PATHOLOGY AND TREATMENT OF

MENIERE'S DISEASE.

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Introduction:

Prosper Meniere was Assistant Professor of the Faculty and Physician to the Imperial Institute for Deaf Mutes in Paris almost a hundred years ago. About that time physicians classed together all conditions which were characterised by vertigo, nausea and vomiting under the diagnosis of "Apoplectiform Cerebral Congestion," and treatment consisted for the most part of copious blood-letting and violent purgation,

In 1861, Meniere presented a series of four papers in which he gave an accurate clinical description of the disease which now bears his name, and also postulated that the inner ear was the site of the causative lesion. Meniere described the deafness as of nerve type, with a greater inability to hear bass voices than treble. He stated that the external auditory meatus, the tympanic membrane and middle ear showed no sign of disease, and showed that the tinnitus could not be stopped by pressure on the carotid vessels, thus indicating its neural nature.

He also described accurately the attacks of vertigo, which he called "the crises," and he made a plea that the inner ear be studied microscopically, in order to discover the cause of the disturbance, a plea to which succeeding generations of otologists gave no heed until comparatively recently. Williams of the Mayo Clinic has shown that Prosper Meniere has been the victim of much misquotation.

HISTOPATHOLOGY.

In 1938, Hallpike made a histopathological study from material supplied by Cairns, in two cases who died following intracranial division of the VIIIth nerve. Subsequently further studies have been made by Hallpike and other workers. As a result of their work, a table has been prepared which gives the histopathological findings in eighteen affected ears. This table is attached as an Appendix to this essay.

An analysis of these findings shows:-

1. Semicircular Canals:

Normal   =   10
Distortion by Utricle   =   5
Degeneration of Cristae   =   2
Subepithelial
Vesiculation   =   4
Rupture   =   1

2. <u>Utricle</u>:

Dilated	=	8
Normal size	=	8
Macular Degeneration	=	3

3. <u>Saccule</u>:

Dilated	=	10
Ruptured	=	1
Normal size	=	5
Lying over Footplate of Stapes	=	6
Collapsed	=	1

4. <u>Scala Media</u>:

Dilated	=	15
Herniated through Helicotrema into Scala Tympani	=	8
Normal width	=	1
Concave Reissner's Membrane	=	2

5. <u>Organ of Corti</u>:

Degenerated	=	13
Well preserved	=	1
Advanced Post Morten Change	=	3

6. <u>Endolymphatic Duct and Sac</u>:

Normal	=	7
Fibroma	=	1
Dilated	=	3
Absence of perivascular Connective Tissue	=	6
Very dense perivascular Connective Tissue	=	1

7. <u>Stria Vascularis</u>:

Normal	=	10
Atrophic	=	3

It will be seen that the basic abnormality, in most cases, is a hydrops of the endolymphatic system. The greater dilatation in the Scala Media, and to a lesser extent the saccule, has been attributed to

1. its greater proximity to the stria vascularis, which according to Guild is the site of the endolymph production; and

2. the greater thickness of the walls of the utricle and semicircular canals (Hallpike).

The primary change may be due either to an increased production of endolymph, or to some alteration in its physico-chemical constitution, as suggested by Crowe.

Hallpike/

Hallpike also considers that decreased absorption of endolymph by an abnormal endolymphatic sac may be a predisposing factor.   This seems unlikely because:

1.   In 50% of the postmortem material no histological abnormality was found in this organ.

2.   Hallpike examined thirteen "normal controls" and found an absence of loose perivascular tissue in two bones.

3.   It would hardly account for the paroxysmal nature of the disease.

4.   The experimental evidence of Lindsay shows that in, at any rate, the lower mammals, the endolymphatic sac is not necessary for the absorption of endolymph.

It is almost universally agreed that the basic process of this disease presents a histopathological picture of a hydrops of the membranous labyrinth. Yet it would appear that at least two cases of Meniere's disease which have been subjected to histological examination, do not show dilatation of the membranous labyrinth.   Seymour believes that during the first stage of this disease, endolymphatic secretion is reduced, and that Reissner's Membrane becomes concave. In one of the recorded cases (see Appendix), such a concavity was present, but this patient had suffered from the disease for nearly thirty years (Arnwig) and clinically the disease had reached a very advanced stage.   Berggren also reported a normal labyrinth in Meniere's disease.

Brunner, in a review of the literature of the pathology of Meniere's disease, noted cases of vertigo in whom no evidence of hydrolabyrinth was found at necropsy, but it is extremely unlikely that most clinicians would have diagnosed some of the patients on whom he reports as clear-cut Meniere's disease. He described two cases in whom he had diagnosed this condition and on whom post-mortems were performed, revealing no evidence of endolymphatic hydrops. - but both cases had Pagets disease!   In/views he supported Liebermann, Herzog, Zainge, Wittmaack and others who were of the opinion that hydrolabyrinth was generally the result of a serous labyrinthitis, but at the same time he pointed out that serous labyrinthitis or hydrops may not invariably cause hydrolabyrinth and that it may be a reversible process.   Many other observers, including Crowe, Mygind and Dederding, supported this statement on clinical grounds.

Dandy (1941) believed the causative lesion to be situated in the trunk of the/

the VIIIth nerve.   He based this belief on his finding that in about one third of
his cases he was able to demonstrate some abnormality in that nerve at operation.
This usually consisted of simple compression by an abberant artery, but
"arachnoiditis" was sometimes present in the vicinity of the nerve, and excised segmer
of nerve were sometimes stated to show areas of fibrosis.   In support of his theory,
he explained that paroxysmal diseases such as epilepsy, and trigeminal neuralgia
are due to lesions in the brain or nerve trunk.   This seems slender and
unconvincing evidence.

As has been said, it is apparent that the histo-pathological changes, when
present, are more advanced in the cochlear part of the inner ear.   Out of eighteen
cases recorded, thirteen showed degeneration of the Organ of Corti, and fifteen had
dilatation of the Scala Media.   According to Dix, Hallpike and Hood, the characteristi
changes in Meniere's disease are seen in Corti's organ, where the cell mass is compress
with obliteration of cell outlines, while the differential staining of nuclei and cytop
lasm is virutally lost.   A n explanation of the fact that these changes are not always
present may lie in the paroxysmal nature of the disease.   They may occur in the active
phase, (the Crisis' of Meniere) and represent, in the earlier stages of the disease
at least, a temporary and reversible reaction on the part of the neuro-epithelium
concurrent with, or as a result of, the endolymphatic hydrops and its probable chemico-
physical disturbance.   It should be pointed out that in no sections studied was there
any sign of inflammation.

AETIOLOGY.

The cause of Meniere's disease is unknown, but there is no dearth of
theories to explain the condition.

1.   Vascular Dysfunction.

Shambaugh in 1906 suggested that the symptoms of Meniere's disease could
be accounted for most readily by a vasomotor labyrinthine ischaemia.   This
hypothesis was further elaborated by Lermoyez in 1929, who explained that deafness,
tinnitus and vertigo might result either from constriction or dilatation of the
vessels supplying the labyrinth (he compared the condition to Reynaud's disease).
Spasm of the internal auditory artery would affect both equilibrial and cochlear
function.   Spasm of the vestibular brances only would give rise to vertigo without
cochlear symptoms, while spasm of the cochlear branches would produce crises of
deafness and tinnitus, without vertigo.   The cochlear and vestibular nerves being
sensory/

sensory would react as any other sensory nerve to ischaemia, producing first pain then anaesthesia.   In the case of the cochlear division "pain" is represented by tinnitus, and "anaesthesia" by deafness, while vestibular "pain" is vertigo. Vestibular "anaesthesia" is not represented as any clinical symptom, but may be demonstrated by tests of vestibular function.

Atkinson added to this theory.   He considered that most cases of Meniere's disease were due to spasm of the internal auditory artery, and this was followed by a secondary dilatation producing increased capillary permeability which in turn led to increased production of endolymph.   He supported his views with the following evidence:-

1.   Small doses of amylnitrite relieve attacks of vertigo.   Larger doses, which lower the blood pressure, increase the vertigo.

2.   Acetylcholine will relieve an attack of Meniere's.

3.   Amphetamine will precipitate an attack, but if this drug is combined with a powerful vasodilator such as nicotinic acid, this effect does not occur.

4.   Injection of Adrenaline will precipitate an attack, this effect being antagonised by nicotinic acid.

Fowler considers that "blood sludging" is the basic mechanism which causes the acute attacks of vertigo.   This is characterised by agglutination of masses of erythrocytes with slowing of the blood flow and increased capillary permeability. He believes that the "blood sludging" follows exposure to stress, which is most commonly psychological in origin.

The original theory of Angiospasm is favoured by Hilger, who believes it may be due to:-

1.   a constitutionally unstable vascular system.

2.   allergy.

3.   physical environmental changes

4.   emotional reactions.

Williams shares the views of Hilger, but includes autonomic dysfunction in the list of aetiological factors.   On this basis, he has evolved a theory which he describes as intrinsic allergy.

The theory of vascular dysfunction is probably more widely supported than any other, but there remain objections to it.   The protagonists hold that the vascular abnormality/

abnormality is functional in type, thus explaining the lack of any histological abnormality in the blood vessels of the inner ear in specimens which have become available for postmortem study. How do they explain the absence of vascular disease in other parts of the body? Cawthorne finds it difficult to understand why such vasospasm should consistently favour one artery. Even in migraine, where the presence of vasospasm has been demonstrated, the attacks show little lateralisation as either side is affected at different times.

2. Allergy.

Atkinson, Dohlman and Harley have all recorded cases of Meniere's disease which were apparently due to food sensitivities, and which were relieved by avoidance of the allergen.

Atkinson, in 1941, stated that about 20% of all cases of Meniere's disease were due to some form of physical allergy. He postulated that the labyrinthine condition was due to vascular dilatation, with increased capillary permeability and increased production of endolymph leading to the characteristic labyrinthine hydrops. He differentiated the allergic group by means of the intradermal histamine test. This test was originally suggested by Dzsinick and Galle in 1939. Atkinson attempted to desensitize these patients to histamine. This theory has not been confirmed by later work, but it/only fair to say that Atkinson himself appears to have abandoned the allergic theory and now considers the disease to be due to a vitamin deficiency.

In an admirable review, Harley has shown that later research into allergy has failed to detect any significance in histamine skin reactions in allergic and non-allergic individuals, and adequate clinical trials have proved that histamine is useless as a specific treatment. In this paper, Harley evidently assumes that histamine therapy is invariably used to reduce "histamine sensitivity," which, of course, is not the fact. On the contrary, it is often used as a vasodilator on the assumption that vasospasm plays some part in the production of Meniere's disease.

Hallpike has advanced several objections to the allergic theory:-

1. Other allergic phenomena are not often seen in Meniere's disease.
2. Most allergic diseases become manifest by early adult life. Meniere's disease usually appears first during middle age.
3. There is a strong family history of allergy in most patients suffering from allergic disease. In Meniere's disease a positive family history is most unusual.

These observations are in agreement with those of most other observers.
Thus Cawthorne in a series of 800 cases of Meniere's disease found the average age
of onset of symptoms to be 44-45 years, and the incidence of other allergic disease was
less than 5% (41 cases).

3.   Abnormal Water and Salt Metabolism.

Mygind and Dederding believe that Meniere's disease is due to the retention
of water in the labyrinth.   This in turn is stated to be the result of a defective
peripheral circulation which is characterised by abnormal capillary permeability.
The periodicity of the disease is due to variation in the amount of water-retention.
The circulatory defect is generalised and results in the appearance of subcutaneous
infiltrations of water, the site of which is determined largely by gravity.   Ear
symptoms are stated to be worse in the morning due to the lowered position of the head
during sleep.   Mygind and Dederding supported their theory with the following
evidence:-

1.   The favourable therapeutic results obtained by limiting water intake in
     Meniere patients.

2.   The results of water retention tests which were performed on 63 patients
     suffering from Meniere's disease, by Neilson.   In 61 cases water retention
     of varying degree was noted.

Furstenberg, Lathrop and Lashmet made careful studies of water and salt
metabolism in one case of Meniere's disease.   They were able to precipitate attacks
of vertigo by increasing sodium intake only despite the absence of corresponding
increase in water intake.   Later they reduced the salt intake and raised the water
intake but this was not followed by any attacks of vertigo.   From this evidence these
authors concluded that Meniere's disease was due to sodium retention in the
labyrinth, and that water retention was not an aetiological factor.

Later work has failed to support either of these theories and the opposing
evidence is considerable:-

1..   Talbott, Brown, Coombs and Consolazic determined the serum sodium levels in
      14 inpatients who were suffering from Meniere's disease.   These were all
      within normal limits.   Later, sodium was administered and resulted in a rise
      of serum sodium to an average of 143.7 Milli equivalents, yet none of these
      patients had an exacerbation of their symptoms.   In several cases electrolyte
      studies were made during an acute attack but no increase in the blood
      sodium/

sodium level was noted, although the serum potassium level was sometimes raised.

2. Perlman, Goldinger and Coles showed that the human body exerts a remarkable control over electrolyte concentrations through the action of the functioning renal tubule. Only by extreme abnormalities in input and output were they able to alter these levels. Patients suffering from Meniere's disease were observed in hospital for 2 - 4 weeks. The first group were given diets containing 300 mgn. of sodium with diuretics and even then it was difficult to maintain a significantly lowered level. The second group were given 8 Gm. of sodium daily with desoxycorticosterone to promote sodium retention. Cochlear function was tested daily. The lability of the disease was evident but no consistent effects on cochlear and vestibular function were noted in the first group of patients. No acute attacks of vertigo or increased deafness were observed in the second group.

The Kepler water test failed to show any impaired water diuresis in these patients and no changes in vestibular or cochlear function were noted during the test.

3. Mygind and Falbe-Hansen made a histological study of the labyrinths of guinea-pigs which had been subjected to gross changes in water and salt intake. In the first group of animals, which had received intraperitoneal water, there was no histological abnormality. The second group of animals received intraperitoneal salt, which produced a pronounced shrinkage everywhere in the tissues. This was, however, least marked in the labyrinth.

4. The renal tubules are largely responsible for the control of electrolyte and fluid balance in the body. Labyrinthine symptoms are extremely rare in patients suffering from renal disease. Study of 117 consecutive cases of Meniere's disease in the department of Dr. J.P. Stewart, Edinburgh Royal Infirmary showed that apart from the aural condition, these patients as a whole were very fit and in no case was there any evidence of renal disease.

5. Crowe has asked these very pertinent questions for which the supporters of the abnormal water and salt metabolism theory have produced no satisfactory answers. If the disease is due to a general metabolic cause (a) why are the symptoms relieved by operation on the VIIIth cranial nerve without change in dietary habits; (b) why should the disease only involve one ear in 90% of cases; and (c) why does the hearing sometimes improve after operation?

4.   Vitamin and Dietary Deficiency.

Some workers have found a lack of ascorbic acid in the urine of
occasional cases of Meniere's disease, and have shown a connection between lack
of Vitamin C. and cases of autonomic imbalance and vasomotor disturbance.

Mellanby's experimental work on growing young animals demonstrated
increased endolymph and perilymph in these animals suffering from Vitamin A.
deficiency, and he found degenerative changes in the Organ of Corti in those
animals in which serous labyrinthitis developed.   Both the cochlear and vestibular
divisions of the VIIIth cranial nerve showed severe degeneration, together with
widespread degeneration of the nervous system.   But it has been shown that this effect
on the VIIIth nerve at least has been due to the pressure of overgrowth of
periosteal bone, and it is most unlikely to occur in mature animals.

Selfridge considered that lesions such as Mellanby described were the
result of peripheral vascular disorders, and concluded from an extensive review of
the literature and from his own work that the entire Vitamin B. complex might be
a causative factor in the production of Meniere's disease.

Atkinson (1949) considers there are two main types of Meniere's disease.
The first type is characterised by a perceptive deafness and attacks of rotary vertigo.
This is due to a lesion in the nerve and not as a result of nicotinamide deficiency.
A conductive deafness with attacks of positional vertigo, is present in the second
type which, he states, is due to an end-organ lesion resulting from riboflavine
deficiency.   Between the two main groups are many transitional cases due to
mixed deficiencies.   Atkinson supports these views by:-

1.   The high incidence of associated signs and symptoms of Vitamin B.
       deficiency in his cases of Meniere's disease.

2.   The favourable response to Vitamin therapy.

3.   Selfridge's evidence that degenerative changes occur in the VIIIth nerve
       in animals deficient in Vitamin B.

There does not appear to be much support for this theory, and several
facts can be placed against it.

1.   There is no histological support for two types   (nerve root and
       end-organ) of Meniere's disease.

2.   Why should a chronic Vitamin deficiency produce such a paroxysmal disease?

3.   Why should the vertigo be cured by operative destruction of the labyrinth
       without/

without any change in dietary habits?

4. Why is the condition unilateral in 90% of cases?

5. Most other workers have failed to confirm the high incidence of
    associated Vitamin B. deficiency.   The 117 cases seen in Edinburgh
    Royal Infirmary were on the whole a very well nourished group of
    individuals.

6. If the main aetiological factor was a Vitamin deficiency, one would
    expect a much higher incidence of Meniere's disease among the underfed
    masses of Africa and Asia.   On the contrary Allan states the disease
    is very rare in Asia.

In consideration of the part vitamin deficiency may play in the production
of Meniere's disease, there is one final and interesting fact to remember.
It has been shown recently that enteric bacteria possess the power of decomposing
ascorbic acid and members of the B. group.   The possibility of such vitamin
destruction in the bowel suggests that a vitamin deficiency may arise though the
vitamin intake is adequate.

5.   Focal Infection.

Wright believed the pathology of Meniere's disease to be a chronic
inflammatory lesion (focal labyrinthitis) secondary to a focus of infection
elsewhere.   Several facts can be claimed to support this view.

1. The similarity between Meniere's disease and chronic iritis, which was
    commonly regarded as secondary to sepsis elsewhere.

2. In a series of 66 cases described by Wright, there was one or more foci
    of infection in each patient.

3. In this series, there was a very high incidence of other disease, such as
    rheumatism, neuritis and iritis, all of which have been attributed to
    septic foci.

4. Wright claimed excellent results in the treatment of Meniere's disease by
    eradication of septic foci (66% cured or improved.)

5. The histopathology of Meniere's disease is rather similar to the condition
    described by Wittmaack as "hydrops labyrinthi" which was regarded as
    representing the reaction of the labyrinth to damage from bacterial or
    other toxins reaching it through the round window or by the blood stream.

In its original form Wright's theory has largely been discredited. This is due to the failure of most other workers to

1. find a septic focus in most of their patients with Meniere's disease

2. to achieve good results by surgical means in the majority of cases in whom such a localised focus was found.

In the 117 cases studied in Dr. J.P. Stewart's clinic, a septic focus was found in five persons.

Harley has resurrected Wright's theory by modifying it to that of bacterial sensitisation or allergy.

6. Chronic Herpetic Neuritis of Labyrinth.

Hallpike and Cairns, and later Altmann and Fowler described the presence of subepithelial vesicles in the semicircular canals of patients who had had Meniere's disease. Lempert believes they form the basic pathological lesion of the disease and he describes four stages in their development. He attributes the paroxysmal symptoms to the rupture of the vesicles with the release of a toxic fluid into the endolymph. Lempert does not advance any suggestions as to the cause of the vesicles.

The real significance of the vesicles is unknown but this theory does not fit in with the known facts.

1. These vesicles were noted in only four out of the eighteen ears which have been histologically examined.

2. Subepithelial vesicles were present in seven out of ten "normal controls" examined by Seymour.

3. If they rupture to liberate their contents, one would expect to find, at least on occasion, a break in the continuity of the wall. This has never been demonstrated.

4. The main histopathological abnormality in Meniere's disease is located in the Scala Media, whereas the vesicles are most commonly situated in the semi-circular canals. Toxin-contaminated endolymph from this site would have to flow against the normal endolymphatic current through the utriculo-endolymphatic duct.

7. Heredity.

Brown believes there is a strong hereditory factor in Meniere's disease, because at the Out-patient Department of the Massachusetts General Hospital

she has seen

1. Two members each of five different families who suffered from the
    disease.

2. Three affected siblings resulting from a consanguineous marriage.

3. A pair of identical twins, one of whom had Meniere's disease, while
    the other had a labyrinthine deafness.

Out of the 117 cases in Dr. J.P. Stewart's Clinic, not one gave a
family history of the disease.

Dr. Brown has failed to win much support for her theory which is based
on what would appear at present to be very slender evidence.

8. Psychological Stress.

Psychological disturbances are very common in patients suffering from
Meniere's disease. Whether such disturbance precipitates the labyrinthine
pathology or whether it results from a primary labyrinthine disorder is disputed.

Goodman suggests that emotional disturbances act on the hypothalamus.
The hypothalamus controls the autonomic system and the resulting autonomic imbalance
influences the state of the blood vessels of the inner ear, producing the
characteristic labyrinthine hydrops. This view is shared by Fowler, Hilger and
Williams.

There are undoubtedly certain features of Meniere's disease which are
difficult to explain unless one accepts that psychological disturbance, if not the
sole cause, plays an important part in its aetiology.

1. Wright has shown that 20% of cases undergo a spontaneous cure. Any form
    of treatment will increase this figure to 50%, including measures which are
    entirely palliative, such as sedation. The main operative factor here would
    appear to be the faith of the patient in the medical attendant.

2. Excellent clinical results are obtained by the enthusiastic origination of a
    new treatment (e.g.Wright, Miles Atkinson, Mygind) and progressively poorer
    results are obtained by later and more sceptical workers. There is no
    doubt that patients frequently become infected with the enthusiasm of the
    physician for a method of treatment, and that this favourably influences the
    response to that treatment.

3. There appears to be a considerable variation in the incidence of the disease
    in different countries (Seymour). The incidence appears to vary directly
    with the pace of life in the country concerned. As has been noted elsewhere,
    Meniere's disease is extremely rare in Asia

9.   Dandy's Theory.

Dandy considered from the histological reports in cases of Meniere's disease that it was doubtful if the cause lay in the semicircular canals.   In his opinion the cause was a lesion in the VIIIth nerve, and gave the following reasons for his belief.

1.   Since both cochlear and vestibular functions were disturbed, the lesion must be in the VIIIth nerve and not in the canals.

2.   Attacks are paroxysmal, and this similarity to epilepsy and trigeminal neuralgia, in which the lesion is in the higher neurone, suggested that in Meniere's disease the lesion could not be in the peripheral neurone or end-organ.

3.   At operation he found extrinsic lesions involving the VIIIth nerve in 35% of cases of Meniere's disease, e.g. compression by arteries, congenital malformations, aneurisms, tumours.   In the remainder, the lesions were intrinsic, and in all the histological sections he made he found increased fibrosis in the nerve..

4.   Meniere's disease is almost exclusively a disease of middle or more advanced age, which favours thickening of arteries along thenerve.

Considering all the factors which would appear to play a part in the production of Meniere's disease and discarding those theories which have not been borne out in clinical practice, we arrive at a general picture of the conditions under which Meniere's disease presents itself.   In the light of our present knowledge, or lack of it, only a general picture is possible.   The symptoms and the patholdgical changes in the disease appear to be the expression of a vasomotor disorder which results from autonomic dysfunction, which in turn is most likely the resultant of several factors such as emotional stress, anxiety, allergy, possible vitamin deficiency, disorder of salt and water metabolism, all acting on a susceptible constitution at the same time.

TREATMENT.

The aim of treatment should be the cure of the disease, and not merely the relief of symptoms.   Unfortunately, this aim has not yet been realised, and the answer to the problem will not be found until we understand more about the physiology of the endolymph, and the aetiology of the disease.

Treatment/

Treatment of Meniere's disease is usually the combination of several measures, and when medical means have failed to help the patient, surgical intervention must be considered.

1. Methods of Increasing Blood Supply.

A. Vasodilator Drugs.

1. Nicotinic Acid.

The use of this drug in Meniere's disease was first suggested by Harris and Moore, who based its use on the fact that vertigo was common in pellagra. It was shown by Aring and others that nicotinic acid and certain of its salts administered intravenously increased the intra-cranial blood flow for periods as long as 60 minutes. Most workers have found this drug to be of undoubted value in Meniere's disease.

The usual method is to give a test dose of 30 mgms. of nicotinic acid intramuscularly, then start on a course of intravenous injections of 25 mgm. daily or twice daily , increasing the dose by 5 mgm. per day to a total of 50 mgm., or even 75 mgm. per injection according to the response and tolerance of the patient. Oral nicotinic acid 50 mgm. b.d., or t.i.d., may be given from the third day onwards. When the maximum intravenous dose has been reached, maintenance treatment can be continued by the patient's own doctor, who gives the maximum dose by intramuscular injection twice per week, while the patient continues oral nicotinic acid. This should continue for 1 - 2 months, according to the patient's response and absence of symptoms. Thereafter the dosage can be decreased, and often the patient can control his symptoms by varying the oral dosage to suit himself.

This routine was used in 26 of the 117 cases in our Edinburgh series, and in 13 of these, vertigo was relieved or improved; of the remainder 4 were considered too recent for assessment, and 9 failed to report for follow-up.

Kodicek, Taylor and Bateman used nicotinic acid orally, in the first place giving 100 mgm. t.i.d. for a month. Severe cases were given intramuscular injections of 50 or 100 mgm. twice a week. They found it necessary to continue maintenance dosage after symptoms were controlled, and also in females to increase the dosage in premenstrual phase.

Thorn (1941) stated that sometimes nicotinic acid produces imbalance in Vitamin B. complex absorption and gives rise to emotional instability, a feeling of fullness/

fullness in the head, and photophobia.

Williams of the Mayo Clinic prefers nicamine, given subcutaneously in 25 mgm. doses daily or twice daily, and follows a scheme similar to that above, reinforcing it with oral nicotinic acid if need be.

2.   Intravenous Histamine.

From a review of the literature it is apparent that histamine is a general vasodilator in man, especially in so far as the intracranial vessels are concerned, though the work of Weiss and his associates suggests there is a group difference among individuals as to their reactivity to histamine.   Other workers have shown that the pharmacological actions of nicotinic acid and histamine are nearly identical.

Sheldon and Horton introduced intravenous histamine in the treatment of Meniere's disease and Horton described their results in a paper published in 1941. Using   1.9 mgm. of histamine acid phosphate in 250 cc. of physiological saline, they treated 49 cases up to 1940.   All of the patients were relieved of vertigo and 50% of tinnitus.   This method was used for acute attacks and repeated daily until the symptoms were controlled.   Thereafter control was maintained by injections of 0.1 - 0.2 mgm. of histamine 2 - 4 times per week.   In a later paper Horton advised the use of 2.75 mgm. of histamine phosphate in 250 cc. of isotonic sodium chloride solution, and stated that the rate of administration of the drip and not the amount of histamine administered was of paramount importance.   Any side effects/as headache such must be avoided, but the rate of infusion increased during the subsequent daily administrations up to the limit of tolerance.   Gastric disturbance due to liberation of excess hydrochloric acid can be avoided by ensuring the patient has food in his stomach during the treatment.

It would seem more logical to administer intravenous histamine in 0.5% glucose in view of the undesirable effect sodium is said to have on the patient with Meniere's disease.

3.   Intravenous Procaine.

Although procaine was introduced about 50 years ago there is still considerable disagreement about its physiological and pharmacological actions, its fate in the body and whether its action is due to procaine itself or a breakdown product.   Some workers state it produces vasodilatation, others deny it, some have demonstrated a curare-like action at the myoneural junctions as well as its main action/

action on nerve fibres, others consider its action after intravenous injection is upon the vasomotor centres.

Hilger considers that the benefit of the use of intravenous procaine lies in its blockade of impulses in the sympathetic ganglia. In Meniere's disease, he advises the infusion of 0.2% procaine solution in 5% glucose and reported no untoward results on using as much as 500 cc. of the solution.

Fowler treats his patients with intravenous procaine when his initial treatment with nicotinic acid, benadryl, and hyoscine has failed. He believes Meniere's disease is due to vasospasm and "blood-sludging," and that unless the lesion is severe, the intravenous procaine speeds up the circulation and relieves it, the speeding of the blood flow being the result of increased cardiac out-put. Blood-sludging is known to occur in physical and psychic trauma, allergy, stress - emotional or infective, and fatigue, and can be produced experimentally by sympathetic stimulation and adrenaline. Fowler uses 0.1% procaine hydrochloride in 500 cc. of [2]. 5% glucose given daily in two doses. Each dose is given in about 10 minutes. He notes numerous side effects such as dryness of the mouth, dysphagia, asthenia, changes in quality of the heard voice, drowsiness, stiffness, flushing, bradycardia, lowered blood pressure, and sometimes increased tinnitus, though usually this diminishes during infusion.

In a series of 35 cases treated in this way, Fowler found vertigo improved in 27, unimproved in 8, tinnitus improved in 13, unimproved in 22, deafness improved in 11, and unimproved in 24.

This is not a treatment to be employed recklessly, and skill and great care are absolutely essential. Deaths have occurred from the injection of anaesthetic agents and spinal anaesthesia, but using the intravenous route has the great advantage that the amount of agent being administered is under constant control.

4.   Other Vasodilators.

Less commonly used drugs are Priscol, Neostigmine, and Banthine. Williams has found the latter useful in Meniere's disease, but considers Neostigmine less effective than Nicamin. Priscol can be used orally, intramuscularly or intravenously, and is reported to have a relatively long-lasting effect.

B.   Cervical Sympathectomy.

This procedure is undertaken by some otologists with the object of improving the blood supply to the inner ear and of preventing spasm of the internal auditory artery./

artery. Much of our basic anatomical, physiological and pathological knowledge concerning sympathetic nerve supply of the inner ear is incomplete, but it would appear that (1) Anatomically the most important contribution comes from the 2nd Thoracic segment, but undoubtedly variations are frequent. (2) Sympathetic control over the intracranial vessels is much less marked than in other regions: Rambo, Wolfe and Freeman have shown that division of the sympathetic nerve supply to the inner ear of monkeys does not produce any lasting vasodilatation. Seymour and Tappin have demonstrated a slight vasoconstriction in the vessels of the spiral ligament in cats on stimulation of the cervical sympathetic.

Passe has performed stellate ganglion blocks on patients just before fenestration operation was performed. He noted marked dilatation of the blood vessels within the bony lateral semi-circular canal.

Choice of Operation.

1. Stellate Ganglion Block.

This simple procedure has been advocated by Hibler and Schubert, but it has not fulfilled its early promise, and Woods has recently summarised present opinion by saying "it is valueless as treatment, and useless as a pre-operative test."

2. Stellate Ganglionectomy.

This was the original operation performed by Passe; results were good, but it produced a permanent Horner's syndrome and was open to the objection (probably entirely theoretical) of being a post-ganglionic section.

3. Smithwick's Dorsal Sympathectomy.

Passe later abandoned stellectomy for this operation, which consists of a pre-ganglionic section of the 2nd and 3rd dorsal sympathetic nerves, with division of the chain below the 3rd ganglion. Horner's syndrome does not follow this operation. This operation leaves the fibres of Th. 1 intact, and therefore does not provide a complete sympathectomy in the head and neck.

4. Stellectomy with Removal of Th. 2 and Th. 3 Ganglia.

This operation is advocated by Lewis and Woods, andprovides a complete sympathectomy in head and neck. It is the operation of choice.

Complications:

The main complication is brachial neuritis which occurs post-operatively in about 50% of all cases. The pain is commonly severe and lasts about three months.

Woods/

Woods thinks it is due to traction on pre-ganglionic rami leading to small petechial haemorrhages in the spinal cord.

Less frequently, post-operative nasal congestion is observed.

Results of Operation.

Surgeon.	No. of Cases.	Vertigo Cured.	Vertigo greatly Relieved.
Lewis	28	9	9
Harrison	14	5	1
Passe (Stellectomy)	45	28	16
Passe (Smithwick)	46	28	16
Dix	5	2	2
Woods	28	20	4
	166	92 = (55%)	47 = (20%).

The effect of the operation on tinnitus and deafness has not been recorded in detail by most authors. Dix reaches the conclusion that these symptoms are less frequently relieved than vertigo.

The results of this type of surgery are poor in the older age groups and this operation has probably no useful place in the treatment of patients over 55 years of age.

II. Treatment of Allergy.

1. Histamine Desensitisation.

The evidence produced by the work of many investigators from Dale and Laidlaw (1910) to Code (1944) showing that histamine played a part in the allergic reaction, led to attempts to desensitise the individual to histamine in the hope that allergic manifestations might be prevented. This practice was found disappointing as a general treatment for allergy, and later evidence indicated that histamine was a by-product of the allergic reaction and not a fundamental factor. Then it was suggested that certain individuals were sensitive to histamine.

Miles Atkinson devised a histamine-sensitivity test in cases of Meniere's disease. He found a sensitive to non-sensitive ratio of about 1 to 5 or 6. The former group he regarded as indicating a vasodilator mechanism, and the latter a vaso-constrictor mechanism. Many workers have disagreed with this theory, especially in America, but Horton's work has tended to support the validity of a histamine sensitivity

Atkinson's test consists of an intradermal injection of 0.5 ml. of 1/10,000 solution of histamine. If this produces a central wheal 1 - 1½ inches across, with pseudopodia and surrounding erythema, the patient is regarded as sensitive. He treated/

treated these cases by desensitisation, and non-sensitive cases with nicotinic
acid.   The routine for desensitisation is as follows:- daily subcutaneous injections
of 1/10,000 solution of histamine phosphate, starting with 0.05 cc. twice on the
1st day, 0.1 cc. on the 2nd day, increasing thereafter by 0.1cc. daily to a maximum
of 0.9 cc.   The patient is then given maintenance injections of 0.25 - 0.5 cc., once
or twice per week for several weeks according to response.   There are variations of
this scheme, and some workers increase the dose beyond 0.9 cc. of 1/10,000 solution to
0.1 - 0.3 of 1/1000   solution.   Atkinson claimed good results, and in the hands of
other also, this method has been successful.

In our series of 117 cases under the care of Dr. J.P. Stewart, 28 cases were
treated in this way.   Of these, 11 were relieved of vertigo, 11 were improved, and
there were 3 failures;   the other 3 cases did not report back for follow-up.   This
gives a figure of 78.5% relieved or improved.

Dr. I. Simson Hall found that 83% of his cases treated by Atkinson's regime
were relieved of vertigo.

In a series of 50 cases treated with histamine desensitisation for positive
cases, and nicotinic acid for negative cases, McLeod achieved the following results:-

roup:	Histamine +ve.	Histamine -ve.	Intermediate.	Total.	%
ertigo free	23	9	2	34	68%
elapsed	6	4	0	10	20%
nimproved	3	1	2	6	12%

Thorn treated a series of 53 patients in the same way.   Of these, 15 (28%)
ere histamine-positive, and 38 (72%) negative.   He found the best therapeutic results
n the negative group.

	Vertigo.	Tinnitus.	Deafness.	Headache.
elieved	32	12	-	17
mproved	20	22	10	6
o Change	1	19	43	2

2.   Antihistaminic Drugs.

A few cases of Meniere's disease obtain some relief from their symptoms when
iven anti-histamine drugs.   Williams (1945) found that Benadryl procured partial
elief in some of his cases, and has since stated that it is just as effective as some
f the later drugs of this type, e.g. Dramamine, though, a combination of both drugs
eemed to produce a more rapid improvement and a greater degree of relief.

There have been as yet, no reports on a large series of cases undergoing

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uch treatment.   In our own experience, Dramamine and Avomine have proved useful
n conjunction with other forms of treatment, such as salt and water restriction,
istamine desensitisation.   A few mild cases of Meniere's disease have appeared
o be fairly well controlled on Avomine alone, at least for periods up to a few months,
ut it is impossible to say in these cases whether the drug is really effective, or
hether the disease is in a quiescent phase.

II.   Dietetic Methods.

1.   Reduced Salt and Fluid Intake.

The first reasonably successful medical treatment of Meniere's disease was
hat suggested by Mygind and Dederding, who, working from the theory of labyrinthine
ydrops, suggested that this could be controlled by alterations in the fluid balance
f the body.   They advised that fluid intake should be restricted to 700 cc. daily,
hat the ingestion of sodium chloride be greatly restricted to promote diuresis, and
hat overweight or underweight should be corrected by a reducing diet or a high calorie
iet.   They reported that after three years of this regimen 67 out of 83 patients
ad no attacks of vertigo.

This would appear to be a dangerously low fluid intake, as physiologists
t present regard a minimum of 1000 cc. daily as essential for normal elimination
rocesses.   Furstenberg and his associates suggested that sodium intake was more
mportant than water, in the production of Meniere's disease, and advocated a "salt-
ree" diet (0.5 Gm. Sodium) which excluded salt from cooking as well as from the table.
he sodium chloride was replaced by ammonium chloride given in doses of 45 grains
3 Gm) three times per day to promote diuresis..   The ammonium chloride was given
nly for three days at a time to avoid the unpleasant irritative gastric effects.
hese authors claimed "splendid" results as long as the patients could be kept in
ospital under strict dietary supervision.

Talbott and Brown suggested that a high potassium intake was more effective
n controlling attacks than a low sodium intake, and advocated daily doses of
- 10 Gm. of potassium chloride in aqueous solution.

In reviewing the results of treatment by the Furstenberg and Talbott
egimens, Walsh and Adson found that symptomatic relief was secured in about a third
f patients in each case.

Williams (1952) recommends a low sodium, neutral ash diet (after Schemm),
hich patients can tolerate with relative ease.   They are allowed 3,000 cc. of fluid

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per day, together with a diuretic, usually 6-0 Gm. of ammonium chloride daily.

In our Edinburgh series, 30 patients were treated by restricted salt and fluids.   Five were relieved of vertigo, four improved and in two there was no change;   eight cases were considered too recent for fair assessment, and eleven cases failed to report back.

In a paper published in 1953, Perlman, Goldinger and Coles showed that in patients with normal renal function it is difficult to induce changes in water and electrolyte balance.   They described the findings of Tasaki and Fernandez in their experiments on the electrical responses of the cochlea to sound, and quoted Bekesy's work on the electrical potential of the endolymph and perilymph electrolytes.   They described the report on their own work as a negative one, and stated that although it did not refute the possibility that Meniere's disease is related to electro-chemical disturbances in the labyrinthine fluids, particularly the endolymph, it merely indicated that the present therapy directed at changing electrolytes is probably ineffective.

Varga treated a series of five patients with a new and effective diuretic, Diamox.   He reported that the vertigo was controlled in every case and also a general improvement in the cochlear symptoms.   The follow-up period was only two months and this was obviously much too short to assess the real value to this drug.

2.   Vitamins.

Cases of Meniere's disease have been treated with vitamins A. and C. with reputedly good results.   Selfridge recommends the whole vitamin B. complex, deficiency of which may act by causing vasospasm.

In 1949 Miles Atkinson stated that there were in Meniere's disease, two distinct types:-

(i)   A group with perceptive deafness, steady tinnitus and rotational vertigo, were histamine negative, and shows signs of nicotinic acid deficiency. Administration of nicotinic acid relieved their symptoms.

(ii)   A second group showed positional vertigo, mixed or conductive deafness, and rhythmic tinnitus, together with signs of riboflavine deficiency. These also gave a histamine positive reaction.   They were treated with riboflavine.

The remainder of cases experienced both types of disorders and were placed in an intermediate group (most cases of Meniere's disease were in this group) being treated/

treated by both fractions.

Atkinson recommended a scheme of treatment starting with low amounts and working up gradually to a very high dosage.

In general, signs of vitamin deficiency should be looked for in all cases of Meniere's disease, and treated accordingly. In our series of cases, all patients were well nourished, displaying no specific signs of such deficiency, but several were given riboflavine in conjunction with other measures. It was not possible to assess whether any improvement that did occur was due to one factor or another, or to a natural remission of the condition.

IV.   Destruction of Labyrinthine Function.

1.   Streptomycin.

This drug has a toxic effect on the vestibular system, and Hawkins of the Merck Institute suggested making use of this property in the treatment of Meniere's disease.

Total destruction of vestibular function usually requires a dose of at least 30 Gm. of Streptomycin. If renal function is impaired, a much smaller dose will suffice. Experimental evidence shows that the damage is widespread. Floberg, Hamberger, and Hyder have demonstrated damage to the vestibular ganglion, nerve and nuclei. Berg and Ruedi have shown that the sensory neuro-epithelium in the end-organ is also damaged.

Fowler in 1948, Hamberger, Hyder and Koch in 1949, Ruedi in 1951, Hanson in 1952, and Foxen in 1954 all reported short series of cases which had been treated by this method, and they all seemed well satisfied with the results, although the follow-up interval was very short.

Later experience has shown that the vestibulo-cerebellar connections are frequently damaged with resultant intractable ataxia. Cawthorne and Ranger consider that the cure is worse than the disease. Schukrecht has attempted the unilateral elective destruction of the vestibular end-organs by means of intra-tympanic injections of streptomycin.

This form of treatment should only be considered in patients with severe bilateral disease who are under 50 years of age. Older people find it impossible to effect a satisfactory compensation for total loss of vestibular function.

2.   Labyrinthectomy.

1.   Membranous Labyrinthectomy.

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This operation was introduced by Cawthorne in 1938. Removal of a portion of the membranous labyrinth is normally followed by complete loss of both cochlear and vestibular function. The membranous labyrinth appears to be more vulnerable in labyrinthine hydrops.

The advantages claimed for this operation are simplcity and the fact that powerful agents of tissue destruction are not used, thus minimizing the risk of facial paralysis. The operation as first described was performed via a post-auricular or a superficial endaural incision.. The mastoid antrum is exposed and the incus removed to give better access to the lateral semicircular canal, which is opened with a dental drill. Using magnification, the membranous canal is identified and removed with a pair of watchmaker's forceps. The wound is finally closed without drainage.

In 1956, Cawthorne modified the operation by adopting Rosen's trans-meatal approach. The stapes is then removed, and pieces of membranous labyrinth removed through the oval window.

As in most labyrinthine operations, there is a period of intense post-operative vertigo. This is usually minimized by the use of graduated balancing exercises (Cooksey and Cawthorne). Cawthorne has performed 337 such operations. Vestibular function was completely destroyed in every case, but on three occasions some cochlear function was retained. The only complications encountered were 7 cases of post-operative infection, and 1 mild temporary facial paresis. Most cases were back at work in two months.

In our Edinburgh series of 117 cases, one patient was treated by labyrinthectomy with complete relief of vertigo and tinnitus. There has been no recurrence after two years.

2. Day's Operation.

In 1943 Day reported his results in labyrinthectomy followed by differential electro-coagulation of the vestibular contents without destroying the saccule or damaging the cochlea. He opened the mastoid antrum by the post-auricular route and removed the outer wall of the aditus far enough to expose the short process of incus, then with a dental burr, the horizontal canal was opened medially to the short process. Then the diathermy needle was passed through the canal into the vestibule, pressed medially to avoid the facial nerve, and a light coagulating current used for 2 - 3 applications of about one second each.

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In a later paper (1952) Day reported on 54 cases treated in this way.
Cochlear function was preserved in 16 cases, but of these only 4 had practical
hearing for speech after two years.   The majority continued to have roaring tinnitus,
distortion of hearing, and gradually increasing deafness.   4 cases had recurrence
of vertigo, all of these being successfully revised.   Day has now abandoned this
procedure because in his experience, most patients are just as discomfited by tinnitus,
diplacusis and distortion of sound as they are by vertigo.   He now favours a
destructive labyrinthectomy, either removing the membranous horizontal canal, or
passing a barbed broach or curette into the vestibule.   This operation relieves
distressing cochlear symptoms as well as veritgo in his opinion.

Altmann and Montreuil (1951) described their attempts to modify Day's
operation to make certain of retaining cochlear function.   They stated that the
diathermy caused necrosis of certain parts of the membranous labyrinth, which was
followed by repair and growth of organising connective tissue which might go far
beyond the area of original damage.   They found that the extent of the changes
depended on the intensity of the current used, and that the coagulation necrosis was
followed by diffuse serous aseptic labyrinthitis, and believed the degree of cochlear
damage was dependent on the severity of the labyrinthitis.   In practice therefore
they reduced the intensity of current used, but got unsatisfactory results, since
either the vertigo was not completely eliminated or the hearing was completely
lost.   In later cases they tried plugging the membranous canal with bone chips to
produce circumscribed fibrosis and limit changes in other parts of the labyrinth.
Again the results were disappointing.

3.   Lindsay's Operation.

Lindsay and Siedentop (1955) considered that the persistence of tinnitus in
their cases following the procedures advised by Cawthorne, Portmann, and Day was due
to the fact that these operations were not radical enough.   They therefore operated
on 4 cases, making a fenestra into both the horizontal and superior canal ampullae, and
enlarging them to make a single broad opening into the vestibule.   The membraneous
structures in the vestibule and both semicircular canals were destroyed as far as
could be reached with suitable hooks, forceps and dental excavators.   Hearing was
totally destroyed, with complete relief of vertigo and tinnitus in all cases, the
follow-up varying from six months to two years.

4.   Mollison's Operation.

Mollison performs labyrinthectomy by opening the horizontal canal, and
injecting/

injecting 0.5 ml. of 95% alcohol into the vestibule. Williams considers this method has no advantage over mechanical destruction or electro-coagulation, but Watkyn-Thomas considers this method as the simplest, which is also entirely adequate.

5.   Wright's Operation.

This was first performed in 1935 and consists of the transtympanic injection of 1 minim of absolute alcohol through the footplate of the stapes into the labyrinth.   The needle is inserted through the drumhead, which normally completely obscures the oval window.   It is therefore necessary to perform the operation blindly and thesurgeon has to rely entirely on his sense of touch.   In a crowded area which contains such vulnerable structures as the facial nerve, this seems a most risky procedure to most otologists.   The only advantage of the operation is its very short duration.   Absolute alcohol easily percolates the bone, and so could damage an inadequately protected facial nerve.   95% alcohol is safer.

6.   Putnam's Operation.

In 1938 Putnam described a method of destruction of the labyrinth using an approach as for subtemporal decompression for Vth nerve section.   He elevated the dura, located the superior semicircular canal and opened it with a drill.   Then he introduced a fine diathermy wire.   He reported 2 cases; in one the hearing was not destroyed, and in the other vestibular function was not destroyed.

3.   Intracranial Section of VIIIth Nerve.

In 1870, Charcot demonstrated cases of Meniere's disease in his clinic. He noted that attacks of vertigo ceased when the deafness became complete.   This led him to suggest that cure would be hastened by intracranial division of the auditory nerve.

What appears to be the first presentation in English of intracranial section of the VIIIth nerve appeared in 1904, when Parry described the operation in Meniere's disease.   In a paper published in 1928, Dandy suggested this was the operation of choice in persistent aural vertigo.   He later modified the procedure to hemisection of the nerve in an effort to destroy vestibular function while preserving cochlear function.

Crowe, in 1938, reviewed a series of 117 cases in which Dandy had performed hemisection of the VIIIth nerve, and found only 22% retained hearing in the operated ear.   In this paper he concluded the vertiginous attacks in Meniere's disease were due to stimulation of the vestibular end-organs as a result of chemical pressure

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or circulatory changes in the endolymph, and produced convincing evidence that
the primary cause of the disease did not lie in the VIIIth nerve or central vestibular
pathways.

In a later review of Dandy's work, Green and Douglas considered 587 cases, of
whom 2 had died of post-operative meningitis. In 23 cases of bilateral disease in
whom unilateral section was performed on the worse side, only 13 were free from
vertigo. 8 cases who had hemisection continued to have vertiginous attacks, so
the operation was repeated with complete section of the nerve, and all were then
completely freed of vertigo. Their complete results were:-

Effect on Vertigo:-	Cured.	Improved.	I.S.Q.
Complete Section	91.6%	2.3%	6.1%
Partial Section	91.8%	5%	3.2%

Effect on Hearing:-	Absent.	Worse.	Improved.	I.S.Q.
Complete Section	85.3%	14.7%	-	-
Partial Section	13.8%	43.2%	9.8%	28.2%

Effect on Tinnitus:-

Complete relief with complete section = 32.9%
Complete relief with partial section = 26.8%

Complications:- most important was facial palsy.

	Transient.	Permanent.
Complete Section	16.0%	9.2%
Partial Section	5.8%	1.7%

Most patients were unsteady for several weeks, but this phase was greatly
prolonged (up to one year) in bilateral cases. These cases experienced great
difficulty in walking in the dark, and had a characteristic visual disturbance in that
when in motion, objects appeared to move up and down rapidly.

Pathology.

One temporal bone was examined histologically and showed changes similar
to those found by Hallpike and Cairns. They noted also that in 85 cases, anomalous
arterial loops compressed the VIIIth nerve.

Another series consisting of 66 cases treated at the Lahey Clinic by
fractional section was reviewed by Lathrop. He found 40 patients completely relieved
of vertigo, 6 without vertigo but more or less continuously unsteady, and 5 with no
improvement. The remaining 13 were not traced. This series produced 2 post-
operative deaths (one from suicide on 6th day), and the most serious complication was
temporary facial paresis (in 2 cases). Of 35 who had pre-operative audiograms,

only 10 had serviceable hearing.   Average stay in hospital was 20 days, and average interval before return to work was 81 days.   He compared these with the corresponding periods in a series of cases treated by Day's operation, which were 9 and 18 days respectively.

Rasmussen studied the VIIIth nerve microscopically and reported that the separation of the nerve into 2 trunks was very variable.   When 2 were present, they rarely represented a true division into cochlear and vestibular parts, for in nearly all cases there were at least a few vestibular fibres in the cochlear division. In one specimen, 20% of the cochlear nerve was occupied by vestibular fibres.   This accounts, at least partly, for the comparative lack of good success of hemisection of the VIIIth nerve.

These findings verified the earlier work of McKenzie, who with McGregor, reported their microscopic findings in Transactions of the Toronto Academy in 1932. McKenzie (1952) stated that he now preferred to treat his patients conservatively reserving operation for carefully selected cases.   He considered section of the vestibular part of VIIIth nerve the operation of choice in cases of Meniere's disease with good hearing in the affected ear, and deafness (middle ear type or otherwise) in the opposite ear.

In a follow-up of 117 cases of hemisection operated on by McKenzie, Barber and Ireland found total relief of vertigo in 83%, and partial relief in 3.8%. Tinnitus was relieved or improved in 41.5% and worse or unchanged in 58.5%   Using pure tone audiometry, they found useful hearing in 26.4%, but of these, half showed a discrepancy when tested for recorded speech perception.   In this series there were 2 post-operative deaths.

Day considers VIIIth nerve section has a definite operative mortality, and that partial section commonly does not control the vertigo, while residual hearing is not very useful.

Putnam stated that intracranial division of the VIIIth nerve was not always is easy, rapid and safe as some accounts would lead one to believe, while Cairns and rain estimated the mortality rate to be in the region of 5% with a large morbidity ate due to injury of other closely associated cranial nerves.   Watkyn-Thomas states the operation is severe;   in the most skilful hands, it is not free from risks, and, lthough immediate results may be good, hearing usually deteriorates."

4.   Ultrasonic Therapy.

Wyt in 1948 treated 18 cases of tinnitus by the external application
of ultrasonic waves and claimed satisfactory results in 16 of them.   He considered
this was achieved by a mixture of micromassage, thermal and thixotropic effects, and
changes in colloid-chemical conditions.

Meyer in Berlin (1950) found this method of no use in the treatment of
tinnitus.   Wyt's view was not shared by Pfonder, who produced nystagmus by ultrasonic
application, but assumed this was due to simple caloric stimulation.   Vyslonzil also
produced nystagmus in rabbits and guinea-pigs and concluded ultrasound caused
depression of labyrinthine activity.

Herrick and Crusen (1954) stated that the heating effect of ultrasonic
waves caused necrosis of bone and also blockage of nerves.   They found there was a
very narrow   margin between reversible and irreversible blocking in nerves.
Welkowitz (1955) has shown that sound propagated in tissues causes damage by a variety
of mechanisms - heat, oscillatory and unidirectional forces.

In severe cases of Meniere's disease, the attacks of vertigo can be
controlled by the destruction of vestibular function in the affected ear.   This can
be accomplished either by labyrinthine surgery or by division of the vestibular nerve.
                                                                        the
The main disadvantage of orthodox labyrinthine operations has been/associated
destruction of cochlear function.   In many cases the residual hearing is so poor
that its complete loss is no additional disability.   There are some patients who
suffer from severe and disabling attacks of vertigo and yet retain good hearing, while
others suffer from bilateral disease.   In these 2 groups it is necessary to consider
forms of treatment which selectively destroy vestibular function only.   This may be
achieved by the application of ultrasonic waves to the affected vestibular apparatus.
For successful therapeutic application:

1.   The damage must be limited to the vestibular part of the inner ear and not in-
     clude cochlea or facial nerve.

2.   Vestibular apparatus must be rendered completely non-functional in a large
     percentage of cases.

     The extent of the destruction depends on:

1.   The size of the focal region of the beam.

2.   The intensity of the ultrasonic waves.

3.   The duration of the ultrasonic waves.

4.   The physical and physiological characteristics of the tissue under
     irradiation.

The absorption of ultrasonic waves results in a temperature rise. The heating effect coagulates all tissues indiscriminately. The degree of temperature rise depends on the absorption coefficient of the tissue irradiated, its blood flow, and ambient tissue temperature.

Sound is a mechanical phenomenon and when it is propagated through tissue various oscillatory and unidirectional forces result. These may be large enough to cause a structural member of the tissue to stretch beyond normal limits. The mechanical effect (unlike the thermal) is selective, and nervous tissue is the most vulnerable. The biological variations in the susceptibility of different tissues to ultrasonic waves has been demonstrated by Ballantine, Hueter, Nauta and Sosa.

Dr. Stefani has studied the effects which result from the application of ultrasonic waves to the labyrinth of dogs. His histological observations were:-

1. Cellular destruction is only recognisable among the differentiated structure of the labyrinth, such as the neuro-epithelium.

2. There are small haemorrhages into the perilymph of the lateral semicircular canals.

3. At several points the endosteum is detached from the bony wall.

4. The membranous canals show a normal diameter.

5. The endolymph is coagulated in several zones.

On the basis of these experimental and theoretical considerations, Arslan has evolved an operative technique which satisfies the two basic therapeutic requirements mentioned earlier.

Arslan's Procedure.

This operation must be carried out under local anaesthesia, since the co-operation of the patient is necessary in the stage of ultrasonic radiation, when the onset, direction, duration and cessation of nystagmus must be noted, and a careful watch kept for signs of facial weakness.

The main principles of the technique arethese:

1. Cortical mastoidectomy is performed. Adequate exposure is required so that the applicator can be applied without difficulty. The incus must not be dislocated.

2. The extremity of the applicator is introduced directly on to the convexity of the bony semicircular canal. There must be close contact between the end of the applicator and the bony canal, because even a thin layer of air will absorb/

absorb ultrasonic waves.   No blood must be allowed to come between
applicator and canal, for that will extend the field of the beam.

3.   The beam must be directed on to the vestibular apparatus, and not towards
the cochlear or facial nerve.

4.   Throughout the period of irradiation it is necessary to observe the
nystagmus.   Usually the sequence of events is:-

   (i)   Irritative nystagmus (1st degree - 3rd degree - 1st degree) about
         one minute after radiation starts, and lasting about 10 minutes.

   (ii) This nystagmus ceases, when the direction of the beam should be changed
         to the vertical canals;   after 10 minutes or so a new nystagmus appears,
         which may be vertical, rotary, or diagonal, and lasts 5 - 10 minutes.

   (iii) After this type of nystagmus ceases, the beam is returned to its
         former direction.

   (iv) 25 - 30 minutes later the paralytic nystagmus (to opposite side)
         appears.

Arslan describes variations in duration and extent of the different types
of nystagmus, e.g. irritative nystagmus may not appear, or may not subside, or
paralytic nystagmus may appear at an early stage.   He never irradiates for less than
30 minutes.

5.   The cavity is filled with antibiotic powder, and closed without drainage.

Dosage:

Usually an intensity of 9-10 watts/cm^2 is sufficient to produce irritative
nystagmus, but this may be increased to 12 - 15 watts/ cm^2.   15 watts/cm^2 is maximum.

Results:

Arslan claims 90% success.   He divides his cases into 2 series.

1st series (Dec. 1952 - Dec. 1955) = 195 cases.

Cures = 184 cases.   5 cases needed a second irradiation to the same ear due to
underdosage.   3 cases needed second irradiation to the other ear, and 3 cases were
failures due to diagnostic error.

2nd series = 58 cases.   1 year cure = 48 cases.

Cure of Vertigo = 90%
Improvement in hearing = 30%
Improvement in Tinnitus = 30%

In Edinburgh, ultrasonic therapy is being used by Dr. R.B. Lumsden, using
the Arslan technique, which has on occasion been modified as regards dosage and
duration/

duration of exposure to erogation. At the same time he has carried out a series
of laboratory experiments in the investigation of the histological effects of
ultrasound on the labyrinth.

In 1958 he reported on a series of 22 cases which had been followed up
for a period of from 6 - 18 months following treatment. Of these, 15 patients had
been free from vertigo, while 4 were improved, and 3 unchanged. In the series,
18 cases exhibited persistent tinnitus before treatment, and this symptom was
definitely improved in 7 of them. As regards the effect on hearing, the deafness
remained unchanged ($\neq$ or - 5 decibels) in 15, was improved in 1 case, and made
worse in 5. At the time of his report, 19 of his cases showed absent or minimal
reaction to cold caloric stimulation, all in the group free from vertigo or improved,
except one. He found as Arslan did, that some successful cases retained a minimal
response to caloric stimulation, and that it was possible for modified vertiginous
attacks to occur during the early post-operative period in cases which could
ultimately be classified as successful. One hazard of the procedure which has already
been mentioned is that of damage to the facial nerve. Lumsden reported facial
paresis in 3 cases (2 severe) all of which made a complete recovery within six months.

Arslan reported more favourably about the post-operative hearing than
Lumsden did, but this is a question which may well depend on such factors as the
pre-existing severity of deafness, and the age of the patient, and the stage in the
disease at which ultrasonic therapy is applied.

V. Sedation, Stemetil & Other Drugs, Psychotherapy.

1. Sedation.

For long, sedation by means of phenobarbitone has been the main stay of
medical treatment in Meniere's disease. Stress plays a big part in precipitating
attacks in many cases, and $\frac{1}{2}$ - 1 grain of phenobarbitone twice or thrice per day is
often effective in dulling the patient's susceptibilities and soothing his anxieties,
thus lessening the frequency and severity of the attacks. In milder cases, this may
be the only treatment needed. In most severe cases, the stronger barbiturates may
be required, or combinations of these with other drugs. In particular, Bellergal
phenobarbitone and hyoscine) has been widely used.

Sedative action is a well-known side effect of the antihistamines, and it
may well be that drugs like Avomine and Dramamine owe at least part of their good
effect to this action.

2. Stemetil.

2.   Stemetil.

Stemetil (M.&B.) has undergone recent trial in Meniere's disease based
on its sedative and anti-emetic effect, and a probable direct action on the
blood supply to the labyrinth.   Stevens (1957) reported a short series of cases, 4
of whom had severe and long-standing Meniere's disease.   Vertigo was completely
relieved in all, tinnitus improved, deafness unchanged, and sound-distortion
relieved.   9 milder cases were completely controlled.

3.   Other Drugs.

Eleparon has been used by Beschwitz in treating inner ear deafness
and tinnitus.   He found this improved hearing in 20%, tinnitus in 80% of cases,
all with labyrinthine vertigo.   This effect is said to be due to the osmo-
regulating effect on the labyrinthine fluid.

Acetyl-di-leucine has been used by Celice and others for its
anti-vertiginous properties.   He claimed improvement in 11 of 13 cases of
Meniere's disease treated in this way.

It is well known that patients with hypo-adrenocorticism are enabled to
withstand stress and the alarm reaction by using adreno-cortical extracts.
Goldman and Tintera believe that Meniere's disease is due to a capillary
dysfunction as a result of hypo-adrenocorticism, and they have instituted a
regime of treatment using such an extract, together with an autonomic nervous
system stabilizer and an anti-hypoglycaemic diet.

4.   Psychotherapy.

Occasionally one encounters a case of Meniere's disease where the
concomitant psychological disturbance (primary or secondary) is do deep-seated
as to be beyond the therapeutic reach of the general practitioner and the
otologist.   In these cases, which fortunately are not numerous, the help of
a psychiatrist should be sought.   With the solution of emotional problems
there is often rapid relief of symptoms, though a tendency to recurrence
remains.

V1.   Eradication of Septic Foci.

Wright has long held that endolymphatic hydrops is usually due to a
focal labyrinthitis produced by sepsis elsewhere.   He stated that a comparison
of all patients treated surgically to eradicate infection in the mouth, nose
or throat with those not treated, showed that 66% were cured or improved among
the group treated, as compared with 20% among those not treated.

Most otologists disagree with Wright's theory, and have achieved
comparable success in the treatment of Meniere's disease by elimination of
focal sepsis.

In our series of 117 cases in Edinburgh only 5 cases of focal sepsis
were found.   These were treated with the following results:- improved - 1,
unchanged - 1, too recent for assessment - 1, failed to report back - 2.

Nevertheless, many investigators have suggested that the presence of
focal sepsis may give rise to an allergic mechanism which may be concerned in
initiating the attacks of Meniere's disease.   Therefore it is wise to look for
focal sepsis in these cases, and if such is found, the general rule of surgery
should apply, namely, that operation is justifiable only if there is good reason to
believe that the benefit to the patient will outweigh the possible disadvantages.

V11.   Other Surgical Procedures.

1.   Portmann's Operation.

Following a series of researches into the comparative anatomy, human
anatomy and physiology of the saccus endolymphatics, Portman introduced an operation
to effect decompression of the internal ear by removal of excess endolymph.

By the post-auricular route he opened the mastoid bone and exposed the
lateral sinus without opening into the mastoid antrum.   Then he removed the medial
part of the bony wall of the sinus groove, elevated dura mater and exposed the fossa
endolymphatica, the greater part of which he removed.   Having identified the saccus
endolymphaticus by exploratory puncture, he made an incision 2 - 3 mm. long in the
saccus, allowing endolymph to escape.   Then he closed the wound, with a small drain
in the form of a piece of gauze.

This/

This is a difficult operation to perform. The facial nerve is endangered and so is the posterior vertical canal, though to a lesser extent. The sac may be adherent to surrounding meninges and difficult to identify, or it may be atrophied in the older patients.

Day (1950) considered that this operation gives uncertain results, and Fowler reported 8 cases in all of which it had been a failure. Watkyn-Thomas considers that Portmann's operation should be given a trial in cases of bilateral Meniere's disease where medical treatment fails.

Flett (1952) reviewed 61 cases of this treatment and reported a perfect result in 14 of them, 8 complete and immediate failures, and 2 deaths. In this series vertigo was cured in 21 cases, tinnitus in 11 cases, and deafness in 6 cases. He considered the operation to be technically difficult, and not without danger.

2. Division of the Chorda Tympani Nerve.

In 1947, Schneider elaborated a new theory of hearing in which he stated there were two sonic systems in man. There is an older system derived from the lateral line organs of the aquatic vertebrates, in addition to the new cochlear system. In these lower animals, nervous impulses pass from the lateral line organs along the chorda tympani nerve to the brain stem.

Rosen stimulated the chorda tympani nerve during the performance of fenestration and stapediolysis operations, and each patient noted either a sonic or equilibratory sensation.

Costen, Clark and Bishop repeated this work and were unable to confirm any of Rosen's findings. In their cases, a sensation of pain in the tongue was noted when the threshold was low, and of taste when the threshold was higher. Occasionally tinnitus was noted, these workers considered this resulted from contraction of the tympanic muscles.

Rosen introduced operative division in the treatment of Meniere's disease. The nerve is reached after reflection of the posterior half of the drumhead. He claims to have relieved completely the vertigo in 11 out of a total of 14 cases.

One case in the Edinburgh series was treated by this method, which was a complete failure, and later vestibular function had to be destroyed by ultrasonic waves.

Discussion.

Many patients with Meniere's disease are subject to anxiety and nervous tension/

tension.   The patient who has just had an attack of vertigo, possibly with accompanying nausea and vomiting, is an anxious and worried person.   Therefore the pyhsician's approach to the case is important, andhe must be prepared to spend time and patience.   This may prove difficult, since these cases, like neurotics, are not easily reassured and often have many symptoms to describe.

The doctor must be prepared to discuss and explain what is happening to the patient, that several kinds of treatment are available and effective in many cases, and that the disease is not due to any irreparable intracranial condition. The first essential in re-establishing the patient's confidence is a complete and careful physical examination.

At the same time it is a mistake not to point out that there is no quick cure, that the course of treatment is liable to be prolonged and that relapses do occur in certain cases.   Most patients are prepared to accept the liklihood of a lengthy period of treatment and at least some restriction of their activities.

Most authorities agree that 70% - 80% of cases of true Meniere's disease are benefited by medical treatment.   It is difficult to estimate the efficacy of any treatment because of the characteristic natural remissions of the condition.

About 20% - 30% of cases are severe enough to call for surgical inter-vention.   In general, destructive surgery is reserved for severe cases with gross incapacity due to unilateral disease.   The factors which must be considered in the decision to operate   or not are:-

1.   The presence of bilateral disease.

2.   The age and physical condition of the patient.

3.   The amount of hearing retained in the affected ear, and the presence of good or bad hearing in the other ear.

4.   The status of the patient, e.g. a labourer may/<u>not</u> be prepared to bear the financial burden of at least two months and possibly longer off work.

In unilateral cases, destructive labyrinthectomy is probably the operation of choice, and here Cawthorne's method would appear to be the safest.

It would appear also that in such cases, with good hearing in the affected ear, there is a place for hemisection of the VIIIth cranial nerve, or ultrasonic therapy, preferably the latter in view of the mortality associated with hemisection.

The difficulty in choice of procedure arises in bilateral cases. Bilateral sympathectomy may be the answer here.   On the other hand ultrasonic therapy/

therapy to both ears may prove the only surgical alternative.   Only time will tell.

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A P P E N D I X.

Table of Histological Findings in Eighteen Cases of
Meniere's Disease.

	Middle ear	Canals		Corti		Duct + Sac	Aqueduct	Ganglion	
Hallpike + Wright	Normal	Subepithelial Vesiculation	Normal	P.M. changes	Gross Distension	Absence of Normal Perisacular Connective Tissue.	Normal	Normal	Normal
Hallpike + Cairns 1st Case.	Chronic Inflammatory Changes.	Subepithelial Vesiculation.	Moderate Dilatation of Utricle. Gross Dilatation of Sacule in contact with footplate of Stapes.	Compression and Shrinkage.	Gross Dilatation Displaced Through Helicotrema into Scala Tympani	Absence of loose Perisacular Connective Tissue.	Normal	Normal	Normal
2nd Case.	Normal	Subepithelial Vesiculation. Degeneration and Rupture of Anterior Vertical Membranous Canal. Degeneration of Cristae.	Moderate Dilatation of Utricle. Gross Dilatation of Saccule in contact with Stapes Footplate. Degeneration of Maculae.	Compression and Shrinkage.	Gross Dilatation bulging through Helicotrema into Scala Tympani.	Absence of normal Perisaccular Connective Tissue.	Normal	Early Degenerative Changes.	Degeneration.
Hallpike + Dix.	Not Mentioned.	Not Mentioned.	Not Mentioned.	Shrunken and Irregular - Hair Cell Framework Demolished. Corti's Tunnel occupied by Coagulum.	Not Mentioned.	Not Mentioned.	Not Mentioned.	Not Mentioned.	Not Mentioned

	Middle Ear.	Canals.		Corti.		Duct + Sac.	Aqueduct.	Ganglion.	
Altmann + Fowler.		Not Dilated	Saccule and Utricle not Dilated.	Not Mentioned.	Moderately Dilated.	Absence of Perisaccular Connective Tissue.	Not Mentioned.	Not Mentioned.	Not Mentioned.
Lindsay 1942. R. Ear.		Not Dilated. Distorted by Herniated Utricle.	Saccule very Dilated and lies over Stapes Footplate. Utricle Dilated and Herniated into Canals.	Extensive Degeneration.	Very Dilated Herniated through Helicotrema into Scala Tympani.	Slightly Dilated.	Normal.	Normal.	Normal.
L. Ear.		Not Dilated.	Slight Dilatation of Utricle and Saccule.	Extensive Degeneration.	Very Dilated.	Slightly Dilated.	Normal.	Normal.	Normal.
1944.		Not Dilated.	Saccule very Dilated. Utricle Herniated into Canals.	Well Preserved.	Very Dilated Beginning of Herniation through Helicotrema.	Normal	Not Mentioned.	Normal	Not Mentioned.
Lindsay + Day 1949.		Semicircular Canals destroyed by Diathermy.	Saccule grossly Dilated. Utricle had been destroyed by Diathermy.	Fused with Tectorial Membrane.	Grossly Dilated.	Normal	Not Mentioned.	Diminution of Cells.	Atrophy.

Middle Ear.	Canals.		Corti.		Duct + Sac.	Aqueduct.	Ganglion.	
Lindsay 1946 L. Ear.	Normal	Utricle and Saccule Normal.	Degenerative Changes.	Normal.	Normal.	Normal.	Reduction in Number of Cells.	Not Mentioned.
R. Ear.	Normal.	Normal Utricle. Rupture of Saccule.	Degenerative Changes.	Widely Dilated.	Normal	Normal	Reduction in Number of Cells.	Atrophic.
2nd Case.	Distortion of Ampullae due to Utricular Herniation. Degenerative changes in Christae.	Expanded Utricle Herniating into Canals. Degeneration of Maculae. Collapsed Saccule.	Degenerative Changes.	Grossly Dilated.	Normal.	Normal	Reduction in Number of Cells.	Not Recorded.
rnvig 1st Ear.	Normal size.	Normal size.	Flattened and Compressed.	Concave Reissner's Membrane.	Dense Perisaccular Connective Tissue.	Normal	P.M. Changes.	Normal.
2nd Ear.	Normal size.	Normal size.	Flattened and Compressed.	Concave Reissner's Membrane.	Perisaccus Normal. Small Fibroma in Duct.	Normal	P.M. Changes.	Normal.

	Middle Ear.	Canals.		Corti.		Duct + Sac.	Aqueduct.	Ganglion.	
Altmann + Fowler. 1st Case.	Normal	Normal Width	Saccule and Utricle dilated. Utricle bulges into proximal part of semi-circular canals. Saccule covers Stapes Foot-plate.	Reduced to a flat mound of disintegrating Cells.	Very Dilated. Apical part Herniated through Helicotrema into Scala Tympani.	Normal	Not noted.	Not noted.	Normal.
2nd lateral. R. Ear.	Normal	Not Dilated. Subepithelial Vesiculation. Christae P.M. Changes.	Utricle not dilated. Saccule dilated and covers Stapes Foot-plate. Maculae P.M. Changes.	Advanced P.M. Changes.	Very dilated and bulging into Scala Tympani through Helicotrema	Dilated duct. Absence of Perisaccular Connective Tissue.	Filled with Fibrous Tissue.	Not mentioned.	Normal.
L. Ear.				IDENTICAL.					
3rd Case.		Normal width Cristae P.M. Changes	Saccule and Utricle Dilated. Utricle slightly bulges into canals. Saccule no contact with Stapes. Maculae P.M. Changes.	Reduced to flat mound of Cells.	Grossly dilated. Herniated through Helicotrema into Scala Tympani.	Normal	Normal	Not mentioned	Normal.