

THE RELATION OF RESPIRATORY CATARRHS
TO INFLUENZA AND TO DIET

by

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A thesis submitted
for the degree of M.D.



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The Relation of Respiratory Catarrhs
to Influenza and to Diet.

Introductory.

It is a matter of general experience that, excluding the exanthemata, the bulk of the illness which occurs in schools is due to catarrhal inflammation of the respiratory tract and its offshoots. There is, moreover, no doubt that the frequency of upper respiratory catarrh has increased of recent years. (1) (2) (9).

In the following pages the thesis is maintained that this increase is related to two factors - to the increased prevalence of Influenza, in the first place, and to increase in the national consumption of Carbohydrate food, and especially of Cane Sugar, in the second place.

Material.

The observations upon which these conclusions are based were made in a boarding school for girls; they consist partly of clinical material and partly of data derived from a study of the incidence of catarrhal illness in the School during a period of twenty-five years.

The School consists of two divisions. In the Senior division (referred to throughout as "the Senior School") the number of pupils has increased, during

the last twenty-five years, from 200 to 350. Their ages vary from 14 to 18 years, the majority spending from three to four years in the school. They live and have their meals in separate boarding houses, each accommodating from 30 to 40 girls. The girls of the various Houses meet in common in the school buildings and in the playing fields.

The Junior Division (referred to as "the Junior School") is an entirely separate establishment with its own buildings, playing grounds and Staff. The boarders number about 100 and live in three boarding houses. Their ages range between 7 and 14 years. A proportion of them pass on to the Senior School at the age of 14.

The pupils of the two divisions are not allowed to meet unless each school is free from infectious illness and even then only occasionally.

The same Medical Officer attends both Schools and any girl in either who requires treatment in bed is removed at once to the school sick houses, of which there are two - the Hospice and the Sanatorium. A register is kept of all admissions to the Sick Houses, and all charts are filed for reference.

General Arrangement of the Paper.

The paper is divided into two parts.

In Part I arguments are advanced in favour of

the view that many of the cases usually regarded as "common cold" or as "mild catarrhal febricula" are in reality suffering from Influenza of a mild type and are therefore capable of transmitting that disease to others.

In Part II evidence is submitted which indicates that susceptibility to catarrhal inflammation is dependent, to some extent, upon excessive intake of Carbohydrate food and especially of cane sugar.

PART I.The Relation of Respiratory
Catarrhs to Influenza.

A. Summary of previous papers on Influenza.

The symptoms of Influenza, as observed in these Schools, have been fully described in the Reports of the St. Andrews (James Mackenzie) Institute for Clinical Research. ((3) (4) (5)). The conclusions arrived at from these studies may be summarised as follows:

- (1) Influenza, if uncomplicated, is of brief duration and free from danger: prolongation of the illness is due to the occurrence of catarrhal complications, the result of secondary infections to which the influenzal process has made the patient particularly susceptible. Any of these complications may assume a dangerous character.
- (2) Infection may be transmitted by an uncomplicated case for at least a week after its onset and by a complicated case for so long as the catarrhal process persists.
- (3) In all cases of Influenza the tongue exhibits characteristic changes from the onset. It is covered by a thin greyish moist fur, its

margins are indented by the teeth, giving it a flabby appearance and it is tremulous (6).

But the most striking departure from normal consists in the presence on the tip and sides of numerous prominent red papillae, which seldom extend on to the dorsum (7).

(4) In the majority of cases the soft palate also shows characteristic changes. It is congested and exhibits on its general surface numerous white glistening prominences (papillae) about the size of a pin's head. Towards the uvula these become larger in size and red in colour. (8) (12) (13).

(5) During an epidemic of Influenza many cases of trivial febrile illness occur, in which the characteristic appearance of the tongue is present, and such cases are prone to develop complications similar to those which occur in undoubted Influenza.

For these reasons it is assumed that they are examples of Influenza in a mild form and that they are capable of transmitting Influenza to others.

In the following account of two further epidemics of Influenza clinical evidence is put forward in favour of that view.

B. Two Epidemics of Influenza.

(1) Epidemic Influenza in Spring 1927.

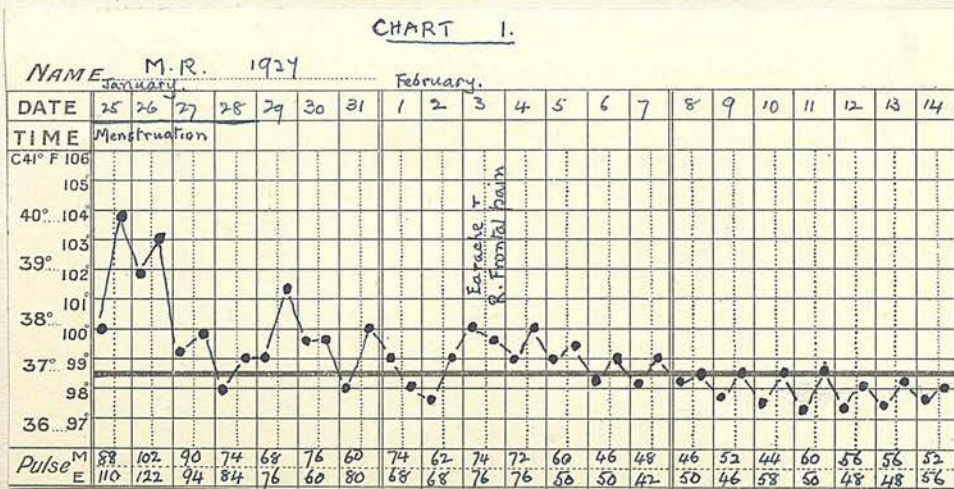
In January and February 1927 a widespread outbreak of Influenza occurred in Europe and Great Britain, which resulted in a definite increase in the death rate. In London the increase began to show decline about the beginning of February, but in the rest of England and Wales the peak was not reached till the beginning of March. In Scotland Influenza of a mild type was present in February, but the prevalence was not unusual for that time of the year. Towards the end of February, however, the prevalence increased greatly in certain districts (notably Dundee) although the type remained mild. (10).

The Outbreak in the Senior School (Cases)

Most of the boarders returned from holidays on the 19th. and 20th. of January. Many of them came from London and the South of England where the epidemic was at its height about that time. St. Andrews (where the school is situated) was not yet noticeably affected. On the 22nd. of January a case of catarrhal febricula occurred in the school. The patient presented the appearances of the tongue and palate that I believe to be characteristic of influenzal

infection. The illness was, however, of a mild type. The first fully developed case (M.R. chart) occurred two days later. This girl was sharply ill, showed a secondary rise after the first subsidence of temperature and suffered from earache and right frontal pain on the 10th day. She had an unusually slow pulse in convalescence, but, in health, her pulse rate is below 60 and she has symptoms of subthyroidism.

Chart (1) M.R.

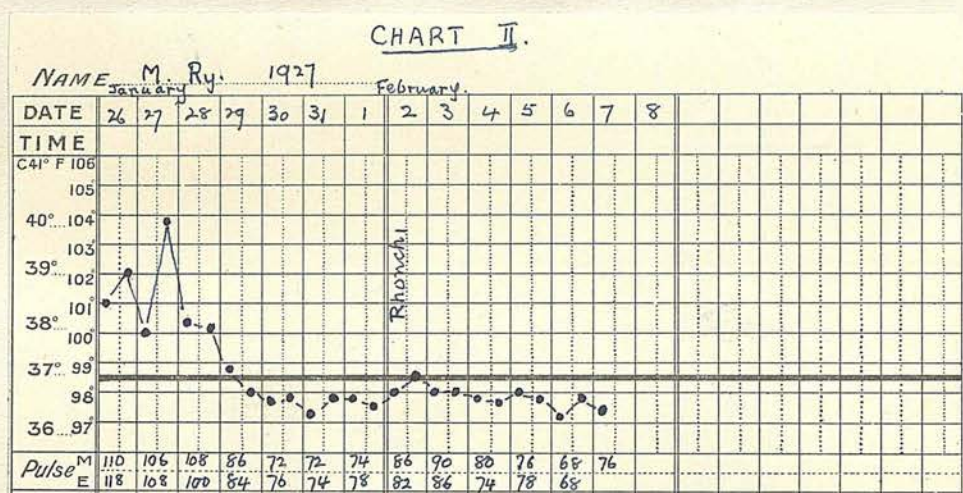


The following cases may also be cited as illustrative.

Case M.Ry. Female age 15. Admitted complaining of headache and slight nasal catarrh, without shivering. On admission she was flushed, but showed no conjunctival congestion. The tongue was furred,

flabby and tremulous with numerous red papillae on the tip and sides. The fauces and soft palate were congested and the latter exhibited some papillae and numerous minute petechiae. A slight secondary rise of temperature was evident on the 8th. day.

Chart (2) M.Ry.



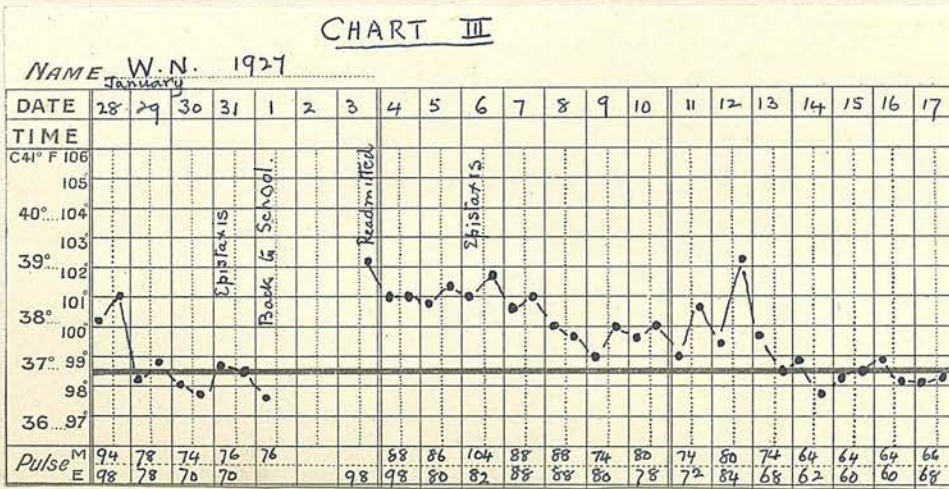
Her chart shows, in addition, the tendency, referred to in earlier papers, for the temperature to reach normal for the first time at the evening reading. The secondary rise of temperature was associated with a rise of pulse rate and at this stage a few general rhonchi were audible in the chest.

Case W.N. Female. Age 17.

Admitted 28:1:27 suffering from slight catarrh and fever and exhibiting a furred, flabby and tremulous tongue with numerous red papillae on the tip and sides.

Two days later the palate was flushed and presented a few red papillae about the base of the uvula. She had slight epistaxis on the third day. On the first of February she appeared to be well and, though the appearance of the tongue was unchanged, she was permitted to return to school. She was readmitted two days later with cough, headache, nasal catarrh and return of fever.

Chart (3) W.N.



Subsequent course.

On 5th February pain in the face was complained of and trans illumination showed comparative dullness of the maxillary antrum on the same side. On the 6th. severe earache demanded paracentesis which resulted in free bloodstained discharge and relief of pain. Otorrhoea continued for about ten days. On

the 9th. there was much cough and occasional rhonchi were audible. On the 12th, headache and severe pain in the left side of the face were complained of and oedema of the eyelids on that side was evident. On the 13th. there was tenderness over the left frontal sinus and distinct exophthalmos of the left eyeball. On the 14th. very free discharge of pus from the left nostril was followed by diminution in the swelling of the face and of the protrusion of the eyeball. By the 20th the oedema was not noticeable and the exophthalmos almost gone. The girl eventually made a complete recovery and examination by a specialist revealed no signs of retained products in any of the nasal sinuses. During the next two years at school her health remained good.

On the 13th. of February her mother arrived from England to visit her and two days later developed Influenza which became complicated by symptoms of pneumonia and pleurisy.

This case illustrates well

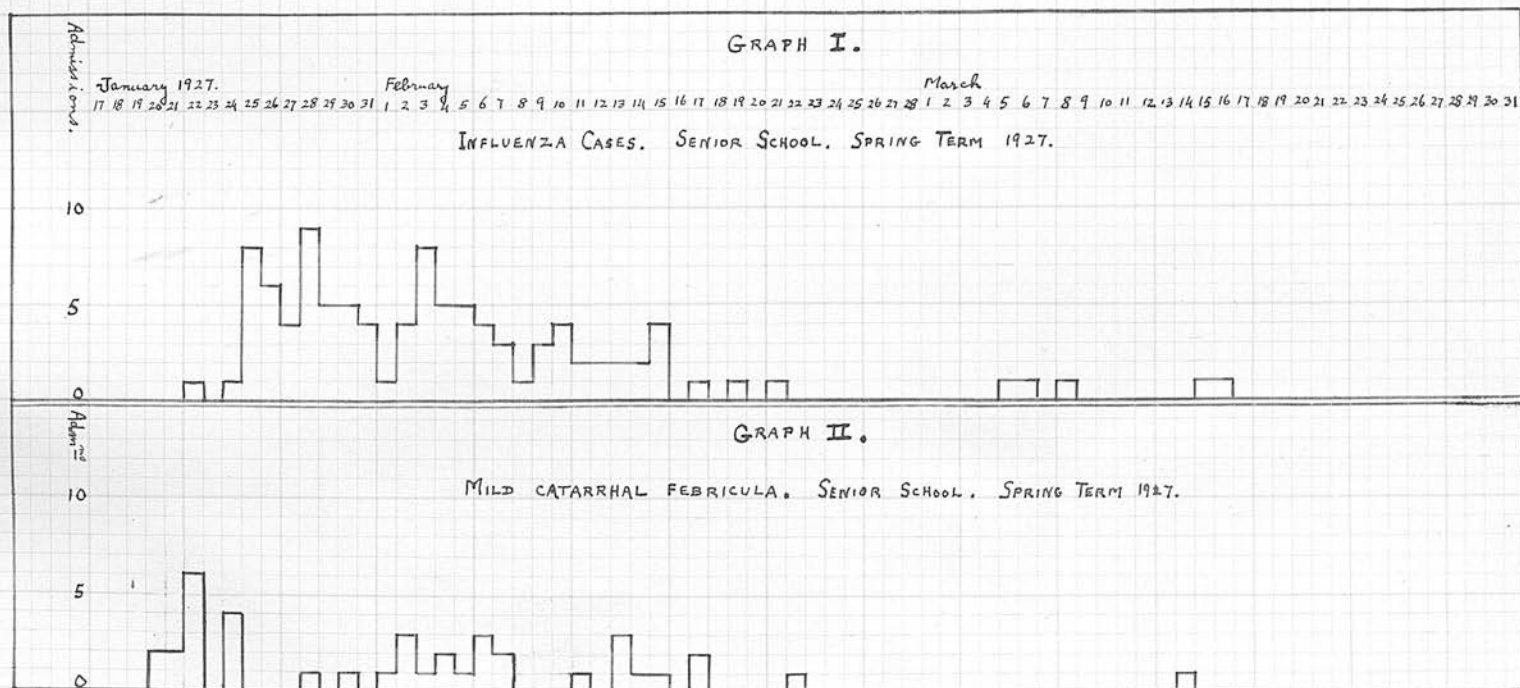
- (a) the trivial nature of the original attack of Influenza.
- (b) the signs that are characteristic of Influenza at the time of onset.
- (c) the subsequent invasion by secondary organisms resulting in complications.

(d) the fact that, while catarrhal discharges persist, the patient can transmit Influenza to others.

The School Epidemic of Spring 1927 as a whole.

The school population was 260. During the first four weeks of term 96 cases of unmistakable Influenza occurred and 38 cases of mild catarrhal febricula (less than 7 days out of school) showing the characteristic tongue. Since some may doubt that illness of so trivial a nature can be true Influenza I have placed these mild cases in a separate group.

In the following graphs the incidence of the two groups is shown.



It will be observed, on comparing the graphs, that the mild catarrhs occurred concurrently with the cases of undoubted Influenza, that they ceased when the outbreak of Influenza ceased and that, when a few cases of Influenza appeared later in the term, an isolated case of the mild type again occurred. This fact supports the view, based upon the appearance of the tongue, that these mild cases are in reality examples of Influenza.

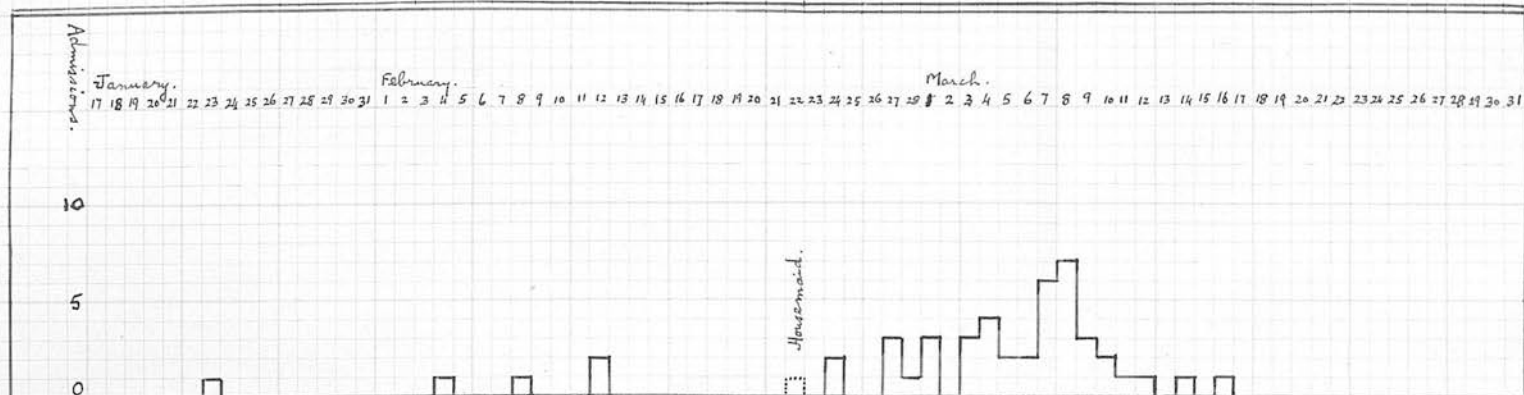
The occurrence of the characteristic tongue in apparently healthy persons during epidemics.

During epidemics of Influenza in the Senior School many individuals who show no symptoms of illness present the characteristic appearances of the tongue in varying degrees. At other times these appearances are not encountered.

For example, in the first half of the Spring Term of 1927 the Junior School was free from Influenza. During the first four weeks of the term some 40 girls in the Junior School came under the observation of the Medical Officer for various reasons. In view of the presence of Influenza in the Senior School special attention was paid to the tongue in these cases. None of them presented the appearance of the tongue which is seen in Influenza. On the 22nd. of February, however, a new housemaid arrived at one of the Houses of the Junior School from a district in which Influenza was epidemic. She was ailing on her arrival and became acutely ill by the evening of the next day, when she was isolated. On the 24th of February a case of Influenza occurred among the girls of that House and 41 cases in the Junior School followed (40% of the school population).

The incidence is shown in the following graph.

GRAPH III. INCIDENCE OF INFLUENZA EPIDEMIC, SPRING TERM 1927, JUNIOR SCHOOL.



All the cases showed the characteristic tongue. From 24th. February onwards, among apparently healthy girls in the Junior School, a furred, flabby and papillated tongue was commonly observed though it had been absent earlier in the term.

Dudley (11) and others maintain that in the course of epidemics of Diphtheria and of other infectious diseases many individuals acquire immunity from the exposure to infection although they show no symptoms of illness. Any immunity acquired after an attack of Influenza is of such brief duration that no indication can be obtained from a study of subsequent immunity. The occurrence, however, of the characteristic tongue in healthy individuals during epidemics of Influenza and its absence in inter-epidemic periods suggests that a similar state of infection without symptoms may occur in this disease.

Spread of Influenza.

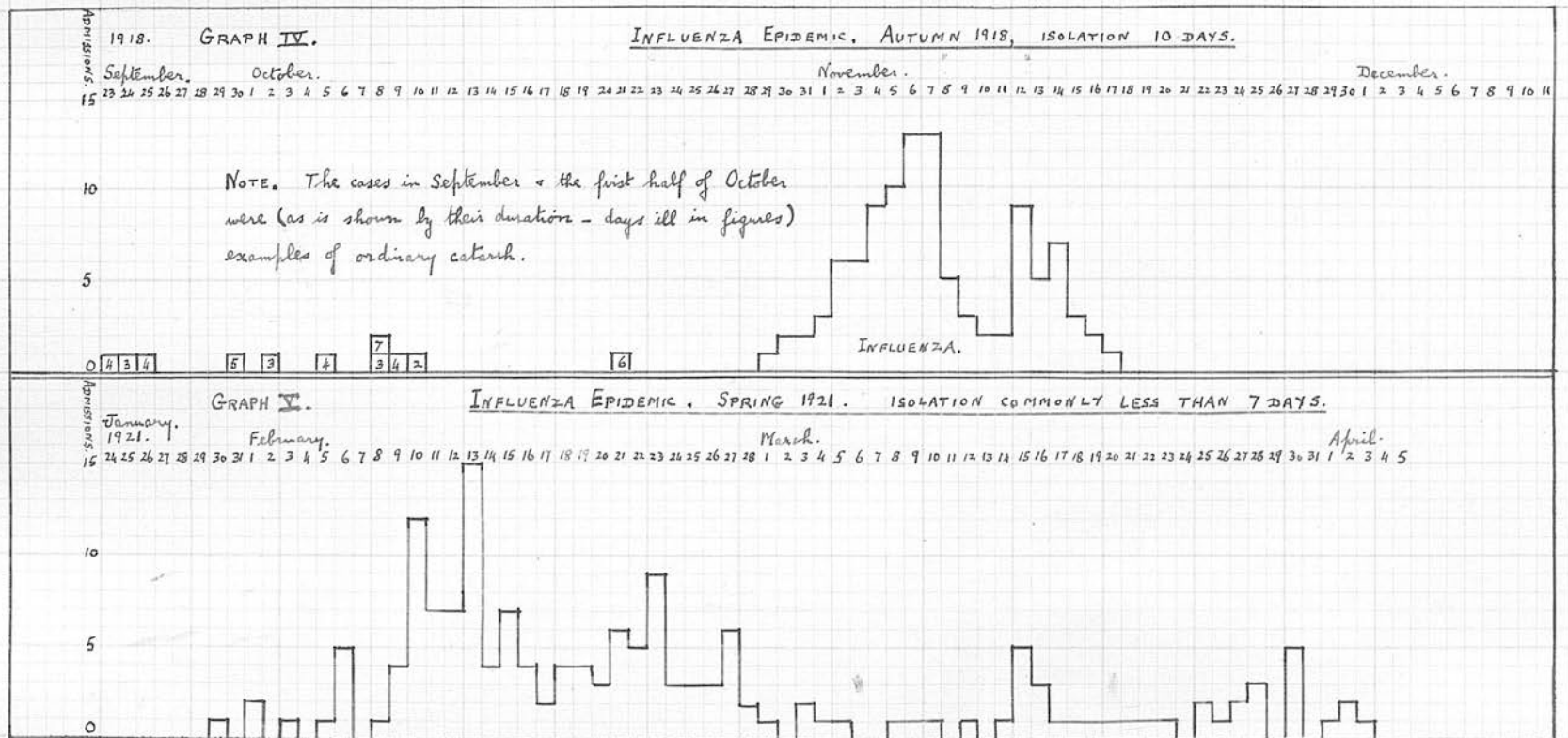
Whether the healthy individual who exhibits this state of the tongue is capable of spreading Influenza to others is not known. It is possible that, in the absence of catarrhal symptoms (and the resulting expulsion of infective droplets) spread of the Virus from a healthy host is unlikely. The infection may, however, undoubtedly be transmitted either by an acute or by a mild case of the disease.

Experimental workers (14) (15) have found difficulty in inoculating animals with the disease by material obtained from influenza patients later than the fourth day of illness and have assumed that cases are only infectious for that number of days. It is probable, however, from the following facts that a case however mild remains infectious for at least seven days from the onset of illness, though infectivity may not be so high as in the acute stage.

In the epidemic of 1918 in School all cases, however mild, were isolated for 10 days. The resulting epidemic was limited to less than three weeks. (Graph No. IV. p.16).

In 1921, on the other hand, many cases were isolated for not more than 6 days. The outbreak on that occasion persisted for over twelve weeks. (See Graph V. p. 16).

In the outbreak under review (Spring 1927 - Senior School) isolation for at least 8 days was adopted, though in a few very slight cases where fever was limited to 24 hours and catarrhal symptoms were absent, the period was reduced to 6 or 7 days. The duration of the epidemic was limited to less than a month. (Graph I. p.11).



It is common for the mildest case to develop some catarrh between the 5th. and 8th. day. I believe, therefore, that a minimum isolation period of 8 days should be observed if spread is to be prevented. If isolation is prompt and sufficient, con-

siderable limitation of spread may be expected. The case W.N. already quoted illustrates the fact that so long as catarrhal discharges persist the patient can transmit Influenza to others.

Introduction of the disease into a community can be prevented if that community is isolated. In 1918 Matthiasson, in Iceland, succeeded by vigorous quarantine regulations in limiting the disease to one half of the island (16). I have shown in Graph III, p.14., how the Junior School escaped infection in Spring 1927 until the accidental introduction of a case of the disease from outside.

(2) Epidemic Influenza in Autumn 1927.

In the Autumn Term of 1927 Influenza again assumed epidemic proportions in the School. There were in all 156 cases of catarrhal febricula. 106 of these were undoubted cases of Influenza, 24 were examples of mild catarrhal febricula, 26 suffered from catarrh without fever.

The state of the tongue was recorded in detail in 117 of the cases.

(a) It was characteristic in 102 girls, fifteen of whom were so slightly ill that they were permitted to return to school within 7 days. The duration of the isolation in the remaining 87 cases is shown in the

following table.

Number of Cases	7	36	27	7	4	3	1	1	1
Days out of school	7	8	9	10	11	12	13	15	17

(b) In six cases the appearance of the tongue was suggestive, but not typical, of Influenza. The duration of isolation of these cases was respectively 3,5,6,7,8 and 9 days.

(c) The tongue showed none of the appearances characteristic of Influenza in 9 cases. These may be briefly considered seriatim.

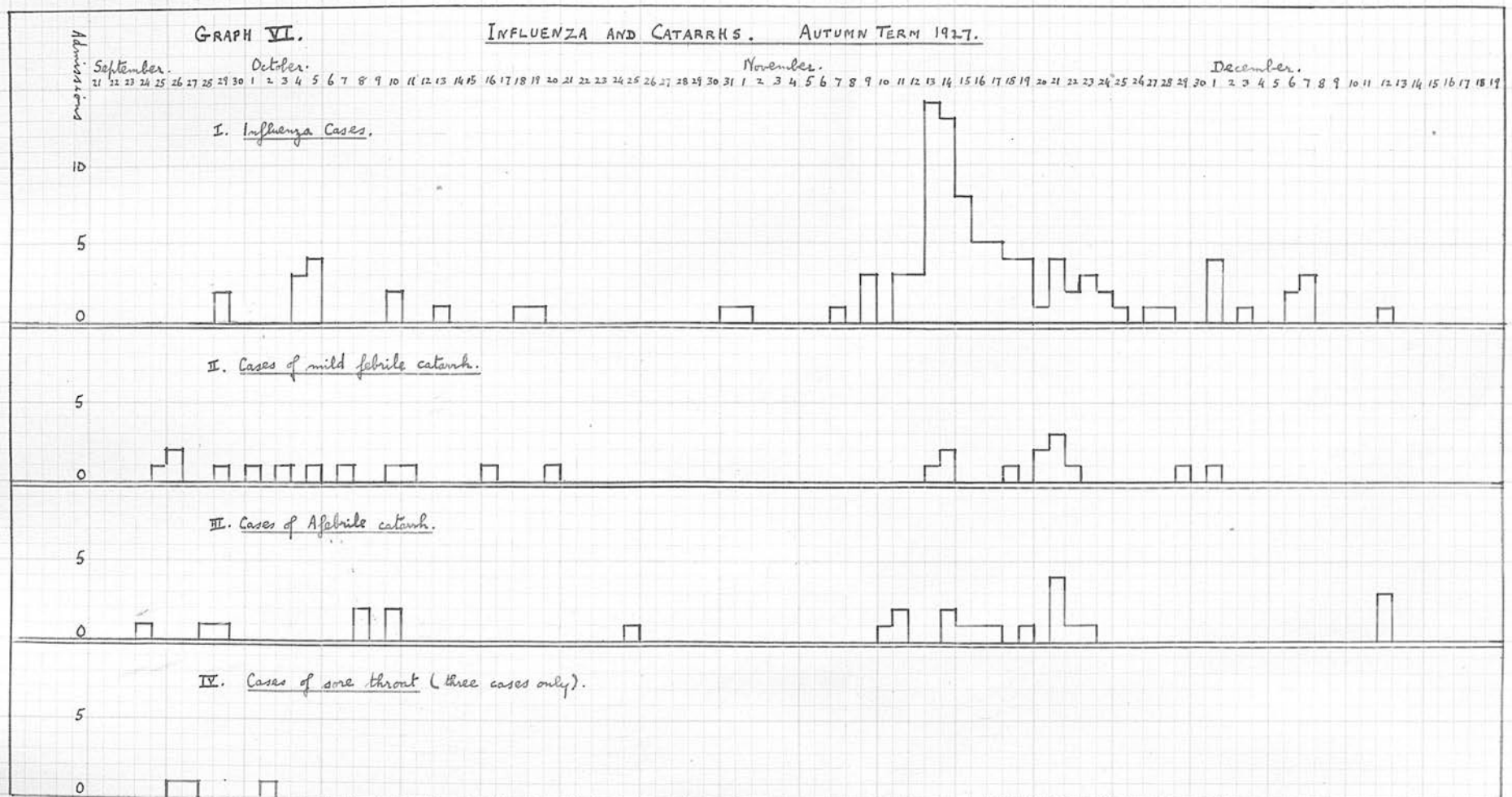
1. C.G. was admitted with slight nasal catarrh without fever and was discharged in 2 days.
2. M.C. complained of similar symptoms and was discharged in 4 days.
3. J.P. was admitted with slight nasal catarrh and very slight disturbance of temperature (maximum 99°F.). She was well in three days but, as she had been exposed to measles, she was kept out of school for 8 days when the quarantine period for that disease elapsed.
4. B.C. suffered from streaming nasal catarrh (maximum temperature 99.4°F.) from which she recovered in 4 days. As she also had been exposed to measles, isolation was continued until the end of the quarantine period.
5. M.L. was admitted suffering from nasal catarrh

- (afebrile) which cleared up in three or four days, but she was kept out of school for 6 days longer owing to the occurrence of a boil on her leg.
6. B.N. was admitted because of cough. There were neither physical signs in the chest nor febrile disturbance, but as she had not previously had whooping cough she was kept in isolation for some days.
 7. L.K. had nasal catarrh and slight cough (maximum temperature 99⁰F.) She recovered in a few days.
 8. A.M. was admitted with nasal catarrh which was followed by slight asthma to which she is liable. She was kept out of school for 12 days (afebrile).
 9. L.A. was admitted on the second of term with her nose much obstructed by nasal catarrh, from which she had been suffering for two weeks. She showed no febrile disturbance throughout. The nasal condition proved very refractory to treatment and she did not return to school until her nose was clear (10 days).

These cases, in which the tongue showed no such features as are found in Influenza, gave no clinical evidence of that disease.

Incidence of Cases Autumn 1927.

In the following graphs (Graph VI) the day to day incidence of cases is recorded, mild febrile catarrhs and afebrile catarrhs being separated from the obvious cases of Influenza.



1. It will be observed that the cases of Influenza occurred in two groups - one in the first half of the term and one in the second.

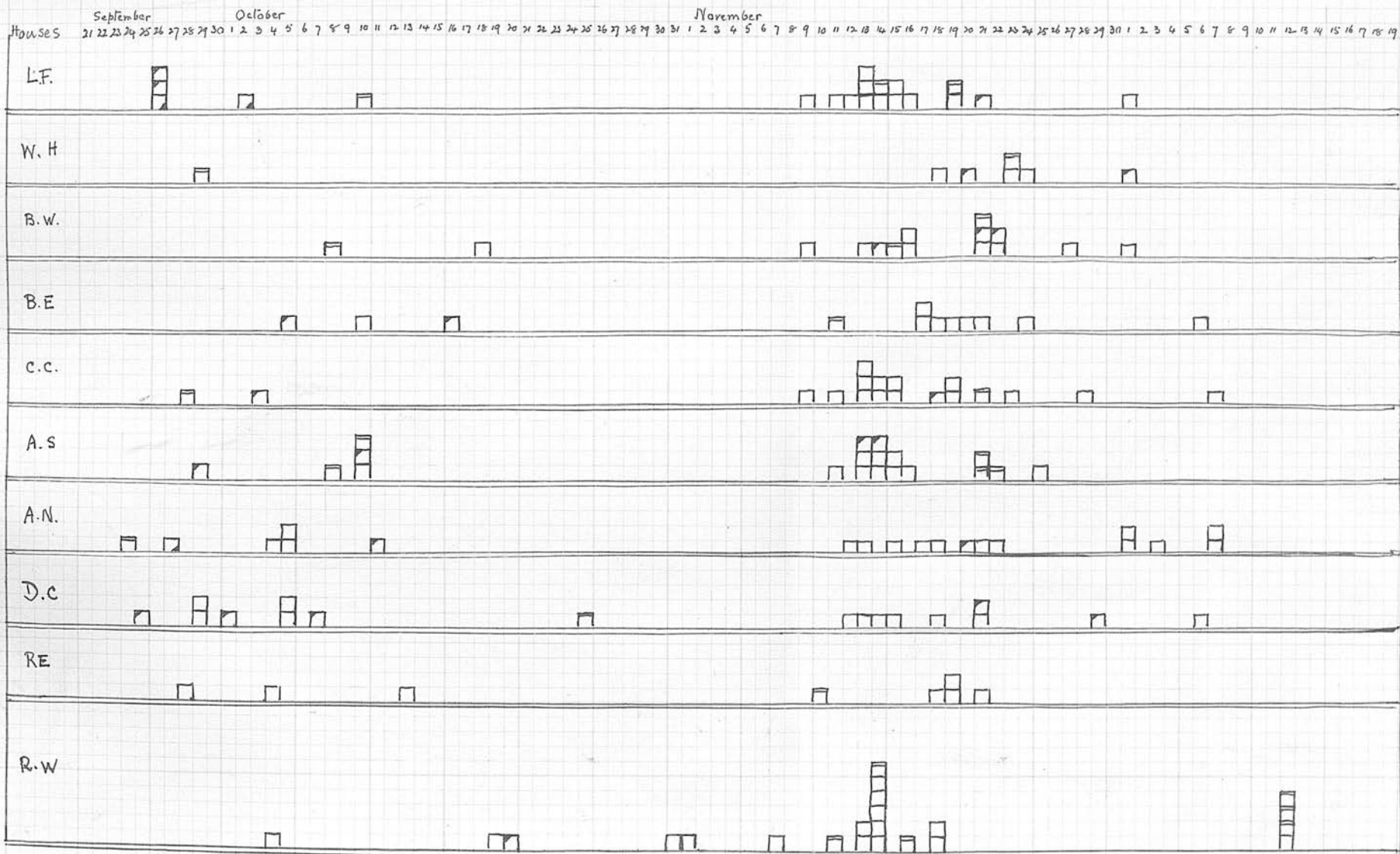
Those in the first half were few in number and scattered, the last occurring on 19th. October. In the second half of the term the disease assumed epidemic proportions.

2. It is evident from the graphs that both the mild febrile catarrhs and the afebrile catarrhs also occurred in two groups corresponding in date to the two groups of Influenza cases.

This separation into two outbreaks is still more evident when the cases are shown according to their occurrence in Houses. I have indicated the types of the cases as follows: (Graph VII).

- = Influenza.
 ◻ = Febrile catarrh.
 ▣ = Afebrile catarrh.

Graph VII Day-to-day incidence by Houses of Influenza + Catarrhs Autumn 1927. □ = Influenza ◻ = Febrile catarrh ▣ = Afebrile catarrh.



The day to day incidence of the cases is strongly suggestive of a definite relationship between the majority of the milder cases and Influenza.

The same synchronicity is shown as in the Spring epidemic already described.

Influenza in non epidemic terms.

It has been my experience that since 1918 hardly a winter has passed without one or two obvious cases of Influenza occurring - cases, that is to say, of acute febrile catarrh, presenting the characteristic symptoms (including the tongue) of Influenza as observed during epidemics. Moreover, a proportion of the cases of mild catarrhal febricula which continually occur present the characteristic tongue of Influenza. In Summer terms the occurrence of such cases is rare. It would appear then that Influenza has been endemic since 1918, although it only occasionally reaches epidemic proportions.

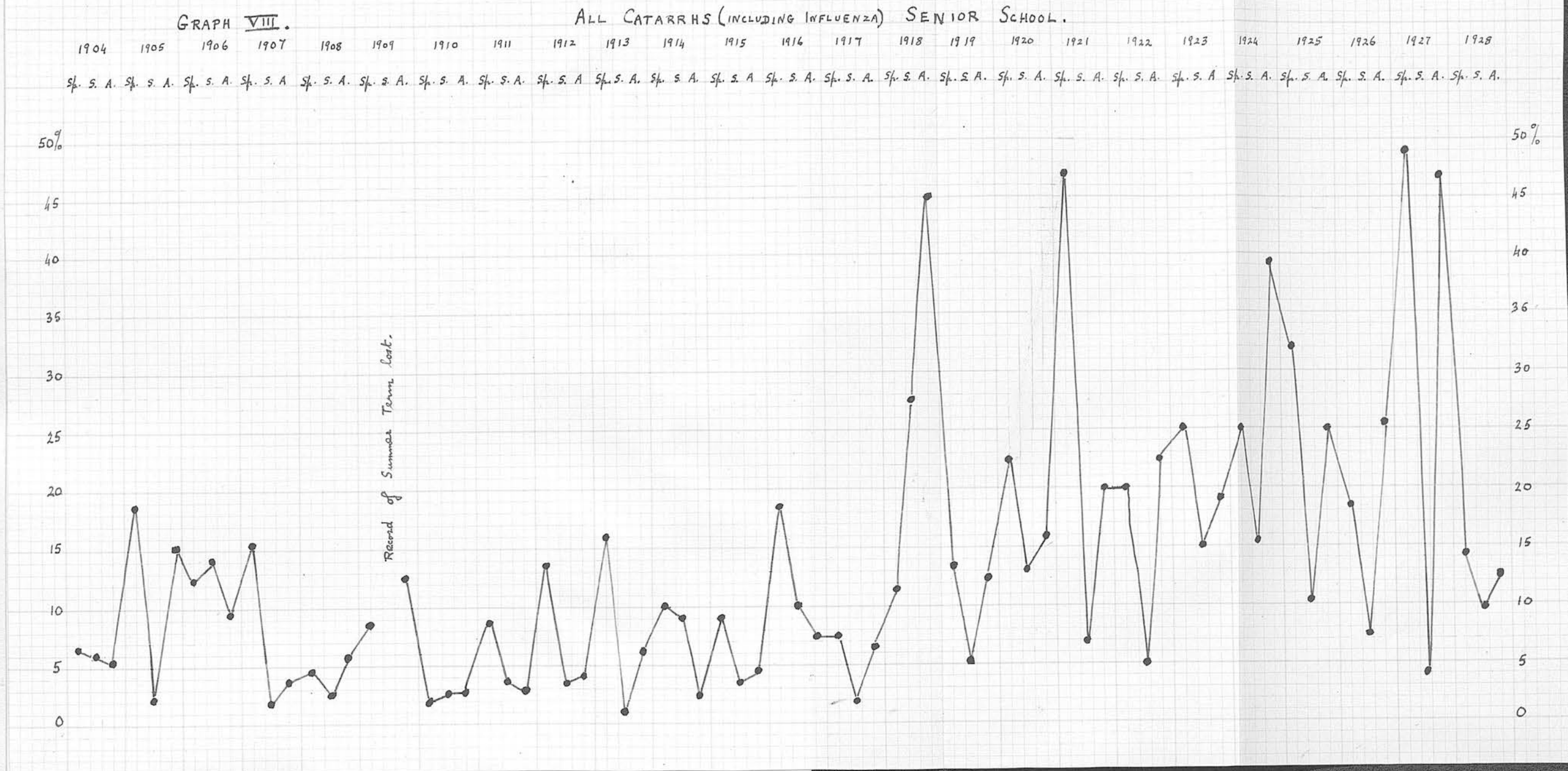
These two epidemics just described confirm the conclusion arrived at from earlier studies and give support to the view that many cases of what is usually referred to as "common cold" or as "mild catarrhal febricula" are in reality cases of Influenza.

C. Consideration of the Catarrhal Incidence in
School for twenty five years.

The relationship which has been indicated between many cases of mild catarrhal febricula and Influenza suggests that the great increase in catarrhal affections which has been observed of late years in many schools may be the sequel of the great pandemic of Influenza which occurred in 1918.

I have therefore, abstracted from the records of admission and discharge in the Hospice register all the cases of respiratory catarrh (including Influenza and sore throat) during a period of 25 years. For each term the numbers are reduced to a percentage of the school population in that term. (The records are complete with the exception of the Summer Term of 1909. The pages dealing with that term are missing).

The results are shown as follows (Graph VIII).



A definite increase of catarrhal affections is seen to occur since 1918, high epidemic prevalence being reached on several occasions.

In order to determine what proportion of the increase is due to the milder catarrhs and whether these show an increase since 1918 an arbitrary division was adopted. Those cases which were out of

school for seven days or more were grouped as "severe catarrhs" and those which returned to work in less than seven days were grouped as "mild catarrhs." This division was arrived at from a consideration of those cases in which notes and charts are extant. From this it appeared that cases of acute Influenza are as a rule out of school for more than seven days. The bulk of them will therefore appear as "severe catarrhs." The milder cases of Influenza, in many of which the diagnosis might be disputed, will appear in the other groups along with most catarrhs which are not influenzal in nature. In the Summer of 1918, for example, an epidemic of undoubted Influenza occurred, which was of so mild a type that the majority of the cases returned to school within a week. This epidemic therefore appears in the graph of "mild catarrhs." On the other hand, some non influenzal cases (e.g. bronchial asthma) will appear under "severe catarrhs." But on the whole the graph of "severe catarrhs" closely corresponds to the incidence of frank Influenza cases in which the diagnosis was undoubted.

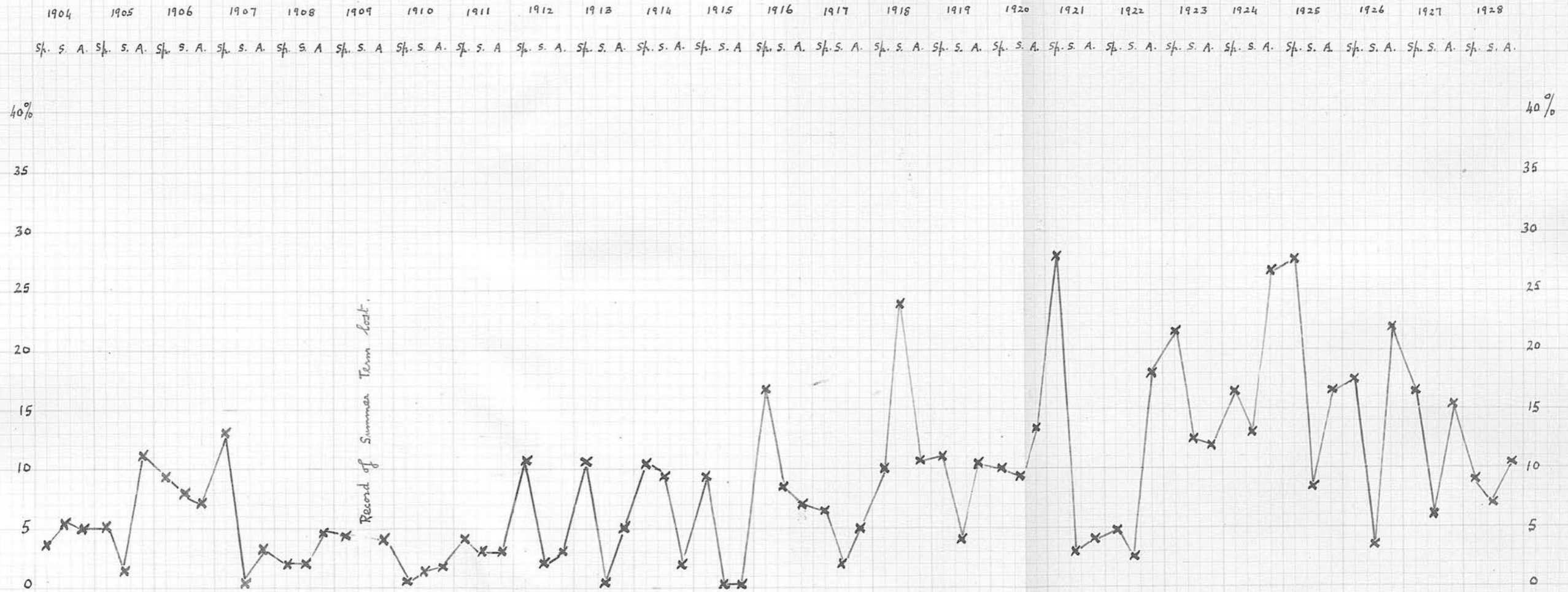
The results are as follows:

(Mild Catarrhs Graph IX. Severe Catarrhs Graph X).

Mild Catarrhs.

GRAPH IX.

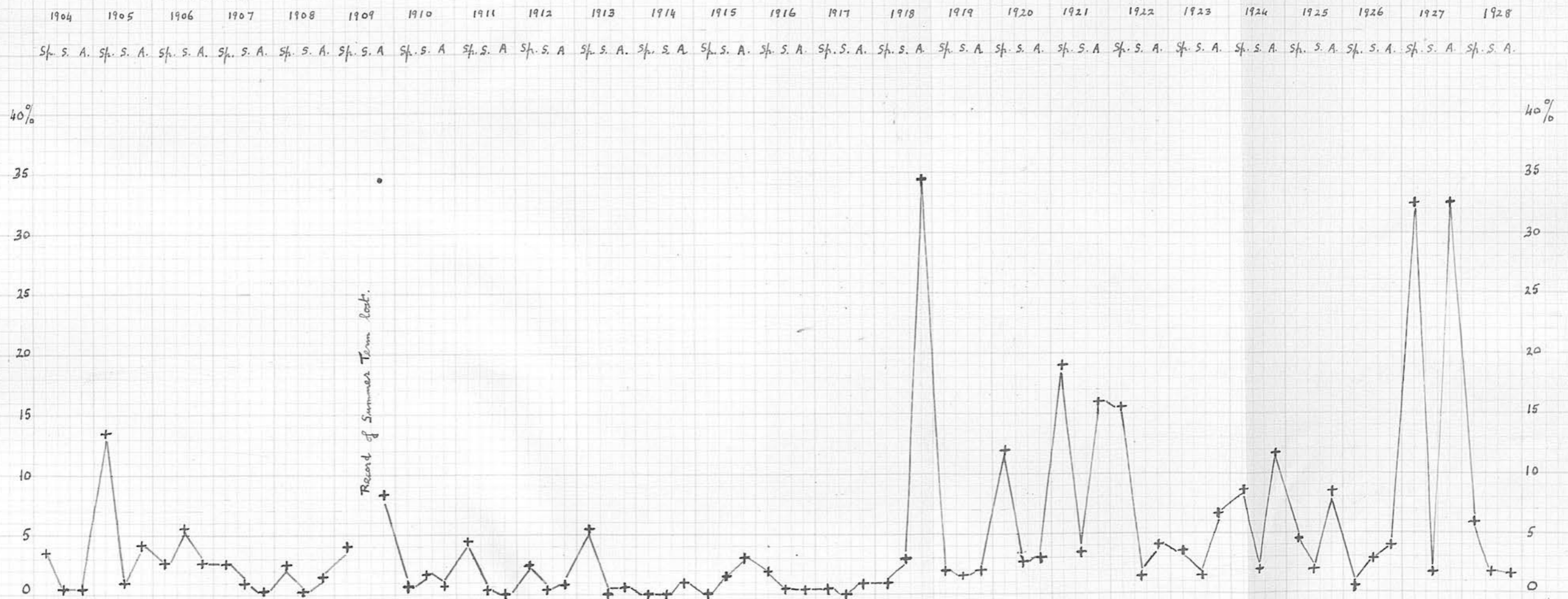
MILD CATARRHS = LESS THAN SEVEN DAYS OUT OF SCHOOL, SENIOR SCHOOL.



Severe Catarrhs.

GRAPH X.

SEVERE CATARRHS = SEVEN DAYS OR MORE OUT OF SCHOOL, SENIOR SCHOOL.



The following facts emerge from a consideration of the graphs:

1. The average incidence of mild catarrhs has greatly increased of recent years and the increase dates from 1918.

The average rate was 5.6% from 1904 to 1917 and has risen to 12.6% in the ten years following 1918.

2. The mild catarrhs reached high epidemic prevalence on several occasions since 1918 but never before that year.

3. The severe catarrhs show similar changes in incidence since 1918.

It is evident then that both mild and severe catarrhs participate in the increase of recent years and that the increase in each group dates from 1918, the year of the appearance of the great pandemic of Influenza.

4. Further, the increase in mild catarrhs and the increase in severe catarrhs have been proportional to one another, as is seen from the following table:

Average of ten years 1904 to 1913

Slight catarrhs	4.7%
Severe catarrhs	2.4%

Average of ten years 1919 to 1928

Slight catarrhs	12.7%
Severe catarrhs	7.25%

A definite association between the mild catarrhs and severe catarrhs is thus evident since each increased about threefold since the year 1918.

It is seen from the graph of All Catarrhs (Graph VIII, p.25) that epidemic outbreaks occurred on seven occasions since 1917. In some of these the type of illness was "severe" in others it was "mild," though severe cases were always numerous except in the Summer of 1918 and the Spring of 1925. The following table shows the proportion of "severe" and "mild" cases in each epidemic.

	MILD	SEVERE	TOTAL
Summer 1918 (the early Pandemic)	24.5%	3 %	27.5%
Autumn 1918 (the great Pandemic)	10.5%	34.5%	45.0%
Spring 1921	28.0%	19.0%	47.0%
Autumn 1924	26.5%	11.5%	38.0%
Spring 1925	27.5%	4.5%	32.0%
Spring 1927	16.5%	32.5%	49.0%
Autumn 1927	15.5%	32.5%	48.0%

It will further be noted, from the graph of "mild catarrhs," (Graph IX, p.27) that these approximated to prewar levels on 3 occasions only:

1919	8.6%
1922	8.3%
1928	9.0%

These are years immediately following the most severe outbreaks of Influenza.

A similar drop in "severe catarrhs" also follows the more severe epidemics.

Seasonal Variation.

It is known that Influenza is especially prevalent in the Spring and Autumn of the year and that the disease occurs but rarely in the Summer months.

It remains to be ascertained whether the increase of catarrhs, and especially of "mild catarrhs," since 1918 shows this seasonal variation.

For this purpose graphs of the mild catarrhs in each term were constructed as follows:

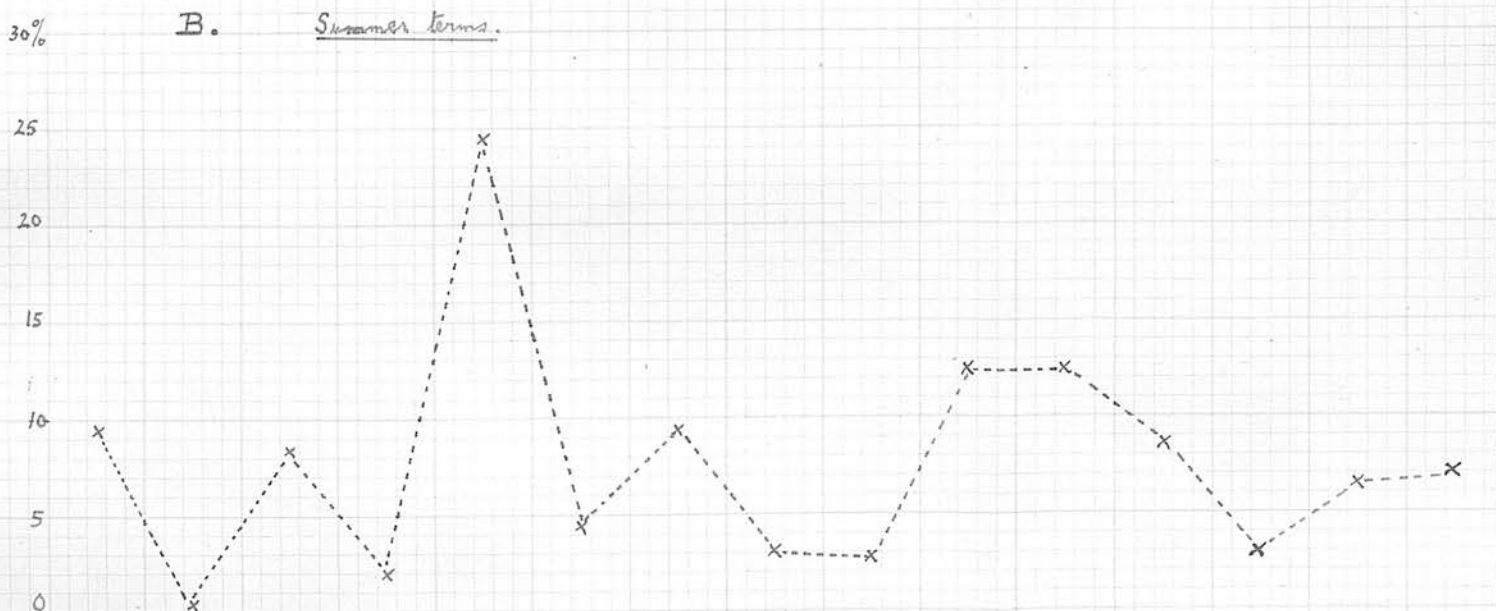
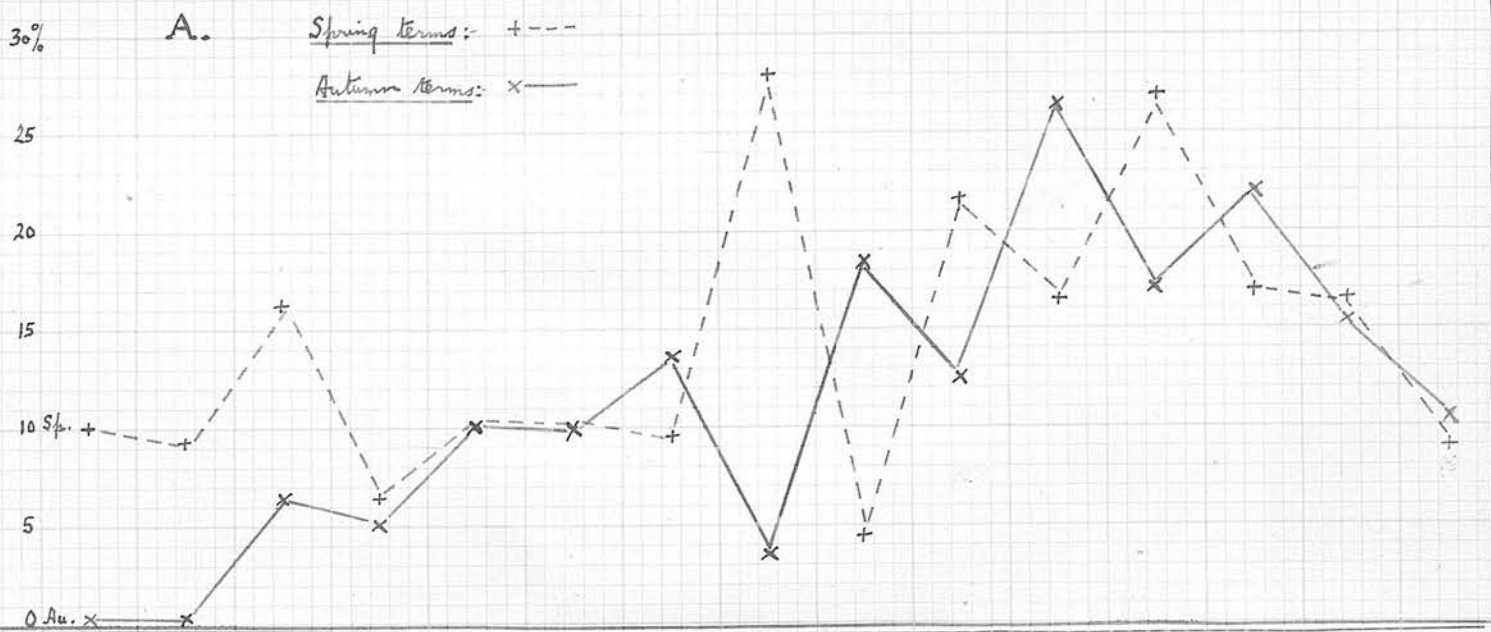
(Graph XI. A. Spring and Autumn Terms. B. Summer Term)

GRAPH XI.

SLIGHT CATARRHS (UNDER 7 DAYS)

To show the increase in Spring & Autumn Terms as compared with Summer Terms.

1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928



It is clear that the increase of "mild catarrhs" occurred in the Spring and Autumn terms (Graph IX. A) only, thus showing the same seasonal variation as Influenza.

When this fact is considered in conjunction with the sustained general increase since 1918 - the year of the great pandemic of Influenza - and the occasional assumption of epidemic prevalence since that date, it affords strong presumptive evidence that many of the "mild catarrhs" are in reality cases of Influenza.

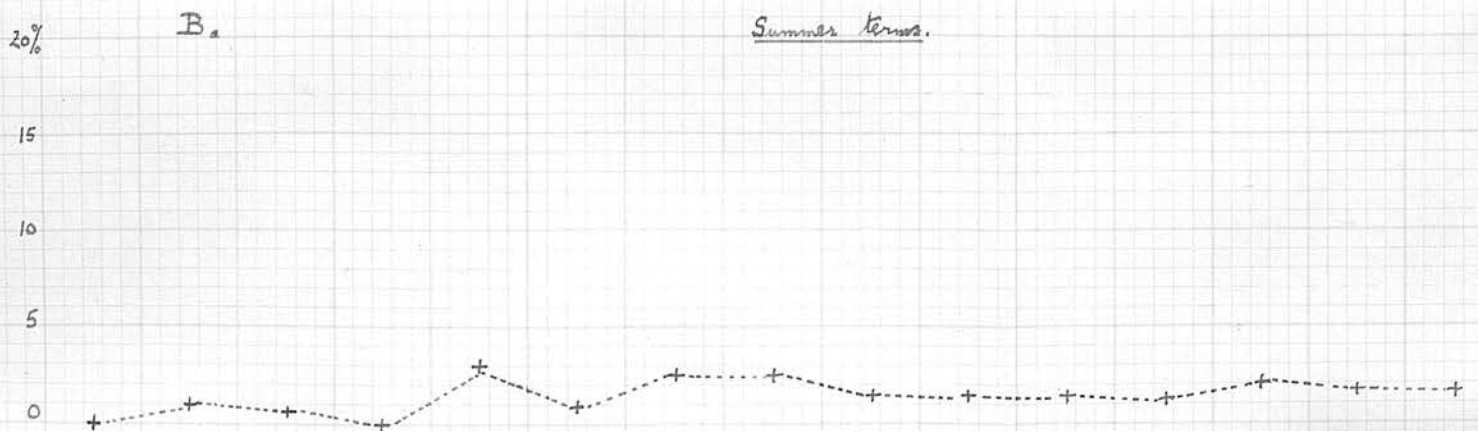
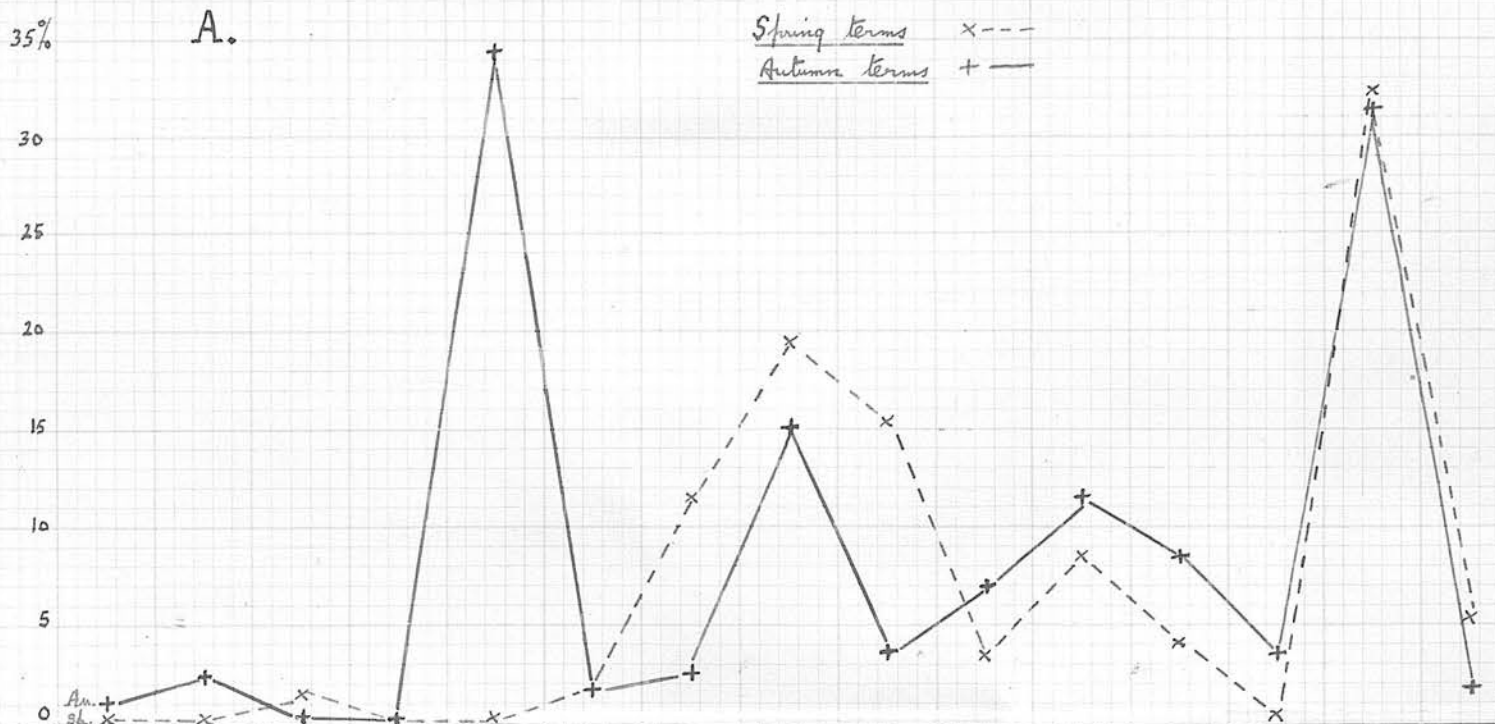
The severe catarrhs show a similar seasonal variation (Graph XII. A).

GRAPH XII.

SEVERE CATARRHS (OVER 7 DAYS)

To show the increase in Spring & Autumn terms as compared with Summer terms.

1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928



D. Summary of Part I.

1. Facts have been advanced which indicate that:-
 - (a) Uncomplicated cases of Influenza, whether they are severe or mild, are infectious for at least 7 days from their onset.
 - (b) Complicated cases of Influenza are infectious so long as catarrhal discharges persist.
 - (c) Prompt and sufficient isolation of all cases of Influenza is effective in limiting the extent of epidemics.
2. A furred, flabby tongue with numerous prominent red papillae on its tip and sides is present in every case of undoubted Influenza.
3. If this appearance of the tongue is present in a case of mild catarrhal febricula the patient is suffering from true Influenza for the following reasons:
 - (a) Such cases are prone to develop similar complications to those which occur in Influenza.
 - (b) The day to day incidence of such cases varies contemporaneously with the incidence of cases of undoubted Influenza.
 - (c) The annual incidence of such cases has been increased since 1918 and this increase has shown the same seasonal variation as Influenza and is proportional to the increase in severe catarrhs.

(d) Such cases have assumed epidemic proportions frequently since 1918 although in the previous fifteen years that did not occur.

4. The appearance of the tongue is so characteristic of Influenza that a diagnosis of that disease should not be made if this sign is absent.
5. The characteristic appearance of the tongue is often seen in healthy girls during an epidemic of Influenza, but at no other time. In explanation of this fact it is suggested that healthy girls showing the sign may be healthy hosts of the virus of Influenza.

E. Conclusions.

- I. Many persons attacked by what is usually referred to as "common cold" or "mild catarrhal febricula" are in reality suffering from Influenza in a mild form and are capable of transmitting that disease to others. They may be distinguished from persons suffering from non influenzal catarrhs by the appearance of the tongue.
- II. The increase in catarrhal illness since 1918 is due in part to the prevalence of Influenza since that date and to the increased frequency of mild cases of catarrhal febricula of influenzal origin.

PART II.

The relation of the catarrhal process to Diet.**A.** Effect of war restrictions on incidence of
Catarrhs in School.

The analysis of the incidence of catarrhal illness during a period of 25 years includes the period of the Great European War, during which our national diet was considerably modified and restricted. It thus affords an opportunity of detecting any effect which that restriction may have exerted upon the school health. During the war years (1914 to 1918) no noticeable increase or diminution was evident in the incidence of "total catarrhs" (Graph VIII, p.25). But when the graph of "severe catarrhs" (that is to say of catarrhs of more than seven days duration) (Graph X, p.28) is examined it is evident that they were reduced in number during the war years.

In the following table the percentage of "severe catarrhs" is shown,

- (1) In ten pre-war years.
- (2) From 1914 to 1917.
- (3) In 1918, the year of the great pandemic of Influenza.
- (4) In ten post-war years.

Table I .

Average incidence of "severe catarrhs" (i.e. of 7 days or over)

	Ten years 1904-1913.	Four years 1914-1917.	1918.	Ten years 1919-1928.
Spring Terms	4.15%	.6%	1 %	10.5 %
Summer Terms	1.1 %	.5%	3 % (a)	2.1 %
Autumn Terms	2.05%	1.3%	34.5% (b)	9.08%
Average "severe catarrhs" per annum	2.6 %	.8%	12.8%	7.25%

Notes. (a) Summer outbreak of Influenza July: most cases mild. But a few were ill for seven days or over.

(b) Autumn epidemic of Influenza (Great pandemic).

The incidence of "severe catarrhs" was, thus, three times as great in the pre-war years as it was during the war years when food was restricted.

This fact suggests that some of the pre-war catarrhal rate was dependent upon excessive consumption of some article of diet, the restriction of which during the war produced a beneficial effect.

B. B. The catarrhal state in relation to carbohydrates.

A considerable body of clinical evidence exists which indicates that excessive carbohydrate intake increases the liability to catarrhs.

(a) Cameron (17) in discussing the Exudative Diathesis applies the term "Status

Catarrhalis" to the condition from which such subjects suffer, and points out that this term has the advantage of leaving open the "question of how far the tendency is due to inherited weakness and how far it is the result of faults of diet and hygiene." He considers that "the high water content of the body is the primary fault" and that "the lymphatic overgrowth and the tendency to profuse and inveterate catarrhal and exudative processes are secondary results of the high content and free flow of lymph." In children of this type he holds that the prejudicial results of even a moderate excess of food are particularly obvious.

"As a rule" he says, "their demand for sugar and starchy foods, especially bread, is insistent, yet it is just these elements of diet which seem to be most harmful in that they tend to the retention of increased amounts of fluid in the body, to a rapid increase in weight and to an exacerbation of the catarrhal tendency." Finally he advises that for catarrhal children "Bread, potatoes, farinaceous puddings, biscuits, cakes and all forms

of sugar must be strictly rationed." He seems to suggest that such subjects suffer from an hereditary difficulty in dealing with carbohydrate food.

It may well be that some children are less well equipped in this respect than others, and therefore fall more readily into that status catarrhalis which he so vividly describes; but it is equally possible that if the amount of carbohydrate absorbed is excessive the best equipped child may fall into a similar state.

- (b) Maitland Ramsay (18) (19) has for years taught that Phlyctenular Conjunctivitis, a common accompaniment of the catarrhal diathesis, is resistant of cure until all carbohydrate food is reduced and sugar completely withheld. When this line of treatment is enforced rapid improvement follows not only in the ocular condition, but in the nasal catarrh which is invariably associated with it. He has demonstrated in such subjects a high resting level of blood sugar ((20) p.475).

His observations point to cane sugar rather than the starchy foods as the aggravating agent. Indeed his

attention was first drawn to the matter by observation made in his outpatient department. There he saw patients on Mondays and Thursdays. Relapse in the cases of phlyctenular conjunctivitis was commonly met with on Mondays but not on Thursdays - a circumstance which he attributed to the spending of the "Saturday penny" upon sweets.

Personally I have ample experience of the beneficial effect on catarrhal subjects of a diet in which jam and sweets are severely restricted. A Convalescent Home of which I have charge admits children in poor circumstances for a month's holiday. On arrival most of them show most of the characteristics of the catarrhal diathesis. In particular they suffer from profuse and obvious nasal catarrh. After a month of the regime restricted as regards sugar no trace of nasal catarrh remains.

- (c) Recently a report (21 and 22) was issued by the staff of the Rowett Institute upon the nature of the diet and the incidence of disease in two East African tribes, whose dietetic habits vary widely. In one, a cereal eating tribe, the

mortality from bronchitis and pneumonia is almost ten times as great as in the other, which is mainly carnivorous.

The authors ascribe this disability of the cereal eating tribe to the deficiency of vitamins and calcium salts in the diet. But in view of Cameron's and Maitland Ramsay's findings excessive intake of carbohydrate is itself enough to predispose to such conditions, and, as I have shown, the catarrhal incidence in the School, to which this paper refers, was reduced during the period of dietetic restriction.

It is true, however, that as the natural carbohydrates in the diet are replaced by cane sugar the vitamin and mineral content of the diet will be correspondingly reduced.

- (d) It is known that patients suffering from diabetes are specially susceptible to the action of staphylococci and streptococci, boils and erysipelas being common complications of that disease.

Bacteriological investigation of upper respiratory catarrhs has shown that they are commonly associated with the activity

of cocci - especially streptococci and staphylococci (20).

- (e) Some observations of my own point in the same direction.

(1) An analysis of the catarrhal incidence in the Senior School in many terms shows that, in each term, there is a tendency for two maxima to occur - one in the first week of term and one in the week following the half term holiday, when girls visit parents and friends. This is due in part, no doubt, to the exposure to infection during the train journey at the beginning of term and during visits to public places such as Hotels, Cafés, etc., at mid-term. But at these times a much greater quantity of "sweets" is consumed than at any other period of the term.

(2) There have been (Graph VIII, p.25) seven epidemics of Influenza in the period under review. With two exceptions, there has always been a considerable proportion of catarrhal complications in each epidemic. Thus, in 1921, 4 cases of otorrhoea and 2 of pneumonia occurred ((3) p.167). In 1922, out of 52 cases of Influenza, 13 developed either bronchial or pulmonary

catarrh or earache. One of those with pulmonary symptoms developed pleural effusion, while two of the cases of earache developed otorrhoea and in none of these the mastoid became involved and later a subdural abscess formed((4) p. 161). The exceptions to this rule were the epidemics of Summer 1918 and of Autumn 1918. In the former there were no catarrhal complications and in the latter, out of 170 cases of the disease, only one developed a catarrhal complication (otorrhoea). These two epidemics occurred during the period of dietetic restriction. That is to say, catarrhal complications have followed Influenza with much greater frequency in the post war years than they did in 1918, when food rationing was in force.

There is, therefore, considerable evidence that the severity and possibly the incidence of catarrhal inflammations of the respiratory tract and its offshoots may be increased by excessive intake of carbohydrate food and especially of cane sugar.

C. The national consumption of Cane Sugar.

An enormous and, I believe, a sinister advance has occurred in the use of Cane Sugar (Sucrose) in the last century. First brought to England by Hawkins in 1560 it did not come into general use until the beginning of the nineteenth century. Even at that date the consumption was very small.

In the following table the consumption per head per annum of Cane Sugar in the United Kingdom is shown at intervals since 1819.

Table II. (for more detailed figures see (20)).

<u>Year.</u>	<u>Sugar consumed per head of population.</u>
1819	17 lbs.
1849	24 lbs.
1869	43 lbs.
1889	75 lbs.
1909	80 lbs.
1913	83 lbs.
1924	79 lbs.
1926	86 lbs.
1928	90 lbs.

During the Great War statistics were not kept, but the amount of sugar imported was greatly reduced even though the fighting forces received it in unrestricted quantity (20). After the war the imports took a little time to reach their former level; but in 1924, 79 lbs. per head were consumed. In 1928, the figure had risen to 90 lbs. per head per annum.

Much of the sucrose consumed is now manufactured from the sugar beet but the sugar cane still supplies large quantities of this substance.

In what follows, the term "cane sugar" is used to mean "sucrose" from whatever source obtained.

It is evident not only that the present consumption of cane sugar is enormous, but that the increase in its use has been very rapid.

D. The Consumption of Cane Sugar in the Senior School.

With the view of checking these figures and of obtaining actual data in regard to school children I obtained a return from each House in the School of the amount of (a) Sugar, (b) Jam, (c) Marmalade, (d) Syrup and (e) Honey, consumed during the Spring Term of 1931.

(a) Calculation of Sugar in Jam and Marmalade.

Some calculations were necessary in order to determine the amount of sugar represented by the jam and marmalade consumed. I calculated the amount of sugar in jam on the assumption that 12 lbs. of sugar are used in making 23 lbs. of jam. I have every reason to believe that this is an underestimate.

Marmalade presented more difficulty since cooks and manufacturers vary enormously in their practice. I found that two of the Houses made their own marmalade. One of these made 175 lbs. of marmalade from 84 lbs. of sugar, and the other made

784 lbs. from 516 lbs. of sugar. So I assumed as a working basis of calculation a mean, viz. 1 lb. of sugar to 1.75 lbs. of marmalade. I have no reason to suppose that this is an overestimate.

Syrup I have regarded as pure sugar though it contains a small percentage of water.

Honey also I have regarded as pure sugar since only dropped honey is used in the School. The amounts of honey used were small, never exceeding half an ounce per week per head.

(b) Results.

On this basis the following results were obtained.

430 persons (including resident staff and domestic servants) consumed in a term of 12 weeks 8402½ lbs. of sugar, or 700 lbs. a week. That is to say that, on an average, each person consumed 1.69 lbs. per week or 87.88 lbs. per annum. It is to be noted that the estimate did not include "sweets" or any of the sugar contained in articles bought, such as sweet cakes and tinned fruits, of which a large quantity is used in each House. The allowance of "sweets" varies slightly in the different Houses but it never falls below ¼ lb. per week, so that with this item added, the average consumption of sugar is in the neighbourhood of 2 lbs. per head per week. The Houses varied widely in their rate of consumption of sugar - from 67 lbs. to 116 lbs. per head per annum.

It is of interest to note that the number of severe catarrhs in the House with the lowest consumption of sugar was about one third of the number in any other House. In this House, which consumed 1.29 lbs. per week the incidence of catarrhs of over seven days duration was 5.5% of the population of the House. In a House which consumed 2.23 lbs. per week the incidence was 24.3%.

E. The Consumption of Sugar Excessive.

There can be little doubt that such a rate of consumption is excessive when we reflect that in order to add 2 lbs. a week of cane sugar to the rest of our diet from natural sources we would have to consume 11.1 lbs. of sugar cane or 15 lbs. of sugar beet.

Certain factors encourage the excessive use of cane sugar.

1. Its pleasant taste.
2. Its small bulk in comparison to other food stuffs.
3. The complete absence in it of any of the accessory food factors such as vitamins, salts, etc. which contribute to the satisfaction of appetite.
4. Its cheapness and portability.

Direct evidence that the consumption of 90 lbs. to 100 lbs. per annum of Cane Sugar is excessive is not, however, wanting.

Detection of Cane Sugar in the Urine.

Cane Sugar is inverted by hydrochloric acid in the stomach and by invertase in the intestine into two sugars - dextrose (glucose) and laevulose (fructose). This inversion is very rapidly effected and is supposed to be complete, unless the amount of sugar ingested is very large. Macleod (22), for example, states that after ingestion of Cane Sugar to the amount of 0.5% of the body weight, some of it appears in the blood and is excreted unchanged in the urine for six or seven hours. It is evident, therefore, that the inverting powers of the digestive juices are not unlimited. So far as I am aware the renal threshold for Cane Sugar is not known. Hutchison (25) states that, being a useless substance, it is excreted as soon as it reaches the blood.

While such experiments as Macleod's tell us the effect of a single massive dose, they give no indication of the results likely to accrue from the consumption of considerable quantities of Cane Sugar three or four times daily as a routine.

An attempt was, therefore, made to determine whether there is evidence of escape of Cane Sugar into the urine of girls who consume the quantity of sugar above recorded.

Method.

The method adopted was based upon

(a) the detection of reducing sugar in urine after boiling with dilute hydrochloric acid. (This would invert any Cane Sugar present into reducing sugar).

(b) the detection of laevulose as a proof that any reducing sugar found was derived from Cane Sugar.

The following routine was applied to each specimen of urine examined.

1. The urine was tested for the absence of reducing sugar - 1 c.c. being boiled with 1.2 c.cs. of Fehling's Solution. This proportion was chosen so that any excess of acid present in the hydrolysed specimen to be examined later would be neutralised.
2. The urine was subjected to hydrolysis. To 1 c.c. of urine a drop of 30% HCl. was added and the mixture was then boiled. By this means any Cane Sugar present would be inverted.
3. The hydrolysed specimen was tested (as in 1) for reducing sugar.
4. 1 c.c. of urine was heated to boiling point with an equal quantity of a 2% solution of resorcin in 20% HCl. as a test for the presence of laevulose. (Seliwanoff's test).

In order to check the reactions obtained with this reagent (No.4) the following experimental solutions were tested with it.

1. 0.2% aqueous solution of Laevulose.

This gave a rose pink colour.

2. 0.2% solution of Laevulose in 2% solution of urea.
This gave a brownish pink colour.
3. 0.2% aqueous solution of dextrose.
This gave no colour reaction.
4. 0.2% solution of dextrose in 2% solution of urea.
This gave a yellow colour.
5. 0.2% solution of laevulose + 0.2% solution of dextrose in a 2% solution of urea. This mixture was chosen as representing the state of affairs which would be present in a urine containing hydrolysed cane sugar. This gave a dark mahogany brown reaction with some precipitation. On dilution with an equal quantity of ethyl alcohol the precipitate was dissolved and a transparent dark mahogany brown solution resulted.

Results.

Urines which, after hydrolysis, reduced Fehling's solution were found to give, with Acid resorcin, colour reactions which exactly corresponded to those obtained with various dilutions of the experimental solution 5, so that the amount of laevulose present could be roughly estimated.

In no case did a urine which failed to give reduction after hydrolysis give a positive resorcin test.

An unselected series of 57 urines were tested according to the routine plan above described, with the following results:-

- (a) 56 did not reduce Fehling's solution.
 - (1) 28 of these, after hydrolysis, reduced Fehling's solution and each gave a positive resorcin reaction - the depth of colour obtained being roughly proportional to the degree of reduction observed.
 - (2) 28 showed no reduction of Fehling's solution after hydrolysis. Each gave a negative resorcin reaction.
- (b) One specimen in the series showed slight reduction of Fehling's solution before hydrolysis, which was not apparently increased after hydrolysis. It also gave a slight but definite positive reaction with resorcin. While it is admitted that other ketone bodies might give this result, it is probable that there was free laevulose in this specimen.

A few girls who showed the positive reaction for laevulose after hydrolysis were admitted to the Hospice and Sugar was, as far as possible, excluded from their diet. After 12 or 24 hours, reduction of Fehling by hydrolysed urine ceased and the resorcin test became negative. Indeed it was very rare to

obtain a urine with a negative reaction until all Sugar was excluded from the diet.

The detection of reducing sugar in urines after hydrolysis, coupled with the fact that a positive reaction for laevulose, proportional to the amount of reduction, was given by all such urines, affords proof of the presence of Cane Sugar.

Cane Sugar was present in the urine, and therefore in the blood, of the majority of the girls consuming the above allowance of sugar - indicating that the mechanism by which it should be completely inverted before absorption was inadequate for the amounts ingested.

It may be concluded that the amount of Cane Sugar ingested by those individuals (about 100 lbs. per head per annum) is excessive.

The Sources of Blood Sugar.

Apart from small amounts of such sugars as glucose and fructose (laevulose), consumed as honey or as fruit, the principal carbohydrate foods from which blood sugar is derived consist of starch-containing vegetables and Cane Sugar. From the former, dextrose (glucose) is the ultimate product which therefore forms the bulk of the sugar absorbed after ingestion of starch. Cane Sugar, on the other



hand, is inverted into equal parts of dextrose (glucose) and laevulose (fructose). From no other food is laevulose derived in so great a quantity.

Little is known of the fate of laevulose in the blood beyond the fact that after ingestion of 50 grammes of laevulose no rise of blood sugar occurs such as follows the ingestion of a similar quantity of glucose (dextrose). If the liver is damaged, the ingestion of laevulose is followed by a rise of blood sugar similar to that which follows ingestion of glucose (24). From these facts it is usually inferred that the laevulose is abstracted from the portal blood by the liver and converted by it into glycogen.

The renal threshold for laevulose is not known. In several of the series of urines examined I found evidence of the presence of reducing sugar, but in none of these was the reduction of Fehling's solution more than slight. That is to say, the reaction obtained was only a greenish tinge with some precipitation. This may have been due to the presence of a trace of laevulose, since each urine in which it was found did not have its reducing power apparently increased after hydrolysis and gave a slight positive resorcin reaction. The instances were so few that no certain conclusion can be derived from them.

It is evident, however, that, when equal quantities of dextrose and laevulose are present in the portal blood, the greater activity of the liver in regard to the latter may permit more of the former to reach the systemic blood than if no laevulose was present. If this is so, the ingestion of Cane Sugar will tend to permit an undue amount of dextrose to reach the systemic blood - although not sufficient to invade the renal threshold. When this state of affairs is repeated three or four times daily it is not improbable that the blood sugar may be constantly maintained above the true fasting level.

If, in addition to this, unhydrolysed Cane Sugar is also present in any quantity, the amount of water necessary to hold the two sugars must be considerable. McClenden (26) has shown that as a result of administration of glucose in a nondiabetic person a high water retention resulted. The same author (27) reports an increase in blood volume after experimental feeding on large quantities of glucose and finally the production of weeping eczema. Oedema was produced in the skin of a mouse by glucose feeding.

The thirst induced by the ingestion of much sugar is familiar to everyone.

Excessive intake of sugar will, therefore, produce that state of the body which Cameron (17) describes as characteristic of children of the

exudative diathesis, and as rendering the oedematous mucous membranes specially susceptible to the catarrhal state.

Summary Part II.

- (a) A reduction in the catarrhal illness in School occurred during the period of rationing. This reduction was also evident as regards catarrhal complications of Influenza.
- (b) Evidence from various sources shows that excessive carbohydrate consumption is associated with an increase in susceptibility to catarrhal illness and that restriction of carbohydrates benefits the catarrhal state of children of the exudative diathesis. Some of this evidence indicates that Cane Sugar is more active than the starches in lowering resistance to the catarrhal processes.
- (c) The national consumption of sucrose (cane and beet sugar) has increased in a century from 17 lbs. per head per annum to 90 lbs. per head per annum, without any corresponding reduction in the use of starchy foods.

- (d) The national consumption of Cane Sugar was much reduced during the period of rationing in the Great War.
- (e) The consumption of Cane Sugar in School is at the rate of about 100 lbs. per head per annum.
- (f) Cane Sugar has been demonstrated in the urine of most girls on the above allowance of sugar.
- (g) The School House with the lowest consumption of sugar had the lowest catarrhal rate in the School.

Conclusions.

It is concluded therefore that:-

- (a) The amount of Cane Sugar (Sucrose) consumed (90 to 100 lbs. per head per annum) is excessive.
- (b) This excess leads to fluid retention in the body and the resulting oedema of the mucous membranes renders them less resistant to the catarrhal state.
- (c) It is not known whether the increased liability to catarrh is due to increased susceptibility to infection or to diminished resistance to the catarrhal process, once it has been established.

It seems probable that both these factors are active, the low vitamin and salt content of a carbohydrate diet lowering resistance to infection and a high blood sugar tending to prolongation of the catarrhal process.

- (d) It is improbable that the harmful effects of excessive use of Cane Sugar are limited to the aggravation of the catarrhal process.

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General Conclusion.

The increase of catarrhs in schools of recent years is associated with two factors:

1. The increased prevalence of Influenza since 1918 (see Part I).
2. The excessive consumption of carbohydrate food and especially of cane sugar (see Part II).

Of these two factors the second is of greater importance in that it increases the duration and

and danger of all catarrhs, including those which complicate Influenza.

The maximum consumption of sugar consistent with health is still to be ascertained, but it is suggested that it is in the neighbourhood of $1\frac{1}{2}$ lbs. per week. The optimum consumption is probably considerably lower.

While cane sugar is of value as a source of muscular energy, it cannot be used as a substitute for natural carbohydrates in the diet since it is devoid of vitamins, salts and indeed all accessory food factors.

A considerable improvement in national morbidity and mortality might be expected from a reduction in the consumption of cane sugar.

REFERENCES

- (1) Glover "Some observations on naso-pharyngeal epidemics in Public Schools." Proceedings of the Royal Society of Medicine - Section of Epidemiology and State Medicine. June 22, 1928. p.1594.
- (2) Lempriere "The Health of the Public School Boy." The Journal of State Medicine. Feb.1928 Vol.XXXVI. No.2. p.79.
- (3) Paton Reports of the St.Andrews Institute for Clinical Research. Vol.I. pp.148 to 182
- (4) Paton Reports of the St.Andrews (James Mackenzie) Institute for Clinical Research Vol.II. pp.160 to 169.
- (5) Paton Reports of the St.Andrews (James Mackenzie) Institute for Clinical Research Vol.III. pp.126 to 138.
- (6) Goodhart System of Medicine. Clifford Allbutt. Vol.I. p.679.
- (7) Bain A Textbook of Medical Practice. p.889.
- (8) Koplinski Medical News. June 1. 1901.
- (9) Bradley "The Tonsils and Nasopharyngeal Epidemics." Archives of Disease in Childhood. Oct.1930. p.335.
- (10) British Medical Journal. 5:3:27. p.440.
- (11) Dudley Medical Research Council. Special Report Series. No.75.
- (12) Shelley British Medical Journal. April 15. 1893.
- (13) Bloomfield & Harrop John Hopkins Hospital Bulletin.
- (14) Oxford Medicine. Vol.IV. p.828.
- (15) Olitsky & Gates Journal Exp. Medicine. 1921. Vol.XXXIII. p.713.
- (16) Matthiasson Medical Science Abstracts and Reviews. Vol.IV. No.4. p.276.

References (continued).

- (17) Cameron, C.H. Diseases of Children. 1926.
Chap.IX.
- (18) Maitland Ramsay Diathesis and ocular diseases.
1909. pp.23, 24.
- (19) Maitland Ramsay The Eye in General Medicine.
1929. Chap.II, p.24.
- (20) Paton Edinburgh Medical Journal.
Aug. 1931. p.477.
- (21) Orr and Gilks Medical Research Council.
Special Report Series No.155.
- (22) Orr, Macleod Lancet. May 30th, 1931, p.1177.
and Mackie "Studies on Nutrition in re-
lation to immunity."
- (23) Macleod Physiology and Biochemistry in
Modern Medicine. 1920. p.690.
- (24) MacLean "Modern Methods in the diagnosis
and treatment of Glycosuria
and Diabetes." 1927. p.25.
- (25) Hutchison Food and the principles of
dietetics." 1929.
- (26) McClenden Journal of Biological Chemistry.
1930. Vol.87, VII.
"Carbohydrates, volatile fatty
acids, water retention and
clinical symptoms."
- (27) McClenden Journal of Biological Chemistry.
1931. Vol.92, XIX.
"The relation of glucose to
water retention."