WAR INJURIES OF THE EAR.
A Résumé of Recent Literature.

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I. Introduction.

In this abstract it seems advisable to deal only with war injuries of the ear and to omit all reference to diseases of the organ of hearing, except in so far as the latter are the result of injury. At the same time it must be admitted that the great majority of ear cases seen by a specialist—at any rate by a specialist in this country—are not due to the war at all. The majority of the deaf soldiers are suffering from chronic purulent otitis media or from adhesive processes in the middle ear resulting from past attacks of middle-ear inflammation, while a few cases are due to otosclerosis or to nerve deafness of syphilitic origin. Most of these conditions have arisen in childhood, and the number of such cases is so great that it is permissible to hope that the attention of the authorities may be called to the urgent need for the better care of children suffering from inflammatory conditions of the middle ear. In many instances the deafness of the soldier is so great that the men should never have been accepted for active service. Indeed, a number of men have been returned from the front because of bad hearing.—Kerr Love (Journal of the Royal Army Medical Corps, November 1916, p. 649).

A description of war injuries of the ear written by a surgeon at a clearing station or a hospital near the front would differ very greatly from one written by a specialist attached to a base hospital, and still more from an account penned by an otologist at a military hospital in this country. The first would deal mainly with cases of severe wounds of the head involving the ear, due to fragments from bursting shells or bombs or to rifle bullets—injuries which are fatal in a very high percentage of cases. Of such injuries we have had far too few accounts, probably because the surgeons who deal with these severe cases have not the time to write about them. On the other hand, military otologists in this country see comparatively few of these cases, but have to deal with indirect injuries of the ear caused by explosions or loud noises, i.e. with "shell" or "explosion" deafness, or "noise" deafness.

According to Haymann (Centralbl. f. Ohrenheilk., 1915, passim) injury to or destruction of the organ of hearing greatly reduces the earning power of the workman. Wounds of the ear may also lead to dangerous intracranial complications, for we now know that von Bergmann was wrong when he said that wounds caused by a modern
rifle bullet were sterile. Infected bullets cause suppuration, especially when they carry in infected clothes, hair, or skin. Secondary infection of the wounds is even more important than primary, i.e. bacteria can find their way to the injured middle ear from the nasopharynx via the Eustachian tube or from the external meatus through a rupture of the drumhead. Many of these cases of perforated drumhead, though really "acute," present the picture of a chronic middle-ear suppuration as regards the appearance of the membrane. When a case of direct injury of the head is admitted, the ear should be carefully inspected, and any escape of blood or cerebro-spinal fluid from the ear should be noted. The track of the bullet—as judged by the position of the wounds of entrance and exit—should be reconstructed and good radiograms (both lateral and antero-posterior) taken to reveal the presence of any foreign bodies or of splintering of the temporal bone.

II. THE EXTERNAL EAR AND MEATUS.

Auricle.—Canuyt (Journ. de Méd. de Bordeaux, April 1916) states that wounds of the pinna should be treated on general surgical principles, special care being taken to prevent perichondritis. Lacerations should be carefully stitched and plastic procedures carried out without delay. According to West (Oxford War Primers, 1915; Henry Frowde) there is good hope of the survival of an almost completely severed auricle, as the blood supply is abundant. Sutures should not penetrate the perichondrium but should go through skin only.

External Auditory Meatus.—Haymann states that the meatus may be injured by bullets which usually come from in front or from behind and make a fairly clean-cut hole with some splintering. The external meatus may also be injured by spent bullets or by pieces of shrapnel or bomb. In all of these cases the facial nerve is frequently injured. The prognosis in cases of injury to the meatus only is good, but stricture or atresia is a not uncommon sequela. A bullet in the meatus or its neighbourhood may keep up suppurative otitis, while if the foreign body be removed fatal meningitis may follow. In injuries of the external meatus the middle cranial fossa is more frequently involved than the anterior or posterior fossae. According to West, direct wounds of the bony portion of the meatus are usually at once fatal unless the bullet be a spent one, when it may lodge in the petrous bone. Such wounds are especially serious if complicated by antecedent middle-ear suppuration. In such cases the radical mastoid operation should be at once performed. Contraction or stenosis of the meatus following wounds are best treated by a planned plastic operation after all is soundly healed. Fractures of the roof of the meatus, which are usually compound, should be treated by careful drying of the passage and insufflation of boric powder. A dry dressing is then applied. The ear should never be syringed.
III. THE MIDDLE EAR.

Drumhead.—Rupture of the tympanic membrane is a fairly common war injury, and generally results from the explosion of a shell or bomb close to the sufferer. The lesion may be due to the sudden great increase of pressure which occurs first of all, or to the rapidly following negative pressure (Haymann). The effect of the explosion varies with its distance from the ear, the size of the shell, and the nature of the explosive. Lermoyez (La Presse Méd., 25th February 1915) says that the effects of explosion are far greater in a trench than in the open field. Further conditions predisposing to injury of the middle-ear structures are a wide straight external meatus, a drumhead almost at right angles to the meatus, or one which is indrawn or cicatricial. If the Eustachian tube is obstructed or if the explosion is unexpected the injurious effects are more severe. Ruptures of the tympanic membrane brought about in this way are much less regular in shape and position than those familiar in civil life, i.e., those due to a “box on the ear.” Japanese otologists have found that in 50 per cent. of cases the rupture is in the posterior part, in 24 per cent. in the anterior part, and in 26 per cent. along the handle of the malleus. The tears are often extensive, and may give rise to the impression of actual loss of substance. The symptoms are slight bleeding from the ear, followed by serous discharge; there is also deafness and frequently vertigo and pulsating tinnitus. (The latter symptoms are, however, due to a concomitant lesion of the inner ear.) The question of infection is even more important than that of rupture of the drumhead. Haymann has found that middle-ear suppuration almost always results in such cases, as the tympanic mucosa has only a small power of resistance. In extreme cases of concussion due to shell explosion, the joint between the malleus and incus may be dislocated and the latter bone displaced backwards towards the mastoid antrum. The treatment of traumatic ruptures of the tympanic membrane consists in careful dry cleansing of the external meatus and packing with a strip of iodoform gauze. If the inner ear is not injured the prognosis as regards hearing is good. If purulent otitis media arises it is probably best to treat it by the dry method.

Middle-Ear Cleft.—Injuries of the Eustachian tube are seldom observed or, at least, recognised. They may be caused by bullets entering through the facial bones with an oblique direction, or by bullets entering near the external meatus and penetrating to the region of the tonsil. The signs of tubal closure are observed, and may be followed by otitis media. Direct wounds of the middle ear always lead to extensive injury—usually to comminuted fracture of the petrous bone. It is only in rare cases that the middle ear alone is injured, and even then suppurative otitis media—usually of long duration—almost
invariably follows. Frequently there is extensive splintering of the bone in the neighbourhood of the channel of passage of the bullet. The tympanic membrane and ossicles are torn or destroyed, and there is extensive hemorrhage into the drum cavity and antrum. The facial nerve is usually involved, along with the tympanic plexus and the chorda tympani. In many of these cases the inner ear is also involved, and the lesion may extend to the internal auditory meatus or the pons Varoli. As a rule, a modern rifle bullet fired at a distance of less than 2000 yards goes right through the head (Haymann). In some cases the bullet may pass from one mastoid to the other without killing the patient, and even apparently without doing much damage to the brain. In such cases the bullet probably passes over the tentorium between the occipital lobes and the cerebellum. Direct injuries of the middle ear may extend upwards to the middle cranial fossa and downward to the jugular bulb. Posteriorly the facial nerve, the mastoid and the sigmoid sinus may be injured, while anteriorly the internal carotid artery and the Eustachian tube may be shattered. As a rule the whole posterior part of the middle-ear cleft is involved, but in rare cases a small splinter only may enter the tympanic cavity, while isolated injury of the mastoid process by fragments of shell or bomb is not uncommon. Such fragments usually give rise to suppurative otitis media, which only ceases after the removal of all foreign bodies. It rarely happens that fragments can remain in the mastoid without causing serious reaction. Surface injuries of the mastoid may involve the emissary vein and may result in septic thrombosis of the sigmoid sinus. The mastoid process may be injured by shots from all directions. In many cases the bullet enters through the orbit or cheek and leaves by the mastoid, but in these cases the mastoid injury is comparatively of small importance. According to Haymann the velocity of the bullet and the structure of the mastoid (pneumatic or sclerotic) have a great effect on the resulting lesion. Concussion of the labyrinth may result from injuries of the mastoid, and facial paralysis is of common occurrence.

_Treatment._—If the patient survives the immediate injury to the ear, the only urgent need, according to West, is the control of hemorrhage. When this is venous it is easily managed by careful gauze plugging. If, on the other hand, the blood comes from the internal carotid the only chance for the patient's life lies in the control of the artery in the neck until it can be ligatured. The plug of iodoform gauze introduced in cases without dangerous bleeding should not be removed for 48 hours (Lermoyez). At the end of this period the meatus should be carefully cleansed with pellets of dry cotton-wool, the plug of gauze reinserted, and dressings applied. Syringing should be avoided. Opinions are divided on the question of operation when the X-rays reveal a bullet or piece of shell in the middle-ear cavities.
The interventionists think that an immediate search for the foreign body should be carried out to obviate the danger of intracranial complications. The abstentionists prefer to wait, so as to avoid unnecessary risk. Lemée holds that we should wait if the wound be recent, but operate at once if otorrhoea or intracranial complications be present. If the facial nerve be paralysed the ends should be placed in contact but not stitched (Canuyt). The intracranial complications following shot injuries of the middle ear are the same as those due to middle-ear suppuration arising from other causes. Labyrinthitis and purulent leptomeningitis are the most common, but extradural abscess, sigmoid sinus thrombosis or septicæmia, and brain abscess (temporo-sphenoidal or cerebellar) may also occur.

IV. THE LABYRINTH.

War injuries of the labyrinth may be classified as follows:—{(A)} Direct injury due to bullets or fragments of shell or bomb. (B) Indirect injury in fractures of the skull which involve the labyrinth capsule. (C) "Noise" deafness, which is especially seen in artillerists and naval gunners, but also occurs in other soldiers and sailors to a less extent. (D) "Shell" or "explosion" deafness, due to the bursting of mines, shells, or bombs close to the soldier.

(A) Direct Injury of the Labyrinth.—In the great majority of cases in which the labyrinth is involved the soldier is killed outright from the concomitant lesion of the brain. Such cases, of course, do not come under clinical observation. Haymann states that injuries of the labyrinth are almost always combined with lesions of the middle ear. In rare cases, however, the bullet may enter through the face and reach the labyrinth without penetrating into the middle ear. There is usually extensive fissuring or splintering of the petrous bone, often followed by intracranial complications. As a rule, the whole labyrinth is involved. The bullet may come (1) from above and in front with a downward and backward direction. (2) From in front, against the face, injuring the eye and maxillary antrum or the mouth before reaching the labyrinth. The wound of exit may be in the mastoid, in the occipital region, or in the neck on the same side, or on the opposite side. The bullet may, of course, remain in the skull. (3) The most frequent injuries of the labyrinth which can be recognised result from lateral wounds penetrating the ear or its neighbourhood. (4) In some cases the shot is an oblique one, the bullet entering in front of the ear and coming out in the neighbourhood of the mastoid process. The symptoms of labyrinth injury are well known—deafness, tinnitus, giddiness, disturbance of balancing, vomiting, nystagmus, etc. According to Lermoyez, in the severely wounded cases which survive, the deafness is only noted when the bandages are removed. Haymann states that in 50 per cent. of these cases death occurs later from septic
meningitis, which may be due to infection carried in by the bullet or shell splinter, or may be secondary to infection from the Eustachian tube. The onset of meningitis may be delayed as long as six weeks. Bullets and bits of shell may remain a long time in the labyrinth without giving rise to severe complications, and they may even heal in this situation, if the middle ear be not injured (Haymann). On the other hand, these foreign bodies usually give rise to pain, which is only relieved by their removal. Some surgeons hold that it is better to wait, while others believe that an immediate exploratory operation should be carried out for fear of intracranial complications. Lermoyez himself holds that it is better to wait if the wound be recent and aseptic, but to operate at once if otorrhoea be present. Further, if facial paralysis, labyrinthine disturbance, or meningitis exist, one should operate at once.

(B) Indirect Injury of the Labyrinth in Fracture of the Skull.—The labyrinth may be indirectly injured by blows on the head from a rifle butt or sword, or by shot-wounds of the head or face, especially by those which involve the lower jaw, which, of course, articulates with temporal bone. Falls on the head may cause fracture of the base, and thus injure the inner ear. Haymann states that basal fractures may run parallel to the long axis of the petrous pyramid or may cross it. (1) If the force is applied at the side of the head in the direction of the petrous pyramid we get a longitudinal fracture, which usually runs along the roof of the middle-ear cleft. At its outer end the line of fracture may turn outwards to the external meatus, or may pass to the squamous or mastoid regions. As a rule, in these cases the labyrinth capsule remains intact, but the stapes may be displaced, or there may be hemorrhage or tearing of the round window membrane. (2) On the other hand, if the force is applied to the back of the head, we get a transverse fracture which runs at right angles to the long axis of the petrous pyramid and always injures the labyrinth. As a rule, these fractures pass through the vestibule. The symptoms of such injuries are extreme or total deafness, marked disturbance of balancing, with loss of the cochlear and vestibular functions. If the labyrinth be injured there is an escape of cerebro-spinal fluid from the ear along with blood. In the cases in which the labyrinth capsule is not injured there is no escape of cerebro-spinal fluid; but, nevertheless, deafness results from hemorrhage into—or tearing of—the eighth nerve. On lumbar puncture blood may be present in the cerebro-spinal fluid (Ferreri). One or two of the cases with fracture of the labyrinth have been microscopically examined many years after the accident, and filling up of the hollow spaces of the labyrinth by new connective tissue and bone has been found, along with secondary degenerative atrophy of the nerve structures.

(C) and (D) "Noise" Deafness and "Shell" or "Explosion" Deafness.
—It is difficult or impossible to draw a sharp line between "noise" and "explosion" deafness. Undoubtedly, there are many cases in civil life of pure noise deafness due to prolonged over-stimulation of the auditory nerve endings, e.g. in boilermakers, riveters, railwaymen, etc. On the other hand, there are in war many cases of pure explosion deafness due to the bursting of a shell or bomb close to the soldier, and the consequent great variation in air-pressure which produces a coarse mechanical effect on the labyrinthine structure (Haymann). There is, however, a third group in which both elements are present, i.e. the acoustic over-stimulation and the mechanical injury. Such conditions are found in artillerymen, naval gunners, and other members of the forces.

(C) "Noise" Deafness.—Wittmaack (Zeitschr. f. Ohrenheilk., 1907, vol. liv.) was the first to show that continuous noise conveyed to the ear by air- or bone-conduction did not cause haemorrhage or tearing of the membranous labyrinth, but produced a degenerative neuritis in the cochlear apparatus. The vestibular apparatus showed no change. According to Wittmaack the primary changes occurred in the spiral ganglion and nerve, while those in Corti's organ were only secondary. Yoshii (Zeitschr.f. Ohrenheilk., 1909, vol. Iviii.), on repeating Wittmaack's experiments, found that Corti's organ was affected first of all, and that the degenerative changes in the cochlear ganglion and nerve followed later. Gruenberg, von Eicken, Marx, and Roehr have confirmed the observations of the Japanese otologist. Hoessli (Monatschr.f. Ohrenheilk., year 47, No. 7) considers that the changes due to noise are caused by excessive stimulation of the nerve-endings, like those produced in the retina by an intensely bright light (eclipse blindness). Both von Eicken (Verhandl. der deut. otl. Gesellsch., 1909, vol. xviii.) and Hoessli came to the conclusion that air-conduction of sound was much more effective than bone-conduction in producing injuries of the inner ear. After prolonged exposure to the sound of rifle- and gun-fire, deafness is usually marked and tinnitus not uncommon. Vestibular symptoms are rare. Patients complain of a feeling of heat in the ear or of drumming in the head. Prophylaxis and treatment are dealt with later.

(D) "Shell" or "Explosion" Deafness.—The pathology of explosion or shell deafness is still very vague. As yet, we have no published accounts of the microscopic examination of the ear from such cases. Theories as to the pathology may be divided into three groups—

(a) Some otologists believe that there are changes in the membranous labyrinth of a molecular nature leading to degenerative neuritis affecting the nerve-endings, ganglia, etc. (b) Others hold that the membranous labyrinth is torn (Stenger, Barnick, and Sakai), and that haemorrhages occur. Yoshii found that explosions produced close to the ears of animals caused rupture of the drumhead and hæmor-
rhages in the cochlear and vestibular apparatus. Hoessli caused explosions at a great distance from the animals, and did not find rupture or haemorrhage, but noted changes in Corti's organ, the cells of which were shrunken and flattened as from excessive movements of the basilar and tectorial membranes. (c) Zange has experimented on animals, but has found no changes in the labyrinth. He therefore believes that the condition is due to small haemorrhages in the pons, medulla, and cerebellum.

Clinical Aspect of "Shell" Deafness.—Haymann calls attention to the injurious effects of long-continued shelling on the soldiers exposed to it. The effects of the shell explosion depend on the calibre of the shell, its explosive force, its distance from the soldier, and the angle at which the explosion meets the ear. The weather and the conditions of resonance must also be considered as well as the nature of the gas which results from the explosion. Lermoyez holds that the results are much more severe if the explosion occurs in a more or less enclosed space, such as a trench, where the force of the explosion and the gas are not quickly dissipated. The direction of the wind, and the humidity and electrical tension of the air must also be considered.

In the bursting of shells and grenades the great variations of air-pressure are the cause of the damage to the inner ear. The explosion produces a coarse mechanical effect, i.e. a blow which reaches the ear before the noise of the explosion, so that, to some extent, there occurs an arrest of the stapes comparable to that produced by Gelle's experiment. Injuries to the labyrinth due to rifles being fired off close to the ear are also of a mechanical nature. During the firing of big guns the shaking of the ground is transmitted by bone-conduction to the labyrinth, though the great differences in the density and nature of the body tissues must make a bad conducting medium. Some observers say that a middle-ear lesion guards the inner ear from injury, while others hold the view that the two tympanic muscles in health act as a protection. If the drumhead remains intact the injury produced by an explosion is more severe than when the membrane gives way, because of the powerful lever action on the stapes. If the drumhead ruptures, the round window is, of course, affected, but to a less extent.

The clinical symptoms of labyrinthine injury are divided into three groups (Haymann)—(1) Those due to injury of the cochlear apparatus, i.e. deafness and noises in the ear. (2) Those due to injury of the vestibular apparatus, i.e. giddiness, loss of balancing, nystagmus, etc. (3) Cerebral or psychic disturbances, i.e. loss of consciousness, headache, nausea, vomiting, vasomotor disturbances, neurasthenia, and hysteria. Two types of cases are met with—(a) Acute cases, due to intense and sudden trauma. In these we meet with cochlear, vestibular, and psychic disturbances. (b) Chronic cases, due to milder but frequently
War Injuries of the Ear

repeated injuries, in which only the delicate cochlear apparatus is involved. When a bomb explodes close to a soldier there is loss of consciousness for a longer or shorter period, varying from a few seconds up to some hours. After recovery of consciousness there is more or less deafness—usually unilateral. Along with this there is nausea, vomiting, giddiness, and disturbance of balancing. Tinnitus comes on at once, and the patient also complains of pain or of a numb feeling in the ear, with headache. There is also marked psychic depression. Lermoyez describes the condition very graphically.—A shell bursts, and, though no projectile has wounded the petrous bone, and no blow has injured the skull, the ear dies. It is not due to the noise, but to the sudden displacement of air, which strikes against the tympanic membrane and causes the injury. The bursting of a shell can affect the ear in two different ways—(a) The intense noise puts the auditory apparatus into an exaggerated state of vibration, and temporarily paralyses it. A sudden light injures the retina in a similar way. A functional deafness is produced, but it disappears in a few days. (b) An explosion causes the air to be violently projected into the external auditory meatus, just as earth might be shot up. The condensed air presses on the tympanic membrane, which transmits the pressure to the labyrinth. (The membrane and ossicles transform vibrations of the drumhead, which are of great amplitude but slight force, into movements of the stapes, which are of small amplitude but of great force, in order to overcome the inertia of the fluid in the labyrinth.) This sudden condensation of air is comparable with, though enormously greater than, the effect produced by a smack on the ear, and is especially the result of explosions in an enclosed space. This type of deafness is frequently observed after the bursting of bombs in the trenches rather than in the open field. The result of the explosion varies according to whether the tympanic membrane resists or gives way. In the latter case the effects are less severe.

If the drumhead resists, the force of the explosion is transmitted thirty-fold by the stapes to the perilymph, producing labyrinthine concussion, such as we find after violent injuries of the skull. The auditory and static labyrinths are both involved, and the patient, on regaining consciousness, suffers from deafness, tinnitus, and vertigo. The prognosis depends on the degree of violence and proximity of the explosion, and on the formation and condition of the external meatus, e.g. a narrow curved meatus, containing a plug of wax, would protect the ear to a great extent. Further, if the soldier expects the explosion, being warned of the arrival of the shell by the increasing “whizzing” sound, he prepares himself for the noise—opens his mouth and unconsciously tightens his tympanic membrane.

From the clinical point of view, Lermoyez distinguishes two degrees of labyrinthine concussion—mild and severe. In a “mild” case, taken
unawares by the explosion, the subject feels stunned at first; when his astonishment has passed he feels in one or both ears an uncomfortable sensation of fulness; it seems to him as if there is at the bottom of the meatus a plug of thick cotton-wool which veils sounds, and which he tries to get rid of by manipulating his auditory meatus with his finger; at the same time he perceives a musical noise, like a swarm of mosquitoes, which at first he erroneously thinks comes from outside, but which eventually he localises as being in his ear. Often he notices that his gait is uncertain; when he turns his head a feeling of giddiness just fails to make him fall down. There is no discharge from the ear, no pain, no lesion visible by the aural speculum. This condition lasts several days, sometimes several weeks; the giddiness disappears first; then the hearing returns, but the musical tinnitus may persist indefinitely. Local treatment is useless; but the patient must be kept absolutely quiet and in silence as long as the ear shows signs of hyperaesthesia. Bromides should be given. These “slightly wounded soldiers” can return to duty after about a month, but the susceptible ear must be carefully plugged.

In “severe labyrinthine concussion” a mine explodes and the man falls unconscious. Coming to himself he tries to get up, but falls again. He has to be assisted to his feet and held up, as he feels drunk or stupefied. Everything about him seems to turn, and he suffers from nausea and vomiting. For several days the patient remains silent and nervous. The slightest movement of his head, or even the sight of anything moving, brings on vertigo, cold sweats, nausea, and epigastric pain. No food is tolerated. At the end of a week the vertigo is less and the patient can sit up, or even get up, though he has to walk holding on to objects for support. He is now chiefly concerned about his deafness, which is usually unilateral, but so severe that he cannot hear a shout in the affected ear, though his head seems full of the noise of whistling and bells. On examination, haemorrhagic spots may be seen on the tympanic membrane, suggesting that haemorrhages have also occurred in the internal ear.

*Functional Examination of Cases of “Shell” Deafness.*—Neumann (*Monatschr. f. Ohrnenheilk.*, 1915, p. 211) has examined 152 patients about a month after the explosion. He found that one ear was almost or quite deaf, while the other showed considerable loss of hearing. The bone-conduction was shortened, the lower tone-limit slightly raised, but the upper tone-limit markedly lowered. Spontaneous nystagmus was rarely present one month after the injury, and the vestibular reactions were usually normal. Neumann thinks that the injury is due to excessive stimulation of the auditory apparatus. Rhese states that 50 per cent. of cases of labyrinth concussion improve within a year. Meyer has reported on 105 cases of war injury of the inner ear due to a sudden great increase in air-pressure. In 70 the
drumhead was injured in addition to the labyrinth trouble. Ninety-five of the patients suffered from "detonation neuritis." The deafness was so great that the patients could not understand what was said, but there were no cases of complete deafness.

**Prognosis, Prophylaxis, and Treatment (Lermoyez).**—The vertigo disappears in from three to six months at most, though sudden turning movements, or looking down from a height, still cause great disturbance of equilibrium. The tinnitus decreases but does not disappear, and the deafness persists. Sometimes there are merely gaps in the scale of hearing, *e.g.* high tones, such as the whistling of birds, are no longer heard. The prognosis should always be guarded, as the deafness, which at first is partial, may later become complete (Haymann).

**Prophylaxis.**—With regard to the use of aural plugs, Suzuki holds that a preventive appliance which is to be used by several thousand men must not be of a complicated nature. Cotton-wool, however, is not efficient unless it be incorporated with jeweller’s wax or plasticine. Such a plug is easy to insert and remove intact, and can be readily moulded to fit the external meatus. Arnulph Mallock (*Brit. Med. Journ.*, 1915, vol. i. p. 25) has invented an ear defender, which consists of a cylindrical ebonite holder and seven components, the sensitive diaphragm, enclosed between two pieces of wire gauze, being the most important. The "defender" transmits ordinary sounds freely, but a sudden extreme change of air-pressure—as from an explosion or gunfire—presses the diaphragm against the gauze and prevents injury to the labyrinth.

**Treatment.**—Immediately after the injury the patient should be removed on a stretcher with great care, and put to bed in a cool, silent, and dark place. The patient himself chooses the position (supine, prone, or on his side) in which the vertigo and nystagmus are least marked. The treatment is really the same as that after a long administration of chloroform, which itself causes intoxication of the labyrinth (Lermoyez). To relieve the thirst a few teaspoonfuls of iced water may be given, but as seldom as possible. A mustard plaster or a hot compress should be applied over the epigastrium to relieve the nausea, while an ice-bag, guarded by a layer of flannel, may be placed over the ear. If the patient complains of buzzing, two leeches may be applied behind the ear. A hypodermic of morphia may be given, and repeated morning and evening for two or three days. In severe cases Ferreri recommends lumbar puncture. Thereafter, bromide of potassium should be prescribed. In the treatment of deafness Lermoyez recommends large doses of strychnine hypodermically (2 mgrms. three times a day for a fortnight, not longer). Electricity is of no use. Later on an artificial aid to hearing may be tried, but lip-reading is likely to be of much greater service. (One notes with pleasure the proposed
establishment in Edinburgh of a centre for teaching lip-reading to deaf soldiers.—Abs.)

V. PSYCHICAL DEAFNESS.

Milligan and Westmacott (Journ. of Laryngology, 1915, p. 302) believe that many cases of so-called "concussion deafness" are due to the temporary abolition of sensory impulses in a brain already anaemic as a result of physical fatigue and mental strain. The actual loss of hearing is induced by a sudden climax, e.g. the bursting of a shell, accompanied as it is by general atmospheric commotion, and the not infrequent burial of the soldier in the earthworks of the trench. The writers have observed ten cases of the "deaf and dumb" state, and believe that the abrogation of function is due, not to an organic lesion, but to a temporary suspension of neuron impulses from the higher cortical cells to the periphery. They state that in cases of sudden blindness and sudden deafness no trace of any peripheral organic lesion can be demonstrated. Moreover, the rapid recovery of so many of the patients is a strong argument against any peripheral lesion. In many of the cases the ears were previously diseased, and Milligan and Westmacott believe that this has tended to throw the effects of the concussion on the sentient segments of the organ of hearing. Canuyt (Journ. de Méd. de Bordeaux, April 1916) states that in the diagnosis of purely functional lesions the principal signs are—absolute deafness; total loss of hearing for the tuning-fork by air- or bone-conduction; retention of the patient's natural tone of voice; absence of spontaneous nystagmus. Neuropathic symptoms may be present, e.g. tremors, disturbance of sensibility, narrowing of the visual fields, hysterogenic zones, along with the exaggeration and self-contradiction characteristic of hysteria. Urbantschitsch (Monatschr. f. Ohrenheilk., 1914, p. 1206) records a case of the deaf and dumb state following shell explosion in which the patient emitted one tone continuously day and night. Massage proved useless, but a strong faradic current applied to both ears brought back some hearing, while similar applications to the larynx resulted in a return of the voice. Zange (Muench. med. Wochenschr., 1915, p. 957) reports a somewhat similar case in which the speech returned to some extent after ten days, but the patient stuttered and spoke in a telegraphic style. Caloric tests were carried out, but produced crying. The patient almost completely recovered in some months. Various methods have been tried in the treatment of these cases of psychic deafness which are often accompanied by dumbness. Massage, electricity, the administration of an anaesthetic followed by stimulation, and the use of asafoetida and valerian may be mentioned. O'Malley recommends that one ear should be syringed with cold lotion so as to produce caloric nystagmus and giddiness. The surgeon then says to the patient, "Now you hear all right; don't you?" As a rule,
the patient answers that he does. O'Malley believes that by influencing the lower vestibular organ in this way one can restore the function of the more highly developed cochlear apparatus. As a rule, bullying methods are better avoided. It must be remembered that the patients are suffering from great psychic disturbance, and that they need rest and quiet more than anything else. They should be made to understand that their deafness is not permanent, and that the power of hearing may return any day.

VI. AFFECTIONS OF THE EAR IN AVIATORS.

Ferreri (Policlinico, 1915) states that on rising rapidly, or on rising to a very great height, aviators experience a feeling of deafness and pressure in the ears, along with tinnitus. There may even be vertigo and nausea, so that in severe cases Ménière's symptom-complex may be met with. The condition is due to a want of proper balance between the air-pressure in the tympanic cavity and that in the external meatus. This want of balance reacts on the labyrinth. In Ferreri's opinion all pilots and observers should be examined for nasal obstruction, and the condition of the Eustachian tubes investigated. In the treatment of the conditions Ferreri advises rest, pilocarpine injections, and, in severe cases, lumbar puncture.