

COMPARATIVE STUDY OF VARIOLA AND VARICELLA IN NIGERIA.

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COMPARATIVE STUDY OF VARIOLA AND VARICELLA IN NIGERIA.

Introductory.

In this paper a comparative study of variola and varicella in Nigeria is made. To enable the various aspects of the thesis to be grasped, it is necessary to give a brief description of the country and her people.

Geography.

Nigeria is a British Colony and Protectorate situated in West Africa on the northern shore of the Gulf of Guinea. On the west and north it is bounded by French territory, on the east by the former German Cameroons, a portion of which was mandated to the British Government, and on the south by the Gulf of Guinea.

Nigeria is the largest British Dependency in Africa with the exception of the Mandated Territory of East Africa, and it covers an area of approximately 372,674 square miles - nearly four times the size of Great Britain! It is divided, for administrative purposes, into Southern and Northern Provinces, the former covering an area of 90,896 square miles and the latter 281,778 square miles. A belt of mangrove swamp forest runs along the coast and is intersected by the branches of the Niger, Delta and other rivers. This belt has a width of from ten to sixty miles and is succeeded by a belt - 50-100 miles wide - of tropical "rain forest" and oil palm bush. We

have beyond this, open woodland which passes to grass savannah. This grass savannah, interspersed with scrubby fire-resisting trees, covers the greater part of the Northern Provinces till desert conditions are reached in the extreme North.

Climate:- The climate is tropical except in parts of the North where it tends to be sub-tropical. There are two main seasons, the dry and the wet seasons. November till April is the dry and hot season, though in the south, light showers fall in the latter part of February till April. In November also, the harmattan wind, laden with dust from the desert, blows across the country till January. The hottest months of the year are February to April, the absolute shade maximum temperature being round about 94°F. The rainy season commences in May, reaches its maximum in June when the rainfall may be 25 inches or more, and by August it tails off. Light showers fall in September and are a bit heavier in October.

Population:- The estimated population of Nigeria is twenty two millions and it consists of ten main tribes and numerous smaller ones. Some of the tribes in the North are of Arab descent, whereas those in the rest of the country are of West African Negro descent.

These several tribes differ in language, customs, religion and beliefs, and general outlook in life. For example, to a Northern Hausa, illness or death is the will of Allah, but to a southern Yoruba or Ibo, it is due to witchcraft.

Housing:- The occupation of the majority of the population of Nigeria is agricultural. They spend most of their time in the open air and use the house as a place for the keeping of possessions, and for sleeping in at night.

Before the adoption of the European type of house (and still in more remote parts of the country) houses were built of dried mud, circular in shape, in the Northern Provinces, and rectangular in the Southern Provinces. Proper ventilation and admission of sunlight were the exceptions. A unit housing accommodation consists of a central or frontal hut which is occupied by the head of the house, and a series of other huts which are occupied by his wives, his relatives, and their family, wards and servants. This unit, or compound, as it is commonly called, may contain anything from twenty people upwards in close communion with one another, so that in the event of a case of infectious disease occurring, a large number of people are open to risk. Even yet, in large towns where the European type of building is adopted, the compound system is not completely eliminated. Often, instead of relatives occupying the extra rooms, these are let out, and a large number of people are therefore resident on the premises. However, in a first-class township like Lagos, the number is kept down by the vigilance of sanitary inspectors, to avoid overcrowding.

Variola and Varicella.

Three thousand to ten thousand cases of Variola and almost as many of Varicella are notified each year throughout the country. There is no doubt that a good many more, possibly twice as many, escape notice. Early recognition or diagnosis, and isolation, are therefore essential to avoid the large wastage of life and incapacitation which may result from an epidemic.

Castellani and Chalmers⁽²⁾ wrote: "The first point in the differential diagnosis between smallpox and chickenpox is to remember that it is very difficult, and that the most distinguished physicians have owned to not one mistake, but a series." This difficulty is increased by the fact that Varicella in Nigeria, as in other tropical countries⁽²⁾, is a disease of adults! The appearance of the rash in the Negro may simulate one another closely. Then there are those diseases for which variola may be mistaken. Not infrequently, cases admitted as severe malaria turn out to be variola. The tragedy which may result from sending a patient home with quinine mixture on a wrong diagnosis of malaria instead of variola, is obvious. The pernicious habit of diagnosing every case of fever and headache as malaria, without going

into a careful history, must be avoided.

Lagos, the capital and chief port of Nigeria, with her 160,000 inhabitants, is provided with a comparatively up-to-date isolation hospital, one of the best infectious diseases hospitals in the country. Lagos thus offers a good scope for the comparative study of these diseases. The cosmopolitan nature of her inhabitants enabled one to study these diseases, not only in Nigerians, but in Negroes from different parts of the world - the sister colonies of Gold Coast, Sierra-Leone and Gambia, the French West African Colonies, the Free State of Liberia, the West Indies, and other parts of the world.

Language difficulties are often a stumbling block, making it sometimes impossible to obtain accurate history and other necessary information.

Synonyms:- Variola and varicella are not differentiated by the people. They are regarded as one and the same disease, varicella being taken as a mild infection. The same nomenclature is therefore applied to both by the different tribes. A few of them are as follows:-

The Yoruba names are: i. Shopono.

ii. Olode (the reigning power).

iii. Ilegbona (the ground (town) is hot).

iv. Baba (father).

The Ijaw names are: i. Okripapa.
 ii. Ingradan.
 iii. Alawoye (mild attack -
 possibly chickenpox).

The Jesse name is: Iroto.

The Ishan name is: Oje (King).

The Asaba names are: i. Okilikpappa.
 ii. Ifeogbigbu.

The Ibibio name is: Mfatito (greater yaws. Mfa =
 eruption, and ito = something
 dreadful).

The Calabar names are: i. Isoti.
 ii. Etinko (good thing).

The Ibo names are: i. Ojuku.
 ii. Oganyelu (that which walks
 above).

The Hausa names are: i. Agana.
 ii. Mepita (covers the body at
 once).
 iii. Enrani (when the sun is hot).

This name shows that epidemics
 of smallpox are associated
 with the hot season in the
 mind of the people.

Throughout the country variola is held in dread. The very name is held in awe and reverence and is seldom repeated for fear of bringing on an attack by the mere repetition. A pseudo-name is often substituted. For example, a Yoruba man would rather call variola by the pseudo-name Olode or Ilegbona than by its real name Shopono, and an Hausa man would rather use the pseudo-name Enranni than the proper name Agana.

The highly infective nature of these diseases is well known to the people. It is usual, among practically all the different tribes in Nigeria, with few exceptions, to isolate a case in a hut specially built in the bush, far away from human dwellings, as soon as it is recognised. The patient is attended to either by a smallpox priest (among the Yorubas) or by someone who has recovered from an attack. (3,4,5)

A measure of disinfection is carried out, either by burning logs of wood in the centre of the hut, as the Jesse people do, or by spraying a herbal preparation on the walls of the hut and also washing the floor with it. The Ina people near Calabar adopt this latter method. The liquid herbal preparation is made in a big pot in the centre of the village, and the villagers also use it to sprinkle on themselves whenever there is an outbreak in a nearby village. A recovered case together with his attendant must wash first with this preparation before they are allowed to return to the village. The fomites are burnt.

The Yoruba people are the chief people who worship smallpox. The smallpox priest is called Oni Shopono. It is he who removes a case to isolation for treatment. He also buries people dead from smallpox. For his treatment and / or burial, he receives as much of the patient's belongings as he chooses. The smallpox priest has been accused of removing scabs and other infective material from the smallpox dead, so that he may use it for the spread of infection for his own end. Either the doors of huts are smeared with the infective material or water polluted with it. The smallpox priest is held in awe and treated with respect and reverence.

As a rule, smallpox dead are denied burial rites. They are often just thrown into the bush.

The Ishan and Benin peoples do not isolate cases of smallpox; but they practise variolation. The Ishan name for smallpox is Oje which means 'king' and therefore, whenever a case occurs, they beat drums, dance and play to please the king. All the children in the village are taken to the hut of the sick and variolation performed on the back of the left hand or forearm. An incision about half an inch is made with a native razor and the contents of a vesicle or pustule rubbed into the cut. After a few days, local reaction sets in, one or two spots may appear on the body and the child is feverish. This passes off and immunity is established.

Historical Note.

Variola has existed before the Christian era in India, China and North Africa, which places are regarded as endemic centres of this disease.

In India, there existed from time immemorial the temple worship of a god whose protection was invoked during an epidemic, and to whom special prayers were offered before inoculation of smallpox virus was carried out by the Brahmins⁽²⁾. In China, the disease had been prevalent for at least 2,000 years⁽⁹⁾. In 395 B.C., the disease broke out among the Carthaginian army, appearing first among the Libyans. Ruffer and Ferguson⁽²⁾ described an eruption on the skin of a mummy which belonged to the twenty eighth dynasty (1200-1000 B.C.), and they believed it was suggestive of smallpox.

During the war of the crusades in the eleventh, twelfth and thirteenth centuries, smallpox was spread from East to West. Numerous epidemics attended with high mortality occurred in Europe from the fifteenth century onwards until a check was imposed in 1796 by the introduction of vaccination by Edward Jenner.

Little is known about the history of the spread of smallpox in other parts of Africa, but Castellani and Chalmers⁽²⁾ suggested that probably an endemic focus has existed in Central Africa from time immemorial. Whether this is so or

not, there is evidence that, at least in Nigeria, smallpox has been in existence from ancient times.

Before the Christian era, trade communication had existed between the Phoenicians and West Africans. Some of the Northern tribes are undoubtedly descendants of Arabs, with little Negro blood. It is thus not improbable that smallpox was spread from North Africa to Nigeria and other parts of West Africa. Yoruba mythology of the origin of smallpox supports this view of the antiquity of this disease in Nigeria.

According to the mythology, Olorun (the owner of the sky or heavens; God) created Obatala as the chief god, and Odudna (patroness of love) as the chief goddess. Obatala married Odudna and two children, Aganju, male, and Yemaja, female, were the offspring. Aganju married his sister Yemaja and had a son named Orungan. When Orungan grew up, he fell in love with his mother Yemaja, and one day, in the absence of his father, ravished her. She immediately after fled from him lamenting and wringing her hands. He pursued and overtook her, but just as he was going to seize her, she fell down to the ground, her body became swollen up immediately, and her abdomen burst. From her breasts flowed two streams which joined to form a lagoon, and from her gaping body came the following:- Dada (god of vegetables), Shango (god of

lightning), Oloso (goddess of the lagoon), Oya (goddess of the river Niger), Oshun (goddess of river Oshun), Oba (goddess of the river Oba), Orisha Oko (god of agriculture), Oshosi (god of hunters), Oke (god of mountains), Aje Shaluga (god of wealth), SHOPONO (god of smallpox), Orun (the sun), and Oshu or Osupa (the moon). If, according to this mythology, the god of smallpox is as old as the god of lightning, the god of the sea, the god of agriculture, the god of the mountains, the sun and the moon, then smallpox must have been known in Nigeria from very ancient times.

The god of smallpox, Shopono, the mythology continues, is old and lame; some say he has a withered leg. One day, all the gods and goddesses were making merry and dancing at the palace of Obatala, the chief god, and Shopono tried to join in the dance, but, on account of his deformity, he stumbled and fell; and the gods and goddesses burst out laughing. This so enraged Shopono that he strove to infect them with smallpox, but Obatala came to the rescue and drove him away with his spear, and forbade him from associating with other gods. He became an outcast and lived in desolate and uninhabited tracts of land. Temples dedicated to him are therefore built in the bush far from human habitation to keep him away. This also accounts partly for the isolation in the bush of anyone suffering from smallpox. This isolation, together with the incantations of the smallpox priest, will keep the

smallpox god from infecting others in the household. It is believed that whistling at night or at mid-day, particularly if near his grove, will draw his attention to the person and bring on an attack.

Varicella. Varicella is probably as old as variola.

Rhazes, the Arab writer who was the first to write on variola, described, in the ninth century, a mild eruption which gave no protection against variola. The first description of varicella is sometimes credited to Ingrassius in 1550. About the same time, Vidus Vidius referred to it as chrystalli. By the latter part of the eighteenth century, varicella was clearly differentiated as a separate disease from variola.

Aetiology.

Smallpox is closely related to pox diseases which occur in cows, horses, sheep and swine. Cowpox and horsepox have been shown to be of the same immunological type as smallpox. The consensus of opinion now is that smallpox, alastrim, cowpox and horsepox are one and the same disease, the latter two being modified through animal passage.

Blaxall⁽⁶⁾ and others on passage of variolous matter through the monkey and on persistent passage through the calf, were able to produce lesions indistinguishable from

vaccinia. Ledingham⁽⁷⁾ affirms that the strains used for most calf lymphs were derived from smallpox.

The work of Blaxall also showed that alastrim could also produce vaccinia in calf; that a monkey inoculated with alastrim was immune to vaccinia; and that a calf inoculated with smallpox was immune to vaccinia.

Gordon⁽⁸⁾ found that immune bodies and agglutinins were present in the serum of animals immunised against vaccinia. These immune bodies and agglutinins reacted equally well with vaccinia, variola and alastrim viruses. There can therefore be no doubt that these viruses are one and the same.

Opinion differs widely as to the importance of Cytor-rhyctes variolae of Guarnieri found in the epithelial cells of smallpox pocks. Some writers consider them as sporozoon parasites analogous to malaria and possessing a definite life cycle. Others regard the bodies as specific, though unrelated to smallpox virus; and there are those who regard them as extrusions from the nucleus or nucleolus.

Other inclusion bodies were described by Prowazek, Paschen and others. They are very minute dancing granules found in the materials from smallpox pustules and also in cowpox vaccine. They can also be seen in the epithelial cells in the active lesion. These granules are very small and they occur singly, in pairs, or in short chains. MacCallum⁽⁹⁾ and

his co-workers separated the active granules of vaccine by centrifugalizing at a certain specific gravity. They were rendered bacteria free by repeated washing and centrifugalizing. Cracium and Oppenheimer found that these granules multiply rapidly in tissue cultures as shown by inoculation in animals. These granules therefore appear to be the aetiological factor.

Characteristics of the Virus.

Dry virus:- The virus in smallpox scab may persist for two months; in vaccinia scab it may persist for about a fortnight. The dried virus can persist for four months at room temperature, and for several years at 0°C .

Effect of heat on virus:- The dried virus can withstand 100°C for five to ten minutes. Exposure of the virus in lymph to a temperature of 60°C for five minutes is lethal. Lymph vaccine virus may withstand 55°C for half an hour, but the virus in a variolous crust emulsified in saline is destroyed by such heating⁽⁸⁾.

Effect of cold on virus:- Glycerinated lymph was preserved for years at -10°C . It was found active after eleven weeks' exposure at liquid air temperature (-180°C).

Effect of Ultra Violet Rays:- Exposure for half an hour to ultra violet rays, which usually destroy bacteria in that period, has no effect on the virus. It is however more

susceptible to Finsen light.

Effects of Antiseptics:- The virus is resistant to undiluted glycerol, saturated borax or boracic acid, ten per cent sodium salicylate, two per cent phenol, .5 per cent chloroform, .2 per cent lysol, and 1/500,000 mercuric chloride. Bile or sodium taurocholate weakens it; 1/10,000 potassium permanganate or ten per cent ether destroys it. It is more susceptible to the action of acid than to that of alkali. Methyl alcohol and acetone are more harmful to it than ethyl alcohol.

Filtrability:- Berkefeld filtrate of lymph vaccine was found quite inactive. If, however, the lymph was first allowed to autolyse, or was digested with trypsin, active filtrate was obtained. Levaditi reports the passage of the virus through collodion sacs.

Cultivation:- Cultivation in vitro has not been successful. Tissue culture, on the other hand, has met with success. Lambert and Steinhardt cultured the virus with pieces of growing skin. Noguchi used the testicle of rabbits to cultivate it free from bacteria. Purified virus obtained by this intratesticular method was cultivated in rabbit testis tissue medium by Parker and Nye. The virus also grows readily in chicken embryo pulp.

Pathogenicity for Animals:- The virus of smallpox is transmissible to a number of animals. The lesions produced are usually indistinguishable from vaccinia. Repeated passage, however, is necessary before it becomes typical in the cow, calf or rabbit. In the monkey, typical smallpox sometimes results. Vaccinia virus readily produce lesions in these animals.

The testicle of the rabbit shows a special affinity for vaccinia virus, and undergoes inflammatory changes following cutaneous vaccination. The maximum concentration of virus is reached on the fourth or fifth day.

Intracerebral inoculation of vaccine produces an encephalitis which is fatal in from four to seven days. The virus is found disseminated throughout the central nervous system. Transmission of this encephalitis can be carried out in series by inoculation of infected brain or cord. Passage in this way will so modify the virus that typical cutaneous lesions are no longer produced on inoculation. The work of Levaditi and Nicolan showed that the virus tends to lose its virulence unless frequently passed through the rabbit's testicle. Cutaneous inoculation into the fowl of this "neuro-vaccine" renders the fowl immune to subsequent inoculation with ordinary vaccine.

The development of a neurotropic modification of the virus suggests an explanation of post-vaccinal encephalitis

in man.

Immunology:- Active immunity to both smallpox and vaccinia develops after an attack of smallpox or after vaccination. The immunity conferred by smallpox lasts for a longer period than that conferred by vaccinia, which usually becomes considerably reduced after seven years. Killed virus is generally regarded as incapable of producing immunity. But Nakagawa reports success with his killed vaccine "koktoimmunogen". Gordon found that attenuated virus, for example calf lymph, heated to 50°C for half an hour, produced a certain amount of immunity which commenced on the fourth day and lasted for fifty to a hundred days.

A number of workers have reported passive immunity. Raynaud protected a susceptible calf against vaccination by using the serum of an immunised calf. The serum of persons convalescent from smallpox, as well as of those successfully vaccinated, possesses both protective and curative powers. Such serum in quantities of 25-100 c.c. was used with favourable results by Teisser and Marie in a series of thirteen cases.

Viricidal, precipitating and complement deviating antibodies have been detected in the immune serum.

Virus in vitro is neutralised by viricidal antibody. This antibody disappears much earlier, before immunity is lost.

A suspension containing smallpox virus or vaccinia is precipitated by the precipitating antigen. Gordon, using the

serum of rabbits inoculated with vaccinia, obtained precipitation with an emulsion of confluent smallpox scabs freed from gross particles, and also with vaccine lymph. Lymph first heated at 100°C for fifteen minutes was more readily precipitated by immune serum. According to Torikata, boiled and filtered lymph extract would, on inoculation, give rise to both immunity and precipitins.

Jobling first noted the presence of complement deviating antibody in vaccinated calves. Sugo, using calf lymph or pustular material from smallpox, obtained the reaction in smallpox patients. This was confirmed by Kolmer, who also obtained the reaction in the rabbit, seven to eight days after inoculation.

Varicella. Though the exanthem in varicella bears close resemblance to that of variola, yet the aetiology of both differs.

Varicella is supposed to be a more generalised and severe infection by a virus which, when milder and more localised, produces Zoster⁽⁶⁾. Varicella vesicles initially present the same pathological features as in Zoster. Similar inclusion bodies are present in the cells of the epithelium. An attack of varicella produces active immunity to zoster. Passive immunity can be conferred by giving 5 c.c. convalescent

varicella serum within five days of exposure to infection. Out of six children inoculated with zoster fluid by Siegl, two developed chickenpox after an incubation period of between twenty two to twenty three days. Convalescent serum in zoster and in varicella equally deviated complement with zoster antigen.

Infection with varicella can be transmitted in man by inoculation with vesicle fluid. Transmission in animals is difficult.

Season:- In cold and temperate climates, variola is prevalent in the winter and spring months. These months are the times "... when people seek comfort indoors, and being indoors are more exposed to spray infection." (Currie¹⁰) In Nigeria, it is the opposite. Variola is prevalent from February to April, the hottest and driest months of the year, when people are least likely to seek comfort indoors (appendix). The prevalence continues into May and sometimes to June, when it begins to fall. From July to December, it is at the minimum.

In this connection, it is interesting to mention the report of the Acting Senior Medical Officer of Gambia on the epidemic of smallpox in that country in 1937. Gambia is also a British territory on the West Coast of Africa. He wrote that there was a widespread epidemic from March to June.

The meteorological observation for the same period gave rainfall nil from March-May and 1.89 inches in June. The epidemic ended in June when the rains were just commencing.

(11)
Rogers observed in India a similar association of high incidence of smallpox with low rainfall or low absolute humidity. Possible explanations for this will be discussed later.

Varicella:- The seasonal incidence in varicella is similar to that of smallpox except for a secondary rise in September and October.

Age:- Variola is a disease which attacks both young and old, though it is more severe in the young. Owing to vaccination in early life, the disease now tends to be preponderant in adult life. In an unvaccinated community, the incidence of attack is still practically the same at all ages as the following illustrates.

In a little village, called Ojukoro, just outside the township of Lagos, there was an epidemic of smallpox. The population was approximately sixty, and out of this, twenty two persons were attacked. The ages of those affected are as under:-

Age in years.	1/3	- 7	-15	-21	21+
No. of cases.	7	6	3	6	

Varicella, in contrast with variola, is selective as to age. In cold and temperate climates, it is a disease of childhood, occurring usually under the age of ten years. In Nigeria, it is a disease of adult life, not of childhood. This experience confirms the observation of Castellani and Chalmers that "in the tropics chicken-pox is very often a disease of adults being very common in India in February to March."

When I took over the Infectious Diseases Hospital in Lagos, I was struck by the number of adult cases of chickenpox which were admitted. Consultation of the hospital statistics for the past twenty three years confirmed my observation. A table of age group in this disease is subjoined. Whereas only 2.9 per cent of cases occur under ten years, 65.8 per cent occur in adults. This observation of increased susceptibility in African adults is further confirmed by the following.

An African medical student in Glasgow contracted an attack of chickenpox while taking his course in infectious diseases. Two other African students who visited him contracted the infection from him. Similar cases occurred in African medical students in Edinburgh. Five contracted chickenpox one after the other.

(Age Group - see page 22).

Sex:- Many writers on infectious diseases, like Rolleston⁽¹²⁾ and others, state that both sexes are equally attacked in variola. But MacCombie⁽¹³⁾ wrote "Hospital records shew that more males are attacked than females." The latter has been my

Chicken-pox - Age Group.

Year	Age distribution in years:				
	-10	-15	-21	21+	
1915	-	-	15	18	32
1916	-	4	22	119	145
1917	4	-	9	17	30
1918	-	-	11	29	40
1919	-	-	14	35	49
1920	-	2	21	36	59
1921	-	2	4	10	16
1922	-	2	7	27	36
1923	-	1	5	16	22
1924	1	-	14	37	52
1925	1	-	13	19	33
1926	-	2	12	20	34
1927	-	-	10	19	29
1928	-	-	2	29	31
1929	2	8	28	72	110
1930	-	1	13	26	40
1931	-	2	4	8	14
1932	2	12	23	57	94
1933	1	2	11	23	37
1934	4	10	20	45	79
1935	8	11	16	35	70
1936	5	1	22	59	87
1937	7	10	14	44	75
Total cases of each age group	35	70	310	800	1,215
% to total cases	2.9	5.8	25.5	65.8	

experience. In consulting the hospital statistics again I found that the ratio of males to females attacked was 4:1. Notifications of variola cases received throughout the country gave a similar preponderance of male attacks. In the five year period - 1931-35 - 1,365 cases were treated in isolation hospitals. Of these, 974 were males and 391 females - a proportion of 2.5:1. (Actually, over 29,000 cases occurred during this period but only 1,365 were treated in isolation hospitals!) According to 1931 census figures there are more females than males not only in Lagos, but throughout the country. In Lagos there are 1,300 females per thousand males, and for the whole of Nigeria 1,150 females per thousand males.

Turner⁽¹⁴⁾ in his medical census of Southern Nigeria, remarked on the greater incidence of smallpox in males than in females in Southern Nigeria. The theory advanced by him that this was because men travel more than women and are therefore more exposed to risk of infection, and that women are more amenable to vaccination, will be discussed later.

Varicella:- In this disease the incidence in males is even higher than in the case of smallpox. The hospital statistics gave a proportion of ten males to every female

attacked. Of the 5,673 cases treated in isolation hospitals throughout the country for the five years period - 1931-35 - 5,168 were males and 505 were females - a proportion of approximately 10 males to 1 female. It is surprising how the female members of a house escape infection. A man lives with his one, two or more wives in an ill-ventilated room with a floor area under 100 sq. ft. He develops chickenpox. His wives escape. But a male friend who visits him develops an attack. This happens not infrequently.

Infectivity:- Variola is a highly infectious disease. It is infectious in all stages, including the incubation period. It is most infectious from vesiculation to scabbing stage.

It may be transmitted through contact with a person suffering from the disease, through contact with a smallpox corpse, through the atmosphere - aerial convection, through fomites, through flies, and through a healthy third carrier.

In Nigeria, next in importance to transmission through contact with a person suffering from the disease is transmission through flies, which will be discussed later. Reference has already been made to the practice

among the people of isolation, disinfection, and burning of fomites. The person who handles a corpse is either a smallpox priest or someone who has had a previous attack.

Varicella:- Infectivity in varicella is not as high as in variola. Epidemics occur occasionally in barracks and prisons. Cases occasionally occur in nurses.

Symptoms - Variola.

Incubation period:- The incubation period varies from 5-21 days. It is usually twelve days. There may be malaise at this period and the patient may complain of headache, vertigo, sore throat and gastric disturbance.

Initial symptoms:- There is a sudden onset of fever, headache, backache, and a varying degree of constitutional disturbance. There may be vomiting or epigastric pain. Prodromal rash may appear. The temperature rises to 102°-104° F. or even higher, and remains high, with slight morning remissions, till the rash appears. The pulse is rapid - about 110 or more. It is full, fairly strong and regular, but in severe cases, weak and soft. The respiration is quickened and laboured.

The headache is a most constant symptom and is usually frontal and severe. It may however be diffuse.

Backache is a characteristic prodromal symptom and is usually confined to the lower lumbar region. The pain is very intense and may in some cases extend to the whole of the back or become generalised. It is generally taught that the backache subsides with other prodromal symptoms on the appearance of the eruption. This is not always the case. The backache continues for a varying period after the appearance of the rash. This persistence of backache is helpful in the diagnosis of doubtful cases with atypical rash, especially where there is language difficulty. The doubling up produced by the intensity of the pain is marked. The patient cannot straighten himself if he attempts to walk.

Retching and vomiting may occur but epigastric pain is much more common. In confluent cases, the epigastric pain is very severe.

Prodromal rashes are described, and are said to be more common in females than males, and in adults than in children. Petechial or purpuric and erythematous types are known.

The petechiae in a petechial eruption may be bright red with dark purplish centre or may be entirely of a dark purplish hue. The usual site is the abdomino-femoral triangle or "bathing-drawers area." Not infrequently

it may be seen in the axillae and flanks. It is usually visible till the papular stage before it disappears.

The erythematous rash may either be partial or general. It appears on flexor surfaces, and sometimes on extensor surfaces, on the second day, though it may appear earlier on the first, or later on the third to fifth day. It reaches its height in twenty four hours and then fades. It is most marked on the trunk and limbs than on the face. Scarlatiniform and morbilliform types have been described. A combination of both the petechial and erythematous rashes may occur.

These prodromal rashes have not been seen in cases which came under my observation, even though many were severe attacks. This may be due to the fact that cases do not come in or are not sent in for admission till the rash actually appears, but I am more inclined to think that prodromal rashes are uncommon in the Negro.

Eruptive Period:- The eruption of variola appears from three to four days after the onset of initial symptoms. The papules appear first on the face, scalp and wrists, then invade the chest and back, later the abdomen and the lower extremities, the ankles and feet being affected last. The lesion is thickest on the face, forearm, wrist and

feet - it is centrifugal in contrast with varicella which is centripetal. Occasionally the eruption is thickest on the back of the trunk. It is more copious in parts of the skin subjected to pressure. The eruption also appears on the mucous membrane of the mouth, on the tongue, hard and soft palate, naso-pharynx, larynx and trachea. It has been described as sometimes occurring in the oesophagus and the lower part of the rectum. The vulva, the urethral meatus and sometimes the vagina are involved. On the appearance of the rash, the temperature falls considerably and there is improvement in the constitutional disturbance.

The papule varies in size from a pin head to a millet seed. It grows rapidly and by the next day distinct central vesiculation may be seen. Sometimes, in the Negro, a jet black spot appears in the centre of some of the papules. This feature is of great diagnostic importance. It is seen only in smallpox. It appears to be due to a rapid shrivelling of the epidermis on the summit of the papule, thus concentrating the normal pigment which becomes darker. It is seen in mild, discrete smallpox as well as in severe confluent attacks. It is not invariably present, but when seen, even if only on a single papule, it is diagnostic of smallpox. The vesicle enlarges and is filled with serum. By the fifth or sixth day it has

attained its maximum growth. A full-sized vesicle is about .25" across, circular, and well above the level of the skin but depressed in the centre (umbilication). In the Negro it assumes a grey or greyish brown colour. A dusky red zone may be seen round the papule or vesicle, but this is best seen in the palm of the hand when there is profuse eruption. The vesicle does not collapse on pricking, but clear serum exudes.

At the end of the fifth or sixth day, the vesicle commences to become opaque. As the opacity increases, the central depression is lost, and a dome shape acquired. In about three days, i.e. nine days after eruption, the pustular stage is reached. If the pustule is pricked, a white or yellowish-white turbid fluid escapes. If it is emptied, its wall collapses. In the Negro, at this stage, the wall of the pustule becomes lighter in colour, assuming a creamish colour. Later, it appears sodden and white. The pustule remains intact for about two days, then it either ruptures and forms a crust, or slow absorption begins. About the twelfth to the fourteenth day the crusts begin to fall, exposing a reddish surface which may be raised, flat, or pitted. In the coloured people, the exposed surface is red and raised, especially on the face, and it may remain so for a long time. In the light skinned Negro, the

exposed surface is often flat or pitted. It assumes a light fawn colour with a brown periphery. This brown periphery slowly extends till the whole area assumes a uniform colour usually darker than the normal skin. This may take months. In the darker skinned Negro, the exposed area is often exuberant. The centre is light in colour but the periphery is deeply pigmented. Within a short time, especially on the face, the whole area becomes jet black. This however lightens a little with years.

The unruptured vesicle becomes inspissated and is of a brown colour. It is most noticeable on the palms of the hands and the soles of the feet where the rash does not come to the surface so readily. It is often necessary to pick it out.

In discrete smallpox the whole eruption appears within forty eight hours. In the Negro it often takes a longer time before the whole eruption appears, especially in confluent cases, when it may take five or six days or more before the rash spreads to the ankles and feet. The papules take a long time to appear on the soles of the feet in the Negro owing to the great thickening of the soles consequent to walking bare footed. The same applies to the hands of those who do heavy manual work.

General Symptoms:- The symptoms of prodromal stage subside on the appearance of the rash. In the vesicular stage, the patient is fairly comfortable, except for itching due to the eruption. Tightness of the skin of the face may be complained of. Dysphagia is common. There may be laryngeal discomfort with husky voice. The patient may be restless and sleepless. In confluent and haemorrhagic cases, they may be violent or delirious. When the vesicles approach the limit of their growth, there is marked oedema of the skin, usually most marked on the face and limbs.

About the sixth day, when pustulation commences, the temperature rises and febrile symptoms develop. The temperature is irregular and may be as high as 104° - 105° F. The face and lips become much swollen and disfigured. The tongue is dry and parched; there is great thirst; the breath is offensive; a peculiar odour emanates from the patient, dysphagia is prominent; the voice is husky; the bowels are constipated. In a severe case there is marked prostration, restlessness, sleeplessness and delirium of the low muttering type or occasionally of the noisy and violent type.

By the fourteenth day, when crusts begin to fall off, the condition of the patient begins to improve. The temperature falls, the pulse improves, but the patient is weak. In

favourable cases the patient gradually regains his health. In unfavourable cases the intensity of the symptoms increases; the temperature rises and may reach 105° - 106° F., the pulse is very rapid and weak, respirations hurried and shallow, low muttering delirium and stupor, set in, and the patient succumbs.

There are three main types of smallpox. Discrete smallpox, confluent smallpox and haemorrhagic smallpox. Other types described are alastrim, modified smallpox and variola sine variolis.

Discrete smallpox:- The characteristic feature of this type of smallpox is the intervals of healthy skin on the face between the rash. The rash varies in abundance; oedema of the face and limbs are not a marked feature. The prodromal symptoms are usually not very severe though, not infrequently, intense prodromal symptoms are followed by a discrete attack. There is practically complete subsidence of symptoms on the appearance of the rash. Complications are rare and mortality low.

Confluent smallpox:- In this, the lesions are confluent on the face and may or may not be so in other parts of the body. But it is commonly so on the distal extremities.

The initial symptoms are usually severe, and often shorter, the rash appearing on the second day. The appearance of the eruption is followed with less remission in temperature and constitutional disturbance than in a discrete case. The eruption may be confluent in the papular stage, though it is more usual to be so in the pustular stage. The eruption may all appear within forty eight hours, but in the Negro it may be delayed for some time, taking as long as five or six days or more to travel from the face and scalp to the ankles and feet. The rash may appear in uniform distribution over the whole surface of the body, not showing any preference for distal parts of the limbs, or it may be more profuse on the arms than the forearms, but in either case it is scanty on the abdomen, on the inner surface of the arm, axilla and flexor surfaces generally.

The vesicles are large and irregular in shape. A vesicle may be $\frac{1}{2}$ -1" across. Umbilication is marked. There is little fluid in the vesicle, and it takes a longer time to mature. Oedema of the face is marked, the eyelids close, and only open with difficulty. Conjunctivitis with mucopurulent discharge is present. Keratitis usually involving the left eye may occur. Rash may be observed in the mucous membrane of the mouth, fauces and pharynx. Deglutition is painful and difficult; the voice is husky. During the pustular stage the temperature may swing between 103° - 105° F.,

the pulse is rapid and thready, respiration is hurried. The patient is very thirsty; the breath is foetid; a characteristic foetid odour emanates from the patient. The disfigurement of the face is increased and the patient presents a picture of terrible disfigurement and helplessness unparalleled in acute infectious diseases. Restlessness, sleeplessness and delirium are marked.

At the commencement of scabbing, the temperature falls in a favourable case. But convalescence is very slow. In an unfavourable case the temperature may continue to rise or it may actually fall, but the pulse is weak and feeble and the patient sinks rapidly. Complications are common and are responsible for the high mortality.

Haemorrhagic Smallpox:- The two types described are variola haemorrhagica pustulosa and purpura variolosa. Both of these are very severe types. The headache and backache are very intense and prostration very severe.

In variola haemorrhagica pustulosa, the papules may be infiltrated with blood from its appearance, or it may become filled with blood during the vesicular or pustular stage. Petechiae and ecchymosis may occur between the pocks. There may also be epistaxis, haematuria, melaena, haemoptysis, or metrorrhagia. The disease is usually fatal within twelve days, though recovery occasionally takes place.

Purpura variolosa is extremely severe, death occurring within thirty six hours of the eruption, though in rare cases it may be prolonged till the seventh day. Erythema of a deeper hue than that of erythematous prodromal rash is seen. Petechiae, ecchymosis and haemorrhage from mucous membranes occur. Albuminuria apart from haematuria is very common. The liver is painlessly enlarged. Death is usually due to cardiac failure or oedema of the lungs.

Cases of variola haemorrhagica pustulosa are occasionally seen in Nigeria, but purpura variolosa is extremely rare.

Alastrim:- This mild form of smallpox which occurs in the West Indies, South Africa, Australia, parts of Europe and America, is uncommon in Nigeria. The invasion may be sharp but, as a rule, the course is mild. The lesions are superficial and their evolution rapid. Secondary fever is usually absent. Complications are rare and mortality very low.

Modified Smallpox:- Modified smallpox or varioloid occurs in people who have a measure of immunity against smallpox, whether such immunity is natural or conferred by inoculation, vaccination, or a previous attack. The constitutional disturbance is not severe. The rash is

scanty and the vesicles and pustules are small. The rash may retrogress and not go beyond the papular or vesicular stage. Complications are very rare and mortality very low.

Variola sine exanthemate vel variola sine variolis:-

This is a non-eruptive modified form of smallpox which occurs in the recently vaccinated. It is apt to be encountered among recently vaccinated persons shortly after joining the staff of a smallpox hospital (Case V). The onset is severe, with high fever, intense headache and lumbar pains. The symptoms subside on the third or fourth day, though a varying amount of weakness persists for a few days. Macules and a few papules sometimes appear, but these retrogress rapidly.

Complications.

Skin:- Superficial abscesses are very common and vary much in size. Gangrene of the skin on pressure points such as the heels or buttocks is not uncommon, especially in a confluent attack. The toes, external genitals, ears and nose may also become gangrenous. Erysipelas may develop round the pocks.

Eyes:- The eyes are frequently involved in severe attacks. Conjunctivitis with purulent discharge is present, pustules form on the palpebral conjunctiva and the palpebrae

are swollen. Keratitis usually of one eye is not infrequent in confluent attacks. There appears to be a predilection for the left eye. Ulceration and perforation may take place, resulting in hernia of the iris and lens and panophthalmia. Retinal haemorrhages may occur in haemorrhagic cases. Blepharitis, dacrocystitis, iritis and optic neuritis are other complications.

Ears:- Acute otitis media is said to be comparatively common. It may be complicated by facial paralysis or meningitis.

Respiratory system:- Nasal catarrh occurs in severe confluent cases, and epistaxis and haemoptysis in haemorrhagic cases. The enanthem on the larynx may give rise to severe laryngitis and oedema of glottis. Bronchopneumonia is one of the commonest and invariably fatal complications.

Heart:- Myocarditis is a frequent complication. Systolic murmurs are heard at both the mitral and aortic areas. This is due to dilatation of the heart which also occurs in other acute infectious diseases. The murmurs gradually disappear with recovery.

Alimentary system:- Ulcerative stomatitis, ulceration of the palate, suppurative tonsillitis, retropharyngeal abscess, gangrenous angina, abscess of tongue and diffuse glossitis, have been recorded.

Nervous system:- Neuralgia is not an uncommon complication in Nigeria. This complication is well known to Native doctors (so-called witch doctors), and the people. Sudden mania which cannot be accounted for as due to witchcraft is labelled smallpox. Hemiplegia, paraplegia, aphasia, and peripheral neuritis have been described, but these are rare.

Pregnancy:- In severe attacks, abortion or miscarriage invariably takes place. The prognosis is unfavourable in confluent and haemorrhagic cases.

Varicella.

Incubation Period:- The incubation period of chickenpox is usually fourteen to nineteen days, though it may extend to twenty three in some cases.

Prodromal symptoms:- These are often entirely absent in children, the appearance of the rash being the first indication of the disease. In adults, there are often malaise, anorexia, headache, and backache. These symptoms may be severe.

Eruption:- The eruption appears first on the front and back of the trunk; sometimes attention is first drawn to it on the face. It is most profuse on the trunk. It is more copious on the proximal than the distal parts of the limbs (centripetal in distribution). It is rare on the palms of the hands or soles of the feet. Areas subjected to irritation have copious eruption.

The rash appears in crops for four to five days, the temperature rising with each crop. The evolution of the rash is very rapid, passing through all the stages of maturation within twenty four to forty eight hours. Sometimes the papular stage is missed, the vesicle arising directly from a macule. In some cases, central vesiculation only of the papule takes place. The vesicle ruptures and scabs and the periphery and base of the papule retrogress. The normal vesicle is superficial and is filled with clear

serum. In the Negro the wall of this vesicle is very light in colour in comparison to that of smallpox vesicle. Umbilication is rare. If pricked the whole wall collapses and clear serum exudes. Partial pustulation takes place in the vesicle, then it ruptures and scabs or is absorbed. A flat or pitted pale pink area is left when the scab falls off. The periphery of this is pigmented, and the pigmentation gradually extends inwards. The area is seldom exuberant as sometimes occurs in Variola, nor is the pigmentation as dark. The palate, fauces, and pharynx sometimes show punctate congestion. The rash is often very profuse in the adult African woman, and the scab takes a long time to fall off.

Constitutional disturbance is very mild. In a large number of cases a practically afebrile course is run. Mild suffusion of the eyes sometimes occurs in adults.

Complications:- Subcutaneous abscesses, ulcers, and local gangrene are most common. These complications are met with almost exclusively in African women in whom the rash is often very profuse, as mentioned above. The most frequent sites involved are the breasts and the abdomen. The thighs, back of trunk, and arms come next.

Diagnosis:- Difficulties are often met with in the diagnosis of Variola, especially during the prodromal stage. Apart from infectious diseases like influenza, typhoid, pneumonia, cerebrospinal fever, which may simulate it, we

have tropical diseases like malaria and yellow fever to consider. In the eruptive stage the diseases likely to be confused with it are varicella, papular syphilide, measles, and in the scabbing stage in children with mild infection, scabies.

The onset of influenza, typhoid, typhus, pneumonia and cerebro-spinal fever may be ushered in with such a sudden attack of fever, intense headache and lumbar pains that diagnosis is impossible until the appearance or non-appearance of the rash. In pneumonia the pulmonary condition is soon evident and in cerebro-spinal fever, nuchal rigidity appears by the second day. In an epidemic of smallpox this difficulty is not so great, but when there is co-existing epidemic of cerebro-spinal fever with smallpox, as occurs from time to time in Northern Nigeria, diagnosis may be very difficult.

A severe attack of sub-tertian malaria simulates the initial stages of smallpox. It is characterized by a very slight cold stage, followed by a hot stage which may extend over twenty four hours, accompanied by severe headache, backache or pains all over the body. Castellani and Chalmers⁽²⁾ described a pseudo-smallpox type of sub-tertian malaria in which high fever and severe lumbar pains are associated with a papular eruption which appears on the second or third day and consists of small shotty papules.

The papules are profuse on the face but never become vesicular or pustular. Blood examination is helpful but it must be remembered that the presence of parasites is not necessarily indicative of an attack.

In an attack of yellow fever, the initial fever is often accompanied by severe headache and lumbar pains. The headache, though frontal, is however more concentrated round the circumorbital region.

When the eruption appears, measles may be closely simulated, especially in a confluent attack. The face is swollen and the eyes injected in both infections. The absence of catarrhal symptoms and Koplik's spots is helpful. In measles, the temperature rises with the appearance of the rash whereas in smallpox it usually falls.

Papular syphilide is often met with in Nigeria, especially among the Northern tribes where the significance and importance of early syphilitic treatment are not known. Indeed the nature of the disease is not understood by the mass of the people in the country. The primary sore is usually regarded as scabies! You ask a patient if he has ever had a sore on the penis, and he replies that he has only had scabies there before and that is all; indeed he may, in truth, have had only scabies, but often the scabies is synonymous with primary chancre or may co-exist with it. This papular syphilide may closely simulate atypical smallpox

and the diagnosis may be difficult, especially where it is not possible to elicit a history on account of language difficulty or when the patient deliberately gives a false history.

Some writers suggest Wassermann or Kahn test as of diagnostic value, but in Nigeria where Yaws is extensive, neither of these tests is of help. Moreover, laboratory facilities for such tests are not uniformly available throughout the whole country.

Mild infections in very young children are often regarded by their mothers as due to scabies until a chance discovery by a health officer.

Chickenpox:- An attack of chickenpox with profuse eruption may be mistaken for smallpox, and a mild attack of smallpox with scanty eruption mistaken for chickenpox. In Nigeria, the difficulty in diagnosis is increased by the fact that chickenpox is a disease of adult life. Great care is therefore needed in diagnosing modified smallpox from chickenpox (Cases III and IV).

The main diagnostic points in chickenpox may be considered under the following heads:-

1. Initial Symptoms:- In children, there are no prodromal symptoms as a rule, the appearance of the rash being the first indication of the disease. In adults, malaise, headache and backache of varying intensity are

not uncommon. There may be generalised pain; the eyes may be injected. These prodromal symptoms are usually mild. In smallpox the initial symptoms are severe. In the initial stage of chickenpox the temperature is only slightly raised, if at all, but it rises with the appearance of each crop of rash. Smallpox, on the other hand, is associated with a high initial temperature which falls on the appearance of the rash.

2. Eruption:- The rash appears in crops extended over a period of four to five days. In smallpox the whole crop appears within forty eight hours.

Distribution:- In chickenpox the rash is most abundant on the trunk and less so on the face. It is scanty on the limbs, but the proximal parts are more affected than the distal parts. It is rare on the palms of the hands and soles of the feet. It does not avoid flexure surfaces.

In smallpox the rash is most abundant on the face. On the trunk, it is more abundant on the back than the front of the chest, and more on the chest than the abdomen. It is more profuse on the forearm, wrist and hand than the arm, and more on the legs and feet than the thighs. The palms and soles are almost invariably involved. There is preference for prominences, extensor surfaces, and areas exposed to irritation. Flexor surfaces are avoided.

Character:- The rash is discrete in chickenpox. The vesicles in a fairly copious eruption are round; some may be oval, especially those in the axillary folds and flanks, in which case the long axis of the vesicle is parallel to the folds of the skin. The vesicle is superficial and the floor only slightly indurated. The vesicles mature very rapidly within twelve to twenty four hours. When mature they are filled with clear serum; and they appear shiny and transparent. If pricked, the contents escape and the wall collapses. Umbilication is rare. Owing to the rash appearing in crops, the rash is seen at different stages on the same area of skin.

In smallpox the lesions are deep seated and indurated. The papules feel 'shotty' to the fingers. A central pigmentation is sometimes seen on the papule in the Negro and when present it is of diagnostic importance as it has never been seen in chickenpox. Maturation of the rash takes a much longer period than it does in chickenpox. Umbilication is usual. The evolution of the rash is more uniform and on a given area of skin the rash is all in the same stage.

3. Laboratory aids to diagnosis:-

Paul's test. The eyes of a rabbit are cocainised and the cornea scarified with a fine dissecting needle. The scarified area of one eye is inoculated with the con-

tents of the vesicle of a suspected case; the other eye serves as a control. After forty eight hours the rabbit is killed and the eye examined in a sublimate bath. In the case of variola the infected cornea shows opaque white elevations on a milky background, and some of them have a central depression. The control cornea is evenly opaque without any elevations. Microscopic sections of these elevations show Guarnieri bodies.

Intradermal test:- This is a certain and more easy test. The rabbit is inoculated intradermally with material from a vesicle. After a short incubation period the characteristic reaction ensues if the case is one of smallpox.

Flocculation test:- In this test, described by Gordon, and Burgess, Craigie and Tulloch,⁽¹⁵⁾ the crust of the skin lesion is required. According to the last three workers, its diagnostic value is limited in coloured people on account of the pigmentation of the skin which vitiates the result, as was experienced by them when working with crusts obtained from Lascars.

In Nigeria, limited laboratory facilities make these tests difficult, and we have to rely wholly on clinical diagnosis.

Evidence of previous vaccination is helpful provided the patient has been vaccinated not more than five years previously. In the illiterate mass, evidence of scars

resembling vaccination scars should be regarded with suspicion, as not infrequently a self-inflicted wound is made on the arm to avoid vaccination. Fortunately this habit is dying out.

Prognosis:- The prognosis in discrete smallpox is favourable, but in confluent cases it is unfavourable and more so in haemorrhagic attacks. The mortality varies in different epidemics and may be anything from 15 to 40 per cent. or more in severe epidemics.

The prognosis in varicella is very favourable, death rarely occurring.

Treatment:- Prophylaxis. Vaccination is the only effective defensive weapon we have against smallpox to-day.

Before the introduction of vaccination by Jenner in 1796, attempts were made to induce mild smallpox by inoculation of the virus through the skin, nostril or alimentary tract. This method has been practised for centuries in China, India and Africa. It was borrowed from the Turks in 1717 by Lady Wortley Montagu, wife of the British Ambassador in Constantinople who had her son inoculated, and who, four years later, set the fashion in England by having her daughter inoculated.

Inoculation was usually made from another case of mild inoculated smallpox. Clean lymph from vesicles four to five days old was kept dry on threads, lint or sponges and then introduced into the skin through an incision.

The reaction varied, a few were refractory, some had abortive lesions, but the big majority were successful. Generalised eruption appeared in a few.

The objections against inoculation were the uncertainty of the mildness of the resulting attack, and the fact that the inoculated person is as infective as an actual case.

Long before Jenner's time it was known among the country people that cowpox is transmissible and that it protects against smallpox. In 1774, Benjamin Jetsy, a Dorsetshire farmer, inoculated his wife and two children with cowpox to protect them from smallpox.⁽¹⁶⁾ But it was Edward Jenner, the country practitioner in Berkley, Gloucestershire, who gave vaccination to the world. He had devoted upwards of twenty years to patient investigations and experiments. On May 14, 1796, he performed his first vaccination on James Phipps, a boy of eight, using matter obtained from the milkmaid, Sarah Nelmes, who had an attack of cowpox. Jenner published an account of his work in 1798, and from then onwards vaccination rapidly superseded variolation which was made illegal in 1840.

In Nigeria, to-day, vaccination is compulsory under the Public Health Ordinance.

Public Health Administration:-

Vaccination - Infant:- Every child must be presented for vaccination at the age of three months. In Lagos and other towns where a registry exists, the list of births for each day is sent to the Health Office. From this list notices are prepared and sent to parents for the presentation of their children for vaccination. At the vaccination office, the children are examined and the temperature noted. If there is any doubt as to the health of a child, the child is referred to a medical officer who decides whether the child is fit or not for vaccination.

Lanolinated lymph is used in preference to glycerinated lymph because it stands the climate better and does not readily deteriorate. The arm is cleansed with methylated spirit, but of late 1/10,000 brilliant green in water has been used as an economy measure to replace spirit, the arm being previously washed with soap and water. Scarification method has been abandoned, and replaced by a single linear incision, a third of an inch long. The parent is requested to bring the child for examination a week after. If successful, a small supply of boric powder is given to the parent to dust on the lesion. If unsuccessful, revaccination is performed.

In the majority the reaction is good and not severe. Sepsis and ulceration occasionally set in, when the mother

is of uncleanly habit. No fatal case has ever been reported.

School vaccination:- School vaccination is carried out from time to time, especially during an epidemic. In the days when registration of births was not compulsory, and still now in parts of the country where there are no registries, the school forms a centre for child vaccination. Also children from different villages coming to town for education are enabled to be vaccinated with others.

Adult vaccination:- Adults are vaccinated in house to house vaccination, street vaccination, or market vaccination. On market days people come to sell and buy from the neighbouring villages and those who have not been vaccinated are vaccinated. Vaccinations are also performed in railway trains and stations. It is possible, in small villages, to make arrangements with the village heads for the collective vaccination of the villagers.

Out of the thousands of vaccinations performed yearly, not a case of post-vaccinal encephalitis has been brought to our notice.

Vaccination is no longer the terror it was in years gone by. The mass of the people are becoming educated to the value of vaccination. Improved technique, asepsis, and purer lymph have all contributed their quota towards doing away with the horror in which vaccination was held.

Isolation and disinfection: - As soon as a case is notified and diagnosis confirmed, the patient is isolated, in the Infectious Diseases Hospital, and his fomites disinfected. Old mats, straw mattresses and the like are burnt. The premises are disinfected. All contacts and all those resident on the premises are vaccinated. If the house and the adjoining ones are built of palm or wood, those resident in these are also vaccinated and their premises disinfected.

Contacts are not isolated as a rule, unless it is felt they might decamp and so escape surveillance. All contacts are however placed under surveillance for twelve days, and if within that period the temperature of any rises above 100°F., he is isolated under observation.

The port health officer is always notified immediately the medical officer of health confirms a case, and vice versa. When the history of a case points to the patient having contracted the infection from another town or district, the medical officer of health in such an area is notified.

Improved sanitation:- Sanitation bears an indirect effect on the prophylaxis of smallpox. A dirty, ill-kept house encourages fly breeding which may spread infection. An ill-ventilated house is not conducive to health. Overcrowding favours the spread of infection.

Great difficulties are often met with in public health administration of smallpox. Tracing of contacts is sometimes impossible as not infrequently the patient is enjoined by his relatives or friends not to give his address when he reports - usually at midnight - at the general hospital. Sometimes he is landed in a canoe or brought by car from a neighbouring village, but neither the canoe nor car can be traced. Occasionally a case is smuggled out of town, but this is rare as the people now definitely appreciate the value of proper care and treatment in this disease. With increasing enlightenment the fear for health officers and/or isolation is being dispelled. Language difficulty has been referred to above. Vaccination marks are often rubbed with limejuice or washed off to prevent them taking as soon as the vaccinator turns his back. It has been necessary to isolate such type of contacts for a short period to let the lymph soak in. Happily this is now almost a thing of the past.

General Treatment:- In all acute infectious conditions, the elimination of toxins and waste products from the system is of prime importance. The skin and the kidneys are the two main organs concerned. In smallpox with profuse eruption, or in a confluent attack, a large area of the skin is put out of action so that very little elimination is carried out through the skin, and the

kidneys have to be relied upon almost entirely.

Fortunately, though albuminuria may occur, true nephritis is rare, and diuretics may therefore be given freely. Of course a preliminary saline purge is given on admission.

Secondary streptococcal and other pyogenic infections are concomitants of smallpox and in my opinion are responsible for the large number of deaths in this disease. Any treatment that would combat streptococcal infection would therefore be helpful in reducing mortality. With this theory in mind, I used both intramuscular and oral administrations of prontosil in three severe cases - two severe confluent and one severe discrete smallpox - with very favourable results. The common features of the cases were the rapid maturation of the rash, diminished contents of pustules, rapid disappearance of the oedema of the face (most obvious in the confluent cases), early scabbing, few complications, and rapid return of strength (a thing uncommon in confluent attacks). Though these cases are few, yet the result justifies further trials.

A drachm dose of xylol in combination with liquorice and milk is given twice daily. This is supposed to keep down the temperature.

The body is painted after bathing with a solution of potassium permanganate, 15 grains to an ounce.

Care of the eyes is most important if keratitis is

to be prevented. On admission, the eyes are bathed three hourly with boracic lotion, and 2 per cent. protargol drops instilled. When oedema of the face commences and the lids close, hourly treatment of the eyes is given.

Bed sores may be difficult to prevent. When present, careful attention is necessary. Carbolacene, a soapy carbolic preparation, is very useful for dressing. It promotes healing.

For the intense headache and backache, aspirin or phenacetin may be given. Paraldehyde or large doses of bromides are sometimes given in noisy delirium.

Enemata are given when necessary.

Careful nursing throughout is very important in the treatment of smallpox cases.

During convalescence, the palms and soles are soaked in warm water and the 'seeds', i.e. dried scabs, picked out. The patient's diet, which was fluid in the early stage of the disease, is gradually increased and made more solid.

Varicella:- Chickenpox is, as a rule, a mild infection, and is of little importance on account of its very low mortality. But in a country where smallpox is endemic it assumes importance in public health administration. All cases of varicella are therefore made notifiable as is

the case with variola. Isolation is carried out when necessary.

Daily baths and the use of dusting powder consisting of equal parts of zinc, starch and boric powder are found most effective in treatment. The patient is encouraged to expose as much as possible of the skin to the air in order to facilitate scabbing. Boric lotion clears the slight conjunctivitis which is sometimes present.

CLINICAL CASES.

Atypical Cases of Smallpox:-

Case I. A female, about 25 years of age, was sent in for admission into the Infectious Diseases Hospital. She arrived in the town the night before the rash appeared. She stated she had neither a headache nor backache. She felt quite well. There was a papular rash scattered over the body, but none on the palm of the hand. The eruption was more copious on the arm than on the forearm. The rash looked like a typical papular syphilide. The patient was unvaccinated. A tentative diagnosis of papular syphilide was made and the medical officer of health who was consulted, and who had had several years' experience in the smallpox wards, confirmed the tentative diagnosis. The patient was isolated under observation and the blood taken for Kahn test. The temperature on admission was 103.2°F. During the next two days the patient's condition was practically unchanged. On the fourth day the temperature fell to 99.4°F., and the patient complained of epigastric pain and backache. The eyes were slightly suffused. A black pigmented centre was noticed in some of the papules which were now larger. There were still no papules on

the palms. The next day the patient was worse, umbilication was present, the rash was leathery to touch, and dusky red colour could be seen round the base. Papules were now present on the palms and there were bright red rings round their bases. The patient developed confluent smallpox. The attack was fatal.

Case II. A young girl of about twelve years was taken to the general hospital as she complained of an attack of cold two days previously. On examination a morbilliform eruption on the face and suffusion of the eyes were noticed. There was, however, on each wrist a single papule with a pigmented centre. This aroused suspicion and the child was isolated under observation. By the third day the rash on the face increased and more rash appeared on the forearm and fresh ones on the arm. The rash then slowly travelled to the ankles and feet which it took fully seven days to reach. The case was also a fatal attack of confluent smallpox.

Case III. A male, about 25 years, was admitted as a case of chickenpox. The rash was scanty and confined to the trunk, face and upper arm. The patient was vaccinated six years previously. A few of the papules had ruptured central vesicle which was scabbing. There was a history of slight malaise the day previous. No intense

headache or backache was complained of. The temperature was 100°F. The next day I noticed that vesiculation had not progressed as one normally expects; but it is not uncommon for papules to retrogress in chickenpox. The temperature had risen to 100.8°F. The patient was up and about, but he complained of sore throat and difficulty in swallowing. There were a few punctiform eruptions on the palate and pharynx. Now sore throat and dysphagia are very rare in attacks of chickenpox in Nigerians, but is almost invariably associated with attacks of smallpox. The patient was therefore isolated under observation. The following day (third day after admission) the rash had spread to the forearm and papules were felt on the palms on careful and deep palpation. The case was a modified discrete attack of smallpox. Recovery was uneventful.

Case IV. Nine days after the admission of Case III, his elder brother, about 30 years, who was placed under surveillance, was brought to me. He gave a history of slight fever the day previous. There were what looked like a few pimples on his face, and a few smaller ones on the points of the shoulders. The patient had been vaccinated many years previously. He was isolated under observation. The next day two papules, one on either side of

alae nasi appeared. Each was surmounted by a ruptured scabbing vesicle very similar to what was observed on the brother. The rash had increased slightly on the face and shoulder, but there was none on the limbs. The next day the rash became more copious and appeared on the arm and forearm. Thereafter it slowly spread downwards and took about eight days to appear on the ankles and feet. A modified discrete attack with profuse eruption developed. The course was practically afebrile throughout.

Case V. Variola sine variolis. The nurse in charge of the isolation had just retired, and another was appointed in his place. The new nurse was successfully re-vaccinated. There were then no cases of smallpox in the wards.

On 23rd February a severe case of confluent smallpox was admitted. (The patient died a week later). This was the first case to be handled by the new nurse.

On the 8th March, the nurse complained of headache and slight fever. Blood film was taken for malaria and quinine given.

9th March. Condition unchanged.

10th March. Temperature began to rise, 101°F., headache severe; backache complained of.

11th March. Temperature 103.2°F., intense headache, and very severe backache. Epigastric pain absent. No vomiting.

12th March. Condition unchanged during the day, but much worse at night. Temperature 104°F., pulse 120.

13th March. Temperature falls to normal. The patient was more comfortable; the headache and backache had eased. Macules appeared on the back; a few very small papules were seen on the face, chest, forearms and wrists; one on the left thigh. The papules retrogressed rapidly within two days. A burning sensation and weakness were felt in the forearms and legs up to the knee, and persisted for a few days. In about a week after he was able to resume duties.

Discussion of Cases.

The atypical features of these are shown in:-

1. Initial Symptoms. The initial symptoms in smallpox are characterised by the sudden onset of fever, severe headache and backache, and often vomiting or epigastric pain. The complete absence of these symptoms in Case I is very unusual, all the more as the case proved to be one of confluent attack, in which type these symptoms are usually severe. In Case II, the symptoms were indefinite and more suggestive of measles. The absence of marked initial symptoms in Cases III and IV may be explained on the grounds that they were both modified attacks.

The development of backache and epigastric pain on the fourth day of eruption and the maintenance of high temperature while the eruption was coming out were other unusual features in Case I.

2. Distribution and Character of Eruption. In these cases the distribution of the rash was atypical. Experience has taught that too much reliance must not be placed on the distribution of the rash. It may be scanty on the face; it may be evenly distributed on the arm and forearm, or it may be more copious on the arm than on

the forearm and wrist. It may be very scanty on the palms, or appear late. In the Negro differentiation between the rash and papular syphilide may be very difficult.

3. Period of Eruption. The period of complete eruption is usually given as forty eight hours. But in the Negro, eruption is often retarded till much later, extending in some cases to a period of about eight days between its appearance on the face and trunk, and the ankles and feet. This may be partly due to the texture of the skin, or to a peculiar slow reaction of the skin to the virus. Not infrequently the papule could be felt before it was visible. In the light-skinned Negro, eruption is extended over a much shorter period. This is probably due to the relation which exists between pigmentation and texture of the skin. As a general rule the darker the pigmentation, the tougher the skin.

Great care must be exercised in the examination of skin rashes in the Negro, especially in endemic areas of smallpox, if pitfalls are to be avoided. Any doubtful case should be isolated. A missed case may be the focus of an epidemic not only in his own village but also in the surrounding villages as well.

General Discussion as to Seasonal Incidence,
Sex, and Age.

Seasonal Incidence:- Smallpox, a spray infection, should be more common at a period of the year when people are most likely to crowd together indoors. In Nigeria the converse is the case, the incidence being highest in the hot and dry months when people are least likely to crowd together. The reason is probably due to one or a combination of the following factors.

1. Fly Prevalence:- Flies can transmit the contagion mechanically. Rolleston⁽¹²⁾ in commenting on the theory of aerial convection based on the high incidence of smallpox in the neighbourhood of smallpox hospitals stated that a more likely explanation was the conveyance of infection by flies as was exemplified in the Basle epidemic of 1921 described by Hunziker and Reese.

Flies seem particularly attracted to smallpox patients. This is probably due to the characteristic heavy emanations from smallpox patients, which are not unlike putrefactive odours. Rosenau⁽¹⁷⁾ wrote: "I have actually seen maggots breeding in the open lesions of

a case of smallpox treated in huts at Eagle Pass, Texas."

In our smallpox wards, and to a lesser extent in the chicken-pox wards, patients are plagued with flies during the hot and dry months. In spite of fly traps, nurses are often kept busy swishing off the flies from patients, who are often too weak to ward them off. There is marked contrast during the heavy rainy season and the comparatively cold weather that follows. One hardly sees a single fly in the wards. The patients are then at peace.

In the Northern Provinces, after taking into consideration its larger size, the incidence of smallpox is far higher than in the Southern Provinces, and this may be correlated with the heavier fly breeding and slightly longer hot and dry season. Fly infestation is heavier because of the poorer sanitation in the North compared with that of the South. Cattle rearing is one of the important industries of the people of the North. Indeed almost all the cattle brought to the South for meat, and those exported to the sister colonies are from the North.

The people are also horselovers and famous horsemen, and most of them keep and breed horses. The large amount of manure which accumulates daily from these sources is, in the absence of proper treatment or

packing, a veritable breeding place for flies.

Earth closets, pit latrines or salgas, and night soil disposal pits unless properly constructed, and the use supervised, are also very suitable for prolific breeding. Water carriage system is a rare luxury. Unregulated disposal of household refuse also adds to the nuisance, though cheap, simple and effective incinerators are now being encouraged all over the country.

I have mentioned above that it is customary to isolate patients in huts far from human habitation, but these huts are never really so far that flies which have crawled on the patients cannot fly back to the village. Perhaps the greatest distance of the hut from the village may be about a mile - as a rule it is much less - but flies are known to travel far greater distances and always to make for human habitation. Bishop and Leak⁽¹⁸⁾, experimenting with marked specimens of flies, found that the maximum spread in open country from the point of release was 13 miles 245 yards. I have also mentioned that a smallpox corpse is denied burial rites and is therefore either thrown into the bush, or into an open pit which is left uncovered. Within a short period thousands of flies will breed from the corpse and make for human habitation, as is their wont, irrespective of the amount of food at the breeding place.

It is therefore quite clear that fly prevalence must play an important role in the transmission and spread of the infection.

2. Increased Facilities for Travel:- During the dry season there are greater facilities for communication between the villages over a wide area, and this naturally tends to the dissemination of the disease.

3. Aerial Convection:- Aerial convection may operate if, of villages close to one another, there is an epidemic in one. The atmosphere is laden with virus, partly in the form of finely powdered scabs, which finds a receptive soil in the nasal mucosa, which is often turgid during the hot season. During the rainy season the atmosphere is cleared of the virus.

4. Effect of Tropical Heat and Sunlight on Vaccine Lymph and Vaccination:- In the tropics, glycerinated calf lymph has been abandoned in favour of lanolinated lymph because the latter retains its potency much longer under tropical conditions. But unless great care is taken to protect it from tropical heat, its potency may be greatly diminished or lost within a short time. This protection is not easy in out-of-the-way places during the very hot months.

After a person has been vaccinated, unless he is warned not to expose the mark to the sun, if he does, it is unlikely that the vaccination will be successful. In Nigeria, as mentioned above, the house is used mainly at night, most of the time being spent in the yard or compound; the mark is therefore exposed to sunlight for a long period. Also a man may have been vaccinated while going to work, or a woman while going to market, and, therefore, the mark is exposed all the time. It therefore follows that in an epidemic at this period there will be a large number of failures in vaccination, and the tide of the epidemic will not be stemmed as it normally would with a larger number of successful vaccinations.

This view is supported by the experience of King⁽¹⁹⁾ while inoculating animals with vaccine. He recorded that after inoculating an animal with vaccine early in the morning in the shade of a building he left it on its side on the table. When he returned the sun had advanced and the calf was no longer sheltered. At the end of the period for the development of vesiculation, there was full vesiculation on the side on which it had lain, and "a practically sterile result on that which had been exposed to the sun."

These factors undoubtedly influence the incidence of smallpox in the hot season, tending to produce epidemics.

Sex Distribution:- We have seen above that, according to hospital statistics, more males than females are attacked. Turner in his medical census of Southern Nigeria, which was referred to above, commented on the higher incidence of smallpox in males than females, suggesting that it is because men travel more than women, and secondly that women are more amenable to vaccination. With regard to the latter, no one who knows African women would say that they are more amenable than men to vaccination. Vaccinators have been known to be assaulted in the course of their duties by women. Women could be particularly difficult to vaccinate.

A brief study of the life and occupation of the African woman would help to disprove the first suggestion that men travel more than women.

In Nigeria the majority of the population are agricultural. The menfolk go to plough and sow. At harvest time both men and women go to reap. After reaping, it is the women who transport the different crops to the various markets to sell. They travel twelve, fifteen, twenty or more miles to and fro, on foot, by canoe, or train, as occasion demands, in rain or heat, to the various markets. They are in this market one day, that the next day, and so on. In these markets where they sell and buy or barter they mix with women from other villages

far and near the whole day long. The womenfolk are the great traders in Nigeria, and in no place are they so open to infection as in the markets where they jostle one another.

Street hawkers in Nigeria are predominantly women. An estimate of 90 per cent. of hawkers as women will be on the conservative side. These hawkers go from house to house, from compound to compound, to workshops, dockyards, and wherever they can earn a penny.

Polygamy is still largely practised in the country as the great majority of the population is composed of Mohammedans and Pagans. In almost every household, therefore, there is a larger number of females than males. In illness they minister to the sick. According to the last census the population of women is greater than that of men.

From the above, one can see that Nigerian women not only travel more than the men, but a far larger number is open to risk of infection, and yet the incidence of the disease is less among them. The possible explanation for this is that African women possess a greater amount of natural immunity to smallpox than the men.

In varicella a still greater natural immunity is possessed by African women, and this accounts for the very low incidence of this disease among them.

Age:- Variola is a disease of all ages, but it is not improbable that the natural immunity enjoyed by many mothers may be transmitted to their offspring. Beclere and his colleagues showed that natural immunity to vaccinia is transmissible through the mother to the child⁽⁸⁾. Statistics are not helpful in this respect as infant vaccination has definitely made smallpox more a disease of adults. But in varicella the high natural immunity enjoyed by the women is reflected in the children in whom the incidence of varicella is very low. As the children grow older, the immunity is gradually lost until adult life, when it is at a minimum and when the incidence of varicella is highest.

Summary.

1. Variola and varicella have been known for centuries in Nigeria, though not differentiated as separate entities.
2. Variolisation was practised by some of the tribes.
3. Isolation in the bush far from human dwellings is the general rule observed by most of the tribes. Cases are treated only by the smallpox priest or by someone who has had a previous attack. The same applies to handling of corpses, which are invariably denied burial rites.
4. Difficulties in diagnosis may be met with not only in relation to diseases like typhoid, influenza, pneumonia, measles, but also in relation to diseases like malaria, yellow fever and papular syphilides, which are common.
5. Stress is laid on the careful examination of all skin rashes in the Negro, and the isolation of any doubtful case.
6. The presence of a dark pigmented centre in variola papules is of valuable diagnostic importance when seen.

7. Variola and varicella are diseases of the hot months when people are least likely to crowd together. Fly prevalence, increased facilities for communication between neighbouring villages, aerial convection, and the effect of heat and sunlight on vaccine lymph and vaccination during the hot season are responsible factors for this seasonal incidence.
8. The incidence of variola is higher in African males than females. An even higher incidence of varicella in males is observed. This is due to a greater measure of natural immunity to both diseases in African women than is enjoyed by the men.
9. Variola is not selective as to age. All ages are almost equally affected, though, on account of vaccination, the incidence is now shifted to adult life. Varicella, in contrast, is selective as to age. In cold and temperate climates it is a disease of childhood, but in Nigeria, and probably in other tropical countries, it is a disease of adult life. The immunity enjoyed in childhood is closely related to the high natural immunity in

African women. This immunity gradually passes off till it is at a minimum in adult life, when the incidence of varicella is highest.

10. The evolution of the eruption in the Negro is slow, and this is probably related to the texture and pigmentation of the skin.

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A P P E N D I X.

Table 1.Variola.

	Total number of cases:		
	1920-24	1925-29	1930-34
January	21	-	14
February	34	7	30
March	35	10	21
April	24	13	21
May	25	13	55
June	28	5	17
July	24	12	11
August	22	5	9
September	11	3	12
October	7	2	4
November	3	3	2
December	3	1	5

Table 2.Varicella.

	Total number of cases:		
	1920-24	1925-29	1930-34
January	21	20	26
February	28	35	56
March	31	14	26
April	14	32	11
May	6	9	15
June	3	11	7
July	5	14	8
August	9	21	11
September	13	39	33
October	20	28	26
November	19	29	25
December	16	16	20