

An address on the treatment of deafness in persons who hear best in a noise (paracusis Willisii) : the mechanism of aural accommodation, the regulation of labyrinthine fluid tension, the tightening of relaxed drums and joints : read before the West Kent Medico-Chirurgical Society, at the Miller Hospital, Greenwich, March 4th, 1910 : amplified / by Charles J. Heath.

Contributors

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Royal College of Surgeons of England

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P. 02
Dracts A. 263

(3)

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THE TREATMENT OF DEAFNESS
IN PERSONS WHO HEAR BEST IN A NOISE
(PARACUSIS WILLISII).

THE MECHANISM OF AURAL ACCOMMODATION
THE REGULATION OF LABYRINTHINE FLUID TENSION
THE TIGHTENING OF RELAXED DRUMS AND JOINTS

*Delivered before the West Kent Medico-Chirurgical Society, at the Miller Hospital,
Greenwich, March 4th, 1910. (Amplified.)*

BY

CHARLES J. HEATH, F.R.C.S.

PAST PRESIDENT OF THE SOCIETY

SURGEON TO THE THROAT HOSPITAL, GOLDEN SQUARE, LONDON

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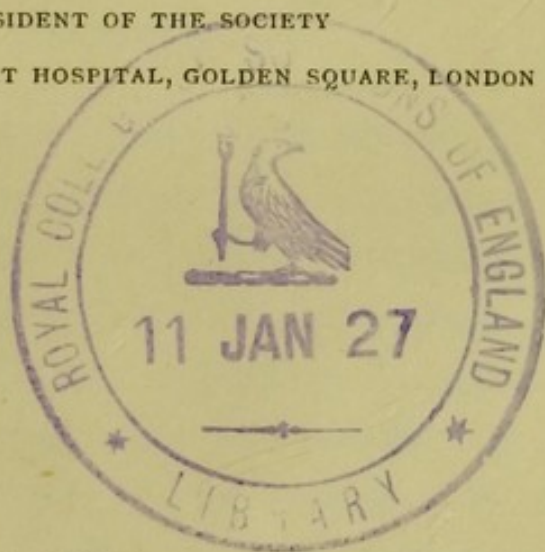
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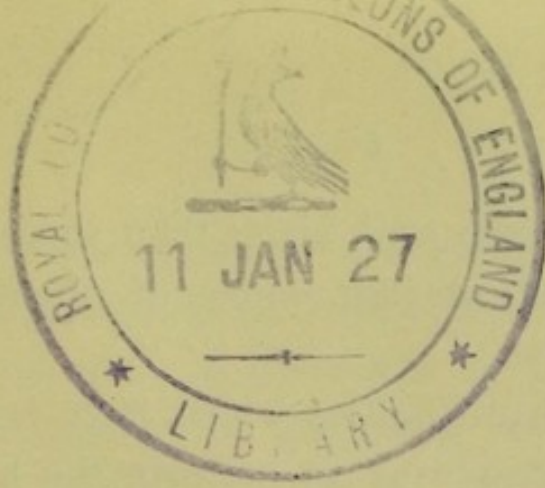
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*Do not bind me by tradition,
Nor say what others do.
I saw my work ahead,
And did begin.*



An Address

ON

THE TREATMENT OF DEAFNESS

IN PERSONS WHO HEAR BEST IN A NOISE

(PARACUSIS WILLISII)

THE MECHANISM OF AURAL ACCOMMODATION

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TENSION

THE TIGHTENING OF RELAXED DRUMS AND JOINTS

MR. PRESIDENT AND GENTLEMEN,

There are far too many deaf people in this country. A large proportion of them derive no benefit from treatment and have paracusis—*i.e.*, they are able to hear better in a noisy place than in a quiet one. This condition is especially noticeable in a moving train or omnibus, or in a factory where machinery is in motion. In such surroundings patients with this kind of deafness

can, indeed, often hear even better than those whose hearing is normal, though some of them seem unaware of the fact.

The well-known difficulties which have been experienced when attempting to improve the hearing of patients with this kind of deafness has resulted in a common belief that no treatment is likely to do it good. Though its cause has never hitherto been satisfactorily explained, yet paracusis has long been observed to be such a bad sign in a case of deafness, that a prominent specialist formerly on the staff of an Ear Hospital, and now in charge of the special department at a General Hospital, recently informed me, that if deaf patients on consulting him were found to have paracusis, he told them not to come to him again as such deafness was incurable.

Drug treatment has been tried for it. Such drugs as quinine and pilocarpine have, indeed, an effect, yet one that is usually only temporary, always uncertain, and often pernicious.

This evening I propose to describe to you some methods of treatment by the aid of which, as my cases will show, it has been found possible to deal effectively with *paracutic* deafness (as we may term it), no matter how intense it may have been, nor how long it may have lasted.

These patients often go from one aural surgeon to another in the hope of getting relief. The measures hitherto employed, however, have usually

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tended rather to aggravate than to improve the conditions responsible for the deafness. These measures were instituted in deference to Politzer's opinion that deafness with paracusis is due to stiffening of the tympanic joints.¹ Thus he writes, the italics are mine: "bin ich der Ansicht, dass das Besserhören im Geräusche hauptsächlich durch die Erschütterung der in ihren Gelenken *starr gewordenen* Gehörknöchelchen bedingt ist." u.s.w. (last German edition of Politzer's "Diseases of the Ear"). In the English edition of his work the translation is as follows:—"The author is of the opinion, however, that this improvement in hearing during noises is due chiefly to a shaking up of the ossicles, whose joints have become rigid." Treatment in accordance with this belief has consequently been in vogue for many years, though it has

¹ If paracusis were due to stiffening of these joints, *at least one of the many thousands* who every year have undergone treatment by inflation and massage would have been cured of this symptom as soon as these structures became obviously relaxed by treatment. I have never seen nor heard of such an occurrence, though I have observed the drums and joints of a great many unduly relaxed by these procedures, and some of them thereby loosened to such an extent as to be quite useless. The deafness was consequently increased, and the paracusis still remained. Unfortunately all the text-books have perpetuated this teaching. The description which I will presently give of its cause will enable the reader to understand why it is that paracusis persists even after the hearing has been restored by the treatment which I have devised.

proved utterly ineffective. For a generation the profession has been blindly following this disastrous teaching,² so ingrained is its attachment to authority and tradition. I shall bring conclusive evidence to prove to you that paracusis is not the result of any such stiffening; that, far from this being the case, it may, on the contrary, actually be associated with excessive mobility amounting, indeed, occasionally, to extreme relaxation. It is obvious that the treatment which has been recommended, and hitherto practised, must necessarily aggravate undue mobility of tympanic structures, for it has mainly consisted either in distending the tympanum with air (thereby stretching still more the relaxed drum-head, joint, and tensor tendon), or in shaking up the tympanic contents by vibrating massage, when, as a matter of fact, they were already too loose.

Having effectively treated a large number of these cases, I feel justified in asserting that the association of paracusis with deafness does not necessarily render the prospect unfavourable. The ability of these patients to hear perfectly in a noise proves that *the hearing apparatus is, under these*

² *Disastrous* because perpetual failure to cure by the treatment recommended has led the Otological world to believe that deafness of this kind is incurable. Of course it is incurable by measures, which, as I will presently prove, are *quite unsuitable* for this sort of deafness. Any disease may prove obstinate if inappropriate remedies are used.

circumstances at all events, working well. It also suggests that the difference between the condition of the ear in a noisy place in which a *paracutic* can hear, and in a quiet one in which he cannot, may be very little. That significant fact has given encouragement throughout my investigations.

This ability to hear better in a noise than otherwise was termed *paracusis* by Willis, who first drew attention to it, and who attributed it to looseness of the drum membrane. It has since been called after him *Paracusis Willisii*. Though a loose drum may be a cause of deafness, I will presently explain why this condition is not the actual cause of *paracusis*. The relaxed condition of the drum-head, so often met with in patients with *paracusis*, and which naturally led Willis to consider it to be the cause of this symptom, is, however, frequently associated with an increase in the mobility of the hammer bone, to which it is extensively attached. An excessive movement of one or of both of these structures can often be demonstrated with the aid of the pneumatic speculum. It can also be seen that the hammer bone, though unduly moveable, is usually less so than the membrane. It is therefore probable that the latter, which in its vibrations pulls the hammer with it, may occasionally be responsible, in some degree, for the relaxation of the joint between that bone and the anvil. Nevertheless great mobility of the hammer can only occur

when the ligaments joining it to the anvil bone are also stretched, for the latter has other attachments, and the relatively large joint between these two bones, is, to all intents and purposes, the only joint in the ear. I have observed and demonstrated that the comparatively motionless drum-head (drum-membrane or tympanic membrane, as it is also called) can be moved to some extent by muscular action alone, though its movement is probably more often due to the direction and amount of air pressure acting upon it. As it is the function of the lower end of the hammer to accompany it, the movements of this bone resemble somewhat those of the pendulum of a clock. The lower end of the anvil is not equally free to move, for by a curious joint the action of which has never been fully described, it is attached to the stirrup bone, the footpiece of which is fastened to the fibrous oval window (fenestra ovalis) closing one of the two apertures in the otherwise bony capsule of the labyrinth, *which is the real organ of hearing.*

My investigations have shown that the two tympanic muscles, the tensor tympani at one end of the chain of bones (employed mainly in raising the tension of the drum-head), and the stapedius muscle at the other end (similarly concerned with the pressure on the labyrinthine fluid), have, in addition to those important duties and under the reflex influence of ordinary sounds, a certain

small amount of balancing or opposing action on each other, through the medium of the chain of bones. Their forces, though apparently somewhat conflicting in their action, are yet harmonised in their effective ratios by the controlling influence of centrally organised reflex nervous impulses, which are regulated in accordance with, and in response to, impressions arriving mainly from the labyrinth. The two muscular forces thus delicately adjusted in gentle tonic opposition,³ and by inhibition or stimulation rendered variable in the alternating incidence of their dominating action, have an effect which may be compared to the neuro-muscular mechanism which reflexly controls the size of the pupil under the stimulus of light. This arrangement in the ear may therefore also be named accommodation—*aural accommodation*. It would take too long on the present occasion to describe fully this accommodation by the ear. I will, however, just mention that, as in the eye, it appears to have a protective purpose.

It is quite in harmony with their diverse duties that the nervous supply of the two muscles in the tympanum should be derived from different sources.

³ The muscles supplied by the facial nerve and those opposed to them seem always to be more or less in action; they do not rest so much as other muscles. They seem to have more tonus, *e.g.*, those that raise and lower the upper eyelid.

These delicate adjustments are deranged by the pathological changes I have mentioned, and will presently more fully describe, as taking place when the drum-head and joint are stretched. These structures may be stretched either by frequently and forcibly distending the tympanum with air, or by the opposing and striving action of the two muscles involved. These muscles are not in such direct opposition as are the weights at the ends of the beam of a pair of scales. Their forces are co-ordinated mainly through the medium of a slight twisting movement of the hammer bone, which, suspended by its ligaments, articulates with the anvil above, and is imbedded in the drum-head below. Thus these structures together comprise the fulcrum, and the stability of each is essential. Excessive movement of the hammer, in whatever manner it may be caused, leads to relaxation both of the joint and the membrane and produces an unstable fulcrum. The result of this relaxation is, that the tensor tympani when in action pulls on tissues which neither adequately resist its powers, nor on account of the relaxation of the joint, are able fully to transmit them to the opposing stapedius. Removal of proper control of the latter muscle by the tensor, through the medium of a soundly-jointed chain of bones, results in derangement of the balance of accommodation between tympanic and labyrinthine muscles ; consequently the drum-head and the

labyrinthine fluid can neither be kept at that precise tension, nor regulated in that precise manner, which is necessary for good hearing. Further, the contraction of the stapedius, now inadequately controlled, exceeds its proper limits, and leads to stretching of the membrane which surrounds the footplate of the stirrup bone and closes the oval window in the labyrinth; and it is relaxation of this membrane, resulting, as I will presently show, in deafness due to diminution of labyrinthine pressure and function, which permits of that better hearing in a noise, which is brought about by reflex muscular action, and to which, by Willis, long ago, was given the name *paracusis*.

During my study of this subject I have often induced these accommodating and protective, though hidden, muscular movements, with the object of investigating their various purposes. I have observed and demonstrated to other surgeons the visible tightening of the drum-head, and also variations in the power of hearing due to alteration of the position of the stirrup and consequently of labyrinthine pressure, which were brought about by the muscular action I had induced in the tympanic cavity of one ear of a *paracutic*, in reflex response to sounds acting directly on the other ear alone. I have also observed and demonstrated similar though slighter changes in the hearing power, similarly induced, in patients whose drums hammer

and anvil bones have been removed from both ears by operation on account of disease, persons in whom only the stirrup and its muscle still remained effective in the tympanum. In the latter case, the improved hearing could not possibly have been due to any altered condition of the drum-head or joints, for those structures had been removed. As I shall prove it later on, it may well be asserted now, that the improved hearing is partly due to the action of the stapedius muscle in raising labyrinthine tension, for that tension, in *paracusis*, is too low. Associated with the rise in tension, there is an increase in functional activity in consequence of which the hearing is improved.

Now there are various ways in which this combination of paracusis with deafness may be caused. One is by frequent and energetic blowing of the nose while holding it tightly in the handkerchief. Deafness thus produced is by no means rare, though this habit has not hitherto been regarded as the cause. The drums and tympanic joints in many deaf people, though weakened by the changes I will presently describe, would not have become sufficiently stretched to cause deafness but for this forcible distension of the tympanum.

Let me give you an example. A boy (Master S.), æt. 10 years, was brought to me suffering from deafness with paracusis. The rest of his family had excellent hearing. He also suffered from nasal irritation due to enlargement of the turbinal bodies.

The discomfort resulting from this condition led to the constant and vigorous use of the pocket-handkerchief, and consequently to violent distension of the tympanum with air. His mother said: "he blows his nose more than anybody I ever met." On examination it was found that the drums and joints of his ears had become much relaxed by this pressure, though he was younger than those in whom such conditions are usually to be observed.

Another instance is that of a lady, who to my knowledge had had good hearing, and in whose family there was no deafness. She had suffered from "hay fever" for several summers and had become deaf. Her deafness also was associated with paracusis, and accompanied by relaxation of the drums and joints. This condition certainly appeared to be the result, as in the boy just mentioned, of frequent and forcible use of the pocket-handkerchief.

These two cases may with confidence be regarded as examples of deafness much increased, if not entirely caused, by the repeated and vigorous use of the pocket-handkerchief—*i.e.*, *pocket-handkerchief deafness*.

While frequent distension of the tympanum with air in this way may be responsible for paracutic deafness in a certain number of people, this habit alone, is not, in my experience, the most common cause. In the majority of cases the condition is more than a mere mechanical ballooning out of the membrane and simple relaxation of the joints: an

actual loss of drum-structure is perceptible, a loss which apparently involves its fibrous elements. The change is often obvious. The drum is unduly thin and often transparent. It is deficient in substance and therefore in strength. For a reason which I will explain later there is atrophy, yet not precisely of that form which is associated with fœtid ozena, nor indeed is the nasal mucous membrane necessarily dry. Atrophy (less marked in the drum-head, than in other tympanic structures), nevertheless, appears to be the most frequent cause of this combination of deafness with paracusis.⁴ Patients with deafness of this kind usually have catarrh of the mucous membrane lining the nose and throat, a condition which is prone to extend to the lining of the ear. Catarrh in these cavities, though associated with swelling at first, causes in course of time some degree of atrophy and relaxation. Further the nasal discomfort, simulating obstruction on account of slight anæsthesia of the mucous membrane,⁵ frequently leads to such use of the pocket-handkerchief as the atrophied and weakened

⁴ Apparently this atrophy affects the drum-head least of all the tympanic components, for the structure of the mucous lining of this membrane does not permit of such a thickening in the early stage of aural catarrh as occurs in the more vascular parts of the tympanum. Consequently gross changes are more evident in other parts of this cavity; indeed, in some of these cases, the drum-head itself has a practically normal appearance.

⁵ Wingrave pointed out this anæsthesia of the nose.

tympanic structures are unable to resist, or sometimes, indeed, even to feel, for there is generally some anæsthesia of the middle ear also. This I have often proved by observing the movements of the drum-head while the patient, though unable to feel that he was doing so, was distending the cavity.

The combination of symptoms associated with this form of deafness is too constant to be merely accidental. The combination I refer to is usually thus: paracusis, a free—unduly free—Eustachian tube with nasal catarrh, a loose and thin drum membrane, a loose hammer bone, together with a negative Rinne test, and a structurally sound labyrinth, as far as we are able to test it. Some of these patients complain of a noise in the head or ears.

The final stage of most of the cases of aural as well as of nasal catarrh being atrophy, this condition, and the relaxation I have mentioned, are usually responsible for most, if not for all of these altered tympanic conditions. It is also interesting to observe that this atrophic change may characterise the final stages of aural catarrh of both the suppurative and non-suppurative varieties. Apart from the liability of suppuration to destroy the drum, the ossicles, or life itself, there is a greater affinity between it and non-suppurative catarrh than has hitherto been recognised. Either may follow the other, and occasionally they

may be associated for a time in the same ear.⁶ In each case there is always microbic infection; both kinds are at first marked by increased discharge, though this usually differs in route and character; both are accompanied by nasal disease; in both there is increased vascularity and swelling; and usually in both deafness: finally, both may get well. Years after suppuration has spontaneously ceased, and the perforation healed, I have found atrophy leading to deafness and paracusis in one ear of a patient, and in the other, paracutic deafness due to a similar atrophic termination, not of suppuration, but of so-called dry catarrh, as in Case 4, to which I will

⁶ *e.g.*, Acute inflammation, obstruction of drainage by swollen tympanic mucous membrane, and consequently, perforation, taking place in an ear which was previously the seat of chronic non-suppurative catarrh, the acute symptoms afterwards subsiding, and the perforation healing, leaving the chronic catarrh unaltered. I have observed this in each ear of one patient, with an interval of ten months between the attacks; the infection on the first occasion was pneumococcal, on the latter it was mixed. This patient has catarrh of the nose, pharynx, larynx, and trachea, which appears to be constitutional and hereditary. Her mother suffers in a similar way, and has likewise a ruddy complexion. This young patient is becoming deaf, and I attribute this partly to frequent use of the pocket-handkerchief in consequence of the discomfort arising from the nasal catarrh. It has often appeared to me that many of the so-called suppurating aural catarrhs, should really be considered as non-suppurative catarrhs, in which the drums have become accidentally perforated (as in this case) and have failed to heal.

presently refer. Aural catarrh in its early stages, whether suppurative or non-suppurative, being accompanied by increased vascularity, swelling, and softening, leads to relaxation of the soft parts. When the active stage of these two diseases is over, this vascularity and swelling are removed, to a variable extent, by Nature's efforts alone. The removal of this swelling may be deficient, as described by Politzer, leaving undesirable thickening and obstructive stiffening of joints; it may be of about the right amount, and result in the restoration of practically normal conditions and fair hearing; or, finally, the removal may be excessive and lead to atrophy and relaxation and consequent loss of resiliency. This is by far the most frequent termination, and the one which I propose chiefly to discuss this evening, as it is helpful in explaining the cause of paracusis, a matter which has been in doubt for centuries, *i.e.*, as long as this name has been in use.

Now if the process ends in atrophy, the drum-head may lose some of its original fibrous constituents. The result is a weakening, and consequent liability for it to give way under the strain to which it is exposed. The other fibrous and membranous structures in the tympanic cavity undergo a similar change: thus the ligaments of the joints become weakened. The neighbouring Eustachian tube also becomes unduly patent in con-

sequence of atrophy, which is usually the concluding stage of catarrh of its lining mucous membrane.⁷ Even during the reaction following the treatment presently to be described and which has often been effective in restoring hearing, a similar excessive absorption of the structure of the drum-head has occasionally been observed. In these cases Nature, when removing the softer elements, has shown no discrimination, and has also removed the new fibrous tissue which had resulted from an inflammatory process induced for the express purpose of exciting fibrosis: she has carried away in the customary clearance something that might have been left to the patient's great advantage. It is, in truth, difficult to put the brake on Nature's proceedings, and to arrest them exactly at the stage most suitable for our purpose.

A remarkable example of the weakening of the drum-head through atrophy was recently brought to my notice.

A Welsh International football player was advised to consult me by Dr. Pryce Jenkins, who deals with so many football accidents. During last season, 1908-9, this athlete was playing in a match and came into collision with an opponent. He was struck on the shoulder only, rather towards the back,

⁷ This enlargement of the tube permits of greater tympanic pressure of air, when the patient is using the pocket-handkerchief.

over the shoulder-blade. His head was not touched. Yet the drum of the ear of that side was split. There was a tiny hæmorrhage which could be seen, and he was able to blow air through the opening for a few days. The rupture healed within a week. Last October (1909) he turned a somersault when playing again as a "three-quarter-back," and pitched squarely on his shoulder-blades, his head escaping. He continued on the field; yet after the match it was found that he had ruptured the drum of each ear; there was again slight bleeding, and air could be blown through the openings for several days until the drums healed. Dr. Pryce Jenkins was a witness of both of these accidents.

It is evident that the drums of this man's ears are too thin and too loose—they are atrophied, they have not the strength they should possess, and as there is deafness with paracusis, it is probable that all his fibrous tympanic structures are similarly affected. Whether his thin and weak drum-heads were torn in consequence of violent contraction of the tensor tympani muscles, or from pressure of the sudden rush of air from the lungs (all of which could not escape through the nose or mouth), or whether they were torn by one of the many other ways it is possible to name, it is difficult to say with certainty. Yet it is well known that air pressure, as from a blow on the ear, may rupture even a strong drum-head.

Another case which illustrates the absorption of essential structures in consequence of prolonged disease may be mentioned, as it also led to paracusis. One afternoon last year (1909) I performed two conservative mastoid operations on a gentleman while he was under one continuous anæsthetic, for both ears were diseased. Within ten days of this double operation the perforations in both ears were healed, though they had been giving passage to offensive discharge for thirty-six years: the hearing was also completely restored. For several months this satisfactory condition continued, the hearing then became rather less acute, and has since remained so. Even now he is not considered to be deaf, and Sir James Sawyer, who saw him recently in Birmingham, wrote to me: "His case is a very strong one in proof of your work. I see you have given him the *eveillé* aspect which only those have who hear comfortably." It was observed during the gradual clearing-up of the inflammatory thickenings associated with suppuration, that this removal was excessive and went so far as to weaken the tympanic structures, and this has resulted in slight deafness with paracusis. The drum-head now is loose and obviously too thin, and as there is evidence that the pressure of the fluid in the labyrinth is low, it is probable that the membranes closing the windows of that cavity are similarly weakened by atrophy, and have consequently yielded under the strain to

which they also are exposed. This diminution of labyrinthine pressure can usually be demonstrated by one or other of the three pressure tests I employ—the “passive congestion” test, the “active congestion” test, and the “muscular” test. Let me now describe them as they were practised on this patient.

And first the “passive congestion” test. When the patient was seated on a chair, a careful observation of the hearing was made. His body was then bent downwards until chest and knees were in contact. After a short interval to give time for the veins to fill, the hearing was again tested: it was found to have improved, and to have returned to the high standard observed soon after the operation. This test brought about some congestion of the head, and consequently an increase in pressure on the cerebro-spinal, and thus on the labyrinthine fluid, raising it in the latter so that it was more in accord with nature’s requirements. The result was an improvement in the hearing.

Next, as to the “active congestion” test, which this patient observed for himself while taking exercise. It was practised thus: the hearing was first accurately observed; he was then asked to run up and down stairs; this caused quick and vigorous action of the heart, and before it had subsided another observation of the degree of hearing was made. Again it was found to have improved, and to have returned to the excellent

condition that was noticed for some time after operation. The improvement observed during the second test, as in the first, was due to increased pressure in the labyrinth, in consequence of increased blood pressure in the head.

My attention has recently been called to a case in which the rise of blood pressure resulting from the drinking of alcoholic stimulants, has had an effect on the hearing similar to these two congestion tests. A patient with paracusis recently informed me that he acquired the habit of taking whisky frequently, during business hours, in consequence of the improved hearing which he observed to follow the drinking of spirit. Another very deaf patient who has paracusis and knows of my interest in the matter, recently wrote to me from the country to say, that the night before leaving town he dined at the club with a friend, and drank several glasses of wine; half way through the dinner he heard perfectly, but that at the end of the meal, and afterwards, he was very deaf. Evidently the alcohol raised his blood pressure, and through it that of his labyrinth early in the evening, though as soon as the large demands of the digestive organs came into force, systemic blood pressure was lowered and his hearing became worse.⁸ When, however, he got into a cab to go home, his

⁸ This is the stage of slight cerebral anæmia, during which some people become sleepy after meals.

hearing was at once restored by the action of his stapedius muscle, which was reflexly brought on by the noise of the rumbling vehicle.

These examples of improved hearing in consequence of a rise in the blood pressure, suggest that the improvement in the hearing which is known to result from the administration of strychnine to some deaf people with low labyrinthine tension, may possibly be due, wholly, or partly, to a cardiac stimulation, and consequent augmentation of labyrinthine pressure, rather than to improvement in the tone of the nerve tissues themselves, as was formerly believed.

On the other hand, the bad hearing of some people who have paracusis, and of others who have not, is often observed to be worse when they are fatigued. Thus fatigue of the heart, by lowering the blood and labyrinthine pressure, leads to further impairment of the hearing.

These congestion tests, depending as they do on a rise of blood pressure, general or local, cannot always be carried out. The "muscular" test, however, can be adopted when the others may be undesirable or impracticable.

This test, which was suggested to me by observations which I made during a long study of the causes of paracusis, is the most important of all: It is therefore the one I usually employ. I have named it the "muscular" test, depending as it does upon muscular

action—*i.e.*, the contraction of the stapedius muscle. The action of this little muscle is to pull the head of the stirrup bone backwards and to drive part of the footplate, accompanied by the membrane surrounding and attached to it, against the labyrinthine fluid. This direct action, however, is somewhat altered in consequence of the one-sided resistance offered by the incus. In spite of the small size of this muscle, it works so advantageously, owing to the leverage obtained by its movement of the stirrup, that its effect in increasing the pressure on the fluid in the tiny closed labyrinth is considerable, and scarcely any obstructive tympanic condition (save the rare bony fixation of the stirrup), is capable of completely arresting its action, which is to increase labyrinthine pressure. In people with paracusis the pressure is thus raised in a noise to that pitch which is necessary for better hearing.

In the patient referred to (on whom the double mastoid operation was performed) all these tests were positive—*i.e.*, each of them resulted in improved hearing by raising the labyrinthine pressure: they all acted, in fact, like paracusis in a noise.

The improvement in the hearing produced by the muscular test is in my opinion the equivalent of paracusis, though brought about in a voluntary and not an involuntary manner. I am aware of no

way in which true paracusis can be produced except by contraction of the stapedius muscle. I do not agree with Politzer's view, that the improved hearing is the result of a violent shaking up of stiffened ossicular joints by noise.

When the healthy ear is exposed to a loud noise, not only the tensor muscle but the stapedius also contracts strongly, partly to defend the labyrinth, and partly to steady the contracting tensor by opposition. While these structures are in this tense condition, though the hearing is impaired, the labyrinth (the most delicate and important part of the ear) is protected, *if the noise is not prolonged.*

Though we have little voluntary control of the stapedius, I have observed, when contracting the facial muscles (which are supplied by the same nerve, the facial nerve) that it is generally possible to induce this little muscle to contract with them. This contraction can be brought about more readily in company with the muscles around the orbits than with those about the mouth. Observation of the amount of contraction of the orbicularis will enable the surgeon to estimate the extent of contraction of the stapedius. Individuals differ in the amount of nerve energy which they can emit, and the resulting muscular action will likewise vary. During the strong contraction of the orbicularis the rumbling vibrations of the stapedius in action can usually be *heard* by the

patient, who will be able to *feel* that its vibrations synchronise with those of the orbicularis, if he places his fingers at the same time over the orbit.

Now should a patient when forcibly contracting the orbicularis muscles (*i.e.*, by strong closure of the eyes, causing deep wrinkling of the skin all round the orbit) be able to *hear* the stapedius muscles in action with them, the surgeon would be justified in considering the muscular test reliable in that individual. I have been able to carry out this test with a positive result, and thus temporarily improve the hearing of some deaf people who have undergone the radical mastoid operation on both ears. I know two such persons, both of whom are ladies. In a train or a motor-car they are able to hear actually better than those who have normal hearing (*i.e.*, paracosis), though at other times they are deaf. Such facts are in strong conflict with Politzer's long accepted teaching that paracosis is due to the shaking up of stiffened bones and joints by violent atmospheric vibration, for in these patients those structures have all been removed by operation, they can no longer be shaken up, they are gone. Yet paracosis has remained! Therefore the structures must have remained which are responsible for that phenomenon. As in these cases the drum-heads have also been removed they show that paracosis cannot be due, as believed by Willis, to looseness of those membranes.

There is now strong evidence that paracusis is not due to the structures which are essentially tympanic, but to those which more directly affect the labyrinth. What are they? That vexed question can at last be answered with some confidence. Doubtless the cause is the same in all cases. Anyhow in these two patients (as nothing else is left in the tympanum), the structures in question can be no other than the stirrup and its muscle the stapedius, and these are concerned, as I have already insisted, in *raising* labyrinthine tension. As long as the function of these two structures is unimpaired and they are free to move, and by their combined reflex action in a noise, to raise pressure in a labyrinth in which it happens to be too low, then this rise in pressure may cause paracusis, no matter if all other tympanic structures be stiffened, as believed by Politzer,⁹ or loosened, as taught by Willis, or absent, as in the two patients last mentioned. These two patients, though their drums, anvil, and hammer bones are removed, and though they have only those structures left in the tympanum which are directly concerned with raising (not lowering) labyrinthine fluid pressure, can yet hear actually better in a noise than those who have perfect ears. Such cases not only help to explain the cause of

⁹ Though I have occasionally observed paracusis in cases in which the hammer was obviously fixed, this occurrence has been rare. The presence of paracusis in such cases, however, proves that the stirrup, at all events, is free.

paracusis, but afford unshakable evidence of the prime importance of the labyrinth, and of the fact that hearing depends essentially on the health of that organ and not directly on the drum.

To carry out the "muscular" test, you let the patient hear the watch or tuning-fork as far as he can, and then suddenly bring his stapedius muscles into action in the manner I have described. Should the test be "positive" the watch or the tuning-fork at once appears louder, or, if inaudible before, may be heard at the moment of contraction of the muscle. In either case it is evident that the labyrinth has been rendered more sensitive, and this is proof of the absence of that condition which is known as "fixation of the stirrup in the oval window," showing as it does, that this bone must have been moved, and pressed with the membrane surrounding it into the window in question, thus raising the pressure within the labyrinthine cavity.

The answer to the question whether a person whose drum-membranes have been destroyed by operation or by disease can or cannot hear a little, depends mainly upon the state of the labyrinth. No person can hear perfectly whose drum membranes are destroyed, and people in this unfortunate condition whose labyrinths are not in good tension can scarcely be said to hear at all, except in a noise, for they have lost their means of accommodation. More or less deafness therefore must always

remain after removal of the drum-head for the cure of suppuration, whether by the proceeding which is known by the names ossiculectomy and otectomy, or by the radical mastoid operation. You cannot hear well, with a drum, if labyrinthine tension is too low. You may hear without a drum, though never perfectly, if labyrinthine tension is in good order; but it rarely is in good order when the stapedius works unopposed in consequence of removal of the drum and tympanic bones, and therefore of the controlling action of the tensor tympani which was previously transmitted through them. Deafness, usually accompanied by paracusis, therefore, is the rule when drum and ossicles are removed. This fact was indeed my chief reason for designing and instituting a conservative operation in which these important structures are retained. I named it the "conservative mastoid operation," designed as it is to preserve all the structures essential to perfect hearing. As usual in this country there was strong opposition to a new measure which was not in harmony with current pathological teaching, in spite of the successful results I obtained.

America, less hampered by tradition, more readily realised the situation. Dr. Ballenger, Professor of Otology at the University of Illinois, promptly adopted the measure, and after an experience of ten operations read a paper before the Chicago Medical Society, entitled "The Heath Mastoid Operation

whereby the Disease is Cured and Hearing Restored.” In that paper he strongly advocated the operation, recorded an improvement in the hearing of every case, and emphasised the safety of this method as compared with the old one. In the discussion which followed, Dr. Frank Allport (the only surgeon present who had actually seen this operation performed by me) said: “I presume I should not discuss this paper, as I have never performed a Heath operation. I had the pleasure last summer, however, of seeing Mr. Heath do some of this work, and on the whole was pleased with it and resolved to try it when I returned home. I therefore purchased all his essential instruments, but have never used them, being influenced perhaps by the fact that the London aurists are quite generally opposed to the operation,” &c.¹⁰

Opposition has never prevented the adoption of any safe and necessary surgical proceeding, and this conservative operation has already been the means of saving the hearing of many hundreds, if not thousands, of people, and as far as I can learn, without a single death. In the recently published Annual Report of the Cheltenham Ear Hospital which I now pass round, which is the first to give detail, you can see that my method (there described as “Heath’s conservative mastoid opera-

¹⁰ *Illinois Medical Journal*, March, 1908.

tion") was adopted in ninety-two per cent. of all mastoid operations performed at that Institution last year, and without any mortality. I am also informed that the remaining eight per cent. would have been treated by this, instead of by the radical operation,¹¹ if the patients had come earlier under observation—that is, before the disease had totally destroyed their ears. This great change from the radical to the conservative operation has taken place rapidly, for it is little more than two years since I demonstrated the method of performing this safe and precise operation before the surgeons of that Hospital, which they have since adopted with conspicuous success; and little more than three years since I first regularly introduced it, and published my reasons for its introduction, as well as a brief outline of the measure, in *The Lancet*.¹²

Two patients whose ears afford examples of the effect of this operation, and who return to their homes next week, are here to-night for your examination because they have paracusis. This is due to the atrophy which has resulted from

¹¹ No Schwartze (or cortical) operations were performed there last year. My method was adopted in all cases of acute mastoiditis.

¹² August 11, 1906. Though this was my first published description, I exhibited a patient before the Otological Society in 1903 on whom I had performed this operation, and whose hearing had been completely restored thereby.

long-standing disease. (The ear of one of them had discharged for thirty years before operative treatment.) The two provincial aural surgeons (one of whom I am pleased to see here this evening) who had charge of them, did not follow previous custom in such cases and perform the radical mastoid operation with which they were familiar, and which leaves deafness. They transferred them to me, in order that they might undergo the conservative operation which does not cause deafness, and of which they had had no experience.¹³

¹³ For it has not yet been fully described in any British, and only in one American, text-book, Professor Ballenger's. In an address recently given before the Yorkshire Branch of the British Medical Association by Mr. Adair Dighton, F.R.C.S. (Aural Surgeon at the Scarborough Hospital), that surgeon briefly describes my method of operation and points out some of its advantages in the following words:—"The advantages of the operation are many, the chief being: 1. The restoration of hearing; 2. The preservation of the drum and ossicles (without these structures perfect hearing has never been observed); 3. The absence of risk of injury to the facial nerve; 4. Its applicability to all cases, if taken in time; 5. The avoidance of disfigurement" (*Medical Press and Circular*, Jan. 11, 1911). His cases endorse, what I have elsewhere stated (*The Lancet*, Aug. 11, 1906)—*viz.*, that it is possible to save the hearing by this operation even in cases of cerebral abscess and lateral sinus thrombosis. But few of the Annual Reports give precise details concerning the operative methods adopted at the various Hospitals. The Scarborough Hospital Report, however, shows that my conservative method was adopted in all the mastoid operations performed at that institution last year (1910). Mr. Dighton informs me that within eight

For they realized that the livelihood of these two patients, one of whom is a member of our profession, and the other a teacher, depended on the saving of the drums of the affected ears (the other ear in each of them being deaf), and consequently they advised them to undergo operation by my method. You now can observe in each of these patients that the drum has been retained, the discharge from the tympanum has ceased, the perforation has healed, and that the hearing is restored, and all this repair has taken place in the three weeks which have elapsed since I performed those operations.¹⁴

When the three tests which I have described can all be carried out in paracutics, they are usually in accord. They each result in improved hearing in consequence of increased labyrinthine pressure, just as it happens reflexly in paracosis. These and other observations have led me to the definite opinion that it is the involuntary or reflex action of the stapedius, which, acting on a low pressure

months he performed 40 mastoid operations at that institution, all of them by my method. He adds that in every case the hearing was thereby considerably improved.

¹⁴ Though I have often observed perfect restoration of the hearing after my conservative mastoid operation, I have never known it follow removal of the drum and bones. The best hearing recorded after the conservative operation (*The Lancet*, August 11, 1906) was exactly six times as good as the best I have ever observed when drum and bones were removed.

labyrinth, is responsible for the condition known as paracusis, and that the voluntary action of this muscle is the cause of the improved hearing during the muscular test. Experience of a large number of paracusis cases has convinced me that "bony fixation of the stirrup," though often diagnosed, is extremely rare. Such a fixation, if present, would absolutely prevent that movement of the bone which can be proved to occur in the two methods just described.

Study of this subject has led to another interesting observation—*viz.*, that many people, who are slightly deaf, are yet aware of an improvement in their hearing during the application of these tests, though they may appear to have no paracusis. Evidently the labyrinthine tension of such is not at "concert pitch." An improvement in the hearing during the application of the muscular test can also be demonstrated in practically every healthy ear. This shows that the ordinary working pressure in the labyrinth is not sufficient to permit of the most acute hearing, though it may be as high as the organ will tolerate for long periods.

I mentioned just now that violent blowing of the nose might give rise to conditions resulting in deafness with paracusis. I will now explain another method by which somewhat similar conditions may be brought about. An abundant appetite, which is gratified with rich food, in persons taking but little exercise (especially if they are exposed to cold winds and dust

as in motoring), often leads to catarrh of the nose and throat, which is prone to extend to the ear, causing swelling of the tissues there. The end of this process is atrophy, and this leads to relaxation of some of the tympanic structures concerned with accommodation. In spite of this catarrh some can hear fairly well; others in whom it is more advanced, are hard of hearing. The latter can often hear quite well while motoring (paracusis), though for some time after getting out of the car they may be more deaf than usual. At such a time I have heard a motorist say his head had a "wooden feeling." This phenomenon is apparently the result of a labyrinthine change—*i.e.*, a sudden fall in pressure due to cessation of the reflex contraction of the stapedius muscle as soon as the motorist gets off the vibrating car. The muscle is tired, it has become fatigued as the result of contraction which may have lasted for hours in the moving car. Reflexly, as in a noise, this muscle will work longer than it can be induced to work voluntarily, because of fatigue of those other muscles in company with which, in the latter case, it is brought into action. Now it is evident that such prolonged uncontrolled contraction of this muscle, pressing on and tending to stretch the oval membrane, must in time, in many people, have a permanently relaxing effect on that structure. Even in healthy ears such a stretching may happen, and does

happen, in many whose occupations entail prolonged exposure to loud noises. This change takes part, and a great part, in the production of that inveterate form of ear disease which is known as "boiler-maker's deafness." The difference between motor or factory deafness, and "boiler-maker's deafness" is mainly one of degree. Though in the late stages of the disease in boiler-makers there appears to be greater deafness, due to greater changes in the sensibility of labyrinthine structures, yet these changes should be regarded as the result of greater pressure on the labyrinthine fluid. Long-continued high pressure there will damage the organ. There is evidence that too low a pressure will also injuriously affect it, though more slowly.¹⁵ Relaxation of the drum and joint, it will thus be observed, by impairing the accommodation, leads to degeneration of the labyrinth in consequence of inadequately opposed stapelial action, which causes high tension before the window has become relaxed, and low tension afterwards. High or low tension beyond certain limits will cause damage to the ear, as it does to the eye. Thus, in boiler-

¹⁵ People with low tension and paracusis usually have slowly increasing deafness which may gradually become so extreme that they are finally unable to hear either in a noise or even with the aid of a trumpet. Further, labyrinthine tension generally falls too low in unused ears, for like all our organs they are the better for work of the kind for which they were intended.

makers, prior to the yielding of windows, the labyrinthine pressure is too high during their noisy work, owing to powerful stapedial action. After the windows have yielded the labyrinthine pressure, when they are not at work and there is no noise to make the stapedius act strongly, is too low. Each of these extremes, though in very different degrees, usually leads to diminution of the function of the labyrinth, as shown, in addition to other ways, by the diminished power of hearing ordinary sounds.¹⁶

¹⁶ I have observed unnatural mobility of the stirrup, due to relaxation of the membrane of the oval window, in cases of nerve deafness, the latter apparently resulting from long-standing low tension in the labyrinth. In one notable case of this kind (observed at the Throat Hospital) the stirrup was so moveable in the window, that it appeared to have scarcely any restrictive attachments. In this case the atrophic weakening of the oval membrane was remarkable. The labyrinthine tension was also much diminished. Had this tension not been so low, it would either have afforded some resistance to my movement of the bone, or would have replaced it after I had displaced it with the point of a probe, instead of which, the tiny ossicle remained in whatever position it was placed, just like a paralysed limb. Though there was neither discharge nor perforation, yet before operation the labyrinthine fistula test was applied; the result was that the patient fell off the chair momentarily unconscious, so severe was the vertigo. There was also some nystagmus, though its character was not accurately observed during our efforts to restore the patient. It seemed certain, even then, that such results could not have occurred but for a great relaxation of the membrane of the oval window. At the subsequent operation this condition was verified.

The responsive and harmonious alternation in the controlling action of the tympanic muscles is deranged, even in healthy ears, when they are exposed to very loud noises. Both muscles then appear to work their hardest in defence of their respective spheres of influence. It is a case of Greek meeting Greek, a tug-of-war. And what is the result? *Damage to both if the exposure is prolonged.* If thus prolonged each muscle will be found to have injured its own dominions: the tensor to have relaxed the main tympanic joint, and to some extent the drum-head; the stapedius to have stretched the membrane of the oval window. The future individual action of these muscles is thus impaired, as well as their mutual control; for, situated as they both are in bony tunnels, the limit of their effective contraction is soon reached. And once the drum-membrane has become relaxed, the strain on the joint is enormously increased by leverage. The joint is the more important part of the fulcrum, for through it, if at all, must be transmitted the force which the tensor tympani opposes to the stapedius. It is evident that the action of the stapedius is protective to the labyrinth under ordinary conditions, though when, by exposure of the ear to an extremely loud noise that muscle is driven to extra exertion, the high labyrinthine pressure it produces causes injury to, and if prolonged, even degeneration of, that

important organ.¹⁷ Here we have an example of a structure, provided by Nature partly for protection, transformed by excessive use into an instrument of destruction.

It would appear that sustained high pressure in the labyrinth, whether accompanied or not by slight variations, as in a boiler-maker's healthy ear during his work, is more damaging to the organ than the occasional, though far more severe augmentation of pressure resulting from big gun firing, for the deafness of the gunner is *usually* temporary. Consequently this sudden high pressure on the ear from gun firing, rarely does more damage to that organ than a blow, as in boxing, does to the eye. Protracted plus-pressure, even of comparatively moderate degree, is thus shown to have a more damaging effect than brief increments of high degree. The boiler-maker more often suffers than the gunner, exposed as the former is to a practically continuous noise resulting in a sustained reflex pressure; there is not a series of concussions as in gun firing, with intervals during which the ear muscles can relax and afford relief by reducing the labyrinthine pressure. It is thus evident that the daily exposure for several hours to high labyrinthine pressure, due to violent stapedial action in a noise, must leave its mark on the delicate

¹⁷ Scarpa's membrane, in the round window, only affords relief to pressure under ordinary conditions. It is not of much use for diminishing very high tension; it is too small.

intrinsic labyrinthine elements, as well as on those accommodating structures engaged in regulating labyrinthine tension. No doubt the oval window yields in time and somewhat mitigates this injurious pressure. Yet before this occurs serious damage may be done; and even after the window has yielded, and the pressure, in the absence of a noise, is too low, degeneration usually progresses, though more slowly, and increasing deafness is the result.

This degeneration will probably continue unless arrested by some re-establishment of the controlling and protective muscular accommodation. Later on I will explain how this has been effected, and has already resulted in the restoration and preservation of hearing in a large number of people.

Wise Nature, when constructing this wonderful, and delicate organ of hearing, made some provision for its defence against the injury to which it is liable from exposure to loud noises. This defence, unfortunately, is not effective under all the trying conditions of modern life. This is mainly in consequence of the weakness of the ligaments of the tympanic joints. These miniature articulations, held by the most slender of ligaments, and therefore admirably adapted for the easy transmission of ordinary sounds, are incapable of acting efficiently as a medium for transmitting the conflicting strains which arise when the tympanic muscles, in their endeavour to protect the labyrinth from the injurious effects of

loud sounds, are driven to violent opposition, for under such stress their delicate construction renders them especially liable to injury. Nothing will give and take so harmoniously as muscles in proper physiological balance. In defensive and striving action the tympanic muscles are not so adjusted; they then chiefly act upon and injure the frail attachments of the structures which they individually control.¹⁸

Great variations in pressure have also in time such an effect on the sensibility of the labyrinth, that the hitherto recognised methods of examination may prove misleading, and may induce the surgeon to attribute to structural defects, certain signs, which, in reality, are merely the result of altered (usually reduced) labyrinthine pressure. Some of the patients, whose hearing has been restored by the treatment I am about to describe, have stated that their disease had previously been diagnosed as nerve deafness, whereas their ability to hear well in a noise should have given the negative to such an opinion. Others

¹⁸ Though the nature of their attachments, the great diversity in their dimensions, and the indirect method of their communication, indicate that they are not in full and direct opposition, it yet appears necessary that the tensor tympani and the stapedius muscles should be (and in point of fact they are), to some extent, opponents in their action. If it were not so, they would be the only exceptions to the physiological law, that all muscles have opponents. I can find no evidence that the muscles in the ear do not conform to this law.

have been told that their deafness was caused by otosclerosis, yet they have been relieved by the same remedy.¹⁹

Here let me briefly refer to another condition, which, though not often met with, should be mentioned—extremely high tension. In some acute cases of labyrinthine disease, and in others less urgent which are associated with very severe tinnitus and vertigo, a condition of obstruction appears to obtain,²⁰ which may be regarded as analogous

¹⁹ I have long observed that there is a great diversity of opinion in the diagnosis of ear diseases by different individuals. There appears to be no other branch of medical science in which prominent and experienced men give such diverse diagnosis and treatment as in Otology. Clearly there is something wrong with the teaching.

²⁰ Increased intra-ocular tension (glaucoma) seems to be far more frequent than high tension in the labyrinth. High pressure within this cavity, *i.e.*, sufficiently pronounced to cause severe vertigo or Menière's symptoms, is not of frequent occurrence, apparently because the channels of communication between the cerebro-spinal fluid and the perilymph are large and therefore not easily nor often obstructed. I took the opportunity, when it offered in an average case, *i.e.*, one in whom the blood pressure appeared to be normal, of measuring the freedom or size of this communication. In a patient on whom I operated for the relief of chronic aural suppuration, with undoubted symptoms of labyrinthine fistula (one, larger than, and including the whole of the oval window, being found at operation), the trans-labyrinthine flow of cerebro-spinal fluid into the meatus was found to be at the rate of 3i in 65 seconds, roughly about a pint in three hours. This flow, gradually diminishing as the labyrinth healed, went on for several days, without ill-effect; ultimately, when the patient recovered, there was a considerable restoration of hearing.

to that which is present in the eye affected by acute or chronic glaucoma: a condition which leads to rapid destruction of the hearing in a manner similar to that in which glaucoma (acute or chronic) destroys the sight. The labyrinth, like the eye, is too delicately organised to tolerate with impunity long-continued high pressure, and its capsule is even less capable of yielding to the strain. The treatment of this disease, which appears to be a veritable labyrinthine glaucoma, must (as in the eye) be such as will rapidly diminish tension. Relief should be prompt, or the organ will be destroyed outright, and we cannot make new labyrinths. In such grave circumstances, if the diagnosis is clear, it may be advisable to tap the labyrinth in order to save the hearing. Access is indeed difficult, yet if the rare occasion arises, the question of the relief of tension by operation should be considered, provided lumbar puncture (as recommended by Balinsky, Bárány, and Wood) prove ineffective.

The case I am now about to relate to you has a most important bearing on the subject of my address, though the patient had neither paracusis nor loose drums.

In 1907 a doctor recommended a lady to consult me about an ear trouble. This lady had not long before suffered from influenza and suppuration in the ear, perforation, and discharge. The suppuration

had ceased, and the ear was dry, though a large perforation remained. In his letter the doctor asked if my method of mastoid operation would close the perforation. Experience of the healing of many perforations after this operation led me to reply that "I hoped to be able to induce it to heal without operation," and I set about it thus:

I procured five small glass-stoppered bottles. Into the first were placed *equal parts* of blistering fluid (liq. epispasticus) and compound tincture of lavender (the latter being used partly on account of its colour); the second bottle held one part of blistering fluid *to* three of the tincture; the third, one *to* five; the fourth, one *to* seven; and the fifth, one *to* nine. Thus the five bottles contained the blistering fluid and tincture in the proportions of one *in* two, one *in* four, one *in* six, one *in* eight, and one *in* ten respectively. This mixture I will call "paint."

At first the drum-head was lightly touched every day with a tiny cotton-wool mop saturated with the weakest paint (1 in 10). After reaction to this irritant had rendered the membrane more vascular a stronger paint was used. (There is in different individuals a great variability in the rapidity of inflammatory response to this treatment: therefore the greatest caution must be observed as to the strength of the paint we employ.) The strongest paint is rarely required, and then only when granulation tissue has been formed on the membrane.

Within a fortnight a wet and whitish epithelial film formed daily on the membrane. This was as regularly removed with a dry cotton-wool mop, and to the moist surface thus exposed a paint of the strength which appeared suitable was applied. The drum-head gradually thickened. It became red and gave off a small amount of discharge, with a foetor which further experience has shown to be characteristic. Numerous bacteriological and other examinations of this effusion, which were made for me by Dr. Wyatt Wingrave, have led to the opinion that this odour is due to a butyric change in the epithelial elements. At the end of four weeks the membrane was much altered, the swollen upper part (in reality a mass of granulation tissue) reached almost to the arched floor of the meatus. By varying the strength of the daily applications according to requirements it was maintained in this softened and vascular condition for another month, and at the end of that time the perforation had healed. The upper half only of the structure was treated, as it has a more generous blood supply, and will therefore tolerate these measures with less risk of perforation, than the lower half. Experience also showed that treatment of this part affected the whole drum-head. The patient was kept under observation for a fortnight during the consolidation of the inflamed tissues, and was then discharged with a sound ear and restored hearing.

The information acquired by the study of this instructive case prompted me to reconsider a subject that has proved a perennial problem—the difficulty of tightening loose drums. The following questions naturally arose. Will these loose and thin membranes tolerate measures of this kind? Can such treatment be safely applied to them? It was difficult to foresee any reason why they should not, if the strength of the application in use, and if the whole proceeding, were suitably and cautiously graded. There was a possibility, too, that the inflammatory process, if maintained for some weeks, might extend through the drum-head, and along the short neck of the hammer to the relaxed joint, and result in the formation of some useful and strengthening adhesions there.²¹ Further, it appeared that inflammation thus induced might lead to an actual increase of scar tissue which, combined with its property of contracting, might result in a strengthening, as well as a tightening, of the loose and weakened structures. Finally,

²¹ It is better to have a stiff joint here, than one which is too loose; a stiff joint may transmit the muscular power of the tensor, and also sound vibrations, a joint which is too loose is not likely to do so. In health the movement of the hammer is the cause of the movement of the anvil, and thus of the transmission of sound waves to the labyrinth. It is better that these bones should be fixed together and thus be capable of combined movement only, than so loosely connected that one may be moved without the other.

it was anticipated that, if the drum could thus be restored, it might vibrate again as in healthy ears, and that those vibrations through the medium of the strengthened joint, would be transmitted to the labyrinth, and result in improved hearing, even if the tension in that cavity were low.

During this treatment, and for some time afterwards, it appeared undesirable that anything should be permitted which would be likely to interfere with the contraction of the old structures thus softened, or of any new elements formed in the drum and joint. It has been my custom therefore to prohibit the common practice of holding the nose while blowing it into the handkerchief. Such a proceeding, by distending the drum and stretching the joint and tensor tendon, might obviously retard, or prevent, contraction.

Long or noisy railway journeys during treatment, and especially immediately afterwards, should also be discouraged; for the reflex and powerful contraction of the tympanic muscles in a noise, must interfere with that continuous contraction of the new or inflamed tissues which is necessary for the relief of deafness of this nature.

Opportunities soon arose of testing the opinions I have expressed, for some of the vast number who suffer from deafness with paracusis are constantly undergoing treatment. Save that the paint used contained no blistering fluid, but was a less

irritating coloured solution of cantharidin,²² which, by containing an equivalent amount of this active principle was equal to the other in its ultimate effect, the treatment of loose drums was carried out as in the patient just referred to. It was at once successful, and Case 1, which I will presently relate to you, was the first patient treated in this way.

Unless there is considerable reaction the paint should be applied daily in order to keep the membrane moist, for if allowed to dry, the resulting epithelial film usually being transparent will be found most difficult to remove. When not removed it interferes with the daily treatment and renders it ineffective. Further, the close adhesion of this film to the drum-head will cause it to act like a splint, just as a dry film of collodion does, and thus prevent that contraction of the membrane which is a primary object of the whole proceeding. The surgeon, when painting the drum, should ensure that the saturated mop is not brought into contact with the meatus, else it may cause an excoriation, and if the outer half of the passage be thus irritated,

²² A stock solution of cantharidin is made thus :— Cantharidin gr.1, Potassium hydroxide gr.1, water 300 minims. This solution contains the same amount of cantharidin as blistering fluid does. Equal parts of glycerine and water are used when diluting this solution to the proper strength for use, the former being used because it delays the drying of the paint when it is applied to the drum-head.

it may lead to the production of a furuncle. In some people the irritation caused by even a small amount of discharge will lead to this condition.

From this description you will realise how diversity in the size and shape of the meatus, and the variable thickness and vascularity of the membrane, may often render treatment extremely difficult of proper regulation and observation. Hence none but experienced aural surgeons should ever attempt it. The patient should also be warned that during the process, the hearing of the ear under treatment will be temporarily impaired.

The painting usually causes so little discomfort that it does not interfere with the occupation of the patient. A pear-shaped plug of absorbent cotton-wool should be inserted at the conclusion of the daily treatment.

The instruments which have been found necessary, and which I have designed for this work, are lying on the table.²³

²³ Since the preparation of an early and abbreviated edition of this address, hurriedly prepared in order to save daily repetition when teaching new members of the Post-Graduate Class at the Throat Hospital, a large number of British and Foreign aural surgeons have adopted the treatment described herein. There has consequently been a demand for the instrumental equipment. One maker of instruments recently called on me with a letter received from abroad; it was an order for twelve sets of my instruments for the treatment of paracutic deafness. I thought it best to lend him a complete set in order that he might have correct patterns, as it is

Besides the patients I have already mentioned, there are others here who have not yet been treated. Their ears afford examples of the conditions I have described; their hearing is therefore likely to be restored by this treatment.

CASES.

CASE 1. (Mrs. G.).—This lady, the wife of a medical man, had been deaf for fourteen years and had consulted several otologists without obtaining any relief. The deafness had slowly increased, as is the rule when aural accommodation is impaired and labyrinthine tension is too low. Her condition was a typical one of this kind of deafness. Shortly after the commencement of treatment a small perforation appeared; ²⁴ this closed rapidly when the membrane

improbable that any but the simplest instrument will be correctly made by following a merely verbal description. At the time I introduced the conservative mastoid operation the same thing occurred, and so many makers asked for the loan of my instruments to copy in order to supply their clients, that I found it necessary to keep one complete set in reserve in order to lend for this purpose, and thus ensure uniformity.

²⁴ A prominent American aural surgeon, recently visiting this country, called on me at the Throat Hospital. There he saw the treatment of these cases, and heard my description of this disease. He asked for, and received, a copy of the short pamphlet I had printed for teaching purposes. On my next visit there

became vascular. The ear was treated for two months, and at the end of that time her hearing was decidedly better. Further improvement resulted from the contraction of the new tissues in the drum. Conversation was no longer carried on by shouting into her ear, nor by lip reading, a method of communication she had been forced to acquire. It is two and a half years since that treatment was carried out, and having recently examined her I find that the improvement had been maintained.

This was the first patient on whom this treatment was tried. Therefore, before commencing it, I clearly explained to her husband (who, being a doctor, was able to understand them) my views of the nature of the disease, and the probable effect of the treatment I proposed. I also informed him that I had never yet tried it in a similar case. He replied that, as she had been given

he made the following statement to me:—"I have been reading your pamphlet, and it has cleared up a case which has puzzled me for years. I was once attending a Judge of the High Court of the State I live in, for deafness. He also had paracosis. I tried all the book teaching for such cases, and could do no good. My patient was on the point of resigning the Bench, when he took a chill, had inflammation of the middle ear, bursting of the drum, and discharge. It lasted a few weeks. When it had dried up and the perforation healed, his hearing had returned. I could never understand the reason until I read your article. Now I see that you are able to bring about a cure by your treatment."

up by the several Otologists he had consulted, he would be glad if the trial were made.

This first case showed that the treatment, the principles of which I had evolved in theory, was likely to prove effective in practice.

CASE 2. Master S.—(One of the two patients already alluded to, whose drums had become relaxed in consequence of violent blowing of the nose, while holding it.) This boy, æt. 10 years, before he was brought to me had been deaf for at least three years, and had undergone two operations for adenoids, without any improvement in his hearing. His parents had previously taken him to several Otologists, by the last of whom he had been recommended to consult a well-known Professor of Otology living in a Continental Capital. After examining him and recording the condition of his ears and nose I asked his father to bring him to me on his return from the Continent.²⁵ He soon came back. His hearing was unaltered. His parents said that the deafness was considered incurable and that

²⁵ It appeared certain, if a remedy for this sort of deafness had been devised abroad, that it would have been published in the public interest, as all medical advances are, that we, in this country, would have heard of it, and that this patient would have found relief at the hands of some of the Otologists he had previously consulted. A vast number of people in every country have deafness of this nature. Many of them believe themselves incurable because they have been told they are so.

they were accordingly advised to let him be taught lip-reading. Having removed an obstruction from his nose,²⁶ and ordered that it was not to be held while the pocket-handkerchief was in use, I began the painting of the drums. Before this treatment, he was unable to hear the small watch at all, and the loud one was heard at a distance of not more than five inches from either ear. After treatment he could hear the loud watch at 150 inches from one ear, and at more than 100 from the other, and the small one, which previously could not be heard, was audible at twenty inches and seven respectively. The contraction of the new and old tissues in the membrane resulted in further improvement, and when tested two months ago the small watch was heard when thirty-three inches from the better ear—*i.e.*, $33/50$ of perfect hearing. I have therefore recently given the worse ear another course of painting with the object of bringing it up to the level of the better one. This has already brought it up to $25/50$, and as contraction has yet to take place further improvement may be anticipated. (A recent observation has shown that there

²⁶ When nasal obstruction has been observed in these cases the deafness has most often been found to be on the same side. Obstruction in the nose leads to irritation there, and frequently to inordinate use of the handkerchief; doubtless the strain on the ear is greater on the side where the exit of air is impeded. This strain has, as I have shown, an injurious effect on the tympanic structures.

has been further improvement in both ears—viz., to 36/50 in one ear and 40/50 in the other). This patient has been examined by many aural surgeons who also made inquiries from his parents regarding the treatment he underwent in this country and abroad. Some of those gentlemen are now present.

CASE 3. (Dr. P.).—This medical man, æt. 46, consulted me in the long vacation of 1908. While in practice and subsequently he had frequently taken expert advice. One ear had been useless for twenty-eight years, and the other (while capable of use) had done double duty. The hearing in the latter ear gradually diminished until it failed completely five years ago. He then sold his practice. My notes make mention of the fact that for two years he had been at Oxford in order to take a degree with the intention thereby of following some other calling. He had all the symptoms I have described, and was so extremely deaf in both ears that I was compelled to communicate with him in writing. There was also marked nasal catarrh. I painted both drums at that time for two months with but slight benefit; he could just hear shouting close to his ear. In May of last year (1909) he returned and was treated for a month. In the long vacation he came to me again and was treated for two months more. At the end of that time his hearing had considerably improved and conversation was easy. The con-

traction which followed the later treatment resulted in the restoration of his hearing in both ears.

Without consulting me on the matter he purchased another practice and has resumed medical work after an absence of five years. Though living some distance from London, he has come here this evening for your inspection, and to hear my remarks on a subject in which he is naturally interested, fortunately he can now hear them. In addition to the quality of his hearing, which you can test with watch and whisper or the acoumeter on the table, you will be able to observe the new fibrous tissue in his drum membrane whereby it has been strengthened. This is most visible near the centre, where the circulation is least active and where therefore the new structures are less liable to removal. The improvement in his hearing will doubtless be maintained, for during the two and a half years which have elapsed since I initiated this treatment no relapses have occurred. I have advised him, however, as I advise all patients with this kind of deafness, to desist from the practice of holding the nose when blowing it. Those who have once known the great affliction of severe deafness are not likely to disregard this precaution, for as it was possible to produce, so surely is it possible to reproduce this sort of deafness.

Cases 2 and 3 appear to indicate that the effect of this treatment is cumulative.

CASE 4. (Mrs. E.)—This lady, æt. 35, living in the country, could hear a little with her left ear by the aid of a long flexible ear trumpet which she carried about with her. With the right ear she could hear nothing. In spite of being so deaf, she could still hear in a train with both ears without the trumpet. There was atrophy leading to paracusis in each ear. The right ear, which was quite useless in consequence of old dry catarrh, was treated first. Within three weeks of the commencement of the painting, and while the reaction was at its height she could hear conversation. Also for the first time for years she was able to talk through the telephone to her husband in the city from her house in the country. It is worthy of note that the second ear, which was subsequently treated, and which had at one time been the seat of long standing suppuration, was also amenable to this remedy. This case affords an interesting example in the opposite ears of one patient of a similar atrophic termination of two different diseases, culminating in deafness and paracusis.

CASE 5. (Mr. F. F.)—This gentleman, æt. 30, had suffered from deafness with paracusis on both sides for many years. Both ears were treated for two months. The result is that one is practically unaltered, though the other has improved from 12/50 to 47/50—*i.e.*, to practically perfect hearing. Treat-

ment having been but recently carried out, there is yet time for further improvement.

CASE 6. (Miss H.)—This lady, æt. 32, suffered from deafness for eighteen years, and had been treated in this country and abroad. There was marked nasal catarrh, and a history of indigestion and anæmia when younger. All the symptoms I have described were present. The small watch was heard at five inches in the left, the better ear; on the right side it was not heard either on or off contact. She had paracusis in both ears, though it was far more noticeable in the left, the better one, the tightening of which has increased the hearing from five to twelve inches for the same watch; and as this drum has not been completely tightened, another course would probably increase her hearing still more. However, with this improvement she is satisfied that she hears well enough for all purposes. I do not think the tightening process would restore the right ear. Here she requires an operation for the removal of tympanic structures other than the stirrup, and the application of the pressure wicks to that bone (in the manner which I will presently describe) in order to raise pressure in the labyrinth, for the tension there appears to be too low for good hearing, even when the stapedius is acting strongly in a noise. In this ear the disease is too far advanced for the mere tightening of tympanic structures to restore the hearing, as it has in the other.

These six cases are derived from my private practice, for I have but recently commenced this treatment at the Throat Hospital. They are selected and brought to your notice because they are of that large and unfortunate class hitherto considered beyond remedy, and prior to their visits to me they had undergone treatment by eminent Otologists in this country, or abroad, or both, and had all been pronounced incurable. By treatment such as they formerly underwent, which was of that ineffective kind uniformly advocated in the text-books, they were of necessity incurable. If they had consulted me over four years ago it is probable that I should have told them all that I could do them no good.

It is about four years since I devised this treatment, and I have since been investigating its effect and various uses.²⁷ Some of my deaf patients

²⁷ Tinnitus has often been relieved. One surgeon, to whom I demonstrated the method of applying this remedy, writes: "Have you noticed that after painting the drum two or three times in some cases the peculiar noises in the ear disappear?" Another letter from the provinces, reporting progress, says: "One of my cases has made a complete recovery, deafness a thing of the past, and all the uncomfortable noises quite gone." An aural surgeon in Liverpool writes: "I am still having good results with your paracosis treatment, both in deafness and tinnitus." A prominent Colonial, President of the Otological section in his country, when referring to an early and abbreviated edition of this address, says: "I am writing to thank you for the help it has been to me in the treatment of these intractable

who were formerly considered beyond remedy have recently come under similar treatment and have been likewise restored. Others, who were not relieved by a first course of "painting," have had their hearing return after a second or a third. This appears to indicate that though we may by these local applications set up an inflammatory process, and thus induce Nature to increase the amount of fibrous tissue in the drum, we unfortunately are unable to ensure that this increase shall be enduring, and that the newly-formed tissue will not be removed during the consolidation which follows the treatment. Such complete removal explains how this treatment may be effective on the first occasion in some people, whereas in others a second course or a

cases; the results have been so striking that I feel I would like to bring up the subject; such a striking departure should be of immense interest. I may say that I continue to use your method in mastoid cases with much satisfaction." The most distressing case of hyperæsthesia of the ear that has come under my notice was completely relieved by this treatment after drugs had failed. When this unfortunate person first came to consult me he was so much upset by the noise in the streets that he broke into tears. Within ten days the hyperæsthesia had abated under this treatment, and at the end of three weeks, musical sounds, which for a time had appeared to be discordant to his educated ears, were properly heard and appreciated. The complex symptoms associated with Menière's name have been arrested by this treatment, and the hearing improved, in persons who years before suffered from deafness with paracusis, time, however, is required to show if the cures are to be permanent.

third may be required.²⁸ Nature appears to tolerate the presence of new tissue here if it be maintained in position for a considerable time by protracted treatment. If the new structures are not removed soon after treatment is concluded, they appear to be permanent, and the improved hearing also. Treatment for short periods—*i.e.*, under six weeks, has occasionally been effective, though not nearly so regularly as when a full course has been given. Early treatment by this method (*i.e.*, as soon as paracusis is noticeable) is usually more readily, and more completely effective, than when it is delayed for many years, during which the disease may have progressed.

In no case has the paracusis disappeared in spite of restoration of hearing. This indicates that but little labyrinthine change has taken place, and that the improvement is to be regarded as chiefly due to changes in the vibrating and transmitting apparatus, and *diminution of tympanic catarrh*, which are brought about by treatment. The effect of these alterations is, as was anticipated, to produce better hearing by enabling more sound vibrations to reach the labyrinth.

Though these applications readily induce vascularity in the drum membranes of some people, in

²⁸ It is a well-known medical fact that effusions have a greater tendency to organisation and persistence in some individuals, than in others.

others it is not so, and in the latter two or three weeks may be required to produce a safe and protective reaction.²⁹ The diversity in the readiness with which different natures react to irritation, appears to explain that early vascular response which is occasionally observed in aural suppuration, and is an effective defence against bacterial attacks, attacks which in those less readily defended lead to rapid, and occasionally to complete, destruction of the drum-membrane.

There's no protection
'Gainst infection
Like the thing
Which blood can bring.

The evidence which I have accumulated has convinced me that people who have atrophic ears, and therefore a tendency to deafness with paracusis (the commonest form of family or "throat deafness"), may delay, and occasionally prevent deafness, by giving up the practice of compressing the nostrils when blowing the nose. This so-called family deafness appears to result from a catarrh of the throat (naso-pharynx), nose, and ear, a condition which is to some extent constitutional, and is

²⁹ Experience has shown that the deafer the ear and the more advanced the atrophy, the longer the drum takes to become vascularised, and the more time and care are required during the early stages of treatment in order to ensure the gradual induction of vascular protection.

apparently associated with an inherited imperfection of digestion, not necessarily painful. The mode of termination of this catarrh in atrophy relaxation and deafness I have already described.

All forms of catarrhal ear disease appear to be increasing, and this one, which in some cases is due to heredity, is yet influenced by surroundings and the nature and amount of food. In this country the diet is usually too rich, and our city atmospheres are surcharged with dust from traffic and from factories.

If the moveable tympanic structures (other than the stirrup and its muscle) are found to be so disorganised, or to interfere so much with labyrinthine function as to constitute an actual hindrance rather than an aid to hearing, they should be removed, just as the lens and iris are when they become barriers to sight. Those other parts, which in consequence of the presence of paracusis are known to be capable of work, can then be brought into use for the benefit of the patient. I may remark in this connection that far better hearing, due to an alteration in labyrinthine pressure, can be produced in some people who have paracusis and no drums, and in others whose drums are extremely relaxed or, being otherwise diseased, have been removed for the purpose,³⁰ by the use of artificial

³⁰ I have done this with most satisfactory results, though it required a radical mastoid operation, specially designed, and the after-treatment to be so ordered, as to ensure that the

membranes or wet cotton-wool wicks, with the object of exercising pressure on the stirrup, and thus increasing the tension of the fluid in the labyrinth. This improved hearing may be regarded as paracusis induced by artificial means. I have often taught patients how to make and apply these drums and

patient shall subsequently be able to place the wick in position on the stirrup without difficulty, else the sufferer must always be near the surgeon in order to hear. I have also designed a single instrument, which can be carried in a thermometer case, for the patient to use both for making and inserting the wick. (Since delivering this address Mr. Wood has called my attention to the fact that Mr. Yearsley had previously designed a somewhat similar though less portable instrument, which, however, was neither intended, nor is it suitable, for the making of these firm conical wicks.) One of the two ladies I referred to just now (as having paracusis in both ears, after the radical mastoid operation on both sides) was treated in this way. She was sent to me for operation on the second of her ears by a Continental Professor of Otology who had observed the result of my operation on the first one. Though no one without drums has perfect hearing, and consequently this patient, when her ears are unaided, is deaf, she yet is enabled to hear fairly well when the stirrup is pressed firmly against the labyrinthine fluid by the wicks which she places in her ears, there wedged between the anterior meatal wall and the stirrup, where they are invisible. This lady is a great traveller, whereas if she were unable to treat her own ears she would be compelled to stay at home. This paracutic case is of great importance. It was the first in which I obtained definite confirmation of my opinion that the deafness of *paracutics* is partly due to deficient labyrinthine tension. In this instance, inadequate tension within that cavity is chiefly responsible for the deafness, for the direct and firm pressure of the rigid wick is the cause of the improved hearing, by raising, as it undoubtedly

wicks. Then, if necessary, they can change them daily. When extra pressure is thus applied these people can hear, and they know when the wick or drum is rightly fixed, from the labyrinthine feeling which they experience, even before they test their hearing. Whether there is a natural or artificial drum

does, the labyrinthine pressure. In proof of this, there is the fact that this pressure can easily be raised so as to cause vertigo. This lady has lost the drums and bones of her ears on both sides. She is therefore deaf in both ears. Yet in a noise she hears well on both sides; she has therefore paracusis in both ears. She has, in each ear, only the stirrup bone and stapedius muscle to produce this better hearing in a noise: therefore in a noise those structures are capable of improving the hearing. By the firm pressure of wicks on her stirrup bones, she, or I, by raising labyrinthine pressure can also improve her hearing. Therefore her hearing is improved by raising her labyrinthine pressure; therefore a rise of pressure is necessary to improve her hearing, whether brought about by reflex muscular (stapedial) action, or by the pressure of wicks. Therefore labyrinthine pressure is definitely too low to allow of perfect hearing in this paracutic, and is doubtless so in all. In such people a rise of pressure is necessary to enable them to hear perfectly, consequently a rise must take place in paracusis (*i.e.*, the stapedius must raise it). Briefly, *labyrinthine pressure in paracutics is too low, and a rise takes place when paracusis is observed,* and this rise is partly the cause of the improvement in the hearing.* The remainder of the improvement is probably due to the reflex muscular tension on the relaxed tympanic structures bringing them

* The old term *paracusis Willisii* conveys no information regarding the pathological conditions present. The term *labyrinthine paracusis*, however, if applied to this condition, would definitely indicate that the improved hearing in a noise is at all events partly brought about by a change in labyrinthine pressure.

in the ear or not, there can be no perfect hearing without adequate pressure on the labyrinthine fluid, and labyrinthine pressure in some degree depends on blood pressure, as I have shown, either directly on the sac of the endolymph, or on the perilymph through the medium of the cerebro-spinal fluid, or probably in both ways.³¹

more into that tense condition necessary for the transmission of sounds. Some electric aids to hearing seem to owe part of their effect to a paracutic action set up by the noise which they make. The second lady patient I referred to underwent operation and skin-grafting at the hands of another surgeon. The grafts, however, interfered with the application of wicks; consequently she remained very deaf until I removed the graft from one of her ears and applied a wick: this immediately improved her hearing. The increase of deafness which grafting causes is one of my many reasons for not adopting this measure after mastoid operations.

³¹ Nature is not purposeless in her architecture. It is not without purpose that she provides a reservoir which, though communicating with the distant endolymph in the labyrinth, is situated far away within the cranial cavity where it can be affected by the pressure of the cerebro-spinal fluid, and therefore also by that of the blood; for the systemic arterial blood pressure and the pressure of the cerebro-spinal fluid rise and fall together. She also has a reason for the free communication which exists between the perilymph of the labyrinth and the cerebro-spinal fluid. It is mainly through these two channels that some relief to the sensitive labyrinth is usually obtained, when pressure within its rigid walls is too high for the safety of the delicate structures which it contains. It is probable too, in some noisy and at the same time laborious occupations, such as the arduous hammering of boilermakers, that the high vascular pressure during work may prevent to some extent that lowering of

In some rare cases in which the labyrinthine pressure has been too high and has caused severe tinnitus and vertigo, we have been able to lower it and to give complete relief, by drawing off cerebro-spinal fluid through a lumbar spinal puncture.

In these sedentary, dyspeptic, and neurasthenic days, besides a lower temperature than appears to have been the rule when the "normal" standard was fixed, low blood pressure is also a very prevalent condition and cause of deafness. By its lowering of cerebro-spinal, and consequently of labyrinthine pressure, it affects the hearing in a great number of people whose accommodation is impaired. They therefore can only hear either in a noise (when the stapedius raises labyrinthine pressure), or when their blood pressure is elevated by exercise, or other means, sufficiently to raise their labyrinthine pressure through the medium of the cerebro-spinal fluid. This part of my subject, though it is an interesting, and may ultimately prove a fruitful one, cannot be discussed to-night. I hope shortly, however, to write more fully on this important subject.³²

labyrinthine tension by intracranial flow which might otherwise take place, and consequently in these cases the labyrinth more often suffers.

³² Paracutic deafness is a very wide subject. It would require a large volume to describe and discuss, with any approach to fulness, the many important matters which have been observed during this investigation, and which should have proper consideration: many of these matters are not even referred to herein.

Judging from the frequency with which patients with deafness and paracusis report that obstruction of the Eustachian tube is considered to be the cause of their trouble, it is evident that this is a prevalent belief. I have, however, already shown it to be an erroneous one. In old-standing cases of deafness of this kind the tube is usually clear (in fact, it is actually enlarged by atrophy of its walls), and in such cases distension with air more often does harm than good. For such distension must increase the relaxation of the weakened tympanic structures, and this allows of a further unopposed muscular stretching of the labyrinthine window, thus aggravating the condition which is the essential cause of deafness.

Among those who suffer from deafness of this kind, some are accustomed to hold their noses and inflate their ears in order to improve their hearing (Valsalva's method). This, though it may be effective for the moment (like inflation by Politzer's bag or catheter), does ultimate harm in that it increases the laxity of the membrane and joint by driving them outwards, and has a similar effect on the fibrous windows in the labyrinth by driving them inwards, though it is the latter which temporarily improves the hearing by raising labyrinthine pressure which previously was too low.

Inflation by this method will also improve the hearing in some who have lost the drums of their ears through disease or operation. Formerly I regarded this improvement as the result of a shifting of

mucus from the Eustachian tube to the stirrup, where it more effectively aided the transmission of sound. Recently, however, I have observed it in ears which were quite dry, and after careful testing have arrived at the conclusion that this temporary improvement is the result not of a shifting of mucus, even in the moist cases, but of a brief arrest of the cerebral venous circulation, in consequence of the violent expiratory effort, and this arrest of circulation raises for a short time the labyrinthine pressure through the cerebro-spinal fluid; it thus appears to be another form of the "passive congestion test."

I have explained how relaxation of the drum-head and main tympanic joint may impair the action of the tensor tympani muscle. The stapedius muscle may be thrown out of action in a similar way by great relaxation of the membrane of the oval window. With labyrinthine tension thus inevitably reduced, it is not possible to restore the hearing simply by tightening the drum and joint, for the fibrous window in the labyrinth is then too loose, and the fluid pressure within the cavity too low, to allow of good hearing, even when the stapedius is acting and thus slightly raising it. In order to restore hearing under such conditions it is necessary to bring direct pressure to bear on the stirrup in the manner I have just described, and in this way to raise the labyrinthine pressure considerably.

It is sometimes difficult to determine whether deafness is mainly due to a relaxed condition of the drum-head, or to a similar condition of the windows in the labyrinth.

If, however, with deafness accompanied by relaxation of the drum and joint indicating atrophy, the tuning fork tests prove that the labyrinthine function is not seriously impaired, and the patient is able to hear well in a noise, the inference is that it is mainly the transmitting apparatus which is at fault, and that tightening the drum and joint may improve the hearing. If, on the other hand, with all the remaining conditions present the patient's hearing is only slightly improved in a noise, the probability is that the labyrinthine window, the oval one, is so relaxed that the stapedius is unable to raise the tension of the labyrinthine fluid, and that the drum or pressure-wick I have mentioned is the only remedy. Pressure on the stirrup, if it be accessible, or can be rendered so, would settle this point.

I recently visited a Home for the Deaf and Dumb in order to examine the ears of the inmates. Some of them could neither write, read, nor hear, even with a trumpet, and from the Principal I gathered that they had given no previous evidence of being able to hear anything. There was great difficulty in communicating with them until I brought to my aid the muscular test. With the assistance of

that method of raising labyrinthine pressure, many were enabled to hear and could repeat what I said,³³ and their condition indicated that treatment such as I have described might restore their hearing. The Principal, a medical man, who gave up general practice on account of deafness, and who has paracusis and the other conditions I have mentioned, is shortly to come under this treatment. At the conclusion of my investigations at this Home there was evidence that the pressure on the fluid in the labyrinths of nearly all the inmates was too low to permit of hearing and was the cause of their deafness, for the majority of them had sound and moveable drums.

The hearing of *paracutics* often varies with the general health and vigour, the consequent rise or fall in blood pressure reacting on the labyrinth through the cerebro-spinal fluid. This is one of

³³ The so-called deaf and dumb usually do not speak because they do not hear. Those who can hear can speak. The public has not taken deafness seriously. It is, however, a terrible affliction. Medicine has yet to do its duty by the deaf. The man with good ears can scarcely realise the misery of deafness. The blind are cheerful, nay happy, in comparison with the deaf and dumb. The dumb, who have been taught, can "speak" with their fingers by day, but in the dark they are alone indeed. The man who is only blind is in touch with the world. One great man, though blind, was appointed Postmaster-General, another and a greater, Prime Minister, on becoming deaf, resigned his office.

the many proofs, that hearing may be profoundly affected by very slight differences in labyrinthine pressure. Even atmospheric changes have an effect on the hearing of some of these patients. They have volunteered statements to this effect. Variations in the weight of the atmosphere are known to affect blood pressure, and doubtless, therefore, react on the labyrinth through this medium, in the manner I have just described.

The loss of acute hearing is rarely complained of. Deaf patients usually desire to be able to hear ordinary conversation; when unable to do so they often say that they are isolated and lose much of the happiness of life.

Conclusion.—The increase in the amount of hearing of patients with deafness and paracusis which can be observed to follow the administration of alcohol, strychnine, and other drugs; the results of the passive and active congestion tests, the muscular test,³⁴ and of pressure by drums and wicks directly on the stirrup, and therefore on the labyrinthine fluid—all, in their usually similar effects, combine to prove that there is deficient labyrinthine pressure in

³⁴ Had it been possible to agree with Helmholtz regarding the effect of the action of the stapedius muscle on the pressure of the labyrinthine fluid, I should have done so. In the light of the facts I have observed and recorded it does not appear to be possible.

the ears of those who hear best in a noise, and are therefore said to have paracusis. These measures also prove that the rise in pressure, which is brought about in these various ways, is the chief cause of this improved hearing. Conversely, the diminution of hearing power which accompanies fatigue of the heart, and consequent lowering of blood pressure in these patients, confirms this opinion.

The old teaching that paracusis is due to stiffened joints has frequently led to futile, and occasionally even to injurious attempts to improve the hearing by inflating, and in this way shaking up the tympanic structures of patients in whom low labyrinthine pressure was the chief cause of deafness.

I have described to you the methods of investigation whereby we are able to identify this diminished pressure. I have also indicated various proceedings by which it may be raised. My experience of the effect of treatment founded on these, as well as on other observations, which would take too long to describe now, leads me to the conclusion that the majority of those deaf patients who hear best in a noise can, by one means or another, be enabled to hear better at all times. Patients with deafness of this kind, who have been treated by the methods I have described, have usually shown improved hearing. Mr. Wood, who assists me and keeps the records, considers that the hearing of all

those with relaxed drums who have deafness of this type, is improved as soon as their tympanic structures have been tightened up.³⁵

When both ears are involved, that one which is the more deaf is usually treated first; but improvement in the power of hearing is so customary, that most of the patients return later in order to undergo treatment of the second and better ear.

Some patients who have undergone treatment have remarked that they have lost the "deaf feeling" which they previously experienced. Others after treatment have noticed a great improvement in their ability to hear conversation, though their hearing of the watch has not improved.

It is not to be expected that responsible surgeons will be constrained to continue the practice of methods which they find to be useless, or actually harmful, merely because they are orthodox.

During the prompt action required in critical surgical emergencies, or when acting in the obvious interest of helpless or ignorant patients, every

³⁵ In typical cases, if it can be properly applied, this treatment is usually ultimately successful, though a second course of treatment may occasionally be required. There are borderline cases also in which this remedy has been tried with success; some with relaxed drums and but little paracusis, others with marked paracusis and but little change in the drum-head. It is difficult to lay down rules for all these variations; the choice of treatment should be left to the discretion of the surgeon in charge.

experienced surgeon must occasionally have observed conditions which justified him in deciding, not to follow precedents, but to make them. New proceedings, thus inaugurated, are all unorthodox at first.

As you are doubtless aware, the treatment which I have just described is founded on a physiology and pathology which are in conflict with long-accepted teaching. Yet it is the only remedy which has proved effective, and has been the means of restoring the hearing of a great many people who have been given up both in this country, and abroad, as incurable. Now which is right? This new treatment which restores hearing; or the old treatment, founded on the old pathological teaching, which does not? I intentionally and purposely broke the accepted pathological canons when instituting this treatment of deafness with paracusis; it has proved successful, and therefore is presumably in harmony with the pathology of Nature if not with that of the books. I knowingly and deliberately broke the rules of conventional pathology when designing my conservative method of mastoid operation for saving the hearing of discharging ears; and a resolution was sent to me, by persons who had neither seen this operation nor the cures wrought by it, to the effect, that I must discontinue its practice, as it was not an orthodox proceeding, and preservation of hearing was not

considered a sufficient justification for operation. Yet subsequently, when all my cases were exhibited before the British Laryngological and Otological Association, my reason for instituting the operation (saving the hearing) was approved, and I received unanimous congratulation on the results of my new operative method, which was there and then described as "a distinct advance in aural surgery."³⁶ Sir Spencer Wells broke the rules too with success, and like me was requested to cease his beneficent work, when he instituted the operation called ovariectomy, an operation which has since been the means of saving the lives of thousands of women. Fortunately, for the community, others have thrown off the yoke of convention when it was found to be harmful, and among them were the early practitioners of the operation for appendicitis. Were it not so, there would be no progress.

On this occasion I am not concerned to justify, except by results, my departure from traditional practice; such cures as I have recorded are the best justification. Nor do I profess to have solved

³⁶ *The Lancet*, December 15, 1906, p. 1666, and *British Medical Journal*, January 5, 1907, p. 19. At the date of my publication of a description of this operation (August 11, 1906), no text-book contained the description of any such measure, and even now there are but few exceptions, so slowly do the *official* wheels of science travel. Yet the operation is now universally practised and hence might at least be termed *orthodox*.

all the problems which are associated with the remarkable phenomenon, paracusis.

When commencing the special study of this subject I did not hold the opinions concerning the causes of paracusis which I hold now. The evidence which has accumulated during this long investigation has compelled me to change my opinion. Before this change I was much more in favour of Willis's loose drum teaching than of Politzer's fixation³⁷ theory, for there is relaxation rather than stiffening in most of these cases. I gave up Politzerization and vibrating massage as useless, or even worse, years before I devised the remedy which has been described this evening, and in the interval employed treatment for the constitutional condition, and for the nasal catarrh. How aural surgeons could so long continue to accept Politzer's fixation explanation of paracusis, when in such a large proportion of these cases not fixation, but the very reverse of it, that is, relaxation of the drum

³⁷ I never accepted Politzer's theory regarding the stiff-joint cause of paracusis, for my observations of the tympanic conditions present in these cases were not in harmony with his. For some years I believed that the cause of the improved hearing in a noise was the contraction of the tensor tympani muscle and consequent tightening of the drum-head. That opinion, however, was necessarily changed when I found paracusis affecting the hearing of patients with no drums to tighten, patients who had also lost their larger ossicles (the hammer and anvil), and therefore with no joints to become stiffened.

and joint, can actually be seen and demonstrated, passes my understanding. I have never seen nor heard of paracusis ceasing in consequence of further loosening of those structures by the treatment he advocated. This constant failure of vibration and inflation treatment to improve the hearing of these patients, should, long ago, have suggested a reconsideration of the whole subject of paracutic deafness.

Was this done? No. The hallowed belief in the infallibility of teachers, no matter how ineffective their treatment proved to be, was such, that the community, and even the profession, have alike suffered, the former through relying on the latter, the latter in repute, from persistent failure.

Otology is a difficult science. We have need of more definite information concerning the physiology of the tympanum and labyrinth, yet great obstacles are encountered when we attempt to enlarge our knowledge. There is, therefore, some excuse for the backward state of this branch of medicine. Before we shall make much progress there is Otological work required, more difficult than any that has yet been done. In a book recently published, entitled "The Physiology of the Special Senses," a hundred and eighty pages are devoted to the eye, and only a bare fourteen to the ear! This will prove to you that Otology is in its earliest, its barest sleeping infancy. Otology must wake up, must grow up, there is much

to be done ! Look at the thousands around us who have become deaf through discharging ears, or suffer from the deafness I have been describing this evening. *The majority of deaf people become so, through these two diseases.* Yet I have lately found, by the prompt adoption of new and more effective methods of treatment, founded, not on the duration nor cause of the disease (often disastrously misleading guides), but on the tympanic conditions actually present and which, as I have shown,³⁸ can now be recognised, that it

³⁸ To the post-graduate classes at the Throat Hospital for over two years I have been regularly describing and demonstrating the pathological conditions, which, when present in a discharging ear, indicate that the tympanic mechanism is in danger of that permanent disablement which means permanent deafness. Unfortunately these conditions and their destructive tendency are not described in text-books, *nor do their writers recommend mastoid operations in order to prevent the loss of hearing through suppuration*, though they advocate interference when life is in danger. I do recommend mastoid operations *in order to prevent the loss of hearing*, and have devised a conservative one* which has proved effective.† The identification of these important yet hitherto obscure tympanic conditions has been rendered possible by the facilities for observation of the tiny tympanic cavity which are afforded at a certain stage in the performance of my conservative method of mastoid operation.

* *The Lancet*, August 11, 1906.

† Bark, *British Medical Journal*, April 20, 1907 (Supplement), p. 200 ; "Annals of Otology," September, 1907; Ballenger, *Illinois Medical Journal*, March, 1908; Dighton, *Medical Press and Circular*, January 11, 1911; Kopetsky's "Surgery of the Ear"; *The Lancet*, December 15, 1906, p. 1666, and April 27, 1907; also *British Medical Journal* January 15, 1907, p. 19, and July 13, 1907.

is possible to save the hearing in nearly all persons with discharging ears who come early under treatment. This evening I have also brought illustrative cases here to prove that even deaf *paracutics*, who have hitherto been considered quite beyond all possibility of cure, can at length be relieved of their deafness, can have their hearing restored by the treatment which I have just described. Therefore I have confidence that our labours will, in the future,

The tympanic symptoms which indicate the presence of those conditions which are important on account of the injury they may cause to the hearing, are usually present long before those more serious changes which imply danger to life, though occasionally both may appear together. I gave an address on this subject, "The Prevention of the Deafness and Mortality which Result from Aural Suppuration," before the Maidstone Branch of the British Medical Association in November last. In that address I classified the prevalent symptoms, described the changes in the tympanic cavity which those symptoms indicate, and explained how these changes, if allowed to persist, must ultimately result in destruction of the hearing. I hope, before long, to find time to write and publish that address. Its publication would answer the numerous communications which are reaching me (mostly from abroad where deafness seems to be regarded more seriously than in this country) asking for a clear definition of the conditions which, in association with suppuration, justify or even demand the performance of a conservative mastoid operation in order to prevent the threatened loss of hearing. They are asking for precise rules to guide them in this matter; they recognise its importance to the community. Since my publication of the description in 1906 a vast number of conservative mastoid operations have been performed throughout the world by the hundreds of aural and other

have more encouraging results than they have had in the past.

Long study of the auditory apparatus must perforce lead the observer to the conclusion that hearing is the function, not of the tympanum, but of the labyrinth, and that in health the tympanic mechanism is subservient to labyrinthine needs, just as the ocular structures subserving accommodation are regulated in harmony with retinal requirements. Unless there is unhampered adjustment between

surgeons who have attended my operations or read my description. It has proved, however, to be such a safe proceeding that all the patients have recovered from it. There is therefore no longer any ground for the traditional fear of mastoid operations, certainly as far as my method is concerned. *The preservation of the hearing—i.e., of the patient's prospects of usefulness in life, should therefore be given more consideration.* Hitherto it has had little, if any, in consequence of the prevailing deference to old and impotent though orthodox practice. The result of this deference to custom is that *many thousands are yearly permitted to become permanently deaf* through the progress of this destructive disease while they are under trusted though futile treatment by powders and lotions,* or *are actually rendered deaf* by the drastic operations which are advocated in order to arrest the disease. I refer to the radical mastoid operation and ossiculectomy, each of which entails removal of the drum and bones and therefore *must always leave the patient more or less deaf*. Such deafness I have shown to be preventable by timely conservative operation (*The Lancet*, August 11, 1906), and being so, *it should, it must, be prevented.*

* *Futile* because these applications do not reach the deeply-seated disease.

the structures dominated by the muscle of the tympanum, and those controlled by the muscle of the labyrinth, there must be some deafness. It is so rare, however, for the labyrinth to be at fault except in the matter of pressure, that it may be laid down as a precept, that *a very large majority of cases of chronic deafness result from derangement of aural accommodation*. This is clearly the cause in patients with paracutic deafness, for they hear well in a noise—that is, when the muscles of accommodation, responding reflexly to the extra stimulation of a noise, overcome some obstacle to their proper working, and then are free to raise the tension of the relaxed tympanic structures and that of the labyrinth to the proper pitch for hearing. Anything, therefore, may cause deafness, which interferes with the freedom of the mechanism of aural accommodation, and consequently with the requisite regulation of labyrinthine fluid tension, which, like the tension of the drum-head, is under reflex muscular regulation, and *appears normally to be varied in accordance with the variation in the character of different sounds*.

When there is an obstacle to this variation, *then there is deafness*; when this obstacle can be overcome by the extra exertion of tympanic muscles in a noise, *then there may be paracusis too*.

In the short discussion which followed the

delivery of this address, the examination of patients, and a few opening remarks by the President (Dr. Kitchin), Mr. Francis Muecke, F.R.C.S., said: "Mr. Heath's description of this disease and his treatment are entirely opposed to what we have been taught in books about it, though after what I have just seen of his cases I shall certainly try it, for no other treatment does any good. However, I have no doubt it will be strongly opposed, for I remember when he brought in his conservative mastoid operation for saving the hearing of discharging ears, how everybody ran it down because it was not in accordance with books, and now every surgeon at the hospital I am attached to practises it." Dr. Westerman said: "Mr. Heath's address, and his cases, have so upset my ideas of the pathology of this disease that I do not feel competent to criticise his statements."

Mr. Heath, in reply, said: "He regretted that the discussion had been so brief. He had expected, and hoped, to be called upon to answer some helpful and desirable criticisms; the subject, however, was a complex one to discuss without time for consideration and reference."



