

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.

Still other factors often aid in producing or in aggravating the unfavorable conditions just enumerated. For example, adhesions may form and may serve as further means of retaining the secretion in small spaces or pockets. Necrosis or caries of the ossicles or of any portion of the tympanum may take place when the disease has been prolonged for any length of time, and this is particularly apt to be the case where the disease has been confined to the attic region. In this locality the head of the malleus and also the inner portion of the superior part of the tympanic ring, upon which the head of the malleus rests, are usually found to be necrotic.

**PATHOLOGY.**—In chronic purulent otitis media we encounter a series of pathological pictures quite different from those observed in the acute or subacute form of the disease. The drum membrane, or what is left of it, is usually out of all semblance to its former shape and position, and whatever portion remains is so distorted from its natural shape, owing to previous involvement and the pressure exerted upon it from behind, that it looks, at first sight, like one red mass of granulation tissue, with usually a small depression—sometimes a pouting outward—at the point of exit of the discharge. If this condition be not speedily relieved, we very soon have the destructive process attacking not only the ossicles but various portions of the tympanic wall. The bony part attacked first is usually that part which has a scant supply of blood-vessels, and, as the incus is not at all bountifully supplied with blood, we usually find necrosis beginning here first. Later, the malleus becomes involved, especially that part which articulates with the incus, and, still later, the head; and if the destructive process be not arrested here, very soon erosions, exfoliations, and necrosis will develop in other parts of the tympanum, and particularly at the inner and upper surface of that portion of the tympanic ring on which rests the head of the malleus, as well as over the tympanic orifice of the Eustachian tube. Very rarely in this disease is the inner wall affected. The amount of destruction involving the drum membrane varies greatly: at one time there may be nothing more than a small perforation, and then at another time the membrane may be almost entirely destroyed. In some cases Shrapnell's membrane remains intact, but in others it also is destroyed. The perforation, in the cases in which the damage done to the middle ear is not specially great, is usually located in the posterior inferior quadrant. When the ossicular chain and other parts of the bony structure are implicated, then we find, as a rule, that the perforation is located in the posterior superior quadrant, below or on a level with the articulation of the incus and stapes, and the higher up the perforation is located in these cases the more sure are we to find intratympanic caries.

The presence of a cholesteatomatous deposit in the ear is caused by a rapid desquamation of the superficial epithelial layer of the mucous membrane, and it indicates that the drainage from the region in which the deposit is found has for a long time been inadequate—so inadequate, indeed, that the solid elements of the discharge have been retained in constantly increasing quantity. Decomposition sets in and there is then conferred upon the fluid portion of the discharge a highly acrid and irritating character which doubtless plays an important part in perpetuating and rendering more active the desquamative process. Wherever the mucous membrane is free to expand the acrid discharge excites proliferation of the connective-tissue elements—that is, granulation tissue is formed; but where the mucous membrane is under a certain amount of pressure—as in the epitympanic space and the antrum,—the irritation caused by the acrid discharge manifests itself in an active desquamative process. A very offensive odor characterizes these cases. At first, the cast-off epithelium mingles with the other solid elements of the discharge, but when these accumulate to such an extent as to form a mass of a certain degree of solidity the desquamated epithelium is cast loose in laminated sheets, oftentimes quite leathery in character. As these increase in bulk, layer by layer, they cause pres-

sure and then give rise to a most distressing set of symptoms, to be followed later by sclerosis of the cavity in which they are formed, or they may cause absorption of adjacent bony walls, thus establishing communications between two adjacent bony cavities. When, as sometimes occurs, we find a collection of this material in a middle ear the drum membrane of which is not at that time perforated, we are warranted in concluding that the cholesteatoma developed at some earlier period in life, at which time there was doubtless a perforation of the drum membrane as also a purulent discharge from the tympanic cavity.

The complications which may arise from such a condition as I have just described—viz., mastoid disease, meningitis, infective sinus thrombosis, brain abscess, etc.—will be treated at length in other articles of this series.

**SYMPTOMATOLOGY.**—*Otorrhoea.*—This, which may be the only symptom present, varies greatly as to its quantity, in some cases being so profuse as completely to fill the canal and meatus, no matter how often these parts are cleansed; at other times it is present only as a dry secretion upon the walls of the canal or around the edges of the meatus. During the early stages, the discharge is rather thin, resembling yellow-colored serum, but afterward it becomes thicker, and finally changes its character to that of the purulent type.

In certain cases of this disease we find no discharge whatever, and only the history of this symptom occurring from time to time. The reason for this is easily explained if we remember that partial destruction of the drum membrane occurs in many of these cases early in life, and then at some later date cicatrization takes place, leaving a certain area of the middle ear exposed; and it is in these cases that we get the history of an intermittent discharge, caused by an acute inflammatory process travelling from the mucous membrane of the nose or naso-pharynx through the Eustachian tube, and thus starting up a similar inflammation of the membrane lining the interior of the tympanum, the results of which would naturally find their way where a minimum of resistance was present, namely, through these old openings in the drum membrane, and later appear at the meatus. The absence of any obstruction to the escape of the discharge from the middle ear would explain the absence of pain under circumstances such as I have just described. It will also readily be appreciated how much more easily in these cases, owing to the absence of a portion of its protective covering, the tympanum may become infected.

**Pain.**—This symptom is of exceptional occurrence. During an acute exacerbation of the disease, when there is an abundance of secretion and not enough space for its exit, the patient is likely to complain of pain. In some of the cases of long standing, particularly where destruction of the osseous tissues has taken place, there is a localized and well-defined headache on the side corresponding to that of the affected ear. This symptom is also present, in its most severe form, in those cases in which the cartilaginous part of the canal, and more particularly the base of the tragus, becomes the seat of an acute otitis circumscripta, caused by an infection from the discharge coming from the middle ear. This intercurrent affection is by no means an uncommon one, and usually takes place by reason of the patient, in his attempts to cleanse the meatus, causing an abrasion of any of these structures, thus opening a gateway for infection from the discharge which passes over these parts.

**Eczema.**—This develops in consequence of the irritating qualities of the discharge that appears at the orifice of the meatus. It is encountered more frequently in children than in adults, because the former are continually carrying their fingers to the affected ear, and thus causing a rapid spread of this most distressing disease. At times the eczema completely encircles the external ear, involving a goodly portion of the skin of the mastoid process and the cheek; and, when present, it is the cause of a great deal of suffering on account of the constant desire to rub the parts infected.

**Facial Paralysis.**—This occurs in chronic purulent

otitis when a portion of the bony canal through which the facial nerve passes has become diseased, thereby exposing the nerve trunk. It may also develop without any such disease of the bone, simply through the effect of pressure exerted by inflammatory products upon a facial nerve which congenitally lacks an outer sheathing of bone.



FIG. 1767.—Polypus Removed from the Right External Auditory Canal of a Man Aged Twenty-nine Years. Peduncle attached to upper and posterior wall of tympanum. (Actual size.)

**Vertigo.**—This may take place at any stage of the disease, but when present, it is usually associated with cases of long standing. It is caused by pressure upon the walls of the tympanum, due to the presence of fluid exudation or other inflammatory product in the tympanic cavity, or by a congestion of the labyrinth. In connection with chronic purulent inflammation of the middle ear in an aggravated form, vertigo is very frequently a symptom of some grave, intracranial complication. The symptoms which indicate the development of some labyrinthine disturbance are, briefly stated, dizziness appearing suddenly, nausea, and marked deafness, lasting for a variable length of time according to the persistency of the cause.

**Fungous Growths or Polypi.**—These sometimes develop from the cutaneous walls of the meatus, and doubtless owe their existence to the fact that an irritating discharge from the middle ear constantly bathes the skin of the canal. Those which grow in the middle ear differ very much in size, some being no larger than a pinhead while others are more than an inch in length and of varying breadth. The usual size, however, is that of a pea or a small bean. In shape they differ also, some being perfectly round, while others are spherical, oblong, kidney-shaped, or lobulated, each one possessing a small, firm, fibrous peduncle, whereby it is attached to its base. Polypi, although the majority of them spring from some part of the tympanic cavity, are usually found either in the external auditory meatus or protruding from it. In some cases, however, they are entirely concealed in the vault of the tympanum. The smaller and soft ones are made up of simple granulation tissue, while many of the larger ones contain fibrous tissue alone. In the latter, the peduncle, although small, is exceedingly strong. These masses usually arise from the margin of an area of exposed or carious bone, and their usual point of attachment is in the epitympanic vault or at the upper and posterior end of the tympanum. Occasionally, however, they arise from the mucous membrane in the vicinity of a mass of decomposing material without any connection with a localized necrosis of bone.



FIG. 1768.—Polypus Removed from the Left External Auditory Canal of a Woman Aged Thirty-six Years. The slender peduncle was attached to the upper and posterior part of the vault of the tympanum. (Actual size.)

**DIAGNOSIS.**—Our first duty in making a diagnosis is to determine what structures of the tympanum and parts adjacent are involved, and to what extent such involvement has taken place. In order that this may be done properly, it is necessary in every case, at the very beginning, thoroughly to cleanse the walls of the auditory canal and the drum membrane of any secretion or debris which may be present. This once done, we have a clear field for inspection and can arrive at an exact knowledge of the structures under examination. The technique for such cleansing will be dealt with in full when the treatment is spoken of.

The various appearances which the drum membrane presents in this disease are so numerous that it is an impossibility to give an accurate description of them all in

detail. Certain types, however, occur more frequently than others, and it is of these that we shall speak more particularly.

Among the commonest perforations are those which occupy the posterior inferior quadrant of the drum membrane. They have rather sharply defined edges, and as

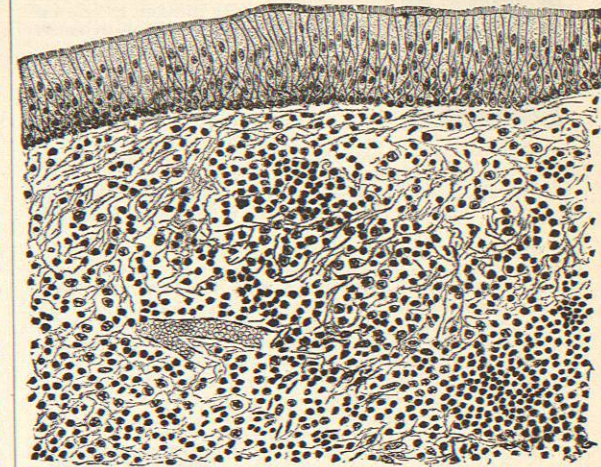


FIG. 1769.—Cross Section of a Mucous Polypus, Covered with Ciliated Cylindrical Epithelium. (From a drawing by Dr. Ira Van Gieson.)

a rule the remainder of the membrane is unaffected. The discharge is scanty, and for periods of varying length it may cease altogether. This type of chronic purulent inflammation of the middle ear is seen more frequently in children than in adults, and is usually associated with a poor state of health or with some diathesis.

In another group of cases we find a perforation in Shrapnell's membrane, about on a level with, or slightly higher than, the articulation of the malleus with the incus. This opening is usually somewhat irregular in shape, and in not a few instances granulation tissue may be seen protruding through it. Such granulation tissue is usually covered with a grayish secretion, which, upon removal, gives forth a decidedly unpleasant odor. Upon passing a fine probe through the opening, we shall almost always encounter diseased bone, existing in an upward and posterior direction.

In a third group of cases the perforation is of rather large dimensions, involving the greater part of the posterior half of the membrana tympani, and its edges look somewhat jagged and irregular, owing to the existence of bands of adhesions which stretch from the free border of the opening to the adjacent wall of the tympanum. In this group of cases we find either a thin serous discharge present, or, as in the majority of cases, we find an abundance of granulation tissue, with a discharge of a purulent character. If a probe is passed directly upward, or upward and backward, through the perforation, it will, in nearly every instance, encounter exposed and roughened bone within the tympanum.

In a fourth group of cases the



FIG. 1770.—Perforation in the Posterior Half of the Drum Membrane.

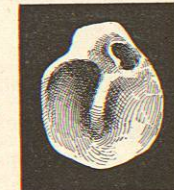


FIG. 1771.—Perforation through Shrapnell's Membrane.