SURGICAL PROCEDURES IN GENERAL PRACTICE

This is one of a series of articles contributed by invitation

HEARING AIDS IN GENERAL PRACTICE

BY

F. J. CLEMINSON, M.A., M.Chir., F.R.C.S.

If the physical intensity of a sound is increased ten times it is said to be increased by one *bel* (this name being in honour of Alexander Graham Bell, the inventor of the telephone). If the increase is a hundred times it is by two bels, and if a thousand times by three bels, and so on. For instance, the average noise in a very quiet room is two bels—that is, the noise is one hundred times as intense as that which would be just perceptible. A bel is divided into ten *decibels*, and a decibel is now recognized as the standard unit for the expression of differences in sound intensity.

Testing for Deafness

The pure-tone audiometer is an instrument for testing the acuity of hearing, both for air and bone conduction, for pure tones at octave intervals over the greater part of the entire auditory range. At each pitch the sound is slowly diminished in intensity till it just ceases to be heard by the patient, who signals the exact moment by pressing a button. In this way curves are obtained for each ear for bone and air conduction, the results being recorded on a chart such as that illustrated here (a modification in monochrome of the chart used by Dr. Kerridge in the hearing aid clinic at University College Hospital). The results are shown for one ear only, for clearness' sake. The zero line (thick) is horizontal, and represents the threshold for normal persons in a silent or sound-proof room. The continuous curve represents the threshold for normal bone conduction. The curve marked with bars registers the patient's air conduction, and the dotted line his bone conduction. The curve shows that at the frequency of 512 cycles per second (C^2) the patient did not hear by air till the note's intensity had been increased by 40 decibels above the normal threshold—that is, until it had been made 10^4 (or 10,000) times stronger than necessary for a normal hearer.

The other form of audiometer in common use consists of a gramophone which reproduces spoken numbers; it shows the level, in decibels above the normal threshold, at which speech becomes *intelligible* (not merely *audible*) to a deaf patient. In this form of audiometer the normal threshold has been determined in a quiet (but not sound-

proof) room—one in which there would be about 20 decibels of noise. Hence a patient who has an average loss of, say, 50 decibels over the important speech frequencies (200 to 2,000 cycles per second) in a *pure-tone* audiometer test would in a *speech* audiometer test have a loss of only 30 decibels—an apparent discrepancy which is at first confusing.

The only excuse for this brief acoustic preface is that, for some readers, it may clear up a certain degree of vagueness in their ideas about units and measurements; we are now free to pass on to the subject of hearing aids. It is difficult for those with normal hearing to realize how speech perception is affected by deafness. If, owing to some fault on the telephone, no frequency

above 1,000 cycles per second could be transmitted a normal hearer would probably say, "I can hear the voice but cannot make out the words," and would at once realize what the deaf mean when they use the same phrase. If the transmitted frequency could be raised to 1,500 cycles intelligibility would be greatly improved, but even then different voices could not be distinguished one from another. A further

Chart showing bone- and air-conduction curves obtained in testing for acuity of hearing by the pure-tone audiometer.

rise to 2,000 cycles per second would allow familiar voices to be recognized with ease, more of their characteristic harmonics being reproduced. In this case the telephone engineer would have done for the normal hearer what the manufacturer of hearing aids aims at for the deaf, and in this aim he has very largely succeeded, especially since the invention of the midget thermionic valve.

Non-electrical Aids

The earliest aid (going back at least 250 years) was a trumpet or tube, and such an aid has still many advantages. It is cheap to buy, costs nothing to maintain, has no "endogenous" background noise, and tends to emphasize the upper end of the scale. It is therefore useful in internal-ear deafness—for example, for old people—in which the greatest loss is always in the high frequencies. There is little distortion, voices sound natural, and it is often the most suitable aid for slight to moderate loss of hearing. These non-electrical aids are made in various forms—for example, single or double auricles, "banjo" horns, flexible conversation tubes, and parabolic reflectors with collecting tubes leading to the ear from the focus. Auricles are more popular among women than men because they can be concealed in the

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(4) MODE OF WEARING A PAIR OF AURICLES (F. C. Rein & Son)

The earpieces of this binaural adjustable auricle can be moved backwards, forwards, inwards, or outwards to suit the direction of the meatus. The auricles are held in position by a light adjustable head-spring. The instrument is built in a number of graded powers and special models are available for children.

(1) "PERCEPTRON" VALVE AID

Crystal microphone. Selective amplification obtainable by the insertion of filters. Three stages of amplification. Bone or air conduction. Made to resemble a "Kodak" camera. Dry batteries used.

(3) MICROTELEPHONE TYPE HEARING AID (F. C. Rein & Son)

(Total weight, complete with battery, $7\frac{1}{2}$ oz.)

The transmitter or microphone (A) is worn by the male user under the necktie, or by the female user similarly under the clothing. Volume control can be fitted. (B) The midget flesh-tint self-retaining receiver. (C) Watch pattern disk receiver interchangeable if desired with midget receiver. Proximal side down. Head-band not shown. (D) Small dry pocket battery.

(5) PETO-SCOTT "MAXADE" (wearable model)

The three units are, from right to left : (1) amplifier with 3 valves and built-in crystal microphone, (2) low-tension cell, and (3) high-tension battery. Small earpiece to fit meatus.

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(6) MULTITONE ELECTRIC CO. V.P. MODEL
with "Book" Container

(A) Amplifying unit (3 valves). (B) Flexible high-tension battery. (C) Dry low-tension cell. (D) Crystal microphone. Earpiece not shown. The contents can be removed easily and disposed about the person.

(8) VERNON-SPENCER
"FULL RANGE"

3-valve Model VS1 ($7\frac{1}{2}$ inches by $3\frac{1}{2}$ inches by $1\frac{1}{2}$ inches) with crystal microphone and crystal earpiece.

(2) SONOTONE AUDICLE (451)

A. Transmitter.—Contains two microphones back to back. Non-directional—picks up sound equally well from every direction. No holes in transmitter, sound enters at side.

B. Amplifier.—Selective amplification obtainable by the insertion of different "booster chambers." "Sound filter" to suppress "staccato" sounds—for example, clatter of knives and forks on plates.

C. Oscillator.—Supplied in different pitches. Large surface to oscillator to fit mastoid bone. Both sides of oscillator can be used. One side loud the other side soft

(7) MODEL C8 AMPLIVOX

The model C8 Amplivox with crystal microphone, three-stages valve amplification, all dry battery working.

hair and coloured to match it. Auricles can be held in place by a head-spring, but the others of this class leave only one hand free and cannot be used at work. The conversation tube is said to produce an amplification up to 35 decibels, and even auricles can average 12 to 15 decibels. Next to the conversation tube the banjo horn is perhaps the most efficient.

Electrical Aids

Electrical aids in their simplest (and oldest) form are merely portable telephones that can be worn on the person. They are well known and need little description. The microphone is of the carbon granule or dust type, and the granules may be larger or softer, while the carbon diaphragm may be made of hard or soft carbon. The earpiece or receiver may be small and be worn in the ear, or it may be large (and more efficient) and be held closely to the ear by a head-spring. The cell is usually of the 3-volt dry type, and is carried in the pocket. Except in the carbon-dust type there is often a large amount of instrumental background noise; but in middle-ear deafness, especially when paracusis is present, this is not so objectionable as in nerve deafness. Recently the receiver has been so modified that a small vibrating surface can be placed directly on the mastoid bone so that the sound reaches the inner ear by bone conduction. This "by-passing" of the middle ear is particularly successful in cases of middle-ear deafness with a fixed or almost fixed stapes. Bone-conduction aids need more current than the simple microtelephones, and are fitted with an amplifier which in some cases is of the valve type. In my experience, bone-conduction aids were disappointing in their early stage, when the vibrator was merely a small button, apt to slip out of place and by no means so efficient or comfortable as the present type. In their original form they were found to be the most suitable aid in only about 3 per cent. to 4 per cent. of my cases; but in their improved form the percentage is far higher than this, and many patients prefer their quality of voice reproduction.

In the Medical Research Council Report No. 219 (*The Use of Hearing Aids*) somewhat unfavourable views are expressed on bone-conduction aids. I think it very doubtful whether such views would be supported now by the experience of most otologists: they certainly seem to be at variance with our experience in the hearing-aid clinic at the Middlesex Hospital. It is unfortunate, however, that the variety I prefer is rather too costly to be available in every case for which it appears to be most suitable.

The Valve Amplifier

The third and most recent class of hearing aid is the valve amplifier. These were formerly large and heavy, and were made in the form of a box; but now they are much smaller, and some manufacturers have divided them into two or more parts so that it is possible to carry them easily about the person or in a bag. In some makes the microphone is separate and can be worn in the button-hole, like a flower, or under the frock. The valves may be two or three in number, of the midget-valve type, and are very reliable. Some makers provide not only a volume control but also a tone control whereby the relative volume of the upper and lower tones in the amplified voice can be varied, and each patient can keep it in the position in which his friends' voices sound most natural. This is a great advantage. Moreover, the amplification in some models is as much as eighty decibels. The low-tension cells tend more and more to be of the easily obtainable

cycle-lamp type. The high-tension batteries usually have a voltage of about 50, and last some months. The earpiece is commonly of the large and more efficient kind, held over the ear by a spring. Small receivers which fit into the meatus can be supplied, but these, though less conspicuous, are also less efficient. The microphone may have a carbon diaphragm. A crystal microphone increases the price by some pounds, but greatly diminishes that part of the background noise due to the instrument itself. Some instruments have a crystal earpiece also, and are particularly quiet. One maker has an automatic volume control which prevents, for example, a hand-clap near the wearer from sounding loud enough to startle him. He has also introduced a special device whereby while one ear receives the whole output of sound, high and low, only the high tones are allowed to reach the other. This involves wearing two earphones. Its purpose is to reduce what is called the "masking" effect of low tones on high tones. The synthesis is probably carried out in the cerebrum.

All valve instruments tend especially to amplify the upper end of the scale, and therefore, with a crystal microphone to minimize instrumental background noise, they are particularly suitable for cases of senile or other internal-ear deafness because they tend to compensate for the disproportionate loss of high tones. Hence it is no longer true that for senile deafness an electrical aid is useless; on the contrary, it is often most valuable.

There are many ways in which the sound output of a hearing aid may be varied. But when all is said and done it remains quite impossible to prescribe aids for loss of hearing in the same accurate way as lenses can be prescribed for changes in refraction. In the microtelephone aid the situation of the peak of amplification can be influenced by the degree of hardness of the carbon diaphragm and to some extent by the material of the earpiece diaphragm, but, broadly speaking, it is the middle part of the range of pitch more than the upper which is amplified, and this fact, together with their greater tendency to record background noise, makes them unsuitable for senile or other forms of nerve deafness, for which either a non-electric aid or a valve aid with crystal microphone and tone control is most suitable. Bone-conduction aids should be tried more often in middle-ear or mixed deafness, especially where there are signs of limitation of movement of the stapes. This condition may occur as the result of otosclerosis, chronic middle-ear catarrh, or the fibrotic changes following suppuration.

The Medical Man and the Deaf

How can a medical man do his best for a patient who needs an aid? In the first place it may be difficult to persuade him (or more often her) to try one. One objection after another may be made. "To use one will proclaim my deafness to the world": but of course his "world" knows it only too well already, and would welcome anything to make social intercourse less exhausting. "I can hear well enough if people will only speak distinctly, but everybody mumbles nowadays": he must be shown that the fault lies in his own ears, and then an appeal to his better nature may succeed if he can be made to realize how tiring it is to talk when the voice has to be raised and almost every remark repeated at least once. "I have no friends now—people avoid me, so why should I bother?": his friends will come back when they find they can talk to him easily. "I am afraid it will make my hearing worse": there is no evidence whatever that an aid makes hearing worse; but, as when a short-

sighted person who takes to spectacles may realize how imperfect his vision was without them, so the deaf man with an aid may wonder whether his hearing really could have been so bad as he now knows it to be. "I shall lose my employment if it is known I am deaf": his employer almost certainly knows it already, and he will be less, not more, likely to lose it if he can hear what he is told. Deep-rooted vanity, perhaps unconscious, is the greatest obstacle. A charming but rather masterful old lady was once persuaded by her friends to consult me, and as conversation was difficult she was induced to try a valve aid "just to see." Everything seemed to be going well and the conversation had become quite brisk when it suddenly came home to her that the apparatus was a great help. She instantly removed it, stiffened perceptibly, abruptly closed her mind to its virtues, and said it was "quite useless, very unsightly, and she would never dream of wearing it." "But what about your family, who tell me they have almost to shout at you?" "Well, they must go on shouting."

Without special knowledge of the subject it may perhaps be inadvisable for the medical man to name any particular hearing aid. The responsibility can usually be shifted to one of greater experience, and if it is impossible to arrange a private consultation the patient can be referred to the aural department of a good hospital or, better still, to a hearing-aid clinic such as those now established by Dr. Kerridge at University College Hospital and, more recently, following the same lines, by the Ferens Institute of Otology, Middlesex Hospital. In time every hospital will probably have one. At such a clinic the patient will have an audiometer test done and then be tested with the most appropriate of the series of hearing aids kept for the purpose. A home trial of the most suitable one, if any, will be arranged, and the almoner will discuss with the patient the best means of payment and tell him what organizations may be prepared to help him and to what extent. If after trial the instrument proves satisfactory it can be obtained through the almoner at a specially reduced price. A number of the leading manufacturers have been kind enough to send specimens of their products on permanent loan for testing patients at the hearing-aid clinic at the Middlesex Hospital; they are Messrs. Amplivox, Multitone Electric Co., Peto Scott, F. C. Rein and Son, Sonotone, and Vernon-Spencer; without their ready help it would have been difficult to establish the clinic. So that the reader may have an idea of the range of hearing aids and know what they look like, illustrations of various models have been included in this article.

Advice to the Deaf

Patients who wish to go direct to a dealer will find the following advice excellent. It is from a paper (*British Medical Journal*, 1935, 1, 1314) by Dr. Phyllis Kerridge, whose work and publications on the subjects of deafness and hearing aids are so well known and so valuable:

1. Take a friend with you, and listen to a voice you know as well as to that of the demonstrator.
2. Move about with the instrument on.
3. Switch the battery on—if it is an electrical aid—and listen when nobody is speaking, both when you are sitting down and moving.
4. Try more than one make of instrument of the type you favour.
5. See that the earpiece fits really comfortably. They can easily be adjusted to individual requirements.
6. Try a large earpiece as well as a small one.
7. Insist on a home trial without obligation to purchase.

8. When at home listen to general as well as to individual conversation.

9. See how long the battery (if any) lasts you, and calculate the cost of upkeep.

10. Do not wear a new instrument for too long at first. You will probably make your ears tired, and therefore seem more deaf.

11. If, after trial of an instrument, you can hear satisfactorily with it and procure one, and subsequently cease to be able to hear with it, or if adventitious noises develop, do not conclude that you are getting deafer or that the instrument is no good. Send it to be overhauled. A simple repair or renewal is probably all that is necessary."

Lip-reading and General Information

A doctor should strongly advise patients with chronic deafness to have lessons in lip-reading and to practise it most assiduously. It is an invaluable accomplishment, readily attained in earlier life but far more difficult to learn after 50. For information about lip-reading classes or teachers, application should be made to the National Institute for the Deaf, 105, Gower Street, W.C.1 (secretary, Mr. A. J. Story). This organization is of the greatest use. It supplies literature in the form of leaflets, pamphlets, and books, gives information about the employment of the deaf, choice of aids, and the danger of the exploitation of the deaf by unscrupulous dealers. To minimize this a list is kept of those dealers and manufacturers who agree, among other things: (1) to permit no representative of the firm to pay unsolicited visits to clients' homes, and (2) to allow a reasonable home trial of their apparatus for a fee which does not exceed 5 per cent. of the purchase price for non-valve and 7½ per cent. for valve aids per week. This fee is deducted from the cost if a sale results. Patients should be urged to keep to this list in making their choice.

ROYAL MEDICAL BENEVOLENT FUND

At a recent meeting of the committee three annuitants were elected, the total amount voted being £86. In addition thirty-eight beneficiaries (including eleven new applicants) were awarded grants amounting to £947. The following are particulars of three cases:

Widow, aged 64, of M.R.C.S. who died in 1916 aged 42. The widow has had a salaried post in social work for many years, but, owing to the closing down of the association, lost her employment in December, 1937, and at the age of 64 cannot find fresh employment. Her two children, aged 34 and 30, are unable to contribute to her support. The Fund voted an allowance of £1 a week for six months, and is seeking the co-operation of other charitable societies to help this most deserving applicant.

Daughter, aged 60, of M.R.C.S. who died in 1914 aged 76. The daughter has helped her mother to run a boarding house since 1914, and they have just managed to maintain themselves. The mother is now 83, and all the work falls on the daughter, who does the cooking for the establishment as well as looking after her mother. For years she has had a hard life and a struggle to make ends meet, with no money for extras or a holiday. The Fund voted £20 to enable the daughter to have a holiday and rest.

Widow, aged 66, of L.S.A. who died in 1915 aged 52. She has an invalid daughter. The widow, since her husband's death, had supported herself and had educated her daughter by successfully running a boarding house until 1933, when circumstances forced her to give up. Recently she has suffered from a duodenal ulcer, which necessitated nursing-home treatment. Her own and her daughter's illnesses have been a great drain on her resources, and the money she had put aside has been used up. Her only income is now £60, and the invalid daughter is able to earn £26 per annum by teaching painting. The Fund voted an allowance of £1 a week for six months, when the case will be reviewed.

New annual subscribers are urgently needed by the Fund. Cheques may be sent to the Honorary Treasurer, Royal Medical Benevolent Fund, 11, Chandos Street, Cavendish Square, London, W.1.