(57%), 6 of 16 middle cases (37%), and 1 of 10 advanced cases (10%).

Ten cases received intramuscular therapy only (in the early part of our work), and two survive. Four cases received intramuscular therapy followed by combined therapy: one of these survives.

Important factors operating against success are vascular changes in the brain and hydrocephalus. Further work is essential to assess the value of surgical intervention to combat the hydrocephalus.

Strains of *M. tuberculosis* isolated from 43 patients have not shown resistance to streptomycin.

Eighteen cases (33%) survive, and of these 16 show full clinical recovery—14 having entirely normal C.S.F. and 2 showing slight abnormalities. Two survivors have a history of relapse and show definitely abnormal C.S.F. The diagnosis has been confirmed bacteriologically in all except one of the survivors.

Apart from streptomycin, the most important aids to successful treatment are the rapidity of diagnosis and the quality of the nursing.

The value of intrathecal sulphatrone in addition to streptomycin is now being investigated.

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NASAL CARRIERS AND STREPTOCOCCAL TONSILLITIS

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In discussing the possible sources of streptococcal infection in puerperal fever Colebrook (1933) considered that the nasal carrier might prove of greater danger than the throat carrier. Hamburger (1944), in a study of the transmission of streptococcal infection in Army hospital wards, showed that the incidence of cross-infections did not necessarily show a close correlation with the throat-carrier rate and suggested that some carriers were more likely to spread infection than others. Further studies by Hamburger and his associates demonstrated not only that many more streptococci were expelled into the environment by nasal carriers than by throat carriers (Hamburger *et al.*, 1945a), but also that the majority of hospital cross-infections studied could

be traced to heavy nasal carriers (Hamburger *et al.*, 1945b). Their findings led to an investigation of the relative importance of nose-blowing, sneezing, and coughing by nasal carriers in the dissemination of streptococci; it was shown that blowing the nose expelled the largest numbers of organisms and also resulted in sudden and heavy contamination of the hands (Hamburger and Green, 1946). These workers concluded that in certain situations, such as hospital wards, Army barracks, and boarding-schools, nasal carriers were of more importance in the spread of streptococcal disease than throat carriers because they caused a greater degree of environmental contamination. In such communities secondary reservoirs of infection—e.g., dust and bedding—are probably of special significance, and the part played by dormitories in the spread of scarlet fever, diphtheria, and streptococcal tonsillitis has been demonstrated (Dudley, 1923, 1926; Hamburger *et al.*, 1945b).

The outbreak of tonsillitis to be described illustrates the importance of both the nasal streptococcal carrier and the dormitory in the spread of infection in a residential school over a period of two terms. Symptoms were mild, complications few, and there were no rashes. Recovery was rapid and boys were usually discharged from the sanatorium in five to seven days.

The Outbreak

The school of 340 boys is housed in five separate buildings, which will be referred to as houses A–E. Each house has its own sleeping accommodation and common-rooms. D house has its own dining-room, but the boys from all other houses feed in the dining-room of A house, though each house has its own table. The classrooms are in a separate building and are shared by all the boys. Thirty-two of the 57 cases occurred in A house, where the sleeping accommodation consists of six dormitories holding 48 boys and 85 single rooms, the latter chiefly occupied by older boys. The boys of this house, whether sleeping in dormitories or in single rooms, mix freely with each other in the common-room and to some extent with the members of B, C, and E houses at meal-times. All boys meet other members of the school during classes, games, chapel, etc.

Epidemiology

The first case, H., occurred in A house on Feb. 16, 1948, and was admitted to the sanatorium with a sore throat and fever. A throat swab examined by another laboratory showed the presence of haemolytic streptococci, but these were not typed at that time, though later swabs grew haemolytic streptococci type 12. This boy returned to the school on Feb. 26; two days later a fresh case was reported, and further cases continued to occur almost daily till the end of the term on March 25. Cases of streptococcal tonsillitis due to the epidemic type were again observed within a few days of the beginning of the summer term, and 20 further cases among the boys occurred during this term, eight of them within the first two weeks. The last of these became ill on July 3. The accompanying Chart shows the daily incidence of cases of tonsillitis among dormitory and single-room boys of A house and the rest of the school. The overall pattern suggested an initial spread through A house, boys in dormitories especially being attacked, with a gradual extension to other houses towards the end of the Easter term. This general spread was continued during the following term until all houses had at least one case.

In all, 57 boys were attacked with acute tonsillitis—37 in the Easter and 20 in the summer term. Of the 37 cases in the first term 29 were in A house. The incidence of disease among boys in A house and the rest of the school for each term is shown in the Table, A house being divided

Table showing Incidence of Cases among Boys in A House (Dormitories and Single Rooms) and in Rest of School during Easter and Summer Terms

House	No. at Risk	No. Attacked		
		Easter Term	Summer Term	Total
A (dormitory) ..	48	19 (39.5%)	2 (4.2%)	21
A (single rooms) ..	85	19 (11.8%)	1 (1.1%)	11
B, C, D, E ..	207	8 (3.9%)	17 (8.2%)	25
Total ..	340	37 (10.9%)	20 (5.8%)	57

into those boys sleeping in dormitories and those in single rooms. During the Easter term the attack rate for boys in A house sleeping in single rooms, while higher than that for the rest of the school, was considerably lower than the attack rate for the dormitory boys. This difference is statistically significant; the probability of its occurring by chance is less than one in a thousand. The attack rate for each of the six dormitories in A house varied from 0 to 73%, though the numbers upon which these results are based are small. In addition to the 57 boys, five members of the staff had tonsillitis—two in A house during the Easter term and three in other houses the following term.

Field and Laboratory Investigations

The aid of the laboratory was sought in the early days of the epidemic, when the majority of cases were from the dormitories of A house. It was therefore decided to take nose and throat swabs from all cases still in the sanatorium and from boys sleeping in the dormitories of A house. This was done on March 12, and further swabbing of new cases and carriers was repeated at intervals till the end of the term.

Grouping and typing were carried out the first time haemolytic streptococci were isolated from the nose or throat of any boy and on all subsequent isolations, except when the interval between swabbings was only a few days. All strains were typed at the laboratory by Griffith's slide agglutination technique and reacted with sera of types 5 and 12. The type was confirmed as type 12 by Lancefield's precipitin method in a number of strains examined from cases and carriers.

Streptococcus pyogenes, type 12, was isolated from 43 out of 57 boys either during their illness or, in some of the earlier cases, after their return to school. Most of the cases with negative swabs were undergoing local chemotherapy at the time the swabs were taken. The epidemic strain was isolated from the five members of the staff who became ill. It was also readily obtained from the dust of two dormitories and two day-rooms in house A during the Easter term and from the dust of one of these dormitories towards the end of the Easter holidays.

Preventive Measures

These were directed towards reducing the dust content of the school buildings and sterilizing the noses of persistent carriers. Thorough suction-cleansing and scrubbing of the premises were carried out during the Easter holidays

together with oiling of dormitory and common-room floors in A house. During the summer term all known nasal carriers and some throat carriers were each treated with penicillin-sulphathiazole snuff and penicillin throat sprays four times a day for fourteen days. The boys continued with their usual school activities during this time. The results of treatment are discussed later.

The Association of Nasal Carriers with New Cases

During the time the first case (H.) was in the sanatorium no further cases of tonsillitis developed in the school, but two days after his return to school a second boy became ill, followed by another six in the next three days. When H. was first swabbed fifteen days after his return from the sanatorium he was found to be a heavy nasal carrier, and it is reasonable to assume that he had been carrying streptococci in large numbers in his nose since his release.

A study of the distribution of 19 cases and four contact carriers among the six dormitories in house A showed

Chart showing daily incidence of new cases of tonsillitis among boys for the Easter and summer terms.

that 18 of these occurred in three dormitories with a total population of 28 boys and only five in the other three dormitories housing 20 boys. The attack rates for these two groups were 64 and 25% respectively. The first case in each of the three dormitories comprising the first group was found to be a heavy nasal carrier (at the time of the general swabbing of boys in the dormitories) and at least one heavy nasal carrier was present in each dormitory during the time streptococcal infections were occurring. Nasal carriers were not found in any of the three dormitories of the group with the low attack rate, except in one dormitory for the last four days of the term.

Throughout the summer term only three nasal carriers from the previous term were detected; a fourth carrier was later identified when a boy with a nasal discharge was swabbed. Only one of these boys slept in a dormitory (one of those heavily infected the previous term), and all four carried for a short time only and responded well to a course of local chemotherapy. During this term the incidence of tonsillitis throughout the school was lower than during the previous term and no dormitory outbreaks occurred.

Persistence of the Carrier State

The work of Lemon and Hamburger (1946) has suggested that most symptomless nasal carriers are missed cases and that true contact carriers are unusual. No mass swabbing of the school was carried out, and it was not possible to form any estimate of the probable carrier rate, though six out of 33 dormitory contacts were carrying streptococci in the nose or throat on the occasion of the swabbing of all dormitory boys on March 12. Two of these developed tonsillitis three days later.

Type 12 streptococci were isolated from 35 boys during their illness—in 13 cases from the nose and usually from the throat, and in 22 from the throat only. Twenty-three of the 35 boys were swabbed ten days later; streptococci were obtained from the nose of three out of eight boys

previously carrying in the nose, and from the throat of 11 out of 15 boys carrying only in the throat.

Twenty-five boys were carrying type 12 streptococci in the nose or throat when last swabbed at the end of the Easter term. Twenty-one were re-swabbed six weeks later at the beginning of the following term and 12 were still carriers of the epidemic type—three in the nose and throat and nine in the throat only. The three nasal carriers and five of the throat carriers were each treated for fourteen days with penicillin-sulphathiazole snuff and penicillin throat sprays and all 12 carriers were re-swabbed at the end of the term. All the nasal swabs were then negative, though two of the eight treated boys and three of the four untreated boys were still carrying in the throat.

One boy had a clinical attack of tonsillitis in both the Easter and the summer term, and type 12 streptococci were isolated from the throat on each occasion. This boy was not one of those swabbed at the beginning of the summer term, so it is not known whether he was a throat carrier from the previous term. This experience is unusual and contrary to previous reports. The second attack was less severe than the first and streptococci were isolated in small numbers only, so it is possible that this illness was not primarily a streptococcal infection. The serum of this boy was not examined for anti-streptolysin titres.

Presence of M Substance

Typing by the precipitin technique was attempted on 10 strains isolated from throat carriers at the end of the summer term and seven gave a positive reaction. This was particularly well marked in strains from three boys who had been carrying for at least 130 days; strains from four new cases in the summer term gave either weak or negative results. These findings are of particular interest in view of the degradation or progressive loss of M substance during the carrier state found by Rothbard and Watson (1948). In this outbreak typing by the precipitin technique was done on only a small number of strains, but a greater proportion of weak or negative results were obtained with strains isolated from boys infected at the end of the epidemic than with those from the earlier cases. The clinical symptoms were also less severe in the later cases.

Discussion

The pattern of the daily incidence of new infections (see Chart) suggests that the epidemic spread fairly rapidly through A house during the three weeks after the return of H., a heavy nasal carrier. By the end of the Easter term it had extended to boys in other houses, and it continued in the rest of the school the following term. During the first 18 days after the return of H. 17 new cases occurred among the boys in dormitories and nine among those in single rooms, the number at risk being 47 and 85 respectively. Thirteen of the 17 dormitory cases occurred in three dormitories where 27 boys were at risk. It is clear that during this time boys in dormitories suffered more heavily than the others and that most of the cases came from three of the six dormitories.

Glover (1920) has drawn attention to the importance of overcrowding in sleeping-quarters as a factor in the production of high carrier rates in cerebrospinal fever. The relation of dormitories to the spread of scarlet fever and diphtheria in naval training establishments was later shown by Dudley (1923, 1926). It is possible that the closer contact of the dormitory boys, together with their younger age, was partly responsible for their high attack rate compared with those boys sleeping in single rooms. On the other hand, not all those dormitories were heavily attacked (in one dormitory no case occurred), although the spacing of

beds, general ventilation, and ages of the boys in each were similar.

It is significant that during the eighteen days when most of the cases in A house occurred nasal carriers were associated with each of the three dormitories most heavily attacked and were not detected in the others. The first case in each of these dormitories was subsequently identified as a nasal carrier, and it was only after this boy's return to the dormitory that other cases occurred. In fact, a heavy nasal carrier was present in each of these dormitories during the time all except one of the boys became ill. One or more boys were carrying large numbers of streptococci in the nose for at least sixteen days in each of these three dormitories, and it is likely that a heavy streptococcal contamination of the environment took place during this time.

Streptococci of the epidemic type were readily isolated from the dust before the majority of dormitory infections had occurred. In addition to the possibility of infection being transmitted more or less direct from the carrier, the dormitory population was thus also exposed to the further risk of a heavily infected environment for several hours each night. Considerable dispersal of streptococci into the air and on to exposed clothing from floor dust and bedding would take place when the boys entered the dormitory at night and again during bed-making in the morning, and the attack rate under these conditions is likely to be high. The beds of the cases were not necessarily adjacent or in close proximity to the bed of the carrier, and the scattered spatial distribution of cases in the dormitories suggested general contamination of the environment. A study of the streptococcal content of the air and environment in wards and barracks occupied by streptococcal carriers has shown that the dispersal of organisms is commonly widespread and not limited to the vicinity of the beds occupied by carriers (Lemon, Loosli, and Hamburger, 1948). In this outbreak neither the streptococcal content of bedclothes or air nor the ability of the nasal carriers to infect their environment was investigated.

Out of 57 cases, however, only 15 came from the three dormitories heavily attacked during the Easter term. The remaining 42 were either boys sleeping in single rooms or sporadic cases in different dormitories. It seems evident, therefore, that a heavily infected dormitory environment was not the chief mechanism by which infection was conveyed to most of the school. Type 12 streptococci were recovered from the dust of the common-rooms in A house during the Easter term, and no doubt other infected environments played a part in spreading disease. All recognized nasal carriers were successfully treated in school during the summer term, but 12 fresh cases occurred during and after their period of treatment before the outbreak ceased. No swabbing of contacts was done during this term, and it is possible that an undetected carrier was responsible for the continuance of cases. Other factors concerned with the spreading of disease may have been infected dust in classrooms, the breathing of air infected by nose-blowing or the use of handkerchiefs, or the transmission of organisms from clothing or hands, either direct or from inanimate objects (Brown and Allison, 1937; Hamburger and Green, 1946; Dumbell *et al.*, 1948; Duguid and Wallace, 1948).

Epidemics of streptococcal tonsillitis in boarding-schools usually run on in the form of "dropping" cases to the end of the term (M.R.C., 1938), and this outbreak proved no exception. The occurrence of streptococcal infections of the same type in successive terms is not unusual, and Boissard and Fry (1944) attributed cases of scarlet fever in the autumn term and the following summer term to the same heavy nasal carrier. This boy was away from school for the intervening term, during which no cases occurred.

Experience of this and other epidemics has shown the frequent association of heavy nasal carriers with outbreaks of streptococcal tonsillitis in residential schools. It is important that nasal as well as throat swabs should be obtained from all cases, however mild; heavy nasal carriers should be treated until their swabs are negative. This is especially necessary with the single case or in the early stages of an outbreak before widespread contamination of the environment and the build-up of a carrier rate has occurred. During the holidays every effort should be made to sterilize the noses of persistent carriers and to disinfect school premises.

Summary

The epidemiological and bacteriological findings in an outbreak of streptococcal tonsillitis in a residential school are described. The outbreak extended over two terms, and 57 out of 340 boys were attacked.

All the early cases were in the same house as the first case, a heavy nasal carrier. A nasal carrier was also associated with each of the three dormitories with the highest attack rates during the time fresh infections were occurring. In most cases, however, the dormitory did not appear to be of special importance in the spread of disease, and the significance of this is discussed.

The early detection and isolation of heavy nasal carriers before widespread dispersal of infection has occurred is emphasized.

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SPONTANEOUS PERFORATION OF THE OESOPHAGUS

SURGICAL REPAIR, WITH RECOVERY

BY

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This rare condition has been the subject of a number of papers, chiefly dealing with single case reports. It is probable that it is not so uncommon as is supposed. Thus Eliason and Welty (1946) were able to record three cases seen by the senior author in the space of twelve months. The mortality until recently has been 100%, but Barrett (1947) and Olsen and Clagett (1947) have recorded recoveries after immediate operative intervention and repair.

In view of these successes it seemed timely to review the condition once more and to put on record two further cases, the second of which represents the third recovery that can be found in the literature; for, as Eliason and Welty (1946) say, "with improved techniques in anaesthesia, freer use of blood and plasma and effective chemotherapeutic agents, the limiting factor in the treatment of this condition is that of diagnosis."

Case 1

A man aged 41 was admitted to the West Middlesex Hospital at 4.30 a.m. on Dec. 10, 1941, with a diagnosis of perforated gastric ulcer. He had always enjoyed good health, apart from occasional indigestion, till 8.30 p.m. the previous day, when after a bout of vomiting he was stricken with severe pain in the lower chest and lumbar regions. A large midday meal of sausage pie was the only explanation the patient could give for the initial vomiting. There was no history of alcoholism. The pain, which was intense, had become more widespread; it was especially felt in the scapular regions and was made worse on breathing. His only other complaints were severe dyspnoea and an inability to lie flat in bed. The temperature was 101.2° F. (38.4° C.), pulse 100, and respirations 64. The blood pressure was 130/100.

Examination on admission revealed a cyanosed, breathless man of rather stout build. His breathing was shallow and obviously painful. At this time no abnormal physical signs were found in the lungs or cardiovascular system. His tongue was moist. The abdomen was tense and rigid but not tender. Rectal examination was negative. The diagnosis was thought to rest between a coronary thrombosis, lobar pneumonia, diaphragmatic pleurisy, and a ruptured oesophagus.

Morphine, $\frac{1}{4}$ gr. (16 mg.), was given and the patient placed in an oxygen tent. A radiograph of the chest taken four hours later revealed a bilateral pleural effusion, but further detail was obscured by respiratory movement, the patient being unable to hold his breath. By this time, some twelve hours after the onset of the catastrophe, the effusions were quite obvious clinically, and well-marked surgical emphysema had begun to develop in both supraclavicular triangles and was extending on to the chest wall. A confident diagnosis of spontaneous rupture of the oesophagus was made. The patient's condition, however, rapidly deteriorated and he died at 6 p.m. on the day of admission—i.e., about 22 hours after the onset of his illness. Before death the surgical emphysema had involved the whole of the upper half of the body and had closed both eyes. It was noted at the time how little relief this patient obtained from repeated doses of morphine.

Necropsy revealed a linear rupture 1 in. (2.5 cm.) long on the anterior aspect of the oesophagus $3\frac{1}{2}$ in. (8.75 cm.) from the cardia. A large quantity of fluid was present in the posterior mediastinum, and 24 oz. (680 ml.) of blood-stained turbid fluid was found in the right pleural cavity and 18 oz. (510 ml.) in the left. No direct communication could be demonstrated between the mediastinum and pleural cavities. Apart from the tear the oesophagus had no disease of any kind, and the rest of the necropsy was essentially negative.

Case 2

A woman aged 63 was admitted to the West Middlesex Hospital on Dec. 1, 1947, with a diagnosis of ? perforated peptic ulcer. After a heavy meal of tinned meat, cheese, and milk at 8 p.m. the previous day she had vomited twice, and this was rapidly followed by agonizing pain starting in the region of the upper part of the sternum and rapidly spreading to the epigastrium. The pain, which was severe and constant, was made worse by breathing and movement. There was no history of previous indigestion or alcoholism.

Examination revealed a pale, dyspnoeic, rather stout woman in extreme shock. The temperature was 100.8° F. (38.2° C.), pulse rate 124, and respirations 32. The blood pressure was 85/60. The trachea was centrally placed; there were rales at the left base and dullness at the right base. Surgical emphysema was present over the upper sternum. The heart appeared normal. There was rigidity of the whole anterior abdominal wall, with pronounced tenderness in the epigastrium. Normal peristaltic sounds were audible and rectal examination was negative.

She was seen by Dr. J. A. Torrens, who suggested the diagnosis of ruptured oesophagus, and exploratory thoracotomy was advised in spite of the patient being in *extremis*.

It was decided to explore the right chest in view of the effusion on this side, and accordingly a large segment of the eighth right rib was resected and an excellent exposure obtained by means of rib-spreaders. At least 2 pints (1.14 litres) of