

"THAT IT IS POSSIBLE TO CORRELATE THE
CLINICAL TYPES OF LOBAR PNEUMONIA
WITH THE SEROLOGICAL TYPES OF
THE PNEUMOCOCCUS."

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I. Introduction

In December 1929 it was noted that in addition to the seasonal variation of case incidence of Lobar Pneumonia, there was also definite variation in the clinical types and an investigation was then begun in an attempt to determine those variations. This was carried on until February 1930, when it was decided that the material available was suitable for a much more comprehensive investigation and it was thought that an attempt to classify the suspected clinical types of Lobar Pneumonia would be of considerable interest.

About this time Dr. Robert Cruikshank of the Glasgow Royal Infirmary was investigating the serological types of the Pneumococcus in Pneumonia and as a result of collaboration with him the scope of the work was greatly extended by having the infecting organism typed in each case.

The manner of presentation of the collected material is somewhat unorthodox but an attempt has been made to present the salient features of lobar pneumonia in a logical manner, endeavouring at the same time to incorporate clinical and epidemiological material.

I desire to acknowledge my indebtedness to Dr. A. S. M. Macgregor, M.O.H. for the City of Glasgow, for his unstinted advice and encouragement and also Dr. Thomas Archibald, Superintendent of Belvidere Fever Hospital, for his permission to make use of the clinical material. Also I have to pay tribute to Dr. J. M. Cowan and Dr. Robert Cruikshank; to the former I owe any clinical skill which has been necessary for this work, and to the latter I owe all the bacteriological findings, in addition to a number of suggestions with regard to their application, without which the finished work would have been much the poorer.

II. Scope of the Investigation.

The inquiry was begun on the 17th December, 1929, and is still proceeding. The present paper deals with 486 cases of definite lobar pneumonia admitted to Wards 9 and 10 East, Belvidere Fever Hospital, Glasgow, in the period between the above date and 9th September, 1931. Of this number there were 317 cases who had attained the age of 15 years and were thus classed as adults and deemed capable of giving an intelligent history. Each of those 317 cases had the causal organism determined by Dr. R. Cruikshank, Glasgow Royal Infirmary. 171 cases of this latter group were examined in detail each day as described in the chapter upon Methods of Investigation.

Of the men who were examined during the period following dismissal, the first hundred who had returned during the first year following dismissal were utilised for the investigation with regard to the carrier problem.

III. Methods utilised in the Investigation.

All the cases examined were adult males who had been admitted to wards allocated to pneumonia. Each patient was counted an adult who had attained 15 years and he was accepted as a true case of lobar pneumonia if he had any one of the classical signs of pneumonia in conjunction with a rusty sputum. The signs and symptoms accepted as evidence on this basis were:- (a) dyspnoea; (b) cyanosis; (c) "pain in the side"; pain at some point on the costal margin; pain in the epigastrium; (d) dulness on percussion over an area of lung normally resonant; (e) tubularity of the respiratory murmur; (f) the presence of crepitations accompanying the respiratory murmur.

The symptom which carried most weight was a rusty sputum

and if, in cases of doubt, this symptom was absent, the diagnosis was withheld until some other confirmatory sign or symptom appeared.

There were occasions where sputum was absent throughout but in these cases the diagnosis was made on a combination of a number of the classical signs and symptoms.

Each patient was subjected to a routine examination and the findings were noted and summarised on a sheet suggested by Dr. Cowan, and of which a specimen is appended.

The routine of the examination was as follows:- As far as possible the examination was carried out at the same hour every day.

On the first day a complete and thorough examination was made, special attention being directed in the first place to the respiratory, circulatory and urinary systems. Thereafter the remaining systems were examined in turn.

Circulatory. The blood pressure was taken before the patient was moved, or had been upset by examination or questioning. This was effected by means of a mercury manometer, a Baumanometer, which should have been absolutely constant, since the calibrated tube was cleaned regularly, and as it was used solely by one person throughout, the personal error should have been minimal.

The method of determining the systolic and diastolic pressures were those detailed by J. F. Halls Dally⁽¹⁷⁾ and were as follows. After the arm had been compressed sufficiently to occlude the artery, the pressure was released and the systolic pressure was read off when the first click of the returning pulse was heard through the phonendoscope. The diastolic pressure was read off when the throbbing thuds which follow the first clicking sounds had reached their maximum intensity and immediately before they faded and became distant. In the majority of cases this change was quite distinct but in

a few the change between the different phases was very indefinite. This difficulty is not confined to ill-health but has also been found in healthy subjects, as noted in a booklet of the Medical Research Council, ⁽¹⁸⁾ p. 34.

After the blood pressure had been recorded, the cardiovascular system was examined in detail and notes made on the duplicate form, with regard to extent of the cardiac dulness, condition of the arteries, etc.

The respiratory system was also examined in routine manner, inspection, palpation, auscultation and in a few cases with some peculiarity, mensuration.

The alimentary system was next examined, the abdomen, the mouth and pharynx and in cases where indicated special examination was carried out, such as laryngoscopy, rhinoscopy, rectal examination and examination of the faeces.

The nervous system was not dealt with in detail but the knee-jerks and pupil reactions were examined as routine and a complete examination was only carried out where symptoms indicated involvement of the nervous system.

The total quantity of urine passed in 24 hours was collected and measured and a fresh specimen was examined each morning by the nursing staff. Albumin, blood, sugar, acetone and diacetic acid and proportion of chlorides were tested for as a daily routine, and the results of the tests were kept and later inspected by the M.O. Microscopical, chemical and cultural examinations were only carried out in special instances.

This examination of the patient was carried out each day but only in detail in the case of the respiratory, circulatory and urinary systems and the findings noted on the duplicate form. On those succeeding days the patient was disturbed as little as possible, but the lungs were examined in detail with regard to every lobe, every day.

Special note was made daily of the sputum with regard

to amount, character, aerated or otherwise, and whether bloody or rusty, and the daily variations noted. Until the crisis a specimen of the morning sputum was collected daily and sent to Dr. Cruikshank of the Glasgow Royal Infirmary for examination, and after the crisis further specimens were sent less frequently. During residence in hospital specimens of any discharge such as from an empyaema, otitis media suppurativa, furuncle, or abscess were sent to Dr. Cruikshank for isolation of the organism. These specimens were collected in sterile wide-necked glass containers and taken by messenger to the laboratory at 09.00. This messenger also carried thence media tubes inoculated with 4 ccs. of the patient's venous blood which had been collected in the following manner on the morning after admission and in a number of cases (about 30 per cent. of the total) within an hour of admission.

The forearm and ante-cubital space were scrubbed with soap and water, dried, and then bathed with methylated spirit, and thereafter a moist gauze dressing of mercuric chloride 1:500 of spirit, was bandaged over the ante-cubital space. This was applied approximately one hour before the morning visit. After the patient had been examined and the findings noted, the anamnesis was taken, particular care being taken to determine the order of onset of symptoms with relation to each other and finally short notes were made in respect of previous respiratory disease. Thereafter the observer "scrubbed up" and made the hands surgically clean, finishing up by painting the palmar surfaces of the fingers with liquor iodi mitis. In the meantime the ante-cubital dressing had been removed and the arm was then prepared for removal of blood. As a final precaution against infection the area was again swabbed with the mercuric chloride solution after a tourniquet had been applied to the upper arm by the ward sister.

The instruments used were (a) a Luer glass serum

syringe of 20 ccs. capacity; (b) a B.W. & Co. No. 210 medium bore steel serum needle, 50 m.m. in length, S.w.g. 18. These had been sterilized by boiling for 20 minutes and were laid out for use, the syringe in normal saline and the needle in spirit. Before use they were both flushed out with fresh normal saline from a sterile receiver. Sterile towels and jaconet were used to isolate the area prepared for vein puncture. The tourniquet having been tightened by the assistant and the patient having been instructed to clench the hand, the median basilic vein was entered in the direction of the blood flow with the eye of the needle turned away from the skin and with the needle as nearly parallel as possible to the line of the vein. 10 ccs. of blood were then abstracted, the needle withdrawn and the tourniquet immediately removed. The site of the puncture was then dabbed with spirit and sealed by means of a patch of gauze moistened with collodium flexile. 5 ccs. of the blood were expressed into the usual glass tube prepared for transmission to the Public Health Department for the purpose of having the Wassermann test carried out. The remaining 5 ccs. of blood were inoculated into a large bore test-tube which contained the culture medium, and which had been kept standing in water at blood heat for some time prior to the inoculation. Before and after the injection of the blood, the cotton-wool stopper and mouth of the tube were flamed. The stopper was removed for as short a period as possible and care was taken to refrain from inoculating the medium by means of the breath. Thereafter the Wassermann outfit was dispatched to the Public Health Department and the culture tube was incubated at 37°C. till it was removed to the Glasgow Royal Infirmary laboratory, which was always done within 18 hours.

The medium used for blood culture was Hartley's digest broth which is a 6 hour digest of horse muscle by the trypsin in fresh pig pancreas. To 70 ccs. of this was added 0.1 per

cent. glucose and the mixture was put up in a large test-tube. After having been inoculated this was put in the incubator and examined daily for four days. If the blood culture was positive there was usually a well-marked greenish colouration of the medium within 24 hours, sometimes within 48 hours, but practically never after two days.

The typing of the organism from the blood culture was done either directly or after inoculation of the culture into a mouse. The latter method was preferable if the culture was contaminated or if the pneumococci were scanty. This latter method was used for identification of the organism from the sputum and was carried out as follows.

The specimen of the sputum was emulsified in broth (2-5 ccs.) after which 0.5 cc. to 1.0 cc. of the sputum emulsion was injected intraperitoneally into a mouse, which was usually dead within 10-24 hours. The abdominal cavity was opened up and the peritoneal exudate washed out with 1.0 cc. $\frac{N}{1}$ saline, the washings being transferred to a small test-tube. An ordinary glass slide was marked into four divisions with a glass pencil and in each division a drop of the mouse peritoneal exudate was placed. A drop of Type i agglutinating serum diluted 1:5 was added and intimately mixed with the drop of peritoneal exudate in division I; similarly, a drop of Type ii serum, diluted 1:5, was added to division II, and a drop of Type iii serum diluted 1:5, to division III, and division IV was left as a control.

The film was dried and fixed at the same time by gentle heating over the bunsen flame and was then stained with dilute carbol-fuchsin (1:10), care being taken not to wash the slide in water afterwards, since washing tends to carry away the film of organisms and serum. Instead of washing, the excess stain was drained off. The slide after drying was examined with the oil immersion lens and the type of organism was determined by noting the presence of clumping in the appro-

priate division. If there was no agglutination, the pneumococcus was Group iv or "X". The sputum collected from the Return cases was dealt with as described above. The throat swabs and post-nasal swabs taken from those cases were used to inoculate 10 ccs. Hartley's broth and this was then incubated overnight (14-15 hours), and finally 0.5 cc. of the culture was inoculated into a mouse peritoneal cavity. Finally the typing was done as described above.

Before each case was dismissed from hospital a final specimen of sputum was collected and examined with regard to the presence and type of pneumococcus.

In a few instances lung puncture was performed. The skin over the affected lobe was prepared in a manner similar to that described under vein puncture and the same apparatus was used; a Luer glass syringe and a No. 210 B.W. & Co. steel needle. The consolidated lung was pierced and an attempt made to remove a specimen of the exudate, which when obtained was injected into a test-tube containing the culture medium. After a number of such punctures had been performed it was considered inadvisable to continue this procedure as a routine and ultimately it was omitted entirely on account of the disturbing effect on the patients.

Two months after dismissal each patient was written and asked to return for examination and over 90 per cent. of the men acceded to the request. This examination was arranged for a definite evening each week and eight of the patients were asked to return on each night. A routine examination, to be described below, was performed and enquiry was made with regard to the progress of the patient's health since dismissal; whether he was working or otherwise; and whether any of his relatives or associates had suffered from pneumonia since he had been dismissed. He was asked with regard to the presence of cough and sputum, the presence of any discharges, or of any pain such as headache, earache, pains over the sinuses or on

either side of the chest. Also he was asked whether he felt better or worse in health since leaving hospital and whether he had gained or lost in weight.

The examination was conducted in the following manner.

(1) The mouth and pharynx were examined and notes made as regards congestion or inflammation; the size and condition of the tonsils and the presence of any post-nasal discharge, and finally a swab was taken of the tonsillar region and of any post nasal discharge and these were inoculated into Hartley's medium as described previously.

(2) The nose was examined by means of a nasal speculum and direct light and notes made of the presence and degree of enlarged turbinates, septal deflection and the presence of any discharge. A swab was taken from the nasal cavities and a culture medium inoculated.

(3) The ears were examined by means of an electric auriscope and any abnormalities noted and if any discharge was present it was swabbed and inoculated into culture medium.

(4) The chest was examined and any abnormalities in the lungs or heart noted. In a few cases after such an examination arrangements were made to have the chest examined by the Radiologist at Ruchill.

(5) Finally a specimen of sputum was collected in a wide-mouthed bottle.

The collected specimens having been incubated at 37°C. overnight were dispatched at 09.00 the following morning to the Glasgow Royal Infirmary for investigation.

A roster of the return cases was kept in the ward and each group of men was sent for at intervals of two months by the sister in charge of the ward.

Continued examinations such as this were made possible only by reason of the great good-will of those ex-patients. This co-operation was unflinching, and their desire to help un-

bounded, and there are a number who still return in response to invitation over two years after dismissal.

A number of the ex-patients were circularised with regard to the incidence of pneumonia amongst their associates and a sample of the circular is appended.

Stamped and addressed envelopes were provided for return of the sheet, in order to prevent any charge falling upon the patient and for the same reason the travelling expenses were paid of all the men who returned for examination.

Permission for an autopsy was difficult to obtain but an examination was carried out whenever possible. The findings were noted and compared with the clinical notes. Specimens of the affected lobes, of the spleen and of any other abnormal organ or viscus were removed for identification of the infecting organism if such proved to be present. In later cases the suprarenals were removed for examination by a pathologist. They were transported in 10 per cent. formalin in saline.

IV. Review of the Literature available in March, 1932, containing references to symptomatic differences in cases due to the various serological types of the Pneumococcus.

The various standard textbooks quote the incidence and mortality of cases due to the different types of pneumococcus and indicate the value of such evidence in prognosis and treatment, but no attempt is made to differentiate clinically those cases infected by the different types of organism.

Lamar and Meltzer⁽⁴²⁾ (1912) stated that Pneumonia due to Type iii pneumococcus was associated with a moist and viscid exudate, but otherwise very few references to clinical differentiation appear. In 1924 Glynn and Digby,⁽¹⁾ (p. 139) briefly

indicated differences in the course of cases due to Type i and Group iv organisms, with special reference to type of onset, type of temperature and duration and manner of termination of pyrexia. In addition they made notes with regard to the varieties of sputa found. They also quote from Park, J.H., Chickering, H.T., (J.A.M.A., 1919, 73, 403), who had noted that Type i cases usually had the so-called typical course. Cecil, Baldwin and Larsen⁽⁸⁾ (1927) noted that Type i cases were complicated by empyaema almost twice as frequently as any of the other types.

Cecil and Plummer⁽²⁾ (1930, p. 1547 et seq) are of the opinion that the biological types of the pneumococcus produce more or less characteristic clinical pictures. Also they feel justified in stating that there is as much difference between Type i and Type ii pneumonias as there is between Typhoid and Paratyphoid fever and consequently the investigation of any case of pneumonia is not complete until the causal organism has been isolated.

Smeall⁽³⁵⁾ (1931) found that empyaemata were much more frequent in cases of pneumonia due to Type i and similar findings are recorded by Glynn and Digby⁽¹⁾ who also found infection of the pleural cavities common in Group iv infections.

V. 1. Case Incidence and Case Mortality of total cases examined during the period of investigation.

The cases dealt with in the investigation were all males. In the total 486 cases all ages from 5 years to 84 years were represented and the case mortality was 11.32 per cent., which compares favourably with the case mortality in pneumonia in Glasgow from 1919 to 1925 inclusive, when there were 7,183 cases above aet 5 years with a mortality of 18.5 per cent.⁽⁵⁾ The majority of the cases in the present series

were below 35 years of age. (Figs. I and III). The graphic representation by means of histograms in Figs. I and III shows the high incidence of cases in the lower age group rapidly falling with the increase in age. At the same time the mortality is seen to rise as age increases; slowly in the younger group but much more abruptly in the group over aet 35 years (see also Fig. II). Histograms constructed to illustrate the total figures of lobar pneumonia in the hospital in 1930 and 1931 (Figs. V and VI) also show this regular increase in mortality.

372 cases, or 76.54 per cent., were below 35 years of age and the case mortality of this section was 21 cases, or 5.64 per cent., as compared with 34 cases, or 29.82 per cent. mortality of the 114 cases, or 23.46 per cent. above 35 years of age. Osler and M'Cræ⁽³⁾ (1925, p. 190) in a large series of over 30,000 collected cases found a much lower number, 40.2 per cent., between 10 and 30 years of age. Their figures, however, include both sexes, which would influence the findings to a certain extent. Glynn and Digby⁽¹⁾ (1924, p. 93) in a series of 123 cases had 94, or 76.45 per cent., below aet 40 years with a case mortality of 21.27 per cent., and 29 cases, or 23.57 per cent., above aet 40 years with a mortality of 48.3 per cent. These figures are similar to those of the present series in some respects but differ as regards mortality. In their group it is found that the mortality below 40 years of age is almost four times as great as that of the younger cases considered in this paper. The mortality of the cases above 40 years is twice as great as that for the similar section in this series. The figures are not strictly comparable since Glynn and Digby include the 1-10 decade which has a very high mortality, and also they considered their cases in age groups of 10 years which prevents accurate comparison with this series which has been considered in group of 5 years. Their results, however, confirm the findings that the large proportion of

cases of lobar pneumonia occur below 35 years of age and that the mortality which is low to moderate in the younger age groups rises rapidly with the age of the patient. (Fig. II). This latter conclusion also finds confirmation in figures given by Cecil and Plummer⁽²⁾ (1930), who found that mortality rose with every decade until over 50 years of age it was 46.2 per cent. Cf. graph in Fig. II.

Stewart and Gibson⁽⁴⁾ (1929, p. 607), investigating a series of 50 cases of whom 76 per cent. were males, found that 80 per cent. of the cases were between 20 and 40 years of age. This is much in excess of the numbers in similar age groups in the present series of 486 cases where 152, or 31.26 per cent., were aged between 20 and 40 years.

317 of the 486 cases considered in the present paper were investigated with regard to Type of infecting organism. The results are depicted graphically in Fig. IV by means of histograms. From them it is seen that Type i and Type ii infections account for 73.8 per cent. of the total 317 cases, the remaining 26.2 per cent. being caused by Type iii and Group iv infections. The Type ii infection preponderates slightly over the Type i infection; viz., 39.1 per cent. as compared with 34.71 per cent. Consideration of the age incidence illustrates a number of interesting points. It is seen that under 25 years of age the case incidence in Type i, Type ii and Group iv infections is somewhat similar, but Type i and Group iv are outstanding in affecting the youngest age group; a point which has been stressed by previous investigators being that Type i is the infection of youth. (7), p. 204, and (8) pp. 253-280. Above age 25 years differences are noted with regard to age incidence, for although 56, or 50.58 per cent., of the Type i cases were below 30 years of age as compared with 65, or 52.4 per cent., Type ii, and 44, or 63.8 per cent., Group iv, the following table illustrates marked differences above that age.

TABLE 1.Age Incidence expressed as Percentage of Type Totals.

<u>Type</u>	-19	-24	-29	-34	-39	-44	-49	-54	-59	-64	-69	-74
<u>i.</u>	26.4	15.46	9.1	14.55	16.37	9.1	2.75	2.75	0.91	1.82		0.91
<u>ii.</u>	23.4	16.94	12.1	10.48	8.06	10.48	5.65	4.03	5.65	3.22		
<u>iv.</u>	34.8	17.4	11.6	4.35	4.35	2.9	10.15	2.9	4.35	4.35		2.9

In the Type i infection there is a greater preponderance of cases between age 30 and 45 years as compared with the numbers in the similar group in the Type ii and Group iv infections. In Type i cases 44, or 40 per cent., occurred between age 30 and 45 years as compared with 36, or 29.04 per cent., Type ii cases, and 8, or 11.6 per cent., Group iv cases. In the cases above age 45 years the incidence again varies, there being 10 cases, or 9.08 per cent., Type i, 23 cases, or 18.55 per cent., Type ii, and 17 cases, or 24.65 per cent., Group iv. The following table illustrates this:-

TABLE 2.

<u>Type</u>	14 - 29		30 - 45		46 -		Total.	
	Cases	%	Cases	%	Cases	%	Cases	%
<u>i</u>	56	50.58	44	40.	10	9.08	110	100
<u>ii</u>	65	52.4	36	29.04	23	18.55	124	100
<u>iii</u>	4	28.7	3	21.5	7	50.0	14	100
<u>iv</u>	44	63.8	8	11.6	17	24.65	69	100

These figures and the histograms in Fig. IV would suggest that the Type i infection is more prevalent in youth and the younger middle-aged person, and less frequent in the more elderly. From the same figures it would seem that Type ii infection affects the young man as frequently as does Type i, the middle-aged man much less frequently and becomes more prevalent than Type i in the elderly. The Group iv infection is seen to be most marked in the younger and more elderly cases,

the incidence of cases being much higher in youth. Type iii appears to affect the older men much more heavily than the younger groups but the figures are insufficient to allow of any conclusive deductions.

The case mortality is seen to vary greatly in the different types, but for the total 317 cases it was 15.77 per cent.

TABLE 3.

To illustrate the case incidence and case mortality of the various Types.

CASES.				
Type	Actual	% of Total	Deaths	% Mortality
<u>i</u>	110	34.7	12	10.9
<u>ii</u>	124	39.1	24	19.36
<u>iii</u>	14	4.41	5	35.7
<u>iv</u>	69	21.76	9	13.05
	317		50	15.77

Type	- 35 years.			+ 35 years.		
	Cases	Deaths	% Mortality	Cases	Deaths	% Mortality
<u>i</u>	72	2	2.78	38	10	26.3
<u>ii</u>	78	11	14.1	46	13	28.25
<u>iii</u>	6	1	16.6	8	4	50.0
<u>iv</u>	47	3	6.38	22	6	27.3
	203	17	8.37	114	33	28.96

From the above figures it is seen that Type iii is much more virulent an infection than any of the others. The number of Type iii cases is so small, however, that any conclusions reached can only be tentative. The numbers below

35 years show that one out of 6 cases died as compared with 4 out of 8 cases above that age, which suggests that though a Type iii infection is not especially dangerous to a young person it is of deadly import to a more elderly one. The Type ii infection is the next in order of virulence with a case mortality of 19.36 per cent. The histogram in Fig. IV shows that the deaths are spread over all the age groups from the youngest to the oldest and that the mortality increases steadily with age. The figures show that the 35-39 age group had no deaths but this possibly may be explained by the small numbers dealt with. Below 35 years the case mortality was 14.1 per cent., which is just half that above 35 years where it was 28.25 per cent. A more detailed study of the age group shows that the case mortality rises steadily with the age group except for the drop in the 35-39 group. The Group iv infection comes next in severity with a case mortality of 13.05 per cent., and this group also shows a much higher death rate above 35 years, being 27.3 per cent. as compared with 6.38 per cent. below that age. In this group also the deaths are spread over the age group in a manner similar to that found in the Type ii cases. In the Type i group, however, where the case mortality is only 10.9 per cent., the deaths are much more frequent over 35 years, the case mortality being 26.3 per cent. as compared with 2.78 per cent. below that age.

TABLE 4.

To illustrate the relationship between case mortality
and the increase in age.

	-19	24	29	34	39	44	49	54	59	64	69	74+	
<u>Type i.</u>	29	17	10	16	18	10	3	3	1	2		1	<u>Cases.</u>
	1	0	1	0	5	3	1	-	-	-	-	1	<u>Deaths.</u>
	3.45	-	10	-	27.8	33.3	33.3	-	-	-	-	100	<u>% Mortality.</u>
<u>Type ii.</u>	29	21	15	13	10	13	7	5	7	4			<u>Cases.</u>
	2	3	3	3	1	3	3	2	3	1			<u>Deaths.</u>
	6.9	14.3	20	23.1	10	23.1	42.9	40	42.9	25			<u>% Mortality.</u>
<u>Group iv.</u>	24	12	8	3	3	2	7	2	3	3		2	<u>Cases.</u>
	2	-	1	-	1	-	2	-	1	1		1	<u>Deaths.</u>
	8.34		12.5		33.3		28.6		33.3	33.3		50	<u>% Mortality.</u>

		Cases	Deaths	Case Mortality
<u>Type i</u>	-35	72	2	2.78
	+35	38	10	26.3
<u>Type ii</u>	-35	78	11	14.1
	+35	46	13	28.25
<u>Group iv</u>	-35	47	3	6.38
	+35	22	6	27.3

In each type it is seen that the case mortality over 35 years is much higher than in the cases below this age and that this is striking in the case of the Type i infection. The Type iii infection would appear to be very deadly in older men and the other three infections are approximately similar in the severity of their attack upon the older cases, except that in the Type i cases it is the younger middle-aged men who are stricken more severely.

In order to facilitate comparison with the above findings the following table has been compiled from figures extracted from papers by various workers.

TABLE 5.

To compare case incidence and case mortality with other's findings.

Date of Investigation.	Investigator	No. of Cases	Case Incidence %.				Mortality Case Incidence %.			
			I	II	III	IV	I	II	III	IV
1917	Avery, Chicker- ing, Cole, Dochez (6).	100	33	31	12	24	25	32	45	16
1920 1922	Griffith (1) p.91.	150	30.6	32.7	6.7	30	-	-	-	-
1923	Glynn, Digby Jones (1).	96	45.8	24.0	2.1	28.1	34.1	36.3	50	11.1
1926	Westlung (9) p.514	1552	36	28	13	23				
1929	Stewart & Gibson (10)	50	19	48	9	23				
1930	Stewart & Alston (11)	186	29	40	4	27	23	31	71	10
1930	Cecil and Plummer (2)	3662	30.9	23.2	11.9	34.1				
Up to 1924	Total American Figures.	1632	32.5	26.2	11.6	29.4	21.2	34.7	54.1	19.1
	Total British Figs.(1) p.91	361	38.2	30.8	3.9	27.1	27.1	36.3	25.0	11.5
1930- 1931	Present Series	317	34.7	39.1	4.41	21.76	10.9	19.36	35.7	13.05

The years of investigation extend from 1917 to 1931 and an attempt has been made to select examples at regular intervals between those dates. The figures show that there is considerable variation in the case incidence of the various types and in the case mortality of each type in different years. In each instance, however, it is found that Type i and Type ii cases combined account for the major proportion of the cases, the incidence varying between 60 and 70 per cent., a point

noted by Griffith, 1928.⁽¹⁴⁾ The incidence of the Type iii cases is small except as reported by American investigators who give figures showing the incidence to be two to three times that found in Britain.

This fairly constant total of Type i and Type ii cases having been accepted, it is seen on closer examination of the figures that there is a suggestion of periodicity in the prevalence of the two types, similar to that found in measles and scarlet fever. (Currie,⁽¹²⁾ p. 366). The figures suggest that when Type i is prevalent, Type ii tends to be less frequent and vice versa, and also that at one period the incidence of each type is similar, depending on the decrease of one and the increase of the other. The Statistical Bulletin of the Metropolitan Life Insurance Company, 1930,⁽¹³⁾ p. 3, from an observed series of death rates shows that the death rate in pneumonia reached maxima in 1920, 1923, 1926, and 1929 not equalled in any other year in the series, which extended from 1920 to 1930.

The figures showing the death rate per million of all pneumonia cases were obtained from the Medical Officer of Health of Glasgow's report for the various years from 1910 to 1931 inclusive. (See Graph, Fig. XVIII).

From the graph it is seen that these figures suggest a periodicity even although all forms of pneumonia are included.

An attempt will be made later to show that the Type ii infection is the more virulent. If this be accepted for the moment, this periodicity in the increase of the pneumonia death rate might be explained, by the peak in the high death rate coinciding with the greater incidence of a more virulent organism, e.g., Type ii.

In each of the series illustrated in Table 5, the Group iv incidence varies, but not so markedly as in the case of Type i and Type ii infections. The case mortality remains approximately constant for each type; Type iii being the most deadly,

Type ii next in severity, then Type i with Group iv the least virulent. The case mortality of the present series differs somewhat from the foregoing, being generally lower and also, in the case of Group iv it was greater than that of Type i. This variance may be due to the investigation having taken place possibly during a mild epidemic⁽¹⁶⁾ (pp. 40, 249), or it may be due to the form of treatment exhibited.

Résumé.

Three quarters of the cases investigated were below aet 35 years with a case mortality of 5.64 per cent. Above that age pneumonia is much more deadly, having a case mortality of 29.82 per cent. The case incidence is high in the younger age group and gradually declines with increase in age. At the same time the case mortality increases until it is 30 to 40 per cent. above aet 50 years. The Type i infection is most prevalent in the young and young middle-aged patient and least prevalent over aet 45 years.

The Type ii infection is also common in the younger age groups and the incidence decreases with age but less markedly than in the Type i infection.

Group iv is very prevalent in the young and slightly less common in older patients.

The figures would suggest that Type iii prevails in the younger and older age groups but is much more deadly to the latter.

As regards case mortality Type iii is the more dangerous, followed by Type ii, Group iv and Type i in descending order of virulence. Over 35 years of age all are dangerous, especially Type iii. Below 35 years of age Type ii and Type iii are most dangerous with Type i but slightly so.

A sub-group consisting of 171 of the main group of cases was examined daily, as described earlier. The results obtained have been tabulated and considered in detail and in the following pages an attempt will be made to demonstrate the conclusions formed.

V. 2. The Incidence and Case Mortality of 171 Cases.

The number of cases examined was 171 and they were aged from 15 years and upward. The number of deaths was 26, or 15.2 per cent. (Fig. VII). The age incidence corresponds to that described previously under the total figures, and the case mortality shows a similar rise with increasing age.

TABLE 6.

Type	Cases	% of Total.	Deaths.	% Mortality
<u>i</u>	60	35.1	6	10.0
<u>ii</u>	78	45.6	14	17.94
<u>iii</u>	2	1.17	1	50.0
<u>iv</u>	31	18.13	5	16.12
	171	100.	26	15.2

Cf. Fig. IX.

These figures show a similar preponderance of Type i and Type ii infections but the Type ii infection is much more prevalent in this smaller number of cases. In the Type i group of this smaller series the figures still indicate that this type is an infection of the young and the young middle-aged adult, as compared with the Type ii cases where the infection is common in the young adult and decreases slowly with the increase in age. Type iii and Group iv infections are

correspondingly less frequent.

The case mortality is similar to that described under the total cases. Of the two Type iii cases, both of whom were over 50 years of age, one died. The Type ii cases had a case mortality of 17.94 per cent., the deaths being spread over all the age groups with the exception of the groups 35-39 and 60-64. Below 35 years of age there were 50 cases with 8 deaths, or 16 per cent., and above that age there were 28 cases with 6 deaths, or 21.4 per cent. The Group iv cases had a case mortality of 16.12 per cent., and the cases were spread over all the age groups, 2 or 9.09 per cent. being below aet 35 years, and 3 or 33.3 per cent. above that age.

The case mortality in the Type i group was low, being 10 per cent., and the deaths were confined to the young middle-aged section, none of those who died being below 35 years of age. If the section above aet 35 years is considered, the case mortality is found to be 30 per cent., which is much higher than in the corresponding sections of the Type ii and Group iv infections.

It would appear, therefore, that the greater number of cases of pneumonia are due to Type i and Type ii pneumococci and that the case mortality is related to the age of the patient and the type of infecting organism. The chances of recovery are lowered as the age of the patient increases, and Type iii and Type ii infections are more dangerous than Group iv and Type i, the latter being the least dangerous especially in young patients.

V. 3. Housing Conditions.

Osler⁽³⁾ (p. 188) states that poor hygiene and overcrowding with the attendant danger of infection are more important factors than climate and temperature in the production of pneumonia and quotes Anders who found the highest mortality from pneumonia in the most densely populated wards of Philadelphia. Also Vaux and Benz⁽¹⁵⁾ (1926) in discussing the environmental predisposing causes of lobar pneumonia placed first, crowding in the home and workshop. Currie⁽¹²⁾ (p. 183) points out that overcrowding shortens the path of buccal spray and favours the transmission of infectious disease. He also gives a standard of overcrowding adopted in Scotland, as being more than three persons per room. Various other standards are in use, but for the purposes of this paper the one above quoted has been used.

The housing accommodation of the cases investigated varied from one apartment to six apartment houses plus a number of cases from institutions.

TABLE 7.

To illustrate Housing Conditions.

A.

House	Type <u>i.</u>	<u>ii.</u>	<u>iv</u>	Total
1 apartment.	12	7	4	23
2 apartments.	30	55	21	106
3 "	10	7	5	22
4 "	2	3	0	5
5 "	3	0	0	3
6 "	0	1	0	1
Institution	3	5	1	9
	60	78	31	169

+ 2 Type iii = 171 cases.

B.

The above Table expressed
in percentages.

House	% of Total 171	% of Type Total	% of Apartment Total.
1 apart.	7	20	52.2
2 "	17.5	50	28.3
3 "	5.84	16.6	45.4
4 "	1.17	3.3	40.0
5 "	1.75	5.0	100.0
6 "	0	0	0
Instit.	1.75	5.0	33.3

Type i.

1 apart.	4.09	8.96	30.4
2 "	32.16	70.5	51.58
3 "	4.09	8.96	31.8
4 "	1.75	3.85	60.0
5 "	0	0	0
6 "	0.58	1.28	100
Instit.	2.92	6.42	55.5

Type ii.

1 apart.	2.34	12.9	17.4
2 "	12.28	67.55	19.82
3 "	2.92	16.12	22.73
4 "	0	0	0
5 "	0	0	0
6 "	0	0	0
Instit.	0.58	3.22	11.12

Group iv.

Cases. % of 171.

1 apart.	23	13.45
2 "	106	62.0
3 "	22	12.86
4 "	5	2.92
5 "	3	1.75
6 "	1	0.58
Instit.	9	5.26
	169	

Total Cases in each size of house ex-
pressed as %age of Total 171 Cases.

+ 2 Type iii = 1.17%.

From these tables it is seen that 106, or 62 per cent., of the cases came from two apartment houses. One apartment and three apartment houses produced 23 and 22 cases respectively, i.e., 13.45 per cent. and 12.86 per cent. Four, five and six apartment houses gave only a very small number of cases. This may be partly explained by the fact that the hospital serves an area which is mainly industrial. Nine cases, or 5.26 per cent., came from institutions.

In considering the cases derived from the varying size of houses, it is seen that the numbers are small, but an attempt has been made to note any possibilities such small numbers might indicate.

Of the 23 cases from one apartment houses, 52.2 per cent. were Type i; 30.4 per cent. were Type ii; and 17.4 per cent. were Group iv; and of the 106 cases from two apartment houses 51.58 per cent. were Type ii; 28.3 per cent were Type i; and 19.82 per cent. were Group iv. There were 22 cases from three apartment houses and of these 45.5 per cent. were Type i; 31.8 per cent. were Type ii; and 22.73 per cent. were Group iv. The remaining numbers are noted in the Tables 7, A and B.

It is seen that of the cases from one apartment houses Type i is the most common infection, followed by Type ii and Group iv cases in rapidly descending order of frequency. The cases from two apartment houses were mostly Type ii in origin and were as frequent as Type i and Group iv cases combined. Of the cases from three apartment houses, Type i is the commonest infection, with Type ii and Group iv a little less common.

The two apartment house is thus seen to produce the greatest number of cases in all three types of infection, and this is most marked in Type ii cases, of whom 70.5 per cent. of the total came from such houses.

One apartment houses produced 20 per cent. of the Type i cases and 12.9 per cent. of the Group iv cases, whilst three apartment houses produced 16.6 per cent. and 16.12 per cent. of

Type i and Group iv cases respectively.

On examining the figures with reference to age incidence and housing accommodation, they suggest that in the one apartment house Type i is frequent in patients under 35 years in the less densely populated houses and again in patients over 35 years in the more populous houses. Thus there were 6 patients below 35 years in houses with an average population of 3.3 persons per room and above 35 years there were 6 patients from houses with an average population of just over 5 persons per room. The Type ii cases in one apartment houses were all over 30 years of age and mostly occurred in over-populated ones. There were 7 cases all over aet 30 years living in one apartment houses with an average population of just under 5 persons per room. The Group iv cases, of whom there were 4, were between 20 and 30 years and came from one apartment houses with an average of 3.3 inhabitants.

In two apartment houses younger men formed the bulk of the cases, the incidence diminishing with age.

TABLE 8.

To illustrate case incidence from two-
apartment houses.

Type	-19	24	29	34	39	44	49	54	59	64	years.
<u>i</u>	6	5	3	7	6	1	1	0	1	0	cases.
<u>ii</u>	12	11	6	3	4	6	2	4	4	0	
<u>iv</u>	5	4	3	2	1	0	3	0	0	3	

Thus it is seen that the Type i cases appear to be spread uniformly over age groups from 15 to 40 years whereas Type ii preponderate in the younger patients and diminish with increase in age but are still frequent up to aet 60 years.

Group iv cases are most frequent in the young adult and they again tend to appear in the older patients.

TABLE 9.

To illustrate average number of inhabitants
in two apartment houses.

	TYPE i.		TYPE ii.		GROUP iv.	
	Cases	Average inhabs. per house.	Cases	Average inhabs. per house.	Cases	Average inhabs. per house.
-35	21	5.4	34	6.2	14	3
+35	9	3.8	21	5.8	7	5.7
	30	4.9	55	6	21	5.2

These figures suggest that Type ii cases occurred in more densely populated houses than did Type i and Group iv cases, and that there was but little difference in the incidence between young and old patients. Also the older Group iv patients occurred in populous houses as did the younger Type i cases.

TABLE 10.

To illustrate average number of inhabitants
in three apartment houses.

	TYPE i.		TYPE ii.		GROUP iv.	
	Cases	Average inhabs. per house.	Cases	Average inhabs. per house.	Cases	Average inhabs. per house.
-35	7	6.3	7	5.4	3	6.6
+35	3	6.3	0	0	2	7.6
	10	6.3	7	5.4	5	7

The figures are small but they suggest that in houses somewhat densely populated it is the younger men who tend to take Type i infection more readily than the older. The same appears to hold even more markedly in Type ii whilst Group iv occurs in the heavily populated house in both young and old patients.

Of the institution cases there were 3 Type i, 5 Type ii, and one Group iv cases. The Type ii cases occurred in all age

groups, whilst 2 other Type i cases and the one Group iv case were below 20 years.

When actual overcrowding is considered it is found by making use of Currie's definition (see ante) that certain differences are to be noted.

TABLE 11.

To illustrate overcrowding.

	One apartment house.			Two apartment house.		
	Type <u>i</u> .	Type <u>ii</u> .	Gr. <u>iv</u> .	Type <u>i</u> .	Type <u>ii</u> .	Gr. <u>iv</u> .
Total No. of cases	12	7	4	30	55	21
Cases from overcrowded houses.	7	6	2	7	20	5
% of Total No.	58.3	85.5	50	23.3	36.4	23.8

From this table it is seen that in one apartment houses the greater number of the Type i and Type ii cases occurred in overcrowded houses and this was especially marked in Type ii cases.

In the two apartment houses the incidence of cases from overcrowded ones was not so great but again Type ii cases were more frequent.

TABLE 12.

To show Incidence of Overcrowding.

	One apartment.			Two apartment.			Total.		
	Cases from overcrowded houses.	% of Type Total	% of Total 171 Cases	Cases from overcrowded houses.	% of Type Total	% of Total 171 Cases	Cases from overcrowded houses	% of Type Total	% of Total 171 Cases.
Type <u>i</u>	7	11.66	4.09	7	11.66	4.09	14	23.33	8.18
" <u>ii</u>	6	7.68	3.51	20	25.65	11.7	26	33.35	15.21
Gr. <u>iv</u>	2	6.45	1.17	5	16.13	2.92	7	22.57	4.09
	15		8.77	32		18.7	47		

Of the total 171 cases there were 15 cases of overcrowding in one apartment houses = 8.77 per cent., and there were 32 cases of overcrowding in two apartment houses or 18.7 per cent. Therefore of the total 171 cases, 47, or 27.48 per cent., came from overcrowded houses. 15.21 per cent. of the total 171 cases were Type ii cases from overcrowded houses, and it is seen that a third of all the Type ii cases came from such houses, with the large proportion from two apartment ones.

Just less than a quarter of the Type i and Group iv cases came from overcrowded houses and in the Type i cases these were equally divided between one and two apartment houses whereas the greater number of the Group iv cases came from two apartment houses.

Résumé.

The cases came from all types of houses but 62 per cent. came from two apartment ones. Type i was the most common type in one and three apartment houses, whilst Type ii was most common in two apartment houses. In the one apartment house the Type i cases were either young or old but the Type ii cases were all over 30 years of age, whilst the Group iv cases were all young men.

The cases who occurred in two apartment houses were usually young except the Type ii cases of whom two fifths were above set 35 years and all of whom came from the more densely populated houses. A third of all the Type ii cases came from overcrowded houses and less than a quarter of the Type i and Group iv cases.

The two apartment house produced the greater number of cases from overcrowded houses, in each type except Type i of which an equal number came from one and two apartments.

It appears, therefore, that overcrowding is an important factor in the causation of pneumonia in the class of person served by such a hospital as Belvidere.

People living in such crowded quarters must surely suffer from the enforced lack of exercise and recreation, the absence of good food and the dismal surroundings, all of which must lay them more open to the risk of infection already increased by proximity.

Consideration of case mortality in relation to housing is illustrated in the following table.

TABLE 13.

To illustrate Case Mortality in relation to Housing.

Apt.	TYPE i.			TYPE ii.			GROUP iv.			TOTAL.		
	No. of Cases	Deaths	%	No. of Cases	Deaths	%	No. of Cases	Deaths	%	No. of Cases	Deaths	%
1	12	1	8.3	7	1	14.2	4			23	2	8.7
2	30	3	10	55	12	21.8	21	4	19	106	19	17.92
3	10	2	20	7			5	1	20	22	3	13.64
4				3	1	33.3				3	1	33.3

+ 8 in larger houses.

+ 6 in larger houses.

From the above it is seen that case mortality is highest in two apartment houses, followed by that in three apartment and then four apartment houses, being least in one apartment houses.

V. 4. Social State.

133 of the cases above age 20 years were investigated with regard to their social state. 51, or 38.3 per cent., were single and 82, or 61.6 per cent., were married.

Of the 46 Type i cases above age 20 years, 19, or 41.3 per cent., were single, most of whom were in the younger age group, and the 27, or 58.7 per cent., married men were mostly in age group between 30 and 45 years.

There were 61 Type ii cases with 23, or 37.7 per cent., single and 38, or 62.3 per cent., married. In the single men the greater incidence was in the young age group but the married men were spread over groups from 25 to 60 years with the greater numbers between 30 and 45 years. There were 24 Group iv cases, 8, or 33.3 per cent., of whom were single, and 16, or 66.7 per cent., married. In both states the greater number were young men with a smaller number of married men in the older groups.

TABLE 14.

To illustrate Social State.

Type		24	29	34	39	44	49	54	59	64	Yrs.	
<u>i</u>	S	9	2	3	2	0	2	1	0		= 19	
	M	1	3	8	7	6	1	0	1		= 27	= 46
<u>ii</u>	S	16	4	1	0	2	0	0	0	0	= 23	
	M	1	5	6	7	6	3	4	4	2	= 38	= 61
<u>iv</u>	S	3	2	1	0		2			0	= 8	
	M	5	3	1	2		2			3	= 16	= 24
<u>iii</u>	S								1		= 1	
	M								1		= 1	= 2

= 133

Total S = 51 = 38.3%

" M = 82 = 61.6%

133

Below aet 35 years the greater number of cases were single whilst over 35 years married men were in the majority, the difference between married and single being much more marked over 35 years. Such findings are not surprising, since the young single adults will probably live at home with parents, in a crowded home, and so be exposed to a greater risk of infection. The older single men may live by themselves, or with a housekeeper, and so run less risks of infection. The younger married men will in all probability run less risk from overcrowding, but as the age of the married man increases so does the probability of increase of family and so appears the element of overcrowding with its attendant risks.

V. 5. Occupation.

The textbooks stress the fact that outdoor workers are more subject to Pneumonia than are indoor workers and that the morbidity is higher in outdoor occupations. Osler⁽³⁾ (p. 188). For the purposes of this part of the investigation the many varied types of occupations of the patients were separated into five groups as follows:-

- (1) Brain workers, such as clerks, teachers and schoolboys.
- (2) Skilled workmen, such as glass workers, electricians, engineers, journeymen, etc.
- (3) Unskilled workmen, such as gatemen, porters, grave-diggers, spirit salesmen, stewards, etc.
- (4) Labourers - of all varieties - dock, builders, engineering.
- (5) Unemployed.

The figures were also examined from the point of view of indoor and outdoor workers.

TABLE 15.

Type of Worker	TYPE i.		TYPE ii.		GROUP iv.		TOTALS.	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Inside	34	4	38	8	16	1	88	13
Outside	26	2	40	6	15	4	81	12
	60	6	78	14	31	5	169	25
Brain worker	6	0	3	1	1	0	10	1
Skilled workmen	23	2	33	8	12	2	68	12
Unskilled "	12	2	4	1	2	1	18	4
Labourer	15	1	32	3	10	2	57	6
Unemployed	4	1	6	1	6	0	16	2
							169	25

The 2 Type iii cases were both outside workers.

From the table it is seen that there were 88 indoor workers as compared with 83 who did outside work, but on making reference to the Medical Officer of Health's Report for 1931⁽¹⁶⁾ (p. 26) it is seen that indoor workers preponderate in the population of the city so that outdoor workers are proportionately highly represented by those 83 cases. With regard to the Type incidence it is seen that Type i infections are more common in inside workers whereas Type ii occurs more often in those with outdoor work, i.e., having in mind the fact that although the figures 38 and 40 are approximately equal, the outdoor workers are greatly in the minority in the city.

On the whole, the figures show but little difference beyond the facts noted above. The mortality is approximately similar except in the case of the Group iv cases where it is higher in outdoor workers.

The figures referring to the type of workmen affected are not very reliable since a hospital such as Belvidere deals mostly with a labouring area. The implications, however, are

that the hard manual worker such as the skilled workman and labourer are more liable to infection by the pneumococcus than are non-skilled men and the unemployed whose risks are approximately equal and whilst the sedentary worker is apparently least liable.

Of the infecting types, Type ii is by far the most frequent invader in the skilled and labouring classes, whereas Type i predominates in the non-skilled and sedentary groups. The unemployed man is attacked by all three types, Type ii and Group iv being slightly more frequent.

The case mortality figures show that the skilled and unskilled men suffer most, the figures being 17.6 per cent. and 22.2 per cent. respectively. The unemployed group comes next with a case mortality of 12.5 per cent., followed by the labourer group with a case mortality of 10.5 per cent., and finally the sedentary workers with 10 per cent.

The figures are small and caution has to be used in interpreting them, but it would appear that the worker who uses mostly the nervous system is least liable to infection and suffers least, whilst the man who uses both the nervous system and the muscular system in hard work is especially liable and suffers fairly heavily, judging by the case mortality rate. The labourer who probably uses his muscular system, with but little mental application, comes next as regards risk of infection, but his risk of death is much smaller than that of the skilled man. The unskilled workman is apparently much less liable to infection, but when he is attacked, runs greater risks of a fatal termination than do the other classes of workers. The fact that Type ii infection has been found to be so prevalent in conditions of overcrowding and so common in men who do the hard manual and specialised work is notable. It is probable that such men suffer from more fatigue after their daily work than do the other classes of workers. Their chances of repose and rest are scanty for it

has been shown that overcrowding prevails in one third of all the Type ii cases and the figures show that over half of the skilled and labouring workmen had a Type ii infection.

Why then should Type ii be the predominant infection in fatigued and overcrowded patients? A possibility which has been considered before by Sir William Collins in "Specificity and Evolution in Disease," 1884, and quoted by Stallybras, (19) (1931, p. 25), but not, however, with special reference to the pneumococcus, is that the organism may react differently to the varied types of soil in which it may become implanted. An attempt to expand this possibility will be made later.

V. 6. Exposure to Infection.

The fact that pneumococcal pneumonia is infectious is not stressed by the textbooks, but each case in this series was questioned closely with regard to the possibility of exposure to infection and the results obtained were tabulated. Currie defines infection as follows:-

"The tendency to infection is a relationship between the contagium and the victim as a result of which infection may take place."⁽¹²⁾ (p. 360).

Various investigators have considered this possibility of spread from person to person, and their varying results have been published. The consensus of opinion seems to be that although Type i and Type ii organisms cause 60 to 70 per cent. of all lobar pneumonias, these organisms are seldom found in the naso-pharynx of healthy people except in those of close contacts, which would suggest that there is some power of epidemic spread. The figures relating to the presence of pneumococci in the naso-pharynx of apparently normal people

all indicate that the Group iv organism is the prevailing type, and that even Type iii is more prevalent in "normals" than are Type i and Type ii.⁽²⁰⁾ (p. 513, and (1), p. 76).

Whittle⁽²¹⁾ (p. 135) in 1927 in a Report to the Science Committee of the British Medical Association reported instances of epidemic spread. One was in a village, Cottenham, in Cambridgeshire, where 26 lobar pneumonias occurred and the spread of infection was traced from house to house and person to person. Another smaller outbreak was traced in Cavendish in Suffolk.

In the present series there were 13 definite instances of some connection with a case of pneumonia before admission. In addition there were other 12 cases who gave a history of exposure which was open to some doubt.

TABLE 16.

To illustrate Exposure to Infection.

Type	Exposure	19	24	29	34	39	44	49	54	59	Total	
<u>i</u>	Definite	3	2	1	1	2					9	} 15
	Indefinite	2	1	1	1	1					6	
<u>ii</u>	Definite			2						1	3	} 6
	Indefinite	1				1	1				3	
<u>iv</u>	Definite							1			1	} 4
	Indefinite		3								3	
<u>Total</u>	Definite	3	2	3	1	2		1		1	13	} 25
	Indefinite	3	4	1	1	2	1				12	

From this it is seen that 25, or 14.6 per cent. of the total cases gave a history of some connection with other cases of pneumonia, and of those 25 cases, 13, or 7.6 per cent., of the total were found to have had definite contact with some

other case of pneumonia. When the contact incidence in the various types is examined, it is found that 25 per cent. of the Type i cases gave some evidence of exposure, but only 9 cases, or 15 per cent., could be accepted with certainty.

Similarly, Group iv had a total of 12.8 per cent. with a definite 3.2 per cent. who had been exposed and of the Type ii cases there was a total of 7.6 per cent. exposed but only 3.8 per cent. were definitely proved. Type i cases, therefore, gave more frequently a history of exposure than did the other types.

As examples of the infectivity of the various types a few of the cases are quoted.

Type	Name.	Age	Sickened	Admitted	Result
<u>ii</u>	Peter Collins.	21	13.vi.30	16.vi.30	Well.
<u>ii</u>	Pat Collins.	56	21.vi.30	23.vi.30	Death.
<u>ii</u>	Pat Collins, Jr.	28	3.vii.30	4.vii.30	"
<u>ii</u>	Mrs. Collins.	?	12.vi.30	At home.	"(hearsay)

The above figures refer to a family of varying ages attacked by a Type ii organism and only one recovered. A specimen of the mother's sputum was obtained from her home for typing. The men were all of moderately good physique, but the father was an alcoholic and the elder son had a blood Wassermann ++ .

<u>i</u>	N. McKay.	42	6.ix.30	8.ix.30	Died.
<u>i</u>	D. Pollock.	19	17.ix.30	19.ix.30	Well.

The second of the two men noted above was a porter in the hospital who had to restrain the first man whilst he was delirious and 9 days later developed pneumonia.

Also there was a man who was admitted with a Group iv pneumonia who recovered and when convalescent developed a Type ii pneumonia in the ward and again recovered.

Then there was a boy who was dismissed from Belvidere after a Type ii pneumonia and a few months later his brother was admitted to Knightswood with a pneumonia. A month after he was dismissed another brother was admitted to Belvidere also with a pneumonia, Type ii.

To elucidate the problems which follow on the above an extensive field investigation would require to be carried out, tracing back and checking all suggestive histories and typing the causal organism of any possible focus of infection.

V. 7. Type of Onset of Illness.

Osler⁽³⁾ (p. 203) states that abrupt onset is the rule and gives figures of 1276 cases of which 80 per cent. began suddenly and 20 per cent. insidiously. Glynn and Digby⁽¹⁾ (p. 140) found 61.8 per cent. of 76 pneumococcal pneumonias began suddenly and they also give figures for the different types of pneumococcal infection.

Their figures may be shown thus:-

TABLE 17.

Type	No. of Cases.	Sudden Onset. %	No. of Cases ex Deaths.	Crisis %
<u>i</u>	36	77.8	24	54.2
<u>ii</u>	19	52.6	10	40.0
<u>iv</u>	21	42.9	14	28.6
	76	61.8	48	43.8

These figures show that sudden onset was prevalent and that this was specially so in Type i cases. Also that

crisis occurred in less than half of their cases.

The figures obtained in the present investigation are shown in the following table.

TABLE 18.

Sudden Onset.

Type	Total No. of Cases	Onset.		No. of Cases ex Deaths	Crisis.		Pseudocrisis and Crisis.		Lysis.		Pseudocrisis and Lysis.	
		Cases	%		Cases	%	Cases	%	Cases	%	Cases	%
<u>i</u>	60	53	88.3	54	18	33.3	9	16.66	19	35.2	1	1.85
<u>ii</u>	78	59	75.6	64	16	25	8	12.5	17	26.56	5	7.82
<u>iv</u>	31	21	67.57	26	8	30.76	4	15.38	4	15.38	1	3.85

Subacute Onset.

<u>i</u>		7	11.66		7	12.96						
<u>ii</u>		19	24.36		3	4.69	3	4.69	10	15.62	2	3.12
<u>iv</u>		10	32.25		2	7.69	1	3.85	6	23.1		
<u>iii</u>		2	100	1			1	100				

Acute onset = 133 = 77.8 per cent.

Subacute " = 38 = 22.2 per cent.

TABLE 19.

Percentages of Type Totals alive.

		Type <u>i</u> .	Type <u>ii</u> .	Type <u>iii</u> .	Group <u>iv</u> .
Acute Onset	Crisis	50.01	37.5		46.14
	Lysis	37.05	34.38		19.23
Subacute Onset	Crisis	12.96	9.38	100	11.54
	Lysis		18.74		23.1

From the above tables it is seen that 77.8 per cent. of the cases commenced suddenly and 22.2 per cent. more gradually, also more Type i cases commenced abruptly than was found in Type ii although more cases with sudden onset occurred in the latter than

in Group iv cases, which is in agreement with the previous observers' findings. Of the cases which began gradually, Group iv preponderates, followed in frequency by Type ii and finally Type i cases.

With regard to the mode of termination, this will be dealt with more fully in later pages, but in order to compare with the figures of Glynn and Digby the following are inserted at this stage.

57.3 per cent. of those who commenced acutely settled by crisis and of those who commenced gradually 48.6 per cent. settled by crisis.

V. 8. Order of Onset of Symptoms.

Most writers are agreed that a rigor or chill is the commonest prodromal symptom. Pain, headache, vomiting and cough are also given as the earliest symptom in descending order of frequency.

Osler⁽³⁾ (p. 203) gives rigor, followed by rise in temperature, cough and pain as the commonest method of onset. Stewart and Gibson⁽⁴⁾ found that 44 out of 50 cases commenced with rigor, cough and half of those had pain in the side.

Abrahams⁽²²⁾ (p. 108) in a series of 558 cases found that rigor was the initial symptom in 70 per cent., pain being present in 60 per cent., and headache and vomiting were fairly common as prodromal symptoms.

Glynn and Digby⁽¹⁾ (p. 139) in a series of 83 cases showed that three quarters of the Type i cases and a third of the Group iv cases began by a rigor and that Type ii cases held a place intermediate to those two.

TABLE 20.

Symptoms in their order of frequency of onset.

		1	2	3	4	5	6
Rigor	Type <u>i</u>	28	7	1			
	<u>ii</u>	30	7	2			
	<u>iv</u>	7	4				
		65	18	3			
Sickness	Type <u>i</u>	11	20	7	4		
	<u>ii</u>	6	9	15	8	1	
	<u>iv</u>	5	7	6	3		1
		22	36	28	15	1	1
Pain	Type <u>i</u>	9	16	23	4		
	<u>ii</u>	18	24	19	5	1	
	<u>iv</u>	7	9	4	1		
		34	49	46	10	1	
Giddiness	Type <u>i</u>	6	3	2			
	<u>ii</u>	15	10	3	2		
	<u>iv</u>	6	3				
		27	16	5	2		
Headache	Type <u>i</u>	8	10	7	4		
	<u>ii</u>	11	17	2	2		
	<u>iv</u>	5	6	1	1	1	
		24	33	10	7	1	
Cough	Type <u>i</u>		2	4	5		
	<u>ii</u>	2	6	12	9	3	
	<u>iv</u>	1		9	4	1	
		3	8	25	18	4	

The above figures are expressed as actual numbers as the addition of percentages would only tend to complicate.

From the table it is seen that the most frequent initial symptom was rigor, followed in descending order of frequency by pain in the side, giddiness, headache, sickness and lastly cough. The symptoms most commonly noted to follow the preliminary one in decreasing order of frequency were as follows:- pain, sickness, headache, rigor, giddiness and cough.

When each symptom is considered separately it is found that rigor was much more frequent as the first symptom. Pain was more common as the second and third in onset and also was moderately frequent as the first symptom. Sickness also was most frequent as a second and third symptom, but not quite so frequently as pain. Headache was commonly the second and occasionally the first to appear. Giddiness did not occur very often comparatively, but when it did it was more often a preliminary symptom than otherwise. Cough appeared late and was most frequent as a third and fourth symptom. The most common symptom, judged by frequency of occurrence no matter at what period, was pain and the others in order of frequency are shown in the following table.

TABLE 21.

	Type <u>i</u>	<u>ii</u>	<u>iv</u>	Total
1 Pain	60	67	21	138
2 Sickness	42	39	22	103
3 Rigor	36	39	11	86
4 Headache	29	32	14	74
5 Cough	11	32	15	56
6 Giddiness	11	30	9	50

When the various types are considered, it is found rigor was the most frequent onset for each type, but thereafter differences are to be noted.

Thus in the Type i cases rigor, giddiness and headache appear early, followed by sickness and later pain and cough.

In the Type ii cases the order of occurrence is thus, rigor, giddiness, pain, headache, sickness and cough. And for the Group iv cases the order of appearance is rigor, giddiness, pain, sickness, headache and cough.

Thus in all the types the effect of the toxins is the first indication of infection. In Type i it appears that this is most marked, for the symptoms of physical distress do not appear until later. It may be, however, that the physical process in the lung does not progress so rapidly as in the case of Type ii where it is earlier in onset, indicating an earlier involvement of the pleura. Unfortunately the degree of severity of the prodromal symptoms was not investigated, otherwise an opinion might have been hazarded as regards the rate of development of the toxæmia.

V. 9. Hour of Onset of Illness.

This was investigated with a view to determining whether the actual onset had any relationship to the state of body vitality; whether the onset occurred when the patient was fatigued after work, or if this latter possibility was true, which of the Types acted most rapidly in overcoming the declining resisting powers.

This idea is admittedly theoretical but the results suggest that there may be some grounds to support it.

The average hour of onset for 160 cases was 12.40. For the Group iv cases the average time of onset was about 13.30; for the Type i cases approximately 13.00, and for the

Type ii cases, 12.15. Thus it may be that patients who were already carrying the organism and just managing to control its spread eventually reached a stage when the defending tissues were overcome and the organism produced toxin in sufficient amount to produce the prodromal symptoms. In the case of the Type i cases the various age groups in most instances showed the onset to be in the afternoon. For the Group iv cases the same held good except that it was slightly later in the afternoon. In the Type ii cases, however, the onset occurred more frequently in the forenoon in the young adults and in the afternoon for the older men. Only 2 cases gave the history of having wakened in the night time with the onset of the illness, one being a Type iii case and the other a Type i. A few stated that the onset was just before or after breakfast.

In all the Types it appeared that the elder men turned ill later in the day.

It is desired to stress the point that this is a theory which is not of any practical value, except that it may serve as an additional indication that Type ii is the more virulent infection.

V. 10. Day of Admission.

The figures appertaining to this chapter are expressed diagrammatically in Figs. XI, XII, XIII.

Is it possible to perceive any indication of difference of virulence in the various types by a comparison of the days of admission?

Fig. XI shows that the greatest number of admissions was on the third day of illness, which is not unexpected when one remembers the difficulties of diagnosis in an early pneumonia. The fourth day shows a figure but slightly lower than

that of the third day. Thereafter there is a sudden drop in the number of admissions for the fifth and sixth and seventh days and another sharp drop in the numbers for the eighth day.

When the day of admission for the different types is considered, it is seen that the Type ii cases are admitted in greater numbers earlier in the illness than are Type i and Group iv cases.

The bulk of the Type ii cases are admitted by the second and third day and later there is an increase in the admissions on the sixth and seventh days.

The Type i cases are not admitted in any great numbers until the third and fourth days and there is a sharp fall in the admissions thereafter.

Of the Group iv cases, a goodly number are admitted on the second day, and there is not the sharp drop in admissions thereafter as found in the other types, but a fairly steady level of admissions is maintained until the seventh day.

A possible interpretation of these figures might be that the Type ii cases are admitted in greater numbers earlier in the disease because the severity of the symptoms has impressed itself primarily on the patient's friends and thereafter on the medical attendant. The small plateau in the graph on the sixth and seventh days may be due to the fact that the practitioner, having attempted to look after the case outside hospital, becomes alarmed by the increasing toxæmia which is common in Type ii cases, and has the case removed to hospital.

In the Type i cases the severity of the illness in the early stages is not so marked and does not impress the attendant until later in the disease and so the case is not admitted so soon as in the Type ii case.

The Group iv cases are sent in to hospital fairly steadily on the various days throughout the illness and this might be attributed to the lack of evidence of symptoms of great severity at any particular stage of the illness.

TABLE 22.

To illustrate the day of admission of
the cases who died.

Day of Admission.									
Type	1	2	3	4	5	6	7	8	9
<u>i</u>		1	3	1			1		
<u>ii</u>	2	3	6	1			1		1
<u>iv</u>		1			2	1	1		
	2	5	9	2	2	1	3	-	1

} Cases.

The greater number of cases who died were admitted on the third and second days and this applies also to Type i and Type ii cases when considered separately. 11 of the 14 Type ii cases who died were admitted by the third day of illness and similarly 4 of the 6 Type i cases who died were admitted by the same time. In the case of the Group iv section the greater number of the cases who died were not admitted until later in the disease. This suggests that the severe cases of Type i and Type ii were diagnosed early and sent in, whereas the similar Group iv cases only became apparent late in the course of the disease.

A point of value in earlier diagnosis is the effect of bacteraemia. Are cases with a positive blood culture admitted earlier than those from whom no organism can be grown? Figs. XII and XIII illustrate this point, for they show that the bulk of the cases with a positive blood culture were admitted by the third day, whereas those with a negative culture were admitted in greater numbers on the fourth day. This is brought out more markedly in Fig. XIII where the figures are expressed as percentages.

These figures suggest, therefore, that cases with bacteraemia give evidence of acute illness earlier in the

disease and enable the diagnosis to be made earlier than is the case where a negative blood culture obtains.

The presence of bacteraemia is also found to have an effect upon the day of admission of cases due to the different types.

TABLE 23.

Table to illustrate day of admission of cases with Positive Blood Culture.

Type	Day of Admission.							
	1	2	3	4	5	6	7	8+
<u>i</u>	1	2	5	4	3	1	1	
<u>ii</u>	2	5	7				2	2
<u>iii</u>				1				
<u>iv</u>	1		1	1	1	1		
	4	7	13	6	4	2	3	2
	50	20.58	29.5	13.95	25.0	15.3	33.3	66.6

= % of Total Cases admitted on each day.

From these figures it would appear that bacteraemia in Type ii cases causes them to be admitted much earlier than are the Type i cases with a positive blood culture. The Group iv figures are too scanty to allow of any justifiable deduction, but the cases appear to be admitted steadily throughout the length of the illness, which would suggest that there is no marked urgency in the symptoms.

Another possibility is that organisms in the blood may be scanty in the Type i and Group iv cases until later in the infection and that it is the earlier appearance of greater numbers of the pneumococcus in the blood which is one of the factors in making Type ii the more virulent infection.

The above phrasing is used deliberately for, as will be discussed in a later chapter, it appears probable that pneumonia is a septicaemia from the onset.

V. 11. Site of Lesion.

For the purposes of the investigation the various lobes of the lungs were denominated R₁, R₂, R₃, L₁, L₂.

It was found that the right side was affected in 91 cases and the left side in 80 cases. The various lobes involved and the differences noted in the different types of infection are displayed in the following tables.

Osler⁽³⁾ (p. 251) gives the findings in 4062 cases which are given below expressed as percentages.

TABLE 24.

To illustrate Osler's figures compared with those of present series.

Lobe	% Cases.		Mortality.	
	Osler	Belvidere	Osler	Belvidere.
R ₁	11.03	10.52	20.0	11.1
R ₂	2.34	2.92	14.7	20.0
R ₃	27.8	32.15	17.2	14.54
R lung.	8.27	7.6	42.0	30.76
L ₁	4.55	4.09	18.9	14.28
L ₂	24.66	31.0	14.4	13.2
L lung.	7.61	11.7	27.1	15.0
Bilobar	6.18		36.2	
Bilateral	7.56		35.5	

These figures in the above table relating to Belvidere refer to the lobe primarily involved and do not take into account any consequent migratory pneumonia.

TABLE 25.To illustrate the lung involved.

	Side	I	II	IV	III	Total.	
Cases	L	27	36	17		80	} 171
	R	33	42	14	2	91	
Mortality	L	2	6	3		11	} 26
	R	4	8	2	1	15	

TABLE 26.

Lobe involved.	Case Incidence					Case Mortality.				
	I	II	III	IV	Total	I	II	III	IV	Total
L ₁	2	1		2	5	1				1
L ₂ & Pn. Mig.	1	-		1	2					
L ₂	9	19		7	35		2		2	4
L ₂ & Pn. Mig.	8	9		1	18	1	2			3
L _{1.2.}	6	5		5	16		1		1	2
L _{1.2.} & Pn. Mig.	1	2		1	4		1			1
R ₁	2	2	1	2	7			1		1
R ₁ & Pn. Mig.	3	6		2	11		1			1
R ₂	2	1			3					
R ₂ & Pn. Mig.	2				2	1				1
R ₃	2	7		4	13					
R ₃ & Pn. Mig.	3	7		1	11		2			2
R _{2.3.}	11	10	1	2	24	2	3			5
R _{2.3.} & Pn. Mig.	4	3			7	1				1
R _{1.2.3.}	4	6		3	13		2		2	4
Total	60	78	2	31	171	6	14	1	5	26

Osler's figures and those obtained in this series of cases are approximately similar although R₃ and L₂ appear to have been more frequently involved in the present series. Also, the mortality is lower for all the lobes except R₂. This

decrease in mortality can be accounted for by the general decrease noted in the total figures.

On inspection of the figures it is seen that the right side was more frequently affected and this remains true as regards Type i and Type ii cases but Group iv was more common on the left side. Similar findings were made with regard to the case mortality.

The right side was affected in 33, or 55 per cent., of the Type i cases, in 42, or 53.8 per cent., of the Type ii cases, and in 14, or 45.2 per cent., of the Group iv cases. The lower lobes were most frequently affected and of those the right lower was more often attacked both by Type i and Type ii. L₂ was the most frequent single lobe attacked, Type ii being the most frequent invader, followed by Type i and Group iv. R_{2.3} came next in frequency, with Type i a slightly more frequent invader than Type ii.

In the cases who died, the pneumonia was on the right side on 15 occasions and 11 times on the left. Also the deaths were more common when the lower lobes were involved either primarily or after pneumonia migrans (See Table 26), there being 12 deaths when the right lower lobes were involved and 10 when the left lower lobes. Death was infrequent when the upper lobe alone was involved. Type ii was responsible for the greater number of deaths when the lower lobes were involved, there being 6 deaths when the left side was involved and 7 when the right side; whilst Type i was more commonly responsible for the deaths in cases with the upper lobes affected, there being 1 case where L₁ and 1 case where R₂ was involved.

All the Group iv deaths occurred when the lower lobes were involved.

Migratory Pneumonia.

There were 48 instances of this, or 28.07 per cent., and on 5 occasions all 5 lobes became involved. There were 3 cases, one Group iv and 2 Type ii, who after some days of normal temperature had a relapse and ran the course of another

pneumonia. One of the cases, a Type ii, had two such relapses. The first occurred 5 days after his original attack cleared, and the second on the day after the first relapse had settled. The original attack lasted 9 days and the second and third lasted 5 days each. The Group iv case, on the occasion of the second attack, was found to be infected by a Type ii organism.

There were 19, or 31.6 per cent., migratory pneumonias in the group of Type i cases, 23, or 29.4 per cent., in the Type ii group, and 6, or 19.3 per cent., in the Group iv group. The cases in which all 5 lobes became involved consisted of 4 Type ii and one Type i case, and of those only one Type ii case died.

Manner of Spread.

TABLE 27.

To illustrate manner of spread.

Type	R. side to lobes on same side.	R. side to left side.	L. side to lobes on same side.	L. side to R. side.	Total.
<u>i</u>	7	4	6	1	18
<u>ii</u>	6	6	6	5	23
<u>iv</u>	2	1	2	1	6
	15	11	14	7	47

Type i appears to spread more readily to another portion of the lung already infected and less readily to the opposite lung and this is most marked where the left lung is primarily infected. Type ii spreads with equal facility from lobe to lobe and side to side and Group iv probably resembles Type i in spreading more easily on the affected side. The total figures suggest that lobe to lobe spread on the same side is more common and that spread from right side to left is much more frequent than vice versa.

Pneumonia migrans was relatively more common in those

cases who had had previous attacks of pneumonia. There were 43 such patients and 17, or 39.5 per cent., had a pneumonia migrans. There were 9 who had a Type ii pneumonia, 5 who had a Type i and 3 who had a Group iv infection, and of those there were 3 deaths, 2 in Type ii and the other being a Type i infection. From this it would appear that wandering pneumonia is more common in patients who have had a previous infection, but the mortality of such cases varies but little from the average.

Site of lesion in relation to Positive Blood Culture.

There were 41 cases with positive blood culture and of these 23, or 56.09 per cent., occurred in right-sided pneumonias and the remaining 18 were left-sided. The pneumonia is denominated right or left-sided according to the lesion present on the day of admission when the blood was removed for examination. In the right-sided pneumonias Type i and Type ii were almost equally represented whilst Group iv and Type iii were much less common. Similarly, on the left side Type i and Type ii were found on 7 occasions and Group iv on 4 occasions. Since Type ii preponderates in the total figures it is thus seen that Type i is found comparatively more frequently in the blood in both right and left-sided pneumonias and this is more marked when the lesion is on the right side. Group iv appears to be found more often in the blood in left-sided pneumonias.

Type i bacteraemia was found more frequently in right lower lobe infections and also fairly frequently in L_{1,2} pneumonias. It was found much less frequently in pneumonia of the other lobes. Type ii was found in the blood most frequently in the lower lobe infections but there was less variation in the frequency of occurrence in the various lobes. The figures for Type iii and Group iv cases are too small to enable any definite statement to be made but bacteraemia appears to be found less frequently in Group iv cases than in the others although

it occurs with equal frequency from the various lobes.

It appears, therefore, that Type i is grown more often from the blood when the more extensive lobes are involved when there is a greater area of infected tissue. Whereas when Type ii is grown there is less reference to the area involved and the same would appear to hold for the Group iv infections although the evidence is not so strong.

V. 12. Herpes.

This has been considered on account of its diagnostic and prognostic significance.

It was a moderately common sign and varied greatly in site and area involved. It appeared most often on the face around the mouth and nose and varied from a few small vesicles which healed rapidly to extensive crops involving the lip, chin, nose and occasionally the eyelids. The cases with such extensive lesions were thus made even more miserable and the work of the nursing staff was greatly increased. On a few occasions the pinna was extensively involved and again in a few the lips were so much involved as to cause difficulty in feeding. (See small photograph). The commonest sites were (a) circum oral; (b) around the ala nasi; (c) inside the nostrils; (d) around the external canthi of the eyes; but no part of the face appeared to be immune.

In this investigation the presence of herpes was noted on admission, as was also the later progress, but no history of onset was sought so that no statement can be made with regard to any relationship between the onset of herpes and the onset of illness. Osler,⁽³⁾ however, states that the eruption generally appears about the third day but may appear earlier with the prodromes. He gives the incidence as 21.21 per cent. in a series of 4447 cases and states that the appear-

ance of the eruption is a favourable prognostic sign. Abrahams⁽²²⁾ in his series of 558 cases found herpes in 17 per cent. with a mortality of 4.2 per cent. In the present series herpes was noted in 40 cases, or 23.4 per cent. of the total, and the case mortality of this group was 6 deaths, or 15 per cent., which is much higher than that noted by Abrahams. Of the 131 cases with no herpes 20, or 15.2 per cent., died so that in the present investigation herpes was of little prognostic value.

Of the 40 cases with herpes 10, or 25 per cent., had a positive blood culture and 3 of those died.

Boyd⁽²³⁾ (p. 762) states that herpes febrilis is dependent upon an inflammatory lesion of a sensory nerve ganglion, and Savill⁽²⁴⁾ (p. 801), quoting Head's findings, points out the connection between the various viscera and the appropriate spinal segments and the corresponding skin areas in relation to those segments.

The various skin areas of the face commonly affected by herpes febrilis fall within areas, noted in Head's tables, as being in relation with the lungs, in addition to other viscera. Therefore if the original point of eruption could be accurately indicated, a useful indicator as regards the lobe affected might be to hand. The point of original eruption is stressed since herpes spreads rapidly. Only one case developed the eruption after admission and this was a boy who had a pneumonia of R_{1.2}. and developed an extensive herpes of the right ear.

Thus it is possible that herpes may indicate a heavy infection and also serve to indicate the lobe affected.

Unfortunately this idea was not evolved until late in the investigation, and therefore did not receive the attention which is now being devoted to it.

Herpes in relation to the various types is shown in the following table.

TABLE 28.

To illustrate incidence of herpes.

	Herpes.		Herpes + Bl.Cult.		
	Cases	Deaths	Cases	Deaths	
Type <u>i</u>	22 36.6% 12.8%	2	5	0	Cases. % of Type Total. % of Total 171
<u>ii</u>	13 13.6 7.6	1	3	1	Cases. % of Type Total. % of Total 171.
<u>iv</u>	4 12.7 2.34	2	1	1	Cases. % of Type Total. % of Total 171.
Total	40	6	10	3	

40 cases with herpes = 23.4% of total 171 cases.

6 deaths = 15.0% mortality.

10 cases with Positive Blood Culture = 25%.

From the figures it is seen that 22, or 55 per cent. of all the cases with herpes were Type i cases, and the case mortality was 2, or 9.09 per cent., which is slightly lower than the average Type i case mortality. Herpes was much less common in Type ii cases, and there were only 13, or 32.5 per cent., of the total cases with herpes. The case mortality of the Type ii cases with herpes was 7.6 per cent., which is much below the case mortality of Type ii cases without herpes. There were 4 cases, or 10 per cent. of cases, with herpes the result of infection by Group iv and one case resulting from Type iii. In both of those groups the case mortality was heavy but the small numbers involved discount their value. It is also seen from the table that herpes is much more frequent in Type i cases of whom 36.6 per cent. showed this lesion as compared with 13.6 per cent. Type ii cases and 12.7

per cent. Group iv cases.

Also in the cases with positive blood culture who showed herpes, Type i again preponderates, there being 5 cases, or 29.6 per cent., of all the Type i cases with positive blood culture. Of the Type ii cases there were 3, or 16.6 per cent., of those with positive blood culture and there was one out of 5 such Group iv cases. There was one Type iii case who had herpes and a positive blood culture and he died.

Résumé.

In this series 23.4 per cent. of the cases had herpes febrilis. The majority of such cases were Type i, these being present to the extent of 55 per cent. as compared with 32.5 per cent. who were Type ii in origin and 10 per cent. who were Group iv. The presence of herpes appears to be of little prognostic value in Type i infections except in those who have a positive blood culture, but the presence of herpes in Type ii cases appears to be of good prognosis. 25 per cent. of the cases with herpes had a positive blood culture, and there were 29.6 per cent. of the Type i cases with a positive blood culture who had herpes and none died. 16.6 per cent. of the Type ii cases with bacteraemia had herpes and one died, whilst of the 5 Group iv cases with bacteraemia one had herpes and died and a similar result was recorded of the Type iii case who had herpes and a positive blood culture.

It may be concluded, therefore, that herpes may be of value in prognosis especially in the case of Type ii infections and also that it may be of value in diagnosis in conjunction with Head's Tables.

V. 13. Sputum.

Several observers describe sputum in pneumonia as falling into different types, such as mucoid, rusty and bloody, but the sputum in each case varies from day to day and on the whole appears to follow a definite course. On the first day it was usually absent and if there was any it was scanty, mucoid and white. Thereafter the typical sputum might appear on the second, and more probably on the third day. At first it was usually mucoid, coarsely aerated and rusty red in colour. Frequently it was blood streaked or definitely bloody and this probably occurred when the alveolar inflammation was very intense. The sputum in pneumonia is, as a rule, odourless, but on a few occasions, an odour has been present. This was noted specially in 3 cases who were butchers to trade and in them the smell was quite distinct and unique. An odour may also be present in those bronchiectatic cases who have developed a lobar pneumonia. Such were rare in this series of cases.

The sputum, as a rule, increased in quantity as the case progressed; it became more finely aerated and the colour changed from bloody through various tones of rusty red to rusty and ultimately to a faint yellow colour which appeared around the time of lysis or crisis, either before or after this event. The consistency changed throughout, being mucoid or mayhap viscid and coarsely aerated at first, but as the disease progressed it might become exceedingly tenacious and either non-aerated or very finely aerated, and this appears to depend upon the effort made in coughing by the patient, for in those who were least distressed by the effort the sputum was usually non-aerated and tenacious.

After the crisis the quantity might continue to increase for a day or two or it might decrease soon after the temperature had fallen. The slightly rusty or yellow colour gradually disappeared and the sputum, which was very finely

aerated, became more coarsely aerated, diminished in quantity and ultimately it cleared up in the form of a few white mucoid lumps or else gradually diminished as a viscid non-aerated spit at long intervals.

If during the course of the illness the sputum suddenly changes its character from a mucoid, coarsely aerated and yellowish sputum and becomes viscid and blood-streaked or becomes a mixture of those two types, it is probable that another lobe has become involved and thereafter the sputum follows the course as detailed above.

In the more seriously ill cases, just before the crisis, the sputum occasionally became a very dark reddish brown colour and much more fluid in consistency.

In some cases after the crisis the sputum became mucopurulent and aerated and persisted somewhat longer. This was most probably due to a super-added bronchitis. In a very few of the cases, there was no spit throughout despite the fact that the patients ran an otherwise normal course.

In another small group the sputum was at first scanty, viscid and rusty and later became absent. One such case had very marked delirium which persisted for several days after the crisis and the patient recuperated very slowly, resolution being much delayed.

In an attempt to differentiate the varieties of sputa in relation to the different types of infection, the figures were tabulated and classified, but as might be expected this led to no definite results for it is improbable that the reaction of the lung tissue would show more than very slight variations in response to organisms of the same family.

Some of the minor variations to be noted were that the Type ii cases produced more often a sputum that was very finely aerated. This may be due to the fact that Type ii cases were more frequently seriously ill and so less capable of coughing up the sputum at the first attempt and thus aerated the secre-

tion more thoroughly by their continued efforts or it may be that the secretion was more difficult to bring up.

There were 3 cases who had bloody sputum throughout the illness, 2 being Group iv and the other Type ii in origin and this latter died. The 2 Group iv patients were over aet 50 years and a possible explanation may be that in cases where resistance is at a minimum the tissues cannot produce sufficient polymorphs, etc., to meet the infection and instead of an inflammatory exudate being poured into the alveoli, all that takes place is leaking from the intensely congested alveolar walls. In this type the probable termination will be death, as in the Type ii case. In the 2 Group iv cases it is possible that only the interstitial elements of the alveoli were involved by an organism of low virulence and the exudate into the alveoli would then be minimal although the congestion resultant upon the infection would still be present.

There were 6 cases with no sputum throughout, 3 being Group iv, of whom 2 died; 2 were Type ii and 1 was Type i in origin. Abrahams⁽²²⁾, in a series of 558 cases, found the sputum absent in 10.9 per cent., which is in excess of the 3.5 per cent. of this series.

Another variation which was noted was that some cases produced more than ordinary quantity of sputum. The gauging of this was purely arbitrary for it was found impossible to keep an accurate measurement of the sputum in a ward of 18 to 20 patients.

There were 24 cases who had somewhat excessive expectoration and of those 4 were Type i, 15 were Type ii, and 5 were Group iv, and of those 4 died, one being Type i and 3 being Type ii in origin. This excessive production may be explained by a failing right heart and is thus an indirect expression of the greater virulence of the Type ii cases.

V. 14. (a) Temperature and Manner of Termination

(See Average Charts).

The average charts used in this section were prepared from 100 Type i, 100 Type ii and 60 Group iv cases. The average was obtained by adding the highest recorded temperature for each day of the illness for each case and taking a mean.

Pyrexia is a manifestation of the response of the body to infection. The body is more able to deal with the invading organisms and their products when the body temperature is raised⁽³⁴⁾ (p. 311), so that pyrexia is primarily a protective reaction. Soon, however, the heat regulating centre becomes disordered and remains so until the infection is overcome.

The body responds by an elevation of temperature to the introduction of micro-organisms or of foreign proteins such as toxins. The micro-organisms may cause this response by their action on the body tissues or by their production of toxins which may then act on the central nervous system. Price⁽⁴⁰⁾ (p. 5).

When a part of the body is infected there is an increased supply of blood to the part in order to supply antibodies, etc. McDowall⁽³²⁾ (p. 345). The classical example of this is the furuncle. In the case of a lobar pneumonia the area involved is large and consequently the volume of blood required at the infected point will be large. To obtain this increase in volume, blood is withdrawn from the surface of the body, with the result that there is a diminution in the heat supplied to the nerve endings in the skin and the infected person receives the sensation of cold or chilliness with a resultant rigor. The heat loss from the body surface is diminished and heat production still continues so that eventually there is a physiological response and the skin mechanism for reducing temperature is brought into action with the production of a flushed dry skin.

McDowall⁽³²⁾ (p. 345) quoting Cramer states that the conditions which present themselves in the early stages of fever are closely akin to intense stimulation of the sympathetic system, such as would occur from secretion of adrenalin, and the findings in the blood pressure changes in this investigation, and noted in the appropriate chapter, seem to substantiate this idea.

Bearing in mind the variation of individual reaction, it is possible that the degree of initial rigor and elevation of temperature may be used as an indicator of the degree of primary infection. Thus on referring to the table illustrating the onset of symptoms (p. 41) it is seen that in 28, or 46.6 per cent. of the Type i cases, in 30, or 38.2 per cent., of the Type ii cases, and in 7, or 22.5 per cent., of the Group iv cases, rigor was the initial symptom. Assuming, therefore, that the hypothesis outlined above is correct, these figures are additional confirmation of the statement made elsewhere, that the Type i infection is heavier than either Type ii or Group iv.

McDowall⁽³²⁾ (p. 346) points out that after the preliminary vaso-constriction there is a rise in temperature to counteract it, and the degree of elevation will be directly comparable with the degree of constriction. He also points out (p. 344) that the temperature reacts to the release of proteins into the blood such as result from tissue break-down coincident with fever or from the release of toxins.

On examination of the average temperature charts it is seen that in the Type i infection there was a brisk response, the temperature rising moderately rapidly and reached its highest point 102.8°F. on the 3rd day of illness, and thereafter was within limits of 101.0°F. and 102.8°F. till the crisis. When the Type ii chart is examined it is seen that the temperature reaction develops more slowly but ultimately reaches a higher level, 103.8°F. on the 4th day, which, how-

ever, is not maintained, but subsides and runs thereafter between 100.8° and 101.8°F . The average Type i chart suggests an effective response developing moderately rapidly and well sustained against an infection of moderate virulence, whereas the average chart of the Type ii case suggests a more slowly developing response to a more virulent infection, a response which is not so well maintained. The average chart of the Group iv case shows an immediate and well-marked response which is maintained thereafter at a slightly lower level but tending to fall as the disease progresses. This suggests an effective and immediate reaction to a less virulent organism which is slowly but surely overcome.

In cases below age 35 years it is seen that in each type the response is more marked and better maintained than is found in the older patients. In the Group iv case, however, there is a slight variation and this is probably explained by the younger men combating the infection more effectively in the first few days.

In the case over 35 years in Type i and Type ii infections the curve follows the norm but suggests a less marked reaction in each instance. In the Group iv case it would appear that the infection is much less easily overcome by the older men and as a result the temperature response is more marked for a longer period.

In the majority of cases the temperature was continuous and formed a plateau three or four degrees above normal. In a number of cases this plateau was much lower, running at a level about one degree above normal. This type of response was noted especially in Type ii cases above 35 years who were acutely ill and usually showing some degree of prostration. In another group of cases there was a series of irregular remissions. These were noted as a rule in younger patients all of whom recovered.

The onset of any complication was usually indicated by some upset in the temperature curve accompanied by upset in the

blood pressure curves. Pneumonia migrans as a rule caused a further rise in temperature the significance of which was not always appreciated at the time but which was outstanding when the completed chart was inspected. (See Chart C).

The blood pressure was especially valuable in such cases where the temperature tended to be irregular. If the Blood Pressure curves pursued a normal course, the mind was set at ease, but an irregularity of the temperature accompanied by irregularity of the Blood Pressure curves suggested the onset of some disturbing factor.

Defervescence took place by crisis or lysis or by one of these after a pseudo-crisis. The following tables illustrate this:-

TABLE 29.

To illustrate Defervescence.

	Type i.		ii.		iv.		iii.	Total.	
	Cases	%	Cases	%	Cases	%	Cases	Cases	%
Crisis	34	56.6	31	39.74	15	48.3	1	81	47.3
Lysis	20	33.3	33	42.3	11	35.4		64	37.4
Death	6	10.0	14	17.94	5	16.2	1	26	15.2
	60	100	78	100	31	100	2	171	100

Those figures were considered in more detail and are illustrated in the following table.

TABLE 29.

	Type i.		ii.		iv.		iii.	Total.	
	Cases	%	Cases	%	Cases	%	Cases	Cases	%
Crisis	26	48.2	19	29.7	11	42.3	1	57	39.3
" after pseudo-crisis.	8	14.8	12	18.72	4	15.38		24	16.55
Lysis	19	35.2	27	42.2	10	38.45		56	38.64
" after pseudo-crisis.	1	1.8	6	9.37	1	3.84		8	5.52
Deaths	6		14		5		1		
	60		78		31		2		

These figures show that crisis was the most frequent termination in Type i and Group iv cases and that lysis occurred more frequently in Type ii cases. Pseudo-crisis was of frequent occurrence and was most often found in Type ii cases, and was most often followed by crisis. This was also noted in Type i and Group iv cases but to a less degree.

It was assumed that the occurrence of a pseudo-crisis or of a lysis was indicative of a more slowly developed resistance than occurred when crisis supervened. If this is true the figures help to sustain the hypothesis that in Type ii infections the body overcomes the infection more slowly, as a result of the greater virulence of the Type ii organism.

There were 27 Type i cases below aet 35 years who settled by crisis as compared with 23 Type ii cases and 12 Group iv cases. The Type i cases were spread evenly throughout the age groups from 15 to 35 years whereas 18 of the Type ii were below 25 years. The Group iv cases also settled more often by crisis in the younger people, 12 out of the 15 such being below 35 years.

These facts seem to indicate that it is more often the younger and more robust patient who can build up his defences

sufficiently rapidly to produce a crisis and it is specially to be noted that this occurs in Type ii cases only in the very youngest age groups. The older men apparently find more difficulty in raising bulwarks against the organism and consequently the febrile reaction is not so marked, tends to persist longer, and ultimately settle by lysis. In contradistinction to this is the greater febrile reaction and greater incidence of crises in the younger men.

There were 41 cases who showed Positive Blood Cultures and of those 13 settled by crisis, 14 by lysis, and 14 died.

TABLE 30.

Type	i.	ii.	iv.	iii.	Total
Crisis	6	4	3	-	13
Lysis	9	5	-	-	14
Death	2	9	2	1	14
	17	18	5	1	41

From this table it is seen that in Type i cases lysis is more common than crisis and this is probably indicative of the heavier infection. The distinction is not so marked in the Type ii cases but this probably is explained by the greater incidence of deaths.

That the previous occurrence of an attack of pneumonia does not enable the body to expedite preparation of antibodies is illustrated in the following table.

TABLE 31.

Type	i.	ii.	iv.	Total.
Crisis	8	7	6	21
Lysis	4	11	3	18
Death	1	3	-	4
	13	21	9	43

Here it is seen that crisis once again is more common in Type i and Group iv cases but it would seem that the incidence of lysis is more marked in those cases who have had a previous attack of pneumonia.

The effect of the presence of bronchitis on the mode of defervescence is illustrated in the following table.

TABLE 32.With Bronchitis.Without Bronchitis.

Type	i.	ii.	iv.	Total.
Crisis	17	14	7	38
Lysis	7	21	7	35
Death	5	11	2	18
	29	46	16	91

i.	ii.	iv.	Total.
17	17	8	42
13	12	4	29
1	3	3	7
31	32	15	78

From those figures it is seen that lysis was comparatively more common in cases with bronchitis than in the cases who had no bronchitis, where crisis was of more frequent occurrence. It would appear, therefore, that in the presence of bronchitis the body takes longer to overcome the infection.

Gaskell⁽²⁶⁾, quoting Armstrong in the Proceedings of the Royal Society, 1925, XCVIII, p. 525, states that the protective power of the serum against pneumococci is very slight at the onset of a pneumonia and rapidly disappears 24 hours after infection and remains absent for the first 4 days.

It rapidly reappears around the fifth day and increases enormously and with great rapidity to a maximum on the seventh or eighth day. It then slowly diminishes throughout convalescence. The rapid rise of this power to kill the pneumococci corresponds with the crisis.

Also the toxin of the pneumococcus is stated by some writers to be an endo-toxin which is only liberated when the coccus is killed, but this is not generally accepted. If, however, it is assumed to be correct, once all the cocci have been killed and the resultant toxins counteracted, the conditions of the body should return to normal in the uncomplicated case, either by crisis or lysis according to the speed of development of the anti-bodies. It might be reasoned, therefore, that the preponderance of crises in the Type i and Group iv cases is evidence of the body overcoming less virulent organisms more rapidly, and thus the endo-toxin will be set free and neutralised with a resultant crisis. In the Type ii infection the organism is more virulent, more difficult to kill and so the infection lasts longer and the endo-toxin is set free in dribblets comparatively speaking, and as a result the final neutralisation is delayed with a resultant lysis.

The variations in the behaviour of the temperature as discussed above have been commented upon by other observers, Cecil and Plummer⁽²⁾ (p. 1548) noting that Type i cases tended to show a temperature curve which ran along a high plateau to defervesce more often by crisis. Glynn and Digby⁽¹⁾ (p.139) found that of the Type i cases investigated by them half

settled by crisis.

The duration of the febrile period was noted and the figures for the various types compared. (See Graphs on Fig.XIV) From the graphs it is seen that the bulk of the Type i cases settle on the 6th, 7th and 8th days, whilst in Type ii the greater number settle on the 7th and 9th days. Below aet 35 years the bulk of both Type i and Type ii cases settle on the 7th day. The peak, however, is much sharper in the Type ii curve but the fall to the right of the graph is much more prolonged after a sharp drop. Over aet 35 years in Type i cases the greater number settle on the 8th day but a large number settle before and after this day, whilst of the Type ii cases the bulk settle on the 9th day.

From this it would appear that the majority of the younger men build up sufficient resistance to overcome the infection by the 7th day whereas the older men take some time longer. This is more marked in the Type ii infections for the graph shows that in the Type i infection a considerable number of the older men settle before the 8th day, whilst as stated above the greater number of Type ii cases settle on the 9th.

The figures are further illustrated in the following tables compiled from 100 Type i, 100 Type ii and 60 Group iv cases.

TABLE 33.

To show distribution of cases according to age and manner of defervescence.

	Crisis.			Lysis.		
	i.	ii.	iv.	i.	ii.	iv.
- 35 years	54	39	15	17	24	22
+ 35 years	17	13	7	12	24	16
	71	52	22	29	48	38

Cases.

TABLE 34.

	Type i.	ii.	iv.	} Days.
Average duration of Pyrexia	7.59	7.69	7.5	
" " - 35 yrs.	7.44	7.44	6.89	
" " + 35 yrs.	7.97	8.10	7.9	

TABLE 35.

To show duration of fever in cases which settled by crisis and in cases which settled by lysis.

	Crisis.			Lysis.			} Days.
	i.	ii.	iv.	i.	ii.	iv.	
- 35 years	7.13	6.96	6.8	8.41	8.2	6.95	
+ 35 years	7.94	8.08	9.0	8.0	8.13	7.4	
AV.	7.32	7.25	7.5	8.24	8.16	7.13	

From these figures it is seen that there is but slight difference in the average duration of fever, but this difference is in favour of the Type i and Group iv case. In cases below aet 35 years the Group iv case has the shortest febrile period and in the Type i and Type ii case the period is equal. In the older cases it is seen that the Type i and Group iv cases are approximately equal in duration and slightly less than the Type ii case.

Also it would appear that of the cases below aet 35 years who settle by crisis, the Group iv case reaches normal a little earlier than the Type ii case and the latter earlier than the Type i case. Above aet 35 years the opposite is the case, the Type i case becoming normal before the Type ii and the latter before the Group iv case. Of the cases which settle by lysis the Group iv case reaches normal earlier than the

Type i and Type ii case in both age groups. The younger Type ii cases settle earlier than the similar class of Type i but the older Type ii cases take longer than the older Type i.

These figures suggest that if a young adult with a Type ii infection is capable of dealing effectively with the infection he does so more rapidly than the young adult with a Type i infection. Also it seems that the young adult with a Group iv infection deals with it rapidly whereas the older man takes considerably longer to do so.

But the figures show that more Type ii than Type i cases settle by lysis which, as already suggested, indicates a greater difficulty in overcoming the infection.

Those Type i cases below aet 35 years who settle by lysis have the longest febrile period and are probably patients with very low defensive powers. Had such patients been infected by a Type ii pneumococcus they would in all probability have become rapidly prostrated and died.

The differences in the figures are slight but they suggest that if a person with a Type ii infection has a high degree of resisting power to the pneumococcus he deals with the infection rapidly and efficiently, but if the resisting power is moderate to low the result is a prolonged febrile period with ultimate lysis or death.

In the Type i infection the greater number of patients are able to deal effectively with the organism and settle by crisis and this is more marked in the younger patients. They, however, do not deal so rapidly with the infection as similar men do with the Type ii infection, but this is probably due to the greater incidence of heavier infections indicated by the relative preponderance of positive blood cultures in the Type i cases.

The comparatively small number of Type i patients who settle by lysis, probably indicates that the majority of people infected are capable of dealing effectively with such an in-

fection. When those who are less capable are infected the result is a prolonged febrile period followed by lysis.

The majority of the Group iv cases settle by lysis and those cases have a shorter febrile period than those who settle by crisis except in the case of the younger men. This might be explained if it is presumed that a Group iv pneumonia results when a person with low resisting power is infected and probably auto-infected by a moderately virulent organism which is rapidly killed from the commencement by those who are capable. The endo-toxins set free are similarly rapidly counteracted so that the violence of the reaction declines throughout with a resultant lysis. The average Group iv pulse chart (See Charts III and IV) bears this out for it is seen that the curve falls throughout.

V. 14. (b) Examination of the pulse rate in the various infections shows one or two points of interest.

Average pulse charts were constructed in a manner similar to that used for the average temperature charts. (See Charts I, II, III, and IV).

The rate of the heart may be affected by a variety of causes, pain, temperature of the blood, toxins formed during a fever (McDowall⁽³²⁾ p.105), and variation in the oxygen content of the blood. Each of those factors is present in pneumonia but when the pulse curves for the various types are examined they are seen to vary considerably, so that if the causal factors are constantly present the variation in the pulse rates must be due to variation in degree of one or other of the factors. The individual variation of the patient may be neglected here, for the curves are the mean of a large number of cases.

The Type i pulse chart suggests the response to an in-

fection of moderate severity, an infection which is moderately rapidly counteracted. The pulse rate reaches its peak around 110 beats per minute on the 4th day, i.e., a day after the peak of the temperature curve, and thereafter falls following closely the curve of the temperature chart. This lag is probably indicative of the setting free of the endo-toxins shortly after the overthrow of the main infection, for the temperature has commenced to fall on the 4th day and the pleuritic pain which might affect the pulse rate has usually been alleviated by that time.

The Type ii pulse chart bears out the suggestion advanced earlier, of a virulent and toxic infection which is more slowly overcome. The toxæmia would appear to be marked from the day of onset, as indicated by the frequency of the pulse, around 120 beats per minute, and which remains moderately high until the 6th day, i.e., 2 days after the peak of the temperature curve. Thereafter it falls until it becomes proportionate to the temperature. This lag, which is longer than that noted in the Type i Chart, may indicate the greater toxicity of the Type ii infection, in that the pulse rate remains longer more disproportionate to the temperature.

The Group iv Chart would appear to illustrate the immediate and effective response to an infection of more than moderate toxicity, which is effectively overcome in the first 3 days, for the pulse rate falls from a high level, around 120 beats per minute, to below 90 by the 3rd day and continues to fall thereafter, proportionate to the temperature.

From the foregoing it appears that the Type i infection is less toxic but heavier than the other two. As a result of the heavier infection the body takes longer to overcome the greater number of organisms and hence the toxæmia is later in developing. The Type ii infection is apparently much more toxic from the onset and the body takes longer to react effectively. Whilst in the Group iv infection the response is immed-

iate to what is apparently a less virulent though toxic organism.

Judging by the comparative incidence of positive blood cultures there were more heavy Type i than Type ii infections, but when the pulse charts are compared it is seen that the frequency of the heart beat is much more marked earlier in the Type ii cases. When the figures concerning positive blood cultures are examined an explanation of this seems possible. (See Table 23 in Chapter upon Day of Admission). From the figures there it is seen that the Type ii cases with positive blood culture are found in the early days of the illness and the similar Type i cases are more often found later. And as already suggested the organisms although probably present in the blood in every case are only grown when the infection is heavy. If this assumption is accepted it is seen that the Type ii infection is heavier in the early days and hence the toxæmic action on the circulatory system will be more marked on those days.

When the average pulse curves of the cases who died are examined it is seen that the results seem to confirm the foregoing, for the pulse in the Type i cases runs at a much lower level than in the other types and there is a slight fall after the 5th day before the final progressive rise, which seems to indicate a control of early toxæmia followed by failure to overcome an increasing toxæmia developing later in the disease. Whereas in the Type ii and Group iv cases the frequency throughout is much more marked, indicating a more severe toxæmia from the onset and in the case of the Type ii infection it tends to rise slowly from the 1st day. The Group iv cases apparently have a preliminary improvement followed by a progressive failure thereafter.

It would appear probable that if the body can withstand the preliminary toxæmia in the Type ii infection, and can cope with the organisms themselves the chances of recovery

are enhanced, whereas in the Type i and Group iv infections it appears to be a toxæmia developing later in the disease which kills.

V. 15. Length of Residence in Hospital.

It is unnecessary to state that this will vary greatly according to (1) the physician's ideas with regard to convalescence, and (2) the class of patient. The working man with a family must return of necessity to work at the earliest possible moment. In this series each case was examined 5 days after the temperature had finally settled. If there were no complications the patient was allowed to sit up in a chair for a few days and then allowed up in clothes. If all went well and no abnormality presented, the patient was finally examined and dismissed 7 days after he was allowed up. This short convalescence was acceded to only after consideration had been given to (1) the demands of patients who feared loss of work and (2) the demand for hospital accommodation. Using the figures relating to the group of 171 cases it was found that the average length of residence was 22.34 days. For an uncomplicated case the average stay was 18.71 days and for the case which suffered some complication 26.8 days.

The following table illustrates the figures for the various types:-

TABLE 36.

To illustrate length of residence.

	i.	ii.	iv.	Av.	
Uncomplicated	18.22	19.54	17.94	18.71	} days.
Complicated	27.56	27.2	23.1	26.8	
Average	22.2	23.25	19.94	22.34	
Death	5.1	4.1	2.9	4.05	

These figures supply more proof of the greater severity of the Type ii infection. The average residence is longer and the deaths occur more rapidly than in the other types except in the Group iv infections where the average stay of cases who died is very short.

The fact that the average stay of the Type i case with complications was longer is probably the result of the higher incidence of empyaemata in the Type i infections.

The effect of bacteraemia on the length of residence is illustrated in the following table.

TABLE 37.

To illustrate the effect of Bacteraemia on length of residence.

	Pos. Blood Culture.				Neg. Blood Culture.				Days.
	i.	ii.	iv.	Av.	i.	ii.	iv.	Av.	
Uncomplicated	17.8	18.5	16.5	17.83	18.2	19.64	18.14	18.84	}
Complicated	25.6	25.2	46.0	27.5	29.06	27.5	20.55	26.66	
Average	23.0	22.2	31.25	23.1	21.8	23.33	19.08	22.02	
Death	2.12	4.05	4.5	3.82	5.69	4.19	1.83	4.22	

Thus it seems indicated that the average stay of a case with a Positive Blood Culture is slightly longer, but whereas the complicated case is longer in residence the uncomplicated case is shorter. The stay in hospital of cases who died is shorter.

With regard to the various types it is seen that in Type i and Type ii cases the uncomplicated and complicated cases have a shorter stay than similar cases with a negative blood culture. The average residence, however, of a case with positive blood culture, whether uncomplicated or complicated, is longer in Type i and Group iv cases and shorter in Type ii cases.

The length of residence of a case with bronchitis differed but little from the case without bronchitis, but the case with bronchitis had an average stay a little less. When the figures were examined in detail it was found that the uncomplicated case with bronchitis had a slightly longer stay than the case without bronchitis and this was found to be the rule in each of the types. Of the cases who had bronchitis and died the stay was less than that of the cases with bronchitis.

Résumé.

It was found that the uncomplicated case had a shorter stay in hospital than the one with a complication, and that Type ii cases had a longer average stay than Type i and Group iv cases and that whilst Group iv cases had the shortest stay, the Type i cases with a complication had the longest. Also that the presence of sufficient organisms in the blood to enable them to be grown, increases the average residence in hospital of those who survive and shortens the stay of those who die.

V. 16. Dyspnoea and Cyanosis.

McDowall⁽³²⁾ (p. 170) states that breathing depends upon a number of factors; the respiratory centre, the replacement of the alveolar air, the circulation of the blood, the quality of the blood, the quality of the air breathed and all those organs which assist in maintaining the neutrality of the blood. In pneumonia it is probable that all those factors are affected, except the quality of the air breathed and the organs which preserve the pH of the blood at its proper value. It seems improbable that the dyspnoea in pneumonia results

from the interference with the respiratory surface since a person with an artificial pneumothorax can go about and carry on his work without becoming unduly distressed. Also a patient with lobar pneumonia who at one visit is found to be markedly dyspnoeic on the following day may be found to be perfectly comfortable, having had a crisis in the interval, the respiratory rate having fallen in frequency perhaps from 8 to 16 respirations per minute. Although the consolidation is still present, the lung being dull to percussion and the RM remaining tubular, the distress is gone. Obviously, therefore, the upset in the respiratory surface is not solely the cause of dyspnoea.

Against the argument that the dyspnoea is toxic in origin, there has been advanced the statement that there is no dyspnoea accompanying a pneumococcal abscess. McDowall⁽³²⁾ (p. 188). This, however, is not conclusive for an abscess is a localised condition occurring in a body which has had time to build up anti-bodies, etc., to prevent a generalised infection, a condition which is different from a pneumococcal septicaemia.

It seems probable, therefore, that dyspnoea is mainly the result of the toxæmia which not only acts on the respiratory centre but also affects the circulation of the blood through its action on the circulatory system. Ritchie⁽³³⁾ (p. 86 et seq.).

McDowall⁽³²⁾ (pp. 187, 191) is of the opinion that the dyspnoea is also dependent upon an upset in the Hering-Breuer reflex, with resultant rapid and shallow respiration.

Cyanosis is due to the presence in the blood of reduced haemoglobin as distinct from oxyhaemoglobin. It is the indicator of the development of anoxæmia and its early recognition and treatment are therefore of considerable importance.

It may result from the circulation of imperfectly

aerated blood, such as results when the aerating mechanism of the lungs is inefficient. Such a condition obtains in pneumonia where a considerable proportion of the alveoli are filled with exudate. But in addition to this there must be some other factor at work, for cyanosis is often very marked in cases where only one lobe is consolidated, such as R_1 , whilst in others with all the lobes except one involved it may be minimal. Boyd⁽²³⁾ (p. 164) suggests also that the anoxaemia may be the result of the rapid shallow breathing which would only ventilate the "dead space" and as was noted earlier this type of breathing results from an upset in the Hering-Breuer reflex which is probably the result of the toxæmia. It would therefore appear that both dyspnoea and cyanosis have a common aetiological factor in toxæmia.

As will be shown later, a form called grey cyanosis was noted and this probably resulted from a combination of anoxaemia and cardiac failure due to the toxæmia, the cardiac failure being superimposed on the original cyanosis.

The results obtained in the present investigation bear out the various hypotheses made above. There was one case who was admitted with a pneumonia involving all the lobes except R_1 and in his case the cyanosis and dyspnoea were negligible throughout. In other 3 cases with $R_{2,3}$ and L_2 all involved, dyspnoea and cyanosis were of less than moderate severity. In others again with only one lobe involved severe dyspnoea and cyanosis were noted. This was found once where R_1 was consolidated, once where R_3 was affected and twice when L_2 was involved. In other 2 cases there was severe dyspnoea but less cyanosis.

On closer study of the figures it is found that severe dyspnoea was more often present than severe cyanosis, there being 6 cases of Type i, 9 cases of Type ii and no cases of Group iv thus embarrassed. Moderate dyspnoea was noted on 21 occasions in both Type i and Type ii cases and on 12 occasions

in Group iv. Very slight to slight dyspnoea was present in 32 Type i cases, 46 Type ii cases, and 18 Group iv cases.

Of cases with severe cyanosis there were 4 in the Type ii section as compared with 2 in the Type i and 1 in the Group iv. There were 24 Type i cases, 20 Type ii cases and 8 Group iv cases with moderate cyanosis whilst very slight to slight cyanosis was noted in 32 Type i, 53 Type ii and 20 Group iv cases.

TABLE 38.

To illustrate incidence of cyanosis and dyspnoea.

Type	Dyspnoea.			Cyanosis.		
	+	++	+++	+	++	+++
<u>i</u>	32	21	6	32	24	2
<u>ii</u>	46	21	9	52	20	4
<u>iv</u>	18	12	0	20	8	1
	96	54	15	104	52	7

There were a number of cases who showed an absence of dyspnoea or cyanosis. There was one Type i case who had no dyspnoea, and two Type i cases who showed no cyanosis. Of the Type ii cases two had no dyspnoea and two had no cyanosis. There was one Group iv case who had no dyspnoea and two with no cyanosis.

From the above it is seen that severe dyspnoea was more common than severe cyanosis and that it was more common in Type ii than in Type i cases. Moderate dyspnoea and moderate cyanosis appeared with much the same frequency and there were slight differences in the Types, Type i cases being more frequently moderately dyspnoeic and even more frequently moderately cyanosed than Type ii cases. Moderate dyspnoea

was much more common than moderate cyanosis in Group iv cases.

A minor degree of cyanosis was more common than a minor degree of dyspnoea, notably in Type ii and Group iv cases.

With regard to any differences in relation to involvement of the various lobes it was found that the only marked variation was that moderate cyanosis was much more frequent in Type i cases than in the others when L_2 was involved. Also it was found that dyspnoea and cyanosis were more marked when the lower lobes were involved and this was most marked when R_3 was affected. Cyanosis and dyspnoea were also commonly present when R_1 was involved, and usually were of moderate degree.

Keeping in mind the fact that there were 60 Type i, 78 Type ii and 31 Group iv cases, the figures indicate that although severe dyspnoea and cyanosis were more frequent in Type ii cases, moderate dyspnoea and cyanosis were much more common in Type i, whilst slight degrees of dyspnoea and cyanosis were slightly more common in Type i cases. Severe dyspnoea and cyanosis were uncommon in Group iv cases and the incidence of moderate and slight dyspnoea and cyanosis was much the same as found in Type ii cases except that moderate dyspnoea was relatively more frequent.

There were a number of cases in whom the cyanosis was less livid and tended to take the form of a grey pallor. As stated earlier, this was ascribed to a combination of anoxaemia and cardio-vascular failure, the latter most probably resulting from the toxæmia and lack of oxygen.

TABLE 39.

To illustrate incidence of Grey Pallor.

Type	Acute	Grave	Death	Total.
<u>i</u>	2	2	0	4
<u>ii</u>	3	6	6	15
<u>iv</u>	4	1	2	7
	9	9	8	26

From the table it is seen that there were 26 cases with this form of cyanosis and of those 8 died. More than half of the cases were Type ii in origin and the death rate in this group was very heavy.

Of the Type i cases 2 were desperately ill and 2 were acutely ill and all recovered. Of the 15 Type ii cases 6 were very gravely ill and of them 2 were below 25 years of age and 4 were above this age. 3 of the cases were acutely ill and were all below 25 years of age whilst the remaining 6 cases, who were all admitted desperately ill, died after an average residence in hospital of 3.1 days. Of the cases who died one was in the 30-40 age group and 5 were above 40 years of age. The Group iv cases were mostly acutely ill although 1 was gravely ill. This latter was aet 60 years whilst the 4 who were acutely ill were all below 40 years of age. Of the 2 who died, one was aet 19 years and the other 25 years and they had an average residence in hospital of 4.5 days.

Thus it would appear that in this series it was not so much the degree as the type of cyanosis which was of prognostic importance. Also it appears that severe dyspnoea was more common than severe cyanosis and that Type ii infections most commonly showed these states. The dyspnoea and cyanosis found in Type i infections were found to be severe less frequently and were more often of moderate degree.

V. 17. Toxaemia.

With but a few exceptions every case showed some evidence of toxaemia, the commonest symptoms being headache, sleeplessness, restlessness and exhaustion, with delirium prostration and incontinence in the graver cases. The degree of toxaemia varied greatly and so far as could be judged this variation had no relationship to the extent of lung tissue

involved. In some cases where a complete lung such as R_{1.2.3} was involved from the 2nd day of illness, toxæmia was slight throughout. In a few cases where each lobe was involved by a migratory pneumonia, the toxæmia was slight as compared with other cases with only one lobe involved. Examples of this latter variety were usually those with an upper lobe involved from the onset of the illness. Other cases again where the upper lobe was involved later by a migratory pneumonia did not show toxæmia to such a marked degree.

In the following table the degree of toxæmia is denoted +, ++, or +++ for classification purposes, according to whether the symptoms were headache and/or sleeplessness, or those symptoms plus restlessness, or finally delirium and/or incontinence and prostration.

TABLE 40.

To illustrate Toxæmia.

Type.	+		++		+++	
	Cases	%	Cases	%	Cases	%
<u>i</u>	22	36.6	25	41.6	13	21.65
<u>ii</u>	26	33.35	30	38.45	22	28.2
<u>iv</u>	14	45.2	8	25.8	9	29.0
	62		63		44	

The figures per cent. refer to the Type Total.

Those figures show that Type ii and Group iv cases suffered more from severe toxæmia than Type i cases. Also a moderate degree of toxæmia was most commonly found in Type i cases but in the aggregate toxæmia was most marked in Type ii cases.

It was found that men with a positive blood culture or a positive blood Wassermann showed greater toxæmia. For example there were 17 cases with Type i infection who had a

positive blood culture and 12 of those showed symptoms of more than moderate toxæmia. Similarly of the 18 Type ii cases with positive blood culture 12 showed evidence of marked intoxication but of the 5 Group iv cases only 2 were toxic and only one of those markedly so.

Evidence of toxæmia was noted in cases in all age groups but the incidence increased with age and this was most marked in Type ii cases. Of the cases with positive blood culture some differences were found in the relationship between age and toxæmia. There were 12 cases each, in the Type i and Type ii groups who showed marked toxæmia. The Type i cases were spread through all the age groups and the percentage incidence increased with age. In the Type ii group there were 7 cases below and 5 cases above aet 35 years and of the cases below that age all were between 20 and 34 years and 4 of them died, whereas of the Type i cases below 35 years with positive blood culture and marked toxæmia, none died.

The two Group iv cases with toxæmia who died were aged 19 and 25 years respectively.

The presence of other constitutional upset apparently has some effect on the reacting powers of the body, for of the 4 Type i cases who had a positive blood Wassermann reaction each showed signs of severe toxæmia and one died. There were 9 Type ii cases with a positive blood Wassermann reaction, 7 of whom displayed signs of severe intoxication, 53 ultimately died. There was one Group iv case with a positive Wassermann reaction and he had moderate toxæmia.

Thus it appears that the degree of toxæmia varies according to the type of organism and age of patient. It also varies according to the heaviness or otherwise of the infection, judged by the positive blood culture; and finally the presence of other constitutional disease appears to be of some importance.

V. 18. Cause of Death.

Essential to the continuance of life are efficient circulation of the blood and efficient respiratory exchange. In pneumonia each of those factors may be interfered with, but in this series scant evidence was obtained which indicated that death resulted from direct interference with respiratory function. Evidence of inefficient cardiac function, however, was the symptom most commonly noted at some period in those cases who died.

In some it was observed from the day of admission; the progressive failure of the circulatory system being indicated by some or all of the following signs; steady increase in the pulse frequency, weakening of the pulse force, the appearance of irregularities in cardiac action, and diminution of the urinary output. In others again signs of cardiac failure did not appear until shortly before the end, the earlier signs and symptoms such as headache, restlessness and delirium with a dry coated and cracked tongue being indicative of toxæmia. In those cases any natural resistance was soon worn down by the delirium and restlessness and cardiac failure set in with rapidity, usually 24 to 36 hours before the end. In a few of the cases who died the outstanding feature was anoxæmia, which became progressively worse despite intensive treatment by means of oxygen. This was probably the result of a combination of progressive cardiac failure and toxæmia.

A few remaining cases displayed some complication in conjunction with toxæmia or a concomitant failing heart.

Previous habits apparently have some part in the causation of death for of the 26 cases who died, 4 had a positive blood Wassermann reaction and 8 had a history of more than moderate indulgence in alcohol. A very much larger number of the cases who survived took alcohol habitually but

not excessively.

The important factors, therefore, would appear to be the degree of resistance inherent to the patient infected, and the toxicity of the infecting organism. If the patient has poor resistance or if his powers have been diminished by abuses, the organism, no matter what the type, will proliferate and ultimately toxins will be produced sufficient to interfere with the functioning of the vital tissues of the body. On the other hand, if the organism is of high virulence the patient will rapidly succumb unless his defensive powers are correspondingly high. This high virulence of the organism may be due to greater proliferative power or to greater toxicity, but it would appear probable that the latter is the correct explanation since although there was a greater percentage of Type i cases with positive blood culture only 12 per cent. died as compared with 50 per cent. of the Type ii cases with positive blood culture.

Those cases who died after showing signs of cardiac failure throughout were probably individuals who were peculiarly susceptible to the toxins produced by the pneumococcus, and to the diminished oxygen supply and in whom the heart failed before signs of general toxæmia became advanced. Or it may be that their cardiac efficiency had been impaired by previous disease.

Of the other cases who showed cardiac failure towards the end, this failure was most probably the result of progressive poisoning of the myocardium associated with the effect of the toxins on the peripheral circulation.

The deaths occurred in all varieties of physical types. Some of the patients were worn-out middle-aged men. Others were apparently strong and robust workmen who had been suddenly stricken and brought into hospital desperately ill. And finally there were a few youths, not fully developed, about whom no fears were entertained but who finally succumbed after

a residence of 6 or 7 days. When the various type groups are considered it is found that of the Type i cases 6 died after an average residence in hospital of 5.16 days and all were over set 35 years. 3 of them died from cardiac failure and in addition 2 of those showed anoxaemia. The remaining case with cardiac failure showed some slight degree of general toxæmia. The other 3 who died showed primarily evidence of toxæmia which ultimately caused cardiac failure and death. One of this latter group had a positive blood Wassermann reaction and developed a pneumonia migrans. The average stay in hospital of those who died from cardiac failure was 3.1 days and of those who died from toxæmia 7.1 days. There were 14 Type ii cases who died after an average residence of 4.14 days and in the majority of them toxæmia was the outstanding cause of death. 11 of the 14 showed evidence of increasing toxæmia and in 10 this was marked.

Of the remaining 3 cases, 2 died from primary cardiac failure and 1 from anoxaemia followed later by cardiac failure.

Of those who died from toxæmia 7 had a positive blood culture, and 3 gave a positive blood Wassermann reaction.

In addition to the toxæmia 2 of the cases had pneumonia migrans and one of those who was also the youngest of those who died, had enteritis.

Also there were 3 cases who showed a more than moderate degree of anoxaemia in addition to the toxæmia.

The average residence in hospital of those cases who died from toxæmia was 4.1 days and of those who died of cardiac failure one was in 3 days and the other 5 days. The case in whom anoxaemia was marked lived 4 days after admission.

Of the Group iv cases 3 died of toxæmia followed later by cardiac failure and one of those had an empyæma on admission. The average duration of stay of those cases

was 2.5 days. One case died from anoxaemia with later cardiac failure and another from cardiac failure with some degree of toxaemia.

When the figures of the various types are compared it is found that the Group iv cases had the shortest residence in hospital with an average of 2.9 days as compared with 4.1 days for Type ii and 5.16 days for Type i. But when the histograms in Figs. IV and IX are examined it is seen that whereas Type ii kills heavily in all the age groups, Type i is most severe in the older men, especially on the middle-aged man, whilst Group iv affects more severely the younger and older age groups.

From the above it seems indicated that the Type ii cases are examples of an infection by a very virulent organism which is particularly deadly on account of its greater toxicity, which kills patients of all ages. Type i and Group iv are apparently less virulent and are of danger only to those in whom resistance has been lowered.

In a few of the cases it was considered that in addition to the physical causes of death enumerated in the preceding pages, another factor was involved and this was almost completely outwith control by the physician. This was a lack of spirit or will to get well on the part of the patient. This may have been an expression of the personality of the patient or it may have been a symptom of disordered cerebral metabolism consequent upon the infection. In addition to the personality factor 2 of the cases exhibited a considerable degree of anoxaemia which might be responsible for disordered metabolism. There was one such case in each of the type groups.

Post mortem examination was carried out on 5 occasions. There were 4 cases of Type ii pneumonia and 1 case of Type i pneumonia. In each instance the infecting organism was obtained from a portion of the affected lung and also from the spleen. Pneumonia migrans was found in each case, the affected lobes being at different stages of the disease. In two of the Type ii cases the affected lung was bound down firmly to the chest wall by very tough adhesions. The liver was slightly enlarged in 3 of the Type ii cases. The Type i case showed some enlargement of the heart with a left-sided pleurisy with effusion, small in amount, and with numerous adhesions. Pneumonia migrans was present and both the liver and spleen were enlarged.

No macroscopical abnormalities were noted in the suprarenal glands.

No definite conclusions can be reached on account of the small numbers, but the cases examined did not indicate any pathological differences between Type i and Type ii infections.

V. 19. Bacteraemia.

Glynn and Digby⁽¹⁾ (p. 101) give an informative table with regard to the positive blood culture of pneumococci from cases of pneumonia. The statistics are compiled from a large number of writings during the period 1901-1923 with a total of 1499 patients of whom 45.3 per cent. gave positive blood culture. The average mortality of those from whom pneumococci were grown was 58.8 per cent. The individual results varied greatly but the results are not strictly comparable since in some of the groups repeated cultures were made, whereas in others the results are based on single cultures.

Boyd⁽²³⁾ (p. 163) gives the incidence of positive blood

culture as 27.8 per cent., with a mortality of 67.1 per cent. Osler⁽³⁾ (p. 197) states that pneumococci can be grown from the blood in about a third of all cases and are most easily obtained at the height of the fever.

All these authorities agree that the finding of bacteraemia is of bad omen and Glynn and Digby⁽¹⁾ (p. 103) add to this that the nearer crisis that a positive culture is obtained the worse the prognosis.

TABLE 41.

To illustrate Bacteraemia.

Type	Cases + B.C.	% of Type Total	% of + B.C.	Deaths	% Mortality.	Cases Neg. B.C.	Deaths	% Mortality.
<u>i</u>	17	28.3	41.45	2	11.76	43	4	9.3
<u>ii</u>	18	23.07	43.9	9	50.0	60	5	8.3
<u>iii</u>	1	50.0	2.43	1	100.0	1	0	0
<u>iv</u>	5	16.12	12.19	2	40.0	26	3	11.5
Total	41		100	14	34.14	130	12	9.23

From this table, which relates to the present investigation, it is seen that bacteraemia was proved in 41 cases, or 23.97 per cent., with a case mortality of 34.14 per cent. Of the 130 cases with a negative blood culture 12 died, which is a case mortality of 9.23 per cent. These figures are comparable to those of other workers and they demonstrate vividly the value of blood culture in prognosis.

With regard to the different types it is seen from the table that though organisms were grown from a greater proportion of Type i cases, the mortality of those cases was much less than that of the Type ii and Group iv cases. This suggests that though there were greater numbers of organisms more frequently in the blood in Type i infections the viru-

lence of those organisms was slight as compared with Type ii and Group iv where the mortality is 50 per cent. and 40 per cent. respectively as against 11.76 per cent. in Type i. These figures would appear to support the contention made elsewhere that Type ii is the more virulent organism; or it may be that the type of pneumococcus identified as Type ii is found in those patients whose resistance is minimal.

If, however, the person infected by Type ii is able to put up some fight the infection is dealt with just as successfully as in Type i and in support of this are the figures of those from whom no organism was grown. The Type i group is here seen to have a case mortality of 9.3 per cent. as against 8.3 per cent. for Type ii.

The figures for Group iv are small and they show that few Group iv patients, 16.12 per cent., had sufficient organisms in the blood to enable growth to be obtained. The mortality of those who had, was heavy, being 40 per cent., which is slightly less than that for the Type ii cases. The mortality of those with negative blood culture is higher than that for the Type i and Type ii cases; this is probably explained by the fact that those deaths occurred in men over 45 years. When age incidence was considered it was found that there were 10 Type i cases below 35 years with bacteraemia and no deaths, whereas there were 12 Type ii cases with 6 deaths below this age. Above 35 years there were 7 Type i and 6 Type ii cases with 2 and 3 deaths respectively. Of the 5 Group iv cases below 35 years there were 2 who died.

The details are shown in the following table.

TABLE 42.

To illustrate Incidence of Positive Cultures and Deaths.

Type		-19	24	29	34	39	44	49	54	59
<u>i</u>	Cases	4	1	3	2	4	1	1	-	1
	Death					2				
<u>ii</u>	Cases	2	4	3	3	2	-	1	1	2
	Death	2	2	1	1	-	-	1	1	1
<u>iv</u>	Cases	1	2	1	1					
	Death	1	-	1	-					

From the foregoing it would appear that when pneumococci are grown from the blood the prognosis is less hopeful, but in the case of Type i this only obtains in patients over 35 years whereas in Type ii cases the outlook is bad no matter what the age. Also it is probable that bacteraemia in Group iv is of bad prognostic value but the figures are not sufficient to allow of any definite statement.

The effect of bacteraemia on the day of admission has been already discussed, as has also the relationship between site of consolidation and bacteraemia. In later chapters various other aspects will be considered, such as the relationship between bacteraemia and the onset of complications, and the effect of bacteraemia on the duration of illness.

Osler⁽³⁾ (p. 197) states that it is now customary to regard pneumonia as a general pneumococcus infection with a local lesion in the lung. Bourne and Stone⁽²⁵⁾ (p. 21) state that the pneumococcus is present in the blood stream in smaller or greater numbers throughout the disease and that positive findings are made more frequently on the 5th day than on any other. As shown elsewhere in the chapter on Day of Admission, the positive blood cultures in this series were made more frequently in the 2nd, 3rd, and 4th days and the tendency was to find bacteraemia earlier in the Type ii cases than in the other Types.

There appears to be some doubt as to the mode of entrance of the organism into the blood stream and in one of the Medical Research Council's publications⁽⁷⁾ (p. 164 et seq.) three possible methods are suggested. Boyd⁽²³⁾ (p. 147 et seq.) quoting the work of Blake and Cecil (1920) gives a lucid and rational description of the pathogenesis of pneumonia. He describes how a virulent organism having been introduced into the trachea, was found in the blood 6 to 24 hours later, having reached there by means of the lymphatics.

Meantime the interstitial tissue of the lung had been invaded via the walls of the bronchi.

The infection spread along the interstitial framework of the lung until finally the alveoli were invaded. The infection is centrifugal and the older part of the process is usually at the hilum and the more recent part towards the periphery. An explanation such as this seems to explain all the phenomena found in a case of lobar pneumonia. The patient becomes inoculated, and probably auto-inoculated on occasion, with the organism which if he cannot overcome spreads down the respiratory tract and having invaded the wall enters the lymph stream. Thence it spreads to the blood stream, continues to thrive, and so the stage is set. The rigor, headache and vomiting indicate that the organism has won the first round and the patient as a rule retires to bed. The organism continues to thrive as is shown by the figures in Table 23, Chapter V, 10, where the incidence of positive blood cultures is high from the 1st to 5th day. Meantime the cocci have been spreading rapidly in a wave along the interstitial tissue of the affected lung and soon reach the periphery where the pleura becomes involved and then pain as a symptom appears. Congestion and consolidation follow upon the invasion of the alveoli and the disease then runs its course.

Osler⁽³⁾ (p. 195) and Gaskell⁽²⁶⁾ suggest that the chief toxin of the pneumococcus is an endo-toxin which is only set free on the death of the organism. But since the toxin formed in the local lesion in the lung must be almost completely shut out of the circulation by the mechanical pressure on the capillary walls by the distension of the alveoli filled with exudate⁽⁷⁾ it seems probable that the toxæmia may be due, in combination with other factors, to an increasing amount of toxin being set free as the body builds up its defences and becomes capable of dealing with the invaders in the blood. The other factors in the causa-

tion of the toxæmia are probably the upset in the general metabolism and the onset of anoxæmia.

V. 20. Effect of Constitutional Disturbances.

The effect of constitutional deficiency upon the reaction of the body to infection has already been touched upon in previous chapters (Housing, etc.), but in order to produce some definite figures more illustrative of this point other aspects of such deficiency were considered and accordingly the results of Wassermann tests were considered and the clinical history of each case with a positive reaction was scrutinised.

There were 14 cases, or 8.18 per cent., of the total who showed some reaction to the Wassermann test upon the blood. They were classified, \mp , ++, +++ as reported by the Public Health Department. The Type i group showed 4 such cases, the Type ii group 9 cases and the Group iv one case, thus:-

TABLE 43.

To illustrate cases with Positive Blood Wassermann.

Type	+ Wass.		Pos. Bl. Cult.		Prev. Atts.		Acute Onset.			Subacute Onset.		
	Cases	Death	Cases	Death	Cases	Death	Cr.	Lys.	Death	Cr.	Ly.	Death.
<u>i</u>	4	1	-	-	2	-	-	-	1	3	-	-
<u>ii</u>	9	3	4	2	2	-	2	4	3	-	-	-
<u>iv</u>	1	-	-	-	1	-	1	-	-	-	-	-

From the figures it is seen that a positive reaction was most frequently found in cases with a Type ii infection. Is this further evidence that the Type ii organism is to be found in the less resistant, or is it due to patients who have been weakened by their luetic infection falling a prey

more easily to the more virulent organism. Whatever the explanation the figures show that a Type ii infection in a man with syphilis is of grave import for 3 cases died and 4 had an infection sufficiently heavy to enable organisms to be grown and of those 2 succumbed. Also, all the Type ii cases were stricken suddenly by this probably virulent invader and of the 9 cases 4 settled by lysis, which as has been stated previously is taken to indicate a slowly developed resistance. 3 died before this had developed and only 2 settled by crisis, indicating a rapidly developed resistance.

3 of the Type i cases took ill more slowly but one took ill suddenly, failed to overcome the infection, and died. The 3 who were more slowly invaded by the infection ultimately built up a resistance rapidly and settled by crisis.

The solitary Group iv case had an acute onset and settled by crisis.

Generally the Type i and Group iv cases were acutely ill, one of the Type i cases was very acutely ill and the Type i case who died was the oldest of this Type i group. He was sharply ill and pneumonia migrans occurred and he died ultimately of exhaustion. Four of the Type ii cases were desperately ill, 2 were very acutely ill and 3 were acutely ill. Of the cases who died, 2 had a positive blood culture and the other had endocarditis and pneumonia migrans. 2 cases were young men and the other was middle aged so that the factor of age played little part.

The figures would appear to indicate that such patients are more prone to repeated attacks of pneumonia for as will be shown elsewhere although 25 per cent. of the total cases had had previous attacks 35.7 per cent. of the luetic patients showed this complication. This disproportion was more marked in the case of the Type i infection where 2 out of 4 cases had been previously infected as compared with

the average figure of 18.9 per cent. for Type i infections without concurrent lues. Of the 9 Type ii cases 22.2 per cent. had had a previous attack of pneumonia as compared with the average figure of 25 per cent. for the Type ii cases without syphilis.

The duration of residence in hospital might also be used as an indicator of the degree of resistance.

TABLE 44.

To illustrate residence in hospital of cases with Positive Wassermann.

Type	i.	ii.	iv.	Av.	Days.
Residence of case	18.6	23.5	20.0	21.7	
Death	12	4.3	-	6.2	

Thus it is seen that the Type i case overcame his infection and recuperated much more rapidly than the Type ii case. There was only one Group iv case and he was in hospital 20 days.

Also the average Type i case who died resisted the infection much longer than did the Type ii case who succumbed, which would appear to be evidence of the greater virulence of Type ii.

Résumé.

The presence of a syphilitic infection darkens the prognosis and this is especially true in the case of a Type ii infection. The chances of recovery are even more reduced if the infecting pneumococcus can be grown from the blood. Patients with lues appear to be more prone to pneumonia but the prognosis is but little different from the ordinary case. And finally of the patients who recover, those with a Type ii infection are longest incapacitated.

V. 21. Behaviour of the White Blood Cells.

(In the early part of the investigation, leucocyte counts were carried out daily in each case and in some cases red cell counts and a haemoglobin estimation were also done. 18 cases were examined thus until the writer sustained a macular haemorrhage in the right eye. On the advice of an ophthalmologist microscopical work was reduced to a minimum and eventually it was deemed prudent to waive this part of the investigation).

Osler⁽³⁾ (p. 216), Boyd,⁽²³⁾ (p. 163) and many other writers stress the fact that a polymorphonuclear leucocytosis is encountered in lobar pneumonia. If it fails to materialise the prognosis is bad and if it is prolonged after the crisis a complication should be suspected and a search made. A poor leucocyte response is evidence of a poor resistance or of a very heavy infection.

A red cell count was carried out in a few cases with results which ranged from 4,500,000 to 5,600,000 per c. mm. The haemoglobin estimation by Sahli's method revealed figures which varied between 95 per cent. and 110 per cent. Insufficient examinations were carried out to enable comparisons to be made between the various types but it seems indicated that anaemia is not a factor in pneumonia.

Leucocyte Counts. The figures dealt with are small but they would appear to confirm various hypotheses already advanced.

An average chart was made of the leucocyte curves for the various types. See Fig. XVII. That of the Type i cases shows on the 3rd and 4th days a leucocytosis around 18 and 19 thousand cells per c.mm. Thereafter the curve rises slowly to a figure around 20 to 21 thousand on the 7th day and from there falls in an irregular fashion. The

general curve shows a fairly regular plateau with a slight rising slope from left to right.

The average Type ii curve shows a marked leucocytosis around 20 to 21 thousand cells per c.mm. on the 3rd and 4th days with a sharp fall on the 5th day to around 14,000 per c.mm. Thereafter the curve rises regularly to around 18 thousand on the 11th day and from that point falls away.

The Group iv curve shows a high leucocytosis on the first 4 days with a fall on the 5th followed by a slightly irregular curve to the 12th day tending slightly downward, and varying between $15\frac{1}{2}$ and 18 thousand.

These figures have the drawback that they are compiled from too small a series and consequently any deduction made can only be tentative.

Blood counts were done in one Type i case with a positive blood culture and in this, the leucocytosis developed very slowly from 13,000 on the 3rd day to 21,000 on the 8th day and 29,400 on the 10th when lysis took place. There was also a Type ii case with positive blood culture, admitted on 3rd day with a leucocyte count of 21,000 which thereafter fell to 16,000 on the 5th day but from there rose to 24,400 with lysis on 8th day.

Examined as a whole such figures suggest that the body reacts efficiently to the Type i infection but where the blood infection is heavy, this defence takes longer to develop.

Against the Type ii infection the body reacts strongly at first but as the virulent organism proliferates the body resources fail for a time and if it does not succumb, eventually manages to marshal its forces and suppresses the invader, the rise in defensive power apparently being associated with a rapidly developing leucocytosis. The Group iv cases react in a manner similar to those infected by Type i with the difference that the reaction is not quite so marked as judged by the degree of leucocytosis.

V. 22. The Effect of Bronchitis.

Osler⁽³⁾ (p. 229) points out that there is almost constantly some degree of bronchitis in pneumonia and that it may be difficult to decide whether it is a complication or a part of the disease, whilst Boyd⁽²³⁾ (p. 135) states that bronchitis may be a complication of pneumonia. Various other writers of textbooks mention the possibility of a concurrent bronchitis but no further information is advanced.

In the course of this investigation it was noted that those cases with bronchitis suffered more severely. The cases included under the heading of bronchitis were those who on admission had present in the non-pneumonic lung persistent medium or small râles. Pratt and Bushnell⁽²⁷⁾ (p. 161) indicate that such cases of bronchitis are the more serious, and consequently it was decided to use the term bronchitis only in those cases which showed medium and small râles. In the cases which showed coarser râles it was thought possible that the condition was consequent upon the pneumonic infection.

TABLE 45.

Table to illustrate Bronchitis.

Type	Bronchitis.		+ Bl. Cult.		Prev. Atts.		Card. fail.	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
<u>i</u>	29	5	7	2	4	-	15	5
<u>ii</u>	46	12	11	7	16	4	19	9
<u>iii</u>	2	1	1	1	-	-	1	1
<u>iv</u>	15	2	3	1	3	-	3	1
	92	20	22	11	23	4	38	16

There were 92 cases, or 52.8 per cent. of the series, who showed evidence of bronchitis, 20 of those died, which is a case mortality of 21.73 per cent. There were 79 cases with-

out bronchitis and of those 6, or 7.6 per cent., died.

With regard to the various groups, it is seen that Type ii showed the greatest number with bronchitis and also had the greatest mortality, 26.1 per cent. as compared with 17.2 per cent. and 13.3 per cent. for Type i and Group iv respectively.

From the table it is seen that 22, or 23.9 per cent., of the cases who had bronchitis also had a positive blood culture and of those 11, or 50 per cent., died. There were 41 cases with a positive blood culture in the complete group so that there were 19 cases with a positive blood culture and no bronchitis and of those 3, or 15.78 per cent., died. Therefore it would appear probable that people with bronchitis, when infected by the pneumococcus, receive a much heavier infection and are much more easily overcome. Or it may be that bronchitic patients are more liable and less resistant to infection by the pneumococcus.

When the various types are considered it is again found that Type ii shows the greatest figures with regard to case incidence and mortality. Half of the cases with bronchitis who had a positive blood culture were Type ii and of them the mortality was 63.6 per cent., which is much in excess of the 28.5 per cent. case mortality of the Type i cases and 33.3 per cent. of the Group iv cases, and thus it would appear that patients with bronchitis when heavily infected by Type ii have a very poor chance of recovery.

The other figures in the table indicate that of the cases who had bronchitis 23, or 25 per cent., had been previously infected by the pneumococcus and the case mortality of those was 17.39 per cent. There were 43 cases with 4 deaths in total figures who had previous attacks of pneumonia, and thus it is seen that there were 20 cases who had not bronchitis but had been previously infected. It would appear that the presence of bronchitis affects but little the chances of repeated in-

fection by the pneumococcus but when such a case is reinfected the prognosis is darkened considerably. The great bulk of the cases with bronchitis who had been previously infected were Type ii and of these 25 per cent. died. Also of those Type ii cases, 5, or 31.2 per cent., had a positive blood culture with 2 deaths. It therefore seems indicated that when a person with bronchitis becomes reinfected, this reinfection is heavy and is most often the result of Type ii organism, and in such cases the prognosis is none too good.

Another important aspect of bronchitis in pneumonia is to be found in the consideration of cardiac failure. Of the 98 cases with bronchitis 38, or 38.7 per cent., showed evidence of cardiac failure and 16, or 42.1 per cent., of those cases died. Once again it is found that Type ii cases showed the greater numbers, for half of the cases with cardiac failure were Type ii although the Type i group also showed a high incidence of cases. Almost half of the Type ii cases and a third of the Type i cases died. On making reference to the total figures it is seen that there were only 6 deaths altogether in the Type i group, so it may be assumed that bronchitis is an important factor in this failure of the heart and apparently the main contributory cause of death.

Of the 38 cases with cardiac failure 16 had a positive blood culture, of whom 10, or 62.5 per cent., died. That cardiac failure is common when the combination of bronchitis and positive blood culture occurs is seen in the following table.

TABLE 46.

Cases who had Pneumonia + Bronchitis

and Type	(1)		(2)	
	Pos. Bl. Culture.		Pos. Bl. Cult. + Cardiac Failure.	
	Cases	Deaths	Cases	Deaths.
<u>i</u>	7	2	6	2
<u>ii</u>	11	7	8	6
<u>iii</u>	1	1	1	1
<u>iv</u>	3	1	1	1
	22	11	16	10

In conclusion it would appear that the presence of bronchitis in a patient infected by the pneumococcus is of considerable importance for such cases seem to suffer from a heavier infection and almost half of them show cardiac failure which was present in 75 per cent. of the cases who died. Bronchitis seems to be especially important as a cause of death in the Type i cases since 5 out of the 6 deaths in the Total Type i group had bronchitis and each of those cases displayed cardiac failure. Also 12 out of the total 14 Type ii cases who died had bronchitis, and cardiac failure was noted in 9 of them.

Why should the presence of bronchitis exert such an influence on the outlook of a case of pneumonia?

As the figures show more than half of the present series had some degree of bronchitis. This high incidence is probably dependent on the type of patient involved, the majority of whom came from unhygienic surroundings and worked in conditions which probably predisposed to the occurrence of tracheo-bronchitis. Also a quarter of the cases had had pneumonia previously and such cases are always liable to show some resultant bronchitis. The probable result of this chronic bronchitis is that the afflicted person carries about with him numerous organisms, most probably including a large number of pneumococci, in his respiratory tract. The virulence of such organisms is probably low, but the resultant inflammation produces changes of importance. The mucosa is congested and infiltrated and in the more severe cases all the coats of the bronchi may be infiltrated with polymorphonuclear leucocytes, Boyd⁽²³⁾ (p. 136), and there may be proliferation of the connective tissue cells. Muir⁽²⁸⁾ (pp. 103, 302). This infiltration, etc., must interfere with the blood vessels to some extent with resultant circulatory disturbances. If this condition is extensive a considerable load must needs be placed on the right heart and so when a pneumonia is superimposed on this condition it is not surprising that cardiac failure results. Also the

mucous membrane of the bronchi is covered with an exudate, mucoid and stringy, and occasionally purulent, which will further embarrass the respiration of the patient with pneumonia and augment the cyanosis and dyspnoea and continue the vicious circle.

V. 23. Changes in Blood Pressure.

Osler⁽³⁾ (p. 209) says that there is considerable daily variation in the blood pressure although the general tendency is towards a fall. This is taken to refer to the systolic pressure for no mention is made of the diastolic pressure. Osler and McCrae⁽²⁹⁾ (p. 89) reaffirm the above and add that a progressive fall indicates the need of stimulation and also that the crisis has no effect on the blood pressure. The results obtained during the present work are slightly at variance with the above, for the crisis was bound to be associated with a change in the pressure curves, both systolic and diastolic, and also a progressive fall of the pulse pressure was present in almost every case no matter what the severity.

Gibson⁽³⁰⁾ (p. 17) formulated a law in which he said that as long as the systolic pressure in millimetres of mercury exceeds the number of pulse beats per minute, the prognosis should be regarded as favourable, and vice versa. Numerous cases in this series did not confirm to this, although there were occasions where application of the rule proved of value.

Taken generally, although there were a number of exceptions, the findings during the investigation suggest that in the ordinary case of lobar pneumonia a definite curve is present, both in the systolic and diastolic pressures. When an ordinary case was admitted moderately early in the illness and not prostrated by the removal to hospital, it was found during the course of the fever that there was a fall in the systolic

pressure accompanied by a rise in the diastolic pressure; i.e., the pulse pressure became progressively smaller. These changes continued until the day of the crisis, although in a few cases the minimum pulse pressure occurred the day before or the day after crisis. After this event the systolic pressure rose slowly and the diastolic subsided, with occasional irregularities in the systolic line, until the approximate normal for the patient was reached. The smoothness of those curves was occasionally marred by sudden rises or falls which were usually found to herald the onset of some complication and in a number of the cases this alteration in the regularity of the blood pressure curve was the first indication that something was amiss. It would appear, therefore, that there is to be found in accurate readings of the blood pressure warning signals of particular value, not only with regard to the ordinary progress of the case but also as regards the onset of complications. Thus in the progressive fall in the systolic pressure there may be an indication of the degree of toxæmia, for toxins of the specific fevers act upon the vasometer centre and induce paresis and also act directly upon the myocardium itself. Halls Dally⁽³¹⁾ (p. 200). Also the fall in the systolic pressure may be taken as an indication of the degree of respiratory deficiency and decreased oxidation. Halls Dally⁽³¹⁾ (pp. 128, 43, 201). The rise in the diastolic pressure indicates the increasing load on the heart and the diminishing pulse pressure a sign of failing circulation. In 3 cases who had relapses whilst in the ward it was found possible to observe the course of the illness from the day of onset. (See Chart A). In those cases it was found that there was a slight rise in the systolic pressure and a slight fall in the diastolic for a day or two and then as the disease progressed the systolic pressure fell and the diastolic rose.

It is probable that this is the usual run of events but since cases are not admitted to hospital until the illness has progressed for a few days, the daily examination only shows

the final part of those blood pressure changes.

When an attempt is made to explain those variations, the way is beset with difficulties. The early rise in systolic and fall in diastolic pressure noted in the case just quoted suggests toxæmic shock as described by McDowall⁽³²⁾ (p. 144) and Ritchie⁽³³⁾ (p. 87 et seq.). McDowall points out that although the capillaries may be dilated as a result of toxic action, the arteries at the same time may be contracted, and quotes Zachary Cope in saying that the first stage in surgical shock may be a rise in blood pressure. McDowall also states that certain toxins have an action on the suprarenals and cause adrenaline to be secreted, and Wright and Vincent⁽³⁴⁾ (p. 104) show that the cortex of the suprarenal attends to the neutralisation of toxins. The exhibition of therapeutic doses of adrenalin during the investigation did not alter the blood pressure variations markedly, and the histological examination of a number of suprarenals removed at post mortem examination showed no abnormalities. Dr. Reynolds of Stobhill Hospital, to whom I am indebted for the reports, carried out these histological examinations. This negative histological evidence is of little import, however, since any biochemical changes which might have been present in life need not be accompanied by any alteration in histological structure.

Wright and Vincent⁽³⁴⁾ (p. 106) also state that small doses of adrenin may cause a definite fall in blood pressure. It may be, therefore, that after the initial response by the suprarenal to the intoxication, the amount of adrenalin secreted diminishes with a resultant fall in pressure.

The explanation of those alterations in pressure is probably not so straightforward as thus described, for various other factors may influence the pressure. For example the CO₂ content of the blood has definite effects and in pneumonia asphyxia must play some part, in varying degree. Remembering this it may be possible to explain the rise in pressure which

occurs with the onset of cardiac failure, since any tendency to asphyxia will be increased if the blood supply to the higher centres is diminished, with a consequent rise in pressure.

Four specimen charts are appended.

Charts A, B, C, and D are copied from cases treated in the ward.

Chart A is that of a man who had a relapse whilst in the ward. It illustrates points to which reference has already been made; e.g., the approximation of the systolic and diastolic pressures which is most marked around crisis and the separation of the curves thereafter. It also shows excellently the chart of a lobar pneumonia from onset to crisis.

Chart B illustrates the rise in systolic pressure accompanying heart failure and persistent hiccough. It is seen that the systolic pressure was raised on the 7th day and continued to rise until the 9th day when cardiac failure was marked. Hiccough was very distressing and not completely controlled until the 10th day. The heart dilated and the urinary output fell during the 7th, 8th and 9th days and the patient's condition gave rise to a considerable amount of anxiety. As he responded, however, it is seen that the systolic and diastolic curves approximated and thereafter separated as he recuperated.

Chart C was that of a youth who developed a pneumonia migrans. The involvement of a fresh lobe was detected on the 7th day but it will be seen that the pressure curves had varied slightly on the day before.

Chart D shows the steady rise in the systolic pressure accompanying the rise in temperature, pulse and respirations which ended ultimately in death. This chart is illustrative of the type of case which almost certainly was harmed by removal to hospital so late in the disease. It is probable that the patient would have died at home but his chances of recovery would have been greatly enhanced if he had been ad-

mitted earlier in his disease.

It is not to be expected that the different types should affect the blood pressure curves, beyond the fact that any variations in the curves will probably be the expression of the degree of response on the part of the body to the varying virulence of the different organisms.

The theoretical blood pressure, systolic and diastolic, was worked out for each patient and it was found that on admission the systolic pressure was below the theoretical figure for the patient's age in 78.2 per cent. of the Type i cases, 80.9 per cent. of the Type ii and 83.3 per cent. of the Group iv cases. 12.5 per cent. of the Type i cases and 14.2 per cent. of the Type ii cases had a diastolic pressure higher than the theoretical value for the age. The pulse pressure fell to the crisis in 81.8 per cent. of the Type i cases and in 66.6 per cent. of the Type ii cases. In 12.5 per cent. of the Type i cases the pulse pressure rose to the crisis, either on account of rising systolic pressure or falling diastolic. Almost 50 per cent. of those cases died and another of them developed an empyaema.

23.8 per cent. of the Type ii cases showed a pulse pressure which rose to crisis and again the large proportion of those cases died.

In a few of the Type ii cases, the pulse pressure at crisis was higher than on admission but on inspection it was seen that this was on account of the curves separating as a result of some complication and later approximating at crisis, but the pulse pressure did not diminish to such a marked extent as in the non-complicated case.

Approximately 20 per cent. of the Group iv cases showed the systolic pressure below the theoretical value on admission and almost three quarters of the cases showed the pulse pressure falling to crisis. Of the cases which showed a rising pulse pressure the majority died.

Taken generally, the cases which died showed in the great majority a rising pulse pressure, most usually the result of a rising systolic pressure. The presence on admission of a pulse pressure higher than the theoretical for the age is of some importance since it was found that over 30 per cent. of such cases died as compared with 10 per cent. of the others who had a pressure lower than the theoretical for their age.

From the foregoing it would appear that regular observation of the blood pressure affords information valuable both in prognosis and treatment, but of little value as regards differentiation of the types. This latter statement can be qualified, however, by stating that the daily observations of the blood pressure may indicate those cases of greater severity which in the majority of instances are Type ii in origin.

V. 24. The Incidence of Previous Attacks of Lobar Pneumonia.

Various writers refer to the frequency of recurring attacks of pneumonia. Osler and McCrae⁽²⁹⁾ (p. 79) give figures of different observers, some showing the incidence of recurrence as high as 50 per cent., but with an average of 26.8 per cent. Osler⁽³⁾ (p. 251) states that the mortality in such cases is lessened, and this is especially so in those cases who have had more than one previous attack.

25.1 per cent., or 43, of the present cases gave a history of previous attacks, and 4, or 9.3 per cent., died, which is much lower than the average case mortality of 15.1 per cent. of the total figures. 13, or 21.6 per cent., of the Type i cases, 21, or 26.0 per cent., of the Type ii cases, and 9, or 29 per cent., of the Group iv cases gave a history

of previous infection.

The case mortality is shown in the following table:-

TABLE 47.

To illustrate cases with Previous Attacks.

Type	Cases with previous attacks.	% of Type Total	Cases with Previous attacks.		MortY. % of Type Total	Cases not previously infected.		
			Deaths	MortY. %		Cases	Deaths	MortY. %
<u>i</u>	13	21.6	1	7.6	10	47	5	10.6
<u>ii</u>	21	26.0	3	14.2	17.94	57	11	19.2
<u>iv</u>	9	29.0	0	0	16.12	22	5	22.6
	43	25.1	4	9.3	15.12	126	21	16.6

Thus it is seen in each Type the death rate of those who had previous attacks is less than the rate for each type total, which is included in the table for the purpose of comparison.

The case mortality is also shown of those cases in each Type group who had not been previously infected. From this it is seen that the chances of recovery are much better in those who have been previously affected and this is most marked in the Group iv cases. Type ii, however, even in reinfected cases, is an infection of some severity.

TABLE 48.

To show the number of previous attacks per patient.

Type	1	2	3	4	5	6		Number of previous attacks.
<u>i</u>	10	1	1	-	1	-	13	
<u>ii</u>	16	2	1	1	1	-	21	
<u>iv</u>	7	-	1	-	-	1	9	
	33	3	3	1	2	1	43	

The above table shows that one Group iv case had had as many as 6 previous attacks and that there were 2 cases, one Type i and one Type ii, who had had 5 previous attacks. The greater proportion of those cases who had been previously infected had only one previous attack.

11, or 25.5 per cent. of the 43 cases who had been previously infected, had positive blood cultures which indicates that it is possible to have a heavy infection despite a previous attack. Only one of those cases died, however.

Of the 43 cases who had been previously infected 17, or 39.5 per cent., developed pneumonia migrans, which is a much higher incidence than prevailed in those cases who had not had previous attacks. There were 128 such cases with an incidence of 31, or 24.7 per cent., who developed pneumonia migrans. Thus it appears that a spreading pneumonia is more common in a patient who has had a previous infection. Also it is this complication which accounts for the majority of the deaths in those who have had a previous infection. 3 out of the 4 deaths occurred in the 17 cases who developed pneumonia migrans whilst only 1 case died out of the 26 who did not develop this complication.

As has been noted in another chapter 5, or 11.6 per cent., of the cases who had a previous infection also gave evidence of syphilis. There were 2 in the Type i group, 2 in the Type ii group, and one Group iv and none died, so that although constitutional disturbance apparently plays a part in exposing the patient to repeated attacks, it does not lower the resistance to any great extent in those who have been previously affected.

Résumé.

An attack of pneumonia does not confer immunity. A history of recurrent attacks was more common in Group iv cases and least common in Type i cases. The case mortality is lower in cases who have had a previous attack, but even in such cases, Type ii is dangerous. Pneumonia migrans is common in cases who have been previously infected and is the most frequent cause of death in

such cases. And despite a previous attack the infection can be heavy enough to enable organisms to be grown from the blood.

V. 25. Complications.

Any condition attributable to infection of the tissues by the pneumococcus which appeared during the course of the fever or during convalescence was considered a complication. The organism was sought for in any discharge such as from an abscess or from an empyaema and also in smears from a corneal ulcer. In the majority of cases also, the serological type of the organism was ascertained. Pneumonia migrans was the most common complication but this has been dealt with fully in an earlier chapter.

TABLE 49.

To illustrate the incidence of complications.

	Type i.		ii.		iv.		Total.		A.%	B.%
	Cases	%	Cases	%	Cases	%	Cases	%		
Empyaema	3	5			1	3.2	4	2.36	2.2	6.5
Pericarditis	3	5					3	1.75	1.2	0.6
Endocarditis	1	1.6			1	3.2	2	1.17	0.44	0.4
Laryngitis	2	3.3	1	1.3	1	3.2	4	2.34		
Phlebitis	1	1.6					1	0.58	0.72	0.5
Enteritis	1	1.6	2	2.6			3	1.75	1.08	
Meningismus	1	1.6					1	0.58		
Furunculosis			2	2.6			2	1.17	2.10	
Corneal ulcer			1	1.3			1	0.58		
Abscess			1	1.3			1	0.58		
Cellulitis					1	3.2	1	0.58		2.8
Arthritis			2	2.6			2	1.17	0.5	0.9
Tonsillitis			4	5.2	2	6.4	6	3.51		
Cervical adenitis			1	1.3			1	0.58	5.4	
Glossitis			1	1.3			1	0.58		
Impetigo			1	1.3			1	0.58		
	12	20	16	20.5	6	19.3	34	19.88		

In the right hand column

A = Osler (3), p. 228 et seq.

B = Cecil and Plummer (2), p. 1548 et seq.

The % columns refer to the respective type totals.

There were 3 cases of Type i and 1 case of Type ii who showed B. tuberculosis in the spit during convalescence.

The pleurisy which occurred during the course of the illness is not included in this table.

There were 10 cases, or 5.84 per cent., who complained of pain in the affected side during the period of resolution. In the majority of the cases this was ascribed to the stretching and breaking down of the pleuritic adhesions consequent upon the pleurisy accompanying the pneumonia. There were 5 such cases in the Type i group, 2 in the Type ii and 1 in the Group iv group. The remaining 2 cases, one Type i and one Group iv, developed definite friction rub 14 and 17 days respectively after the temperature had settled. Both cases cleared rapidly under treatment.

Jaundice and albuminuria were not classed as complications but looked upon as symptoms of the pneumonia.

From the table of figures it is seen that out of the total 171 cases 19.88 per cent. showed some complication and that Type ii cases were involved very slightly more frequently than Type i and Group iv cases. Type i and Group iv showed fewer instances but were comparatively equal as regards incidence. The figures of the present series are similar to those of other observers.

The occurrence of empyaemata appears to vary considerably for in the present series the incidence was 2.36 per cent. as compared with 2.2 per cent. of Osler⁽³⁾, 6.5 per cent. of Cecil and Plummer⁽²⁾, and 20.8 per cent. of Abrahams⁽²²⁾. The high incidence in Cecil and Plummer's figures is probably due to the fact that their cases were all Type i. This connection between Type i and empyaemata will be discussed later.

Meningitis did not occur in the present series whereas tonsillitis and laryngitis were relatively frequent but are not mentioned by other writers as occurring with any frequency. When the figures in the table are examined it is seen that the bulk of the Type i complications involve tissues adjoining the medias-

tinum, and when they are considered from another aspect it is seen that the tissues involved are mostly mesoblastic in origin, whereas the Type ii cases are much more scattered and tend more to involve epithelial surfaces, or tissues epiblastic or hypoblastic in origin. The Group iv complications are not confined to any one particular area. Gaskell⁽²⁶⁾ in his studies of experimental pneumonia found that if a large dose of pneumococci was administered to the animal, lobar pneumonia did not result but the thoracic cavity was involved in an extensive inflammatory process, with resultant pleurisy, pericarditis, etc.

On analogy with the above if a patient acquires a very heavy infection the result will depend on the type of infecting organism. If it is Type ii, the probability is that he will die (cf. figures in chapter on Bacteraemia); if it be the less virulent Type i he may manage to hold his own but as a result of the high degree of infection the various surrounding cavities and organs become involved in much the same way as happened in Gaskell's experiments in animals.

If this is true, those Type i cases with complications should show a greater prevalence of bacteraemia. On referring to the figures this is confirmed, for 7 of the 12 Type i cases with complications had a positive blood culture as compared with 3 of Type ii cases and 2 Group iv cases. A possible explanation of the complications of Type ii cases affecting the epithelial surfaces may be that the general defensive powers of the body have been greatly lowered in dealing with the severe infection. This will lay the tissues open to any chance infection, and the epithelial surfaces will be more often involved since they are more exposed to minor traumata and infection.

Digressing from the main argument for a moment, and considering, from another angle, the greater frequency of empyaemata, etc., in the Type i infection, it is possible that these may act in a manner similar to the old fashioned seton, for it was found that the onset was usually early in the disease.

A few notes on the more prevalent complications are appended.

Empyaema. The onset was signified in each case by the temperature beginning to alternate, in one case 2 days, another 3 days and the other 6 days after the pneumonia had settled. Diagnosis was clinched by means of thoracentesis and pus was found 2 days, 3 days and 8 days after the recurrence of temperature in each of the above cases respectively. In the latter case 3 explorations had to be made before the effusion was encountered. The cases were thereafter subjected to operation under local anaesthetic when the pneumonia had cleared completely. Rib resection with open drainage was performed and excellent results obtained. The residence in hospital, however, was greatly increased.

Pericarditis. Treatment was carried out along the usual lines, and none of the cases died, but the average stay in hospital was greatly prolonged, being approximately 2 months.

Laryngitis. In the Type i cases this occurred once during the course of the illness and during convalescence in 2 others, in one of whom it was afebrile. In the other it occurred 10 days after lysis and prevailed for 4 days with a slight temperature. In the one Group iv case it appeared on the day of lysis and there was a slight temperature for 3 days. The voice resumed its normal quality slowly.

Tonsillitis. This was of the follicular type in each instance. In 2 of the Type ii cases it was of acute onset and occurred 2 and 8 days after the crisis. In both instances it cleared under treatment in 2 days. The remaining 2 Type ii cases and the 2 Group iv cases showed the condition during the course of the pneumonia.

The condition in each instance responded rapidly to treatment.

Arthritis. This occurred in 2 cases - both Type ii -- and in one affected joints of the hands, arms, legs and feet. The temperature rose sharply 2 days after lysis and continued

for 2 days whilst the pain and stiffness continued for other 7 days. In the other case only one hip joint was involved 5 days after lysis. Extension was applied as X-ray examination suggested a slight effusion. This extension was maintained for 44 days and the patient made a good recovery.

Enteritis. This was a very distressing condition. In two cases one Type i and one Type ii it occurred during the acute course of the illness and the Type ii patient ultimately died. The stools in his case were negative to B. typhosus, etc. The other Type ii case developed the condition 11 days after the crisis and rapidly cleared up under treatment, having had only a slight temperature for 2 days.

Furunculosis. This occurred in 2 Type ii cases, 5 and 6 days after crisis, and both took 14 days before they were clear of the infection. The pus from the boils showed Type ii pneumococci.

Phlebitis. This developed in one Type i case 7 days after lysis and did not clear for 10 days. There was slight febrile disturbance but the pulse frequency was accelerated.

Meningismus. This occurred in one Type i case late in the acute phase, on the 9th day, and persisted for 7 days.

Adenitis. This occurred in one Type ii case and affected glands deep to the sterno-mastoid 9 days after crisis with a slight temperature for 2 days. The condition cleared slowly.

Corneal ulcer. This occurred in a Type ii case 7 days after lysis and responded to treatment and was cured in 12 days.

Cellulitis. This appeared in the big toe of a Group iv case on the 3rd day of illness and spread over the foot. It continued for some time and did not clear until 9 days after lysis.

The relationship between bacteraemia and the incidence of complications.

Of the 41 cases in the series who showed bacteraemia 12, or 29.5 per cent., had some complication. Of the remaining 130 with negative blood culture 21, or 16.9 per cent., had some complication.

TABLE 50.

The relationship between bacteraemia and complications.

Type	i	ii	iv	Total.
Empyaema	1		1	2
Enteritis	1	1		2
Endocarditis	1			1
Pericarditis	2			2
Phlebitis	1			1
Laryngitis	1		1	2
Adenitis		1		1
Abscess		1		1
	7	3	2	12

Two of the cases who had pleuritic pain during resolution had positive blood cultures.

It would appear from the table that the presence of organisms in the blood in sufficient numbers to be grown predisposes to the onset of some complication.

This was most marked in the Type i group where 7 cases with a positive blood culture had complications as compared with 3 Type ii and 2 Group iv cases.

There were 7 cases with complications who died, but of those 6, one Type i and 5 Type ii, had pneumonia migrans. These were considered in the chapter on Site of Lesions. The remain-

ing case was Group iv in origin and he developed an empyaema and died 4 days after admission. The condition was syn-pneumonic and could only be treated by aspiration whilst he was acutely ill.

There were 92 cases in the complete series who had bronchitis and of these, 13, or 14.1 per cent., had complications. The 79 cases who had no bronchitis showed complications in 21 instances, or 26.5 per cent. The mortality of those with bronchitis, however, was three times that of those who had no bronchitis so that it is not unexpected when it is found that the incidence of complications was greater in the latter group since there were more survivors. It would appear, therefore, that the presence of bronchitis plays little part in the causation of complications.

Inspection of the figures with reference to stay in hospital shows that the presence of some complication prolongs considerably the residence in hospital.

TABLE 51.

	i.	ii.	iii.	iv.	Total.
Av. residence of case	22.2	23.25		19.94	22.34
" " Uncomplicated	18.22	19.54		17.94	18.71
" " Complicated	27.56	27.2	34	23.1	26.8
" " Death.	5.1	4.1	3	2.9	4.05

From these figures it is seen that the case with a complication has the longest stay in hospital and of the different groups Type i has the longest average residence. This may be explained by the greater prevalence of the more serious complications in the Type i cases.

Résumé.

Some complication occurs in approximately 20 per cent. of all cases. The incidence for each type is similar but the site of attack varies. Type i infections show more frequent involvement of the tissues around the mediastinum whilst Type ii attacks the epithelial surfaces.

The presence of bacteraemia predisposes to the onset of complications, whilst bronchitis plays little part in the production of complications.

The presence of a complication lengthens the illness considerably, whilst death is relatively infrequent in those cases with some complication, if pneumonia migrans is excepted.

V. 26. Treatment.

In this chapter the treatment will be discussed in a general manner with special reference to the use of oxygen or a mixture of this and carbon dioxide, and some proprietary preparations.

Specific treatment such as the exhibition of Felton's serum was not utilised.

It is assumed that the body, having been invaded by the pneumococcus, the physical reaction will be the same in each case, no matter what the type of pneumococcus may be, although the degree of reaction will vary. Consequently specific treatment having been omitted, the same symptomatic treatment will be called for in each case, always having in mind that the exhibition of such symptomatic treatment will vary according to the virulence of the infecting type. Thus it will be impossible to compare accurately the effect of treatment in the different types.

To conserve the energies in order to combat efficiently the invader is the essential treatment of pneumonia. Various

manifestations of the infection therefore require immediate treatment. Anything which is going to cause unnecessary expenditure of energy on the part of the patient must be obviated. Therefore efficient nursing is of outstanding importance. The ideal would be to have the nurse do everything for the patient; turn him in bed, feed him, give him drinks, supply his sputum mug on every occasion, cleanse him, in fact have the patient lie as passively as possible throughout the illness. Unfortunately practice falls far short of this, but every effort was made to attain to the ideal. In certain respects it was followed out, for all the acute patients were always fed and bathed and as far as possible they were assisted with drinks and sputum mugs, etc., but in a ward with 18 to 20 patients and a limited staff, it was found impossible to do everything for each patient.

The next point was to ensure sleep. In the first place the toxæmia was attacked by thorough elimination. An enema was administered following admission and mercury in the form of calomel was given the next day after any possible abdominal condition had been excluded. Thereafter purgation was kept at a minimum, any tendency to constipation being corrected by means of Mag. Sulph. or enemata at long intervals. As a rule this was seldom necessary.

Copious fluid intake was encouraged, in the form of ordinary water, Potus Imperialis, and to a less extent aerated waters or lime juice with glucose added, 5 ounces in a 5 per cent. solution being given in the 24 hours.

An attempt having been made thus to reduce the toxic causes of insomnia, sleep was ensured every night by means of morphia. This was given by mouth in the form of oral tablets of omnopon, alopon or some such preparation. The dosage employed varied according to the age and state of the patient and it was used with especial care in cases with bronchitis. Keeping in mind the usual contra-indications it was used in every case every night if it was found that sleep was not forthcoming.

The dose given was gr. $\frac{1}{3}$ alopon, equivalent to gr. $\frac{1}{6}$ morphia, and this was repeated in one hour if necessary. On succeeding nights gr. $\frac{1}{6}$ was given and repeated if necessary, but gr. $\frac{1}{3}$ was reverted to, if the necessity arose. Before this policy of free use of morphine was begun, the pros and cons were fully considered. It had been found that bromides, chloral and paraldehyde, etc., were of little value in the majority of cases. If the patient slept after one of those, it was usually a sleep of short duration, for in a large ward there were always some cases who were delirious and noisy. Consequently the necessary repose and alleviation of pain was not obtained, and it was considered that the gain acquired by sound sleep would fully balance any depression of the respiratory centre. In any case the presence of pleurisy modifies respiration in such a way that the frequency is increased whilst the depth is decreased, whereas when morphia has been administered, in addition to the narcotic action, the pain is diminished and as a result the breathing becomes slower and fuller. This slowing and increase in depth are not only due to the relief of pleuritic pain but are also due to the central action of the drug. Poulsson⁽³⁷⁾ (p. 77). Thus in addition to sleep and relief of pain, the patient derived advantage from more efficient respiration.

Lord Dawson⁽³⁸⁾ (p. 625) is of the opinion that this fear of depressing the respiratory centre is a bogey which should be disregarded and the results obtained during the investigation support his view.

The foregoing was the basis of the treatment employed but there still remain a number of methods which may be classified under the usual headings.

1. Prophylaxis. The beds were separated by as great a distance as possible, in order to prevent cross infection by the different types.

2. Empirical. A variety of proprietary preparations were used with the following results.

S.U.P.₃₆ was given to 157 cases of whom 23 died.

Pneumococcus immunogen was given to 6 cases of whom 2 died.

Edwenil was given to 3 cases with 1 death and salvochin to 5 cases with no deaths.

TABLE 52.

To illustrate results of treatment.

Type	S.U.P. 36			Pn. Immunogen.			Edwenil.			Salvochin.		
	Cases	% of 171	% of Type Total	Cases	% of 171	% of Type Total	Cases	% of 171	% of Type Total	Cases	% of 171	% of Type Total
<u>i</u>	55	32.15	91.52	1	0.58	1.66	1	0.58	1.66	3	1.75	5
<u>ii</u>	75	43.85	96.15	3	1.75	3.85						
<u>iv</u>	25	14.62	80.6	2	1.17	6.45	2	1.17	6.45	2	1.17	6.45
	155	90.65		6	3.51		3	1.75		5	2.92	

DEATHS.

Type	S.U.P. 36.			Pn. Immunogen.			Edwenil.		
	Cases	Died	%	Cases	Died	%	Cases	Died	%
<u>i</u>	55	5	9.1	1			1	1	100
<u>ii</u>	75	12	16.0	3	2	66.6			
<u>iv</u>	25	5	20.0	2			2		
	155	22		6	2	33.3	3	1	33.3
<u>iii</u>	2	1	50						
	157	23	14.84						

The figures show that the majority of the cases were treated with S.U.P. 36 and that of those cases the Type i group showed the best response, and the Group iv section responded least successfully, judging by the case mortality. One ampule

of S.U.P.₃₆ was given thrice to each case. The first was given as soon after admission as possible, the 2nd 24 hours later and the 3rd 48 hours after the 2nd. The usual response was an elevation of temperature 2 to 4 hours after the injection followed by a fall thereafter. Occasionally the temperature curve continued down from this point but in the majority there was a rise again. A similar reaction took place after the 2nd dose but not usually so markedly, the general trend being down. Those changes in the curves may have no relation to the injections but it was noted that a few hours after the injection almost every patient felt better. The following morning this feeling was not so marked but was usually regained after the next injection.

Although the results of such treatment are not outstanding this feeling of general improvement suggests that it may be of some value in making the patient's lot more comfortable.

The numbers treated by means of Pneumococcus Immuno-gen, Edwenil and Salvochin are meagre and therefore no definite opinion can be formulated as regards their value. Salvochin was apparently the most successful since 5 cases were treated with no fatalities.

3. Symptomatic. This was carried out on customary lines. Pain was treated by poulticing with linseed meal, or antiphlogistine and if those were unsuccessful an ice bag was utilised. On a few occasions when such measures failed it was found that puncture of the pleura by means of an exploring needle alleviated the condition.

Morphia was used at night time both for pain and sleeplessness.

Cough. An alkaline mixture was used occasionally, the constituents being varied as conditions necessitated. Ammon. Carb., Pot. Iodide, Stramonium or Codeine formed the basis of the various combinations.

Hyperpyrexia. If on any occasion the temperature was found to be above 102.6°F. tepid sponging was carried out until the temperature had regained a less dangerous level.

Anoxaemia. Early in the investigation oxygen was prescribed only for the cases in whom this condition was marked. It was given by means of an intra-nasal catheter which was passed well back into the naso-pharynx after having been thoroughly lubricated. The gas was bubbled through a large bottle of heated water which required almost constant renewal. Later Haldane's apparatus (see photographs) was obtained and thereafter this was used in every case from the hour of admission until the anoxaemia had finally gone. Various writers state that such an apparatus with a mask is resented by the patient. This was not found to be the case in the majority of patients dealt with in this survey. The plan followed was to explain to the patient the reasons for the use of the gas and apparatus; and he was urged to persevere despite any preliminary discomfort. At first the oxygen was given for 20 minutes followed by an interval of 20 minutes before the next inhalation. Ultimately it could be given almost constantly without the slightest demur on the part of the patient, although there were a number of men who required an interval about every half hour. There were four non-delirious men who refused absolutely to use the mask. Also on a number of occasions it had to be withdrawn on account of delirium.

The mode of use was to adjust the mask and set the control knob to allow the delivery of 6 litres per minute. This flow was continued until the colour and pulse improved and then the flow was reduced slowly until a point was reached where the improved colour was just maintained. This was found usually to be between 2 and 3 litres per minute. Many of the men became so accustomed to the mask that they could sleep comfortably with it in position. The opinion formed is that oxygen alleviates part of the distress in pneumonia; the restless-

ness is lessened, the colour improved and in a large number of cases the frequency of the pulse is reduced. Therefore it should be given from the earliest opportunity and given as constantly as is compatible with the patient's comfort, for the diminution of cyanosis indicates improved oxygen supply of the tissues; the control of restlessness, a lessening of toxæmia; and the reduction in pulse frequency, conservation of the heart.

Theoretically the exhibition of oxygen should improve the patient, for anoxaemia increases the heart rate, Wright and Vincent⁽³⁴⁾ (p. 207) and therefore if the anoxaemia can be reduced the heart will be spared. Experimentally the presence of oxygen retards the growth of pneumococci⁽⁷⁾ (p. 193) therefore despite the fact that the lesion is most probably shut out of the circulation, it is possible that an increase in the oxidative power of the blood might reduce the degree of bacteraemia, and from this the toxæmia. In practice it was found that the heart rate and dyspnoea were reduced to some extent but there was always some increase in frequency of the pulse and respirations remaining. These were ascribed to toxæmia acting upon the vasomotor and respiratory centres.

Symptoms of cardio-vascular involvement.

As already described, absolute rest was enforced; elimination was commenced; glucose was included in the diet and oxygen was utilised as were adrenalin and pituitrin when conditions seemed to indicate their use. All these played a part in treatment devoted to this system. The treatment of toxæmia was considered an important safeguard of the cardio-vascular system for the resisting power of the tissues depends on efficient blood circulation and if the bloodstream is loaded with toxins, it is possible that the small blood vessels and capillaries in addition to the myocardium may be so damaged that a form of toxæmic shock is produced. This theory is dealt with at length and in a convincing manner

(33)
 by Ritchie (p. 87 et seq.). Digitalis in the form of Digitaline Nativelle was used in appropriate dosage from the day of admission, in a number of cases. Opinions expressed in the literature vary with regard to the value of digitalis in pneumonia and in the present series it did not appear to have any effect in reducing pulse frequency, when compared with the cases which were not digitalized. The prescription of the drug was continued, however, in an attempt to have the patient sufficiently digitalized as a precaution against the onset of more grave circulatory complications later in the disease. Auricular fibrillation occurred in 3 cases who died, all of whom had had digitalis.

Venesection was carried out with great benefit in 4 patients of a plethoric type in whom marked cyanosis accompanied an enlarging right heart. One pint of blood was removed from a vein in the forearm by means of a French's needle and aspirating bottle. All the cases recovered after a prolonged convalescence. This is a procedure which is of considerable value in selected cases.

Gastro-intestinal system.

Distension of the gut was treated by attention to the dietary and if it persisted by the use of enemata or by the passage of a flatus tube and the injection of pituitrin.

Diarrhoea. This was treated by varying the diet, the use of enemata and finally if those were of no avail some form of sedative in conjunction with a so-called intestinal antiseptic.

Empyaema. If syn-pneumonic this was not dealt with until the pneumonia had settled. The usual method of treatment was aspiration during the acute course of the illness, followed later by rib resection under local anaesthetic with open drainage thereafter.

4. Dietetic. The diet was made fluid and as nourishing as possible. Water, aerated water in smaller quantity, diluted milk and weak tea formed the basis, and were given in small quantities at regular intervals. Glucose was added, five ounces being given in 24 hours in a 5 per cent. solution either in water flavoured with juice of lemons or in aerated water. Fruit juice was added whenever possible to the fluids. After crisis, milk puddings, jellies and a little porridge and bread and butter were gradually added to the diet and after 2 days the diet was moderately rapidly brought back to normal.

Alcohol was used with some frequency. It was given in all cases who were suspected of indulgence. In others again it was given in the form of toddy as a sedative. Also it was given to those very toxic cases with sordes and a thickly coated tongue, who appeared to be acutely conscious of their condition and utterly miserable. In those it was of value in dulling the upper critical centres and making the patient less conscious of his condition and at the same time supplied a fair amount of energy. In those cases also it is possible that it was of value in relieving the load on the heart since alcohol lowers the venous pressure. McDowall⁽³²⁾ (p. 168). Murchison's directions⁽³⁹⁾ (p. 219 et seq.) for the use of alcohol in fever were kept in mind and utilised in appropriate cases.

The form of alcohol used was whisky and it was prescribed in half ounce doses 4 hourly, thus giving 3 ounces in 24 hours. Sherry was used in convalescence as a stimulant of the appetite in a few of the cases who had empyaema and who lost desire for food.

An interesting point noted was that the majority of the patients refused such foods as Benger's, Allenbury's, and such like proprietary foods.

A factor of some importance in the treatment of pneumonia is the type of mental make-up of the patient. In a few of the cases the patient's outlook from the day of admission was dismal. They lay listlessly, and although conscious took no interest in their surroundings. All enquiries were met by the reiterated statement that they were worse or at the most no better, and they would make no effort to cooperate with the staff in an effort to get well.

This condition may have been a manifestation of toxæmia but as the majority of such patients were markedly Irish or Highland it was suspected that the personality of the patient played some part in the condition.

V. 27. Seasonal Incidence.

The graphs displayed in Figs. XV and XVI illustrate the incidence of (1) all cases of lobar pneumonia treated in the hospital from January 1930 to May 1932, and (2) the smaller section in whom the infecting organism has been typed. The graphs show that there is a definite seasonal variation in case incidence with a marked preponderance of cases during the winter months, i.e., in the last and first quarters of the year. The curves in Fig. XVI show also that there has been definite variation in the peak of this winter prevalence during the three winters. In 1930 the peak was reached in April, whilst in 1930-1931 the rise commenced earlier and reached its peak in January, and finally in 1931-1932 the rise commenced still earlier, was not maintained, and again rose in March, but at no time was the rise as high as the peak in 1930-31. The total numbers admitted in each winter also varied and it is seen that there was a higher incidence of cases in 1930-31 than in either the preceding or succeeding winters. The mortality curve follows that of the case incidence and it

is seen that deaths were most frequent in the first quarter of each year, the peak being later in the years where the case incidence was low and earlier in 1930-31 where the incidence of cases was high.

The graphs in Fig. XV illustrate the seasonal incidence of the various types and from them it is seen that there was a definite periodicity. The figures dealt with are too few and the period of time covered is too short to allow of any conclusive statements but the curves suggest that during the period of investigation the increased incidence of Type i pneumonias began sooner and diminished earlier than did the Type ii pneumonias. It is also seen that the Type i curve of incidence was more sustained showing fewer intermissions than did that of Type ii and in this it resembles that of Group iv which was maintained, however, at a lower level. Also it would appear that when Type i pneumonias were prevalent, Type ii were less prevalent and vice versa, and this alternation continued during the winter seasonal increase. The curves of incidence of Type i and Group iv pneumonias are much smaller, and using waves as a simile would appear to have a longer wave length than has the Type ii curve. If then the wave lengths of the curves of incidence of the types vary and if the virulence of each type varies as suggested by Thomas⁽⁴¹⁾ (p. 2101) a possible explanation is forthcoming of this three yearly increase in pneumonia mortality discussed in the chapter on Incidence and Mortality. If the wave lengths of the incidence curves all vary a point is bound to occur when the peaks of all the waves coincide. The result will be an increased prevalence of pneumonia with a varying mortality depending on the virulence of the predominant organism.

The seasonal variation in the incidence of Group iv pneumonia is not so marked as in the others and it appears to follow a course similar to Type i cases, but the height of the wave is less.

The graph of the incidence of positive blood cultures shows how the curve corresponds fairly closely to that of general incidence, but it would appear to follow more closely the Type i curve. It is also seen that the mortality curve of the total cases mirrors fairly accurately that of the positive blood culture mortality curve which would appear to indicate the value of bacteraemia in prognosis.

V. 28. Condition of the patients after dismissal from hospital.

As described in a previous chapter the cases were brought back for re-examination at regular intervals. The data used in this chapter have been drawn from the results of examination of the first 100 cases, each of whom was seen at regular intervals for a year after dismissal. The average number of visits per man was three, but a large number of the cases had been back 5 and 6 times in the year.

In the chapter on Exposure to Infection it was shown that 7.6 per cent. of the total cases gave a history of definite contact with a case of pneumonia and 7.0 per cent. gave a questionable history of exposure. The figures detailed in that chapter suggest strongly that the acute case is infectious and the origin of a fair number of fresh cases in his immediate vicinity.

Whence do the remaining cases derive their infection? Glynn and Digby⁽¹⁾ (p. 76) show that an average figure of pneumococci carriers is 43.5 per cent., and that 67.4 per cent. of those are Group iv carriers. Is it, then, that the remaining cases who gave no history of contact were infected by unsuspected carriers, or was the infection autogenous from their own upper respiratory tract?

Griffith⁽¹⁴⁾ (p. 114 et seq.) suggests the possi-

bility of mutation with regard to the various types and quotes evidence from his experimental studies. If it be assumed that such changes are possible in the human subject it may be that following some metabolic change in the carrier, conditions became favourable for the mutation of the organism carried in his naso-pharynx with resultant infection. Or it may be that the changes are such that he becomes infected by the organism carried and the change in type takes place thereafter being the reaction of the infecting organism to the varying resistance of the body, i.e., a variation in the soil.

Evidence having been produced that the acute case is infectious, an attempt will be made to show that patients recovered from pneumonia still carry the infecting organism and are capable of spreading infection. Of the 100 cases examined, the original infecting organism was Type i in 38, Type ii in 49, and Group iv in 13.

TABLE 53.

To illustrate incidence of Carriers and Non-Carriers.

Type	<u>i</u>	<u>ii</u>	<u>iv</u>	Total
Carriers	9	13	10	32
Non "	29	36	3	68
	38	49	13	100

From the table it is seen that the average number of ex-patients who carried their infecting organism for some period was 32 per cent. Of those who returned for examination there were 9, or 23.6 per cent., of the Type i cases, 13, or 26.5 per cent., of the Type ii, and 10, or 76.9 per cent., of the Group iv cases who carried the original infecting organism at some period after dismissal. A large number of the cases did not carry the organism longer than 2 months as far as could

be shown by culture methods. The figures expressed as percentages of the total return cases of each type are tabulated below.

TABLE 54.

Type	2	4	6	8	10	12	months after dismissal.
<u>i</u>	21.05	0	0	2.63	2.63	2.63	} = % of total return cases of each type.
<u>ii</u>	20.4	8.16	14.3	2.04	0	2.04	
<u>iv</u>	69.2	15.4	23.1	15.4	7.7	7.7	
	27	6	10	4	2	3	

The figures are small but it is seen that in each Type group there is a small percentage of cases who carried the original infecting organism for a year after dismissal. It is seen that there is a considerable number who retained their infecting organism for two months but that there was a rapid diminution in numbers thereafter, followed by a slight increase later. The curve is somewhat irregular and this irregularity is noted in each of the Type curves, consisting of a sudden diminution in carriers between the 2nd and 4th months followed by a rise at the 6th month with a more gradual decline thereafter. The preponderance of Group iv carriers is not surprising since various investigators found Group iv to be the most common type in the naso-pharynx and saliva of apparently normal persons. Glynn and Digby⁽¹⁾ (p. 76); Griffith⁽¹⁴⁾; Smeall⁽³⁵⁾ and Stillmann⁽²⁰⁾ all demonstrate the prevalence of the Group iv type in the throats of apparently normal people. The incidence of this organism in such people apparently varies, but in each of the above references it is over 50 per cent.

As shown in the foregoing tables, the Type i and Type ii return cases carried the original infecting organism in a manner similar to the Group iv section but to a lesser degree. The Type ii group retained the organism in a greater number

of instances for a longer period than did the Type i group, but ultimately there was one persistent carrier in each section. During the period covered the carrier and the non-carrier groups showed a variety of types at various times. Of the Type i cases who carried the original organism, the majority were found to have reverted to a Group iv organism at the 2nd visit, i.e., 4 months after dismissal. One case was found to have a Type ii organism at his 1st visit and he carried this until the 8th month when he reverted to Type i, but at the 10th month the organism found was Group iv. Four cases of the Type i carrier group showed streptococci in addition to Group iv on several occasions and one case was found to have a Type iii and a Group iv organism, 8 months after dismissal.

Of the Type i cases who did not show the original organism at any time on return, the vast majority were found to carry Group iv, although 2 at 2 months and 1 at 4 months showed a Type ii. Two also showed a Type iii at one visit and 3 a streptococcus.

Similarly in the Type ii carrier group, Group iv was assumed eventually, although not so rapidly as in the Type i group. 3 of the cases showed Type iii at one visit and 2 showed streptococci at one visit, but all of those, except one, ultimately showed Group iv. The exception was a case which eventually showed a Type iii. Of the Type ii non-carrier group all but 6 showed Group iv on return and continued to do so. The 6 exceptions were found to have Type iii and although 3 of these finally carried Group iv, the other 3 showed Type iii at the last examination, one 6 months and two 4 months after dismissal.

Of the Group iv carrier section, one of them showed a Type i at the 2nd visit, 3 showed Type ii at intervals, and 2 showed Type iii. One of those cases showed the Type iii at the 1st return, or 2 months after dismissal, a Type ii at the 2nd return, and a Group iv at the 3rd return, and a Type ii

at the 4th.

Of the Group iv non-carrier cases there were only 2 who showed a Type i or Type iii respectively 2 months after dismissal. Those cases did not return again so that the results with regard to them are inconclusive.

From the foregoing it is seen that the greater number of cases of pneumonia ultimately carry a Group iv organism. Some assume this type sooner than others, notably the non-carrying sections of all the Types, and also notably the Type i carriers and Group iv carriers. The Type ii carriers, however, tend to retain the original organism longer, but ultimately the majority carry Group iv.

A noticeable point is the fact that a number in each section showed a variety of types throughout the year and this was most marked in the Group iv carrier section. Type iii and streptococci were the commonest alternatives in all the groups before the final Group iv character was assumed.

How can the occurrence of these varieties be explained? To assume that they are the result of infection by other carriers is too much, for it has been shown by various writers already mentioned that Type i and Type ii carriers are very infrequent. Mutation would appear to be the simplest explanation. Muir and Ritchie⁽³⁶⁾ (p. 397) discuss the possibility of mutation occurring in members of the coli-typhoid group in response to variations of the culture media, and produce evidence in support of this. On analogy with this, if conditions vary in the naso-pharynx of the carriers and varying types of organism are isolated in the course of those variations, this possibility of mutation of the pneumococcus demands consideration. It will be shown later that the naso-pharynx did vary in a large number of return cases.

Those variations in the type of organism carried by ex-patients are of interest also, in that they indicate that in these people there are present reservoirs or sowers who may

vary as regards their power of causation of fresh cases, depending upon the type of organism present in their naso-pharynx when they sow the disease. For it is generally accepted that the various types vary in virulence, a fact which has been corroborated by the findings in this investigation.

To investigate still further this question of foci of infection, a circular letter was addressed to 44 ex-patients. 22 of those had been found to carry their infecting type after dismissal and the remaining 22 had not shown any persistence of their original infecting organism.

The result of the enquiry is tabulated below.

44 circulars sent.
41 replied.
2 not found by postal service.
1 did not reply.

TABLE 55.

	Carriers.			Non-carriers.		
	Replies	No. associated with Pneumonia.	No. of cases produced.	Replies	No. associated with Pneumonia.	No. of cases produced.
Type <u>i</u>	9	1	1	10	3	5
" <u>ii</u>	13	3	4	9	1	1
	22	4	5	19	4	6

Thus it is seen that of the 19 Type i cases who replied, 4 gave a story of being associated with a total of 6 new cases, whilst of the 22 Type ii cases, 4 were associated with 5 new cases. That is of the 41 cases who replied 8 of them had 11 friends who developed pneumonia. The figures are scanty but the fact that 11 cases occurred within the circle of acquaintances of 41 ex-patients is suggestive of some connection. Some of the new cases were men who worked alongside the ex-patient and so the risks of employment may be a factor, but in other cases the affected people were relatives living in the same house, e.g., brothers and children, some of whom were admitted to Belvidere.

The new cases occurred in equal numbers in connection with carriers and non-carriers. It is possible that the latter group in some instances may have carried the organism despite the fact that it was not isolated.

The numbers of those in each Type associated with new cases are similar and the resultant cases show that one more Type i case than Type ii was produced.

When those figures are compared with those obtained from patients on admission (see chapter on exposure to infection) it is seen that somewhat similar deductions may be drawn, in that in both instances Type i cases showed a more frequent history of association.

From the foregoing it would appear that ex-patients are a fertile source of fresh cases, and that the power of dissemination is not confined to the carriers of Type i and Type ii organism.

An attempt was made to investigate the possibility of contact carriers among the staff of the pneumonia wards. The results were unsatisfactory for a number of reasons. The nursing staff is changed frequently and as a result the exposure of nurses is intermittent and the changes from ward to ward makes it difficult to follow up each individual. Also the off-duty time interfered with regular swabbing of the nurses. Despite those minor difficulties a series of nurses was investigated, although it was found impossible to procure specimens at regular intervals for a proper record. A small number were found to carry the more virulent types intermittently. It was found that those organisms were present when the individual had a cold in the head and in one case, a post nasal discharge. Two of the staff carried the organism, Type ii, for 4 months and they were found to have chronic conditions, one having a chronic otitis media suppurativa and the other was suspected of having a chronic sinusitis.

As far as is known no case of pneumonia resulted

from these contact carriers, but the numbers are small and the manner of investigation too unsatisfactory to base any conclusion on the findings. It seems indicated, however, that contacts as well as convalescents may carry virulent organisms.

The clinical condition of the return cases was considered in some detail with the following results.

There were 100 cases who returned during the year following dismissal from hospital, and of those 52 were in regular employment, 13 worked intermittently and 35 were idle.

TABLE 56.

To illustrate employment of Return Cases.

	Type i.		ii.		iv.		% of Type total who returned.
	Carrier	Non-Carrier	Carrier	N.C.	Carrier	N.C.	
Idle	6.06	18.18	11.1	22.2	50	8.3	
Working irregularly	6.06	3.03	4.45	13.36	8.3	0	
Working	15.16	51.5	13.36	35.52	25.0	8.3	

From the table it is seen that in Type i and Type ii groups the greater number of the carriers were working but in Type ii the difference is slight between the numbers of unemployed and working carriers. In the Group iv group the majority of the carriers are idle.

Taking the figures generally it is found that of those working 25.9 per cent. were carriers, and 38.4 per cent. of those who worked intermittently, and 37.1 per cent. of those idle carried the organism. It appears, therefore, that carriers are more frequent amongst those of whom it may be justifiable to say are less able to live in moderate comfort.

The next point considered was the general appearance of the patient. An arbitrary standard was used and the cases were classed in groups denoted "very well," "moderately well," "poorly," and "varying." There were 25 classed very well,

53 moderately well, and 15 who were noted as poorly, and 7 who varied in appearance at each visit.

TABLE 57.

To illustrate appearance of Return Cases.

	Type <u>i.</u>		<u>ii.</u>		<u>iv.</u>	
	Carrier	Non-Carrier	Carrier	N.C.	Carrier	N.C.
Very well	6.05	27.25	4.44	15.56	8.33	-
Moderately well.	15.15	24.25	17.78	44.4	50.0	8.33
Poorly	-	12.12	4.44	11.12	25.0	-
Varying	6.05	9.09	2.22	-	8.33	-

% of Type total who returned.

From the figures it is seen that the bulk of the carriers were moderately well in appearance and this was most marked in Type ii cases. In the group titled "very well" the incidence of carriers is small. Of those dubbed "poorly" the greater number of carriers was found in the Group iv section with a much smaller number in Type ii group. The number of carriers in those who varied in appearance was small, but again Group iv showed the greater number.

The table also brings out the point that more of the Type i return cases were entered in the very well group as compared with the Type ii and Group iv cases of whom the majority were classed moderately well.

The figures examined from another angle show that of those who carried their original organism at some period after dismissal, there were 24 per cent. of the very well group, 34.6 per cent. of those moderately well, 33.3 per cent. of those classed poorly, and 57.2 per cent. of those who varied in appearance.

The patients' statements as regards their health and progress were next considered and the results are tabulated below. Once again the standard is arbitrary but it is probably sufficiently accurate to indicate certain features. A classification similar to the last section was used.

TABLE 58.

To illustrate the patients' opinion of progress.

	Type i.		ii.		iv.	
	Carrier	Non-Carrier	C.	N.C.	C.	N.C.
Very well	6.06	21.2	2.25	20.0	8.33	
Moderately well		27.27	17.78	46.54	66.7	8.33
Poorly		9.09	4.49	8.89	8.33	
Varying	6.06	15.16	2.25	2.25	8.33	
Improving progressively	15.16	12.12	4.49	17.78	16.66	

% of Type
Total who
returned.

Here again it is seen that the bulk of the carriers were in the "moderately well" group and this is specially marked in the Group iv section. The "very well" group shows a small percentage of carriers as does also the section labelled "poorly." Amongst those who felt well at times and poorly at others the incidence of carriers was higher, this being especially noticeable in Type i and Group iv groups.

There were a number of patients who when seen first after discharge stated that they felt in poor shape but at each succeeding examination they felt improved. A special note was made of such cases and it was found that they included a considerable number of carriers notably in Type i and Group iv sections.

The table also shows that a greater number of Type i cases stated they were very well as compared with the Type ii cases of whom the majority felt moderately well. The Group iv cases similarly appeared more frequently in the moderately well class. It is noticeable also that more of the Type i cases appeared to vary in their state of health, judged by their own feelings and it is seen that a greater number of Type i cases improved progressively after dismissal as compared with the other groups.

Thus it is found that carriers were present in 24 per cent. of those who felt very well, in 29.6 per cent. of the moderately well and in 27.2 per cent. of those grouped as poorly and in 36.4 per cent. of those who varied and it is of note that those findings are approximately similar to those made under the heading of the patients' appearance.

From the foregoing it would appear that it is possible to isolate virulent organisms from men who both look and feel well, but such organisms are more commonly found in those who appear and feel less fit.

The records of illness in the hospital staff from July 1927 to June 1932 inclusive were searched for cases of pneumonia and only 2 were found, one being a nurse in a pneumonia ward in January 1929 and the other a ward maid in a different pneumonia ward in January 1929. From this it would appear that infection by the pneumococcus does not occur readily in the well-housed and well-fed individual and it seems probable that some other factor must obtain, in addition to inoculation by the organism, before infection results.

A spot map showing the residence, the date of onset and the type of infecting organism of each case was prepared for the writer by the Public Health Department but the paucity of numbers rendered it valueless.

Examination of the nose and throat revealed the presence of abnormalities in a large number of cases. Enlarged and congested tonsils were common as were also deflected nasal septa and enlarged turbinates. There were 4 men who showed follicular tonsillitis on examination, one Type i carrier, one Type i non-carrier, and 2 Type ii non-carriers.

There were 37 cases who showed enlargement of the tonsils, as illustrated below:-

TABLE 59.

To illustrate degree of tonsillar hypertrophy.

Type		+	++	+++	V.	Totals.	
<u>i</u>	Carrier	4				4	14
	Non "	3	4	1	2	10	
<u>ii</u>	Carrier	8	1			9	20
	Non "	10	1			11	
<u>iv</u>	Carrier	3				3	3
	Non "					0	
		28	6	1	2		37

} Cases.

V = varying in size.

Carriers = 16.
Non " = 21.

These figures suggest that the carrier state has no direct relationship to the degree of enlargement of the tonsils for it is seen that there are more non-carriers than carriers with tonsillar hypertrophy. It may be that this hypertrophy is a protective device and this might explain the scarcity of Type i carriers with large tonsils as compared with the greater number of Type ii. If the enlargement is protective the incidence of Type ii carriers with enlargement may be explained by the greater virulency of the Type ii organism, which will be less easily killed.

Of the 100 return cases there were 37 with hypertrophied tonsils and 16 of those were carriers, which is just half of the total carriers (see Table 53). Of the 68 non-carriers 21 had tonsillar hypertrophy and as was shown above this condition was present in 16 of the 32 carriers. It would appear probable, therefore, that the carrier state is associated with enlarged tonsils.

The degree of congestion of the fauces and tonsils was also noted and the results are illustrated below.

TABLE 60.

To illustrate degree of congestion of fauces
and tonsils.

Type		+	++	+++	V.	Totals	
<u>i</u>	Carrier		2		6	8	33
	Non "	4	5		6	15	
<u>ii</u>	Carrier	3	4	4	2	13	34
	Non "	3	7	9	2	21	
<u>iv</u>	Carrier	5	1	3	1	10	12
	Non "		2			2	
		15	21	16	17		69

} Cases.

V = varying.

Carriers = 31.
Non " = 38.

Here again it is seen that there were more non-carriers than carriers with congested fauces, and this holds true for each of the types except Group iv where the carriers show greater frequency of congestion. As noted earlier there were 32 carriers in the 100 return cases and from the above figures it is seen that 31 of those showed congestion of the fauces as compared with 38 of the remaining 68 non-carriers.

Is this congestion a result of the presence of the pneumococcus or is the pneumococcus present because of the inflammation? The latter hypothesis seems the more feasible for the congestion which results from invasion by the pneumococcus is usually a more intense reaction with pus formation as the expected result.

Examination of the nose showed deflection of the septum and turbinal enlargement to be very common.

TABLE 61.

To illustrate nasal abnormalities.

<u>Septum.</u>	Type i.		ii.		iv.		C = Carrier = 27. N.C. = Non " = 36.
	C.	N.C.	C.	N.C.	C.	N.C.	
Deflection to R	4	4	6	5	4	-	
Deflection to L	5	11	6	15	2	1	
	9	15	12	20	6	1	= 63 cases.
<u>Turbinates.</u>							
+	1	4	5	4	1	-	C = 32. N.C. = 40.
++	4	5	4	6	6	2	
+++	3	-	2	9	1	-	
Varying	1	5	1	5	3	-	
	9	14	12	24	11	2	= 73 cases.

The tables show that a large proportion of the return cases had some nasal abnormality of varying degree. Also it is to be seen that a large proportion of the carriers had some deflection of the septum and each of the 32 carriers had some degree of turbinal hypertrophy. Carriers of Type i and Type ii show comparable figures in that more than a third of the cases had abnormalities and almost all the Group iv cases with some abnormality were carriers.

Consideration of any other possible abnormality which might encourage the presence of organisms, caused the attention to be directed to other areas associated with the throat. The teeth in 78 per cent. of the cases who had retained them showed either caries, pyorrhoea or lack of attention. Caries was very frequent in the younger men and pyorrhoea, tartar and staining were extremely common in the older men.

One Type ii case had antrum disease and had lavage performed with success and thereafter the Type ii organism

which he had carried was replaced by Group iv for six months with a Type iii on one intermediate occasion. Group iv was finally carried.

There were 14 cases who showed some degree of either chronic rhinitis or post-nasal discharge. The distribution is shown thus:-

TABLE 62.

	Type i.		ii.		iv.	
	C.	N.C.	C.	N.C.	C.	N.C.
Cases	1	5	2	5	1	0

C. = Carriers = 4.
N.C. = Non " = 10.

From the figures it is seen that 4 out of 14 cases with some nasal discharge harboured the original organism at some period.

Another cause of local discharge was otitis media suppurativa which was present in 8 cases as shown below. Chronic bronchitis was present in 11 of the cases when seen on return and the distribution is also shown below.

TABLE 63.

	Type i.		ii.		iv.	
	C.	N.C.	C.	N.C.	C.	N.C.
Cases	3	1	1	2	1	
		2	3	4	2	

C. = 5. N.C. = 3.
Otitis media suppurativa
Chronic bronchitis:
C. = 5. N.C. = 6.

This table suggests that otitis media suppurativa and chronic bronchitis appear to provide conditions suitable for the persistence of the organism for it is seen that of the 8 cases with otitis media 5 carried the original organism at some time and similarly 5 of the 11 cases with bronchitis carried the organism.

There were 67 men who stated they had some degree of cough with resultant spit. The 11 cases noted above who had

bronchitis are included in this number so that there were 56 cases who had cough and spit and no signs of bronchitis on examination.

TABLE 64.

To illustrate incidence of tracheo-bronchitis.

Type	i.		ii.		iii.	
	C.	N.C.	C.	N.C.	C.	N.C.
+	4	10	4	7	-	-
++	2	5	6	15	7	-
+++	-	2	3	2	-	-
	6	17	13	24	7	-

C. = 26.
N.C. = 41.

= 67.

The presence of cough and spit without clinical evidence of bronchitis was ascribed to tracheo-bronchitis, affecting only the upper part of the respiratory tract, with smoking as a causal factor. Since there were 26 carriers, or 38.9 per cent. of the 67 cases who had some degree of this, the remaining 33 cases with no cough produced only 6 carriers, or 18.1 per cent. The table also shows that Type ii and Group iv carriers were especially common in such patients.

There were 34 men who gave a history of recurrent colds of varying severity.

TABLE 65.

Type i.		ii.		iv.	
C.	N.C.	C.	N.C.	C.	N.C.
4	8	8	10	4	-

C. = 16.
N.C. = 18.

= 34.

This shows that almost half the cases with recurrent colds carried the original organism at some period and also that Type ii and Group iv were the organisms most commonly carried.

TABLE 66.

To show Incidence of Abnormalities in Carriers and Non-Carriers.

	Carriers.		Non-Carriers.	
	Cases	%	Cases	%
Rhinitis	4	12.5	10	14.7
Otitis Med. Supp.	5	15.62	3	4.42
Chronic Bronchitis	5	15.62	6	8.84
Cough and spit	26	81.2	41	60.3
Colds	16	50.0	18	26.45
Deflected septum	27	84.4	36	52.58
Enlarged Turbs.	32	100	44	64.54

In the above table the incidence of abnormalities found in the return cases is contrasted between carriers and non-carriers. It is seen that enlarged turbinates, deflected septum, tracheo-bronchitis and colds were very common in both, but in each instance they were more frequently found in the carrier. The figures although very few suggest that the presence of a variety of pathological conditions in the upper respiratory tract and adjoining areas favour the presence of the pneumococci. Various other lesions occurred in a number of the men after discharge and are illustrated below.

TABLE 67.

To illustrate the incidence of Sequelae.

	Type i.		ii.		iv.	
	C.	N.C.	C.	N.C.	C.	N.C.
Fresh attack Pneumonia				2		
Laryngitis					1	
Pleurisy				1		
Sciatica				2		
Pains in side		1	3			
Furunculosis			1	1	1	
Onset of T.B.				2		
	-	1	4	8	2	-

Unfortunately the men who had fresh attacks of pneumonia were taken to other hospitals and it was found that they had not been typed. The pains in the side were ascribed to pleural adhesions for no abnormalities were found on examination. The outstanding feature is the preponderance of sequelae in Type ii cases, 12 out of the total 15 cases with sequelae having been originally infected by that organism.

The clinical condition of the men who had friends who had developed pneumonia was considered with a view to picking out any outstanding evidence of abnormality. One of the cases was a Type i carrier and he had a follicular tonsillitis at his first return visit. Also he had a chronic otitis media suppurativa and his turbinates right and left were greatly hypertrophied. The next was a Type i non-carrier in whom nothing was found abnormal except moderately enlarged turbinates. Another Type i non-carrier showed a very brightly congested throat, a septum deflected to the right and turbinates enlarged +++. He also had a slight cough with a spit and very carious teeth and pyorrhoea, which were eventually removed. The first Type ii case was a carrier with enlarged and very congested tonsils, who also had a deflected septum to the left with hypertrophied turbinates and considerable degree of bronchitis. Another Type ii carrier had enlarged and congested tonsils with a deflected septum to the left and slightly enlarged turbinates. He also had a slight bronchitis.

Also there was a Type ii carrier who had enlarged tonsils which were very congested. The nasal septum was deflected to the right and the turbinates occluded the nasal passages and he suffered from very frequent colds. Ultimately he had an antrum washed out by proof puncture and the organism carried became Group iv with a Type iii on one occasion. And finally a Type ii non-carrier had a nasal septum slightly de-

flected to the right with moderately hypertrophied turbinates on the left side. Ultimately he was readmitted to Belvidere, but too late to be included in this series of cases and he eventually died from a streptococcal pneumonia.

All the evidence therefore seems to point to the fact that the carriers of pneumococci have some pathological condition in the naso-pharynx or respiratory tract which favours the retention of the organism and the more numerous or the more extensive the lesion the greater the likelihood of the carrier acting as a virulent reservoir.

V. 29. Conclusion.

The ideas and hypotheses expressed in the foregoing pages suffer from the drawback that they are dependent upon a small number of cases. To the writer, however, they appear to provide sufficient evidence to support the original thesis.

It must be noted, however, that the clinical picture of any case of lobar pneumonia will show variations depending upon factors other than the type of infecting organism.

These other factors which are of importance are:-

- (1) the age of the patient,
- (2) his personality, and
- (3) the degree of natural resistance to the pneumococcus which he may possess, and it seems probable that factors (1) and (3) are associated.

Bearing in mind that these factors may affect any case in greater or less degree and so complicate the picture, it seems justifiable to claim that the following descriptions are representative of the course and appearance of cases resulting from infection by the different types of pneumococcus. Finally it must be remembered that these descriptions are the result of observations made solely upon hospital patients.

Type i Lobar Pneumonia.

This most commonly is found in a young or young middle aged man, who gives fairly frequently a history of exposure to infection. The onset is sudden in approximately 9 cases out of ten and is heralded by a rigor followed by giddiness, headache and sickness with pain and cough appearing later. As a rule the severity of the infection is not appreciated until the 3rd or 4th day and when examination is carried out it is found that the right lung is slightly more commonly affected, especially the lower lobe. Approximately one out of three cases shows evidence of a migratory pneumonia, the adjoining lobes on the side of the original focus being most commonly affected. With regard to symptoms, herpes is commonly present and may be of considerable extent and a source of much annoyance, and is usually of little value in prognosis. The sputum differs but little from that found in pneumonia due to other types of pneumococcus, varying from bloody and aerated in the early days to rusty and tenacious and finally yellowish de-colourised plugs late in the disease.

The temperature rises moderately rapidly and as a rule reaches its highest point around 103°F. about the 3rd day and thereafter is well maintained until it settles most commonly by crisis about 7½ days after the onset. The pulse rate is proportionate to the temperature throughout, but its peak is reached as a rule upon the day following that of the temperature. Dyspnoea and cyanosis are usually slight to moderate in degree and are not often severe. If they are present to a marked degree the dyspnoea is commonly the more severe. Toxaemia is usually moderate in degree although approximately one in five cases show it more markedly. The pneumococcus can be grown from the blood in almost 30 per cent. of cases, most commonly around the 3rd, 4th and 5th days of illness. Such cases, however, have only a slightly less favourable outlook than those from whom organisms are not grown. The leuco-

cyte response to the infection is usually good and after a moderately violent response at the onset this falls somewhat abruptly around the 4th day, to rise slowly thereafter until the crisis. The leucocytosis is maintained irregularly until the 10th day and then falls rapidly towards a more normal figure. The blood pressure shows changes in that the systolic pressure at first rises steadily as the disease progresses, to be followed later by a fall to the crisis. The diastolic falls from the onset, but this is not so marked as the rise in systolic pressure. As the disease progresses the diastolic pressure rises towards the crisis, the combination of changes in systolic and diastolic pressures causing a marked diminution in the pulse pressure. After the crisis the systolic and diastolic pressure curves separate somewhat irregularly until the patient's normal is reached. These movements of the curves may vary according to the onset of complications or to an increase in the severity of the case. Some complication occurs in approximately one out of five cases, not taking into consideration pneumonia migrans which occurs in approximately 30 per cent. of cases. Among the more frequent complications is empyaema and to a less extent pericarditis. The chances of surviving a Type i pneumonia are good, only one in ten dying, and as a rule young men run but little risk. Death may result from primary cardiac failure or from cardiac failure following upon toxæmia, or from a combination of one or both of those and a complication. The latter is the least common cause and the first two are of much the same frequency as a cause of death. The majority of the cases who recover feel very fit when re-examined although approximately one in five of those patients carry the infecting organism for some time, varying from 2 months to a year as far as is known. A considerable number of such patients are found to have some abnormality of the ear, nose or throat, but similar abnormalities are found in the cases who do not carry the organism, and it is found that a member of either class is

occasionally associated with cases of pneumonia amongst his friends.

Type ii Lobar Pneumonia.

This is found in men of all ages occurring in younger men with a frequency somewhat similar to the Type i infection, but with considerably less frequency in middle aged men although it is twice as common as the Type i infection in men over 45 years of age. A history of exposure to infection is much less common than is found in Type i cases. Three out of four cases have a sudden onset commencing with a rigor and followed by giddiness, pain in the side, headache, sickness and cough, and these are of such severity that the case is admitted as a rule early in the course of the illness, usually by the 2nd or 3rd day. The right lung is usually affected, although a little less commonly than is the case in the Type i infection and as in it the lower lobes are most often affected. Migratory pneumonia is slightly less frequent than in Type i cases but when it does occur it spreads with equal facility from lobe to lobe and side to side. Herpes is present infrequently, occurring in about 3 out of 20 cases, but its presence is usually of good omen. The sputum is much the same as found in other cases but is more frequently finely aerated. The elevation of temperature develops more slowly than it does in the Type i infection but ultimately reaches a higher level, 103.8°F. on the 4th day, which, however, is not maintained but runs thereafter between 100.8°F. and 101.8°F. until it settles, usually by lysis. Pseudo-crisis is of common occurrence. The duration of pyrexia is slightly longer than occurs in Type i cases, being just under 8 days. The pulse rate is slightly disproportionate to the temperature during the first few days, being very frequent, and it falls but slightly until about 2 days after the peak of the temperature curve, after which it reaches a level more proportionate to the temperature. Severe dyspnoea and

cyanosis are more frequently present than in Type i cases and severe dyspnoea is more often noted than a similar degree of cyanosis. Toxaemia of marked degree is more frequent than is found in the Type i case and as a result the facies and decubitus are often more striking than found in cases due to Type i or Group iv organisms. The organism can be grown from the blood in approximately one in five cases, most frequently in the 2nd and 3rd days of illness. The ability to do this is of bad omen for half of such cases die. The leucocyte response is fair during the first four days but falls markedly thereafter around the 5th day. This is followed by a slowly developing response which continues till the 11th day, when it is between 17-18 thousand cells per c. mm. before it commences to return to normal. The response is never so marked as in Type i cases but it is continued for a day or two longer. The blood pressure changes are similar to those in Type i infections but show more frequent variations on account of the greater severity of the infection. Complications arise with much the same frequency as in Type i cases but appear to involve surfaces, epiblastic in origin, more frequently. The chances of recovery are not so good in Type ii infections, the case mortality being almost twice as great as in Type i cases. Young and old men are liable to die but the risk increases greatly with age. The cause of death is toxaemia in two thirds of the cases and primary cardiac failure and anoxaemia account for the remainder. Of the cases who recover the greater number feel and look well on re-examination, although there are fewer who feel very fit and more who are poorly than occur in Type i cases on re-examination. One in four of these cases carry the infecting organism at some time after dismissal, varying from 2 months to a year, and they carry the organism more persistently than do the Type i cases. Abnormalities of the ear, nose and throat similar to those found in Type i cases are usually present both in carriers and non-carriers but a greater number of the Type

ii carriers are associated with fresh cases amongst their friends than are the Type i cases.

Group iv Lobar Pneumonia.

This is usually found in men below aet 30 years and above aet 45 years and there is fairly frequently a history of exposure to infection. Such a history is only half as common as in Type i cases but is almost twice as frequent as found in Type ii cases. A story of sudden onset is given in the majority of cases but subacute onset is much more common than in the other types. The appearance of symptoms is usually in the following order:- rigor, giddiness, pain in the side, sickness, headache, and cough, and they are of sufficient severity to have the patient admitted to hospital on the 2nd day. The site of the lesion is usually in the left lung in the lower lobe and when a migratory pneumonia occurs, which it does in approximately one in five cases, it usually spreads to a lobe on the same side. Herpes is not common in a Group iv infection about one in eight cases displaying the vesicles. The sputum is similar to that found in pneumonia due to the other types, being bloody in the early days and changing through various tones of colour to rusty and finally yellowish plugs. There is a sharp elevation of temperature reaching its highest point around 102.8°F. on the first day of illness and thereafter it falls slowly to normal, crisis being only slightly more frequent than lysis as the mode of defervescence. The duration of pyrexia is similar to that found in a Type i case, being 7½ days. The pulse curve is slightly disproportionate to the temperature curve for the first few days, running at a frequency around 120 beats per minute before falling to a more proportionate figure on the 4th and 5th days of illness. The dyspnoea and cyanosis are usually slight to moderate, the dyspnoea being more marked as a rule, and whilst toxæmia is slight to moderate also, there are a considerable number of cases where it is

marked. The infecting organism can be grown from the blood in approximately one out of seven cases and this bacteraemia is not markedly present at any particular period of the illness. When it is possible to grow the organisms the outlook is considerably darkened for 2 out of 5 such cases die. The leucocyte response to the infection is marked during the first two or three days and thereafter falls rapidly before the response becomes more marked again on the 7th and 8th days. This is not maintained, however, but falls to a level usually below that found in Type i and Type ii infections at the corresponding day of illness. The blood pressure changes resemble those found in the pneumonias due to the other types and complications appear with a frequency almost similar to that found in Type i and Type ii cases. The risk of death is slightly greater than in a Type i infection, and this applies to both old and young men but more especially to the latter. Toxaemia is most frequently the cause of death. When the cases who recover return for re-examination the majority feel well and a few state that they feel in excellent health. Three quarters of those cases carry the infecting organism after dismissal and greater numbers of them carry the organism for longer periods than do similar Type i and Type ii cases. Also like the similar Type i and Type ii cases they show abnormalities of the upper respiratory tract, recurring colds and chronic bronchitis being especially prevalent.

It is impossible to give a composite picture of a typical Type iii case on account of the scarcity of such cases in the consecutive series examined clinically, but from observation of such cases which have been admitted outwith the period of investigation a number of conclusions have been reached. It seems probable that this infection is most commonly found in older and debilitated men who are suffering from some pathological state such as tumour of the lung or chronic nephritis or some form of tuberculosis. The risk of death is considerable

and this is especially marked in cases who show bacteraemia which occurs in a large proportion of the cases.

V. 30. Summary.

Lobar Pneumonia has been considered on a number of grounds:-

- (a) Clinical,
- (b) Epidemiological,
- (c) Bacteriological, and to a less extent
- (d) Pathological,

and the conclusion has been reached that it is a specific infective disease which is consequent upon the invasion of the susceptible individual by the pneumococcus of which there are four serological types, each of which produces a different clinical picture.

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Practice of Med.
- (30) Gibson, G., (1908), Edin. Med. Journ., (new series),
xxiii.
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- (32) M'Dowall, R.J.S., (1931), Science of Signs and Symptoms.
- (33) Ritchie, W.T., (1931), Trans. of Roy. Med.-Chir. Socy.,
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- (34) Wright, S., & Vincent, S., (1926), Applied Physiology.
- (35) Smeall, J.T., (1931), B.M.J., April 18, p. 661 et seq.
- (36) Muir, R., & Ritchie, Jas., (1921), Manual of Bacteriology.
- (37) Poulsson, E., (1924), Text Book of Pharmacology and
Therapeutics.
- (38) Dawson, Lord., (1931), Lancet, Mar. 14.

- (39) Murchison, Chas., (1884), Treatise on the Continued Fevers of Gt. Brit.
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- (41) Thomas, W.S., (1921), J.A.M.A., 77.
- (42) Lamar, R.V., & Meltzer, S.J., (1912), Jour. Expt. Med., xv, p. 133.
-

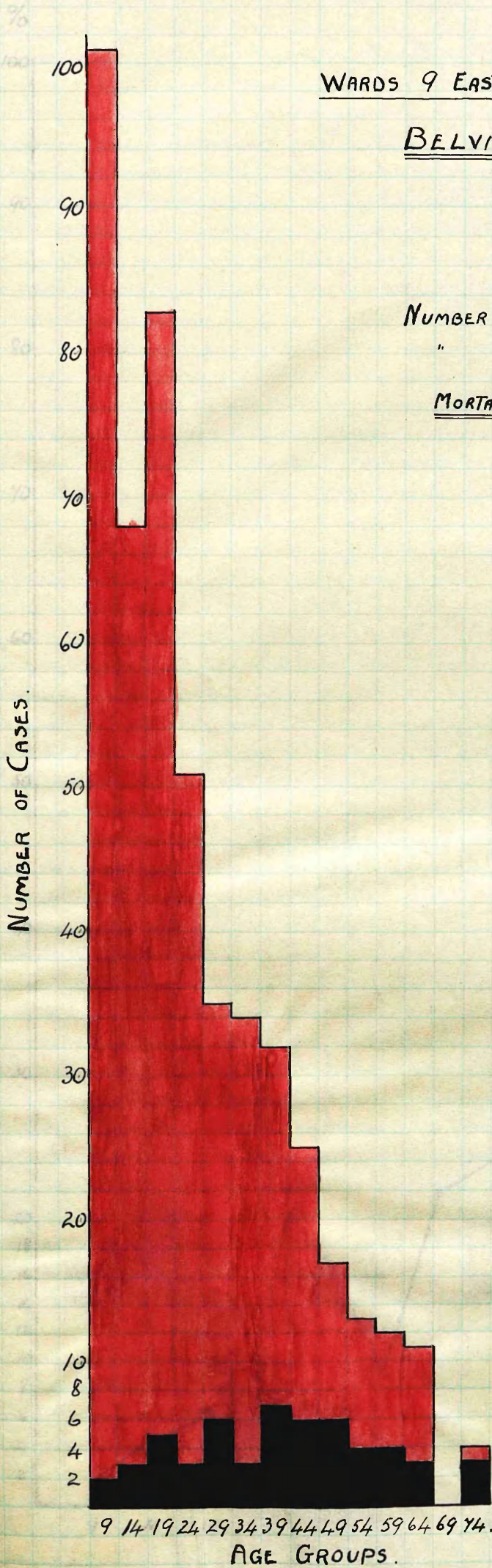
HISTOGRAM SHOWING AGE INCIDENCE AND MORTALITY

I.

OF 486 CASES OF LOBAR PNEUMONIA.

WARDS 9 EAST AND 10 EAST,

BELVIDERE. FEB. 1930 — SEPT. 1931.



NUMBER OF CASES. = 486.

" " DEATHS. = 55.

MORTALITY. = 11.32%.

GRAPH TO SHOW MORTALITY PER CENT.

II.

486 CASES IN AGE GROUPS.

IN THE THREE GROUPS:

1. 216 Cases of Acute Pneumonia
2. 171 Cases of Acute and Chronic Infectious Mononucleosis
3. 99 Cases of Group No. 2 which had Positive Blood Culture.

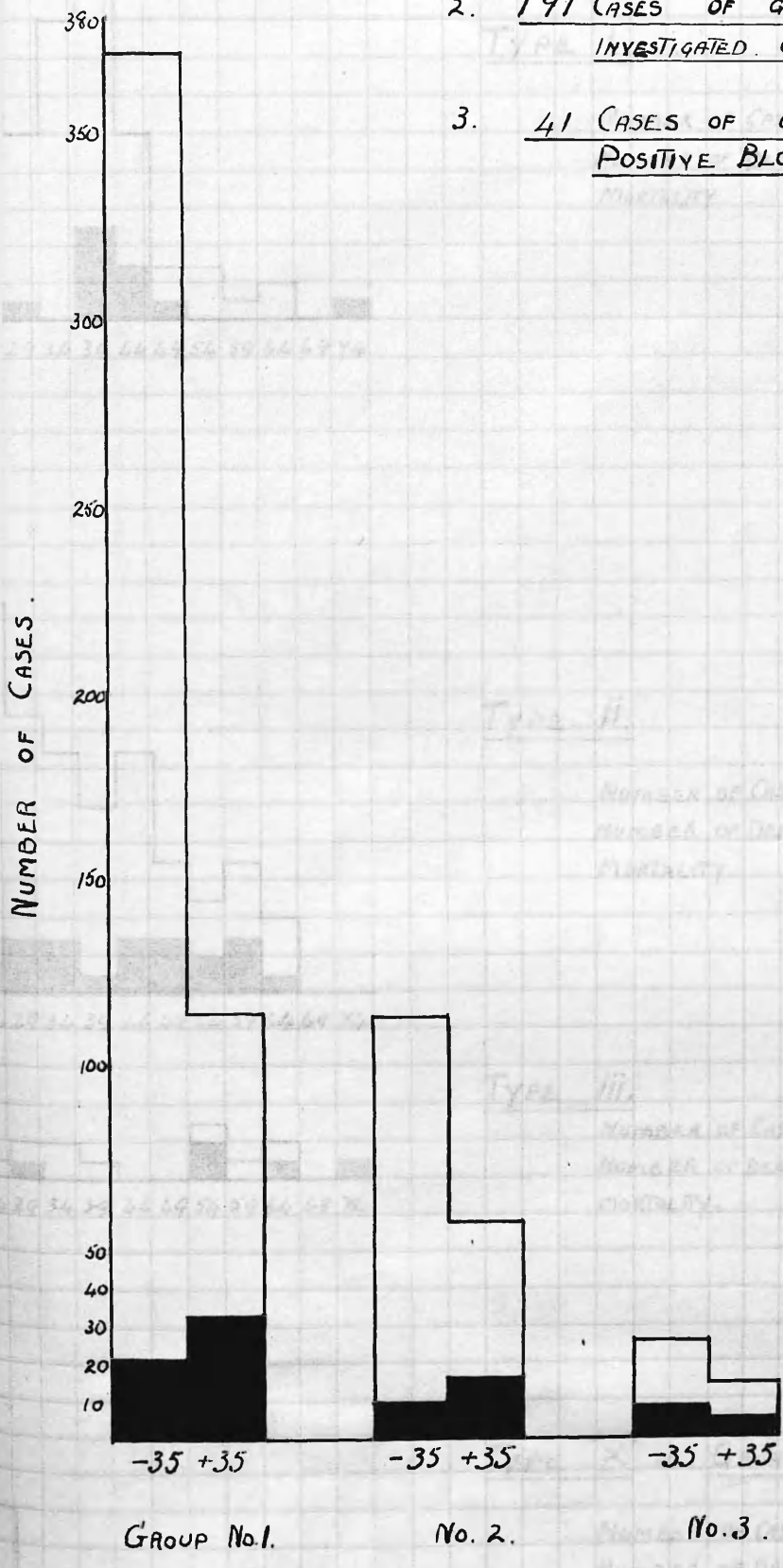


HISTOGRAMS SHOWING:

CASE INCIDENCE AND MORTALITY BELOW AND ABOVE AGE 35 yrs..

IN THE THREE GROUPS:-

- 1. 486 CASES OF LOBAR PNEUMONIA.
- 2. 171 CASES OF GROUP No.1 WHICH WERE INVESTIGATED CLINICALLY.
- 3. 41 CASES OF GROUP No.2 WHICH HAD POSITIVE BLOOD CULTURE.



Type II.

Number of Cases = 124
Number of Deaths = 26
Mortality = 21%

Type III.

Number of Cases = 14
Number of Deaths = 5
Mortality = 35%

GROUP No.1.

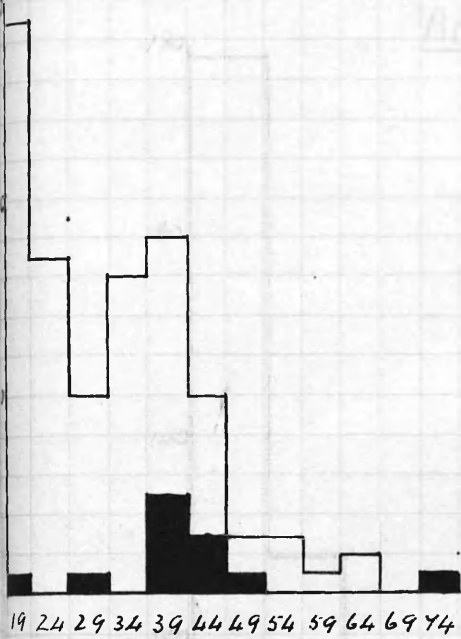
No. 2.

No. 3.

HISTOGRAMS SHOWING AGE INCIDENCE AND MORTALITY

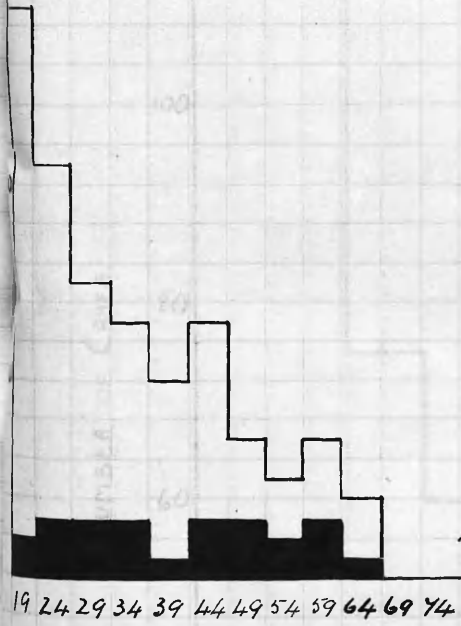
OF
TYPE i, TYPE ii, TYPE iii, AND GROUP iv PNEUMONIA CASES.

TOTAL NUMBER OF CASES = 317.
 NUMBER OF DEATHS = 50.
MORTALITY = 15.44%



TYPE i.

NUMBER OF CASES = 110. = 34.4%.
 NUMBER OF DEATHS = 12.
 MORTALITY = 10.9%.



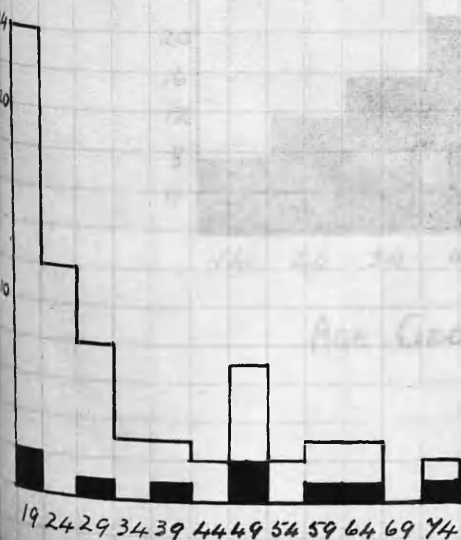
TYPE ii.

NUMBER OF CASES = 124. = 39.1%.
 NUMBER OF DEATHS = 24.
 MORTALITY = 19.36%.



TYPE iii.

NUMBER OF CASES = 14. = 4.41%.
 NUMBER OF DEATHS = 5.
 MORTALITY = 35.4%.



TYPE "X" OR GROUP iv.

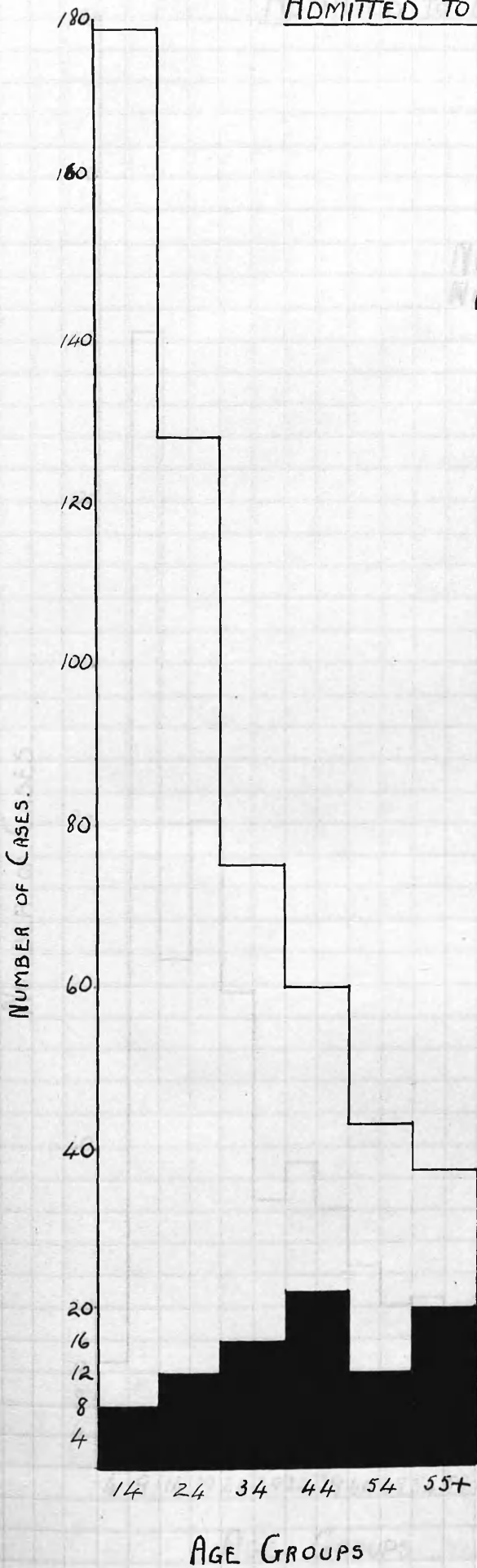
NUMBER OF CASES = 69. = 21.46%.
 NUMBER OF DEATHS = 9.
 MORTALITY = 13.05%.

AGE GROUPS.

HISTOGRAM SHOWING AGE INCIDENCE AND MORTALITY V.

OF ALL CASES OF LOBAR PNEUMONIA (MALE AND FEMALE)

ADMITTED TO BELVIDERE IN THE YEAR 1930.



NUMBER OF CASES. = 518.

NUMBER OF DEATHS. = 91.

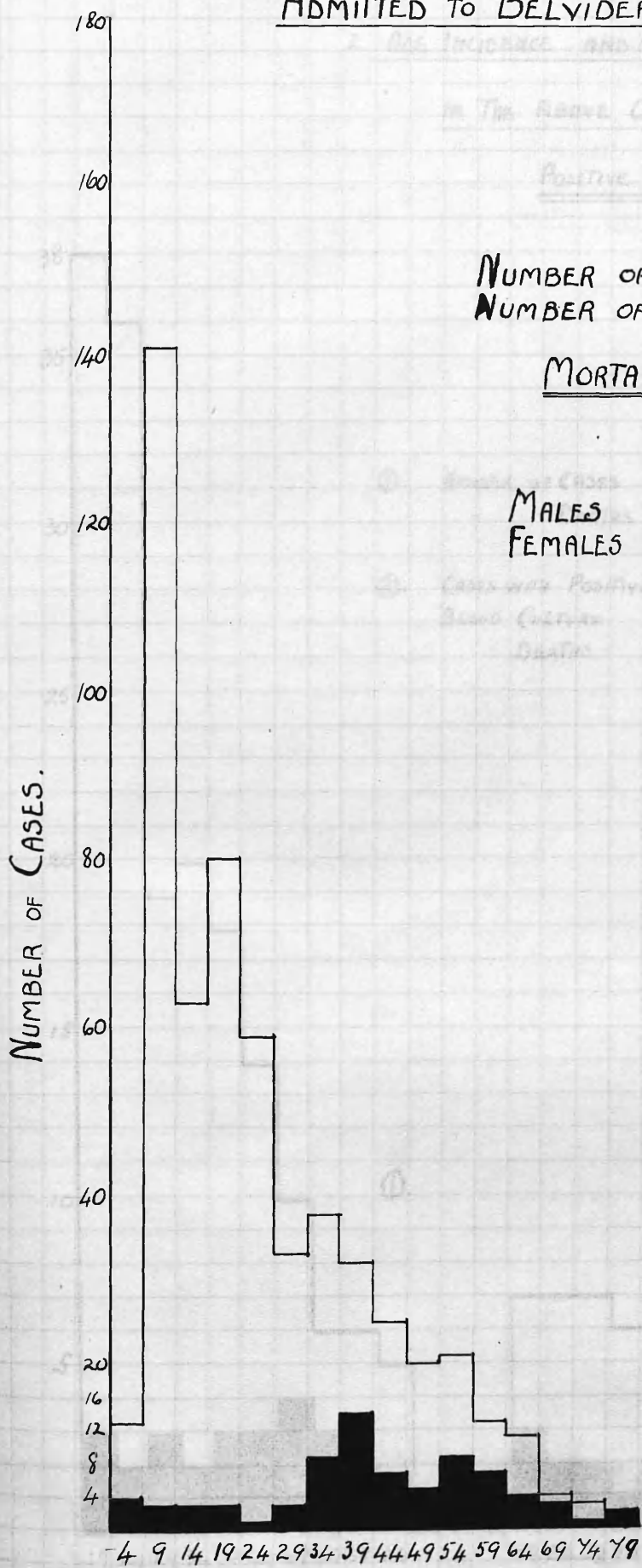
MORTALITY = 17.57%.

	Adms.	DEATHS.	
MALES =	414	49	= 19.1%
FEMALES =	104	12	= 11.5%

HISTOGRAM SHOWING AGE INCIDENCE AND MORTALITY VI.

OF ALL CASES OF LOBAR PNEUMONIA (MALE AND FEMALE)

ADMITTED TO BELVIDERE IN THE YEAR 1931.



NUMBER OF CASES = 558.
 NUMBER OF DEATHS = 78.

MORTALITY = 13.97%.

	Adms.	DEATHS	
MALES =	436	64	= 14.67%
FEMALES =	122	14	= 11.48%

AGE GROUPS

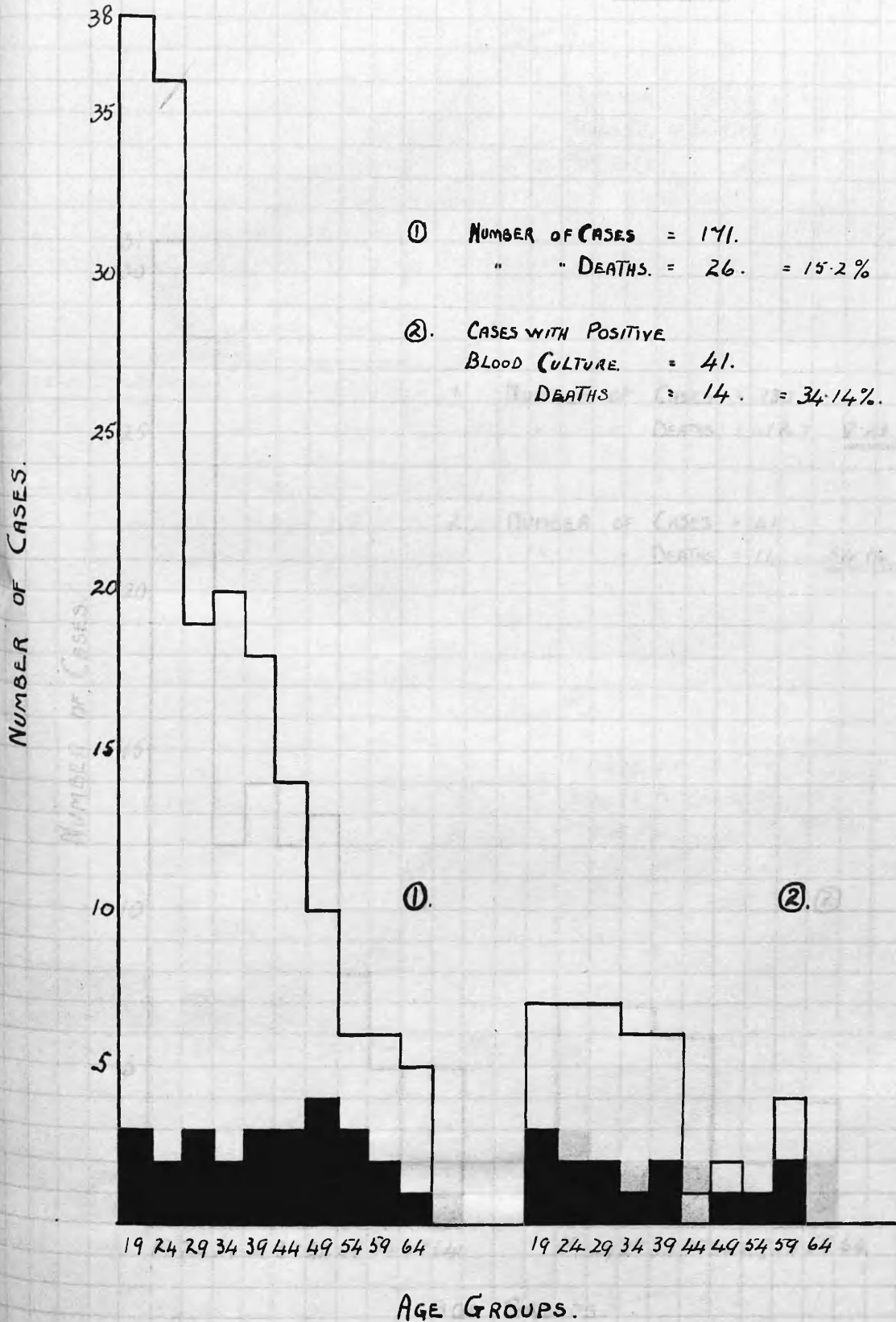
HISTOGRAMS SHOWING :-

1. AGE INCIDENCE AND MORTALITY OF GROUP
OF 171 CASES.

2. AGE INCIDENCE AND MORTALITY OF THE CASES

IN THE ABOVE GROUP, WHICH GAVE

POSITIVE BLOOD CULTURES.

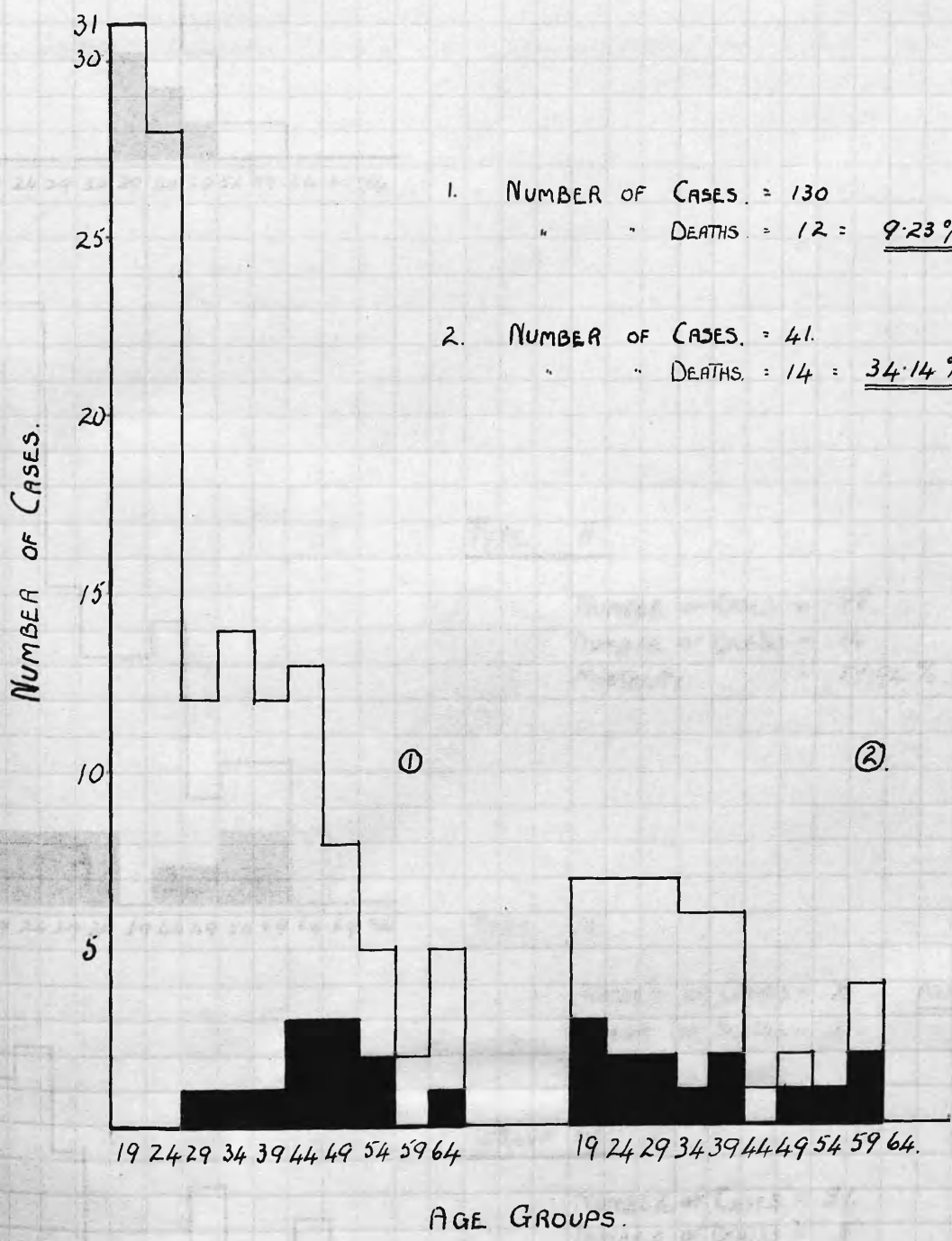


HISTOGRAMS SHOWING:-

1. AGE INCIDENCE AND MORTALITY OF CASES WITH NEGATIVE BLOOD CULTURES.
2. AGE INCIDENCE AND MORTALITY OF CASES WITH POSITIVE BLOOD CULTURES.

TYPE I.

Number of Cases = 60
 Number of Deaths = 6
 Mortality = 10%

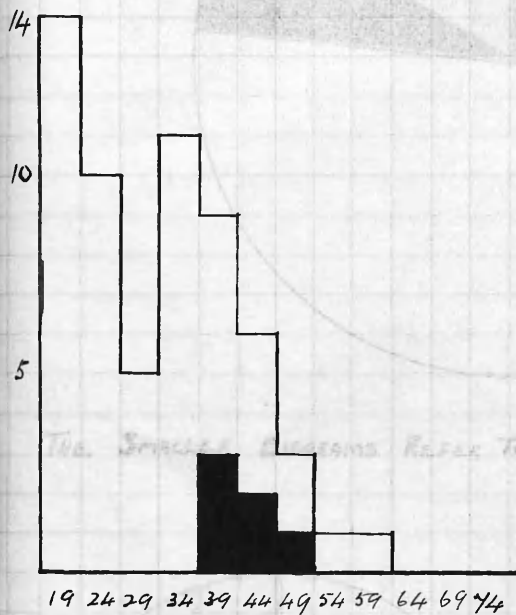


1. NUMBER OF CASES = 130
 " " DEATHS = 12 = 9.23%
2. NUMBER OF CASES = 41
 " " DEATHS = 14 = 34.14%

AGE GROUPS.

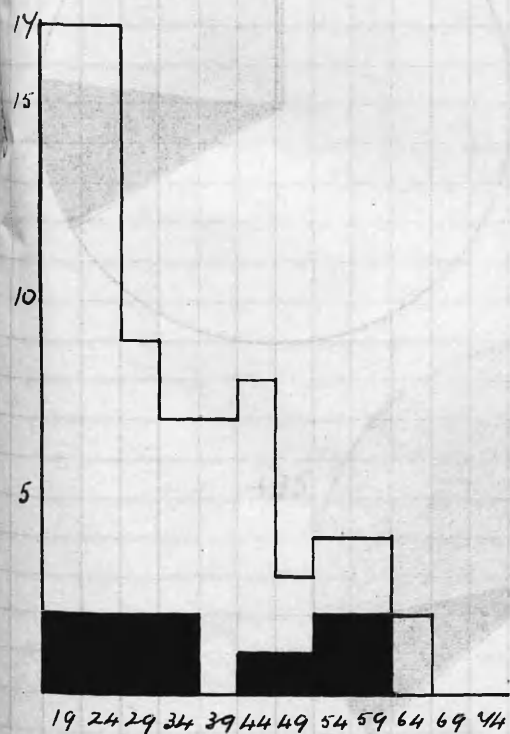
HISTOGRAMS SHOWING AGE INCIDENCE AND MORTALITY
OF THE
GROUP OF CASES INVESTIGATED CLINICALLY.

TOTAL NUMBER OF CASES. = 171.
NUMBER OF DEATHS = 26.
MORTALITY. = 15.2%.



TYPE i.

NUMBER OF CASES = 60.
NUMBER OF DEATHS = 6.
MORTALITY. = 10%.



TYPE ii.

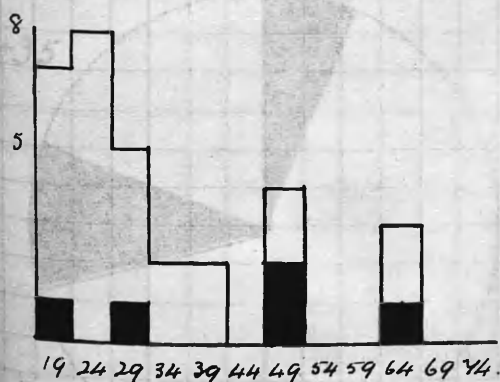
NUMBER OF CASES = 48.
NUMBER OF DEATHS = 14.
MORTALITY = 14.94%.

TYPE iii.

NUMBER OF CASES = 2. AGES = 52 AND 56 yrs.
NUMBER OF DEATHS = 1.

GROUP iv.

NUMBER OF CASES = 31.
NUMBER OF DEATHS = 5.
MORTALITY. = 16.12%.



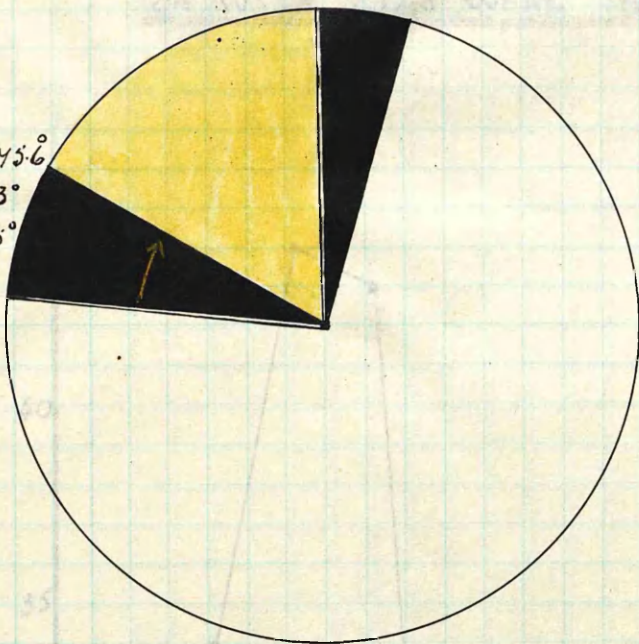
AGE GROUPS.

DIAGRAMS TO ILLUSTRATE INCIDENCE AND MORTALITY

X.

OF CASES ABOVE AND BELOW AET. 35 YEARS.

$360^{\circ} :: 372 : 245.6$
 $:: 22 : 16.3^{\circ}$
 $:: 33 : 24.5^{\circ}$



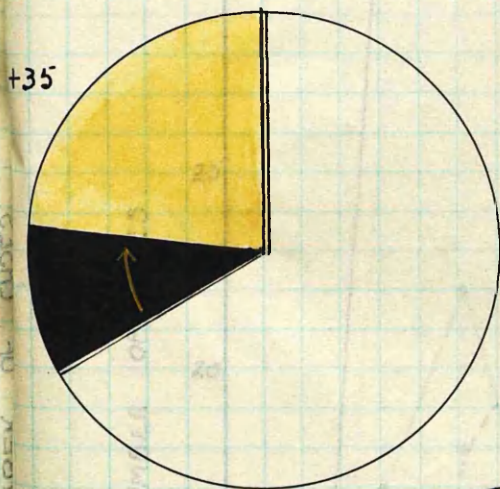
TOTAL CASES = 486

- 35 = 372
 + 35 = 114

DEATHS
 - 35 = 22
 + 35 = 33

THE SMALLER DIAGRAMS REFER TO THE OBSERVED GROUP OF 171 CASES.

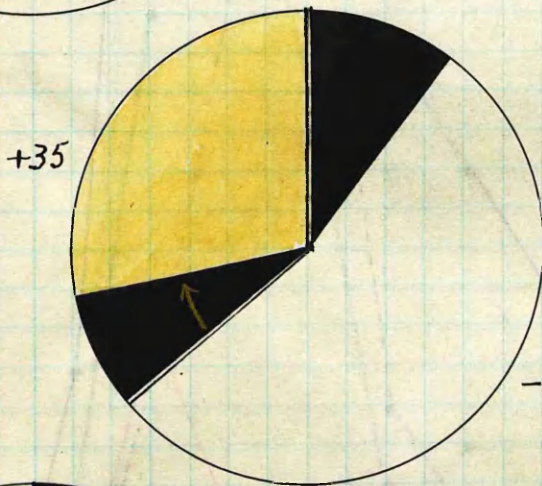
INFECTION YEAR NOTED ON THE 4th DAY OF ILLNESS



TYPE i

- 35 = 40 CASES.
 + 35 = 20 "

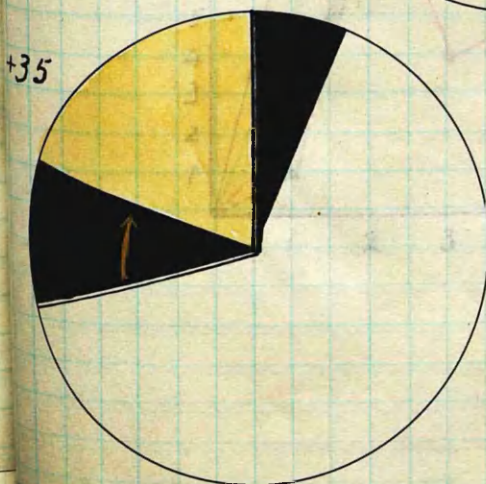
DEATHS
 - 35 = 0 "
 + 35 = 6 "



TYPE ii.

- 35 = 50 CASES
 + 35 = 28 "

DEATHS
 - 35 = 8 "
 + 35 = 6 "



GROUP IV.

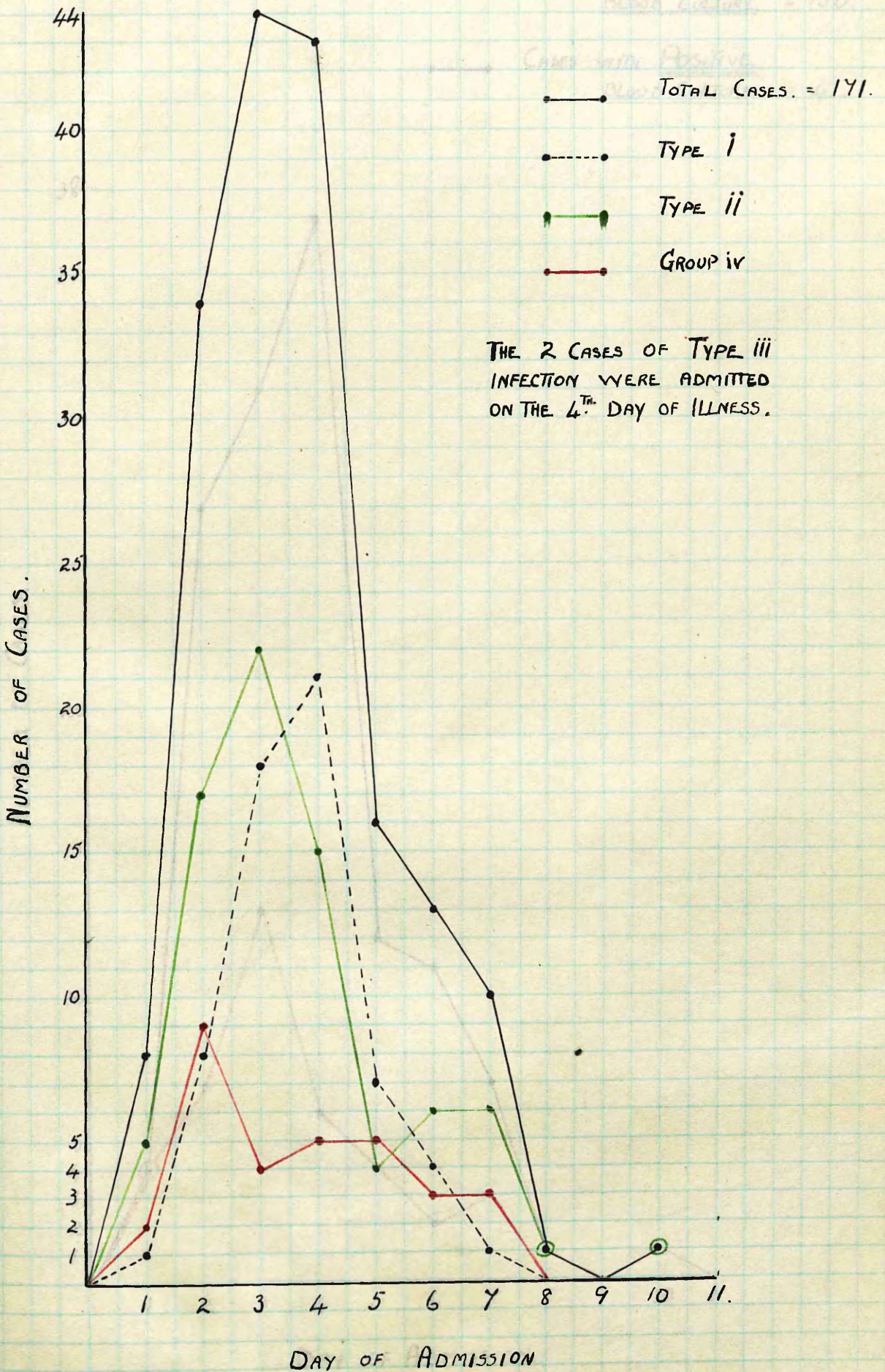
- 35 = 22 CASES.
 + 35 = 9 "

DEATHS.
 - 35 = 2 "
 + 35 = 3 "

- 35.

GRAPH TO ILLUSTRATE THE DAY OF ILLNESS

ON WHICH CASES WERE ADMITTED.



GRAPH TO ILLUSTRATE DAY OF ILLNESS

ON WHICH CASES WERE ADMITTED

FIGURES EXPRESSED AS PERCENTAGES

—●— CASES WITH NEGATIVE
BLOOD CULTURE. = 130.

—●— CASES WITH POSITIVE
BLOOD CULTURE. = 41.



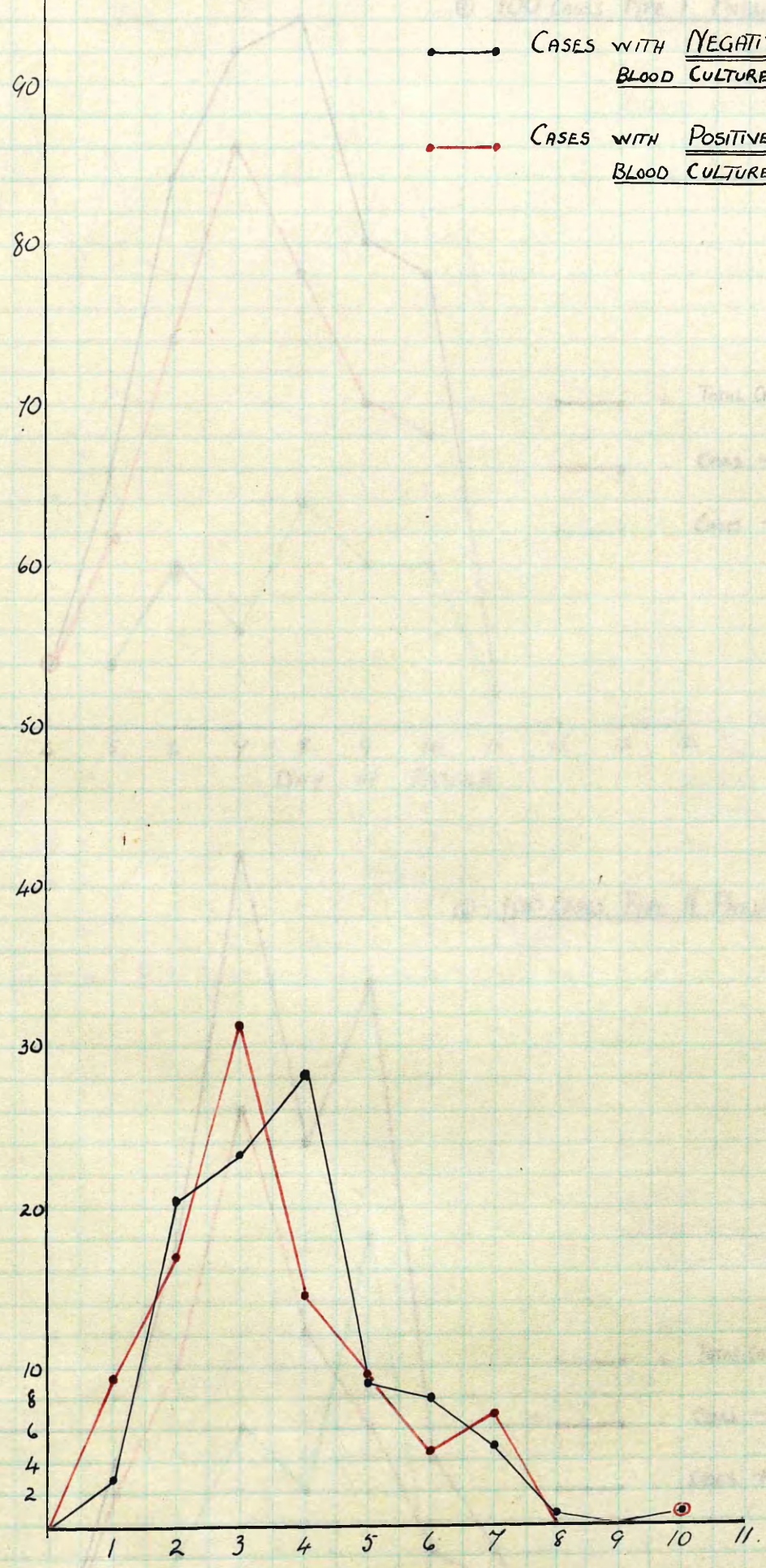
GRAPH TO ILLUSTRATE DAY OF ILLNESS

ON WHICH CASES WERE ADMITTED.

FIGURES EXPRESSED AS PERCENTAGES.

- — ● CASES WITH NEGATIVE BLOOD CULTURE.
- — ● CASES WITH POSITIVE BLOOD CULTURE.

NUMBER OF CASES

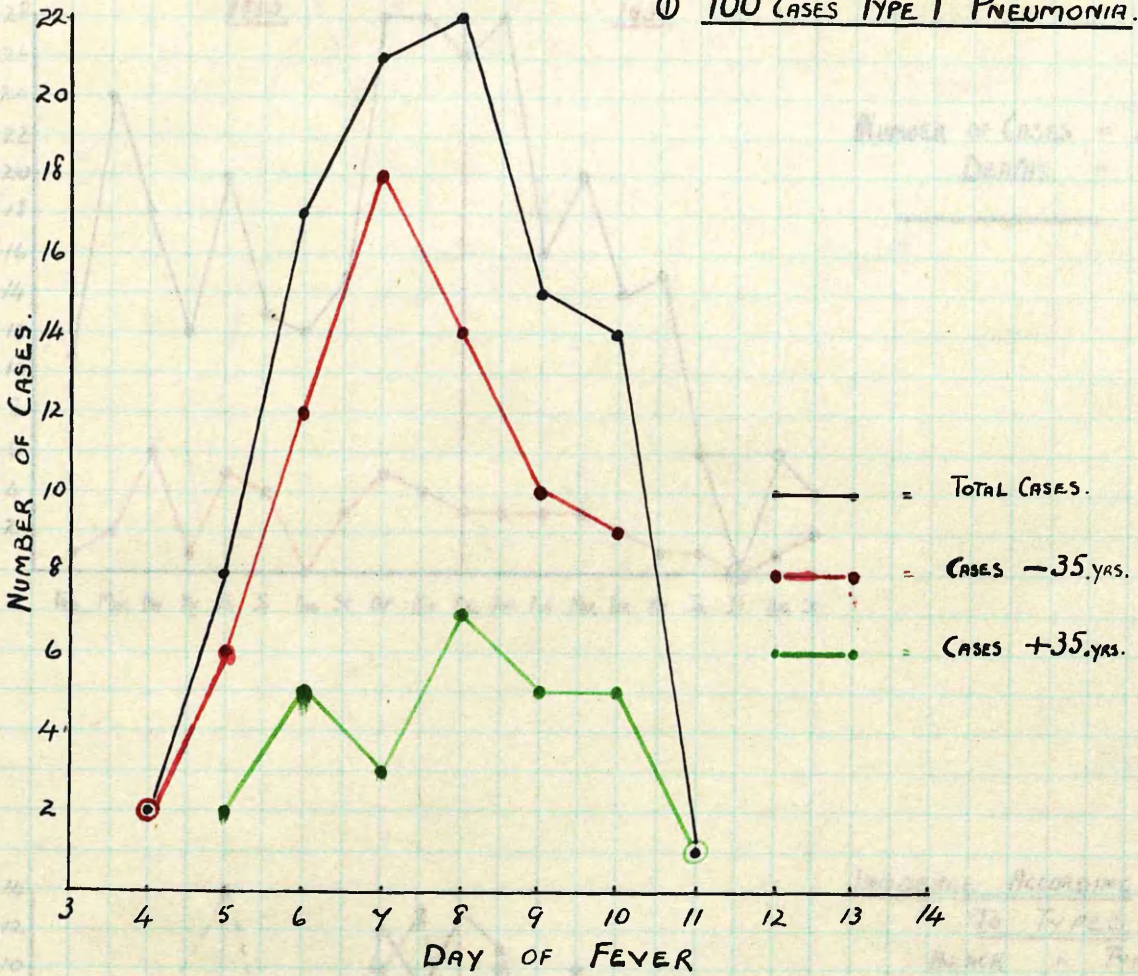


DAY OF ADMISSION.

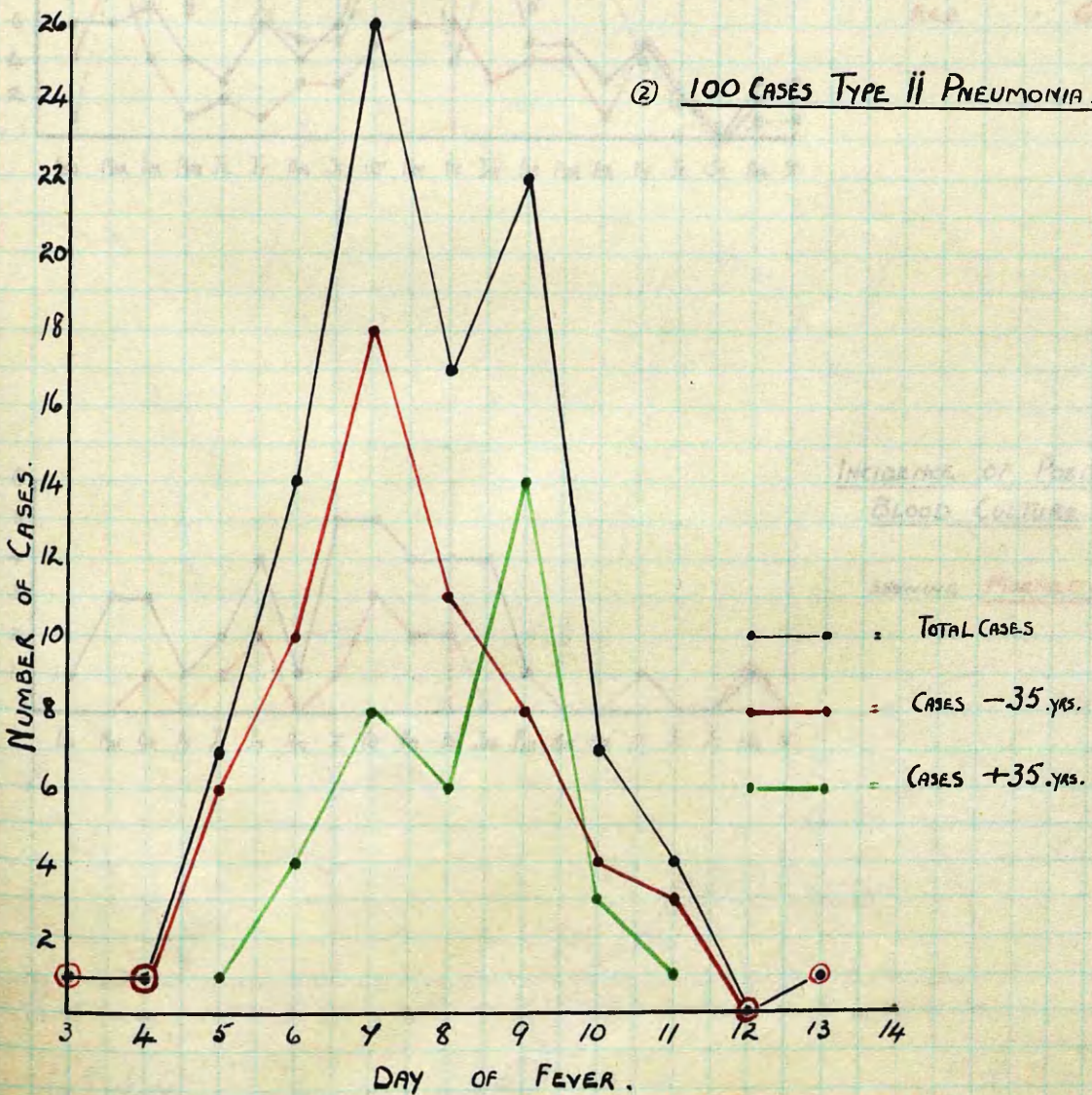
GRAPHS TO ILLUSTRATE DURATION OF FEVER.

IN

① 100 CASES TYPE I PNEUMONIA.

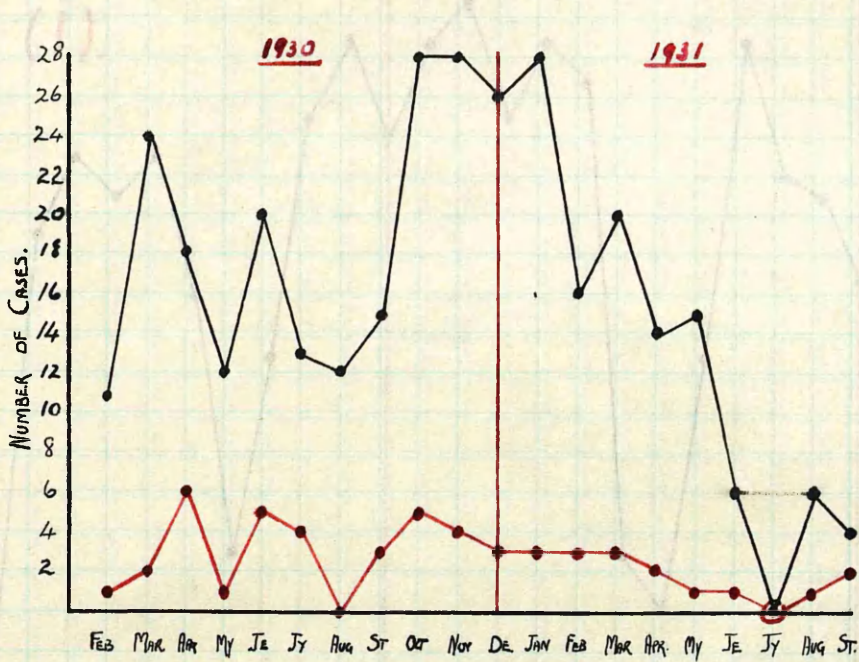


② 100 CASES TYPE II PNEUMONIA.

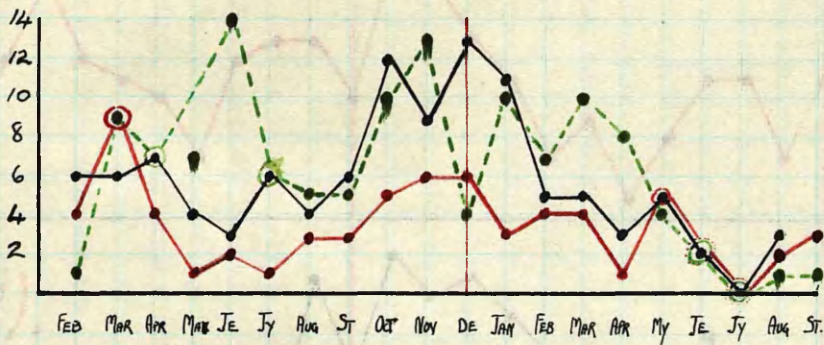


GRAPHS TO ILLUSTRATE

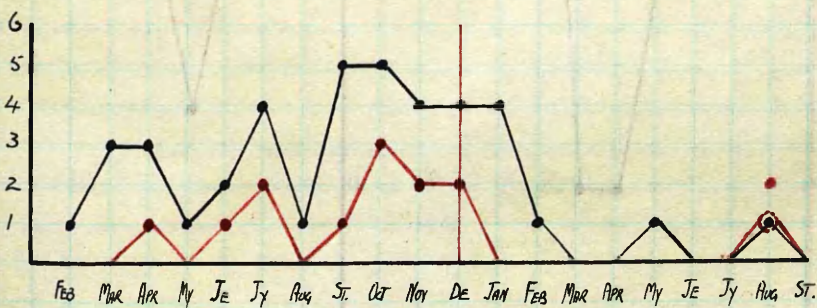
SEASONAL INCIDENCE.



NUMBER OF CASES = 317.
DEATHS = 50.



INCIDENCE ACCORDING TO TYPES.
BLACK = TYPE I
GREEN = " II
RED = GROUP IV



INCIDENCE OF POSITIVE BLOOD CULTURE.

SHOWING MORTALITY.

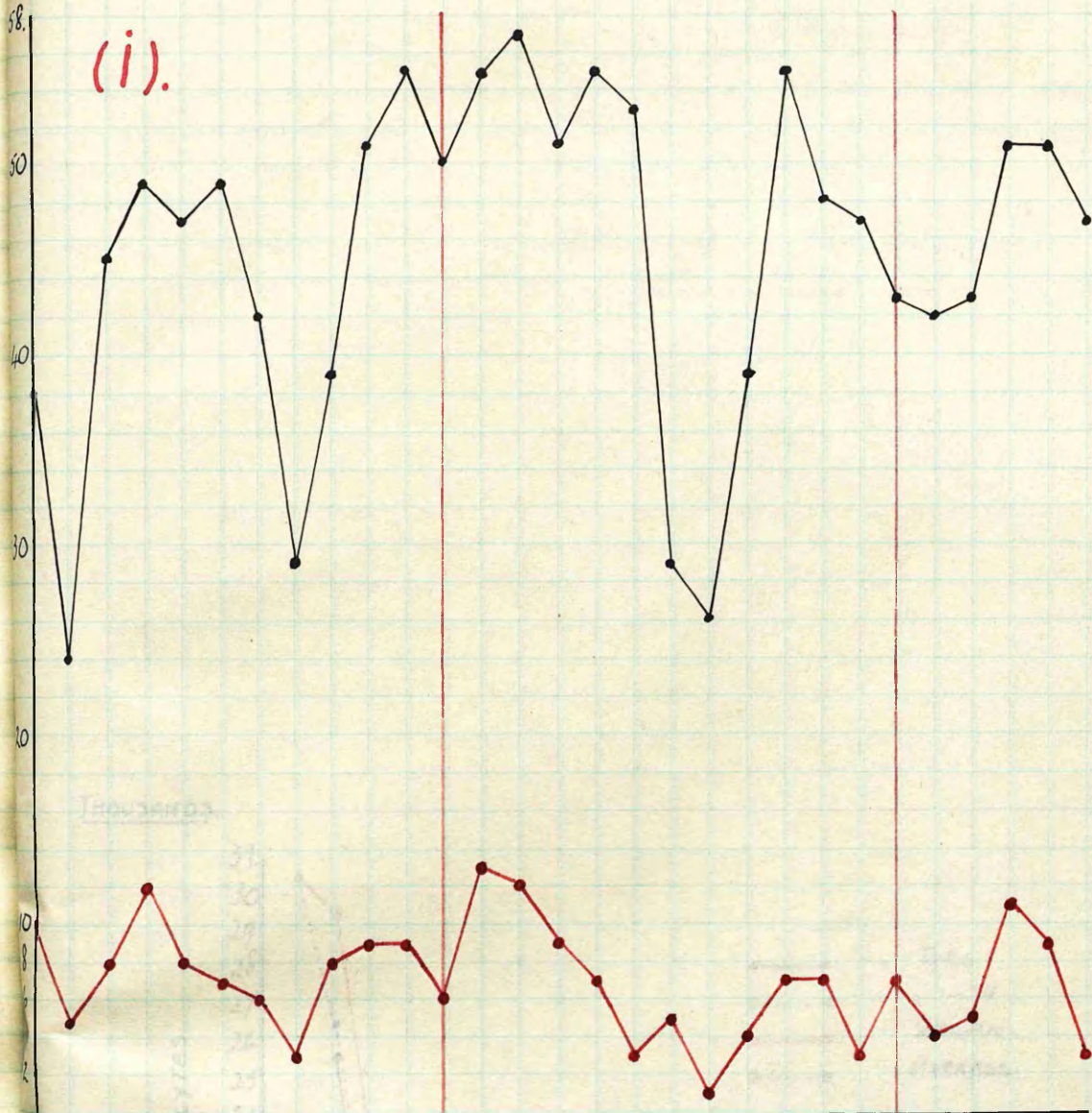
GRAPHS TO ILLUSTRATE SEASONAL INCIDENCE IN BELVIDERE

XVI.

OF (i). TOTAL CASES OF LOBAR PNEUMONIA AND (ii) MALE CASES OF PNEUMONIA.

IN
1930
1931
AND 5 MONTHS OF
1932

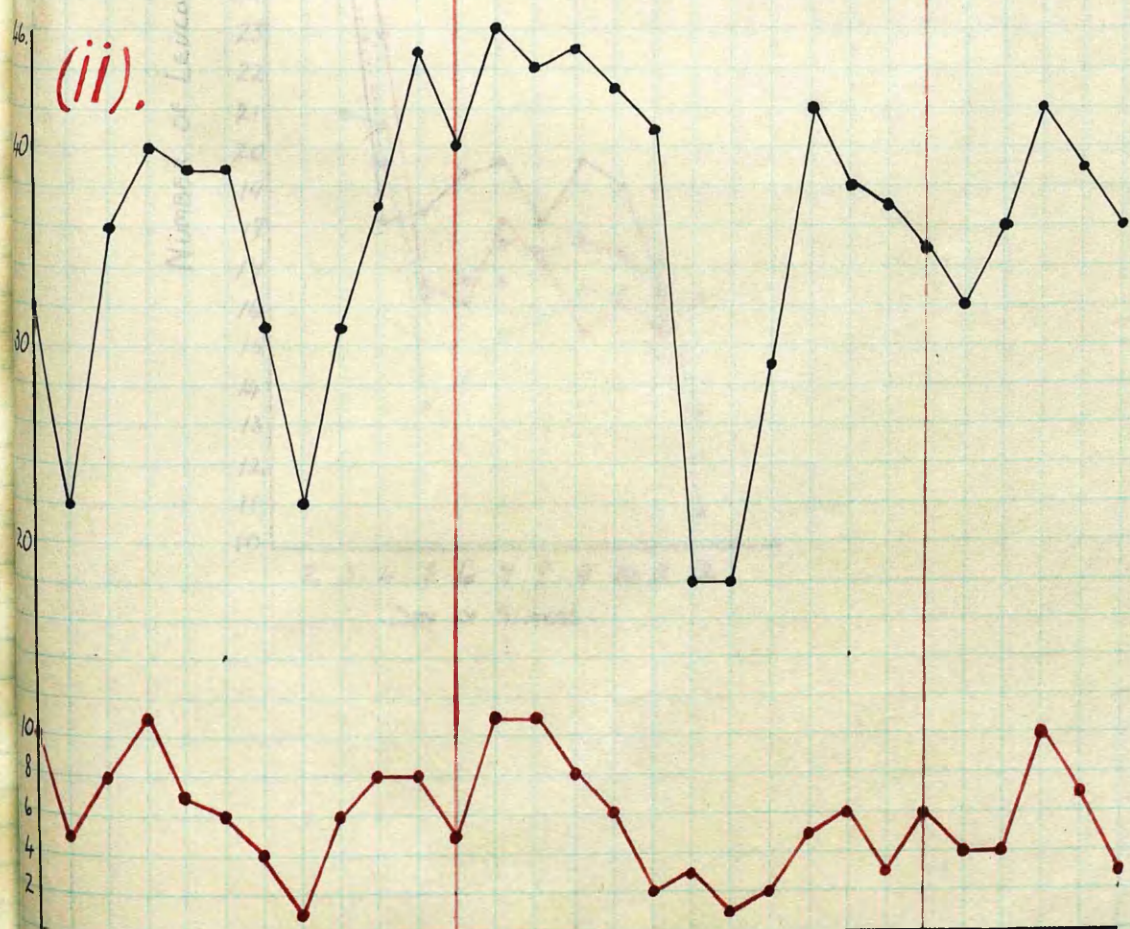
(i).



CASES = 1310.

DEATHS = 201.

(ii).



CASES = 1035.

DEATHS = 171.

Jan Feb Mar Apr May Jun July Aug Sept Oct Nov Dec Jan Feb Mar Apr May

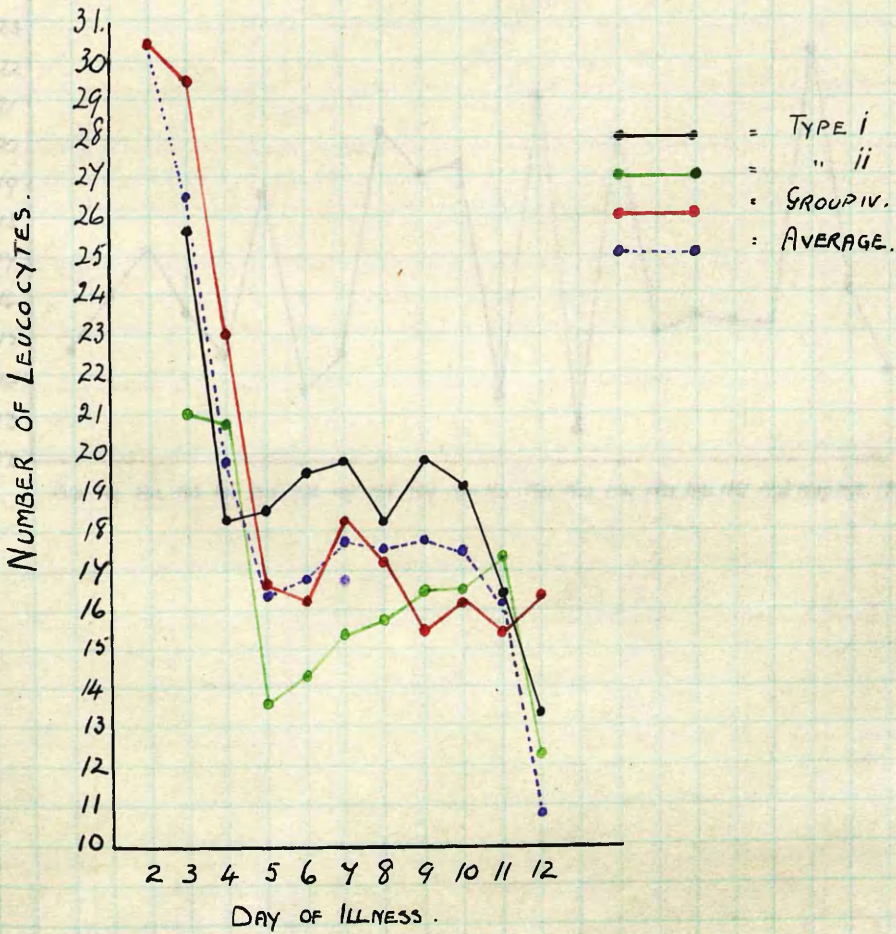
1930

1931

1932.

GRAPHS ILLUSTRATING LEUCOCYTOSIS

THOUSANDS.



(ANNUAL)
GRAPH TO ILLUSTRATE DEATH RATE PER MILLION

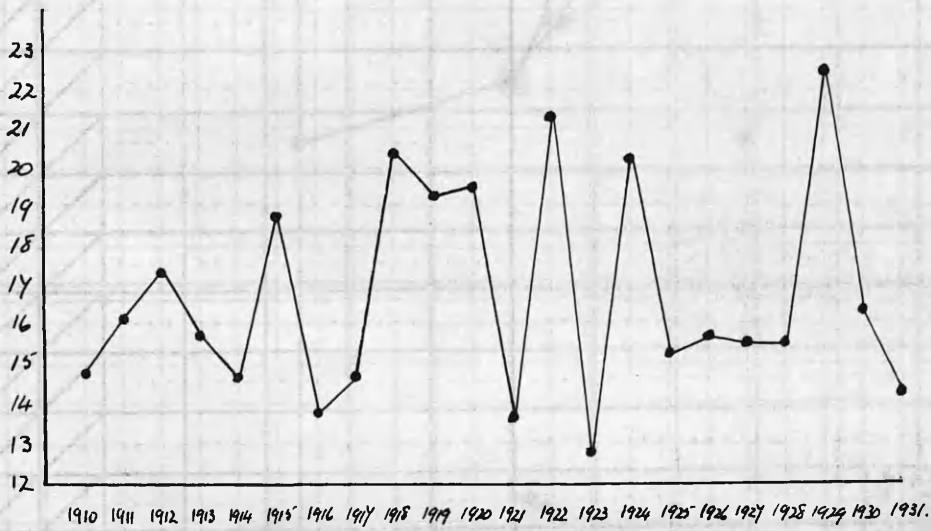
XVIII.

OF PNEUMONIA.

COMPILED FROM REPORTS OF THE MEDICAL OFFICER OF HEALTH

FOR THE CITY OF GLASGOW.

FROM 1910 TO 1931 INCLUSIVE.



THE AVERAGE TEMPERATURE CHART OF 60 CASES GROUP IV PNEUMONIA. AGES 15-71 YRS.

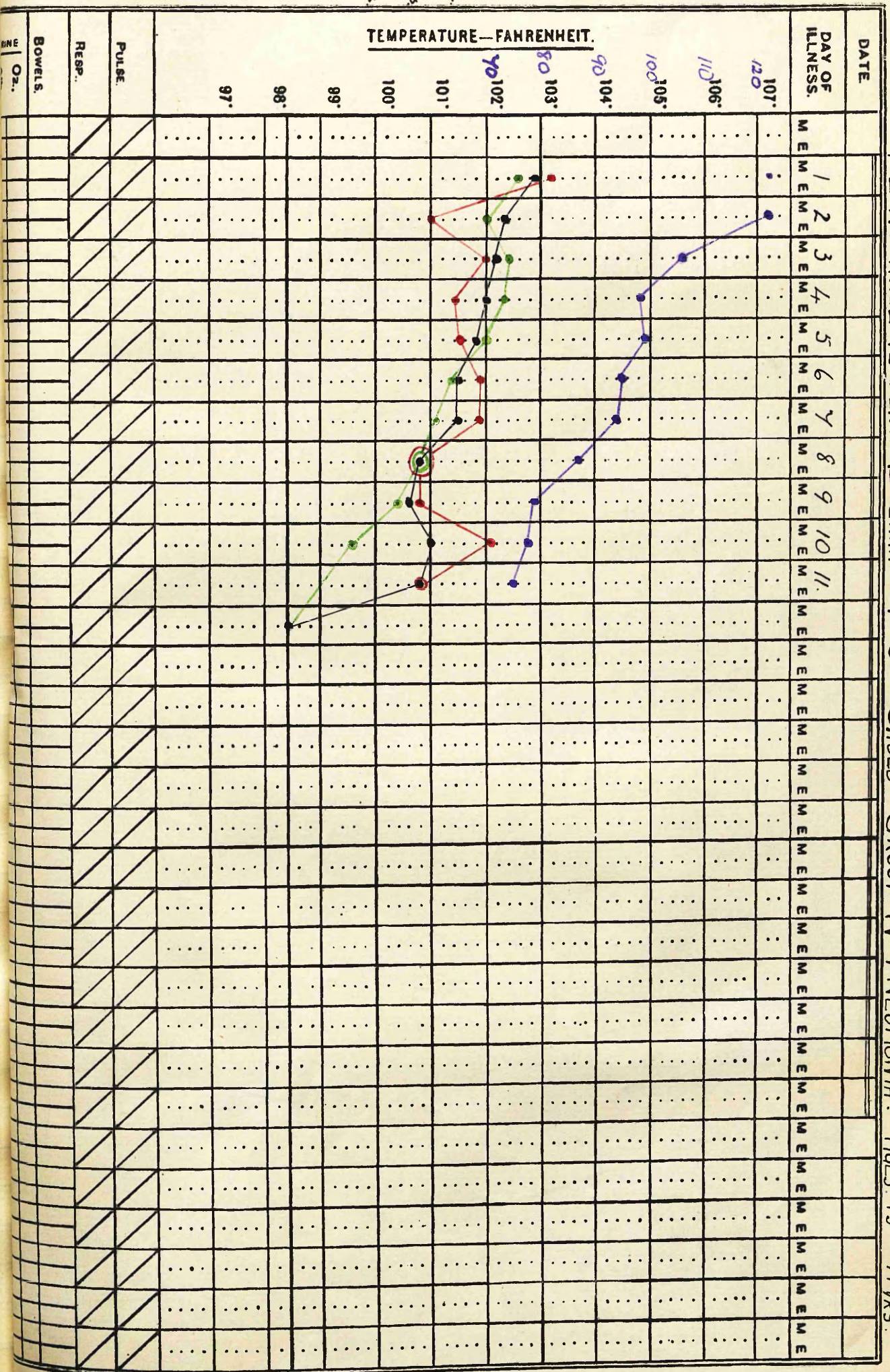


CHART A.

Ty.ii.

1057

A.

NAME ANDREW STEVART. AET 22yr ADDRESS WD 10E. ADMP 20 X 30. ADDRESS Nov. 1st Nov. 2nd Nov. 3rd Nov. 4th Nov. 5th Nov. 6th Nov. 7th Nov. 8th Nov. 9th Nov.

Date	20th	21st	22nd	23rd	24th	25th	26th	27th	28th	29th	30th	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
Day of Mo.	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

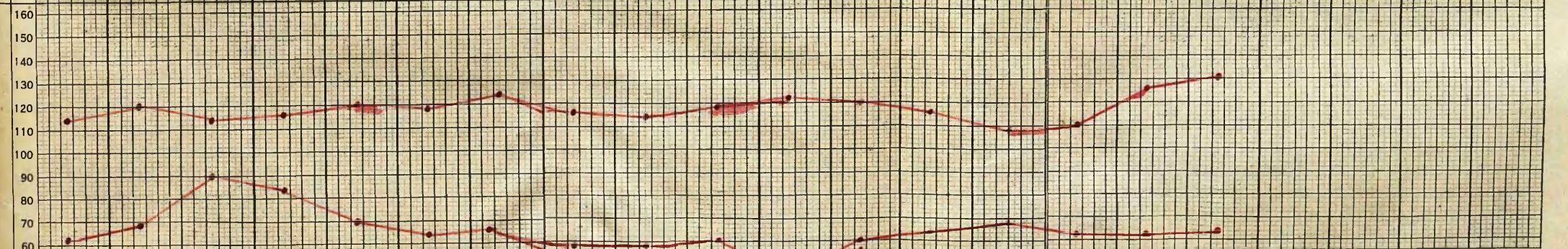
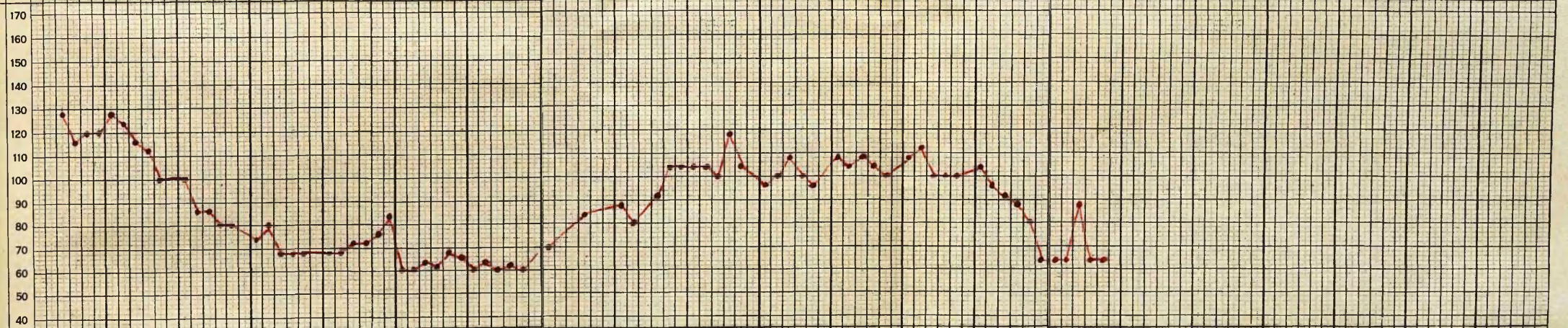
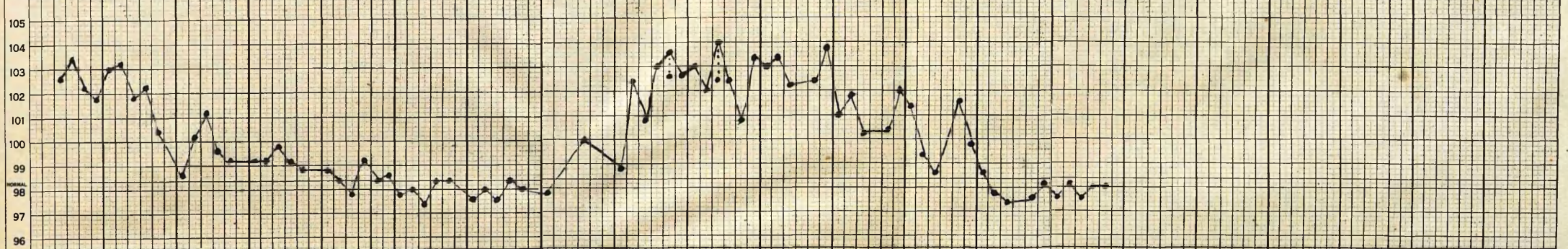


CHART B.

B.

B.

Ty. II
 NAME W^m. BAILLIE. AET. 22YRS ADDRESS W^m 10E. Adm^o 14.1.31.

ADDRESS.

Date	14 th	15 th	16 th	17 th	18 th	19 th	20 th	21 st	22 nd	23 rd	24 th	25 th	26 th	27 th
Day of Day	4	5	6	7	8	9	10	11	12	13	14	15	16	17

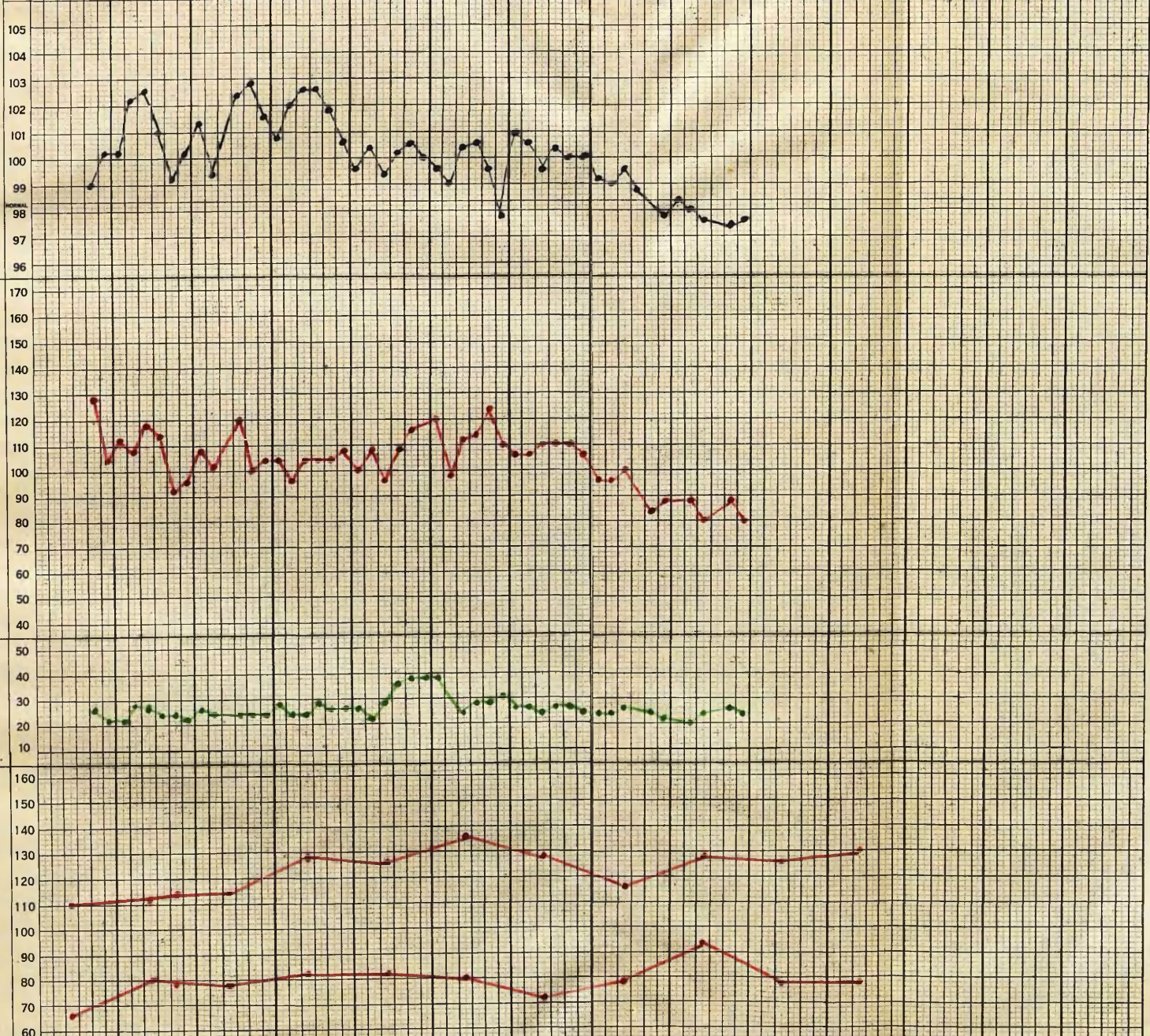


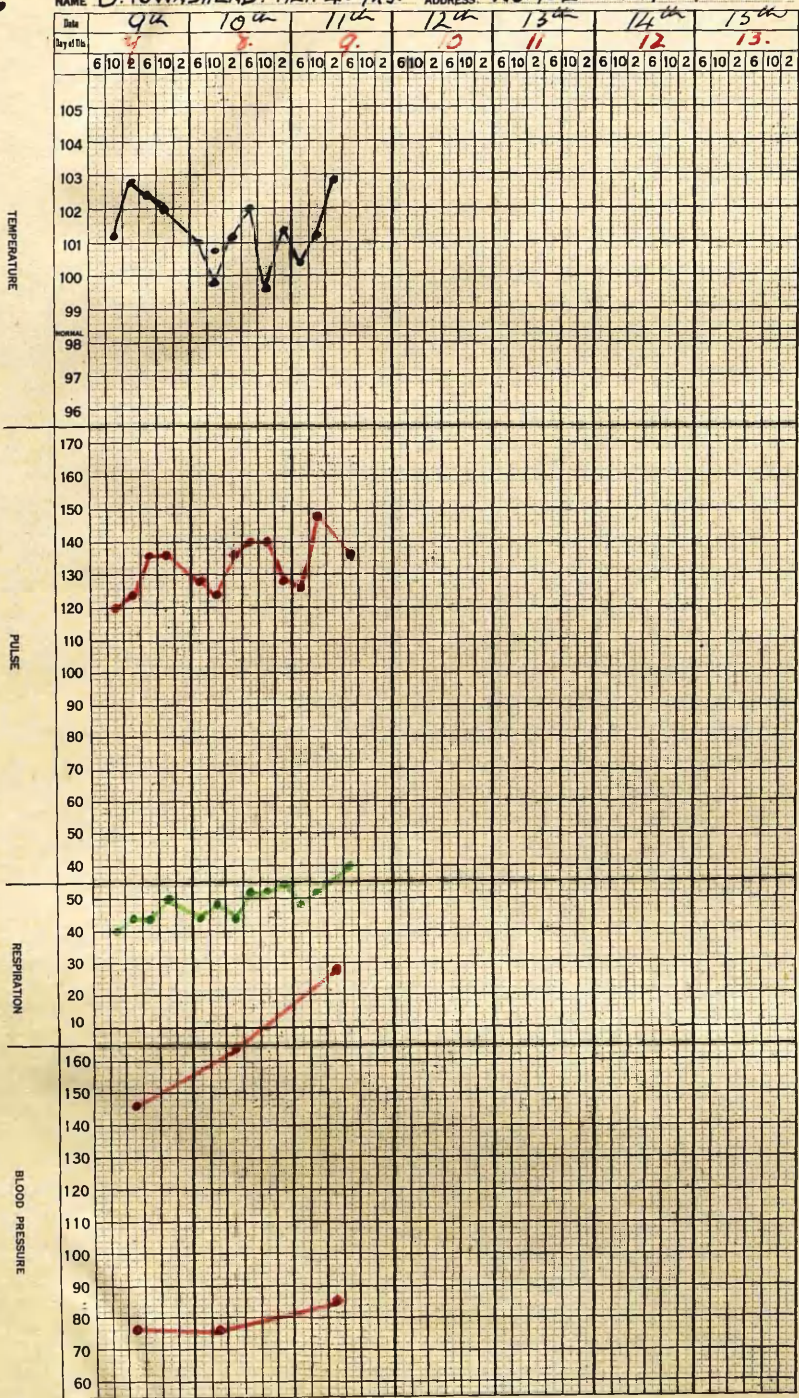
CHART D.

D.

SR. IV.

NAME D. TOWNSEND. AET. 45 YRS. ADDRESS NO. 10E. ADRY. 9. 1X. 31

D.



BELVIDERE HOSPITAL

Name:

CLARKSON, E. Z. V. 1932.

Mr. J. Doyle

Occupation:

Address: 6 Main St

Postal:

Soran

Type of House:

Dear sir,

Subject:

As you already know, I am extremely interested in all the patients who were in ward 10 East with pneumonia.

Mode of onset:

I am now investigating the conditions which follow

pneumonia, and I would be very indebted to you if you would answer the undernoted questions and return this letter to me.

Yours faithfully,

James W. Montgomery

Resident Medical Officer.

Any previous serum:

Address:

Post:

Isis, pseudo-crisis, etc.

1. Have you had any further attacks of pneumonia? _____

Asphyxia, toxemia, cardiac failure:

2. If so, how long were you ill? _____

Result:

and where were you nursed? _____ Duration _____

3.

Since you left the hospital have any of your friends or people with whom you come in contact had pneumonia? _____

4. If you answered "yes" to the last question, would you please give the number affected? _____

PNEUMONIA.

6908

Institution : Ward : J. : P. : Date Admitted :

Certified by Dr. : Date of Onset :

Name : Hours :
Age :

S.M.W. : Occupation :

Address : Position : Municipal Ward :

Size of House : Inmates—Adults : Children :

Acute : Sub-acute :

Possible exposure :

Mode of onset :

Previous health (pneumonia—respiratory, catarrhal conditions, etc.) :

Any previous serum :

Throat :

Chest :

Crisis, pseudocrisis, lysis :

Asphyxia, toxæmia, cardiac failure :

Result : Duration :

P.M. :



HALDANE'S APPARATUS IN USE.



HALDRUP'S APPARATUS.



SEVERE HERPES FACIALIS.