

IV.

Report on the Epidemic of Influenza in Manchester, 1918-19.

By

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Towards the end of June 1918 an epidemic of influenza burst on the City of Manchester, as on other large towns, flared up with extraordinary rapidity, and sank away at the beginning of August. Although, perhaps, its incidence was most evident in South Manchester, at all events as regards the schools, yet it was universally diffused over the whole city. If we consult the Registrar's weekly returns, simultaneity of incidence is observed for the different towns. The explanation may be found, perhaps, in the prevalence of the disease amongst the troops in France in May and June. No doubt it would be brought over to a great variety of localities by men on furlough about the same time; but this hardly accounts satisfactorily for the absolute agreement in time of the outbreaks in so many different centres of population. It must be borne in mind, however, that there was much movement of soldiers about that time, and that railways and trams were much crowded then and later.

Unhappily there are no data available here for the first outbreak to show the latent period of the disease, and, therefore, its speed of travel. It is certain, however, that it swept over schools and works with very great rapidity. Still a certain amount of time was required and great towns were affected, so to say, in the lump.

Assistance is given in understanding how the epidemic in this country may have arisen from that in the Army, by figures given in the report of the Medical Research Committee on Influenza in Hospitals of the British Armies in France, page 10.

We there see that the wave of influenza began to ascend definitely in the week ending June 8th and rose most energetically in the weeks ending June 15th and June 22nd. The largest number was admitted to hospital in the week ending June 29th, viz., 46,273.

If we may assume that the disease was disseminated in this country by men on furlough, it would follow that a large number of men must have come over from June 8th to June 29th, and also that the subsequent outbreak in Great Britain took some time to start into full operation. It is probable from the curves, that the infectious material from cases in the weeks ending June 15th and June 22nd possessed an enhanced power of diffusion.

This, on the whole, appears to be the most likely explanation of the outbreak in this country which started in the week ending June 29th, with faint indicia in the previous week.

We must otherwise assume some meteorological factor which stirred into activity the existing agencies causing influenza, acting at different times in France and Great Britain. This is a most unlikely hypothesis.* There can be no doubt that either some new infective agent was at work, or else that a specially infective strain (or strains) of a common agent of infectious disease was responsible for the outbreak in France, and very little doubt that the infection thus started was passed on, accompanied by a number of other more common agents of disease, all stirred into activity, possibly by the pabulum presented to them by the operations of the primary agents, possibly by the changes in the constitution of the blood caused by it.

The only common agent of which one is aware, which is normally highly infective, and is capable at times of causing rapid diffusion of disease with high mortality, is that responsible for the so-called "common cold."

* It does not follow, however, that meteorological conditions have no effect in promoting rapid spread of this and other diseases.

The bacteriology and behaviour of common colds, especially when they appear as they often do, in a highly infectious form appears, therefore, to deserve special study, and it will probably be desirable to bring all respiratory diseases into the sphere of public health at an early period. Unless this is done, and definite machinery provided for the study of different forms of respiratory disease and of influenza, epidemiologically and bacteriologically, little progress will be made, since the existing machinery is inadequate to the steadily growing tasks to which it is put. Rough work, in a matter of this kind, is of little value.

When the first outbreak occurred the medical officer of health, in the first week, issued a leaflet of precautions, which to the number of 30,000 was distributed chiefly to a number of works in the city, to the press, and in houses, through the health visitors. Five hundred large posters were also put up in conspicuous positions throughout the city. The newspapers were very obliging in giving publicity to this and other matters connected with the disease.

The medical officer of health, having no assistant in the public health department, was unable to give much attention to individual cases, but visited two works affected. In one of these he interviewed a number of girls who had just been taken ill, and contracted the disease, the latent period being two days. The attack was a mild one.

As a rule, the persons attacked at this establishment were not very severely affected. The attack was sudden, marked by chill, headache, pain in the back and limbs, temperature of 101° F. to 103° F., and, in some instances, by a feeling of prostration.

The disease appeared to spread rapidly through the works, but how it was conveyed was not clear. In my own case droplet infection could scarcely have accounted for it, but I took their temperatures, and in some cases handled the patients. It is probably in this way that nurses suffer so severely, that is to say, from contamination of the hands. As regards the operatives themselves, the use of common towels and common washbasins would give opportunity for spread of the disease. Also those working contiguously to affected persons, and handling the same articles, would be liable to infection. The effect of droplet infection may be exaggerated, as there is not much coughing in the early stage of the disease, but it may have more to do with the subsequent spread in households. By the courtesy of Dr. Ritchie, I had the opportunity of seeing influenza occurring in schools. At one school I observed the children falling ill. They simply dropped on their desk like a plant whose roots have been poisoned, the attack being quite sudden, and drowsiness a prominent symptom. This aspect of the onset was said to be common. Another much larger school adjoining was practically free from the disease. This was as Dr. Ritchie had mentioned, and, it has been a striking feature in these outbreaks how widely the incidence has varied in different institutions, even when close together.

For example, one of the works in which I witnessed the occurrence of small one, was quite near the Fine Cotton Spinners Association employing a large number of people. I was assured that the latter was quite free from the disease.

It is not a mere matter of hygiene, good light and good ventilation, as one large business, admirable in all these particulars, as in their care for their workpeople, suffered rather severely.

The difference cannot be due to difference in droplet infection.

It is possible that difference would arise in schools from the use of closets, and of common towels; but as these would be common to schools * severely and slightly infected, the suggestion scarce seems adequate. It is probable that differences arise in schools from the differing extent to which children are grouped closely in classes. But it is also suggested by the different rates of diffusion in one and another outbreak that differences in infectivity, and by the history of households that differences in receptivity may have to do with the varying amount of spread in different institutions.

It may be that facility of growth of the same infecting agent is correlated with mildness of attack. To some extent this would appear to apply to scarlet fever. When different diseases are compared we see that the more destructive, viz :—typhoid fever, typhus, plague, cholera, tuberculosis, are all difficult of spread. The fact that they attain massive dimensions in no way interferes with this observation, This applies still more to cerebro-spinal fever, pneumonia and streptococcal diseases.

It may be that there are different strains of the infecting agent, and that the more slowly acting strains were those introduced into works in which, at that time, the disease did not make headway.

Possibly individuals affected infect others with a like strain of the disease.

At all events it is evident that an enormous number of persons were affected in the first outbreak, although the fatality was considerably less than in the second and third outbreaks.

Particulars were obtained from a number of works, though not in such a form as to admit of brief presentation; but some idea of the extent of prevalence of the outbreak commencing in the end of June may be obtained from the following figures :—

- A.—Letter, dated August 13th, 1918, from Armstrong and Whitworth's.
Total who have been absent through influenza—1,591, out of a total of 7,656.
Ditto. Shell factory, 313 out of 1,380,
- B.—Messrs. Lewis's.
Total No. 720; absent on July 8th, 108.
Total number attacked not given.
- O.—Crossley Brothers.
Absent at the height of the epidemic—333 (about) out of a total of 1,976.
- D.—Manchester Tramways.
No. of employees, 4,613; absent for the week ending July 4th, 765, of whom 363 supplied medical certificates that they were suffering from influenza.

Writing on July 19th, 1918, Dr. Ritchie stated that the number of schools which had been closed on account of the disease was 76, all of which we may assume to have been severely affected. On 18th July, acting on his recommendation, the Education Committee closed all the Elementary Schools till August 26th. This course of action we had previously discussed and were agreed upon. The number of children affected could not then be given, but in a letter, dated November 1st, 1918, Dr. Ritchie informed me that the number of school children known to have been affected in the first epidemic was 39,255.

The deaths amongst school children were few, absolutely as well as relatively, being 28 at ages 5-14, giving a case mortality of less than • 1 per cent. The total number of deaths ascribed to influenza in this outbreak was 332, 177 in males and 155 in females.

The Block Census made for Dr. Carnwath by the Health Visitors Department in Manchester shows the number of attacks in summer to have been 694 in a population of 4,666, so that there must have been well over 100,000 attacks in bumper alone, assuming that the sample is a fair one. This agrees with Dr. Ritchie's figures. In the autumn attack there were 407 attacks amongst those who escaped in the summer. The preponderance of attacks in summer agrees with the experience of the B.E.F. in France, though in the latter the difference is greater.

The total number of men on service admitted into hospital in the weeks ending 25th May 1918 to 10th August 1918 is stated to have been 226,615, as compared with 86,636 or 93,670 in the weeks ending October 12th, 1918, to January 18th, 1919.

The latter outbreak was, however, far more deadly than the former, the number of deaths being 5,555 ascribed to influenza and broncho-pneumonia.

The number of deaths ascribed to influenza primarily was 2,613. Taking account of the difference in age constitution between men on service and the general population of Manchester, and of the intensity of mortality at ages 25-29 and 30-34, it would appear that the intensity of mortality was much the same in Manchester as in the Army. In Manchester the corresponding number of deaths was 1,715, though the number attacked was probably not so high as in the Army. Similarly the number of deaths in the Army was about 1,400 for 11 weeks, including the wave of June and July, out of a total number of stated cases 226,615. In Manchester the corresponding number was 332 deaths out of over 100,000 attacks. The Manchester mortality in the first outbreak was lower than in the Army.

The milder character of the outbreak in summer would be conditioned by various causes, one of which would, no doubt, be that men who came over suffering from influenza would bring a comparatively mild disease with them. The rise of the wave in France preceded that in England and Wales by three weeks. As regards the second wave, this appears to have begun simultaneously in France and in this country, and may, therefore, have developed from the preceding wave in the same manner in both countries. Evidently the two waves, though differing from each other, were the same in England and France in summer and autumn respectively. Further on it is suggested that the second outbreak may have been introduced from America.

During the summer outbreak numerous applications were made for advice, especially as to cleansing premises, and all the assistance possible was given. As a rule, the corporation disinfecting staff were not employed; where disinfection was advisable the recommendation was to cleanse the premises and use a formalin spray of 2 per cent.

The disease appeared to have sunk into quiescence by August 3rd, but in the week ending October 19th the number of deaths ascribed to influenza began to increase, and the numbers ascended week by week more slowly than in the first outbreak, but culminated in a terrible fatality in the week ending November 30th. In this week the number of deaths ascribed to influenza was 383, as against 120 in the week ending July 19th. Moreover, the distress was prolonged, so that it was realized that a real calamity had befallen the city. Mothers and fathers were often stricken together. The children, themselves ill, could not receive attention, and for a time it seemed as if it would not be possible to get coffins for the dead, or grave-diggers to dig the graves. This outbreak of disease lasted till the week ending January 25th, 1919, or a period of 15 weeks.

The comparative length of this wave by itself strongly suggests that a new strain or strains of disease had been added, or at all events that some change had occurred from the milder type of the summer outbreak. There died in all in this outbreak 1,715 persons, of whom 702 were males and 1,013 females.

The question as to what determines the length of the epidemic wave may prove to be an important one when the bacteriology of the disease is better understood. It may be that the virulence of the organisms causing a wave, and their relative amounts, may give the necessary warning as to the steps which require to be taken, and conversely the character of the wave may give the clue to the organism concerned. Some clue to the position may be furnished by an accurate determination of the latent period between exposure and attack, and comparison in this respect of different infecting agents. It does not follow, of course, that a short latent period means a short wave. If, however, we assume that the end of an outbreak means the exhaustion of a strain, that strain is likely to become most speedily exhausted which has the shorter latent period. If two strains are present together, and both in considerable amounts, the wave length may correspond to that which causes the longer latent period. The shorter latent period will probably correspond also to the milder form of the disease. With a mixture of strains, the duration in virulent form and the degree of virulence will follow the dominant strain.

Many members of the staff contracted the disease, but no fatalities occurred in the summer outbreak. On the other hand two clerks in the Public Health Office died in the course of the autumn outbreak, and also one of the tuberculosis nurses, while, notwithstanding exceptional exposure, there was no death amongst the health visitors.

During the summer outbreak a number of the patients at Baguley Sanatorium contracted the disease, and the admission of cases was suspended. One of the medical assistants was ill for some time. Later on, in the autumn outbreak, a number of nurses had influenza; but, fortunately, there was no death.

Monsall also was severely affected, and the course of events can be followed by means of a return kindly supplied by Dr. Dickinson, at that time acting as medical superintendent.

Incidence of Influenza on the Nurses and Maids at Monsall Hospital, 1918 and 1919.

1918.	March 2	April 1	May 1	June 6	July 14	Aug. 2	Sept. 1	Oct. 7	Nov. 23	Dec. 6
1919.	Jan. 0	Feb. 10	March 8							

The cases occurring in June 1918 were all in the week ending June 29th. On March 18th, 1919, the matron died of influenza, and on March 27th, one of the nurses. The attacks varied greatly in severity, but, on the average, appeared to become more severe in the winter outbreak.

Great reluctance was felt to take cases of influenza into Monsall Hospital, but as the epidemic increased, it was felt that this reluctance must give way before the urgency of the need, and a ward was opened for cases of pneumonia following influenza on March 8th, 1919, and closed on April 19th, 1919. During this time 25 cases were admitted, among whom there were five deaths.

Similarly great reluctance was felt to divert the health visitors from their regular and most useful work to the visiting of influenza cases, but a small portion of whom they could hope to overtake; but this reluctance also had to give way, and the visiting of houses in which death had occurred, or in which they knew otherwise of the presence of influenza was begun on December 4th, 1918.

The Public Health Committee also sanctioned from this period the giving of assistance in nursing and otherwise. Fortunately there was a large stock of coal which had been given by a generous donor to the Child Welfare Department, and food, chiefly milk, was granted by the committee.

Every grant of food and coal was signed for by the chairman of the hospitals sub-committee and the medical officer of health, after investigation; but in some cases the family was in extreme distress, perhaps both parents and all the children were ill, and no nurses were available from any quarter.

Under these circumstances the following nurses generously volunteered to nurse, either by day or night, patients who could not otherwise receive the necessary nursing, Miss Sizer, Miss Appleton, Miss Oliver, and Miss Hall.

Others would have done so, but for difficulties connected with their lodgings.

Altogether an excellent spirit was shown.

It may be asked how it was that nurses could not be obtained from the Manchester and Salford District Nursing Association. There were, at the greatest time of need, many of their nurses ill of influenza, and at one home to which we applied the matron died from the disease. It is to this cause that we must ascribe the impossibility of securing nurses from the Association for continuous nursing. The nurses were too few and were over-worked. It

was no part of their duty to do continuous nursing, but that would not have hindered them from assisting us. Otherwise the nurses of the Association did most valuable service.

Later on in 1919 there seemed a prospect of getting assistance in nursing cases from the V.A.D. nurses of Red Cross Society, and one lady, Mrs. Needham, gave valuable help; but this class of work, viz., continuous nursing, does not accord well with their home obligations, and their services were available rather for work which does not exact prolonged strain and absence from home. I have a list of names and addresses, through the kindness of the Local Secretary, Mr. Oliver, so that, in any emergency I can call upon them for assistance.

Further, the Manchester and Salford District Nursing Association will (in emergencies) supply nurses to work under the Medical Officer of Health, and to report direct to him. We shall, therefore, in future possibly be better able to meet a similar heavy stress, though it must be pointed out, as regards the Manchester and Salford District Nursing Association, that in such a period of stress it is possible that they may have difficulty in supplying nurses, for the same reasons as prevailed during the autumn outbreak of 1918.

The difficulties experienced were materially relieved by the action of the Royal Infirmary, which received cases of pneumonia, whether suffering from influenza or not, to the limit of their accommodation. The cases were conveyed by the Public Health Department.

But it must not be supposed that the emergency was fully met. The greatest need experienced was a sufficient body of trained nurses to visit the homes, and nurse the cases when required.

Home helps to go in and clean up, attend to the children, &c, were very difficult to procure. In some cases neighbours met this need as far as they could; in one or two cases we were able to find someone to give the service required; but people were afraid to go to houses in which the cases were numerous and severe, as they had their own families to consider. No doubt the difficulty could be overcome, and, indeed, from December 1918 onwards, was fairly met.

The forms in connection with the health visitors are given herewith:—

FORM 1.

Practitioner's Form.

CITY OF MANCHESTER.

Influenza Distress.

Name..... Address..... District.....

*Assistance needed:—Attendance.

Coal.

Food.

Otherwise.

Doctor's Signature.....

Address.....

Date.....

* Please strike out particulars in which assistance is not required.

For Form 2, see following page.

FORM 3.

METHOD OF GRANT.

Copy of Form filled up to illustrate.

Public Health Office,
Civic Buildings, 1, Mount Street,
Manchester,
9th December 1918.

Influenza Allowances.

Address.—13, Back Factory St., Acts C.

Name.—Barlow.

Members ill.—2, Grandmother and child, (child has pneumonia).

Members dead.....

Allowances.—Milk or glaxo, 1 lb. per 2 days } for 1 week.
Coal, 2 cwt. }Standard income.—1*l.* 3*s.* 4½*d.*Actual income.—18*s.* 6*d.*

Recommended to Nursing Association.—Already attending.

Signatures { Medical Officer of Health - JAMES NIVEN.
Chairman - M. J. O'LOUGHLIN.

It is to be understood that practically the whole staff of the Health "Visitors was engaged in this work up to the end of the third outbreak in March, during which time much valuable material in the shape of reports, has been accumulated. These relate, however, chiefly to homes severely visited.

No fatality occurred amongst Health Visitors, but the number of attacks was considerable, viz.:—

1918	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	—	—	—	2	10	—	1	2	6	3
1919	Jan.	Feb.	Mar.	—	—	—	July.	—	—	—
	2	2	6				1			

It has been mentioned that great difficulty occurred in getting the dead buried at the height of the epidemic, partly because of the lack of grave diggers, partly because of the difficulty in getting coffins. Bodies were left as long as a fortnight unburied, partly at home, partly at the public mortuaries, and partly at the premises of undertakers.

A great amount of work was thus entailed in ascertaining where coffins could be most readily procured, and in bringing pressure to bear on individual undertakers. The difficulty was in part due to want of knowledge as to where coffins could be most readily obtained; partly it was due to depletion of the undertakers' staffs.

The services of a detachment of the Labour Corps from the "Western Command were secured by Mr. Pettigrew, Superintendent of Parks and Cemeteries, and in this way the difficulty, as regards grave diggers, was overcome.

No doubt other towns had a similar experience, but the facts are here recorded to show the conditions under which the civil population laboured in November and December, 1918.

Allusion has already been made to the manner in which the nurses met the calls upon them during this outbreak. Needless to say, the medical practitioners, many of them ill themselves, though much overworked, did all that was possible to meet the emergency.

FORM 2.

HEALTH VISITORS ENQUIRY FORM.

Copy filled up to illustrate.

CITY OF MANCHESTER.

Investigation into Influenza.

Address, 13, Bk. Factory St.

District, Ancoats C.

No. in Family, 3.

Surname.*	Christian Name.	Age.	Sex.	Taken ill. (Date).	Early Symptoms.	Later Symptoms.	Date of Death.	Had they Influenza in Summer.
Barlow	- Lily.	48	F.	28.11.18	Vomiting, bronchial symptoms. Pains in head and limbs.	Dr. diagnosed pneumonia, 2.12.18. Had been getting up to attend to grandchild.		
McDougal	- Frederick. - Andrew.	34 11/12	M. M.	- 16.11.18	Soldier on Active Service. Pains in limbs and body. Vomiting, bronchial symptoms.	District Nurse attending. Pneumonia 26.11.18.		

* All Members of family, whether ill or not, to be entered above.

Amount and kind of assistance needed:—Attendance. District Nurse already attending.
Coal - Needed very badly.

Standard Income, 23s. 4½d.

No. of Rooms $\frac{2}{2}$ Total Income of family, 12s. 6d. and 6s. from S.S.F.A. promised.

House, Clean. Isolation, F. Good.

No payment for Andrew.

Signature of Investigator M. DUDLEY.
Date of Visit, 6.12.18.

On November 14th a phial of prophylactic vaccine, received from Sir Arthur Newsholme, was forwarded to Monsall hospital for trial. The Acting Medical Superintendent, Dr. Dickinson, offered inoculation, and five of the nurses accepted. Of these, one, 15 days afterwards, developed an attack of influenza.

It is possible that, if a suitable prophylactic were used at a critical time, when exposure is acute, an effect would be produced in the way of prevention or mitigation of an attack.

The mortality in school children was high in the second outbreak, and though the disease spread in the schools more slowly than in the first outbreak, Dr. Ritchie informed me on November 4th, 1918, that it had then become general throughout the schools all over the city. At that comparatively early period in this outbreak, he gave a list of 25 schools severely and 43 slightly affected.

At a later period, viz., on December 19th, 1918, the schools were again closed on his advice, till after the Christmas holidays.

On November 20th I sent a circular letter to superintendents of Sunday schools, requesting the managers to close the schools. All addresses could not be ascertained, but, in addition, there were managers who declined to close the schools.

An announcement was also given in the Press that Sunday schools should be closed. It is difficult to understand the perversity of those who neglected, or withstood the request to close.

By the Public Health (Influenza) Regulations, No. 122, dated November 18th and November 22nd, 1918, admission to public entertainments was regulated, with a view to securing good ventilation. These were discussed at a meeting of the Watch Committee held on November 25th, 1918. After discussion, the Committee received a deputation of the licensees and managers of many of the theatres, cinemas, &c, in the city, and slight modifications in the regulations were agreed to, consistent with their main object.

The managers and licensees agreed to exclude children under 14 from their entertainments, though this restriction was afterwards withdrawn by the Medical Officer of Health on December 17th, as the epidemic was then declining. About the same period the closure of Sunday schools was withdrawn.

On 22nd January 1919, the Medical Officer of Health sent a statement to the Chief Constable, advising that the requirements of these regulations might be relaxed. The date was an unfortunate one, as a third outbreak began early in February.

By the Regulations No. 2 the managers, &c, of places of public entertainment were bound to exclude school children under 14, if the public schools were closed.

The President of the Local Government Board, Sir Auckland Geddes, took a share in the education of the public by offering to Public Authorities the loan of a film, "Dr. Wise" on Influenza. This was shown at a number of cinemas in Manchester and was greatly appreciated. A report on the subject was prepared by Inspector Higginbotham, who made the arrangements.

The following handbill was prepared and issued as soon as possible after the commencement of the second outbreak. It is, in effect, the same, though longer and more detailed than the first. 150,000 copies in all were printed and distributed.

(Copy Handbill.)

CITY OF MANCHESTER.

PRECAUTIONS AGAINST INFLUENZA.

Influenza is again prevalent in Manchester. It is a highly infectious and very fatal disease, frequently leading to inflammation of the lungs. If

neglected, it is often followed by prolonged weakness and depression. The disease is generally marked by its sudden onset, by severe headache, with pains in the back and limbs, and by fever. Wherever possible the following precautions should be taken :—

1. The spread of disease is favoured by the crowding together of the healthy and the sick. Those desirous of escaping infection should therefore, avoid crowded rooms and assemblages of any kind. The use of towels common to a number of persons should be avoided.

2. THOSE TAKEN ILL SHOULD BE AT ONCE ISOLATED. This is especially important in the case of first attacks in a household, factory, workshop, or home.

In this way the spread of disease will be delayed. Those infected will, on the average, not have the disease so severely, and workshops may avoid the dislocation of work which will ensue if this action is not taken.

For persons taken ill at a workshop or factory who are too ill to walk home, an effort will be made to provide an ambulance on receipt of a telephone message at Tel. City 8680, Medical.

3. ISOLATION FROM THE REST OF THE COMMUNITY IS TO BE FOLLOWED BY ISOLATION AT HOME.

When possible the sufferers must have a separate room. Whether this is or is not possible the room should be ventilated by means of an open window, so as to diminish the risk to those waiting on the sick. But as the sick are very liable to develop pneumonia, they must be kept warm by a sufficiency of clean bedclothes.

If there is fog the window is to be closed, and a fire maintained in the sick room.

If a separate room cannot be provided, it may be possible to rig up a screen, so as to separate the sick from the healthy.

When any member of a household is taken ill, the others should as far as possible, avoid close personal contact.

4. PERSONS WHO ARE ATTACKED SHOULD AT ONCE SEEK REST, WARMTH, AND MEDICAL TREATMENT. — Any delay may result in dangerous complications. There is also great risk of relapse and, generally, there is serious weakness in convalescence. Sick persons should therefore not return to work except under medical advice.

5. DISCHARGES FROM THE NOSE AND MOUTH SHOULD BE AT ONCE DESTROYED. — At home they should be collected in a clean rag or paper, which should then be burnt. Matters coughed up may be collected in a cup or mug when they cannot be immediately destroyed, in which case a little Condy's fluid should be poured into the cup, which should afterwards be emptied into a drain. The cup is then to be cleaned with boiling water and soda.

6. DURING THE OUTBREAK A GENERAL EFFORT SHOULD BE MADE TO OBTAIN THOROUGH CLEANLINESS IN THE WORKSHOP AND HOME.

Any dust or dirt in either may cause the illness to be more severe than it would otherwise be.

If it is desired to go further in the way of prevention, the easiest way will be to spray all surfaces with a solution of Formalin in a strength of 2 per cent.

7. THOSE ATTACKED EVEN SLIGHTLY SHOULD ON NO ACCOUNT JOIN ASSEMBLAGES OF PEOPLE FOR AT LEAST A PERIOD OF TEN DAYS FROM THE COMMENCEMENT OF AN ATTACK, AS THEY MAY CONVEY THE DISEASE TO OTHERS.

The most infectious period, however, appears to be at the outset of the attack.

If the epidemic advances it will be advisable for the healthy to avoid crowded gatherings, since their neighbours may quite well have a slight attack of influenza without being aware of the fact.

8. IN SEVERE CASES, THE PERSON ATTACKED SHOULD REMAIN ISOLATED FOR A PERIOD OF AT LEAST THREE WEEKS FROM THE BEGINNING OF THE ATTACK.

9. During the outbreak, workpeople are advised to wear warm clothing and to avoid unnecessary exposure.

10. A SUFFICIENCY OF PROTEID FOOD IS NEEDED, BOTH FOR HEALTHY WORKERS AND SCHOOL CHILDREN TO ENABLE THEM TO RESIST THE DISEASE WHEN IT COMES.

The cheapest sources of proteid are oatmeal, flour, peas, beans, and lentils, herrings, mackerel, and milk. Fresh milk may be replaced by good dried milk made from unskimmed cows' milk.

Flour, peas, beans, and lentils require the addition of fat. Some vegetable, such as turnips, carrots, and onions, should also be used.

By Order,
JAMES NIVEN,
Medical Officer of Health.

December 5th, 1918.

Besides the issuing of this handbill information was given to the Press for their use from time to time. A memorandum prepared for the Local Government Board on Influenza, by Sir Arthur Newsholme, was also distributed to the Press and to members of the Public Health Committee. This most valuable memorandum arrived too late to be used in the preparation of the handbill then issued.

Considering the character of the infection and experiments made on the conveyance of catarrhs, as well as other facts in the conveyance of disease, one would now feel inclined to lay more stress on certain points.

In the handbill the use of common towels is deprecated, it is true ; but it should probably be made a very prominent feature of a precautionary leaflet. Of great importance, also, is it to avoid the use of common wash-basins during an outbreak, unless these have been sterilised after each use. It is important, also, to avoid the use of eating utensils which have not been disinfected with boiling water before each time of use. This should be strongly impressed on the keepers of restaurants.

During this outbreak my attention was drawn to the general custom of handing practically uncleaned glasses, containing beer, to customer after customer. The time available did not appear to the bar-keeper to admit of more complete cleansing. I communicated with the Clerk to the Licensing Justices, who did all that was possible to remedy the practice complained of ; but matters concerning food and drink are probably not so important as those which bring infected matters in contact with the nose, as occurs from infected towels and hands. Hence, the care of the hands is all important. This is well recognised in connection with the conveyance of tuberculosis, scarlet fever, and other infectious diseases. It has its application at the workshop, where infected persons handle articles which are then handled by others, as yet free from disease. In this way the hands become contaminated.

Also, if there is a dining room, articles of food, especially bread, are infected by the hands of persons already attacked. Persons attacked by no means give up work in all cases. Indeed, I was assured that it was very difficult, owing to home conditions, to force some workers to leave work, however ill.

The question of droplet infection, that is to say, conveyance through the air, has also to be considered. Having regard to the large number of tram employees affected, and to the manner in which common colds are caught by one person from another who does not use the same towels, wash-basins, food, &c, it would seem evident that, if this is, in any given case, not the

readiest means of transference, in the aggregate it is the most formidable. We have, therefore, to take precautions against giving or receiving infection from all these sources. At the same time, in a period of acute catarrhs, there is much dispersion of infection from handkerchiefs used by persons suffering.

Personally, I am disposed to think that direct droplet infection is not always the most important agency of conveyance. Some of the sources of infection could be guarded against. The danger from common towels could be guarded against by requiring each worker to provide his or her own towel; that from wash-basins by requiring them to be cleansed after each use, preferably with very hot water; the danger from transference at work by washing the hands after work, and taking care to avoid touching the face during work.

The danger from droplet infection can only be escaped by avoiding all crowded places, which makes the use of trams and trains impossible. Hence, it cannot be altogether avoided, unless the public will consent to the wearing of face masks. Persons travelling by tram or train should carefully avoid shaking their handkerchiefs.

The value of prophylactic injections has yet to be determined, and in any case they are scarcely available for a whole population.

It will be seen, however, that the above modes of infection tend to limit outbreaks to particular schools and works, being all contained within the individual establishment.

The same is true of the home, and it is certainly remarkable how the disease spreads through a particular house and spares others in its vicinity. All the above risks of infection are contained within the house itself. The inmates are, it is true, probably in more intimate relation with each other than they are with neighbours; but this special intimacy of relation has concern chiefly with the common slopsink or wash-basin, the common towel, and the common eating utensils and articles of food.

Having regard to the manner in which the disease spreads in households Dr. Ritchie was inclined to think that the spread was from household to household, and that schools were not themselves places of dissemination.

This, however, is contradicted by the fact that the same difference in dissemination occurs between school and school, as between house and house,

It is not necessary to understand intimately the bacteriology or epidemiology of influenza to see that more might have been done to limit the spread of the disease, and that the public health authorities may be expected, in future outbreaks, to press for further elementary precautions to be taken, in presence of a severe outbreak, in works, vehicles, and private houses.

In the week ending February 1st a third outbreak of influenza commenced, and the facts are briefly set forth in a report to the public health committee, dated 4th March 1912, which is here reproduced.

Needless to say, the Public Health Committee has been advised, by reports, of the whole course of these epidemics and the steps taken have been sanctioned by the Committee directly or retrospectively, or, in emergencies, by the Chairman, or Deputy Chairman. The following is an example :—

Copy.

Public Health Office,
Civic Buildings,
1, Mount Street, Manchester,
4th March 1919.

REPORT TO COMMITTEE.

Influenza.

The present epidemic of influenza is the third within the year. In the first outbreak in July 1918 there were 332 deaths, in the second, 1,715. The

first outbreak lasted 6 weeks, the second 15. In the first outbreak the incidence of mortality on children was comparatively light, in the second comparatively heavy. Thus, among boys under 10 in the July outbreak 8•6 per cent of the total mortality in males occurred, 4•5 per cent, among females. In the Autumn outbreak, of the total male mortality; 29•7 per cent occurred among boys under 10, and of female mortality 23•3 per cent among girls under 10. As regards the present outbreak individual cases do not appear to differ from those of the previous outbreak. It is noticeable, however, that there have been some cases lately of encephalitis lethargica, and of cerebro spinal fever. Pneumonia is much in evidence as in the Autumn, but the incidence, so far, has been comparatively light on school children.

The course of the deaths is shown on the attached slip, which gives the number of deaths week by week from influenza, bronchitis and pneumonia. The measures brought into action in the Autumn outbreak have been at once resorted to in the present one, viz.:—

(1) The whole of the health visitor staff has been turned on to visiting where a death has occurred and elsewhere, when information of a severe outbreak in a house has been obtained. Several of the nurses have volunteered actually to nurse cases, and their services have already been used.

(2) The Sanitary Inspectors are engaged in visiting cases of influenzal and other pneumonias reported under the new order.

(3) The British Red Cross Society has sent in the names of Voluntary Aid Nurses, who are willing to assist in nursing cases. So far one has been placed on duty, and two more are coming to-morrow.

(4) 50,000 handbills of advice have been distributed through schools and works and health visitors.

(5) The ambulance service has been made available for moving cases of influenza, especially those taken suddenly ill.

(6) A ward block will be opened at Monsall Hospital on Monday next for the reception of cases of pneumonia.

(7) Cases needing home nursing are referred to the Manchester and Salford District Nursing Association.

(8) Cases visited by the health visitors and reported to need coal and food are considered and provision is made so that they may purchase what is necessary, or, where they are unable to do so provision is made by the Public Health Committee.

At the same time an effort is made to secure home-helps, whose services, in case of need, will be paid for by the Corporation, and also to secure nursing; but the former is usually the greater need.

(9) The Chief Constable was communicated with on February 19th to the effect that influenza was increasing, and that the Local Government Board's orders relating to places of amusement should be again brought into effect.

(10) The press has again been good enough to give prominence to advice in connection with the disease.

Further measures will be taken as may seem necessary.

JAMES NIVEN.

The following figures show the course of the mortality from influenza in this outbreak up to date.

Week ending	Influenza.	Bronchitis.	Pneumonia.
Feb. 1, 1919 - -	11	36	33
„ 8 - - -	28	42	37
„ 15 - - -	44	56	41
„ 22 - - -	127	66	52
„ 29 - - -	191	78	63

It is not possible to give an exact forecast of the present outbreak, but I am disposed to think that it will be neither so prolonged, nor so fatal as the Autumn outbreak.

The forecast given was based on the rapid ascent of the numbers of deaths week by week, in this respect resembling the first outbreak. As a matter of fact this outbreak was neither so prolonged, nor so severe as the second. Its features, so far as mortality is concerned, will be considered further on.

As regards the assistance given in the previous outbreak, the following brief statement made by Miss Seed, Superintendent of Health Visitors, shows the manner and amount of material aid given from December 4th, 1918, to January 11th, 1919. It will be noted that there was no expense put down for coal, for the reason stated.

Statement by Miss Seed on the Procedure used with regard to assistance given in the recent Epidemic of Influenza, and the amount expended.

The very earliest cases of distress were found by the health visitors in the course of their work in the district.

Later, every house wherein a death from influenza had taken place, was visited, and an investigation sheet made out (*see* Forms attached).

A further number of cases (not many) were notified by the doctors as needing assistance, chiefly in the form of coal and milk.

Every application was subjected to the standard income test before help was given, and every application where help was given was signed by the Medical Officer of Health and the Chairman of the Hospitals Sub-Committee, or of the Sanitary Committee. When coal was needed the supply was obtained from the remainder of the gift of coal of December 1916, which is, consequently, nearly exhausted.

The health visitors investigated the cases in their own areas, and the outer and unworked districts were allocated to the sanitary inspectors.

All the assistance needed was discovered by the health visitors.

The investigation of family circumstances was made by the health visitors, but the medical officer of health took into account all the circumstances of each far as was practicable.

9th February, 1919.

EXPENDITURE IN CONNECTION WITH VISITS TO INFLUENZA CASES AND ASSISTANCE GIVEN, DECEMBER 4th, 1918, TO JANUARY 11th, 1919.

	£	s.	d.
Total number of pints of milk given, 322 at 4½d.	-	6	0 9
Total number of cwts. of coal given, 246½ at 2s. -	-	24	13 0
Total number of lbs. of Glaxo given, 348 at 1s. 10d.	-	31	18. 0
Money for food expenses - - - - -	-	4	0 9½
Total expenditure - - - - -	£66	12	6½

The total expenditure for the autumn and winter outbreaks was 124*l.* 8*s.* 10½*d.*

The following may be given as an example of various memoranda prepared for the use of the press, though these were but variants on one theme.

19.2.19.

OUTBREAK OF INFLUENZA.

Additional observations.

The public are reminded of certain points in connection with influenza, which has extended rapidly within the last few days, and threatens again to exact a high mortality.

The disease is communicated from the sick to the healthy, usually by direct infection which is projected in coughing, sneezing, and speaking, for a distance of some feet.

Hence, persons who desire to escape infection, especially where there are others already ill, should wear a mask of butter muslin, as already described in the newspapers.

Persons suffering from colds should avoid coughing or sneezing amongst others, without using their pocket handkerchief, which should not be shaken when used. At present it is to the public interest and his own, that anyone suffering from cold, with raised temperature, should stay at home, at all events until there is no fever. Influenza itself requires a more prolonged rest, but it is necessary to remember that what is regarded as a common cold may be influenza.

From these remarks, it will be seen how dangerous it is at the present time to come into close contact with a number of other persons brought together from various quarters.

Ordinarily, such considerations would raise a smile; but, unfortunately, last year some 2,000 deaths occurred in Manchester alone, and there is a prospect of high mortality from the present outbreak.

All dances and private entertainments should, just now, be avoided.

The present crowding into licensed premises at certain hours is a ready means of spreading disease, especially as the glasses are by no means always cleaned before passing from one customer to another. The disease is thus taken in by two channels, nose and mouth.

The strictest cleanliness as regards eating and drinking utensils should, for the same reason, be carried out at public restaurants.

Unfortunately, it is impossible for many people to avoid exposure to infection, as they are obliged to travel to their work in trains and trams, and when they go to their places of work they are again exposed to infection in a like manner, and from fresh causes. It is customary for people employed at works to use towels in] common, as is also the case at offices, restaurants, and schools. This should be avoided. As already mentioned, persons travelling should wear masks, and persons coughing should use their handkerchiefs to cough or sneeze into.

All assemblages involving crowded meetings should, as far as possible, be avoided until this wave of influenza has passed over.

There are, however, many activities which cannot be interfered with, except in the last resort, and with the agreement of all concerned, such as churches, hospitals, out-patient departments, meetings on 'Change, public schools.

Sunday schools are important, no doubt, but stand in a different category, and should at once be suspended when any cases are known to have occurred.

The Local Government Board has dealt in a special manner with places of amusement, but it lies with the individual, both for his own sake and for that of others, to take no unnecessary risks.

At home, the danger of infection is at once greater and more easily escaped, with ordinary care. A new risk comes into view. Members of the family attacked with the disease, as well as those waiting upon them, are very liable to place their hands on bread without cleaning them. The

bread thus gets infected and carries on the disease to other members of the family.

It is, therefore, important that any one handling food such as bread, cheese, &c, should wash their hands carefully before doing so. This remark applies to all catering establishments.

It is important at such a time as the present, that the body should be kept warm, and that a sufficient amount of good food should be available. The former object may be attained by warm underclothing and good boots, coupled with exercise, or by a sufficiency of fuel; but it seems necessary to point this out, as the disease not only infects more easily, but is more severe, where deficiency of food, clothing and fuel is present.

As regards the home the Public Health Department, Civic Buildings, 1, Mount Street, would be glad of an intimation when influenza has appeared in a family, which is not able to procure sufficient fuel, food or attendance.

THE BACTERIOLOGY OF INFLUENZA.

No attempt has been made to obtain bacteriological investigations in the case of persons dying from influenza. Three swabs were submitted to Professor Delepine from cases occurring at Baguley Sanatorium, and one was submitted by me. In none of these was the bacillus of influenza found. On the other hand three swabs, submitted by Dr. D'Ewart, at my request, from school children, all showed the presence of Pfeiffer's bacillus.

Professor Dean, also, on November 1st, 1918, was good enough to give me a short account of his experience obtained amongst the American troops at the Pavilion, Old Trafford. In the majority of cases the influenza bacillus was found in the sputum. He made blood cultures from five of the worst cases, and in three obtained a pure culture of the pneumo-coccus. In three of the cases he made a post-mortem examination and found in each very extensive confluent broncho-pneumonia and purulent bronchitis.

In the British Medical Journal, January 5th, 1919, Colonel Muir described the results of examination of 30 bodies of persons who died of influenza at Glasgow, of whom 26 were American soldiers. In the great majority of these the bacillus of influenza was present, viz., in 22 out of 26, and in all the broncho-pneumonic cases.

The outstanding feature from the point of view of morbid anatomy was the broncho-pneumonic lesion. The number of septicaemic cases was high.

The organisms most frequently associated with the influenza bacillus were pneumo-cocci and streptococci.

Similar findings are recorded in the publication of the Medical Research Committee. In one of the researches there given the close association of the influenza bacillus with streptococcus viridans is a prominent feature. The influenza bacillus appears to become more abundant some time after the commencement of the illness.

The influenza bacillus is frequently not present, in the experience of other observers, and is present in conditions having no relation to influenza.

It is not communicable to animals, so that proof of its causative relation to influenza is wanting.

In a publication by the Medical Research Committee, Major Gibson, R.A.M.C., Major Bowman, C.A.M.C., and Captain Connor, A.A.M.C., record a research into a filtrable organism which they believe to be the cause of the disease.

They show that the filtrate from sputum obtained early in the course of the disease, is capable of producing, when inoculated in animals (monkeys, rabbits, guinea-pigs and mice) lesions in the lungs similar to those occurring in man, more particularly as regards the haemorrhages which were so prominent a feature in the lungs of patients dying in the second outbreak, to which period their research relates.

These appearances were found even in animals which presented no sign of ill-health after inoculation.

By adopting Noguchi's technique they obtained cultures of a minute coccoid body, which they were able to subculture, and which, when inoculated into animals, were able to transmit disease.

By employing rabbits they were able to pass on disease from one animal to another.

This research followed the lines of one by Dr. G. Foster recorded in the (American) Journal of Infectious Diseases, 1917, 21, on Common Colds.

The above workers did not venture to use human material to test the cultures obtained, but Dr. Foster could more safely do so, and by instilling the filtrate from sputum in common colds, and the cultures which he obtained, into the nostrils of volunteers, he found that acute catarrh was produced in periods varying from 6 to 48 hours.

Gibson, Bowman, and Connor found that, when the inoculated animals showed signs of illness, it was not until the 6-7th day after inoculation.

This may be accounted for by difference in the channel of entrance, but is more likely to have been due to a difference in the infecting agent.

The cultures which these observers obtained were, in appearance, exactly like those obtained by Foster; but no proof exists that those cultures had anything to do with the results obtained, or that they constituted the filtered virus. This may quite well have been in each case some organism which not only was in the first instance, but remained ultra-microscopic,

On the other hand the behaviours of "common cold" and of "influenza" are remarkably alike. As with influenza a "common cold" is at one time infectious, at another non-infectious, at one time a member of a family gets a cold and it stays there; at another it passes through the household with extraordinary rapidity. It behaves differently in different households..

The results of a cold are much more severe at one time than another, as regards the respiratory troubles which it stirs up.

It may well be that a close study of the common cold is necessary to the elucidation of influenza.

Another feature of these outbreaks is the manner in which micro-organisms ordinarily more or less quiescent took on infective and malignant properties. Thus pneumococcal, streptococcal, staphylococcal, and even meningococcal infections all became more active.

This is perhaps more likely to happen if they are associated with a very minute filterable body than as the result of association with the influenza bacillus.

PART II.

EPIDEMIOLOGY.

In studying the epidemiology of the disease the only material which I possess is the Register of Deaths. Fortunately, by the kindness of Dr. Carnwath and Dr. Arnold, of the Ministry of Health, I have had the opportunity of seeing the results of investigations made by different observers, Dr. Carnwath in Manchester, Dr. Arnold in Leicester, Dr. Macewen on schools, Dr. Hutchinson in a rural district, and other observers on the effects of special occupations on the incidence of influenza.

Further, Dr. Major Greenwood has kindly furnished me with the results of his calculations on the facts for these and other districts. I much regret now that I did not apply for a special staff to carry out observations on the course of the epidemics on the lines pursued by Dr. Carnwath, Dr. Arnold, Dr. Hutchinson, and in Cambridge; but it did not occur to me to use the staff for this purpose until Dr. Carnwath requested that a block census should be taken. The best was done in Manchester which then appeared possible, and Dr. Carnwath had the services of the health visitors for a week. The material thus collected will be useful in various ways.

Areas were selected so as to obtain a total of about 1,000 houses, distributed in such a way as to be representative of different districts in the city.

At the time of Dr. Carnwath's investigation only the facts for summer and autumn could be given. The names and ages of each member of the household were recorded, the date and character of the attack in autumn, and the fact of a previous attack in summer. The summer outbreak covers the period from the week ending July 20th to the week ending August 3rd, the autumn outbreak extending from the week ending October 19th, 1918, to the week ending January 25th, 1919. The facts for the winter outbreak have been subsequently obtained.

As my figures are arranged in age groups of five, it is proposed to re-arrange Dr. Carnwath's data in the same manner. The mortality curves exhibit striking peculiarities when thus arranged, which do not appear otherwise, and they lend themselves better to the construction of frequency curves.

On the other hand their value would not be nearly so great, unless the facts of incidence collected for Dr. Carnwath were there for comparison.

When the Manchester and Leicester experiences are compared in this manner, I expect the frequency curves of incidence for age groups will be found to differ. There is also the gross fact for Manchester of the much larger incidence in summer than in autumn, while the incidences in Leicester show the opposite relation. The two experiences are, probably, in important respects different.

This is important as regards the comparative immunity shown in the two cities of persons exposed in the autumn who had been infected in summer.

The investigations made for the Ministry of Health on the block census method show for Leicester immunity against autumn attacks in those infected in summer, and immunity against winter attacks in those infected in autumn.

In Wigan, where the investigation was carried out by Dr. Hutchinson, there was, in addition, immunity against winter attacks of those attacked in summer.

In Cambridge University there was immunity for summer attacks in autumn, and against winter attacks of those attacked in summer.

On the other hand the Finchley Elementary Schools show protection in autumn of those attacked in summer, and in winter for autumn attacks, but not in winter for summer attacks, in this agreeing with Leicester. The experience of Finchley Elementary Schools was also that of Clifton College.

In the Manchester figures no protection is apparent in autumn for summer attacks. There would thus seem to be some variable factors.

So far as my own experience goes it is intended to submit the deaths to a careful examination, and then to compare the results obtained with corresponding figures for incidence obtained by Dr. Carnwath, and a further set of additional figures obtained afterwards.

First, then, as regards deaths. The deaths are recorded in males and females respectively, week by week, and for 16 five-yearly groups of ages, from the beginning of January 1917 to the end of June 1919, registered as due to influenza, pneumonia, broncho-pneumonia, bronchitis, and tuberculosis respectively. Those ascribed to tuberculosis have not been used in drawing the curves submitted to study, since there was but little effect produced on tuberculosis.

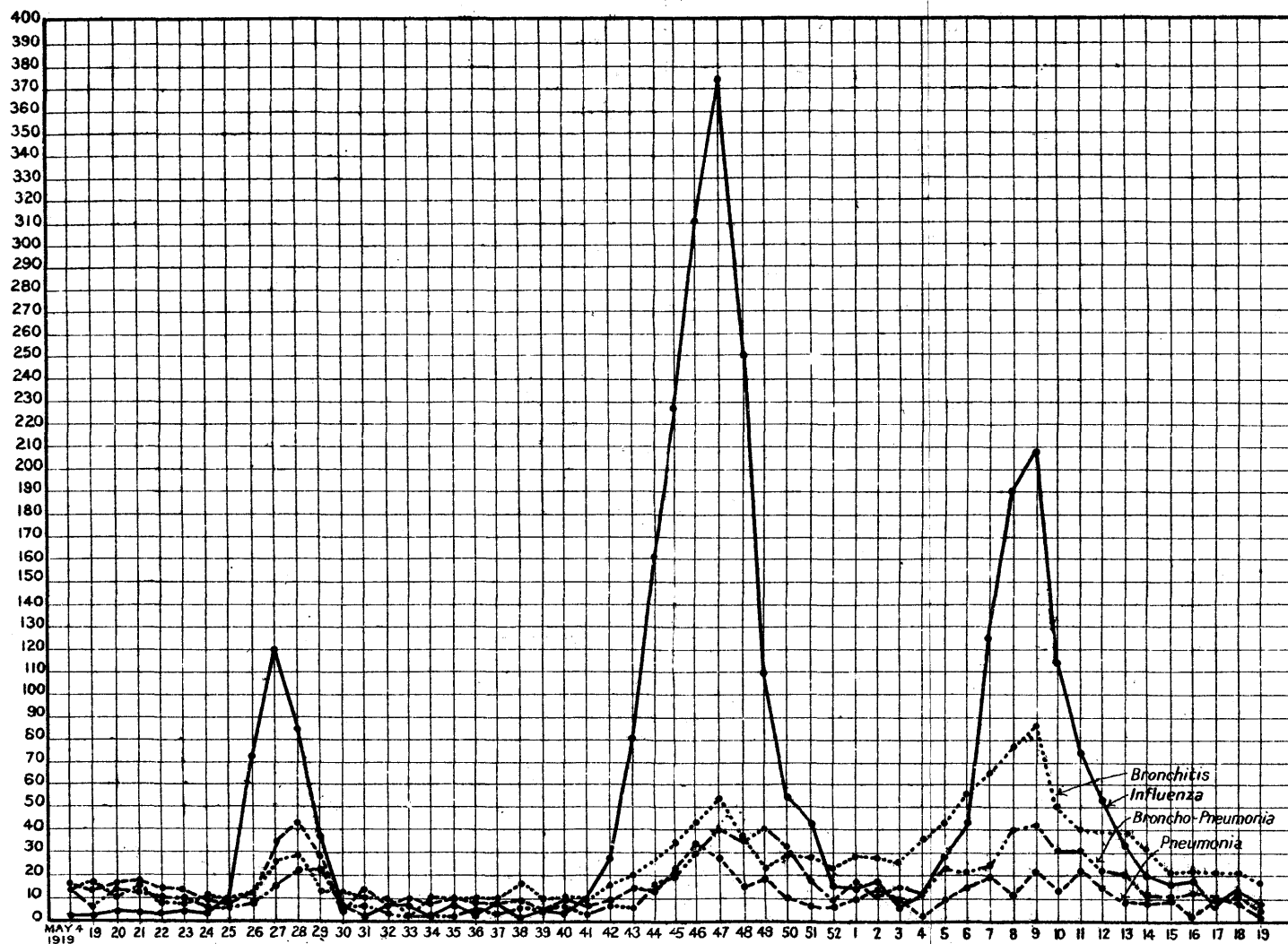
The following curves have been constructed for deaths :—

Curves 1.—Continuous frequency curves on the same scale from "influenza" from the 18th week in May 1918 to the 19th week in 1919, showing deaths from influenza, pneumonia, broncho-pneumonia and bronchitis.

We thus see that three waves of influenza mortality occurred, the first lasting from the 25th week, 1918, to the 30th. The duration of this wave was six weeks. It will be seen that the mortality sustained was far slighter than in the second and third waves.

FREQUENCY OF DEATHS FROM INFLUENZA, BRONCHITIS, BRONCHO-PNEUMONIA AND PNEUMONIA

CURVES 1 (See p. 506) IN WEEKS FROM THE 19TH WEEK 1918 TO THE 19TH WEEK IN 1919.



The second wave lasted from the 42nd week in 1918 to the 4th week in January 1919, a period of 15 weeks. This was by far the most fatal visitation.

The third outbreak lasted from the 5th to the 16th week in 1919, a period of 12 weeks, and was intermediate in severity between the first and third.

Roughly the second wave was twice as severe as the third, and five times as severe as the first.

In appearance they are very much alike, so far as influenza alone is concerned. The third wave is somewhat flattened at the top, and is narrower than the second, except at the base.

It will be remembered that notwithstanding the great fatality in the second wave, there is reason to believe that far more persons were attacked in the first wave, many of them, no doubt, so slightly as to make them forget that they had been attacked.

An important difference was observed in the second wave in the greater number of persons who suffered from bleeding at the nose, and, when post-mortem examinations were made, in the comparative frequency of haemorrhages into the lung.

Important differences also are observed in the curves for pneumonia, bronchitis, and broncho-pneumonia.

The curve of pneumonia mortality reached its highest point in the first wave, and in this wave it resembled, more than the waves of the other two diseases, that for influenza. In the second wave the pneumonia mortality shows a well marked wave, but it is now lower than that from bronchitis or broncho-pneumonia. In the third wave it again rises above the level, but the rise is not a sustained one, and does not attain nearly the height of either broncho-pneumonia, or bronchitis.

It may be observed that, in the first wave, the crest of the pneumonia wave follows that of influenza, by a week, in the second it precedes it, in the "third the pneumonia wave has no distinct crest though its upper part corresponds roughly with that of influenza mortality.

It would thus seem as if the impulse towards the creation of an epidemic pneumonia diminished from the first wave onwards.

In the first outbreak the broncho-pneumonia mortality shows also a distinct wave, considerably less than that of pneumonia, which attained its crest a fortnight after influenza, and a week after pneumonia. The wave of broncho-pneumonia is throughout greater than it appears, however, as it rises from a lower base than pneumonia or bronchitis.

In the second outbreak broncho-pneumonia rises well above pneumonia, its wave having two crests, one coinciding with that of pneumonia, the other a fortnight later; but it only rises in a conspicuous manner in the latter part of the wave, in a part of which it rises above bronchitis.

As a separate cause of death broncho-pneumonia thus becomes much more important in the second outbreak than in the first. Its importance relative to pneumonia is much more emphasised in the third wave, where it separates itself from "pneumonia" entirely, and as a cause of death is as important as in the second outbreak. This is the more remarkable since this outbreak coincides with the season at which lobar pneumonia is most in evidence.

There is, however, not much difference between the mortalities from broncho-pneumonia in the second and third waves.

Bronchitis presents a different picture. Like the other two respiratory conditions the mortality ascribed to it has a well-marked wave; but this wave has very definite features throughout.

In each wave the crest coincides with that of influenza, and the course of the mortality pursues a similar course though flattened down. In the first outbreak this wave precedes that of broncho-pneumonia, as it does in the second. It is not materially greater than that from broncho-pneumonia in the first wave, though smaller than the wave of pneumonia. In the second it is somewhat greater than the wave of broncho-pneumonia. In the third

it rises far above both pneumonia and broncho-pneumonia as a cause of death.

In order, however, to be able to form an opinion as to the relation which the frequency curves from those respiratory conditions bear to influenza, it is necessary to consider the number of instances in which each of them occurs as a complication of influenza. It is manifest, of course, that the waves affecting these conditions, when given as independent causes of death, are in reality waves of influenza, though the most prominent feature and character may be those of the cause of death assigned; but it is at least possible that these waves, when compared one with the other, may be raised or depressed according as the number of complications in the corresponding period from that particular cause is low or high.

Moreover, a study of the complications in fatal cases may throw light on the character of the respective outbreaks.

These conditions, when occurring as complications of influenza, have therefore, been taken out in 16 age groups for four periods, viz., January to June 22nd, 1918, June 23rd to August 3rd, 1918. October 23rd, 1918, to January 25th, 1919, and January 26th to April 26th, 1919.

The second, third and fourth of these periods cover the three epidemic waves.

For convenience of reference the corresponding facts for influenza are given at the head of the table.

Table showing four Periods for Deaths from Influenza, Deaths Registered simply as from Influenza, and Deaths Registered from a Variety of Complications, divided into 18 Age Groups, each of five Years.

Influenza age frequencies in fatal Cases.

—	Period.	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
	Jan. - June 22, 1918.	2	1	3	1	3	2	2	3	2	8	5	8	8	10	4	1	2	1	66
	June 23-Aug. 3 -	14	8	17	28	27	42	31	27	23	23	21	19	17	14	15	3	2	1	332
	Oct. 13-Jan. 25, 1919.	304	130	65	96	127	181	155	105	80	93	80	78	71	73	42	19	10	5	1,714
	Jan. 26-April 20 -	109	31	22	48	44	112	94	57	53	73	64	44	49	50	43	29	13	1	936

Complications of Deaths from Influenza—1918-1919.

Complication (Secondary Cause).	Period.	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
Broncho Lobular, Catarrh, Pneumonia	Jan.-June 22 - 1	1	—	—	1	—	—	—	—	—	—	—	—	—	3	1	—	1	—	7
	June 23-Aug. 3 2	4	3	3	8	2	9	4	4	5	4	4	4	5	3	1	—	1	—	64
	Oct. 13-Jan. 25 3	161	73	16	19	22	44	43	24	21	24	28	10	18	16	7	2	1	—	529
	Jan. 26-Apr. 26 4	54	13	5	8	12	33	18	15	10	16	17	13	11	9	14	4	1	—	253
Other Pneumonia	Jan.-June 22 1	—	1	1	—	—	1	2	1	—	2	2	3	1	2	1	—	—	1	18
	June 23-Aug. 3 2	2	2	11	15	18	19	19	14	12	11	8	10	3	3	4	1	1	—	153
	Oct. 13-Jan. 25 3	77	35	35	61	83	107	86	62	28	46	30	26	21	14	9	1	1	—	722
	Jan. 26-Apr. 26 4	30	10	12	24	25	56	56	28	22	39	24	9	11	13	11	9	—	—	379
Bronchitis	Jan.-June 22 1	—	—	—	—	1	—	—	—	1	2	1	2	2	—	—	—	—	—	9
	June 23-Aug. 3 2	—	—	—	1	—	3	2	2	1	3	4	2	2	4	6	—	—	—	30
	Oct. 13-Jan. 25 3	11	2	2	3	3	11	5	4	10	13	10	22	19	25	13	12	3	1	169
	Jan. 26-Apr. 26 4	10	1	—	2	2	8	2	3	13	6	17	9	17	19	10	9	5	—	133

Complications of Deaths from Influenza—1918-1919.—continued.

Complication (Secondary Cause).	Period.	0-5.	5-10.	10- 15.	15- 20.	20- 25.	25- 30.	30- 35.	35- 40.	40- 45.	45- 50.	50- 55.	55- 60.	60- 65.	65- 70.	70- 75.	75- 80.	80- 85.	85 and above.	Total.
Other Respiratory Dis.	Jan.-June 22	1	—	—	1	—	—	—	1	—	1	1	1	1	1	—	—	—	—	8
	June 23-Aug. 3	2	1	—	—	1	1	—	1	—	2	—	—	—	—	—	—	—	—	6
	Oct. 13-Jan. 25	3	2	1	—	—	2	2	1	3	1	2	—	1	1	2	—	1	—	22
	Jan. 26-Apr. 26	4	—	—	—	—	—	—	1	1	3	—	1	1	—	1	—	—	—	9
Tuberculosis	Jan.-June 22	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	June 23-Aug. 3	2	1	—	1	—	—	2	1	2	—	—	2	1	—	—	—	—	—	12
	Oct. 13-Jan. 25	3	—	2	5	4	10	8	3	3	4	2	1	1	2	—	—	—	—	45
	Jan. 26-Apr. 26	4	—	—	1	3	1	4	1	—	3	1	2	—	1	—	—	—	—	18
Meningitis	Jan.-June 22	1	—	—	1	—	—	—	—	1	—	—	—	—	—	—	—	—	—	2
	June 23-Aug. 3	2	3	1	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—	6
	Oct. 13-Jan. 25	3	14	5	1	1	2	1	1	—	2	—	1	—	—	—	—	—	—	28
	Jan. 26-Apr. 26	4	—	1	1	2	—	1	1	1	—	—	—	—	1	—	—	—	—	8
Nervous Dis.	Jan.-June 22	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	June 23-Aug. 3	2	2	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	3
	Oct. 13-Jan. 25	3	9	2	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	14
	Jan. 26-Apr. 26	4	1	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	3
Digest Syst.	Jan.-June 22	1	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2
	June 23-Aug. 3	2	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
	Oct. 13-Jan. 25	3	8	—	1	1	1	—	—	—	—	1	—	1	—	—	—	—	—	16
	Jan. 26-Apr. 26	4	—	1	—	1	—	—	—	1	—	—	—	—	—	1	—	—	—	4
Heart and Blood Vessel Dis.	Jan.-June 22	1	—	—	—	—	—	—	1	—	2	—	1	3	4	2	1	—	—	14
	June 23-Aug. 3	2	—	1	1	3	6	5	3	2	2	3	1	6	3	3	1	—	—	41
	Oct. 13-Jan. 25	3	5	4	—	4	2	1	9	7	10	4	2	9	6	7	1	2	—	80
	Jan. 26-Apr. 26	4	2	1	1	5	2	6	7	5	4	4	3	9	4	3	2	5	6	1

From the above table we find that the following complications form the percentages of deaths from influenza in the respective periods given underneath:—

Percentages of Influenzal Deaths.	First Period.	Second Period.	Third Period.	Fourth Period.
	Jan. 1918 to Week ending June 22.	First Wave, 26th-31st week inclusive.	Second Wave	Third Wave.
Pneumonia - - -	27·27	46·08	42·12	40·49
Broncho-pneumonia - -	10·61	19·30	30·86	27·03
Bronchitis - - -	13·64	9·04	9·86	14·21

To compare this with the corresponding causes of death registered as primary during the second, third and fourth periods, it is necessary to remove that part of the waves which is permanent and occurs in other years. This can be done approximately by subtracting the figures for the corresponding weeks in the year before; we thus get:—

Disease.	Second Period.	Third Period.	Fourth Period.
Pneumonia - - - -	136	209	165
Less	49	155	144
	<u>87</u>	<u>54</u>	<u>21</u>
Broncho-pneumonia - - -	78	310	303
Less	32	181	245
	<u>46</u>	<u>129</u>	<u>58</u>
Bronchitis - - - -	111	419	629
Less	67	360	295
	<u>44</u>	<u>59</u>	<u>334</u>

The percentages which these residues form of the deaths from influenza in the corresponding period as shown in the above table are:—

Disease.	Second Period.	Third Period.	Fourth Period.
Pneumonia - - - -	25·30	3·15	2·24
Broncho-pneumonia - - -	13·86	7·53	6·20
Bronchitis - - - -	13·25	3·77	35·68

On reference to the curves of frequency it will be seen that this mode of treating the figures meets the case very well.

It shows the powerful influence of the first wave on pneumonia, broncho-pneumonia and bronchitis. This is much less conspicuous in the second wave, even as regards broncho-pneumonia, which is the condition most affected.

The striking characteristic of the third wave is the dominance of bronchitis, which may, presumably, be taken to mean absence of consolidation.

It would thus appear as if some more fatal influence had become dominant in the second wave, and taken the place of the more common complications of the disease, perhaps a haemolytic streptococcus.

Adding, now, the residues of the waves of pneumonia, bronchitis and broncho-pneumonia obtained above to each of the influenza waves, we obtain the figures given below for the approximately correct number of deaths from influenza and its complications.

When we treat the figures in the way suggested we get:—

Number of deaths.	First Wave.	Second Wave.	Third Wave.
Influenza - - - -	509	1,956	1,349
Having pneumonia - - -	240	776	400
Having broncho-pneumonia -	110	658	311
Having bronchitis - - -	74	228	467

This gives for the percentage of complications in:—•

—	First Wave.	Second Wave.	Third Wave.
Pneumonia - - - -	47·15	39·67	29·65
Broncho-pneumonia - - -	21·61	33·64	23·05
Bronchitis - - - -	14·54	11·66	34·62

On this mode of treatment it will be seen that pneumonia, which includes lobar pneumonia and other pneumonia not specifically named, but usually lobar, is more in evidence in the first wave than in the second, and still less in the third. Broncho-pneumonia, on the other hand, is less evident in the first and third waves than in the second.

Bronchitis is least evident in the second wave, most marked in the third.

In the third wave 87 per cent of the deaths have respiratory disease as a complication, in the second wave, 85 per cent., in the first wave 83 per cent.

Pneumonia, including broncho pneumonia, is present in 73 per cent of the fatal cases in the second wave, in 69 per cent in the first, and in 53 per cent in the third.

It would thus seem that marked differences appeared in the three waves as regards the complicating conditions in the lung, which probably corresponded to changes in the character of the organisms responsible for the fatal issue, and perhaps also for the incidence in the three waves.

It is important to observe that, while the true curve of influenza mortality may probably be constructed by adding to the waves of deaths from influenza, the simultaneous waves of deaths from pneumonia, broncho-pneumonia, and bronchitis, the "transference is not all on one side. This will be seen on comparing the control waves; in curves 6 for January 1917 to June 1918, with those for June to December 1918 and January to June 1919. It will be seen, on examining the latter curves for pneumonia and broncho-pneumonia at advanced ages, and comparing them with the control curves, that there is evidence of transference from pneumonia and broncho-pneumonia to influenza.

"With influenza so prevalent as it was in the summer and autumn of 1918, and in the first-half of 1919, the tendency is, in fact, to regard as influenza every acute fever, especially those of short duration. In this way a large amount of error must have been introduced into double attacks,

sufficient to obscure the facts of immunity, unless these were ascertained, with great pains and discrimination. This is especially likely to occur in districts such as Manchester, where the incidence of pneumonia and other acute respiratory affections is always high.

With less severe affections it is not possible to say whether these normally occur in Manchester with exceptional frequency, but it is likely, if we may judge from the high death rate from pneumonia, and also from the very-smoky state of the atmosphere, which I have elsewhere shown to be, at times,, associated with a high respiratory mortality.

The difficulty in determining in any given case, whether two reputed attacks have been from influenza may be illustrated by the histories which I obtained from four of our health visitors who are said to have had double attacks.

Health Visitors.

- (1) First attack. Mrs. S. aet. 30.
Second attack, 1st in June 1918.

First attack, began on July 1st, in Warrington, where she was a health visitor. Severe headache, temperature 102° for several days, pains in the limbs, &c, no epistaxis, no catarrh of the eyes and nose, slight sore throat, anorexia; no diarrhoea. Away a fortnight. Had cough, but no pneumonia picked up very quickly; felt quite fit on returning.

Second attack began October 26th. Very well in morning; afternoon: gradually felt ill; severe headache, very fatigued; anorexia, chill; temperature not taken; no epistaxis; no actual sickness; no diarrhoea; no chest affection, but cough. Went to bed, but got up and tried to work it off. Was away a fortnight. Second week had palpitation very badly.

- (2) Miss B.C., Higher Broughton.

I. At Radcliffe, nursing soldiers at the Radcliffe Military Hospital.

Took ill in July; came on suddenly. Shivering, general pains, headache, prostration, temperature, 101° . Vomited, no appetite, no epistaxis, running eyes, sore throat or diarrhoea. Did not go to bed but continued duty. Ill about a month, but no cough. Feeling of lassitude.

II. Took ill about November 1st. Came on rather suddenly; chill general pains, great depression, severe headache, temperature, 100° twice; cough, pain in the chest, went to bed and stayed in bed three or four days, then came down to the office. Has a cough now and does not seem to me fit, but will not stay at home (seen on her return).

- (3) Mrs. B.

I. Took ill July 1918. Having dinner, directly after took suddenly ill, like fainting fit. Went home; temperature, $103 \cdot 8^{\circ}$; was then a health visitor at Oldham. Severe headache, sore throat, ending in tonsillitis. Pains all over, vomited; no diarrhoea. Went to bed and stayed there a week. Very weak; off work three weeks.

II. Took ill November 6th. Felt heavy, severe cold in the head. November 7th, severe diarrhoea; chief symptom was headache. Came down November 8th, was sent home. Temperature, $101 \cdot 4^{\circ}$. Had another sore throat; not sick; had cough; two days in bed. Got up the day the Armistice was signed, November 11th.

- (4) Miss C.

I. Took ill on July 18th. Ill, out of sorts, headache and pains. No rise of temperature. Very quick pulse. Went to bed, stayed in bed a week. Very ill three days; temperature, third day 102° . Vomiting, pains in hands and toes; epistaxis third day. Running eyes and nose, cough afterwards; no pains in the chest; no sore throat. Very weak on getting up. Doctor prescribed a week's rest; felt all right when she got up.

II. Home at Llanberis. Began with pains in her chest about October 27th, followed by a cold. No severe headache or general pains. Temperature not taken. Returned to work on November 5th.

It is very doubtful how many of these attacks were really influenzal. Thus it is doubtful whether the second attack was influenza in cases 1, 3, and 4, and not merely common colds, and if that can be said to be so in the case of health visitors, it is much more likely that untrained persons would call every feverish attack influenza.

On the other hand, it has been necessary to make further inquiries at houses to bring the cases up to date, and I am informed that the tendency now is for people who formerly stated that they well ill with influenza in the summer of 1918 to deny that there was then anything the matter with them, being afraid that the continued enquiry implies blame imputed in regard to their previous statements, so easily may these statements swing to one side or another. No doubt their first statements were what they believed, allowing for some natural exaggeration.

But such transference is most likely, at all events as regards cases of such diseases as tuberculosis, enteric fever, scarlet fever, and ordinary catarrh.

The rest of the table of complications may be stated briefly. There is little evidence that influenza caused any rise in the number of deaths from other causes than those named above. We may, while giving the facts, also state what number of deaths were to be expected had the disease exerted the same influence on all of the causes of death as it did in the first outbreak. For this purpose we may multiply the deaths in the first outbreak by 5 to give the expected number in the second, and by 3 to give the expected number in the third.

—		Broncho-Pneumonia.	Pneumonia.	Bronchitis.	Other Respiratory Diseases (mostly Pleurisy).	Tuberculosis.
Actual number	1	64	153	30	6	12
	2	529	722	169	22	45
	3	253	379	133	9	18
Expected number	2	320	765	150	30	60
	3	192	459	90	18	36

—		Meningitis.	Nerve Diseases.	Heart Disease and Diseases of Blood-Vessels.	Digestive System.
Actual number	1	6	3	41	1
	2	28	14	80	16
	3	8	3	70	4
Expected number	2	30	15	205	15
	3	18	9	123	3

"We thus see that under other respiratory diseases (mostly pleurisy) the numbers in the second and third outbreak are fewer than we should expect.

Under tuberculosis also the numbers indicate the greater influence of the first outbreak on mortality. The same is true of meningitis and other diseases of the nervous system.

It is, however, under heart diseases that the influence of the first outbreak is most conspicuous, "which again may indicate pneumo-coccal septicaemia.

Probably these unexpected facts may be related to the larger numbers attacked in the first outbreak.

It has been said that it is by no means clear that, in the aggregate, influenza had any influence on deaths from tuberculosis. The matter would seem to be easily tested. There were 2,096 from influenza in 1918, and 1,390 deaths from tuberculosis in the year out of a total of 12,181. The chance that a death from tuberculosis would coincide with a death from influenza on the hypothesis of independence of the two is therefore—

$$\frac{2096}{12181} \times \frac{1390}{12181}$$

and the number of deaths which might be expected to coincide is—

$$\frac{2096}{12181} \times \frac{1390}{12181} \times 12181 = 239 \cdot 2.$$

The number to be expected in the six weeks of the first outbreak is—

$$\frac{6}{52} \times 239 \cdot 2 = 27 \cdot 6,$$

in the second—

$$\frac{15}{52} \times 239 \cdot 2 = 69,$$

in the third—

$$\frac{13}{52} \times 239 \cdot 2 = 59 \cdot 8.$$

The actual numbers were 12, 45, and 18. This seems to give some support to the view that there is an actual antagonism between the two diseases. But this is open to fallacy, since deaths from tuberculosis might quite easily be ascribed to concurrent influenza.

These figures need some revision. Strictly speaking, the figures should not be applied to the third outbreak at all. Moreover, the calculation should be restricted to the second half of the year when influenza was prevalent, and when also the mortality from tuberculosis is least. It is, however, clear enough to enable us to say that, in the aggregate influenza had little effect on tuberculosis mortality.

The corrections mentioned, when applied, give the following figures. The chance of influenza occurring in a case of tuberculosis in the second half of 1918 is—

$$\frac{2004}{6342} \times \frac{619}{6342}$$

and the number which may be expected to occur in six weeks out of 6,342 deaths is—

$$\frac{2004 \times 619}{6342} \times \frac{6}{26} = 44,$$

the expected number in 15 weeks is 110. The actual numbers are 12 and 45 respectively.

If we take the experience of the first half year of 1919 the corresponding expected number is 43, the actual number being 18. The results do not differ materially from those already given.

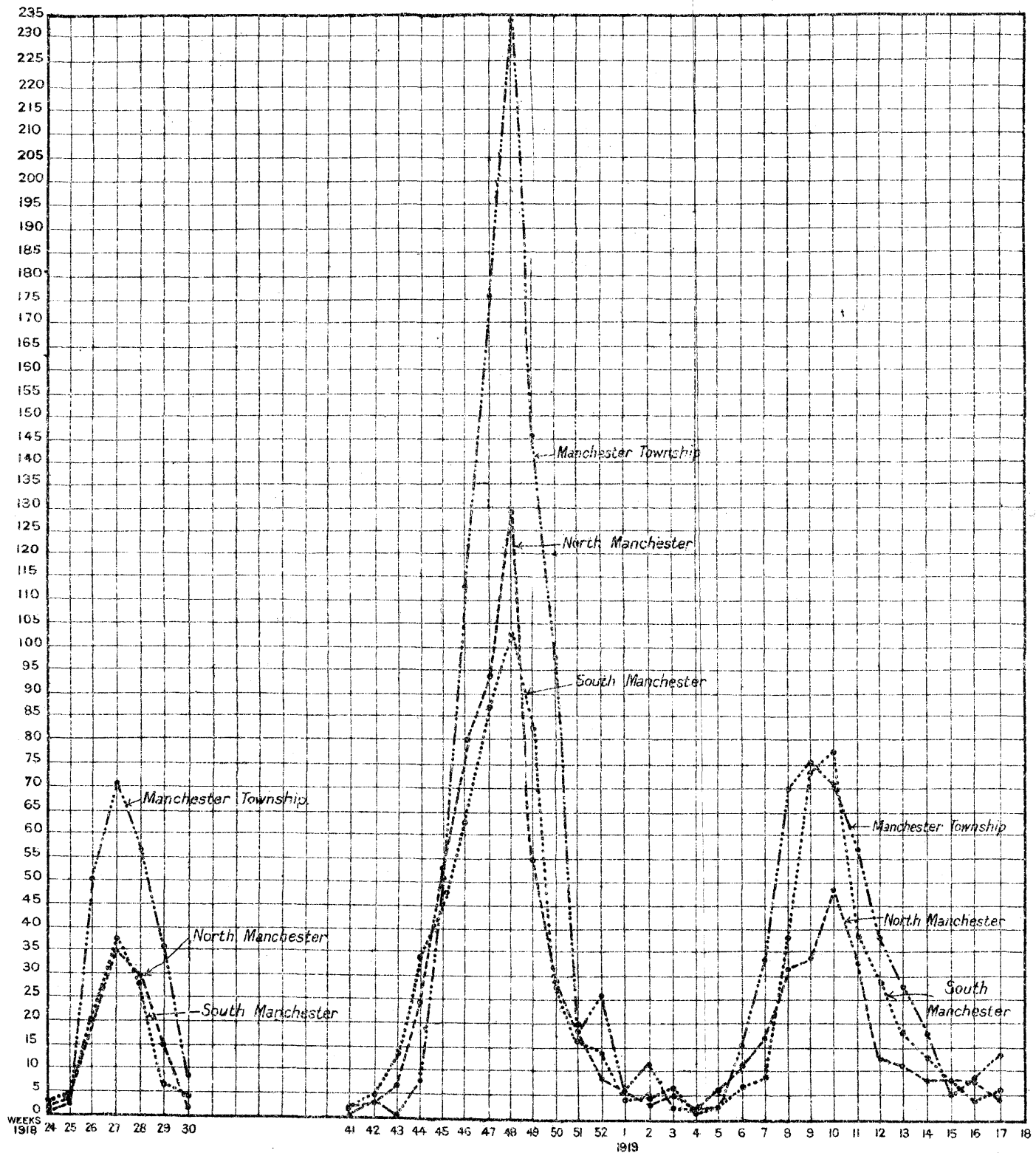
Tables have been prepared showing the numbers of deaths occurring week by week from the 19th week in 1918 to the 19th week of 1919, from influenza, pneumonia, "broncho-pneumonia, bronchitis, and tuberculosis. If we refer to the deaths from tuberculosis during the influenza wave periods we find that no definite increase occurs in July 1918, or during the second wave. In this instance the figures for 1919 have not been given.

Curves 2.

Curves 2 have been prepared showing the death-rates from influenza in each of the principal divisions of the city from the week ending June 22nd

FREQUENCY IN WEEKS OF INFLUENZA DEATH RATES IN THE THREE PRINCIPAL DIVISIONS OF THE CITY FOR EACH WAVE.

Curves 2 (See p. 507)



1918, to the week ending April 19th, 1919. Unfortunately the populations have become very uncertain, so that the accuracy of the death-rates is somewhat uncertain absolutely, though not so much relatively. In order to appreciate the constant differences in mortality rates between the three divisions of the city, it is necessary to have figures showing the death-rates from all causes, and from the main causes of death in which large differences are shown every year. The following figures will suffice for this purpose :—

Death Rate.	All Causes.		Pneumonia.		Bronchitis.		Heart Disease.		Tuberculosis.	
	1901.	1917.	1901.	1917.	1901.	1917.	1901.	1917.	1901.	1917.
Manchester Township.	27·52	20·63	2·94	2·22	2·55	2·70	2·93	2·72	4·63	3·77
North Manchester.	17·57	11·62	1·64	0·98	1·64	1·18	2·21	2·05	1·63	1·57
South Manchester.	21·08	12·55	2·21	1·10	1·86	1·27	2·50	2·33	2·75	1·87

South Manchester has been extended since 1901, and its death rates ought now to be lower relatively than in that year.

Passing to the frequency curves from influenza it will be seen that the death rates from influenza in the first outbreak rose simultaneously in all three divisions to a peak in the same week, and declined simultaneously. The space between the curves and the base line may be taken as showing the number of deaths per 100,000 in the outbreak.

In the first and second outbreak the relative death-rates from influenza correspond generally to the relative death-rates from respiratory disease, except that we should expect the area embraced by North Manchester deaths to be rather smaller than that embraced by South Manchester deaths. In the first two outbreaks the relation is the reverse of this. This might be taken to indicate some effect of industrial occupation, North Manchester being the industrial part of the city. There is, however, but little difference in mortality between these two divisions. In the third outbreak, however, the South Manchester death-rates attain the same height as those in the Township, although the aggregate mortality per 1,000 is not so great in the former. North Manchester has now a much lower death-rate than either of the other two divisions.

We may conclude that there was exceptional incidence in South Manchester in the third outbreak.

In the second outbreak the mortality rate in the Township does not begin to ascend till a week after the other two divisions, and it commences more abruptly in South than in North Manchester.

This abrupt commencement in South Manchester may have to do with the presence of a number of American soldiers suffering with influenza who were treated on the south side of Manchester in October. It is conceivable that the difference in these curves supplies the explanation of the second outbreak. Large numbers of American soldiers visited this country and France in September and October, and it is known that some ships witnessed very painful scenes, the men suffering from influenza in a very severe form. It appears likely that this outbreak was introduced from America and that an increased virulence was imported at the same time, possibly by a new race of streptococci, or pneumococci, or both, possibly by some as yet unknown micro-organism.

On examination of the Registrar General's weekly return it would appear that the influenza fatality started to ascend at Southampton and Portsmouth, as well as at Exeter, Bath and Gloucester in the week ending October 5th, that is a fortnight before it commenced in Manchester, and that the ascent began in the week ending October 12th in Liverpool, Birkenhead, Bootle, St. Helens, Blackpool and Southport, slightly also in Salford. In Manchester

there was no definite ascent till the week ending October 19th. There was certainly an impression here that the disease travelled from Liverpool, *via*-Bolton to Manchester, although, as we have seen, there was material in Manchester from which it could have spread. At all events it appeared to start in Southampton, Portsmouth and Liverpool before it reached Manchester. If the suggestion made with regard to its importation from America be the true explanation of the change of character of the outbreak from summer to autumn, the circumstances would be easily explained, since there were a great many American soldiers moving about this country in September and October. This would explain why the disease appeared simultaneously in France and in this country generally, and why it began to be fatal a little before this time at English ports.

When we pass to the third outbreak we find that all three waves embrace a much less area than in the second, and that the curves have somewhat changed their outline, two of them having now flat tops as if the attending respiratory conditions tended to take precedence of the specific infecting agent as a cause of death, thus spreading out the curve.

On this occasion the curve begins to ascend abruptly in the Manchester Township as in the first curve, and the onset of fatality and presumably of spread is delayed in South Manchester, though this is made up for in subsequent weeks. In North Manchester the curve rises and descends more slowly, besides attaining less height than in the other two divisions.

There is nothing in the manner of ascent taken by itself to account for the differences of these curves from those in the first two outbreaks. So far as respiratory diseases are concerned, it is associated with the rise of bronchitis as a cause of death, though it is necessary to remember that, at this season, bronchitis is normally, at its highest point as a cause of death. For this allowance has already been made.

Curves 3.

The third set of curves show the deaths in each week of each outbreak from influenza, pneumonia, broncho-pneumonia and bronchitis as percentages of the total deaths from the particular cause occurring in the course of that outbreak. Naturally the longer curves are flattened. The particular points brought out are:—

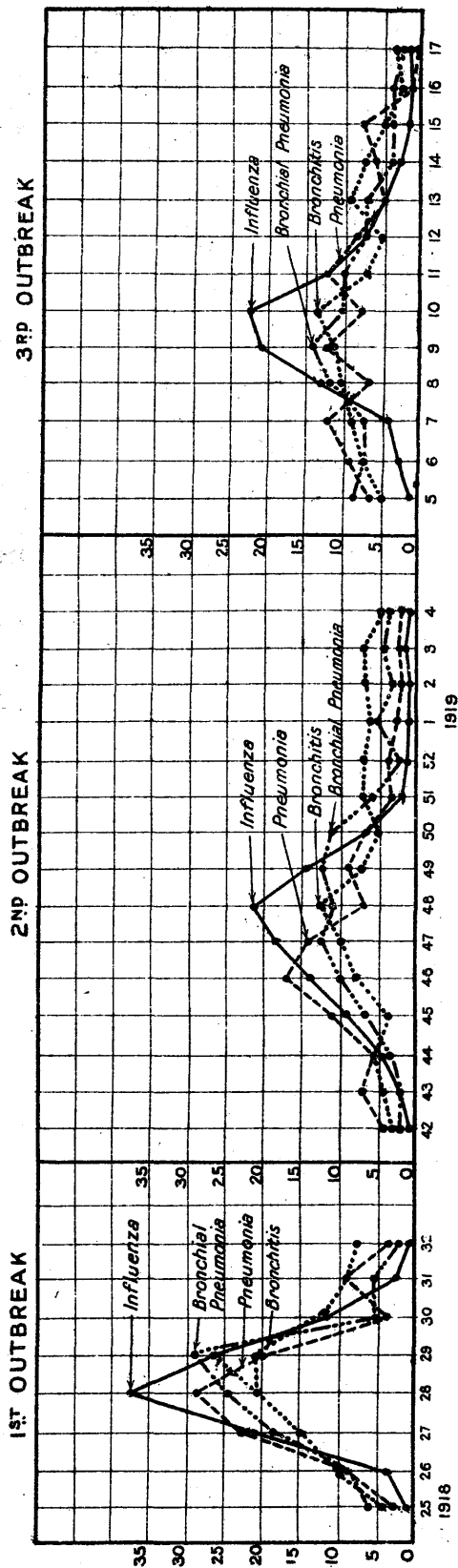
1. Each cause of death above enumerated swells into a wave.
2. The crest of the wave is pointed for influenza.
3. The pneumonia wave is peaked in the first and second outbreak, but appears only as a general swell in the third.
4. The broncho-pneumonia wave is crested in the first outbreak appears as a rounded swell in the second, and as a broken continued ridge in the third.
5. The bronchitis wave in each outbreak rises continuously to a crest simultaneously with the influenza wave, falls more quickly than it rose, and has a dip-two-thirds of the way down, after which, in the second and third waves, it rises again. This wave corresponds throughout more closely with the influenza wave than do the other two, and comes into increasing prominence with each successive wave, while pneumonia undergoes a steady decrease, if we exclude broncho-pneumonia.

Curves 4.

Frequency curves for influenza deaths week by week, similar to the foregoing have been constructed for males and females respectively. In the first outbreak male outnumber female deaths, though not by much. In the second the male mortality falls below the female throughout especially in the middle part of the outbreak. In the third the female mortality exceeds the male, though not by much; but throughout the first half of the wave it is in advance of the male. It is evident that the advent of bronchitis as a cause of death does not explain the relative position of the sexes in the third curve, which is like the first, with male exchanged for female deaths. In Manchester female deaths from bronchitis normally exceed male to some extent, and assuming an unknown factor for the greater mortality of females

MODE OF DISTRIBUTION OF THE DEATHS FROM INFLUENZA, BRONCHITIS, BRONCHO-PNEUMONIA, AND PNEUMONIA IN EACH WAVE, THE TOTAL NUMBER OF DEATHS FROM EACH DISEASE IN THE RESPECTIVE EPIDEMICS BEING TAKEN AS 100.

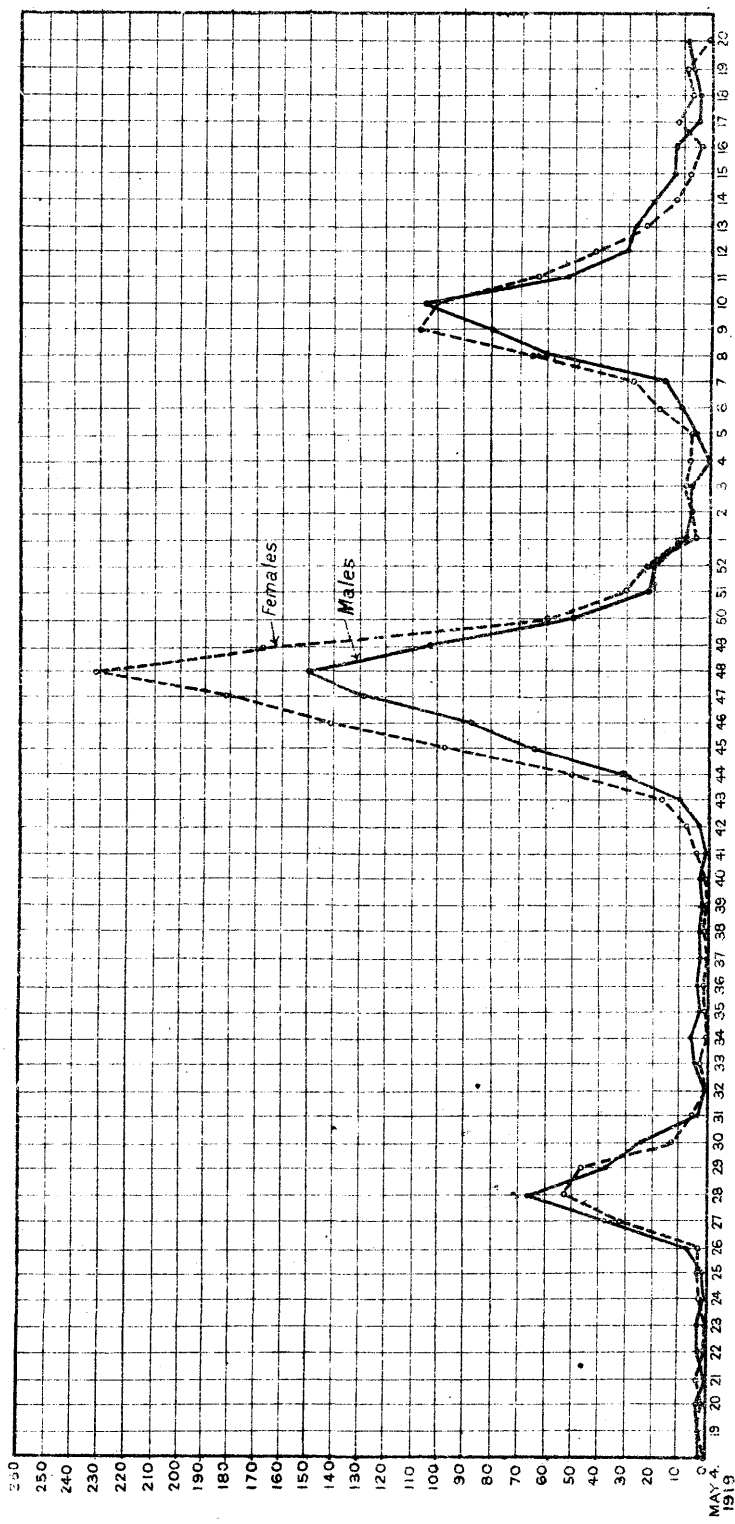
CURVES 3. (See p. 508)



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CURVES 4 (See p. 509.)

INFLUENZA DEATHS. MALES & FEMALES.



M. A. GORHAM LTD. LITHO. LONDON & E.

To face p. 500.

COMPARISON OF THE AGE FREQUENCIES OF DEATHS OF MALES & FEMALES IN EACH OF THE THREE OUTBREAKS OF INFLUENZA.

The graph displays three outbreaks of influenza, each showing the age frequency of deaths for males (dashed line) and females (solid line). The y-axis represents the number of deaths, ranging from 0 to 160 in increments of 10. The x-axis represents age, ranging from 0 to 85 in increments of 5. The outbreaks are separated horizontally for clarity.

- Outbreak 1 (Left):** Occurs between ages 0 and 10. Both sexes show a peak in deaths around age 5, with females reaching approximately 15 and males reaching approximately 10.
- Outbreak 2 (Middle):** Occurs between ages 20 and 30. Both sexes show a peak in deaths around age 25, with females reaching approximately 110 and males reaching approximately 100.
- Outbreak 3 (Right):** Occurs between ages 70 and 85. Both sexes show a peak in deaths around age 75, with females reaching approximately 150 and males reaching approximately 140.

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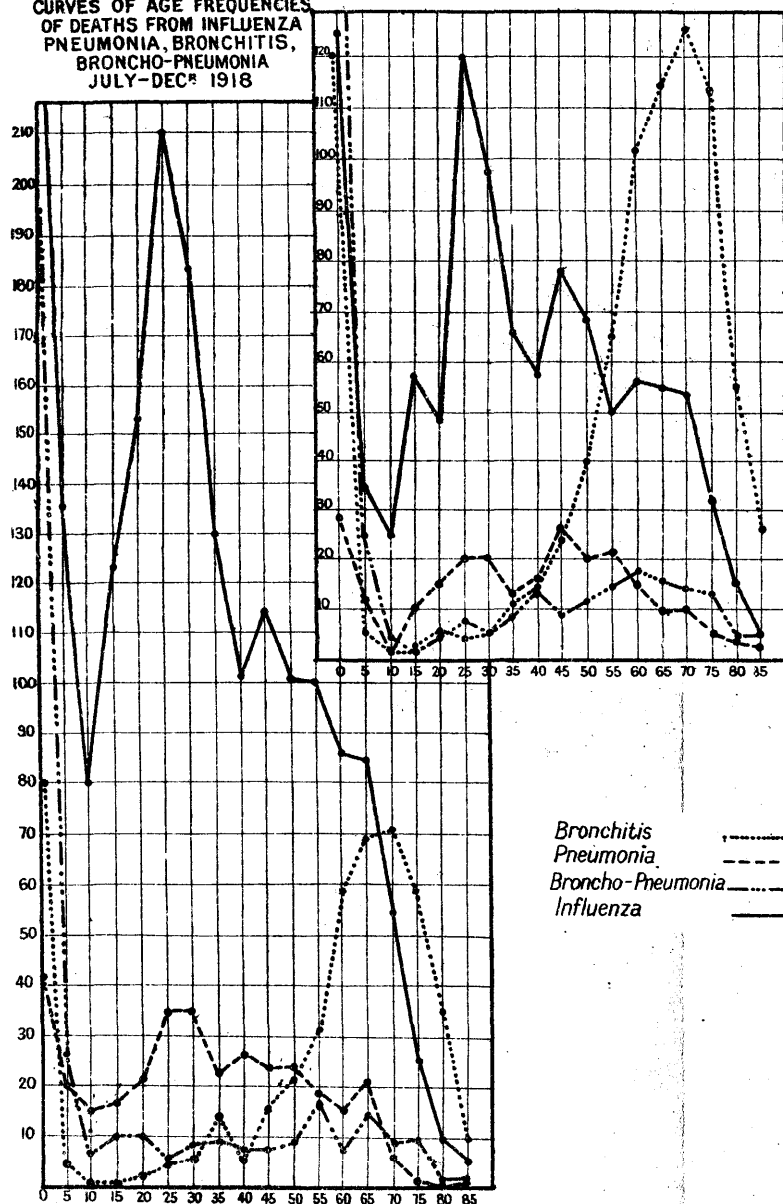
CURVES 5 (See p. 510)

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CURVES 6. (See p. 512)

**CURVES OF AGE FREQUENCIES OF DEATHS FROM
INFLUENZA, PNEUMONIA, BRONCHITIS,
BRONCHO-PNEUMONIA.
JAN-JUNE, 1919.**

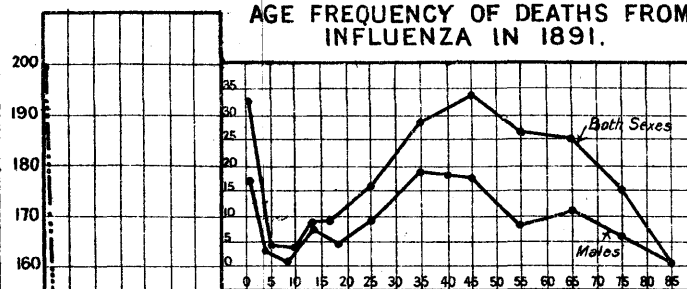
**CURVES OF AGE FREQUENCIES
OF DEATHS FROM INFLUENZA
PNEUMONIA, BRONCHITIS,
BRONCHO-PNEUMONIA
JULY-DEC^r 1918**



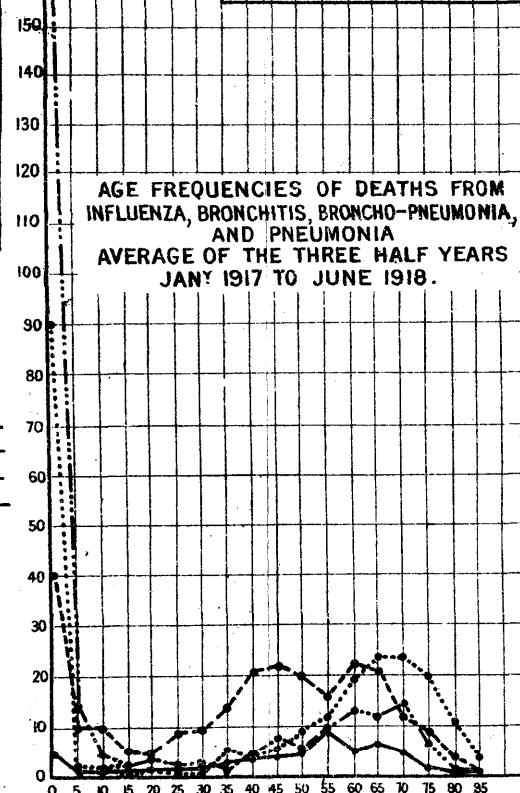
Bronchitis ······
Pneumonia - - - -
Broncho-Pneumonia - · - ·
Influenza ————

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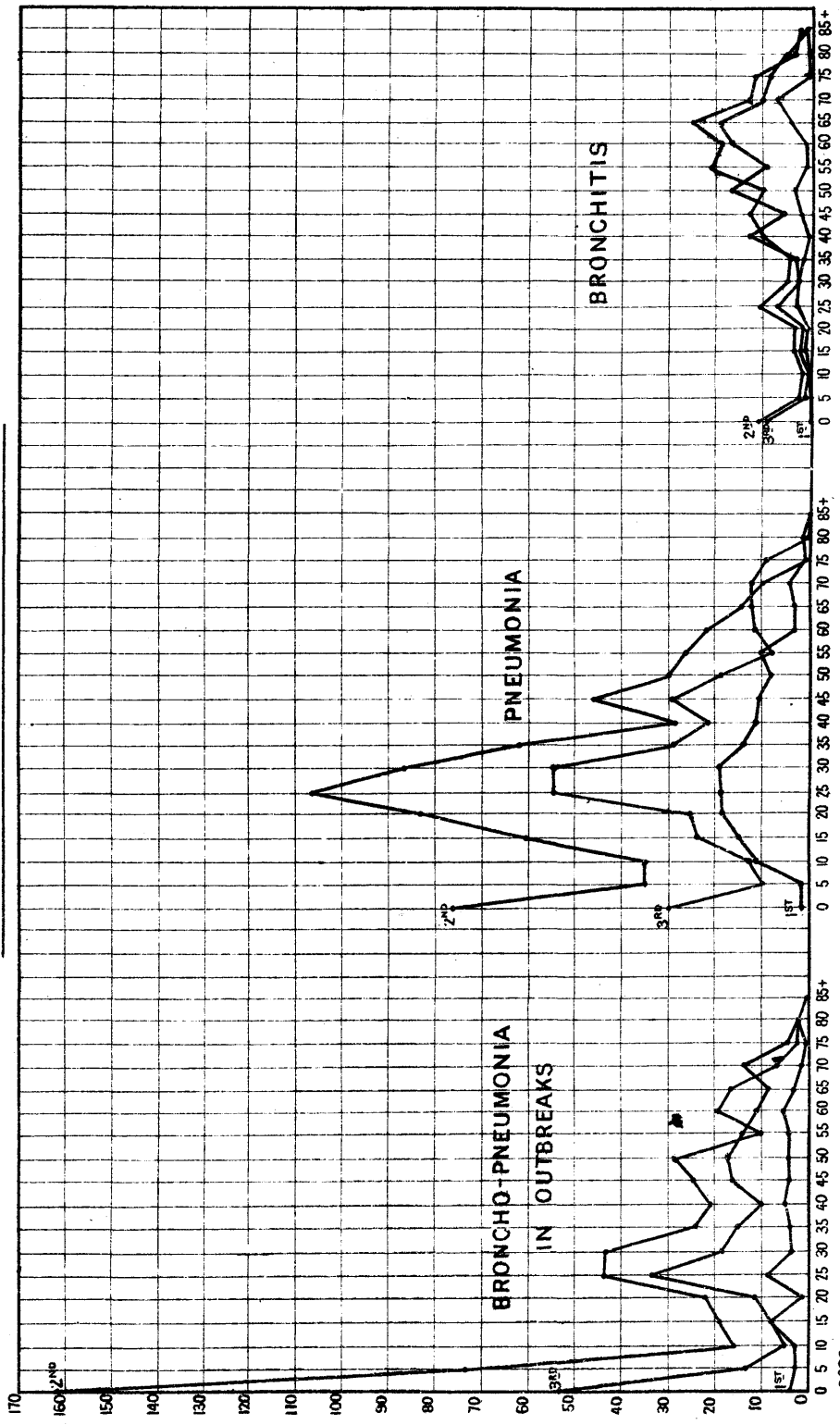
**AGE FREQUENCY OF DEATHS FROM
INFLUENZA IN 1891.**



**AGE FREQUENCIES OF DEATHS FROM
INFLUENZA, BRONCHITIS, BRONCHO-PNEUMONIA,
AND PNEUMONIA
AVERAGE OF THE THREE HALF YEARS
JAN^y 1917 TO JUNE 1918.**



AGE FREQUENCIES OF THE CHIEF COMPLICATIONS IN DEATHS REGISTERED AS FROM INFLUENZA, IN EACH OF THE THREE OUTBREAKS, SUMMER AND AUTUMN 1918 AND WINTER 1919.



in autumn, we might regard the third curve as a partial return to the first type, modified by bronchitis.

Curves 5.

Age frequency curves have been constructed for each of the outbreaks for males and female respectively, at 18 groups of ages, each of a period of 5 years.

That for the first outbreak shows that the female mortality rises above the male at ages 10 to 30, and falls below it at ages 45 to 85. In both cases the difference is considerable.

In the second outbreak the female mortality rises greatly above the male, immensely at ages 0 to 45, but also considerably up to the age 75.

In this curve, broncho-pneumonia shows signs of being a potent factor, if infant mortality be any test.

Usually, at ages 0 to 4, broncho-pneumonia is more fatal to males than females; but the excessive fatality of females in the second outbreak affects even this age. All these curves, males and females, show a maximum fatality at ages 25 to 29, and any explanation of this epidemic must explain this very unusual and unlikely occurrence. The only exceptions to this rule are the high fatalities in infancy in the second outbreak, and the fatality from males in infancy in the third outbreak.

Curves 6.

Curves showing the number of deaths occurring at each age group of 5 years have also been constructed for July to December, 1918, thus embracing the first and second outbreaks, and for the first half-year of 1919, for influenza, pneumonia, broncho-pneumonia, and bronchitis.

In order to afford a basis of comparison with the normal, the three half-years, January 1917 to June 1918, have been averaged, and corresponding frequency curves prepared.

Also a curve has been prepared showing the age frequency of deaths in the influenza year 1891.

The two first set of curves show the high death rate from influenza in children under 5 years, especially in 1918. The peak at ages 25 to 30 is manifest in both curves. Both curves show a secondary, but much lower peak, at the ages 45 to 50. This low peak corresponds to the influenza experience of 1891, which shows nothing to correspond with the peak at ages 25 to 30. These outbreaks are, therefore, in some essential particular, quite different from the wave in 1891.

Indeed, when we compare the 1891 experience with the curves constructed for comparison and control, we see that the age distribution of influenzal mortality in 1891 corresponds very much with that of pneumonia in the comparison curves. It is permissible to suppose that the dominant influence in 1891 was pneumonia, but that other and disturbing factors enter in 1918 and 1919. Moreover, the age-frequency curves of influenza for the three half-years preceding the first influenza outbreak, correspond with that of 1891, as does also that for the interval between summer and autumn.

In the curves for July to December 1918 and January to June 1919 pneumonia reaches a maximum at ages 25 to 35 in the former period, at 25 to 30 in the latter, though in the latter it attains a still higher maximum at 45 to 50. Influenzal infection has been able to distort the normal pneumonia curve. This will be made clear by the comparison curve of age frequency from pneumonia; but the effect of influenza is but little manifest at ages over 40.

The effect on bronchitis of the influenzal wave is very different. Here the chief effect is to raise the natural rise of this part of the curve, greatly in 1918, very greatly in 1919, though the base of the enlargement is also extended, especially in the latter.

The effect of influenza on broncho-pneumonia is again different. In 1918 the whole curve is lifted up, except at ages 0 to 4, at which the mortality is high, with or without influenza. At all other ages the impress of influenza is manifest, particularly in the earlier ages. The character of

the age distribution is quite altered. In the first half of 1919 the mortality from broncho-pneumonia at ages 0 to 4, reaches the high figure of 237, but this cannot be ascribed to influenza, especially as the effect of influenza does not begin to be evident until the age 20 to 25. After that, it is general, and affects all ages.

The frequency curves in weeks of the three main complications of influenza have been already dealt with.

From a consideration of all these curves, we see—

1. That the true influenzal curve has to be constructed by subtracting the deaths at each group of ages in the control curve from the corresponding group of influenzal curves from pneumonia, broncho-pneumonia, and bronchitis, and adding the number thus obtained to the number of deaths ascribed to influenza at the corresponding ages.

2. The identity of bronchitis with influenza is very easily overlooked, as may be seen on examining the complications of influenza, and the curves for bronchitis in July to December 1918, and January to June 1919. That is to say, a severe cold cannot easily be distinguished from influenza. The essential identity of the curves of influenza and bronchitis has already been pointed out. It appears likely, as already stated, that a study of common colds will throw light on the occurrence of influenza.

3. The proposed change of the curve of age frequencies of deaths from influenza will not, however, alter the peaks at ages 25 to 30 and 30 to 35.

4. The difference in sex distribution of the deaths in the three epidemics seems to indicate some fundamental difference in character, but might, if all the factors were known, receive some explanation from the amount of immunity in the two sexes. This does not, however, appear likely to give an adequate explanation. Other differences in the character of the epidemics have already been mentioned.

The most probable explanation is the introduction of fresh strains or elements.

If we may suppose, for example, that the infective element in influenza attached itself in succession to the pneumococcus, to a streptococcus, and to the influenza bacillus, the occurrence and behaviour of the outbreaks might receive some explanation; but these must be matters for further enquiry.

5. The whole group of respiratory affections needs to be brought under enquiry.

Various accessory inquiries arise in connection with these facts. As streptococci were such a prominent feature in the bacteriology of the disease, it is natural to inquire whether any increase occurs amongst the notified cases of erysipelas, puerperal fever, or scarlet fever. No such occurrence shows itself, as will be seen from the following figures:—

Cases notified in Quarters from —

Erysipelas.				Puerperal Fever.			
—	1917.	1918.	1919.	—	1917.	1918.	1919.
1	52	81	44	1	19	15	22
2	45	65	70	2	23	18	26
3	58	63	98	3	12	25	58
4	77	71	—	4	15	19	—

Thus the increases which occur are in periods outside influenza prevalence, and they are particularly marked in the second half of 1919, as is the rise of scarlet fever, or appears to be so. This qualification is necessary, as the prevalence of influenza might cloak a rise in all three. But the suggestion already made, that the infective element in influenza may give wings to the infections of other diseases, may have application to scarlet fever, erysipelas, encephalitis-lethargica and other epidemic diseases of short latent period. With this idea we may connect the tendency to epidemicity of other infectious diseases round about influenzal periods.

It is evident that during an outbreak, pneumococci, streptococci and influenza bacilli all gain greatly in infectivity and numbers. It is possible that they become infective by associating themselves with a more minute organism. In that case there would be some restriction on spread by the increased size of the infecting agent.

"We may, therefore, bring together the facts available, without attempting meanwhile to interpret them further.

It appears to be worth while also to bring together the periods between the occurrence of primary and secondary cases, with a view to see whether there is any evidence of agencies with different latent periods. The facts are collected without attempting to draw conclusions which would be difficult unless one also knew the degrees of exposure to infection.

INFLUENCE OF SEVERITY OF DISEASE OF INFECTIVITY.

When a number of deaths are investigated it would at first sight appear as if there were an unduly large number of households with single cases in them. These investigations do not quite all relate to deaths, but they do all relate to severe cases.

The figures obtained from them are :—

Households having Cases.	1.	2.	3.	4.	5.	6.	7.	Total.
Number of households.	234	101	57	30	12	4	2	440
Number of persons.	1,083	513	326	186	78	32	19	2,237
Average number of persons per house.	4.63	5.01	5.72	6.2	6.5	8	9.5	—

Thus in 234 households there is only one case, while in 206 there is more than one case.

Advantage has been taken of the block census made for Dr. Carnwath to control this by ascertaining what occurs in houses as they come along. The figures relate mostly to the autumn outbreak with a few from early winter.

Households with Cases.	1.	2.	3.	4.	5.	6.	7.	Total.
Number of above	162	77	37	10	5	2	2	295
Deaths included above.	7	1	2	—	—	—	—	10

It would thus appear that while more than half the total number of households have as before only one case, amongst those having only one case there are seven deaths as against three deaths amongst the rest of the cases. Notwithstanding the similarity of experiences in the two sets of

households there appears, therefore, to be association between the severity of the case and the failure of the disease to spread. It does not, of course, follow, supposing severity to restrict propagation of the disease, that there should be any difference in the two experiences, nor would there be if the first case were invariably slight. But this is not the case. The question cannot be determined in this way.

A portion of the attacks were therefore analysed, restricting those selected to the autumn outbreak, and putting aside the instances in which a death occurred. The remainder were grouped as before, according to the number of cases in the household, but the classification is according to the character of the attack in the first case.

Character of Attack in the first Case.	Number of Cases in Household.							Total.
	1.	2.	3.	4.	5.	6.	7.	
Broncho - pneumonia.	2	—	1	—	—	—	—	3
Pneumonia -	9	—	2	—	1	—	—	12
Otherwise severe	13	4	3	—	—	—	—	20
First case not severe.	86	59	26	6	4	3	1	185
Total -	110	63	32	6	5	3	1	220

Thus the total number of households in this group was exactly halved by the number in which there was only one case in the house. But among those in which only one case occurred, viz., 110, the first case was severe in 24, with two cases there were four severe first cases out of 63, with three cases six severe cases out of 32, of the remainder one out of 14.

Summing up, there were 24 severe first cases where only one was attacked out of 110, 11 severe cases out of 110 where more than one was attacked.

When this is added to the experience regarding fatality, a case seems to be made out for association of severity of first case with infectivity.

The point is one of some importance.

Supposing such an association to be made out, the infectivity of the patient is restricted by his being confined to his bed. It is difficult to believe that it is otherwise much restricted on the average. The restriction is plainly on his power of infecting others by handling towels, washbasins, utensils, food, and might be greater than is here shown, since the aggregate judgment of a case which is not severe gives no sufficient picture of the commencement of attack. Experience of the way in which the sick are cared for shows that the danger from droplet infection is at least as great from those confined to bed as from those who can get up, while the danger from the handling of utensils, though much diminished, is by no means abolished.

So far as they go, the figures seem to suggest the importance of severe illness in restricting infection, whatever be the explanation.

But that this is not an adequate or complete explanation of the failure in many cases of influenza to spread in the household is shown by the large number of single cases whose attacks were not severe.

INTERVAL BETWEEN EXPOSURE AND DEVELOPMENT OF THE DISEASE.

This has been taken out for 278 instances, which relate almost entirely to households in which a death occurred, but in all of which severe cases have occurred.

The previous analysis shows that the results will not differ greatly from those obtained as the result of a census.

These results are as follows :—

Interval in days between First and Second Attack.

—	0	1	2	3	4	5	6	7	8	9	10	11
Number of cases occurring in each group.	48	39	46	26	18	17	18	18	6	3	6	5

—	12	13	14	15	16	17	18	19	20	20 and above.
Number of cases occurring in each group.	3	6	4	2	2	0	1	0	2	8

It thus appears that the intervals are gathered in a group in the first four days, then follows a group from the fourth to the seventh days inclusive, in which there is a marked fall from the first four days, but in which the intervals stand at a level, indicating apparently a different level of infectivity. After this point there is a drop, the intervals again remaining fairly level for another week, after which a marked drop again occurs.

Although this may be taken as fairly representative of what happens, it needs to be checked by an indifferent group, irrespective of severity of individual cases occurring in the household.

The Significance of the Incidence on Ages 25-29 and 30-34.

Perhaps undue stress has been laid on the incidence of mortality at the above ages. The most evident suggestion is that a large degree of immunity remains over from the epidemic period 1889-1891. This explanation has to contend with the apparent slightness of protection conferred on persons attacked in the summer and autumn outbreaks. Even if we assume that older persons may have been protected by repeated attacks in the previous epidemic years, all the features of age incidence would not be explained.

CURVES 1.—Number of Deaths Week by Week from the Causes given below in the Weeks named.

1918.

—	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35		
Influenza - - - - -	2	1	2	3	2	2	2	9	71	120	85	38	9	2	5	4	2		
Pneumonia - - - - -	14	16	16	13	12	5	5	12	33	42	29	7	13	4	6	6	5		
Broncho-pneumonia - - - - -	8	11	14	11	10	4	5	7	16	21	24	5	5	2	1	2	1		
Bronchitis - - - - -	16	10	15	11	8	8	6	12	19	27	28	14	11	9	6	2	8		
1918—cont.																			
—	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52		
Influenza - - - - -	4	1	3	—	3	2	9	29	83	163	229	313	383	250	109	55	42		
Pneumonia - - - - -	4	3	8	2	4	5	9	15	12	22	34	28	14	19	10	7	7		
Broncho-pneumonia - - - - -	3	2	4	4	4	2	6	6	14	21	31	41	35	41	32	19	10		
Bronchitis - - - - -	6	7	8	16	10	10	9	15	21	19	34	44	55	35	22	29	29		
1919.																			
—	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Influenza - - - - -	14	14	16	6	11	28	44	126	191	206	114	74	52	35	20	17	18	6	12
Pneumonia - - - - -	9	12	9	2	10	15	19	13	22	15	21	15	9	9	11	3	3	7	10
Broncho-pneumonia - - - - -	16	11	15	12	24	21	23	40	41	31	31	22	21	12	14	14	9	11	9
Bronchitis - - - - -	24	29	28	26	36	43	56	67	77	87	50	41	55	39	32	23	23	24	24

CURVES 2.---Death Rates from Influenza in the Manchester Township, North Manchester and South Manchester, in the Weeks shown above, to the nearest decimal.

1918.

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Township - - - - -						0	0.5	10	14	11	7	2					
North Manchester - - - - -						0	0.5	4	7	6	3	0					
South Manchester - - - - -						0.2	0.7	4	7	4	1	1					

1918—cont.

	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
Township - - - - -						0.0	0.5	0	1.5	10	23	35	47	29	19	4	5
North Manchester - - - - -						0.2	0.5	1.2	5	11	16	19	27	11	6	4	2
South Manchester - - - - -						0.1	0.6	2.5	7	10	13	17	21	17	5	3	3

1919.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Township - - - - -	1	2	.5	.5	.5	3	7	14	15	14	12	8	6	4	1	2	3		
North Manchester - - - - -	1	1	1	.5	1	2	3	7	8	10	6	3	2	2	1.4	1	1		
South Manchester - - - - -	1	1	1	.4	.6	1	2	8	15	16	8	6	4	3	1.4	1	1		

1918—cont.

—	46.	47.	48.	49.	50.	51.	52.
Males - - - -	88	130	150	103	51	23	20
Females - - - -	141	183	233	147	58	32	22

1919.

—	1.	2.	3.	4.	5.	6.	7.	8.	9.
Males - - - -	8	7	8	2	5	9	17	61	82
Females - - - -	6	7	8	4	6	19	27	65	109

1919—cont.

—	10.	11.	12.	13.	14.	15.	16.	17.	18.
Males - - - -	106	52	31	28	22	12	13	6	2
Females - - - -	100	62	43	24	13	8	4	12	4

CURVES 5.—Frequency Curves of Deaths in Age Groups, Male and Female, each of 3 Outbreaks.

SUMMER.

—	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.
Males - - - -	10	5	9	12	8	20	16	13	13	9
Females - - - -	4	3	8	16	19	22	15	14	10	14

—	50-55.	55-60.	60-65.	65-70.	75-80.	75-80.	80-85.	85 and above.	Total.
Males - - - -	15	13	12	8	9	3	1	1	177
Females - - - -	6	6	5	6	6	—	1	—	155

AUTUMN.

—	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.
Males - - - -	142	62	27	37	32	66	48	40	27	47
Females - - - -	162	68	38	59	95	115	107	65	43	46

	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
Males - - - -	36	29	35	25	20	14	4	1	702
Females - - - -	44	49	36	48	22	6	6	4	1,013

WINTER.

	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.
Males - - - -	70	17	9	21	17	41	43	25	32	42
Females - - - -	39	14	13	27	27	71	51	32	21	31

	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
Males - - - -	28	23	21	22	18	10	5	—	444
Females - - - -	36	21	28	28	25	19	8	1	492

For Curves 6 see following page.

Comparison of the above Facts with those obtained from Block Censuses.

In January 1919 a block census was made in Manchester by the Health Visitors at the request and under the direction of Dr. T. Carnwath, a medical officer of the Ministry of Health, with a view to ascertaining the facts as regards incidence on households and persons of attacks of influenza in the summer and autumn outbreaks, also as regards immunity, if any, conferred by the summer outbreak of persons then attacked and living in the autumn outbreak. To these have now been added the facts for the winter outbreak. In addition a control census has been taken so as to ascertain how representative a block census for 1,000 houses is.

The Summer outbreak lasted from June 22, 1918, to August 3, 1918.

„ Autumn „ „ „ October 12, 1918, to January 26, 1919

„ Winter „ „ „ January 27, 1919, to March 10, 1919.

The facts are arranged in five-yearly age groups, males and females, as in the tables below. (Tables E. and F.)

The figures have been very carefully corrected, and the slight difference between the total and that of Dr. Carnwath is no doubt due to exclusion by him of some of the cases.

The figures are arranged in these groups so as to furnish a comparison with the curves for age frequencies of deaths for the whole city.

The figures at the side of Table C. mean—

1 escaped in summer; 2 attacked in summer; 11 escaped summer and autumn; 12 escaped summer, attacked autumn; 21 attacked summer, escaped autumn; 22 attacked both in summer and autumn, and so forth. Thus 121 means escaped summer, attacked autumn, escaped winter. * means death in summer; † in autumn; ‡ in winter.

CURVES 6.—Deaths from Influenza, Pneumonia, Broncho-Pneumonia, and Bronchitis—July to December, 1918.

	0-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
Influenza - - -	301	136	80	123	154	210	183	130	102	117	101	100	87	85	54	24	11	6	2,004
Pneumonia - - -	42	20	15	17	22	35	35	22	27	24	24	18	16	22	7	2	0	0	348
Broncho-pneumonia	197	26	7	10	10	5	8	9	6	7	9	17	7	15	9	10	0	0	352
Bronchitis - - -	81	5	2	0	2	4	6	14	5	16	23	32	58	69	72	59	35	10	493
<i>January-June 1919.</i>																			
Influenza - - -	126	35	23	58	48	120	98	65	57	79	68	49	57	55	48	31	15	1	1,033
Pneumonia - - -	29	12	1	12	15	22	20	13	16	27	19	21	15	10	10	4	3	1	250
Broncho-pneumonia	237	24	3	1	4	8	6	9	14	9	12	15	17	16	14	13	3	3	408
Bronchitis - - -	121	5	1	1	4	4	6	11	19	29	42	66	103	116	131	114	55	26	854
<i>January 1917-June 1918—Control.</i>																			
Influenza - - -	14	5	4	2	2	6	5	8	6	13	14	26	16	21	15	8	4	4	173
Pneumonia - - -	120	26	30	17	14	28	28	43	63	65	64	51	70	65	37	28	9	1	759
Broncho-pneumonia	598	40	11	4	8	2	6	7	12	21	16	23	38	36	42	20	3	3	890
Bronchitis - - -	266	12	4	0	3	17	14	32	45	53	80	121	172	208	230	194	96	43	1,590
Influenza, 1891 -	29	4	3	9	10	32		58		66		54		51		30		1	—

CURVES 7.—See Table of Compilations.

The figures are arranged first without removal of deaths to facilitate checking the figures and the deaths are shown in their place in summer and autumn. In the winter outbreak 111 to 222, all the deaths are shown in their places.

The figures are then re-arranged (Table "C") by omission of deaths in the preceding outbreak, and the deaths are shown in their appropriate places in summer, autumn and winter. There is no material advantage in this correction of the populations as much greater changes occur owing to the interval between one outbreak and another. However, using the re-arranged figures, and glancing over the table, we note that there were two deaths in autumn in persons previously attacked in summer, and one in winter amongst those attacked both in summer and winter. Table C. relates to the second block census. The corresponding table (Table A) for the first block census is not reproduced.

The case mortality rate in summer is 0.71, in autumn 2.75, in winter 2.66. It will be seen that, so far as this census goes, the attacks in autumn and winter were about equally severe. This table affords no evidence of protection acquired by cases attacked in summer against attack in autumn. Thus, the chance of a person being attacked in autumn who escaped in

summer is $\frac{403}{3,977}$, of a person being attacked in autumn who was attacked in summer $\frac{70}{709}$. The difference is negligible.

We may next enquire what is the evidence of protection in winter for those attacked in summer. The chance of a person being attacked in winter

who escaped in summer and autumn is $\frac{(112)}{(11)} = \frac{73}{3574}$. The chance of a person attacked in summer, but not in autumn being attacked in winter is $\frac{(212)}{(21)} = \frac{26}{634}$ which is considerably greater than the above fraction. There would, therefore, appear from these figures to be no protection, but the reverse. The result is not altered if we take instead of the last fraction—

$$\frac{(212)}{(21) + (22)} = \frac{26}{709}$$

As regards protection in winter of those attacked in autumn, the chance of a person being attacked in winter who was attacked in autumn but not in

summer is $\frac{(122)}{(12)} = \frac{11}{403}$, which again is greater than $\frac{73}{3574}$. There is, therefore, the reverse of protection.

"We may now examine the distribution of persons in the population. We note the great preponderance in the population of women over men, at ages 15 to 34, and the remarkable reduction amongst both men and women at ages 20-24 (compared with all other ages).

As regards incidence of the disease we note the excessive incidence on females, even taking into account the differences in population, from the age of 10 upwards. This is not reflected in the numbers of death for the whole population in the first outbreak, and to that extent this census is not representative. Doubtless the reason why it is not reflected is because of the special connection between the first outbreak and lobar-pneumonia, a connection which may have been particularised in districts. As is well known lobar-pneumonia is more fatal to males than to females.

This excessive incidence on females is shown in the second outbreak. It is, however, absent in the principal section of the third outbreak, viz.:—(112), though again present in the sections (122) (212) and (222), as might be expected.

TABLE "C."
MANCHESTER.

INFLUENZA, 1918-19. (Second Block Census.)

KEY:—

- | | | | | | |
|---|---|-----|---|---|--------------------|
| 1 | { | 11 | { | 111 | Escaped infection. |
| | | 112 | | Escaped Summer and Autumn, attacked Winter. | |
| | | 121 | | Escaped Summer and Winter, attacked Autumn. | |
| | | 122 | | Escaped Summer, attacked Autumn and Winter. | |
| 2 | { | 21 | { | 211 | Attacked Summer. |
| | | 212 | | Attacked Summer and Winter, escaped Autumn. | |
| | | 221 | | Attacked Summer and Autumn, escaped Winter. | |
| | | 222 | | Attacked Summer, Autumn, and Winter. | |

—	Sex.	0-1.	1-2.	2-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Totals.
1	M.	105	72	255	351	284	186	76	137	157	180	155	114	89	47	33	21	15	5	3	1	2,286
	F.	90	82	274	340	332	227	212	235	206	210	148	108	79	72	44	27	20	11	8	1	2,726
2	M.	1	2	18	52*	56	37	12	28	34*	33	30*	16*	10	4	3	1	1				338
	F.	2	1	21	61	61	51	41	69	65	56*	31	22	9	13*	4	7	4	4			522
11	M.	99	67	231	320	264	171	71	127	146	163	143	104	85	45	27	21	15	5	3	1	2,108
	F.	83	74	238	300	286	205	188	199	167	184	131	93	72	65	40	24	20	10	8	1	2,388
12	M.	6†	5	24††	31†	20†	15	5	10	11	17	12†	10	4†	2	6						178
	F.	7††	8	36†	40	46	22†	24†	36†	39††	26	17†	15	7	7†	4†	3†		1†			338
21	M.	1	2	18	42	51	35	12	27	29	31	24	14	10	4	3	1	1				305
	F.	2		19	59	58	47	36	67	57	51	26	21	9	10	4	7	4	4			481
22	M.				9†	5	2		1	4	2	5	1									29
	F.		1†	2	2	3	4	5	2	8	4	5	1		2							39

111	M.	97	65	230	317	264	167	71	127	142	162	140	104	84	44	27	20	15	5	3	1	2,085
	F.	82	74	236	298	286	205	188	190	163	180	129	91	70	64	39	22	20	10	8	1	2,356
112	M.	2	2	1	3		4			4	1	3		1	1		1					23
	F.	1		2	2				9	4	4	2	2†	2	1	1	2					
121	M.	5	5	22	30	18	15	5	10	11	16	11	10	3	2	6						169
	F.	5	8	35	40	45	20	23	35	37	26	16	15	7	6	3	2					323
122	M.					1					1											2
	F.					1	1†															2
211	M.	1	2	18	41	50	35	12	27	29	30	24	14	10	4	3	1	1				302
	F.	2		18	56	57	47	36	64	54	49	26	21	9	10	4	6	4	4			467
212	M.				1	1					1											3
	F.			1	3	1			3	3	2						1					14
221	M.				8	5	2		1	4	2	5	1									28
	F.			2	2	3	4	5	2	8	4	5	1		2							38
222	M.																					
	F.																					
Deaths	M.	†		††	*††	†				*		*†	*	†								
	F.	††	†	†			††	†	†	††	*	†	†		*†	†	†				†	

Note { From Classes 11 to 22 Summer Deaths have been extracted.
From Classes 111 to 222 Summer and Autumn Deaths have been extracted.

Deaths shown :—* Summer. † Autumn. ‡ Winter.

TABLE " E."

A Summary of Facts relating to the Age Frequencies of Population, of Attacks, and the Percentages of Attacks to Population in each of Eighteen Groups of Ages, from the Block Census taken in Manchester under the direction of Dr. Carnwath.

Age Groups.	0-4.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
First outbreak— Population (1) -	666	655	600	407	251	366	376	342	280	208	188	123	94	67	39	17	5	2	4,686
Attacks -	44	92	88	72	59	83	73	68	37	32	20	13	14	8	3	8	1	0	715
Percentage of attacks -	6·61	14·05	14·67	17·69	23·51	22·68	19·41	19·88	13·21	15·38	10·64	10·57	14·89	11·94	7·69	47·06	20	0	
Second outbreak— Population (2) -	666	654	599	407	250	365	376	342	280	207	188	123	94	67	39	17	5	2	4,681
Attacks (2) -	84	84	52	30	24	47	53	30	21	15	11	5	7	6	3	0	1	0	473
Percentage of attacks to population -	12·61	12·85	8·68	7·37	9·60	12·88	14·63	8·77	7·5	7·25	5·85	4·06	7·45	8·96	7·69	0	20	0	
Third outbreak— Population (3) -	661	653	599	407	249	365	374	342	280	207	188	122	92	66	39	17	5	2	4,668
Cases -	12	14	11	9	6	18	5	11	10	5	4	3	3	1	1	0	0	0	113
Percentage -	1·82	2·14	1·84	2·21	2·41	4·90	1·34	3·22	3·56	2·42	2·13	2·46	3·23	1·52	2·56	0	0	0	
Total percentage of Incidences -	21·0	29·0	25·2	27·3	35·5	40·4	35·4	31·8	24·3	25·0	18·5	17·0	25·5	22·4	17·9	47·06	40	0	27·6

TABLE "F."
SUMMARY TABLE.

BLOCK CENSUS 2.

Outbreaks.	0-4.	5-10.	10-15.	15-20.	20-25.	25-30.	30-35.	35-40.	40-45.	45-50.	50-55.	55-60.	60-65.	65-70.	70-75.	75-80.	80-85.	85 and above.	Total.
1. Population - -	923	804	733	501	341	469	462	479	364	260	187	136	84	56	40	20	11	2	5,872
Attacks - - -	45	113	117	88	53	97	99	89	61	38	17	19	7	8	5	4	0	0	860
Per cent. attacked -	4.9	14.1	16.0	17.6	15.5	20.7	21.43	18.5	16.8	14.6	10.2	12.5	8.3	14.3	12.5	20.0	0	0	—
2. Population - -	923	803	733	501	341	469	461	478	363	259	187	135	84	56	40	20	11	2	5,866
Attacks - - -	89	82	74	43	34	49	62	49	39	27	11	11	10	3	—	1	0	0	584
Per cent. attacked -	9.6	10.2	10.1	8.6	10.0	10.4	13.4	10.2	10.7	10.4	5.9	8.1	11.9	5.4	0	5.0	0	0	—
3. Population - -	916	801	732	500	340	468	459	478	361	259	186	134	83	55	40	19	11	2	5,844
Attacks - - -	9	9	4	5	0	12	11	9	5	2	3	2	1	4	0	0	0	0	76
Per cent. attacked -	0.98	1.12	0.6	1.0	0	2.6	2.4	1.9	1.4	0.8	1.6	1.5	1.2	7.3	—	—	—	—	—

The principal object, however, in rearranging the figures in these age groups was to ascertain what relation the age frequencies bear to the age frequencies of deaths for the whole city, as exhibited in curves. To ascertain this, differences between males and females have been neglected, and the age frequencies for the two added, so as to show for each age group the total population at risk, and the total number of attacks at that age group. When this is done we get the following table in which the percentages of attacks in the corresponding populations are also given. Tables E. and F.

The percentages in the three outbreaks are then added to get a total percentage throughout the epidemic periods. The age frequencies of the total percentages are remarkably like the age frequencies for deaths at ages 20-35.

In all the attack frequency curves there is a swell in childhood, due chiefly to the large numbers at risk. The percentages attacked at these early ages, however, tell a different tale.

The true test, however, is the percentage of attacks to population at corresponding ages, which again brings out quite clearly the peak occurring about the ages 20-35. The particular age period 25-30 will be seen to dominate the picture of attacks in the table, small and large alike, as it does also in the Summary Table, Curves 8.

There is, therefore, both as regards incidence and fatality in these outbreaks as they affected Manchester, a quite special tendency to attack and fatality at the ages 25-29, and 30-34, a new feature, and one requiring explanation.

The striking agreement of the age frequencies of attacks with the age frequencies of deaths for the whole population may be taken as evidence that the facts have been collected with reasonable accuracy.

It may be observed that the figures above given may be taken as showing the number of cases which would have occurred in the City if the sample were representative. Taking the population of the City in 1918 as 730,000, the number of attacks in the first outbreak may be taken as

$$730,000 \times \frac{709}{4684} = 110,450.$$

The number of cases in the second outbreak would be—

$$730,000 \times \frac{473}{4681} = 73,704,$$

and in the third—

$$730,000 \times \frac{113}{4668} = 17,671.$$

The total number of cases would thus be about 200,000; but if females and males are taken separately for a calculation, the number would be greater.

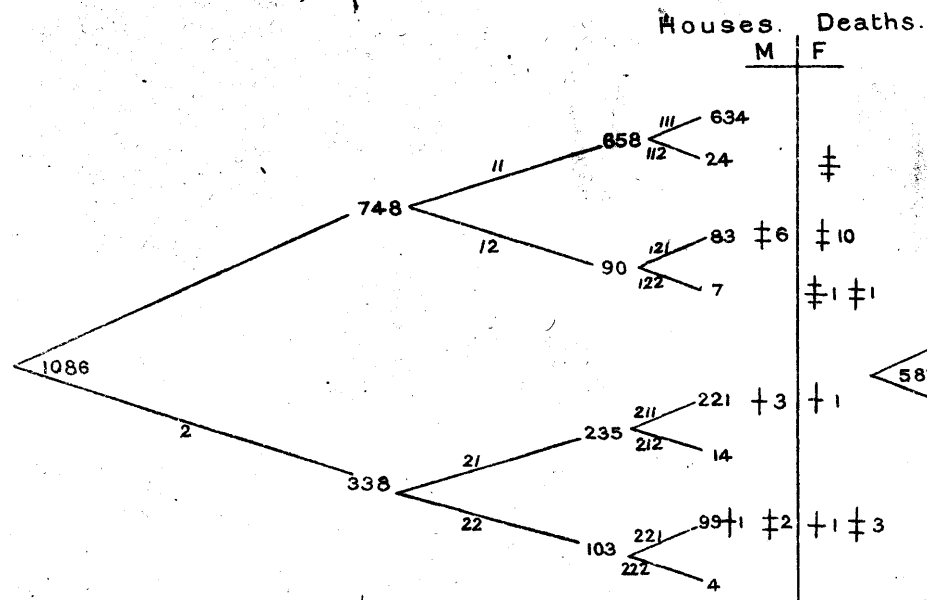
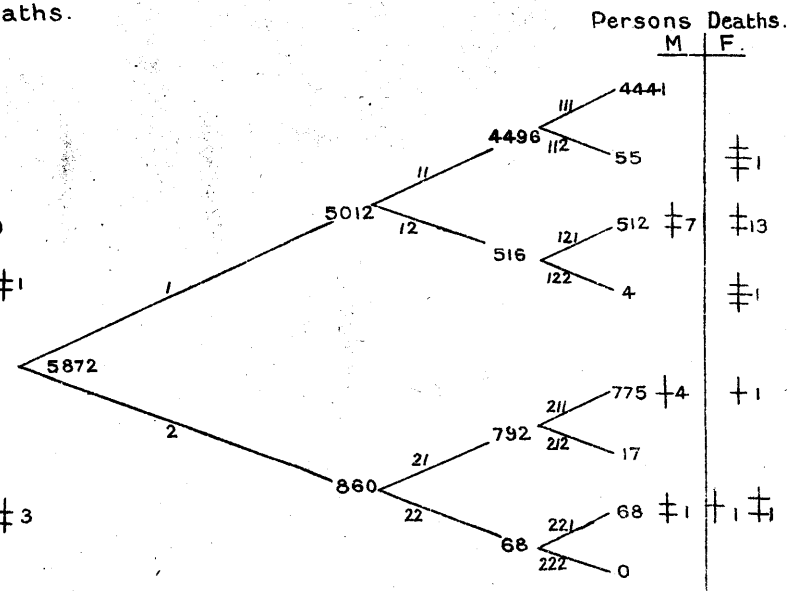
It will be noted that the numbers of attacks in successive outbreaks were 709,473,113. If no protection was afforded by the summer and autumn attacks, this great decline in the number of attacks is not readily explicable. The method of analysis adopted, therefore, would seem to overlook some cardinal facts, and it is possible that slight overlooked attacks play a large part in the production of immunity, as they do, for example, in enteric fever.

There is, however, another way in which we might estimate the number of attacks, viz., from the case fatalities, which leads to very different results. The objection to it is that these case fatalities are founded on small numbers, and on an experience in the total death-rate quite at variance with that of the whole population. However, accepting the case fatality in the first outbreak $0 \cdot 7$, in the second as $3 \cdot 25$, in the third as $2 \cdot 7$, we get the number attacked in the first outbreak, $332 \times \frac{1000}{7} = 47,420$, in the second 50,860, in the third 34,630.*

* These case fatalities are founded on the two block censuses taken together.

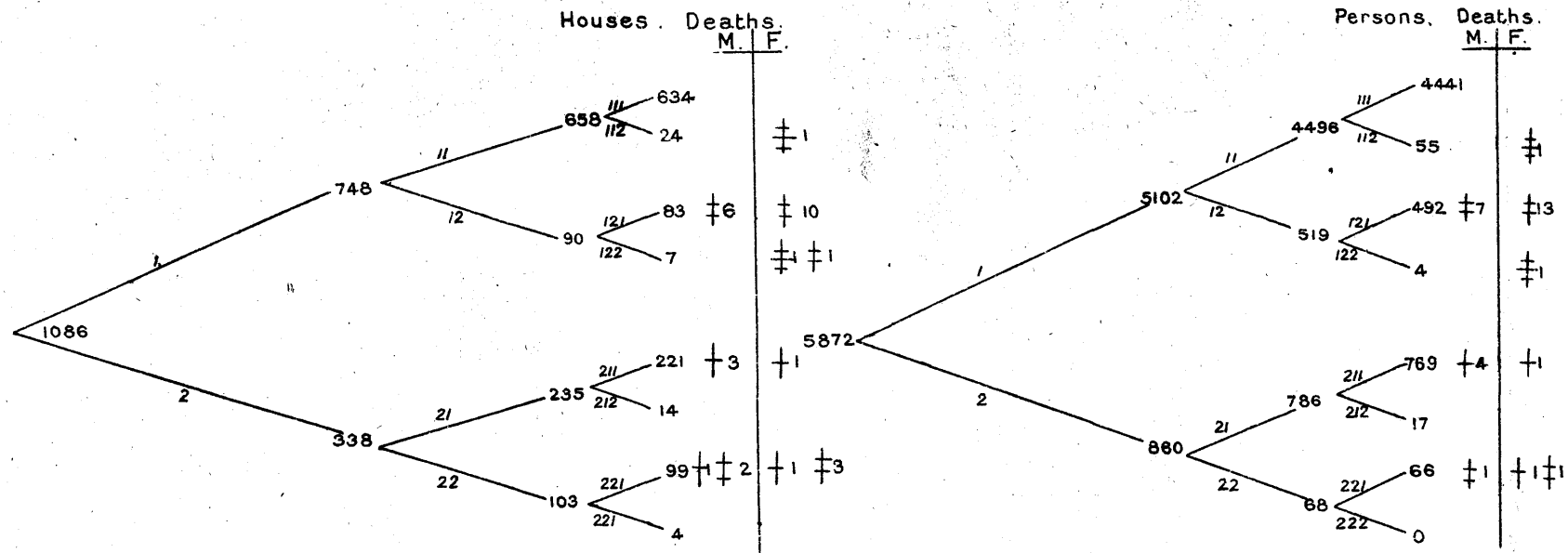
MANCHESTER.
INFLUENZA 1918-19. — SECOND BLOCK CENSUS.

(For Key see Table c.p.514.)

HOUSEHOLDS.PERSONS.

MANCHESTER. INFLUENZA 1918-19.—SECOND BLOCK CENSUS.

(For Key see Table c.p. 514)



Note:- From classes II to 22 Summer Deaths have been extracted.
 " " III to 222 Summer & Autumn " " "

- The other method should be more correct.

The facts may also be looked at in this way.

A second Block Census related to a population of 5,872 in 1,086 households situated in the same parts of Manchester, as in the first Census.

In the first outbreak 860 attacks are recorded and six deaths, in the second, 584 attacks and 22 deaths, in the third, 76 attacks and two deaths.

Taking the first and second censuses together, we have a population of 10,558, 11 deaths in the first outbreak, 35 in the second, and five in the third. Taking the whole population at 730,000, and assuming that the deaths over the whole population occurred at the same rate as in the Health Visitors' Districts, the above figures would give 761 deaths in the first outbreak, 2,420 in the second, and 346 in the third. Having regard to the comparatively high mortality in these districts the first two figures are sufficiently near the actual number of deaths, viz.:—332 and 1,702; but the third is so much below the actual number viz.:—936, that it needs special explanation.

In comparing this with the first census, we find that the chance of being attacked in summer was $\frac{860}{5872}$, or rather under one in seven, herein agreeing with the first census.

The chance of a person escaping in summer being attacked in autumn was—

$$\frac{(12)}{(1)} = \frac{516}{5012}$$

The chance of a person being attacked both in summer and autumn was—

$$\frac{(22)}{(2)} = \frac{68}{854}$$

The first chance exceeds the second by less than $\frac{1}{30}$, not a very large amount.

The chance of being attacked in the winter outbreak alone was—

$$\frac{(112)}{(11)} = \frac{55}{4496} = \frac{1}{82} \text{ approx.}$$

in summer and winter—

$$\frac{(212)}{(21)} = \frac{17}{786} = \frac{1}{46} \text{ approx.}$$

The chance of being winter only is—

$$\frac{(122)}{(12)} = \frac{4}{516} = \frac{1}{129} \text{ approx.}$$

It would thus seem that persons attacked in summer, but not in autumn, were more liable to attack in the winter outbreak than persons attacked neither in summer nor autumn.

This again agrees with the result obtained in the first census. $\frac{(122)}{(12)}$, however, is less than $\frac{(112)}{(11)}$, but the difference is under $\frac{1}{200}$, and no immunity can be inferred.

In the first census the reverse of immunity was shown, and taking the two together we may conclude that no degree of immunity was established in individuals by a previous attack. It is, however, possible to state the facts in another way, viz.:—That in the population selected there was an exceptional number of persons with special receptivity to the disease.

* If we may assume that it is more correct, the facts are not consistent with the mortality figures in the winter outbreak. To reconcile the discrepancy we must assume either that the facts for winter are not correctly ascertained, or that the winter incidence fell mainly on fresh areas.

In the mortality figures, however, neither census reflects the death rate for the whole city, and the second less so than the first, at all events as regards the winter outbreak. Thus, out of 860 attacked in summer six died; giving a case mortality of approximately seven per thousand, which is nearly the same as in the first outbreak.

The differences between Block Censuses No. 1 and No. 2 are only such as might be expected for the limited number of houses taken.

The curve of percentage of attacks to population at corresponding groups of ages is shown in Curves 8.

The Summary Tables E. and F., on which the curves are based, are given herewith, pp. 516-17.

PERCENTAGE OF ATTACKS TO POPULATION .

in groups of ages, the first census shown thus ———
 the second shown thus - - - - - shown for each outbreak.

