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C O N T E N T S:

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1. OBJECTS OF THE INVESTIGATION AND GENERAL
FEATURES OF LOBAR AND OF BRONCHO-PNEUMONIA.

The following investigation was carried out in order to determine the types of pneumonia found in children up to twelve years of age and the relative frequency of each type. The incidence of lobar pneumonia in the first three years was specially considered.

Pneumonia occurs in two main forms, lobar and lobular, and it is importance in the first place to recognise what is generally implied by these terms. Attempts at classification have been made from various aspects, both clinical and pathological, but there is still much confusion as regards the two types, the main difficulty arising in children below two years, all writers being in agreement that there is more variation in the lesions during this period. Much has been written in the past on the relative occurrence of lobar and lobular pneumonia during childhood and very different opinions have been recorded, but so far the various statistics are unreliable because they depend to such a large extent on the personal view of the collector.

The differentiation of the various types of pneumonia has usually been decided from the clinical features, and these vary to such an extent that the diagnosis often presents some difficulty. A gradual onset in a young and feeble infant and

(2)

a typical temperature curve ending by lysis are in favour of broncho-pneumonia but by no means pathognomonic. Primary and secondary forms are usually easily differentiated clinically, but difficulty arises in distinguishing between lobar and primary lobular forms, many cases of primary broncho-pneumonia having an acute onset and course so closely resembling that of lobar pneumonia that they would, without doubt, be classed as such if the clinical course alone were taken into consideration. These lobular forms have been described by S. West. who classes them as pure pneumococcal infections closely allied to lobar pneumonia and only differing in the distribution of the lesions. In such cases, a corroborative histological examination is essential. A point which has been emphasised as a clinical distinction between the two conditions is that whilst in broncho-pneumonia local signs predominate over general, in lobar pneumonia the general symptoms may be very marked with few local pulmonary signs to account for them; this, however, is of little practical value in the case of young children.

Though the clinical history may be a valuable guide, the final classification must be made from pathological findings. The chief distinguishing features of each type may be summarised as follows: lobar pneumonia spreads by direct continuity of lung tissue leading to massive consolidation with a lobar distribution/

distribution; the disease may spread more widely till it involves almost the whole lung but it is not common to find two separate areas in the same lung. Broncho-pneumonia, on the other hand, is disseminated by the air passages in a patchy manner causing widespread lesions in both lungs, though one may be much more affected than the other; rarely if ever is an entire lobe consolidated.

The histological findings in lobar pneumonia are fairly constant, the chief features being the abundant *0-nuclear leucocytes* exudate of fibrin and polymorphs into the alveoli, septa and sometimes the bronchioles. There is universal involvement of every portion of the lobe, and greater or less involvement of every alveolus in this lobe, whilst the larger air passages are comparatively free. With this intense inflammatory affection of the lung, there is, in the lobar type, very little infiltration of the actual lung tissue in contrast with the marked interstitial changes in broncho-pneumonia. This is pointed out by MacCallum x (4) as a striking and distinguishing feature in which the two forms differ.

The picture in broncho-pneumonia is more complex but on section, the lobular distribution of the lesions usually can be made out, patches of dense leucocytic exudate being found in relation to the bronchioles. The margins of the consolidated areas are ill-defined, irregular in outline and separated by healthy, collapsed or emphysematous lung./

lung. The abundant fibrin formation, so constant in the lobar variety, does not occur, though some fibrin is seen occasionally in the alveoli immediately surrounding the affected bronchi; this is said to be found more often in the influenzal than in any other form * (3).

0-nuclear leucocytes
The inflammation is largely catarrhal in nature, though in some cases polymorphs are the predominating cellular elements. As previously noted, the interstitial tissue is always markedly affected, being infiltrated with large numbers of cells. *(3 and 7)

Although in typical cases the histological features of the two forms are quite distinct, many intermediate forms, which partake of the characters of both are recognised. In such cases the points to be relied upon are (1) the nature of the exudate, (2) the affection of the interstitium, and (3) the mode of spread as evidenced by a patchy cellular reaction.

11. HISTOLOGICAL FINDINGS IN 65 CASES:

A study was made at the Royal Hospital for Sick Children, Glasgow, of all pneumonic conditions examined post-mortem during the eighteen months from January, 1925 to June, 1926, and a bacteriological examination was made in some of these cases. Material was taken from the various lobes of the lungs and fixed in (1) ten per cent formalin solution/

solution, (2) Zenker's solution, and (3) a saturated solution of bi-chloride of mercury. Paraffin sections were stained with

- i. Harris's haematoxylin and eosin.
- ii. Gallego's modification of Mallory's method. * 8.
- iii. Weigert's fibrin stain. * 9.
- iv. Iron haematoxylin.
- v. Methylene blue and eosin.

From the study of the morbid anatomy and histology in conjunction with the clinical histories, the 65 cases thus obtained were classified into the following types:

1. BRONCHO-PNEUMONIA which was subdivided as follows:

- (1) Primary in which the onset was either sudden or gradual in a previously healthy child; this group includes some cases with a clinical history indistinguishable from lobar pneumonia but in which lobular lesions were found post-mortem.
- (2) Secondary in which the pneumonia followed on some preceding disease, such as --
 - (a) Infectious fevers, disease of respiratory passages (e.g., bronchitis), urinary tract, or nervous system.
 - (b) Chronic disease or malnutrition, e.g., marasmus, pyloric stenosis, syphilis, tuberculosis, congenital disease of the heart, tetany, rickets and gastro-enteritis.
 - (c) Following operations.
- (3) Influenzal.

11. LOBAR PNEUMONIA:

The relative number of the different types and the age distribution from the findings in 65 cases are given in/

in the following table:

Table 1 showing age incidence of cases examined histologically:

Age in years:	0-1	1-2	2-3	3-4	4-5	5-6	Total:
Primary broncho-pneumonia	22	8	3				33
Secondary broncho-pneumonia	10	5	2	1			18
Influenzal broncho-pneumonia	6	2		2		1	11
Lobar pneumonia		1				1	2
Lobar pneumonia + broncho-pneumonia			1				1
TOTAL:	38	16	6	3		2	65

(1) Primary Pneumonia:

Primary broncho-pneumonia and lobar pneumonia will be discussed together as most difficulty was found in the differentiation of these two forms. Thirty-six cases were examined, thirty-three of these being lobular in type, two lobar and one mixed. All except one case of lobar pneumonia occurred in children below three years of age. Of the thirty-three lobular forms, seventeen were diffuse and ~~in~~ three cases closely simulated lobar pneumonia; the remaining sixteen showed typical lobular lesions as described in the first part of this paper (see p. 3). The following table shows the relative numbers of the different forms found on histological examination and/

and the age incidence of each.

Table 11 showing age incidence of different histological forms of primary pneumonia.

Age in years:	0-1	1-2	2-3	3-4	4-5	5-6	Total:
Lobular:	14	1	1				16
Diffuse lobular:	8	5	1				14
Simulating Lobar:		2	1				3
Lobar:		1				1	2
Lobar and Lobular:			1				1
	22	9	4			1	36

On microscopical examination of all the cases of broncho-pneumonia, the lobular distribution could be made out at some part. In many cases by aggregation of foci the consolidation had spread through almost an entire lobe giving the appearance of hepatization but the microscopical features were still more of the lobular type, areas of emphysema being intermingled with densely cellular, diffuse areas whilst typical lobular lesions were found in other lobes.

The commonest findings were those of a pneumonia of about two weeks' duration, and these will first be described: The bronchi showed desquamation of epithelium varying/

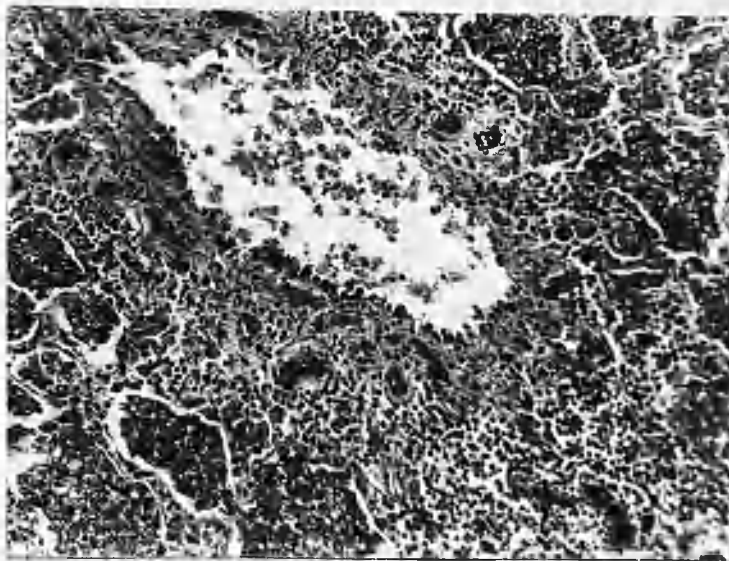


Figure I(a). A medium sized bronchiole showing infiltration of the wall with small round cells.

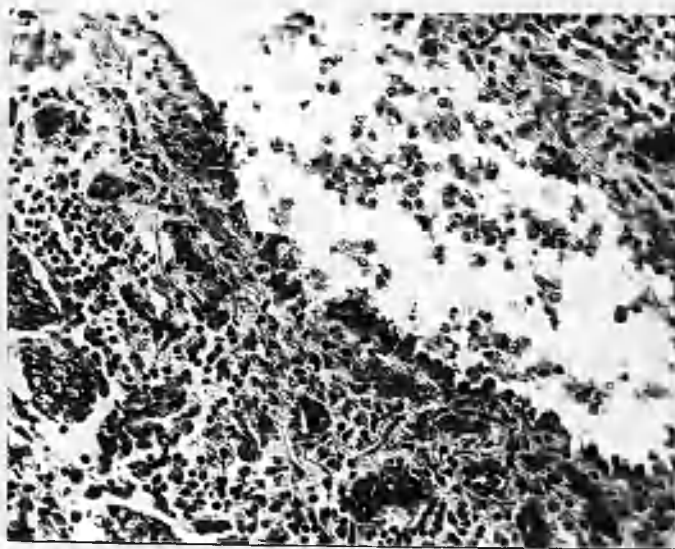


Figure I(b) Higher magnification of above showing the broken down bronchiole wall

varying in degree in different parts of the same section, but seldom as severe as in the smaller bronchioles. Their lumina were plugged with a cellular exudate of polymorphs and epithelial cells, the latter often in plaques, with a few red blood cells and small round cells. The bronchial walls were congested and often infiltrated with numbers of small round cells. According to Gaskell, this lymphocytic peribronchial reaction varies directly with the virulence of the infecting organisms. There was less desquamation of the lining epithelium of the bronchi than of the bronchioles, some parts generally remaining covered with normal epithelium. Sometimes only a thin layer of polymorphs and epithelial cells was to be seen on top of the basement membrane lining the lumen. In a few of the diffuse types, fibrin was found extending through the walls into the air vesicles immediately surrounding some of the more severely affected bronchi.

The desquamation of the lining epithelium of the bronchioles in the consolidated areas was always severe, the walls being either partially or completely denuded. A densely cellular exudate of polymorphs and epithelial cells completely filled the lumen and extended directly into the alveoli through the infundibular passages. Definite suppurative change was found in

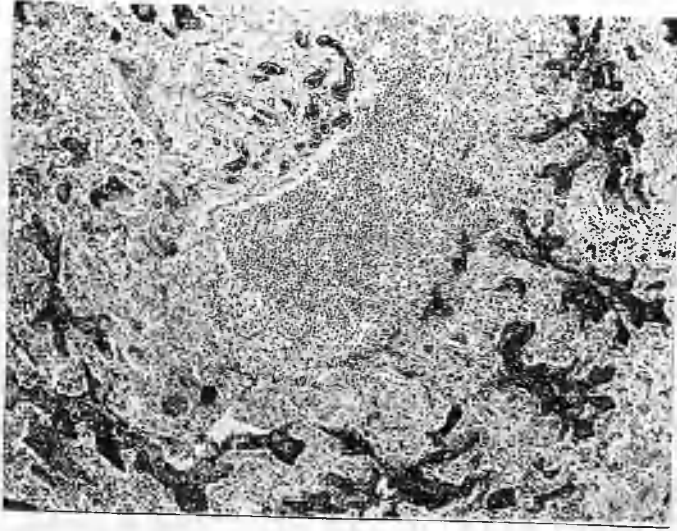


Fig II A SMALL BRONCHIOLE IN A CASE OF DIFFUSE
BRONCHO-PNEUMONIA SHOWING FIBRIN EXTENDING THROUGH
THE WALL INTO THE AIR VESICLES

35 per cent of cases: in these the basement membrane showed a break in continuity and the cells were invading the surrounding lung tissue. In more than half of the cases lymphocytic reaction was present round the bronchioles, (Figure 1), this being very marked in nine cases in which several aggregations of small round cells were seen in the walls. In the lobular forms no fibrin was present but some of the diffuse types showed a little extending through the bronchiole walls into the adjacent alveoli. (**Fig. II**)

The air vesicles round the affected bronchi and bronchioles were consolidated in an irregular, patchy manner. In the lobular forms, the areas of consolidation were small, and in the centre of each, one or more plugged bronchus or bronchiole could be distinguished, whilst the alveoli surrounding the patch were emphysematous. The diffuse types, however, showed widespread consolidation and in some sections no unaffected alveoli could be seen as the patches had completely merged into one another. The cellular exudate was in twenty-one cases mainly polymorphonuclear, but in the remaining twelve cases, small round cells and catarrhal cells predominated. In several cases it was noted that whilst the exudate in the bronchioles was wholly polymorphonuclear, the cell reaction in the alveoli consisted of catarrhal and mononuclear cells.

The density of the consolidation always varied considerably in different parts, some alveoli being packed tightly/

tightly with a mass of polymorphs, some containing mucoid and granular material with only a few cells in various stages of disintegration, and others again containing chiefly large endothelial cells and large mononuclears. (Figure V). The cellular exudate was always more abundant in the air vesicles immediately surrounding the bronchial passage than in those at the margin of the patch, and sometimes definite zones of inflammation could be made out resembling successive stages of lobar pneumonia, these being from within outwards (1) grey hepatization, (2) early red hepatization, and (3) primary catarrhal stages. Areas of oedema with haemorrhage were occasionally seen but these were both more common in the influenzal forms. Interspersed among the affected areas were emphysematous alveoli or single distended vesicles in which no exudate was present. Small areas of collapse were often found round the terminal bronchioles, at the margin of the consolidation or, in many cases, as described by Armstrong and Gaskell, especially along the pleural surface.

The interstitial tissue was invariably affected to a greater or lesser degree, depending on the extent of the lesion (Figure IV). The alveolar walls were swollen and/

and infiltrated with polymorphs, sometimes thereby encroaching on the alveolar spaces to a marked degree. In the more advanced stages the walls were often broken down and indistinguishable, masses of polymorphs with a broken down bronchiole in the centre being all that remained. In several cases the fibrous tissue between the lobules and in the neighbourhood of the bronchi and vessels was increased and infiltrated with polymorphs and fibrin.

A slight fibrinous deposit on the pleura was found where the consolidation reached the surface of the lung but extensive pleurisy was never present. The pneumococcus was invariably found in the pus from the finer bronchi, seldom alone but generally mixed with the streptococcus, Friedlander's bacillus and occasionally also with the staphylococcus.

The above description applies to all types of primary broncho-pneumonia encountered. In sixteen cases the lobular distribution was easily recognised both macroscopically and microscopically and the clinical history was also typical of that form of the disease. In the eighteen remaining cases of lobular and in one of the cases of lobar pneumonia more difficulty was found in differentiation, and careful histological examination was necessary before they could be finally classified. Fourteen of these showed the characteristics of a lobular lesion which, by/

by fusion of adjacent foci of consolidation, involved the greater part of one lobe and so simulated lobar pneumonia on naked-eye examination. Histologically, however, the reaction was found to be most severe round the bronchi, the exudate was irregular in density and nature, parts of the same lung showing a polymorphonuclear exudate whilst other parts were catarrhal, and fibrin was scanty only being found in six cases and always confined to the air vesicles immediately surrounding the bronchioles.

The remaining five cases showed features of both lobar and lobular types and the following summary of the findings in each case will demonstrate the difficulties encountered in arriving at a satisfactory conclusion regarding these forms.

CASE ONE: Boy, aged 1 year, 10 months:

He was drowsy and off food for about one week before the onset of cough and dyspnoea. Two days later he had a rigor and symptoms increased in severity till admission to hospital three days later where he remained till death twenty-six days later. During this time, the physical signs were limited to the left base. The temperature remained irregular between 99° and 103° F. and the pulse and respirations were correspondingly high. The leucocytes were 28,000 per cubic m.m. At the autopsy, there was found a diffuse consolidation of the entire left lower/

lower lobe, apparently of lobar type and in the stage of red hepatization, the other lobes being unaffected.

Fibrinous pleurisy and slight pericarditis were also present.

On histological examination, the consolidation was found to be loose and fairly uniform, cells were polymorphs and mono-nuclears but the reaction was most intense around the bronchioles, fibrin was absent and there were occasional unaffected alveoli. The pneumococcus alone was present in the pus from the smaller bronchi.

In this case the symptomatology was atypical whilst the physical signs and the naked eye post-mortem findings were those of lobar pneumonia and it was only on histological examination that it was possible to make out the lobular nature of the lesion.

Recovery would probably have taken place if the additional burden of pericardial infection had not supervened in a child worn out by a long continued fever, and the case would have been classified as one of lobar pneumonia.

CASE TWO: Girl, aged 1 year, 2 months:

Since bronchitis at eight months, she had never been well. Ten days before admission, cough and heavy breathing developed, and symptoms gradually increased in severity. On admission the child was very ill with physical/

CASE II

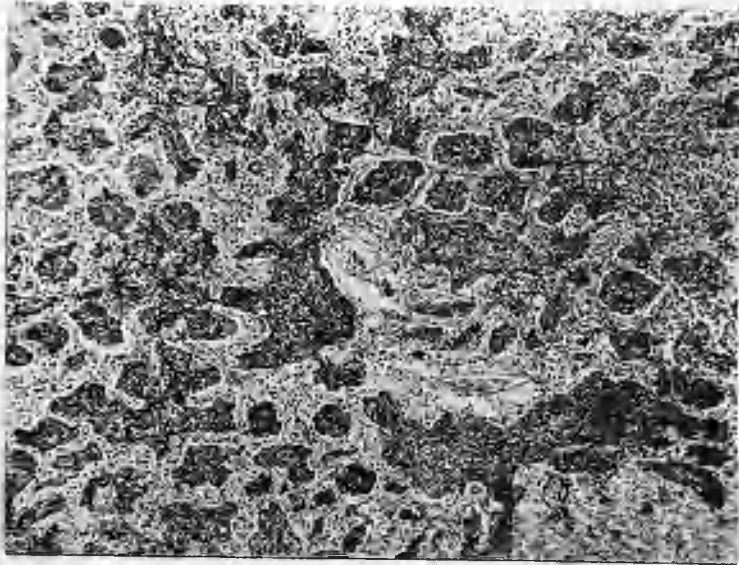


FIG. III SHOWING ABUNDANT FIBRINOUS EXUDATE

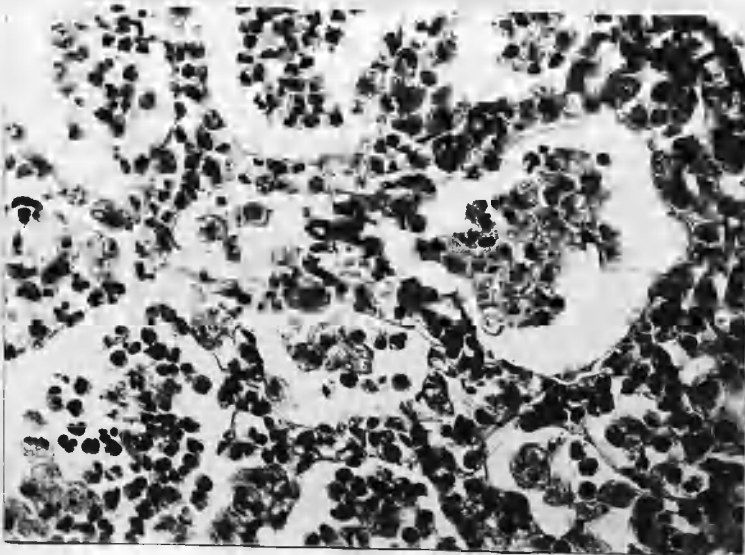


FIG. IV SHOWING INTERSTITIAL CHANGE.

physical signs of pneumonia of the entire right lung and the left apex; the condition remained unchanged till death eight days later. The temperature was persistently high and the pulse and respirations correspondingly increased. The leucocytes were 97,600 per cub. m.m. on admission. At the autopsy, a diffuse lesion was found involving almost the entire right lung and simulating the grey stage of lobar pneumonia except that the anterior margin of consolidation was irregular; fibrinous pleurisy was present over the right lung, and the left upper lobe was the seat of typical lobular lesions. Histologically, the most notable features were the abundant fibrinous exudate extending throughout the alveoli (Figure 3), and the marked peribronchial polymorphonuclear reaction. The interstitial tissue was affected to a considerable extent, being infiltrated with large number of polymorphs and fibrin (Figure 1V). There was no dense consolidation, catarrhal and endothelial cells were scanty, the exudate in the bronchi and air vesicles being polymorphonuclear in type; collections of polymorphs were found in some parts. No areas of collapse, oedema or haemorrhage were present.

Clinically, this case showed many of the features of lobar pneumonia in the severity of the general symptoms and the maintenance of high fever throughout its course but the mode of onset and the physical signs were more of the/

the broncho-pneumonic type. The lesion in the right lung closely resembled a lobar pneumonia on naked-eye examination but the histological findings, though atypical, were more of the nature of a lobular form of infection, and the fact that a definite broncho-pneumonic consolidation was present in the other lung gave additional support to this conclusion.

The above two cases, both the result of a pure pneumococcal infection, showed many differences in general and histological features. Both were diffuse lesions of a lobular type but whilst in the first the symptoms were only moderately severe and the signs were localised to one base the second ran an acute course with severe general symptoms and involved both lungs extensively. The findings in Case 1 suggest a less virulent infection in which the spread of infection and reaction from the bronchioles was slower and more limited. In Case 11, on the other hand, the spread has been rapid and the high leucocytosis and excessive fibrin formation suggest a high degree of virulence on the part of the infecting organism. Much, however, depends on the resistance of the host so that conclusions based on post-mortem findings alone are of little value.

* (10)

Gaskell, in his experimental work, describes
four/

four types of pneumonia produced by organisms of varying degrees of virulence, the less virulent causing lobular lesions, whilst with increase of virulence, lobar and finally septicæmic forms, were produced.

CASE 111: Girl, aged 2 years 6 months:

The symptomatology was that of a pneumonia of fairly acute onset and course with death in three weeks. The following lesions were found at the post-mortem examination:- (1) consolidation of the entire right lower lobe with collapse of right upper and middle lobes, (2) large right sided empyema, (3) slight pericarditis, (4) bilateral otitis media. The histology of the affected lung showed a mixed type of lesion, in many respects resembling lobar pneumonia. There was diffuse consolidation with a close network of fibrin extending through the alveolar walls into all parts, but the cells, though numerous in the bronchi, were scanty in the air vesicles and mainly mononuclear in type. The desquamation of the bronchi and bronchioles was almost complete, their lumina being plugged with dense collections of polymorphs showing marked fragmentation and degeneration of nuclei, the exudate being continuous with that in the air vesicles. Peribronchial lymphocytic reaction was very marked. No areas of emphysema, collapse, oedema or hæmorrhage were present, but there was much suppurative change of a characteristic lobular type.

In this case one single lobe was affected in its entirety, it was associated with empyema, a fact thought ~~x~~(12) by Still to be almost pathognomonic of co-existing lobar pneumonia, and the exudate was largely fibrinous in nature, all points in favour of a lobar lesion yet the histological features were more characteristic of broncho-pneumonia and the suppuration was distinctly lobular in type. Such an intense affection of the air passages and marked peribronchial reaction is never found in a lobar pneumonia.

CASE 1V: Boy, aged 2 years.

The illness began with diarrhoea followed two weeks later by cough, fever and rapid breathing. He was admitted to hospital one week later when the symptoms had increased in severity, and a right-sided pneumonia was present. Death occurred three weeks later.

At the autopsy, a diffuse, uniform consolidation - granular in appearance, and suggesting red hepatization -- was found to involve the entire right upper lobe, whilst the middle and lower lobes showed typical lobular lesions. There was fibrinous pleurisy of the right lung; the left lung was normal in appearance. Sections of the right upper lobe showed a diffuse fibrinous consolidation with a mixed exudate of polymorphs and small round cells. The desquamation of the bronchi and bronchioles was not severe and all were affected more or less to the same degree. Peribronchial lymphocytic reaction was slight; the interstitium/

interstitium was practically unaffected and there were few catarrhal cells and no areas of emphysema or collapse. The pneumococcus alone was found in the pus from the smaller bronchi. The lesions in the other lobes were typically lobular in type.

The lesion in the right upper lobe in this case was typically lobar in distribution, post-mortem appearances, and histology, though the symptomatology was not typical of this disease. The fact that lobular lesions were present in other lobes may account for the atypical course of the illness.

The next case, though lobar in type, showed many atypical features and will be described briefly to compare with the above four cases.

CASE V: Boy, aged 1 year.

A history of fever and heavy breathing of three week's duration was obtained, marked anaemia was present, the blood containing only 10 per cent haemoglobin and leucocytes 2,000. He died a few hours after admission. At the post-mortem examination, extensive consolidation, greyish and uniform in distribution was found involving the entire right upper lobe and the lateral part of the middle lobe, the rest of the lungs being unaffected. Associated with this, there was left otitis media, longitudinal sinus thrombosis and a meningeal haemorrhage. On histological examination of the parts of the lung involved,

a/

a very diffuse, fairly uniform consolidation was found with much fibrin, polymorphonuclear exudate and in some parts retraction from the alveolar walls. The desquamation of the bronchioles was only moderately severe but there was marked peribronchial lymphocytic reaction. Many large endothelial cells were present in some parts. The interstitial tissue was very little affected and there were no areas of emphysema, collapse or haemorrhage.

This case, though showing many of the features of broncho-pneumonia, was certainly more of a lobar type of consolidation in that the fibrinous exudate was uniform in distribution, the air passages were less involved than would be expected in such a severe broncho-pneumonic infection, and the interstitium was practically unchanged. In addition, it is very unusual to find the rest of the lung free from infection in a severe, confluent form of broncho-pneumonia. One concluded, therefore, that this was a lobar pneumonia showing somewhat atypical features.

These five cases represent very different forms of pneumococcal infection and may illustrate some of the difficulties encountered in reaching a correct classification even after careful histological examination. A feature common to all, was the occurrence of the disease in the second or third year of life. In the cases occurring during/

during the first year and after the third year there was no dubiety regarding the nature of the lesion; it was only in those cases occurring during the intervening period which presented difficulties in classification, and one would infer from this that a transition takes place at this time, the pneumonia gradually losing its lobular character and approaching nearer to the lobar form of the adult. In support of this view one may quote the findings of M. Valleix, who, as early as 1850, described similar differences according to age and divided the cases into three periods as follows --- (1) 0 to two years, (2), two to six years, and (3) six to fifteen years, the second stage being one of transition from the lobular form invariably found in the first period to the lobar during the third; the fatality of the disease was found to diminish correspondingly.

Both clinical and post-mortem findings were atypical in all five cases. From clinical features alone the differentiation between lobar and lobular pneumonia was impossible and naked-eye examination post-mortem gave little help in the diagnosis. In each case one or more lobe was consolidated in its entirety thus simulating the stage of red or grey hepatization and in only two cases was there any lobular consolidation in other parts.

The/

The only characteristics pointing to the lobular nature of the lesion were the irregular margin of consolidation in Case 11 and the type of suppuration in Case 111.

Even after histological examination the findings were by no means typical. Four cases showed such an abundant fibrinous exudate as is rarely found in broncho-pneumonia whilst no areas of emphysema or collapse were found in the consolidated area. The first three cases were distinguished as lobular in type, the significant features in classification being firstly, the evidence of bronchial spread in the marked affection of the air passages with intense peribronchial reaction, and secondly the affection of the interstitium. The fourth case showed lobar and lobular lesions whilst the fifth was lobar in nature, though atypical in many of its features.

To compare with these mixed forms, I will detail the only case of typical lobar pneumonia in the whole series.

CASE VI: Boy, aged 5 years:

The history was that of an acute illness of three weeks' duration with marked general symptoms, high fever and definite physical signs of consolidation of the right lung.

At post-mortem examination, complete consolidation of the right lung was found with a localised empyema, slight/

slight pericarditis, bilateral otitis media, and pneumococcal meningitis; the left lung was unaffected. Sections of the right lung showed extensive fibrinous consolidation of uniform density. The cells were chiefly polymorphs showing much fragmentation of nuclei. There was fairly severe catarrh of the bronchioles and to a lesser degree of the bronchi and marked peribronchial infiltration with small round cells but there was not much variation in the degree of change and no free alveoli. There was some early suppurative change. The interstitium was practically unaffected; there were no areas of catarrhal inflammation and no collapse. The pneumococcus, staphylococcus and Friedlander's bacillus were all found in pus from the fine bronchi and the pneumococcus was found in the pus from the surface of the brain and from both middle ears.

The great differences between this case and those previously cited were the uniformity of the lesion, the slighter degree of affection of the bronchioles and interstitium and the absence of catarrhal inflammation. In the above case, also, clinical and post-mortem findings agreed and were typical of the lobar form of the disease.

(2) SECONDARY BRONCHO-PNEUMONIA:

In the secondary cases, the pathological picture was more constant, and conformed fairly closely with the typical/

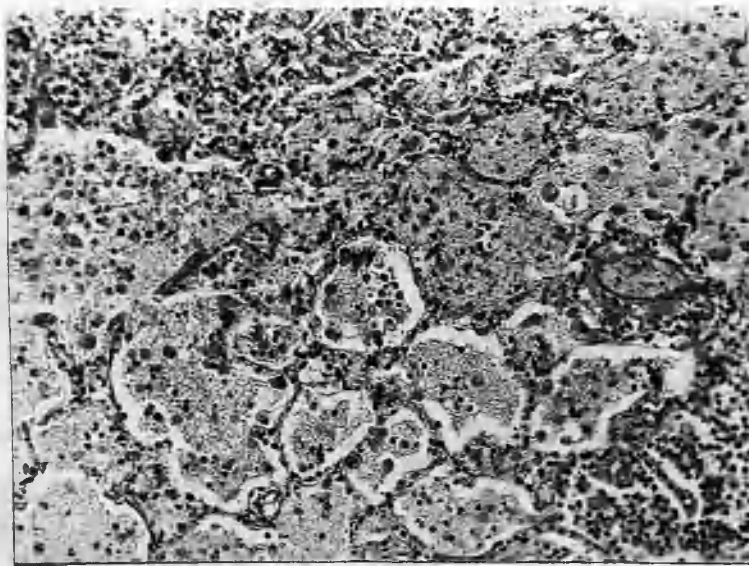


FIG. V. SHOWING CATARRHAL, LARGE AND SMALL MONO-
NUCLEAR CELLS IN AIR VESICLES.

typical lobular form already described. Seventeen of the total eighteen were of this type. The lesions were of a patchy nature, affecting both lungs in more than half of the cases and often being at a more advanced stage in the posterior parts of the lower lobes. Microscopically, the chief features were the lobular distribution of the consolidation with marked affection of the bronchi and bronchioles, areas of emphysema and collapse and absence of fibrin, whilst oedema and haemorrhage frequently occurred. In eleven cases the cellular exudate consisted of polymorphs and mononuclears, though polymorphs were more abundant in the bronchi; in the other seven cases polymorphs predominated throughout the consolidated area. Peribronchial lymphocytic reaction was very marked in half of the cases, clumps of small round cells being present in the walls of the bronchi and vessels. Catarrhal cells in all cases, and in four, large mononuclear cells containing much pigment, were found in large numbers. (Fig. V) Suppuration was the exception. Pleurisy only occurred in two cases in which there was a scanty deposit of fibrin on the pleural surface.

In only one case did the infection show any tendency to spread through an entire lobe in a diffuse manner. This was in a girl of three years and nine months, the condition being secondary to a sub-acute nephritis. The history was of generalised oedema of two weeks' duration with the development/

development of cough, fever, and rapid breathing one week before death. The lungs showed a diffuse consolidation of all the lobes with much hypostatic congestion and oedema and some hypostatic pneumonia; there was a little clear fluid in both pleural sacs, and a definite sub-acute nephritis was present. Sections of the lung showed a diffuse fibrinous consolidation, loose and irregular in density with intense peribronchial lymphocytic reaction and practically complete desquamation of the bronchioles. A dense polymorphonuclear exudate was present in the bronchioles continuous with that in the terminal air vesicles, and many of the bronchiole walls were completely broken down. In some areas there were numbers of large round cells, endothelial cells and phagocytes. No areas of collapse were seen and none of haemorrhage. Though this case showed a lobar distribution, the histological features were those of a lobular pneumonia with aggregation of adjacent foci of consolidation, oedema being present in the intervening areas, and the diagnosis presented very little difficulty after microscopical examination.

(3) INFLUENZAL BRONCHO-PNEUMONIA:

The lesions most often found in the Influenzal forms were similar to those of a diffuse primary broncho-pneumonia of a very severe type. Eleven cases were examined/

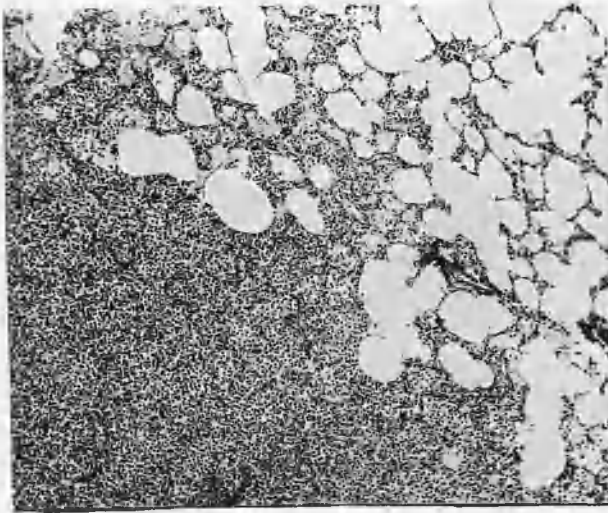


FIG. VI SHOWING IRREGULAR MARGIN OF CONSOLIDATION,
INTERSTITIAL CHANGE AND EMPHYSEMA .

examined and in all of these a bacillus of the influenzal type was isolated from the pus in the finer bronchioles, whilst in the larger bronchi, the pneumococcus and streptococcus were present in addition. Eight of the cases occurred in the first two years of life, two in the fourth year, and one in the sixth year (see Table 1). The duration of the illness was in all cases less than three weeks; in six, being under one week. Extensive lesions were found in both lungs, in seven cases every lobe being affected, whilst the remaining four showed lesions in both lower lobes. In six of the cases there was diffuse consolidation of the lower portion of a lower lobe simulating hepatisation but the upper margin was irregular (Fig. VI) and showed a less advanced stage of consolidation. Emphysema was always marked in the free parts, much more so than in any other form of pneumonia. Microscopically the consolidation was invariably bronchial in distribution and cellular in nature, fibrin, when present, being confined to the air vesicles in immediate relation to the bronchi. Bronchitis and bronchiolitis were severe, and in most cases suppuration had occurred. In the lobular forms and less advanced parts of the diffuse forms, the cells were mixed polymorphs and mononuclears; fibrin was absent and the patches, which varied in size, always surrounded a bronchiole and were separated from one another by areas of compensatory emphysema. In the diffuse forms, the consolidation still retained its lobular character, the cells were mixed but/

but polymorphs were more numerous in the suppurative areas, in the lumina of the bronchi, and in the bronchioles, and there were many areas of haemorrhage and collapse. Peribronchial lymphocytic reaction was only slight. Catarrhal cells and large mononuclears were present in all cases but were scanty. Pleurisy was only present in three cases.

(4) CONCLUSIONS:

From the above study of the histology of pneumonia it is evident that broncho-pneumonia is the typical lesion of infancy and early childhood and is the invariable type in secondary and influenzal forms. It may be concluded, also, that lobar pneumonia, though it does occur, is the exception during the first three years of life and never takes the typical form of the same disease as found in the adult. During this period, however, certain mixed forms with many of the characteristic features of lobar pneumonia do occur, and can only be distinguished by a careful histological examination. These mixed forms occur most frequently during the second and third years of life. After three years, the disease is more often lobar in type, though it would appear from the post-mortem records (see appendix) that this lesion is frequently associated with broncho-pneumonia. If the latter does occur alone after three years of/

of age, it is usually either secondary or influenzal, in the few cases in which it is primary, it occurs in an atypical form.

It is difficult to find an explanation of the difference in distribution of lesions in the earlier years of life. * (10) Gaskell, in his experimental work on rabbits, found great difficulty in producing lobar lesions, and suggests that the size of the lung may be of some importance, the larger lung of the adult allowing time for concentration of the inflammatory reaction and therefore being more favourable for keeping the infection within the lobe. It has also been suggested that lobar pneumonia is always a pure pneumococcal infection, whilst a mixed infection is the rule in broncho-pneumonia but this does not hold good as in many cases of primary broncho-pneumonia the pneumococcus alone is found and on the other hand some cases of lobar pneumonia show a mixed type of infection.

(5) SUMMARY:

1. Sixty-five cases of pneumonia were examined by histological methods, and a bacteriological examination was made in some of these.
2. Only one case of typical lobar pneumonia was found, this being in a boy of five years, but two atypical lobar forms were found in children of one and two years and in one of/

of these there was a lobular lesion in the other lung.

3. Of the remaining thirty-three cases of acute primary pneumonia examined, sixteen showed typical lobular lesions, fourteen were diffuse lobular with a lobar distribution in one lobe, but easily differentiated on microscopical examination; and three were mixed types with features of both lobar and lobular forms and these occurred in the second and third years of life.

4. In the eighteen secondary cases, the lesions were typically lobular in distribution and histological features.

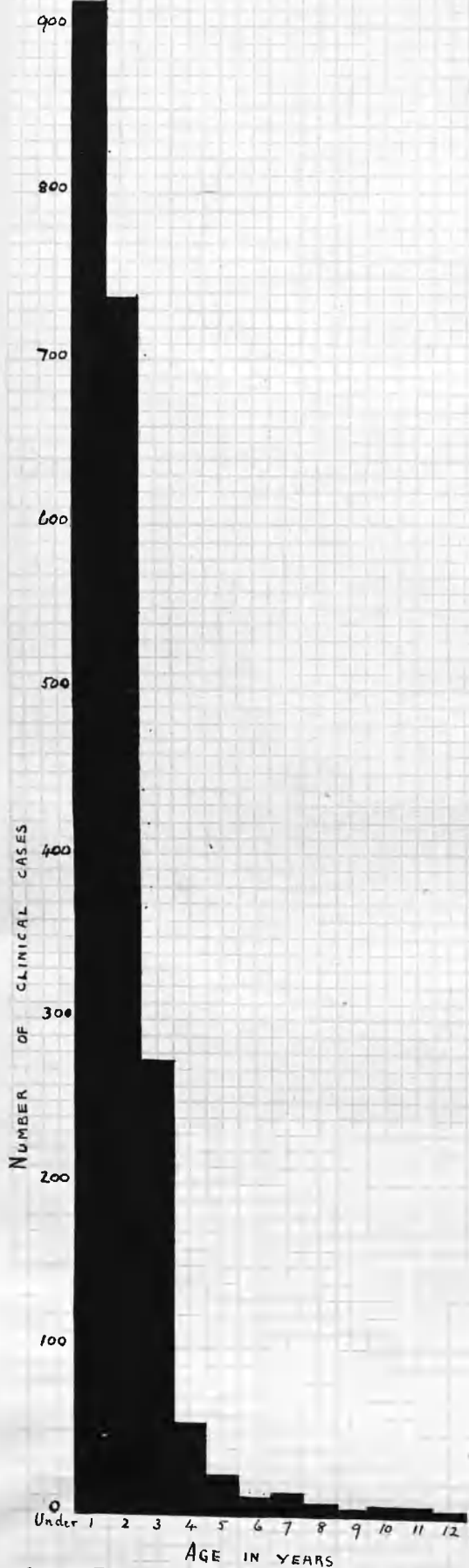
5. The influenzal cases showed characteristics of an intensely virulent infection. The lungs were extensively involved, six of the eleven cases showing almost a lobar distribution, but the consolidation was always lobular in nature.

6. Pure pneumococcal infections occurred in both lobar pneumonia and primary broncho-pneumonia, but in many cases the pneumo-bacillus, streptococcus and staphylococcus were also found, whilst in secondary and influenzal forms, a mixed infection was invariable.

111. ANALYSIS OF CLINICAL AND POST-MORTEM RECORDS:(1) Classification and Age Distribution:

From clinical features alone it was found impossible to differentiate between the two forms of primary pneumonia in young children and as no cases of typical lobar pneumonia in children below three years of age were encountered in the histological series recorded above, it was concluded that this form does not occur in its typical form until after three years of age. On this assumption, all cases of primary pneumonia met with at the Royal Hospital for Sick Children since 1915 have been classified as primary broncho-pneumonia if the disease occurred during the first three years of life.

An analysis was made from the ward records of all cases of pneumonia occurring during the twelve years 1915 to 1926 and also of all cases examined post-mortem during the same period. The classification adopted was similar to that used in the former study (see page 5). Records of 2,475 ward cases and 520 cases examined post-mortem were obtained; the following table shows the relative numbers with the percentage incidence of each type:



GRAPH I. SHOWING AGE INCIDENCE OF BRONCHO-PNEUMONIA



GRAPH II. SHOWING AGE INCIDENCE OF LOBAR PNEUMONIA

TABLE 111 SHOWING THE RELATIVE NUMBERS
OF THE DIFFERENT TYPES OF PNEUMONIA IN
CLINICAL AND POST-MORTEM CASES:

		Clinical Cases:		Post-mortem Cases:	
		Cases:	Percentage:	Cases:	Percentage:
BRONCHO-PNEUMONIA	Primary	1670	67.4	217	42.
	Secondary	280	11.4	251	48.0
	Influenzal	94	3.8	36	7.
LOBAR-PNEUMONIA		431	17.4	16	3
	TOTAL	2475	100	520	100

It is seen from this table that the large majority of clinical cases were of primary broncho-pneumonia, the next in frequency being lobar pneumonia, whilst of the post-mortem cases only 3 per cent were lobar in type.

The next two tables show the age incidence of ward and post-mortem cases of each form of pneumonia in groups of one year up to twelve years. (See also Graphs 1 and 11).

TABLE 1V SHOWING DISTRIBUTION
ACCORDING TO AGE OF CLINICAL

CASES:

Age in years:	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	TOTAL:	
Primary B. pneumonia	75	46	17	22	28	37	11	7	7	2	1	2	2	1670
Secondary B. pneumonia	135	91	30	9	4	2	4	4	1					280
Influenzal B. pneumonia	26	29	15	9	7	1	1	1	1	2	2			94
Lobar pneumonia				82	80	52	65	47	43	30	23	9		431
TOTAL:	915	737	273	137	102	62	77	54	46	34	27	11		2475

TABLE V SHOWING DISTRIBUTION
ACCORDING TO AGE OF POST-
MORTEM CASES:

Age in years:	1	2	3	4	5	6	7	8	9	10	11	12	Total:
Primary B. pneumonia	129	62	19	2		2	2				1		217
Secondary B. pneumonia	158	54	20	7	5	2	1	1	1			2	251
Influenzal B. pneumonia	15	11	2	3		2	2					1	36
Lobar pneumonia	1	1		3	2	2	3		2	1	1		16
TOTAL:	303	128	41	15	7	8	8	1	3	1	2	3	520

Up to three years of age the cases of primary broncho-pneumonia are far in excess of any other form, but at the end of the third year the incidence of the disease falls markedly and lobar pneumonia becomes more common. Few cases of any form were found in the post-mortem records in children over three years of age. The percentage of each type in the two groups of cases below and above three years are shown in the following table, and in Graph III in which the above points are more strikingly shown:

100

90

80

70

60

50

40

30

20

10

0

0 to 3 years

3 to 12 years

0 to 3 years

3 to 12 years

GRAPH III SHOWING PERCENTAGE OF EACH TYPE OF PNEUMONIA IN THE TWO AGE GROUPS.

GRAPH IV SHOWING PERCENTAGE DEATH-RATE OF EACH TYPE OF PNEUMONIA IN THE TWO AGE GROUPS.





-  PRIMARY BRONCHO-PNEUMONIA
-  SECONDARY " "
-  INFLUENZAL " "
-  LOBAR PNEUMONIA

TABLE VI SHOWING PERCENTAGE
OF EACH TYPE OF PNEUMONIA AT
DIFFERENT AGES:

	(a) Clinical Cases:			(b) Post-Mortem Cases:		
	0-3yrs:	3-12yrs:	Total:	0-3yrs:	3-12yrs:	Total
Primary broncho-pneumonia:	64.6	2.8	67.4	40.4	1.3	41.7
Secondary broncho-pneumonia:	10.3	1.1	11.4	44.6	3.6	38.2
Influenzal broncho-pneumonia:	2.8	1.0	3.8	5.4	1.6	7.0
Lobar pneumonia:	-	17.4	17.4	0.4	2.7	3.1
TOTAL:	77.7	22.3	100	90.8	9.2	100

After three years a larger proportion of cases are lobar than lobular in type, though only a small percentage are found post-mortem, owing to the lower mortality of the lobar form (see Graph 1V); below three years the majority of cases are of primary broncho-pneumonia, though as will be shown later, the fatality of secondary cases is higher.

Of the total 2044 clinical cases of broncho-pneumonia, 1925 (i.e. 94 per cent) were in children below three years of age, and in the 504 post-mortem cases 470 (i.e., 93 per cent) occurred during this period. In the post-mortem records of lobar pneumonia 2 cases were reported in children below three years. One of these was in a girl of ten months and the illness had an acute onset, was of three weeks' duration with high continuous fever during this/

this time and during its course a right-sided empyema developed. At post-mortem, grey hepatisation of the entire right lower lobe was found with empyema and pericarditis; the other lobes were unaffected. The other case was in a boy of one year, four months and the history was that of a wandering pneumonia of six weeks' duration, four previous attacks having occurred since he was eight months old. The post-mortem examination revealed complete consolidation of the right upper lobe in the greyish-red stage and a more recent consolidation of the left upper lobe. In these cases, however, the histology was not taken into account and as mentioned above, this is the crucial point in the final classification.

In the cases of primary pneumonia in children over three years, the type of lesion was often mixed. Of the fourteen post-mortem cases of lobar pneumonia in this group, three showed a lobar lesion at the right apex with broncho-pneumonia throughout the rest of the lungs; and in two extensive consolidation was found in one lower lobe, doubtfully lobar in character, but the clinical history was typical of lobar pneumonia.

Among the seven post-mortem cases of primary broncho-pneumonia in children over three years, two were diffuse, and by aggregation of foci involved the greater/

greater part of one lobe thus simulating the lobar type; three showed lobular lesions but the symptomatology was that of lobar pneumonia; and the remaining two were typical cases of broncho-pneumonia complicated by meningitis and peritonitis respectively.

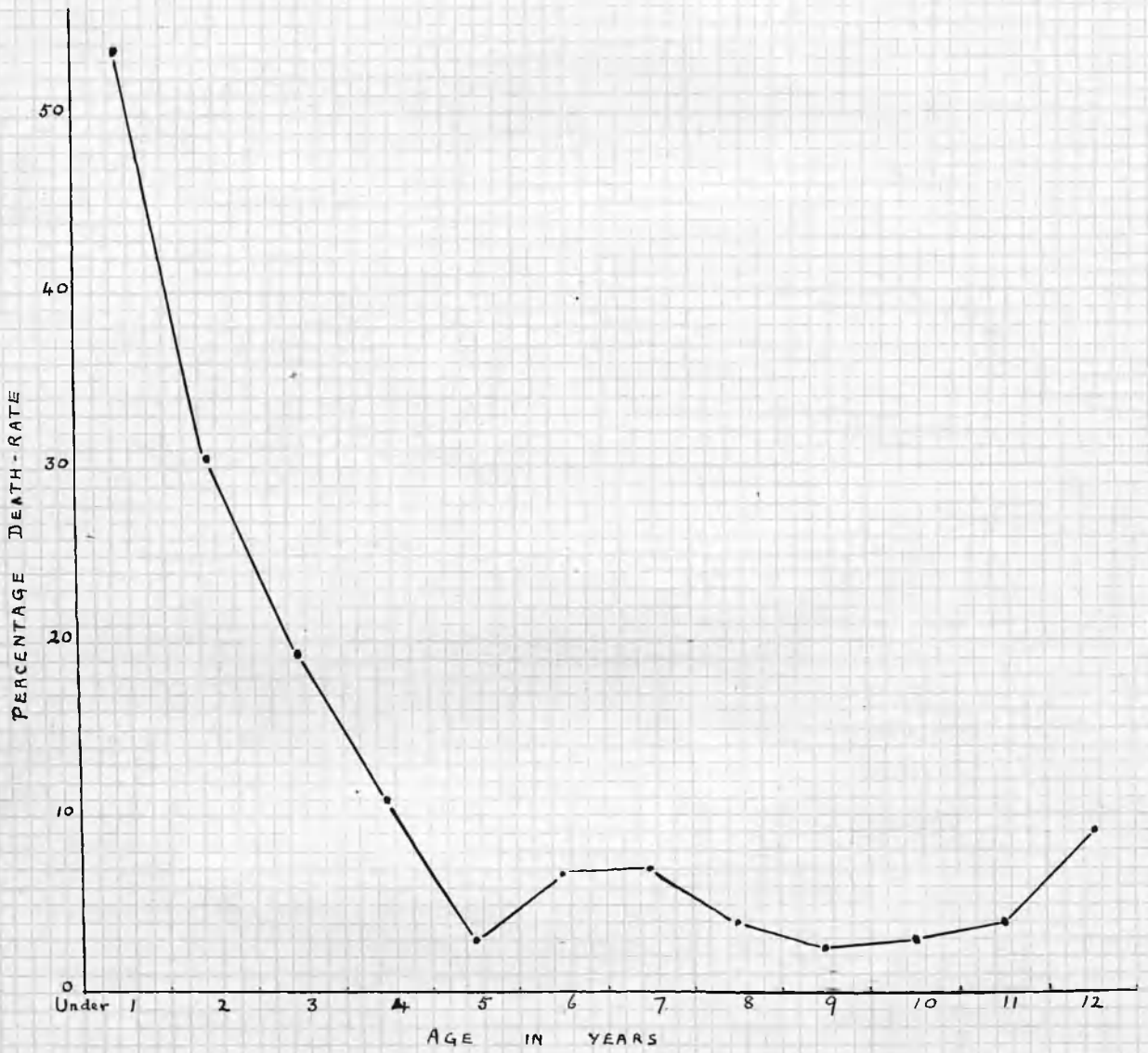
(2) Mortality rates:

As the differences in the mortality of each form of pneumonia are so considerable, the estimation has been made from clinical data, and the following table shows the death-rate per cent of each type: (See also Graph 1V):

TABLE VII SHOWING PERCENTAGE
DEATH-RATE OF DIFFERENT TYPES
OF PNEUMONIA:

Age in years:	0 to 3	3 to 12	0 to 12
Primary broncho-pneumonia:	34	21	} 39
Secondary broncho-pneumonia:	64	29	
Influenzal broncho-pneumonia:	74	58	
Lobar pneumonia:		4	4

The cases have been divided into two groups as before, the first including all children below and the second/



GRAPH V SHOWING PERCENTAGE DEATH-RATE OF ALL TYPES OF PNEUMONIA EACH YEAR UP TO 12 YEARS

second all those above three years of age, this, as previously noted, being the time at which lobar pneumonia is considered first to occur. Broncho-pneumonia occurs more frequently in the first three years than in any other equal period of life and the mortality is also relatively higher during this time. (Compare Graphs III and IV). Influenzal broncho-pneumonia is the most fatal form at any age but up to three years the death-rate from secondary broncho-pneumonia is almost as high. During the first year 85 per cent of the influenzal forms, 77 per cent of the secondary and 48 per cent of the primary ended fatally, and the mortality of the total nine hundred and fifteen cases during this period was 53 per cent (Graph V).

Lobar pneumonia, on the other hand, is seldom fatal, the death-rate being as low as 4 per cent in four hundred and thirty-one cases, and, as will be seen later, death was due in the majority of these cases to the complications rather than to the primary disease.

Similar results are recorded by most writers. In the case of broncho-pneumonia it is said that probably 70 to 90 per cent of cases are fatal during the first year but that the prospect of life improves year by year till five years when the disease becomes much milder. Heiman, however, from a series of three hundred and thirty-six cases in children below five years found that only 22 per cent succumbed/

succumbed during the first year, but this is a much lower figure than is given by most writers.

There is more difference of opinion regarding the mortality of lobar pneumonia; all workers, however, record a large proportion of fatal cases in the first few years of life, the complications being much more common at this time. ^{* (15)} Melville Dunlop records a mortality of 26.6 per cent from lobar pneumonia during the first two years, whereas between two and twelve years he found only 2.9 per cent ended in death. Heiman, from a study of forty-eight cases in children below five years, gives a death-rate of 25 per cent (a higher figure than that of broncho-pneumonia) during the first two years and only 5.5 per cent from two to five years.

From the above analysis it may be concluded (1) that broncho pneumonia is the commonest lesion in children below three years and the most fatal form at any age. After three years it becomes infrequent as a primary disease and is often atypical in its clinical and post-mortem features. (2) That lobar pneumonia rarely, if ever, occurs below three years of age, but is the most prominent lesion after that age, and is often associated with broncho-pneumonia. It is rarely fatal apart from complications.

My own results are not in accordance with the work/

work of most writers who record instances of lobar pneumonia during the earlier years of life, though all are agreed that broncho-pneumonia is the commoner type in early childhood. * (12) * (2)

Still and Sutherland both maintain that lobar pneumonia is common at all periods of childhood and is much commoner in the first year than is usually stated. Still, in a series of fifty cases of lobar pneumonia, found that 16 per cent occurred during the first two years. He considers it true that up to nine months a primary pneumonia is usually, but not always, a broncho-pneumonia, but after this age a primary pneumonia is just as likely to be lobar pneumonia as in an adult. The secondary form of broncho-pneumonia he considers less limited to infancy than the primary but this is not very evident from my own results. * (16)

Holt makes the division from the predominant clinical or pathological features classifying most of the doubtful cases as broncho-pneumonia and finds that of three hundred and seventy cases of acute primary pneumonia during the first two years 25 per cent were lobar; and of a series of five hundred cases of lobar pneumonia 15 per cent occurred in the first year. He still maintains, however, that though lobar pneumonia may occur at any age it only begins to be frequent after the third year. The incidence of broncho-pneumonia is found to diminish steadily up to the fourth year/

year and after four years to become infrequent as a primary disease.

✕ (17)

Dr. J. A. Coutts at Shadwell Children's Hospital records a much higher incidence of lobar pneumonia in childhood than is given by most writers. From a series of eighty-six cases of pneumonia in children below twelve years he found 50 per cent lobar in type and he refers to statistics which show that lobar pneumonia is more frequent in the first year than in any other succeeding equal period of life. He considers the most disturbing factor in distinguishing between the two types to be the fact that lobar and broncho-pneumonia frequently exist together, the broncho-pneumonia being secondary to the lobar.

✕ (15)

Dr. Melville Dunlop at the Children's Hospital, Edinburgh, found 30 per cent of the cases of lobar pneumonia in children under two years of age.

✕ (14)

Henry Heiman in his study of three hundred and thirty-six cases of pneumonia in children below five years found forty-eight lobar in type and of these 25 per cent occurred below two years.

The figures given by all the above writers were compiled largely, and in some cases entirely, from clinical data, and therefore, as previously noted, vary somewhat according to the personal view of the collector. With so high a mortality during the first few years of life, one/

one would expect to meet with lobar forms post-mortem. On the evidence of the preceding paper one would question the high incidence of lobar pneumonia recorded in the first three years of life, and suggest that cases diagnosed as such might be classified by others as cases of primary pneumonia indistinguishable from lobular pneumonia from clinical features alone:

ANALYSIS OF POST-MORTEM CASES:

(3) DISTRIBUTION OF LESIONS:

The following table was compiled from the records of 520 post-mortem cases and shows the part of the lungs involved in percentage of each type:

TABLE VIII SHOWING DISTRIBUTION
OF LESIONS OF CASES PERCENTAGE:

	Primary B. pneumonia:	Secondary B. pneumonia:	Influenzal B. pneumonia	Lobar pneumonia
Right Upper Lobe only:	1.0	4.0		25%
Right Middle Lobe Only:	.5	.7		
Right Lower Lobe only:	5.0	6.7		12.5%
Left Upper Lobe only:	.5	1.6		
Left Lower Lobe only:	4.1	8.7	2.8	12.5%
Whole Right Lung:	2.8	3.2		12.5%
Whole Left Lung:	3.7	1.1		12.5%
Both Lungs	82.4	74.0	97.2	25.0%
TOTAL:	100	100	100	100.

In all forms of broncho-pneumonia either lung was involved in almost an equal number of cases, the lower lobes posteriorly being most often affected and in a more advanced stage than other parts. The right upper lobe suffered next in frequency, whilst the left upper and right middle were least often involved. Both lungs were affected in the vast majority of cases; in only 2.8 per cent of the influenzal forms was the disease limited to one lobe, whilst in primary and secondary, 11 per cent and 22 per cent respectively involved one lobe only. Both lower lobes were affected in 22 per cent of secondary forms, and one lower lobe only in 15 per cent; this high proportion seems to point to hypostasis and oedema as being factors of importance in the development of the disease. In lobar pneumonia the right apex was the most frequent site, it being involved alone in 25 per cent of cases whilst in 56 per cent one or other apex was involved with some other part of the lungs. In three cases the lobar pneumonia was associated with broncho-pneumonia in other parts and in all of these the lobar lesion was at the right apex.

Apical lobar pneumonia is said to be much commoner in children, especially infants, than in adults. Still found 38 per cent apical, Dunlop 23 per cent, and Coutts 60 per cent. The last writer found among/

among forty-three cases under two years of age involvement of the right apex in 15, of the left base in 13, of the left apex in 10, and of the right base in 5, whilst Holt gives the order of involvement as left base, right apex, right base and left apex. The common belief that apical cases are more often accompanied by nervous symptoms is not confirmed by my own figures, where in five apical cases and two involving the entire left lung only one had marked nervous symptoms. In broncho-pneumonia, also, there was the same lack of association as, though head symptoms with delirium were present in thirteen cases, only four of these showed apical lesions. These findings are in accordance with those of Still and Holt. The idea that apical lesions and head symptoms are frequently associated is probably due to the fact that the apex is the most common seat of the disease.

(4) PREVIOUS DISEASE:

The following is a list of the primary conditions in 251 post-mortem cases of secondary broncho-pneumonia and shows the percentage of each:

TABLE 1X:

	No. of Cases:	Per Cent:
Enteritis... ..	69	28
Marasmus... ..	37	15
Post-anaesthetic. ...	21	8
Acute disease of Urinary tract, e.g. Pyelitis, Cystitis, Nephritis... ..	17	7
Tetany and Rickets:...	17	7
Measles	16	6
Whooping Cough... ..	6	2
Diphtheria... ..	4	1
Disease of Nervous Sys- tem e.g. Meningitis, Encephalitis	17	7
Bronchitis.. ...	10	4
Pyloric Stenosis. ...	5	2
Congenital Malformations of the Heart	10	4
Tuberculosis.... ..	7	3
Syphilis... ..	8	3
Other Diseases... ..	7	3
	251	100

As seen from the above figures, broncho-pneumonia was a common sequel of acute intestinal infections; the fact that both lower lobes posteriorly were/

were very frequently the only parts of the lungs involved, leads one to believe that many of these cases were probably terminal in nature and aided by hypostasis.

The twenty-one cases of post-anaesthetic pneumonia in all probability include several primary pneumonias undiagnosed before operation.

The above figures cannot be taken as representative of the true proportion of cases secondary to the infectious fevers, as such cases, unless through an error of diagnosis, are not admitted to the Children's Hospital.

(5) ASSOCIATED LESIONS:

The lesions of other organs are shown in the following table in the order of their frequency, giving the total number of cases of each among the total 520 post-mortem cases.

TABLE X SHOWING ASSOCIATED
LESIONS WITH NUMBER OF CASES
OF EACH:

	<u>Total No. of Cases:</u>	<u>Per Cent:</u>
Pleurisy... ..	172	i.e. 33
Empyema.... ..	33	i.e. 6
Pericarditis ...	22	i.e. 4
Otitis Media ...	21	i.e. 4
Pyelitis and Pyelone- phritis.... ..	19	
Suppurative Meningitis:	18	
Tuberculosis...	15	
Thrombosis of Cerebral Sinuses:... ..	12	
Bronchiectasis...	11	
Nephritis (All forms)	8	
Pneumococcal Peritonitis	7	
Jaundice:... ..	5	
Encephalitis....	5	
Ulcerative Endocarditis:	5	
Fibrosis of Lungs:	4	
Influenzal Meningitis:	3	
Suppurative Abscesses in Axilla:... ..	1	
Metastatic Arthritis and Chondritis	1	
Epiphysitis of Shoulder Joint	1	

(i). PLEURISY: was usually found over large areas of consolidation or in cases of over five days' duration. The percentage incidence in each type of pneumonia was as follows:-

TABLE XI SHOWING PERCENTAGE INCIDENCE
OF CASES OF EACH TYPE WITH ASSOCIATED

	<u>PLEURISY:</u>			<u>Total:</u>
	<u>Right Side:</u>	<u>Left Side:</u>	<u>Bilateral</u>	
Primary Broncho-pneumonia	11	8	19	38
Secondary broncho-pneumonia	6	6	10	22
Influenzal broncho-pneumonia	8	8	25	41
Lobar pneumonia	21	21	29	71

It occurred more frequently in lobar than any form of broncho-pneumonia; its incidence depended on the proximity of the pneumonic lesion to the pleural surface, a fibrinous exudate being almost invariably found if the consolidation reached the surface of the lung. A serous effusion, on the other hand, was very rare and in no case was there a large collection of fluid unless this was of a purulent nature.

(ii) EMPHYEMA: According to all workers this is the most common complication of lobar pneumonia but a less common one in lobular forms. Lobar pneumonia is said to be responsible for 80 to 90 per cent of all cases of empyema in childhood, and Still goes so far as to say that the occurrence of a pneumococcal empyema is, in his opinion, prima/

prima facie evidence that the antecedent pneumonia was lobar in type. In the present series, however, a fairly large proportion were found associated with broncho-pneumonia as is seen in the following table:-

TABLE XII SHOWING TOTAL NUMBER OF
CASES OF EACH TYPE WITH ASSOCIATED

EMPHYEMA:

	Total Cases:	Percentage of each type:
Primary broncho-pneumonia	18	8
Secondary broncho-pneumonia	6	2
Influenzal broncho-pneumonia	4	11
Lobar pneumonia	5	31
TOTAL:	33	

Among the total 520 cases of pneumonia examined post-mortem, empyema occurred in thirty-three (i.e. 6 per cent) and of these only 15 per cent were associated with lobar pneumonia. A larger percentage of cases of lobar than broncho-pneumonia, however, developed empyema (see above table.) It is interesting to note the association of empyema with cardiac lesions. Of the five cases occurring in lobar pneumonia, pericarditis was present in three, and these were all right-sided lesions; of the remaining two, one was bilateral and associated with ulcerative endocarditis of the mitral valve and the other was left-sided without any cardiac involvement. In the twenty-eight cases/

cases of broncho-pneumonia with empyema, fifteen were either left or bilateral and eight of these were associated with pericarditis; whilst of thirteen cases of right-sided empyema no cases of pericarditis occurred but one was associated with ulcerative endocarditis of the aortic and tricuspid valves. The fact that in broncho-pneumonia pericarditis only occurred with left-sided infections whilst in lobar pneumonia it was found with empyema of the right side alone, would suggest that only in the former was the pericardium involved by direct extension, the spread in the lobar form possibly being by the blood; the cases, however, were too few on which to base any definite conclusions regarding this question. The association of empyema with meningitis is discussed below.

(iii) SUPPURATIVE PNEUMOCOCCAL MENINGITIS is said to be a rare complication, but its incidence seems to vary at different times and in different parts. Osler found only 2.4 per cent in a series of cases extending over twenty years and Heiman records only one case among three hundred and thirty-six investigated. Of eighteen cases of suppurative meningitis among my own series of 520 cases, (i.e. 3.5 per cent) sixteen were associated with primary broncho-pneumonia and two with lobar pneumonia. Still found empyema usually associated with meningeal infection, but this was the exception in the present series, as they only occurred together in two of the broncho-pneumonic cases, but/

but both of the cases of lobar pneumonia showed empyema, also bilateral otitis media and in one ulcerative endocarditis of the mitral valve. In two cases of broncho-pneumonia with meningitis in which the ears were examined, only one had co-existing otitis media. All cases except one of broncho-pneumonia and the two lobar cases were in children below two years of age.

(iv). INFLUENZAL MENINGITIS: occurred in three cases of influenzal pneumonia and all were in children below one year; two had otitis media and one ulcerative endocarditis; none of these were associated with empyema.

(v). OTITIS MEDIA: Both Coutts and Heiman record this as the most frequent complication encountered. Coutts, ^{* (17)} from a routine examination of the ears in a series of clinical cases of lobar pneumonia, found pus yielding a pure culture of pneumococcus in over 60 per cent after a small puncture of the membrane, but only a small percentage of these developed definite signs. Heiman found otitis media in 22 per cent of his three hundred and thirty-six cases. ^{* (14)}

Unfortunately in the present series until recent years the ears were not examined in all cases, and only twenty-one middle ear infections were found, five of these being in primary broncho-pneumonia, eleven in secondary, three in influenzal and two in lobar pneumonia, seven of them being associated with meningitis.

(vi). CARDIAC LESIONS: were exceptional. Pericarditis was found in twenty-two cases as follows:-

TABLE XIII SHOWING OCCURRENCE OF
PERICARDITIS IN DIFFERENT FORMS
OF PNEUMONIA:

Primary Broncho-pneumonia:	15 cases.
Secondary Broncho-pneumonia:	No cases.
Influenzal Broncho-pneumonia:	2 cases.
Lobar Pneumonia:	5 cases.
TOTAL:	22 cases.

Of these, six were associated with bilateral fibrinous pleurisy, two with left, and two with right-sided pleural effusion, eleven with empyema (see above) and one in lobar pneumonia with endocarditis of the mitral valve.

Ulcerative endocarditis was very rare occurring in five cases, one in secondary broncho-pneumonia involving the mitral valve; two in influenzal pneumonia, one of which affected the mitral valve and was associated with sero-fibrinous pleurisy and influenzal meningitis, the other involving the aortic and tricuspid valves with empyema; and the two with lobar pneumonia affected the mitral valve, one showing also otitis media and meningitis/

meningitis, the other pericarditis.

(vii). THROMBOSIS OF THE CEREBRAL SINUSES: was found in twelve cases and involved the longitudinal sinus in all cases, with the lateral sinus and superficial vessels of the brain cortex in three of these. The condition occurred in six cases of primary broncho-pneumonia, in five of secondary and in one of influenzal. Otitis media was associated with the thrombosis in three cases, encephalitis in two and meningitis in one.

(viii). ENCEPHALITIS: in many cases marked congestion and oedema of the brain was noted, but encephalitis was only present in five cases and in three of these it was the primary condition.

(ix). BRONCHIECTASIS: was found in eleven cases of broncho-pneumonia all of which were in children below three years of age. In five cases there was a history of cough and wasting over a period varying between four and fifteen months; the bronchiectatic lesion was in the left lower lobe in three of these, in the left apex in one and in the right apex in one. In the remaining six cases there were no symptoms indicating this condition, the history being that of a broncho-pneumonia of short duration, in all cases below one month. Post-mortem early bronchiectasis with numerous small abscesses were/

were found in the consolidated parts.

(x). FIBROSIS OF THE LUNGS: was noted in four cases only and in all there was a history of a previous attack of broncho-pneumonia with chronic cough since that time.

(xi). TUBERCULOSIS: was met with in very few cases and in these it generally affected the lungs or glands. Only two cases of primary broncho-pneumonia were associated with tubercle, one being co-existent with a tuberculous focus in the lungs, the other with caseous mesenteric glands. In thirteen cases of secondary broncho-pneumonia four were associated with pulmonary tuberculosis, four with miliary tuberculosis, four with caseous bronchial and mesenteric glands and one with a lesion of the lumbar vertebrae and a psoas abscess.

(xii). URINARY TRACT: Infections of the urinary tract were occasionally found. In primary broncho-pneumonia, two cases of acute nephritis was found at autopsy, in one of which there had been no clinical symptoms pointing to the condition. Two cases of pyelitis were also met with.

In secondary broncho-pneumonia six cases of primary nephritis, twelve of pyelitis and five of pyelonephritis were encountered. Still records only two/

two cases of nephritis in lobar pneumonia, albumen casts and blood being found in the urine but no signs suggesting nephritis and both made a good recovery. It is generally thought that co-existent nephritis does not affect the prognosis disadvantageously.

(xiii). PERITONITIS: was only found in seven cases, four in primary broncho-pneumonia, and three following operations for appendix abscess.

(xiv). JAUNDICE: occurred in four cases of primary broncho-pneumonia and one secondary.

(xv). One case of each of the following occurred: suppurative abscesses in axilla, metastatic arthritis of the hip joint with chondritis of the third right costo-chondral junction and epiphysitis of the shoulder joint.

(6)

S U M M A R Y:

1. An analysis was made from the records of 2,475 clinical cases and 520 post-mortem cases of pneumonia in children below twelve years of age, and 65 of these were examined by histological methods (see previous paper).
2. Broncho-pneumonia was the lesion most often found in the first three years of life, but its incidence diminished from year to year; after three years it became infrequent as a primary disease and was then usually atypical in symptoms and morbid appearances.
3. Lobar pneumonia very rarely occurred till after the third year, though two doubtful cases in the post-mortem series were recorded. After three years it became the most frequent type, though often combined with lobular lesions.
4. Lobar pneumonia in itself was seldom fatal, but death occurred as a result of complications such as empyema and meningitis. The mortality from broncho-pneumonia, on the other hand, was high, especially so in infants; influenzal and secondary forms were the most fatal.
5. Broncho-pneumonia involved both lungs in the majority/

majority of cases, but was usually most advanced in the lower lobes posteriorly. In lobar pneumonia the right lung and upper lobe were the commonest sites, the minority showing bilateral lesions.

6. Pleurisy in the form of a fibrinous exudate was extremely common over surface areas of consolidation; a serous effusion, however, was very rare.
7. Of associated lesions, empyema, otitis media, pericarditis and meningitis were the most frequent. Nephritis, pyelitis, cerebral sinus thrombosis, tuberculosis, bronchiectasis, peritonitis, jaundice, encephalitis, ulcerative endocarditis, fibrosis of lungs occurred in a few cases.

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