

pressed tightly against the auricle without in any way interfering with its vibrations. The spring connection between the disc and handle gives to the user control over the matter of degree of contact. If the patient is very deaf the diaphragm should be pressed firmly against the ear. Another form of this instrument is useful for hearing at a distance and for general conversation.

The Rhodes audiphone (Fig. 1766), which does not come under my classification, is an appliance made of a thin plate of vulcanite which is shaped like a fan and by

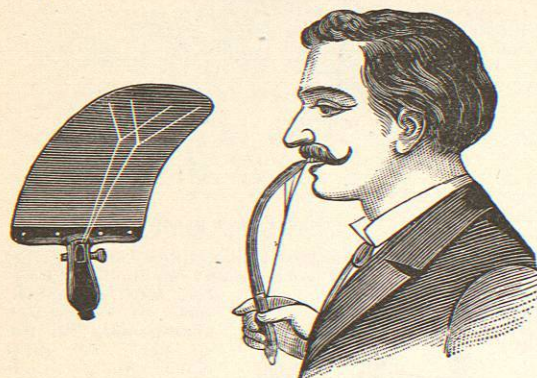


FIG. 1766.—The Rhodes Audiphone.

means of a cord may be bent to any degree of curvature. The upper margin is placed against the upper teeth and the instrument is held with convexity forward. In this invention a large convex surface is provided for the reception of waves of sound, and these are transmitted first to the teeth, and thence through the bones of the skull to the labyrinthine fluid and the auditory nerve independently of the normal sound-conducting apparatus. This instrument is very limited in its conducting property; hence waves of sound with no greater intensity than those of the human voice can affect it but slightly, and on account thereof it has proved disappointing in most instances.

The Akouphone, which has recently come into use, is perhaps attracting more attention than any instrument yet devised. It is the invention of Mr. M. R. Hutchinson, an electrical engineer, and is seemingly the best aid to defective hearing yet discovered. A most satisfactory demonstration of its usefulness was recently made before the Otological Section of the New York Academy of Medicine. The instrument consists of a receiver, an ear-piece, a dry pocket storage battery, and a small flexible cord connecting the parts together. The ear-piece is adjustable at will to conform to the degree of deafness of the person and the intensity of sound desired. The pocket storage battery can be easily recharged from any direct electric light current. Mr. Hutchinson also manufactures a desk and opera outfit to meet the indications which the names imply.

Numerous appliances which have not been referred to, both of foreign and domestic manufacture, might with advantage be brought within the scope of this article. It seems best, however, to limit description to those which experience has proven to be the best. In any given case we should try many of them and not be content until the one is found which proves to be most beneficial. The improvement in hearing which may be temporarily secured from the use of these instruments, in cases in which the function of the auditory nerve has not been destroyed, is very often indeed most gratifying to the individual, and the relief afforded his friends is by no means an unimportant consideration. Where acute inflammation exists they are never to be used. In chronic ear affections, they should be used at a sufficiently early

stage to furnish the necessary stimulus to the nerve, which is tending toward atrophy owing to the absence of its normal vibration.

Franklin M. Stephens.

#### EAR DISEASES: CHRONIC CATARRHAL OR NON-PURULENT INFLAMMATION OF THE MIDDLE EAR.

—ETIOLOGY.—In considering the etiology of the process which is usually treated in the text books under the title of chronic catarrhal inflammation of the middle ear, it is necessary to recognize two separate and distinct processes: one in which the thickening process is tubal in its origin, whether in consequence of nasal trouble or the result of some other pathological process; and a second in which the process begins primarily at the base plate of the stapes (primary periostitis of the labyrinthine capsule: Politzer) and is for a long time confined to that region, later extending to the internal ear and also to the other middle-ear structures.

The first series of cases are usually nasal or post-nasal in their origin, although such nasal trouble need not necessarily be organic. In these patients the first process is an acute secretory middle-ear catarrh which is neglected by the patient and which passes off leaving a certain amount of middle-ear thickening to be increased by the next attack until the resulting deafness becomes perceptible to the patient and his friends. Of all diseases, adenoid disease in the naso-pharynx unquestionably causes the greatest number of chronic middle-ear thickenings,—many of which never receive treatment until the patient reaches adult life. Next to this, acute or chronic hypertrophy of the turbinates, spurs on the nasal septum, and any process interfering with nasal respiration, have an important bearing on the etiology. The prominent part formerly assigned to disease of the faucial tonsils and of the naso-pharynx (other than adenoid) was undoubtedly a mistake.

In many persons a head cold has a decided tendency to produce an acute catarrhal middle-ear trouble and to repeat this process with each succeeding cold. Often the entire deafness can be definitely traced to a simple acute rhinitis where the ear complication was at the time dismissed with the too common remark that "it would improve as the cold grew better."

Many of the acute infectious diseases, although more frequently causing acute suppurative processes, often start a chronic catarrhal middle-ear trouble. Especially where both ears are simultaneously affected,—the one with an acute inflammatory process, the other with an acute catarrhal process,—the pain of the former is apt to cause the patient completely to overlook the existence of the latter. When the catarrhal process occurs as a complication of influenza or of typhoid it is apt to be disregarded, while, on the other hand, a painful ear disease would, under these circumstances, be at once recognized.

Infections of the middle ear are apt to terminate in a chronic catarrhal process; this being especially likely to occur in influenza, typhoid, and measles.

A large number of middle-ear thickenings come from certain constitutional diseases, particularly rheumatism, gout, and syphilis.

Certain occupations are important factors: those in which the patient is exposed to draughts, dust, or other conditions tending to cause an acute rhinitis; and those in which the ear is subjected to the jar of loud sounds, particularly boiler working, nail making, the shuttle rooms in mills, etc. Also the constant use of the telephone certainly plays the part of a cause in a number of cases. It has been the writer's experience that where the ear is healthy when the patient enters an occupation such as that of a telephone operator or a mill operative, no trouble will be experienced, but this is not true of boiler making and nail working.

Those cases in which the disease process begins primarily in the neighborhood of the stapes base plate are rarely tubal in origin and not catarrhal in nature. The process is apparently a vaso-motor one in many instances and often a sequel of neurasthenia. In many individuals it is clearly hereditary. In other cases syphilis, gout, and

rheumatism are prominent factors, as are also debilitating diseases or severe anaemias.

PATHOLOGY.—The pathological conditions found in chronic catarrhal middle-ear disease are either local—*i. e.*, confined to the neighborhood of the stapedo-vestibular articulation—or diffuse throughout the middle ear, according to the type of disease present. In the first form, the Eustachian tube, mastoid process, and membrana tympani are unaffected. The stapes may be fixed by a union of the base plate only or by union of the crura to one or more sides of the fenestra ovalis, or the rigidity may be due to a general membranous or bony fixation, the latter often in extreme cases projecting into the vestibule and cochlea. The pathological lesion here was well understood and studied very early by Toynbee and carefully described by him, but his observations seem to have been too long neglected. In an examination of 1,149 cases he found 53 in which there was a membranous ankylosis of the base plate of the stapes without any enlargement of the base or of the articular surface. In 49 cases there was ankylosis from enlargement of the base plate with no alteration of the structure. Twenty-nine cases showed an osteoma of the base of the stapes, hypertrophy of the normal bone tissue, firm ankylosis, and the enlarged base plate projected into the cavity of the vestibule. New bony tissue beyond the limit of the oval window was found in 85 cases. In 4 cases there was firm adherence to the inferior portion of the oval window, and in 13 cases the entire circumference was ankylosed. In 12 cases the circumference and vestibular surface were affected and the rest of the stirrup was normal.

In the second form of chronic middle-ear catarrh we may find the stapes ankylosed, but such ankylosis is associated with other pathological changes in the tympanum. Often the fenestra rotunda is filled with connective tissue and greatly thickened; some cases of calcification at this point have been reported; at other times the tympanic mucous membrane over the oval window is greatly thickened. Ankylosis of the malleo-incudal articulation is occasionally seen, but that of the incudo-stapedial joint is rare—Toynbee reports only two cases in his 1,149 dissections.

In beginning cases the mucous membrane of the tympanum is swollen and infiltrated, so that the depressions in the attic, the round and oval windows, and the promontory are obliterated and the normal mucous membrane folds are much swollen. At a later stage organization takes place, the mucous membrane is much thicker than normal, and the folds of the tympanum as well as the capsules of the joints of the ossicles are consequently much more rigid.

Similar alterations take place in the Eustachian tube so that the lumen is narrowed by the swelling of the mucous membrane, but actual stricture is rare. Secondary changes take place in the intratympanic muscles, largely from their disuse; they become degenerated or atrophied. From the swelling of the mucous membrane of its inner coat, the membrana tympani becomes less and less transparent and thicker, either in whole or in part.

SYMPTOMATOLOGY.—The onset of this disease is so gradual and the preliminary symptoms are so slight that usually several years elapse before the patient presents himself for treatment. His friends have assured him for some time that he was "becoming absent-minded," and he himself has probably noticed a slight tinnitus, possibly at first only with an acute rhinitis, but later constant. For many years, in slowly progressive cases, the deafness and tinnitus remain the only subjective evidence of trouble. Then, as the stapes and the membrane of the round window become more rigid, the patient begins to have, with a marked increase of these symptoms, auditory vertigo and nausea. The latter symptoms are much more common in ear disease, and especially this particular form of ear disease, than is ordinarily supposed, and it is the experience of every aurist that the correct diagnosis is not made until the patient has been put through a long course of stomach treatment.

The amount of vertigo varies very much, but in the

middle-ear cases it is usually of a mild type and not apoplectic in character, but instances of this are occasionally seen. It varies directly with the amount of thickening about the stapes and within the labyrinth, and with the general condition of the patient. He may stagger when he walks, as if drunk, or in the apoplectic type he may fall to the ground so suddenly as to injure himself. The vertigo is usually worse in the dark and continues when the eyes are closed. In some cases the attack wakes the patient from his sleep. Pure aural vertigo is, however, never accompanied by unconsciousness or local paralysis.

The amount of nausea and vomiting is as a rule dependent on the amount of vertigo and is independent of indiscretions in diet. With some the vomiting is persistent for four or five days and requires rectal feeding.

In many cases of chronic middle-ear catarrh the patient complains of a dull, heavy pain in the depth of the ear; acute pain is, however, never caused by the disease.

In the beginning stage there is apt to be an over-accumulation of cerumen, so that once in six or eight months a large mass blocks the canal and has to be removed. In the later stages of chronic middle-ear thickening the reverse is true,—little or no wax forms, the canal is dry and glistening, and the resultant itching from the dryness of the canal is often very annoying to the patient.

It was long ago noticed that many of these patients possess the ability to hear better in a noise than persons with normal hearing (paracusis—Willis), and this often leads those engaged in noisy occupations to disregard their deafness until it has reached a high degree.

A more annoying symptom which is occasionally noticed, especially in neurotic people, is a hyperaesthesia to tones either of a certain pitch, usually high, or of a certain loudness. This presumably arises from the unnatural tension of the auditory mechanism and will be found very difficult to treat successfully.

When the membrana tympani is relaxed, and also in some cases from the simple increase of intratympanic pressure, the patient is annoyed by a sharpening or flattening of tones in the affected ear, producing a discord when a simple musical tone is sounded. This symptom is probably present in many cases, but is observed only when the patient has a knowledge of music. The middle and upper registers are most often affected. A variation of this symptom is seen in some persons when a jarring sound is heard in the ear whenever a certain note is struck.

In the beginning stages of middle-ear thickening autophony is often complained of. Either the patient's own voice or the sound of his footsteps, or outside sounds, echo in the ear as if a resonator were held to the auricle. Of all the annoyances to which this type of ear disease subjects one, the tinnitus is usually the most wearing. All sorts and varieties of sounds are heard in most cases—either vascular or from spasmodic action of the intratympanic or pharyngeal muscles; hence we have clicking, buzzing, beating, roaring, or singing sounds. In the cases of stapes fixation a very characteristic symptom, often noted one or two years before any other, is a continuous high-pitched tinnitus like escaping steam or the sound of the fields in August. All these varieties of sounds are of course dependent upon the circulation and general condition and are apt to increase when certain drugs are ingested or when certain positions of the body are assumed. Thus, for example, a beating tinnitus is usually increased by alcohol or by bending forward or lying down. As elsewhere stated, the rarefaction of air obtained at an altitude of over one-thousand feet will modify many cases decidedly.

Both the tinnitus and the deafness are apt to be worse in damp weather, and at such times the patient also notices a feeling as if the tympanum were filled with wool. Bodily fatigue also influences both symptoms to a marked degree.

DIAGNOSIS.—The diagnosis of this affection is made by the objective examination of the ear combined with a

functional examination. In the cases in which the process starts in the fenestra ovalis, we may expect to find no pathological change in the membrana tympani, except that in some rare cases a reddish glow is seen instead of the normal yellowish reflex from the mucous membrane of the tympanic cavity. This congestion may cover the whole inner wall of the tympanum or be confined to the region of the oval and round windows.

When the process is tubal in its origin we get immediate objective changes. The membrane is retracted, the short process of the malleus more prominent, and the manubrium less so, being pulled backward and upward and foreshortened. When the retraction is extreme, especially in children, a band extending nearly horizontally from the short process of the malleus to the periphery of the membrane is put on the stretch and made more prominent. The color of the membrana tympani is much altered, being whiter than normal, and there is of course a more or less complete loss of transparency from the increase in thickness of the mucous layer of the drum membrane. Except where some acute process is present, the lustre of the membrana tympani is either unaffected or increased in brilliancy.

The functional examination is the more important of the two in all forms of middle-ear thickening, and should always be made with instruments giving tones of several different pitches. In even a routine examination at least the amount of deafness for spoken words, the results obtainable by the Rinne test with a fork of the middle register, and the upper and lower tone limits should be ascertained before an intelligent opinion can be given.

As a general rule it may be said that the more fixed the stapes becomes in the oval window and the more rigid are the membrana tympani and the ossicular chain, the greater the loss for air conduction of bass tones. At the same time there will be a diminution of air conduction for all tones, this being more marked the lower the pitch of the tuning-fork used; the hearing by bone conduction will also be found to be either unaltered or increased. If the labyrinth is unaffected, the hearing for high tones will be unaltered even where the deafness for tones of the middle or low register is very pronounced.

As a matter of practical experience, it will be often found that in cases of thickening and rigidity of the membrana tympani alone, or of this membrane and the malleo-incudal and incudo-stapedial articulations, the amount of deafness for the watch will be proportionally greater than for other tones, whereas in the primary stapes fixations the hearing for the watch is better than for other tones and the bass-tone hearing is the most affected.

In all testing allowance must be made for the intelligence of the patient, and the test should be made in a quiet room, for the reason that many of these patients hear much better in a noise. One should also be careful not to allow the patient to see the lips in testing with spoken words, as such patients are often proficient lip readers.

**PROGNOSIS.**—Chronic middle-ear catarrh has always been considered the opprobrium of aural surgery, and certainly the prognosis of this disease in the past has often been given too hastily and with too little regard to the etiology and the general condition of the patient.

The prognosis of those cases in which the middle-ear thickening is confined to the membrana tympani alone, or to this membrane and the malleo-incudal and incudo-stapedial articulations, is usually much more hopeful than where the process starts in the stapedo-vestibular articulation. In all cases in which the chronic middle-ear catarrh is the result of a general disease process, as for instance gout or rheumatism, the prognosis must, of course, depend upon that of the causative disease.

As a general rule, all cases in which the tuning-fork reaction in the Rinne test shows the bone-conduction hearing a great deal prolonged over the normal, and especially in those cases in which the air conduction is lost for forks of 512 v. s. or over, the chance of any restoration of hearing is very small. Much depends upon the duration of the disease; and owing to the fact that the onset is in the

great majority of cases slow and insidious, the treatment is apt to be begun long after the middle-ear thickening has become far advanced. It should, however, never be forgotten that the disease left to itself naturally tends to increase year by year, and it is as much the duty of the physician to arrest its progress as to relieve what deafness has already become the fate of the patient.

The tinnitus is often as annoying or even more annoying to the patient than the deafness and requires as careful consideration in the prognosis of any individual case. In brief, it may be said that any symptomatic treatment of this symptom by drugs—such, for example, as the bromide—will prove an utter failure except to tide the patient over a temporary increase of the trouble. Treatment of this symptom should be with reference to the pathology of the disease, and no symptom will be found more dependent upon the patient's general health than this.

Many patients with middle-ear thickening are troubled with a certain amount of vertigo and often also nausea—symptoms which increase in proportion as the rigidity of the ossicular chain increases, and which are decidedly more common in neurotic individuals than in those who show no such predisposition. Here we may hope to effect some improvement by the administration of drugs, especially those which act on the circulatory system; but we should again remember that the vertigo is a symptom of a disease and that it is our chief duty to consider its causation in our treatment.

Especially in the primary stapes fixations, we may consider the prognosis worse when there is a history of hereditary deafness. When the chronic middle-ear thickening clearly results from nasal or post-nasal trouble and is worse after colds, much can be done in checking the progress of the disease; but certainly far too hopeful a prognosis has often been given in these cases, for it is manifestly impossible for any nasal or post-nasal operation to improve a case of middle-ear trouble where there is ankylosis of the ossicular chain, and especially of the stapedo-vestibular articulation, and where the air conduction for bass tones has been markedly diminished for any length of time.

When the disease process is owing to syphilis or to myxœdema, and has not been of too long duration, much improvement can be obtained by appropriate treatment even when the deafness is of a high grade.

**TREATMENT.**—Treatment of this disease may be divided into two great classes, local and general. Considering general treatment first, we find that a very large number of cases are nasal or post-nasal in their origin, and such must receive appropriate local treatment before any permanent improvement can be attained. A large number also are secondary to some disease, particularly gout, rheumatism, and syphilis, or originate during some acute disease, such as influenza, typhoid, or pneumonia. Furthermore, middle-ear thickenings of whatever cause are always much influenced by an intercurrent neurasthenia or anæmia. The treatment in these cases is, of course, plain.

So commonly is the syphilitic element present in middle-ear thickening that the author believes that iodide of potassium and pilocarpine should always be tried before a case is abandoned as hopeless. The disease process here is, as a rule, a tertiary manifestation. Pilocarpine hydrochlorate, in doses of gr.  $\frac{1}{4}$  to  $\frac{1}{2}$  once or twice a day, is often of very great benefit to such patients, especially when given subcutaneously; but as a rule it is of only temporary value, unless given in conjunction with iodide of potassium or mercury.

In the deafness which develops in the course of myxœdema much may be expected from the use of thyroid extract, but it has been the author's experience that no improvement is to be expected from this drug in any other class of middle-ear catarrh, although many claims have been made for it, especially in cases of primary stapes fixation.

For the relief of tinnitus aurium and vertigo a formidable list of drugs has been advocated by various authors, and a careful consideration of the individual case must

always be made in the selection of treatment. Iron and arsenic will of course benefit the anæmic case, and anæmia will be found to be a factor in a very large proportion. The bromides will often, at least temporarily, benefit the neurotic patient. In such cases as are circulatory in their origin, digitalis, nitroglycerin, or strychnine will be found of benefit. Small doses of quinine, gr.  $\frac{1}{10}$  to 1 every three hours, have been strongly advocated for the relief of vertigo, especially by the French writers, but the author has found that very little improvement follows such treatment. In an occasional case some improvement may be obtained from the use of other drugs frequently mentioned for the relief of tinnitus—as, for example, gelsemium, hydrobromic acid, etc. Particularly in the nasal, rheumatic, and gouty cases climatic conditions may have an influence, and much may be gained if the patient is able to make a change of surroundings. When the tinnitus has been due to an increased intralabyrinthine pressure from indrawing of the drum membrane and locking of the ossicular chain, much temporary improvement may be secured by residence at an altitude of one thousand feet or over.

Repeated head colds being a very common cause of this disease, much benefit may be derived from fresh air and exercise, proper clothing, and other measures designed to prevent the recurrence of the acute rhinitis.

**Local Treatment.**—Pre-eminently in local treatment stands inflation of the middle ear by the Eustachian catheter or by means of the Politzer bag, but there is no doubt that in the past this treatment has been adopted too indiscriminately and that much harm has been done thereby.

The Eustachian catheter should be used in preference to Politzerization in all cases in which its use is possible, as in this way the amount of intratympanic pressure can be much better gauged. Also it is possible by this mode of inflation to treat one ear independently of the other. In children and old people the Politzer bag must usually be employed. Care must be taken not to inflate too vigorously or too frequently, and in all cases treatment should be abandoned when the drum membrane shows signs of overstretching, as indicated by an abnormal light reflex in the upper posterior part of the membrane. TheValsalva inflation is very little used at present and is of doubtful benefit, if not of positive harm, to the average patient. By many aurists the middle ear is inflated by means of a compressed air apparatus instead of a Politzer bag; in this case the pressure should not exceed fifty pounds to the inch.

The Eustachian bougie was formerly much used, and at the present time Eustachian electrolysis is having some vogue; both are based on an insufficient study of the pathology of the disease, as actual stenosis of the Eustachian tube is comparatively rare.

Occasionally the Eustachian catheter is used for injecting fluids or vapors into the middle ear: pilocarpine, menthol, muriate of ammonia, and albolene are the remedies which have been especially recommended for use in fluid form, while as vapors the fumes of iodine, chloric ether, camphor, and ammonia are generally employed. In the author's experience very little benefit, other than that due to the effect of the simple inflation of the ear, is to be derived from the employment of these drugs in this manner.

In primary stapes fixation little or no benefit can be derived from any form of middle-ear inflation, as it is obvious that such a process does not start in the Eustachian tube. Here some form of aural massage, such as the tragus pressure of Hommel, or one of the various methods of instrumental massage—*e.g.*, that by means of the Siegle speculum, or the Delstanche masseur, or Luce's pressure probe, or that which is based upon the employment of some form of musical tone vibration—may be of some service. Undoubtedly the simple Siegle or the Delstanche instrument is vastly preferable to their electric prototypes, and by their use an occasional improvement as to tinnitus may be obtained; but there is a great risk of stretching the membrana tympani. The Luce pressure probe also relieves an occasional tinnitus aurium,

but is usually unsatisfactory in its results. All the different forms of musical massage now on the market are unscientific in principle and either productive of no benefit or positively deleterious to the patient.

In this form of the disease much more is to be expected from general than from local treatment, and a careful consideration of the etiology of a given case will usually give a clew to the best treatment to adopt.

Where a patient with tinnitus presents one spot on the membrana tympani which is thinner than the rest of the membrane, relief may occasionally be obtained by covering this place with a very thin piece of rice paper or with the vitelline membrane of the egg. The paper in such cases must be highly sized and thin, and must be made to adhere by moistening it with water. Where relief is obtained by its use the tinnitus will return when the paper works off the thin spot over which it has been placed, *i.e.*, usually at the end of about eight or ten weeks. The egg film is best moistened in the egg albumen, and will then remain in place for about the same length of time as the paper patch.

Where from treatment or otherwise the membrana tympani has become stretched, the patient will complain of a flattening or sharpening of tones. Such cases may nearly always be relieved by placing a paper or egg-film patch over the stretched portion of the membrane, but in some cases it may be necessary to place several layers one above the other. The same result is obtained by painting the flaccid portion with contractile collodion.

From the very beginning of otology aurists have tried by operative means to relieve the patient. Among these operations may be enumerated: making a permanent opening in the membrana tympani; tenotomy of the tensor tympani alone, or of both the tensor tympani and the stapedius; cutting the posterior fold; removing the membrana tympani, malleus and incus, or the incus alone; and, finally, excision of the membrana tympani, malleus, incus, and stapes, or of the stapes alone. All these have had more or less extravagant claims made for them, have had a vogue for a time, and then have gradually been abandoned. Unquestionably each of these measures is applicable to an occasional case and harmful to most others, but this subject will be better handled in the chapter devoted to it. (See article on *Ear Diseases: Operations upon the Tympanic Membrane and Ossicles.*)  
Eugene A. Crockett.

**EAR DISEASES: CHRONIC PURULENT INFLAMMATION OF THE MIDDLE EAR.**—(Synonyms: Otitis Media Purulenta Chronica; Chronic Purulent Ear Catarrh; Chronic Suppuration of the Middle Ear.)

In the present article it is to be understood that the term chronic purulent otitis media applies only to those cases in which the inflammation has lasted for a period of three months or more, with or without treatment; and that the parts involved in the inflammation are the structures which form the middle ear.

**ETIOLOGY.**—A chronic purulent inflammation of the middle ear may be said to develop, in all cases—with the exception, perhaps, of those which are of a tuberculous nature,—out of the acute form of purulent otitis media; and the factor which plays the most important part in conferring the characteristic of chronicity upon them is the lack of proper drainage. There are various pathological conditions which may favor such imperfect drainage. Thus, for example, the perforation in the drum membrane may be of such small size or may occupy such a position that it can drain only inadequately the cavity which lies behind it. Polypi and large granulations may form, and these may partially obstruct the escape of the discharge, while at the same time they aid in rendering it more profuse. Then, as a result of the retention of the discharge, the solid elements which it contains will accumulate in constantly increasing amount, until finally there will be lodged in the attic, or farther back in the mastoid, a cheesy substance—the so-called cholesteatomatous material. Through the agency of the bacteria of decomposition this material soon becomes foul-smelling.