summarized and extended by a survey of the incidence of trichinosis in 200 necropsies at four hospitals in London, covering a representative selection of districts and population classes in and around London.

The scarcity of previous records and the present findings of an incidence of 1 per cent. indicate that trichinosis is uncommon in Great Britain. Both cases found in the present survey had light infections, but the infection was endemic.

The system of pig-rearing in this country is such that swine can have little chance of acting as infective bearers of trichinosis, but imported bacon may form a slight source of infection.

The general level of hygiene and habits of the British peoples probably plays the principal part in reducing risk of infection.

In conclusion it is a pleasure to thank Professor G. P. Wright and the staff of Guy's Hospital pathology department; Professor H. M. Turnbull and the staff of the pathology department of the London Hospital; Professor J. McIntosh and the staff of the Bernhard Baron Institute of Pathology, Middlesex Hospital; and Dr. G. R. Cameron and the staff of the pathology department of University College Hospital, for generous assistance and co-operation in providing material from necropsies carried out at these hospitals. Mr. W. McDonald of the helminthology department of the London School of Hygiene and Tropical Medicine kindly made a number of the examinations in my absence, and Mr. Nicholson, laboratory assistant in the same department, gave valuable assistance in the routine work connected with these examinations.

The Ministry of Agriculture and Fisheries and the Ministry of Health generously supplied information concerning the system of pig-rearing and meat inspection in this country. I have also to thank the Imperial Bureau of Agricultural Parasitology for tracing most of the published records of trichinosis in Great Britain.

This work was carried out under a Medical Research Council grant to Professor R. T. Leiper, F.R.S., to whom my sincere thanks are due.

REFERENCES

- Bellingham, O'B. (1852). *Dublin med. Pr.*, **27**, 51.
Cobbold, T. S. (1879). *Parasites*, London.
Curling, T. B. (1835-6). *Lond. med. Gaz.*, **17**, 768.
Hall, M. C., and Collins, B. J. (1937). *Publ. Hlth. Rep., Wash.*, **52**, 468.
— (1937). *Ibid.*, **52**, 539.
— (1937a). *Ibid.*, **52**, 873.
Hardy, T. W. (1927). *Lancet*, **2**, 1380.
Harris, J. D. (1909). *Ibid.*, **1**, 1381.
Herzberg, E., and Vitenson, I. (1930). *British Medical Journal*, **1**, 650.
Hickling, R. A. (1931). *Ibid.*, **2**, 654.
Jones, W. M. (1889). *Ibid.*, **2**, 658.
Paul, H. (1927). *Med. Off.*, **37**, 144.
Rice, D. A., and Williams, H. O. (1922). *Lancet*, **2**, 799.
Sutherland, L. R. (1897). *Trans. Glasg. path. clin. Soc.*, **7**, 19; also *Glasg. med. J.*, **48**, 444.
Topham, J. (1850). *Lancet*, **1**, 45.
van Someren, V. D. (1937). *J. Helminth.* (in press), **15**, 4, 177.
Wood, H. (1835). *Lond. med. Gaz.*, **16**, 190.

G. F. Göthlin (*Acta paediatr.*, Stockh., October, 1937, p. 71) gives an account of the employment of the capillary fragility test for judging the effectiveness of the supply of vitamin C in adults and in children. It was found that in certain parts of Sweden there were school children who, although not ill, exhibited during the late winter and the spring a fragility of their cutaneous capillaries due to a deficiency of this vitamin in their diet. These children had a normal capillary resistance in the summer. This test is of value when there are no resources for estimating the amount of ascorbic acid in the blood, but can only be applied to fairly healthy persons. If the findings of a first test are doubtful ascorbic acid is given for a week and the test repeated. A detailed account of how to apply the test is given.

PREVALENCE OF MIDDLE-EAR DISEASE IN ELEMENTARY SCHOOL CHILDREN

OTOSCOPY AS AN ADJUNCT TO ROUTINE MEDICAL INSPECTION*

BY

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In this investigation an attempt has been made to assess the prevalence of middle-ear disease in elementary school children seen at routine medical inspections.

The Chief Medical Officer to the Board of Education referred in his report for the year 1934 to a particular symptom of middle-ear disease, otorrhoea, and explained that the ordinary methods of routine medical inspection give an understated assessment of its prevalence useful only for comparative purposes from year to year. A section of this report may be quoted here:

"An ear may have no discharge for a long period, and be apparently cured, yet as the result of slight nasopharyngeal infection—for example, a common cold—or often from no ascertainable cause, the ear may begin to discharge again. The system of routine medical inspection therefore only detects those cases that have active otorrhoea at the time of examination, and since as a rule it does not include a detailed examination of the ear, even some of the active but slight cases may be missed. Were an examination of the ears by an electric auriscope included in routine medical inspection there is no doubt that more cases of slight otorrhoea and potential otorrhoea would be discovered. The practicability of amplifying routine medical inspection in this way should receive consideration by school medical officers."

The Incidence of Otitis Media

This opinion is supported by evidence supplied by Dr. W. A. Bullough, school medical officer for Essex, whose report for 1934 contained an account of an investigation by Dr. A. Elliott in which 2,074 Dagenham elementary school children were subjected at routine medical inspection to otoscopy and special inquiry made in each case regarding any history of ear discharges. This procedure resulted in finding an incidence of 4.82 per cent. cases of chronic otitis media, while of these only 31 per cent. (that is, 1.49 per cent. of the 2,074) were continuous, 69 per cent. (3.33 per cent. of the 2,074) being intermittent and therefore liable to have been missed by the ordinary routine methods. It is presumed that all the cases so detected may be considered as "requiring treatment," but the author does not record cases of non-suppurative otitis media (such as chronic catarrhal otitis with an intact drum) requiring treatment—which latter are presumably included in the Board of Education figures given below—nor is the age distribution of the children given, though as the investigation was commenced in April, 1934, and completed before the end of the same year it appears unlikely that all age groups are included. The figures therefore are not strictly comparable to those issued by the Board, which for cases of otitis media requiring treatment *per thousand* children seen at routine medical inspection are as follows:

1929	1930	1931	1932	1933	1934	1935
5.3	5.4	5.1	5.1	4.7	4.6	4.1

Thus in 1934 the figure given by the Essex investigation for only otitis associated with active or potential otorrhoea was over ten times as great as that for all forms of otitis media requiring treatment found at inspections throughout the country as a whole; and although, as the

*Received for publication July 28, 1937.

Chief Medical Officer pointed out, the national figures understate the true picture, the actual degree of understatement suggested by the Essex figure is startling.

Otoscopy in Routine Medical Inspections

These observations regarding otorrhoea and otitis media should apply equally well to middle-ear disease in general; and so with a view to testing the practicability of adding otoscopy to ordinary routine medical inspections under field conditions without any special arrangements or warning and over a reasonably long period of time, and to assessing the prevalence of the commoner forms of middle-ear disease, I commenced in January, 1936, to practise otoscopy of every child seen at routine inspections. The innovation was received very well, meeting with no opposition from teachers or parents, and often being highly appreciated. More important, the otoscopic examination was very well tolerated by children of all ages, only two or three infants during the whole investigation raising any protest. Lastly, and contrary to expectation, it adds very little to the time taken to inspect a batch of children, it being found that on an average only about thirty seconds per child seen must be added to the usual time allowed, for in most cases otoscopy of both ears can be accomplished in ten seconds, which leaves an adequate margin for more prolonged examination of diseased ears. This means only an extra ten minutes for twenty children. That time so spent is of value is shown by the results of this investigation.

An ordinary electric otoscope with round-section specula in three sizes, and with no lens, is used. The round-section specula are more convenient than the oval-section type for rapid examination of children of varying height needing frequent changes of posture by the examiner, and it has been found much more satisfactory to dispense with the lens usually fitted to the illumination chamber; for in these children the length of the external auditory meatus is so variable that no single lens can be expected to give a clearly focused image of the structures at the distal end of the meatus in every case. The open unobstructed chamber also saves time if palpation of abnormal meatal or tympanic structures such as polypi is desired, while if Siegle's method is used to test drum mobility or to detect a very minute perforation the lens can always be inserted momentarily. To the presence of the lens, indeed, may be attributed much of the difficulty which those unfamiliar with otoscopical examination may at first experience, because lenses are usually fitted by the instrument makers with a focal length too short, so that a clear image can only be obtained at the actual end of the speculum, and not half to three-quarters of an inch further down the meatus, as is required for the drum or other tympanic structures.

The System of Investigation

The investigation was begun in the Surrey County Council elementary schools in the county area comprising the borough of Godalming, the urban district of Haslemere, and the large rural district of Hambledon. On an average the district might be considered more rural than urban.

Between January 1 and May 31, 1936, when I moved to Oxford, 763 children were seen at routine medical inspections. In this area the first, or "entrant," age group of children are seen in the autumn term, the "intermediate," or 8-year-old, group in the summer term, and the 12-year-old group in the spring term; hence the age distribution of the 763 children is above the average, and as older children have had more time in which to acquire chronic disease this fact might be considered to

favour an overstatement of the prevalence of middle-ear disease. This criticism, however, does not apply to the remainder of the investigation, which was carried out in the elementary schools of the county borough of Oxford, for in this case the results of the inspections during a complete year are recorded and all age groups are embraced in approximately equal numbers, though, if anything, the balance is in favour of the younger ages. Altogether in Oxford 1,634 children were seen during the year, giving a total of 2,397 for the two areas together.

Records were kept in an "Ear Book," as follows:

1. The number of children inspected on the day's date.
2. The number of children in whom middle-ear disease was detected by the ordinary procedure of routine inspection—that is, from the history given by the parent verbally or on the questionnaire form circulated before each inspection in both the areas concerned, and from a superficial examination without otoscopy.
3. The number of children in whom disease was detected when the above procedure was supplemented by otoscopy.
4. The number of children in whom further inquiry, after disease had been discovered by otoscopy, revealed a history of ear trouble not previously mentioned (usually because the parents had not considered it important enough).
5. The name and sex of each child found with middle-ear disease.
6. The particular diseases or conditions of the middle ear found.

From these daily records the results for each term are obtained by summation.

In the case of a child having bilateral disease, if the same disease is present on both sides it is recorded as only one "case," but if the pathological condition in one ear differs from that in the other each is recorded separately as a "case"; hence, as will be seen from the tabulated findings, the sum of the "cases" slightly exceeds the number of children found afflicted with ear disease.

Children showing evidence of operations for mastoiditis (of which there were five among the 763 Surrey and nine among the 1,634 Oxford children, giving a total of fourteen cases among 2,397, or 5.8 per 1,000 children) are not included separately as "old mastoiditis" in the table, but are placed under the heading most appropriate to the condition of the middle ear at the time of examination. For example, if either wound or meatus is discharging pus the case is recorded as "chronic suppurative otitis media," or if both wound and drum are healed and healthy, as "healed otitis media." Incidentally, some of the operation wounds were so inconspicuous that the old mastoiditis might have been missed had not the otoscopic appearance suggested further investigation; also once or twice no history of operation was given.

Cerumen was found to be much less of a nuisance than expected. It was very rarely plentiful enough to obstruct the view of the drum, and when this did occur no attempt was made to clean out the ear on the spot, the ear being classed as healthy and the child referred to a clinic for syringing and re-examination. It has been found, however, that the presence of excessive cerumen is scarcely ever associated with middle-ear as distinct from external-ear disease, and hence the recording of the occasional wax-filled ear as normal results in no significant understatement of the incidence of middle-ear disease.

The Findings

The findings of the investigation are recorded in the table, from which the following may be selected for particular comment: First, as expected, there is a marked difference between the number of children detected with middle-

ear disease by the ordinary routine inspection and the number detected when the latter is supplemented by otoscopy. Thus in the Surrey area the former method revealed twenty-five cases in 763 children, but with the addition of otoscopy the twenty-five were increased to

Table showing the Prevalence of Middle-ear Disease in 2,397 School Children

Area		Surrey, 1936			Oxford, 1936-7				Total
School Term		Spring	Summer (1st half)	Total	Summer (2nd half)	Autumn	Spring	Summer (1st half)	Total
No. of children seen at R.M.I.		549	214	763	338	337	468	491	1,634
M.E. disease detected by ordinary routine only		16	9	25	8	13	9	19	49
Ditto per thousand		29	42	33	24	39	19	39	31
M.E. disease revealed by ordinary routine and otoscopy		59	15	74	26	31	31	48	136
Ditto per thousand		108	70	97	77	92	66	98	88
History of ear trouble admitted only after disease detected		23	5	28	14	23	9	15	61
Ditto per thousand		42	23	37	41	68	19	31	37
Sex distribution		♂ 25 ♀ 34	9 6	34 40	14 12	16 15	25 6	27 21	82 54
Cases of Middle-ear Disease	Associated with Otorrhoea								
	Acute suppurative O.M.	0	0	0	1	0	0	1	2
	Chronic " "	4	3	7	4	0	3	2	9
	Total active S.O.M.	4	3	7	5	0	3	3	11
	Do. per thousand	7.3	14	9.2	12	0	6.4	6.1	7.5
	Quiescent S.O.M. (dry perforation)	13	3	16	8	1	2	7	18
	Total cases of active and potential otorrhoeal otitis media	17	6	23	13	1	5	10	29
	Do. per thousand	31	28	30	35	3	19	20	22
	Not Associated with Otorrhoea								
	Old S.O.M. (perforation healed)	24	8	32	9	15	11	16	51
	Acute catarrhal O.M.	1	1	2	1	2	2	1	6
	Chronic " "	15	0	15	5	7	9	11	32
	Retraction of drum—Eustachian obstruction	10	1	11	1	6	8	10	25
	"Chronic adhesive process"	2	0	2	1	0	0	1	4
	Other conditions	1	0	1	0	1	0	0	2
Total non-otorrhoeal cases		53	10	63	17	31	30	30	108
Do. per thousand		97	47	82	50	92	64	61	71
Total cases of middle-ear disease		70	16	86	30	32	35	40	137
Do. per thousand		128	75	113	89	95	75	81	93

seventy-four, giving proportions of 33 and 97 per 1,000 respectively. After otoscopy had revealed disease the parents of a further twenty-eight children, or 37 per 1,000, furnished a history of ear trouble, making a total of fifty-three with a positive history. The inability to secure a positive history in every case of disease detected by otoscopy is explained by some of the parents being absent and neglecting to fill in and return the questionnaire form, while the younger children cannot always remember or describe their symptoms.

In Oxford during a complete year 1,634 children were seen, among which forty-nine, or 30 per 1,000, children with middle-ear disease were discovered by the ordinary routine, and 136, or 83 per 1,000, with the aid of otoscopy; after which a history of ear trouble was obtained in a further sixty-one children—37 per 1,000, as in Surrey. For the two districts together, with a total of 2,397 children

seen, 31 per 1,000 children with middle-ear disease were detected without and 88 per 1,000 with the aid of otoscopy.

Concerning the statistical significance of these findings, the examination supplemented by otoscopy as compared with the ordinary examination gives in the case of the Surrey children an increase of 64 per 1,000, or 6.4 per cent. The "standard error" of this difference computed for 763 observations for each of the groups, experimental and control, since the actual children submitted to each procedure are the same, works out at 1.52 per cent. Thus the observed percentage difference is more than four times the standard error, and hence is very unlikely to have arisen by chance. Still less so is the observed difference noted in the case of the 1,634 Oxford children, which is 53 per 1,000, or 5.3 per cent.—five times the standard error of 0.96 per cent.; while in the case of the total of 2,397 children the observed difference given by the two methods is 5.7 per cent.—seven times the standard error of 0.82.

A comparison between the Surrey and Oxford figures would be hardly fair, the Surrey children all being seen in the course of a term and a half and not including any of the first or "entrant" age group, in which the incidence of any chronic illness might be expected to be less than in older children. Yet, as the table shows, there is only a slight difference between the final figures for the two districts, though in each there is considerable difference in the incidence of ear disease from term to term. The numbers seen per term, however, are too small for it to be asserted that such differences occur otherwise than by chance.

It is interesting to note that only two among the ninety-seven Surrey children found to have some form of middle-ear disease failed to hear the "forced whisper" test (then practised in the Surrey area) in each ear at twenty feet, although according to teachers' reports a greater number actually appeared to have somewhat impaired hearing. The unreliability of the whisper test, in which although vowel sounds are greatly suppressed the consonants are as loud as in ordinary speech, has led me to abandon this test altogether in Oxford and, in lieu of hearing tests by gramophone audiometer, to rely on teachers' reports and the response to conversation in a quiet voice during the examination, sometimes supplemented with a watch-tick test.

Incidence of the Varieties of Middle-ear Disease

Concerning the incidence of the commoner varieties of middle-ear disease in the children seen, the table separates these conditions into two categories, "otorrhoeal" and "non-otorrhoeal." In the first category cases of acute, chronic, or quiescent suppurative otitis media are placed. The last-mentioned term describes those cases in which the perforation still exists, but at the time of examination no discharge was evident. This condition is particularly dangerous because often symptomless, and thus apt to be forgotten or ignored by the parents, so that the child runs a constant risk of a flare-up of acute otomastoiditis from a fresh infection, not only by the external meatus, but, as Tumarkin (1934) has emphasized, by the Eustachian tube; for the perforation allows escape of air from the tympanum and so facilitates a massive passage of infectious material up the tube when nasopharyngeal pressure is suddenly raised, as in violent nose-blowing or during the respiratory struggles of a child learning to swim. The cases of chronic suppurative otitis media include a few with polypi or cholesteatoma.

In the second category are placed those pathological conditions not associated with ear discharge—namely,

cases of old suppurative otitis media apparently healed but with scarred drums; "acute catarrhal" (or "sub-acute") otitis media; chronic catarrhal otitis media; chronic adhesive process (which may be considered to be an advanced stage of the previous condition, with tympanic structures matted by adhesions, and stricture of the Eustachian tube); retraction of the drum due to temporary Eustachian obstruction and without obvious catarrhal changes in the middle ear itself; and finally any other condition noted.

In the first category the Surrey children give an incidence of active suppurative otitis media of 9.2 per 1,000, the Oxford children 6.7, and both together 7.5 per 1,000. After adding the cases of quiescent or old disease with an unhealed perforation, the figures for all active or potential otorrhoeal disease are increased to 30 for Surrey, 18 for Oxford, and 22 per 1,000 for the total.

If the 1934 Dagenham figures for "chronic otitis media" refer only to the suppurative or discharging type, as is suggested by all the cases described being associated with active or potential otorrhoea, it will be seen that the Surrey and Oxford figures are both lower than those of Dagenham, which from the percentages given in the report referred to work out at 15 cases of active and 33 of potential otorrhoeal otitis per 1,000, or a total of 48 cases per 1,000 children.

Concerning the second category of middle-ear disease, not associated with either continuous or intermittent otorrhoea, the frequency with which old cases of suppurative otitis media, now healed, were discovered will be noticed. This condition, interesting to record, is probably the least important of all those noted as regards prognosis, for if the drum is nicely healed and healthy in appearance the other tympanic structures are unlikely to have sustained permanent damage. Attention is drawn, however, to the number of cases of chronic catarrhal otitis media and the four cases of chronic adhesive process noted, since these conditions are apt to cause the distracting symptom of tinnitus in addition to deafness.

Two cases are recorded under "other conditions": one being that of a Surrey girl with circumscribed labyrinthitis and irritative symptoms, the other that of an Oxford boy with a healing traumatic rupture of the tympanic membrane. As regards sex, no significant difference was shown; rather more girls than boys were afflicted in Surrey, but the converse was noted in Oxford.

Comparison with Board of Education Figures

It is of interest to compare the findings in this investigation with the Board of Education figures previously mentioned, but in order to obtain comparable figures only those children with "otitis media requiring treatment" must be considered. Of the various conditions recorded in the table, only "healed otitis media" may be regarded as requiring no treatment, while neither "retraction of the drum due to Eustachian obstruction" nor traumatic rupture of the drum is strictly "otitis"; but after subtracting these there remain forty-three cases, or 57 per 1,000, of "otitis media requiring treatment" in the Surrey area, sixty cases, or 37 per 1,000, in Oxford, and 103 cases, or 43 per 1,000, for the children in both districts together, the latter proportion being approximately ten times the Board of Education figure for all children seen at routine inspection during 1935.

The Preliminary Audiometer Test

There is thus evidence to establish the value of otoscopy in routine medical inspection; but the question may now

be raised whether otoscopy of each child would still be necessary if a preliminary audiometer test of the batch of children due for inspection were carried out, for this would enable the examiner to choose only a fraction of the children for otoscopy. In 1933 Wells examined 2,083 London school children with the gramophone audiometer and found 13.7 per cent. (285 children) to have a hearing loss of nine or more units. He then examined 246 of these selected children and found ninety-two cases of "catarrhal changes in the ear," forty-six of otorrhoea, five of "dry perforation," eleven of Eustachian obstruction, and forty-three of other pathological conditions of the ear, nose, and throat, exclusive of wax. The audiometer is also useful in detecting certain ear conditions, other than strictly middle-ear disease, which are likely to be missed by otoscopy alone—notably otosclerosis, in which the flush over the promontory is often hard to see through the drum, and invisible if the latter is thickened. On the other hand, otoscopy enables the detection not only of certain middle-ear conditions, such as "dry perforations" and old healed otitis with scarred drums, in which hearing loss may be negligible, but also of pathological conditions of the external auditory meatus which would be missed if an audiometer test were relied upon in choosing cases for otoscopy. Moreover, some of the cases of otitis externa discovered in the course of this investigation showed a thin discharge which might have been diagnosed as otorrhoea had not otoscopy revealed a normal drum.

On the whole, even if all education authorities could afford to provide gramophone audiometers, it seems desirable that every child at routine inspection should still be given an otoscopic examination; for, granting the great value of the audiometer in detecting cases of impaired hearing, it is yet doubtful whether the very slight saving of time that would result from otoscopy of only a chosen fraction would compensate for the occasional cases of middle-ear disease and also those of otitis externa that would be missed by this procedure.

Summary

In a mixed urban and rural district of Surrey, and in the city of Oxford, a comparison between the prevalence of middle-ear disease in elementary school children as estimated by the ordinary procedure of routine medical inspection, and the prevalence as assessed by the same procedure with the addition of otoscopy, resulted in the latter system showing an incidence about three times greater than that given by the former, and for each area the difference is statistically significant.

In the particular case of "otitis media requiring treatment" the Surrey children, with a slightly unfavourable age distribution, show a prevalence slightly over, the Oxford children slightly under, and the children of both areas together almost exactly, ten times the incidence recorded by the Board of Education in the results of ordinary routine medical inspection throughout the country.

I desire to express my thanks to Dr. J. Ferguson, county medical officer for Surrey, and to Dr. G. C. Williams, medical officer of health for Oxford, for permission to publish the results of this investigation.

REFERENCES

- Board of Education (1934). Annual Report of the Chief Medical Officer, *The Health of the School Child*, London, p. 79.
- Essex Education Committee (1934). Annual Report of the School Medical Officer.
- Tumarkin, A. (1934). *British Medical Journal*, 2, 357.
- Wells, A. G. (1933). London County Council: Report of the School Medical Officer, p. 77.