DIAGNOSIS AND TREATMENT of CHRONIC DEAFNESS

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Diagnosis

It is really very simple to make a diagnosis of deafness of the middle or inner ear, and, indeed many patients arrive with a perfectly correct and self-made diagnosis. The necessary requirement of the practitioner in the first place is to handle an auriscope well enough to exclude wax as a cause, and after this, to distinguish between deafness due to suppurative, and deafness with a whole drum. The history will often give enough information to be reasonably sure of the diagnosis as far as these broad groups, and it is often possible to make a fair guess of the type of deafness using no special equipment of any kind.

History

Age. The age will alone be a great help; in the old, a recent deafness for general conversation or for distant voices is suggestive of a senile deafness, which affects the inner ear and primarily the hearing for high tones.

(1) A man of 73 consulted me with the complaint that he heard badly, at committee meetings. He heard well when anyone spoke to him directly, but he could not pick up general conversation, and this was worse when he was tired.

Examination showed an inner ear deafness on both sides and the audiogram (Fig. 1) shows the typical curve of a high tone deafness.

Occupation. The only kind of work which is likely to cause deafness is work in a noise. One of the earliest groups to be investigated was that of the hammer men in shipbuilding yards, where the noise is, of course, very loud.

Aeroplane noise is now more common as a cause of occupational deafness.

(2) A pilot with 1,000 hours' flying to his credit complained that he could not hear the talk at a

party. He heard my questions fairly well, but examination showed an inner ear deafness of the same type as the senile deafness, but more pronounced.

The audiogram (Fig. 2) shows a loss on both sides chiefly for high tones, but extending into the 2048 D.V. level.

The most important single complaint is deafness for speech. It is astonishing to realise when one deals with deaf people that there are so few sounds that are essential in life. In the vast majority the complaint is simply: 'I cannot hear what people say to me, doctor,' and any other introduction is a

curiosity. For a few the complaint is that music is distorted.

(3) A piano tuner, blinded in the war, complained that for the last six months he had difficulty in adjusting the high notes of the piano. Examination showed an early high tone deafness.

A slight deafness may often not be realized, especially that beginning in the high tones, and only when it involves the hearing for speech in the late stages, will it cause trouble.

Deafness for speech means a loss of some five-sixths of the available hearing. The conversational voice is heard normally at 30 ft. in a quiet room, and it is only when it cannot be heard at a distance of 5 ft. or less that this deafness is realized. It is easy to understand this, for a distance of about 5 ft. is that naturally chosen for conversation.

Hearing for general conversation is, however, more important than this would suggest. So much information is gathered during the day by overhearing news, that to be able to hear words which are spoken directly to the hearer, and nothing else, is rather like reading the headlines of a newspaper with the rest blacked out.

Hearing for the telephone is good in middle ear deafness, bad in nerve deafness. Good hearing on the telephone usually means that a hearing aid can be used.

Hearing in halls or lecture rooms is, of course, lost early in all forms of deafness. It is of little help in diagnosis.

Duration

Few people give an accurate answer when asked how long they have been deaf. This is not surprising when it is remembered how much hearing is normally possessed above essential needs, and the duration is therefore nearly always under-estimated.

The remaining questions are standard, and are in a way a reflection on our ignorance of the causes of deafness.

Family history

Otosclerosis, one of the commonest forms of deafness, is often familial and passes from the mother's side.

Fig. 3 shows an example of the family of an

otosclerotic; in this case a girl of 9 years, the daughter of a doctor.

FIG. 3

Previous suppuration

An otitis media due to infection will cause deafness, and this deafness may remain when the infection has subsided. Fig. 4 shows the audiogram of a case of active suppuration, but this curve is typical of the later deafness as well. Deafness due to suppuration either improves or remains the same when the discharge dries up. If the deafness increases in the absence of active infection, it is due to other causes, such as otosclerosis.

Tinnitus is nearly always present at some stage. It is usually worse in nerve deafness, and its cause is unknown.

A woman of 36 complained that she had been deaf for 5 years, but that she could hear quite well, if it were not for the noises. The audiogram showed a bilateral middle ear deafness,

with the tinnitus localized between 1024 D.V. and 2048 D.V. (Fig. 11).

Vertigo is a detail seldom volunteered. It is common in otosclerosis, usually in the early stages, and lasts only a few seconds. Its occurrence is so haphazard, that the deaf often do not connect it with their disease. The only exception to this is vertigo associated with Meniere's disease, where the vertigo comes on like a thunderclap and the deafness is a secondary consideration.

Deafness after pregnancy is characteristic of otosclerosis. The onset of chronic middle ear deafness can seldom be given exactly even in the most intelligent. Its course is so quiet that no cause can be given or even imagined. Its most definite character is that it becomes steadily worse, with pauses, sometimes of many years, when the hearing remains the same, but ultimately the deafness increases, it never improves.

Paracusis Willisii, or the ability to hear better in a noise, is typical of all forms of middle ear deafness. Its cause is not understood, but it is common.

Examination

The ear should be examined as a preliminary, for wax and for suppuration. If these are absent, it is a curious fact that no diagnosis or estimate of the hearing can be made by examining the drumhead alone. If the drum is indrawn, middle ear deafness is likely, but in otosclerosis, for example, many varieties of appearance may be found without their true meaning being understood.

Hearing tests

The most important single test is to find out how well the spoken voice can be heard. After all, what is wanted is to hear speech, not the pure tone audiometer or a tuning fork.

A good way to do this is to stand at 20 ft. from the patient and to ask him to repeat words or sentences spoken in a quiet voice. Each ear should be tested in turn while an assistant blocks the other ear with a finger to close the meatus, by pressure and gentle movement. The eyes should be screened at the same time, to stop lip-reading and intelligent guesses (Figs. 12 and 13).

It is again surprising how those not accustomed to dealing with the deaf will overestimate their powers of hearing. For instance, I have difficulty sometimes in convincing a Medical Board that a recruit who could only hear the quiet voice at 6 in., was deaf, so well did he conceal his difficulty. The deafness is nearly always found to be greater, when examined by an expert.

The Rinne test

This classical test for distinguishing middle and inner ear deafness was described as positive, if the tuning fork, having been held by its base against the mastoid until the sound was no longer heard, was heard again when its prongs were held close to the meatus. In practice it is usually enough to find out which of these is the louder without waiting for the sound to die away when the fork is held against the mastoid. The best fork to use is one of 512 D.C., but one of 256 D.V. is quite satisfactory. The Rinne test is recorded as positive if the fork is heard better when held closer to the meatus than when held on the mastoid. It is negative if it is heard better on the mastoid.

Air conduction is tested most easily by three forks 64 D.V., 256 D.V. and 4096 D.V., and the results expressed simply as positive (heard) or negative (not heard) when the fork is held close to the meatus.

The Weber test is most useful in distinguishing between a pure inner ear deafness, and a middle ear deafness.

A fork of 256 or 512 D.V. is held with the base on the skull in the midline, over the forehead or vertex, and the patient asked in which ear the sound is heard. The sound is heard better in the deaf ear in middle ear deafness, and better in the good ear in inner ear deafness. In a right middle ear deafness, for example, Weber's test would be recorded as being referred to the right. This test is of little use in bilateral deafness, or in early inner ear deafness.

Absolute bone conduction

A fork of 256 D.V. or 512 D.V. is held against the mastoid with the meatus closed. When the fork is no longer heard, it is transferred to the examined mastoid and the length of tune if it is still heard under the same conditions is an indication of the loss of hearing by bone conduction.

When carried out in this way, it shows the loss of hearing of both inner ears acting together, normally a loss of 10 seconds is due to lack of training, losses greater than this indicate an inner ear deafness.

Eustachian catheterization

If improvement occurs after catheterization, the diagnosis of middle ear deafness is certain.

Fig. 6 shows the audiogram of a patient before (i) and after (ii) Eustachian catheterization. Repeated audiograms are really the best test of success, as patients will often say they hear better after Eustachian catheterization when no real improvement has occurred at all.

In a longstanding severe deafness, in any case, improvement after catheterisation will

only last a few days. There is no doubt it has been used too much in treatment, one reason being that, in the past, it has often represented the only method of treating chronic deafness.

To memorize these tests more easily the following list will help.

	Middle ear	Inner ear
Hearing to conversation.	reduced early.	difficult to find exactly ; reduced late.
Rinné.	negative.	positive.
256 D.V.	positive.	positive.
64 D.V.	negative.	positive.
4096 D.V.	negative late.	negative early.
Absolute bone conduction.	normal.	reduced.
Weber.	to affected side.	to normal side.
Eustachian catheterization.	occasional improvement.	no improvement.

The Audiometer

The audiometer is simply a method of testing hearing for pure tone in more detail than is possible with tuning forks. It is capable of producing pure tones at varying amplitudes, the tones varying from a pitch of 64 D.V. to 11,000 D.V. and in some makes, even higher. The unit of amplification is the decibel, which for practical purposes may be regarded as the smallest increase in noise perceptible to the human ear. Fig. 15 shows the Maico audiometer, which is one of the easiest types to use. The sound is conveyed to the ear through a large moving coil earphone, to test air conduction. A separate attachment is used to test bone conduction.

It must be remembered that the audiometer is a test of the smallest sound heard by the ear ; it is a test, therefore, of the threshold of hearing, and not of the capacity to hear speech, which is normally 60 decibels above threshold. Most audiograms can be translated roughly into amounts of deafness for speech, but it is not possible to say accurately what type of hearing aid is necessary, simply by consulting the audiogram. The audiogram is, however, an accurate measure of the capacity to hear pure tones. There is seldom a variation of more than 10 D.B. for audiograms of the same person taken on the same day, and a difference of 15 decibels may be regarded as a real change in hearing. The audiograms shown in the illustrations show a loss of 10-20 decibels in

frequencies below 512 D.V. due to interference by external noise. In a soundproofed room, this loss would not be found. The Maico chart shows readings for frequencies at octave intervals from 64 D.V. to 512 D.V. (middle C) and so on up to 11,584. This last frequency is not the highest which can be heard, and in order to find the upper limit of hearing a monochord is still necessary. The dotted lines on the chart link up points of equal loss for sounds. Thus a loss of 15 decibels at 64 corresponds to a loss of nearly 30 decibels at 1,024 D.V. It is evident from these curves that the greatest sensitivity to sound occurs in the middle range between 512 D.V. and 2,048 D.V., and it is in this area that most of the sounds used in speech occur.

Fig. 5 shows an audiogram of a patient whose loss was chiefly above 4,096. He complained of slight deafness only, and had this loss been in the middle frequencies, he would have been so deaf as to be excluded even from direct conversation.

Fig. 7 is interesting because it shows audiograms of a malingerer. It is really quite

impossible to simulate deafness well enough to produce identical audiograms at successive tests.

This test was made on a conscript who was unwilling to return to the Army. He quite agreed that his deafness was feigned when this curious graph was explained to him.

Types of Deafness

Chronic suppurative otitis media

This is given first place, because it is most often neglected as a cause of deafness. It is usually one-sided and the problem is the treatment of the discharge; if, however, suppuration has caused deafness on both sides, a bone conduction hearing aid, with a carbon microphone, may be a great help.

Otosclerosis

The largest group of deaf people in any deafness clinic are the otosclerotics.

Otosclerosis, it is well known, is difficult to diagnose certainly, but equally the conviction is growing that otosclerosis is far commoner than was formerly thought, and that a doubtful case is more likely than not to be a true otosclerosis.

Otosclerosis is found most commonly in women. The course is slow, there is often a family history; the fork tests suggest a middle ear deafness, and there is no improvement with Eustachian catheterization.

The audiogram of an average case shows a generalized loss for air conduction, usually with some improvement for high tones. Bone conduction may be normal, or there may be a loss for high tones. Otosclerotics will be helped by any form of electrical aid. The bone conductor carbon microphone aid is the simplest, but a valve amplifier with a crystal microphone will give better reproduction.

Senile deafness

Some degree of loss of hearing for high tones is normal in old age. It is only when this hearing loss is sufficient to interfere with the understanding of speech that advice is sought. An electrical aid is of little help, for one reason that it is difficult to amplify the high

notes alone. In nerve and inner ear deafness, there is also the factor of recruitment, when sounds are not heard at all at the normal threshold, but when amplified until they are audible, they sound as loud as in a normal ear, and in most cases therefore, unbearably loud.

A small pair of auricles fitting the head are often useful, particularly in general conversation, such as in a committee, or at the theatre. The effect of the auricles is simply that of a hand placed behind the ear as a cup, a gesture of the old with which everyone is familiar.

Traumatic deafness

The audiogram shows much the same picture as a senile deafness, but the loss is more abrupt. Common causes are aeroplane noise and gunfire, while a common cause during the air raids was bomb blast. It is not progressive, if the noise is removed, but no aid will help except auricles.

Menière's disease

The pathology of this disease is now known to be an excessive accumulation of fluid in the labyrinth.

The deafness, which may be profound, is of an inner ear type and no electrical aid is of help. Fortunately, the disease is most often one-sided, and therefore no hearing aid is required.

Deafness due to Eustachian obstruction

This, as has been said already, is uncommon, and the diagnosis rests on proof by the audiogram that the hearing has improved by inflation.

Good results have been claimed in America by radiation of the nasopharynx, with resulting atrophy of the lymphoid tissue around and inside the orifice of the Eustachian tube.

Treatment

The Deafness Clinic at the Middlesex Hospital has been working since January, 1946, and a description of this will give the best idea of treatment.

About six new patients are seen at each

session, each case taking half an hour. The first visit is to the Almoner, who records such information as work and income, and the way leisure time is spent.

This record is passed to the otologist who conducts the clinical examination proper. The audiometer is used last, and the audiogram is usually made by the technician. The patient then returns to the otologist, who correlates the findings, and decides whether or not a hearing aid is likely to help, or if any other treatment can be undertaken.

The hearing aid test is made in a large room, and a friend or near relation is asked to attend, as it is a great help to have a voice the patient knows.

If a suitable hearing aid is found, arrangements are made for a fortnight's trial, after which time there is another interview with the Almoner and otologist to find out whether the aid has been really useful.

It is some indication of the difficulty of fitting hearing aids that of 161 patients seen in 6 months, we have fitted 46 satisfactorily with an aid. In spite of this, it is fair to say that everyone who is deaf should have the chance of trying a hearing aid, sometimes the most unlikely cases are happily fitted, and no one can say on the clinical examination and audiogram alone that no help is possible.

Fig. 8 shows the audiogram of a butcher who was regarded to be so deaf as to be hopeless. He is an active man, and his whole outlook has been changed by a large valve model by Rein, strapped to his waist.

It is difficult to know exactly how the hearing aid section should be run, and this difficulty is obvious to anyone who visits the shops of the hearing aid manufacturers. At present,

FIG. 12.—Hearing test for the conversational voice. The examiner would, of course, be on the right of the patient; the wall was used for convenience of photography.

FIG. 13.—Hearing test for the conversational voice.
The patient as he appears to the examiner.

Auricles (Rein).

Carbon microphone with bone conduction ear-piece (Rhein).

in this clinic, the work of fitting is done by the otologist, but probably a trained worker could do it equally well. It must be remembered that a hearing aid has a peculiarity as a commodity. The majority of people are reluctant even to try its use and show keen disappointment that no other treatment is to be undertaken. It is unwise to say to any deaf person: 'You should try a hearing aid'—as for one reason or another they will postpone a visit to the manufacturers. At all events this testing should be done at the time of the clinical examination and should be done by someone who clearly has no financial interest in the aids to be tried. At this clinic, there is available as large a selection as possible of hearing aids, British and American. There has been no difficulty in obtaining them, as the makers realize the value of the clinic as an advertisement, and in all cases both supply their aids and maintain them at regular intervals.

The fitting of an aid falls roughly into three stages. First an aid has to be found which is found to be of use in ordinary conversation. This is found by the rough test of quiet conversation, preferably by a relative or friend at 5 or 10 ft. It is hoped that we may ultimately have a more accurate method of testing the efficiency of an aid. The second stage is more difficult in some ways; it is to find an aid which a deaf person will really use, and also at the same time to persuade him to adjust himself to the thought of using an aid constantly. The lighter and less conspicuous the aid, of course, the more acceptable it is. At the beginning, it is worth while to try a carbon microphone with a bone conduction ear-piece. Its use is really to supplement words rather than to provide all the material heard.

If this is not enough, one of the many valve aids may be tried. The Multitone portable valve aid, with the microphone and batteries worn separately, is as good as any, while if still more amplification is needed, a box model such as that made by Charles Rein & Son is quite reliable.

Those of us who have the management of a Deafness Clinic are apt in our enthusiasm to compare a hearing aid to a pair of spectacles. Nothing, of course, is further from the truth. In the first place, it is quite impossible to use

a hearing aid continuously, and secondly, hearing aids are so unusual that the wearer is conspicuous, and ashamed of his disability.

In fact, it must be recognized that the main disadvantages of the hearing aid at present are its appearance and its bulk.

For these reasons, a carbon microphone aid fitted with a bone conduction receiver is often more likely to be used than is a larger valve amplifier. The carbon microphone can be concealed; the bone conduction receiver in women is invisible under the hair; and the single battery easily carried in a coat pocket or slung round the neck.

The reproduction is not good, and amplification is limited to sounds below 2,000 a.v. Nevertheless, because it supplements sounds heard, and leaves the ears free to receive everything normally heard, it is often more popular than any other aid, particularly with the otosclerotics.

There are several valve aids on the market now, which are only slightly heavier than the carbon microphone aid and in the near future there will be large advances in design. At present, however, the valve aid is larger, and it requires two batteries, one of which actuates the valves. The amplification is greater, and lies over a wider range than the carbon microphone, and the sound in the receiver is more natural.

A difficulty in all types of aid is the so-called background noise, due chiefly to the difficulty of suppressing the small noises in the neighbourhood which, when amplified, may be so loud as to drown the speech. Advances in design tend to suppress this background noise more and more, but an obvious difficulty for a slightly deaf person is to hear a lecturer in an ordinary classroom, since between the lecturer's voice and the hearer lie the many noises that the ear naturally ignores, such as the scratch of pens, the shuffling of feet and crackling of paper, all maintaining a barrier for the aid, which is surmounted with no trouble by those hearing normally.

The real difficulty is to be able not only to amplify with an aid, but also to discriminate, and still to keep an instrument which is small, light and inconspicuous. The American aids are, at present, better than the average English models, the Sonotone bone conduction hear-

ing aid, in particular, having no equal in this country.

In general, it may be said that if direct conversation is understood at 5 ft. with an aid, it is worth while to use it, and any result better than this is more than can be expected.

A hearing aid has no effect on the course of a chronic deafness; it neither improves the disease, nor does it make it worse.

The objection to the box models which comprise most of the more powerful aids, is, of course, that they have to be carried, and the hands are not left free. They are quite satisfactory for work such as interviewing, when the aid can be left in one place on the table. A medical man, for example, can use a box aid quite well, to conduct a surgery.

For nerve deafness, none of the electrical aids is satisfactory. Occasionally, a valve aid is successful, but usually either sounds are inaudible, or else they are so loud as to be quite deafening. Nerve deafness, too, nearly always leads to the complaint of the background sounds being too loud, when any attempt at electrical amplification is made.

Unfortunately, a large number of cases seen in old people are deaf from internal ear and nerve deafness. The simplest aid for nerve deafness is a pair of auricles.

They are simple, easily worn and require no maintenance, and are always worth a trial.

The last aid of all is the speaking trumpet, and again this is worth a trial, because in so many households where the deaf live, those with normal hearing exhaust themselves with shouting information, and a speaking tube is an economy of effort, however mediaeval it may appear. I always keep a speaking tube in my consulting room.

The last stage is to lend the instrument for a fortnight, and then to see the patient again to decide whether it is worth while for them to buy it. This does not take long, and old patients are seen at any time, and not by appointment. A few are not intelligent enough to manage an aid at all, but usually this is found out at the first examination.

A good guide is to decide how many hours' use justify purchase of an aid, and at present

we have decided that an aid must be used for six hours a week.

The cost of batteries should not in any case be more than three shillings a week, but this is seldom exceeded; if it is, the instrument wants adjustment.

The question of cost has been deliberately left to the last. Phyllis Tookey Kerridge laid it down, before the war, that no one who attends a hearing aid clinic need be refused a hearing aid on account of cost. Whether this will hold in post-war years has yet to be seen. The makers all grant generous reductions for hospital patients, and so far, certainly, we have been able to supply everyone who needed an aid. The raising of money, however, takes time and effort, and the hardest worked member of the clinic is the Almoner, who is occupied intermittently for the whole week, with work arising out of one morning's work on the part of the otologist.

Operation of Fenestration of the Labyrinth

This operation is the only form of treatment which is likely to be of real use in the treatment of otosclerosis. It is an operation which has been largely developed in America during the war, whilst in England few people have had sufficient experience to be able to say with any confidence what place it will hold in the future. While the literature from America shows clearly that in a suitable case, there is a fair chance of improvement, sometimes of a striking improvement, it is disturbing that failures are common and success cannot be promised in any case, however promising may be the clinical examination and audiogram.

It has long been known that a breach in the bony wall of the labyrinth will produce an improvement in hearing which has been, however, in the past, only temporary. Surgical ingenuity in America has been concentrated to find whether this temporary improvement can be made to last.

It is noteworthy that the explanation of the improvement in hearing has yet to be given, and equally the reason for the deterioration is by no means clear, although the evidence suggests that deterioration is accompanied by closure of the artificial breach of the labyrinth.

The method most often used at present is

to approach the external canal through an endaural incision, removing the overlying mastoid cortex and cells. The outer wall of the aditus is removed together with the posterior bony wall of the meatus, and to lay open the anterior end of the semi-circular canal, the incus and head of the malleus are taken away, with the adjacent segment of the tympanic ring. The external canal is next breached by a dental burr at a position overlying the ampulla, the final result showing the membranous canal lying visible and free from dust and bone debris, in the depths

of the hole produced by the burr. A small plug is then fashioned from the cartilage of the meatus or pinna, and the posterior meatal wall cut to form a flap hinging on the posterior part of the drum membrane. The flap is then swung back to cover the fenestra and the cartilage plug, and the cavity is filled with a dressing of liquid paraffin wax, and left untouched for seven days. The wax is removed at the end of this time, and the cavity allowed to epithelialize from the matrix of the flap.

The audiograms of an otosclerotic, Figs. 10 and 11, show a successful result from fenestration. It must be remembered that no improvement can be regarded as permanent, unless it has lasted for eight months.

At present, we are recommending patients for operation only if they realize that the procedure is experimental, and that while improvement is possible, there is at least an equal chance of failure.

I must thank Wing Commander Kersley for the photographs showing the method of testing hearing for the conversational voice.

ASSOCIATION OF SURGEONS OF GREAT BRITAIN AND IRELAND THE MOYNIHAN FELLOWSHIP

THE ASSOCIATION OF SURGEONS OF GREAT BRITAIN AND IRELAND invite applications for the Moynihan Fellowship up to the value of £600, including expenses, to be held for one year.

The object of the Fellowship is to enable the holder to pursue a definite line of research or to study surgery in specified clinics either at home or abroad.

Candidates in their applications are required to state the lines of research or study that they intend to pursue, and also to give short accounts of their past careers. If candidates intend holding the Fellowship in conjunction with some other appointment they should state their total emoluments. No testimonials should be sent, but each candidate is required to provide letters of recommendation from two sponsors who should forward them direct to the Honorary Secretary.

Applications must be received by the Honorary Secretary of the Association on or before March 1st, 1947, as must letters from the sponsors of candidates.

H. W. S. WRIGHT,
Honorary Secretary.

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LONDON, W.C.2.

29th November, 1946.