fell to 82 mm's.

With the end of the anaesthesia it rose to 100 and one hour later to 116 mm's. The next reading, however, taken six hours after operation, was only 66 mm's. At the same time the pulse was thready and the general condition critical. From this time he never rallied, at twenty-four hours the pressure reading was 62 mm's and the patient died thirty-six hours after operation.

The post-mortem examination revealed no abnormality and it seemed to me that the cause of death was surgical shock occasioned partly by the extensive intra-abdonimal manipulation and partly by the inefficiency of the anaesthesia during the early intra-abdominal manipulation.

The remaining charts are illustrations of the behaviour of the blood-pressure in chloroform anaesthesia after induction by means of ether.

12.38.

XXVI.

Name
Janet Cameron

Age 19

Disease
Inguinal Hernia.
Op.n Radical Cure.
17.7.11.

Notes
Anaesthetic:- Nitrous oxide – Ether – Chloroform sequence. (Chloroform by Vernon Harcourt)

15.7.11 B.P. 116.

Minutes during Operation

Hours after Operation

Anaes. (N2O & E) begun

2nd stage

3rd stage

Ether

Incision.

Sac exposed.

Stitching

Tying

Anaes. discont.d

Time: 5 10 15 20 25 30 35 | 1 5 12 24 48 72

Pulse Rate: 300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

100 90 80 70 60 50

Case XXVI.

A girl of 19.

Heart and lungs normal.

Operation :- Radical cure of inguinal hernia.

Anaesthetic, 35 minutes.

In the early part of the ether anaesthesia a fall in pressure was noted but at ten minutes during a light anaesthesia (second stage) a rise had occurred. At this point, coincident with the incision, chloroform was adopted and the next reading of pressure during the manipulation of the hernial sac showed a fall of 30 mm's. From this point to the end of the operation a rise occurred and the level was well maintained afterwards.

XXVII

Name
Mrs Jack.

Age 42.

Disease
Umbilical Hernia.
Operation:- Radical Cure.

Notes
Anaesthetic:-
Ether, Clover then open method.
Chloroform, Skinner's mask and Vernon-Harcourt inhaler.

30·4·12 B.P. = 118.

Minutes during Operation.

Hours after Operation.

Anaes. began. Ether (Clover)
2nd stage Ether open method
1st stage Chloroform
Incision.
Manipulation of Omentum.
Ligation of Omentum
Sutures Hernial
Manipulation of Peritoneum.
Stitching Ring
Stitching parietes.
Anaesthetic discont'd.

Date
Time

5 10 15 20 25 30 35 40 45 50 1 4 8 12 24 48

300 290 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30

Pulse Rate. 90 80 70 60

Case XXVII.

A very stout woman, age 42.

Heart and lungs normal.

Operation:- Radical Cure of Umbilical Hermia.

Anaesthetic, 50 minutes.

The first stage was quiet. A slight fall in pressure took place during the administration of ether, then two minutes after changing to chloroform a fall of 10 mm's was noted. The next reading taken during the early part of the operation, during manipulation of the omentum was the lowest observed during the operation - 88 mm's.

A rise then occurred followed by a second fall during the last part of the peritoneal manipulation, and finally a rise with the finish of the operation.

One hour later a rise to 120 mm's had taken place, at four hours a very pronounced fall then a rise and after this a well maintained pressure.

To sum up the effects of the two anaesthetics on the blood-pressure.

(a) Chloroform produces a fall of blood-pressure throughout its administration. With the establishment of full anaesthesia this fall amounts to at least ten millimetres, and sometimes considerably more; along with this the pulse beats slower, and a varying degree of pallor is present.

Surgical shock occuring during chloroform anaesthesia produces a slight further fall of pressure. With the withdrawal of those two depressants - chloroform and shock - the blood pressure exhibits a tendency to rise rapidly, and very often soon reaches a point a few millimetres below the patients normal.

As has been stated, experimental evidence goes to show that the fall in pressure is partly due to action on the vaso-motor centre and partly to direct action on the heart.

(b) Ether produces little alteration of the blood-pressure. It may cause a slight rise, it may maintain a constant level, or it may cause a slight fall.

It causes more rapid and more forcible cardiac action, with dilatation of the smaller vessels (as evidenced by the flushing which takes place), the latter probably counteracting the former in maintaining the blood-pressure level almost constant.

With intercurrent shock a considerable fall of blood-pressure takes place, a fall almost equal to the combined effects of chloroform and shock.

The/

The subsequent recovery after severe shock is slow, some time elapsing before the blood-pressure approaches the normal level.

What influence do those considerations have in the choice of the anaesthetic? In answering this question it is again necessary to differentiate with regard to the nature of the operation into:- (1) those cases in which only slight surgical shock is to be anticipated; and, (2) those cases in which severe surgical shock is to be anticipated.

(1) In slight surgical shock.

In all cases chloroform causes considerable lowering of the blood-pressure, whereas in this class of cases there is but little lowering of the blood pressure under ether. With the latter anaesthetic therefore the margin of safety is greater than with the former. This consideration should therefore weigh very largely in the choice of the anaesthetic. I have already referred to the disadvantages of ether but the only one which would have any weight in precluding its use in this class would be the presence of some lung complication.

Otherwise, in this class, ether is the anaesthetic of choice.

(2) In severe surgical shock.

At the end of an operation in this second class the blood pressure shews more tendency to reaction with chloroform/

chloroform than with ether, there is a more decided and better maintained rise with the former. This consideration it seems to me, should go a long way as a guide to the choice of anaesthetic. At a time when it is of vital importance that patients should be able to make use of all their resources, after chloroform anaesthesia, they are in a better position to do so than after ether.

I do not wish to ignore in any way the danger of chloroform as evidenced by the rapid fall of blood pressure which it produces, particularly in the early stages of its administration. The only death by anaesthetic which I have had, occurred under chloroform, eight minutes from the time of commencing the administration, and before the operation had been commenced.(20) This case along with other less serious experiences have been quite sufficient to impress upon me the care which is necessary in making the choice of anaesthetic and in the use of chloroform where it is chosen.

But there is another point of view and one whose value it is much more difficult to estimate. I mean the relative safety of the two anaesthetics with regard to the period immediately succeeding operation. Is it not possible that the anaesthetic may play a part in causing or averting death in the period subsequent to operation, as well as in the chances of rapid recovery? I cannot help thinking that in Case XXV. the choice of anaesthetic as well as the extensive/

extensive intra-abdominal manipulation was a factor in the subsequent death from shock. Possibly ether is to blame for many deaths in similar circumstances.

It must also be remembered that the chloroform danger can be lessened by employing ether for inducing anaesthesia. Under those circumstances the fall of blood-pressure caused by a change to chloroform is less decided than when chloroform is used throughout.

The principal other objection to the use of chloroform, referred to earlier, is its part in causing delayed poisoning, but this is of such rare occurrence as to be almost negligible.

After weighing up all those considerations, I think that, in this second class, chloroform is the anaesthetic to be chosen, the induction of anaesthesia, however, being effected by means of ether, unless in presence of lung complications when chloroform should be used throughout.

The observations which led up to those conclusions extended over a period of three years and were quite independent of any previous work done by others, as only during the last few months have I consulted the literature on the subject. I find that most of the writers have formed conclusions entirely opposed to my own.

At the same time all the writers whom I have consulted base their opinions on the fact that during anaesthesia chloroform produces a fall in blood pressure, ether does not; and as far as I have been able to discover no one has continued observations on the behaviour of the blood pressure subsequent to operation.

Lockhart Mummery (17) made a series of observations on blood pressure during operation. From those he came to the following conclusions:-

"There is a marked rise in the blood pressure in the early "stages of ether anaesthesia, and the net result of all the "investigations into the effect of ether anaesthesia upon the "blood pressure shows that it tends to remain at its normal "level or to be raised slightly throughout the whole period of "anaesthesia, any fall in blood pressure which occurs during "an operation being due to the steps of the operation and "not due to the anaesthetic.

"With chloroform anaesthesia the results are almost the "exact opposite of those with ether anaesthesia. It has "always been said by London surgeons that ether "anaesthesia is safer in long operations and those where

shock/

"Shock is anticipated than chloroform anaesthesia. This "fact based upon clinical observation is proved beyond all "shadow of doubt by blood pressure records of operations. "Chloroform anaesthesia is accompanied by a fall in blood- "pressure during the whole anaesthesia".

Walton following up Lockhart Mummery's investigations agrees with his main conclusions (20) In dealing with the treatment of shock however, he makes a statement which it seems to me, is quite contradictory:- "In no case should "any form of stimulant, either brandy, strychnine, or ether, "be administered previous to or during the course of an "operation". He then states that the administration of such "stimulants leaves the patients in worse condition than if they had not been given.

So that while disapproving of ether as a stimulant he recommends it as an anaesthetic on account of the fact that it is a stimulant.

Burton, speaking of the open method of ether administration, says:[22] "Given in this way ether has the advantage over chloroform in that it is safer and tends to the prevention of shock during operation".

Blumfield [23] referring to the subject of shock says:- "Thus ether tends to keep up blood-pressure, and thus to diminish surgical shock. Chloroform on the other hand, throughout an administration, tends to cause a lowering of blood-pressure, and thus adds an additional degree to any surgical shock that may be caused by an operation".

In nearly all the literature it seems to me that too much emphasis is placed on the conditions obtaining during anaesthesia and too little on the subsequent state.

Dudley Buxton, however, in an article on the relative merits of chloroform and ether in operations for exophthalmic goitre [24] refers to the latter point:- "Though he had employed chloroform he was ready to "believe that the open ether method or venous infusion of "ether were useful methods. In the latter, however, there "was a danger of collapse when the unnatural stimulation "of the ether passed off."

The/

The same writer, in a biographical article on Long, the discoverer of ether, (25) makes a similar reference to ether:- "The very safety of the drug became its chiefest "danger, since etherists were so obsessed by the fact that "ether does not lower blood-pressure or cause cardiac collapse "through depression, that they failed to recognise the "perils incident to over-stimulation, especially in asthenic "persons".

Brown (26) writing on "Post-Operative Shock", after pointing out that shock is due to exhaustion of the cells in the vaso-motor centre, claims that chloroform narcotizes the cells of the vaso-motor centre and in this way prevents their energy being used up during shock, so that with the withdrawal of the anaesthetic they regain their activity. Ether, on the other hand he thinks does not possess this narcotic effect on the vaso-motor cells, and may even act on them as a stimulant. In summing up he says:- "And the conclusion to which I am led is that, while ether "is undoubtedly the safer anaesthetic so far as the time "during which the patient is under its influence is concerned, "as regards the after-effects shock is more likely to be "lasting and serious when ether has been used for a prolonged "operation than if we had recourse to chloroform and kept "the /

"the vaso-motor cells partially narcotized".

The last quotation is in agreement at all points with my own abservations.

In concluding my paper perhaps I might apply Professor Waller's test to myself. What anaesthetic should I choose for myself? My reply corresponds very closely to his.

I should say that, if I had to undergo anaesthesia at the hands of an unknown administrator I should take ether.

If I had to undergo anaesthesia under the hands of a skilled administrator, if for a short operation or one in which little shock was anticipated, I should prefer ether; if for a prolonged operation or one in which severe surgical shock was anticipated, I should prefer chloroform.

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