EMERGENCIES IN GENERAL PRACTICE

SEVERE EARACHE

BY

C. GILL-CAREY, F.R.C.S., F.R.C.S.Ed.

Surgeon, Royal National Throat, Nose and Ear Hospital

Among the causes of severe earache, only one—severe otitis media—merits full consideration as an emergency, for it carries risks to the important function of hearing and, at times, even to life itself. More than 15 years' experience of chemotherapy in acute otitis media has shown that, given efficiently, only a small percentage of cases fail to respond. The first few weeks, previously a time of anxious waiting, have become a period of purposeful activity. The emergency continues, now in most cases with the general practitioner bearing full responsibility, and with need for the trained otologist in only a small number of cases. To be comfortable in this emergency, the practitioner must acquire a reasonable degree of skill in examining the ear-drum and in interpreting the presenting signs. He must be aware of the changes which take place in the drum as the disease waxes or wanes, of the picture presented by partially successful chemotherapy, and of that in chronic otitis media temporarily overshadowed by a flare-up of acute disease.

The occasional failure with chemotherapy, as much as the good results, has given a new and practical interest to the pathology and bacteriology of acute otitis media.

Bacteriology and Epidemiology

There is evidence that the virulence of some of the organisms concerned in otitis media may change from time to time. Friedmann* mentions that Haymann, reporting the results of experimental otitis media in the guinea-pig during the years 1912–14, found that streptococcal infections were of a serious nature, with rapid invasion and high mortality. Clinical reports during the next 10 to 15 years confirmed the dangerous character of streptococcal infections. Friedmann, in the early 1950's, using organisms from cases of human otitis and sinusitis, conducted a similar research to that of Haymann's but on a much larger scale. Streptococcal infections were found to be mild, whereas some strains of the pneumococcus, benign when Haymann did his investigation, had become extremely virulent with a high mortality, usually from meningitis which occurred at an early stage of the experimental disease. Both authors give similar reports on the results of infection by *Pseudomonas pyocyanea*, an organism highly resistant to antibiotics and therefore of increasing clinical importance, especially to the otologist, as such cases usually end in his hands. Friedmann described a characteristic clinical picture with this organism. After a stormy acute phase there follows a period of active chronic infection during which, although the animal appears quite healthy and there is no discharge from the ear, the inflammation persists, with intense new bone formation causing obliteration of the air spaces.

In a further report based on the study of 1,278 cases of acute otitis media seen at the Royal National Throat, Nose and Ear Hospital in 1951 and 1952, Friedmann† found the incidence of the infecting organism fairly constant during those two years: β -haemolytic streptococci accounted for 19% and 24% respectively of the cases in 1951 and 1952, *Staphylococcus aureus* for 46% and 40%, and pneumococci for 0.5% and 1%. The epidemiological pattern may also show wide variations in different localities at the

same time; Scandinavian statistics during the same period, for instance, showed a rate much higher for pneumococci and much lower for staphylococci.

Chemotherapy

On clinical as well as bacteriological grounds, Friedmann found that penicillin was still the antibiotic of choice†. As well as being effective in most cases of acute otitis media it was quick in action, with fewer side-effects than many of the newer antibiotics. In acute streptococcal otitis it was found that with penicillin no organisms could usually be found after 24 hours, whilst with other antibiotics they were still present after three to four days' treatment. Penicillin-resistant staphylococci were found in 14% of cases; but these figures tend to give a false clinical impression, for the degree of resistance is variable and difficult to estimate with accuracy; many cases in which the organisms were resistant on *in vitro* testing responded clinically to penicillin therapy. The newer wide-spectrum antibiotics are for use against Gram-negative organisms and penicillin-resistant staphylococci. Unfortunately, for several of the organisms in the Gram-negative group—that is, *Ps. pyocyanea* and *Proteus vulgaris*—there is at present no completely satisfactory drug. Of the antibiotics at present available, streptomycin seems to offer the best method of control, despite its toxicity and the rapid development of resistance to it.

In 1946, Munro Black‡ decided to try the effect of penicillin on the child with acute otitis media who already had signs of mastoid involvement with no chance of spontaneous recovery. In all his patients gross signs of acute mastoiditis, including post-aural swelling which was often fluctuant, were present. These children were treated in hospital under conditions which, apart from a daily examination by an otologist, might obtain in an isolated community. No bacteriological investigations were carried out, myringotomy was not performed. Surgery was limited to incision and drainage of post-aural abscesses which existed in 59 cases. All, with the exception of three children who developed chronic mastoiditis, when examined some months after discharge from hospital were found to have made a good recovery, with satisfactory hearing. In all he treated 118 children by this method. A different picture, however, is painted by Goodale and Montgomery,§ who, quoting cases seen in 1954 at a large otological hospital in the United States, drew attention to the dangers of complacency brought about by years of successful chemotherapy. In the light of their recent experience they feel that the dangers of masked mastoid disease are again increasing and they advocate that in all cases antibiotic treatment of acute otitis media should be guided by bacteriological findings.

It is as well to remember that, in spite of the advances in chemotherapy, otitis media and mastoiditis still account for an appreciable number of deaths. In England and Wales in 1953 there were 336 deaths from this cause; a notable improvement on the 1,050 registered in 1943 and on the 1,562 in 1933.

Differential Diagnosis of Severe Earache

The equipment needed is simple: an electric auriscope or an electric headlamp used with aural specula; in both cases there should be provision for suction (Siegle's speculum). Failure to remove wax and pus is responsible for many wrong diagnoses, and an ear syringe, wool carriers,

*Friedmann, I., *J. Laryng.*, 1955, **69**, 27.

†"The Chemotherapy of Acute Aural Infections" in *Modern Trends in Diseases of the Ear, Nose, and Throat*, edited by M. Ellis, p. 123. London, 1954.

‡Black, J. I. Munro, *British Medical Journal*, 1951, **2**, 1191.

§Goodale, R. H., and Montgomery, W. W., *Ann. Otol. (St. Louis)*, 1955, **64**, 181.

and aural forceps are essential. The routine use of a simple hearing test may be a deciding point in a difficult diagnosis as well as a guide to progress. The forced or stage whisper, normally heard at 20 ft. (6 metres) needs no special equipment and is reasonably accurate. The ear not under test is put out of use by rapid rubbing movements of a finger over the meatus.

Extra-aural Causes

There are three possibilities to be considered when the complaint is severe earache: extra-aural causes of earache, acute external otitis, and acute otitis media which may be infective or non-infective in origin.

On rare occasions, more often in adults than in children, severe earache may occur without any sign of disease in the middle or external ear. The nerve supply of the ear is provided by the fifth, seventh, ninth, and tenth cranial nerves as well as by the second and third cervical nerves. Thus, as might be expected, earache of extra-aural origin may be a symptom of many unrelated conditions in a wide area of the head and neck. Those causing severe earache are:

Dental Conditions (Fifth Nerve).—These are commonly the result of disease in the lower molar region. Earache after a dental extraction may be severe, but presents no diagnostic difficulty; buried impacted teeth and buried infected roots, both requiring radiological examination to confirm the diagnosis, are often missed for long periods.

Post-tonsillectomy Neuritis of Ninth Nerve.—This may produce severe pain in the ear in children, but more often in adults. It is a moderately common cause of earache and of fear of otitis.

Malignant disease of the base of the tongue (ninth nerve) and extrinsic carcinoma of the larynx (tenth nerve) must be kept in mind, for both are easily missed. In some cases earache is the only symptom for weeks, and such growths, infiltrating deeply, are also often difficult to see.

Herpes and neuralgias of the nerves supplying the ear are a cause of severe earache. Special mention should be made of herpes affecting the seventh nerve. Seen after the vesicles have ruptured, it may be confused with external otitis unless a search is made for vesicles on the lobe and cranial aspect of the ear. Diagnosis at an early stage may be impossible, as pain precedes the appearance of vesicles.

Acute External Otitis

Acute external otitis is sometimes confused with acute otitis media, for both may present with deafness as well as severe earache. The history often gives the first clue. Chronic external otitis often precedes the acute form; in many cases the symptoms are slight and overlooked, being remembered only on questioning. A story of chronic itching and of attacks of frequent deafness relieved by syringing is suggestive. The acute attack itself may be related to minor trauma produced during wax removal.

In acute otitis externa, one sign—pain on manipulation of the meatus—is constant, whether it be obtained by the insertion of a speculum, probing, or the movements of chewing. Inspection shows a tender swelling or swellings in the outer half of the canal. Removal of pus and debris, a step as essential in treatment as in diagnosis, reveals the drum to be hyperaemic but in its normal position; hearing is unimpaired. There is a mastoid lymphadenitis, showing itself as a localized tender swelling superficial to the lower half of the mastoid bone.

Acute Infective Otitis Media

Severe acute otitis media is commoner in children than adults, and it is usually preceded by an acute infection of the upper respiratory tract. In many cases additional factors such as diving, flying, or nasal douching play an important part. Pain, although severe, is often intermittent and stops when the drum ruptures or is incised. Marked deafness is constant. Repeated attacks without preceding nasal or pharyngeal infection should raise suspicions of chronic mastoiditis with exacerbations.

The drum, seen at an early stage, shows hyperaemia localized to the attic, malleus, and periphery (Fig. 1, A). Within

FIG. 1.—Ear-drum in acute otitis media: (A) showing generalized injection and thickening; (B) at a later stage, the malleus hidden by the bulging drum.

a few hours the drum becomes purple, the malleus no longer visible (Fig. 1, B), and often, shortly before it bursts, the drum is seen to pulsate. Successful chemotherapy given early in the attack produces a return to normal almost as rapid as the onset of the disease. Severe middle-ear infections invariably spread to the outlying regions, the mastoid antrum and mastoid cells.

Failure to respond to treatment shows itself in two pictures, differing according to the site of the defeat. In one the middle ear, first to be involved, fails to recover, while the mastoid antrum and cells rid themselves of the infection. A central perforation, actively suppurating, persists (Fig. 2). In the other, the middle ear heals but infection lingers in the mastoid cells and antrum, finding an exit through perforations in nearby regions of the drum (Fig. 3). This is a more serious state of affairs than the preceding one. Failure to overcome infection in both regions is not uncommon. The tympanic perforation is seen without difficulty, but those in the attic if covered with a waxy crust are easily missed.

The last drum picture is one of active chronic infection behind an intact but slightly abnormal drum. Friedmann's work suggests that this type of infection may be characteristic of certain organisms; clinical reports implicate inadequate chemotherapy. The appearances cannot be indicated diagrammatically, for the changes in the drum are of minor degree. Persisting hyperaemia of the attic and deep meatus, combined with some loss of hearing, should arouse suspicions of this type of disease. It is in these cases that radiography is of outstanding value in diagnosis.

Otitis media in infants and young children differs from that in adults in that, owing to lack of thick cortical bone, mastoid swelling may appear early. In infants the signs and symptoms of acute otitis media are often overshadowed by systemic effects such as high temperature, fits, and

FIG. 2.—Chronic suppurative otitis media with central perforation.

FIG. 3.—Chronic mastoid infection, showing perforation in attic.

occasionally serious diarrhoea and vomiting. A further difficulty sometimes arises from lack of the usual signs of acute middle-ear infection. A grey drum, lustreless but slightly bulging, may cover a middle ear filled with highly infective pus.

Non-infective Otitis Media

Severe earache may also occur in the absence of infection, as a result of vasomotor or allergic oedema or following sudden changes in atmospheric pressure.

Acute allergic otitis media should be suspected if the signs and symptoms of acute otitis, without, however, the constitutional disturbance of a severe infection, are associated with a marked nasal reaction on exposure to a high concentration of an allergen. This type of acute otitis media is sometimes seen in cases of severe hay-fever or as the result of inexpert opening of the bag of a vacuum cleaner by a person sensitized to house-dust. A satisfactory response to adrenaline, ephedrine, or antihistamine drugs supports the diagnosis. Deafness may follow an effusion of mucus or serum unless the middle ear is emptied by incision of the drum followed by inflation of the Eustachian tube.

Patients with Eustachian obstruction, either infective or allergic—for example, a heavy head cold or hay fever—should not be allowed to fly, even in fully pressurized aeroplanes. These persons are likely to develop serious complications owing to their inability to equalize the pressure in the middle ear with that outside.

Persons with chronic otitis are quite safe in being allowed to fly, however. They already have a hole in the drum, and therefore have no difficulty in maintaining the pressure in the middle ear in equilibrium with that of their environment.

Treatment of Acute External Otitis

The treatment of this painful condition is surprisingly difficult. The sensitive meatal skin is closely bound by firm fibrous tissue to bone and cartilage, and inflammatory swellings—whether the result of infected hair follicles (circumscribed type) or subcutaneous connective tissue (diffuse type)—produce severe and long-lasting pain. There is a danger that the anxiety to give relief may lead to unwise decisions. Incision before localization of pus has led to pyaemia. In a condition in which the risks to life and to function are negligible chemotherapy should be reserved for selected cases.

Some of the features peculiar to this acute dermatitis and many of the difficulties in its treatment are related to the effects of a preceding chronic dermatitis. So common is this association that success in the treatment of the acute condition depends largely upon knowledge of the chronic variety.

Chronic external otitis—a disease with a complicated aetiology, in which infection, mycotic as well as bacterial, is combined with underlying non-infective conditions—is sometimes secondary to otitis media and very often to infections of the scalp. Local conditions in the meatus such as tortuosity, narrowness, deep terminal pockets, or thick hairs at the entrance favour chronicity.

Underlying chronic dermatitis, often unsuspected, is responsible for the occurrence of acute infection after minor trauma; damage by water, for instance, as from ear syringing, bathing, or even excessive sweating, is a common antecedent.

Association with chronic dermatitis accounts also for the unusual bacteriological findings in acute external otitis. Gram-negative organisms such as *Ps. pyocyanea*, *Proteus vulgaris*, and *Bact. coli* are found in a high proportion of cases.

Systemic chemotherapy for acute external otitis is of limited value. With one exception, that of erysipelas of the ear, for which penicillin may be given with confidence, the

use of "blind" chemotherapy is difficult to defend. The antibiotics most effective against Gram-negative organisms have dangers and side-effects, immediate and remote, which should limit their use. The most effective *in vitro*, polymyxin, in its present form is too toxic for systemic use, except in cases where there is danger to life. Toxic effects and the rapid development of resistant strains may follow the use of streptomycin, chloramphenicol, and the tetracyclines, making their routine use unjustifiable.

Incision should be delayed until the pus points; it may conveniently be performed with a pointed match-stick dipped in phenol.

Local applications can have little effect upon the infection until the pus has discharged. By controlling surface infection, however, they reduce the chances of reinfection. The canal, in particular the terminal pocket, should be cleaned as thoroughly as possible before use. Liquor aluminii acetatis *B.P.C.*, applied on a cotton-wool wick, has given good results for many years in pyocyanous and other infections.

Local applications of antibiotics usually fall into disfavour as cases of sensitization occur; with polymyxin there is, at present, no evidence of frequent sensitization.

Treatment of Severe Acute Otitis Media

Success in the management of this emergency depends largely on the skill with which the numerous chemotherapeutic remedies now available are employed. In the choice of those most suitable for the occasion it is unwise to be influenced unduly by clinical reports, especially those based upon small numbers. It is well to remember that in pre-chemotherapeutic times it would be reasonable to expect that between 70% and 80% of the cases of acute otitis media would run a benign course, ending in spontaneous resolution and restoration of hearing to normal. In such cases, methods of chemotherapy, dangerously inadequate for serious cases, would probably do no harm and might hasten recovery. On the other hand, virulent infections, recognizable by well-marked signs of toxæmia and early mastoid invasion in addition to severe earache, must be treated with all possible efficiency. Half-measures bring risks of masked mastoiditis as well as the possibility of intracranial suppuration.

Ideally the causative organism should be identified and its sensitivity to antibiotics established at the earliest opportunity; to do this it may be necessary to incise a bulging drum.

Fortunately, however, chemotherapy in true acute otitis media presents few difficulties. In the large majority of cases the causative organisms belong to the Gram-positive group and are sensitive to the sulphonamides, penicillin, and many other antibiotics; "blind" chemotherapy has therefore a fair chance of success. Sulphonamides, being less effective than the antibiotics, are no longer used in severe infection. Of the antibiotics, penicillin is still the most effective and the least toxic; large doses are constantly given without ill effect. As penicillin is a potent sensitizer adrenaline should be on hand in case of emergency. To maintain effective blood levels in severe infection, the drug must be given intramuscularly. For cases of average severity, a daily injection of procaine penicillin, 300,000 units for a child of 7 to 12 years, and twice or three times this dose for an adult, has proved satisfactory.

Cases causing special anxiety, and therefore in need of a second daily visit, may be given an injection of sodium penicillin at each visit, 250,000 units for a child and a corresponding higher dose for adults; in an alternative method, sodium and procaine penicillin are combined in one injection and given once or twice daily according to the severity of the symptoms.

In a few cases of acute otitis media and in the majority in which the symptoms are due to an acute exacerbation of

chronic otitis, the organisms belong to the Gram-negative group, for which there is at present no outstandingly satisfactory antibiotic. Polymixin, used systemically, may produce severe toxic reactions of such degree that it is reserved for cases in which life is in danger. Streptomycin, another effective drug, tends rapidly to produce resistance in the causative organisms; rather less effective are chloramphenicol and the tetracycline group. All these drugs are toxic and should be given in doses based on weight in accordance with the manufacturers' tables.

Local and general signs of a satisfactory response to treatment are apparent within the first two days. When the middle ear becomes dry and the drum is seen to be almost normal, a clinical cure can be announced; treatment, however, should continue for a further 48 hours, making a total period of treatment varying from 4 to 12 days.

In acute otitis media the prognosis for hearing is excellent. Young and Simson Hall* found only one case of serious deafness among 115 treated by penicillin. With regard to further attacks, the outlook is influenced largely by the condition of the nose and nasal sinuses, the adenoids, and the Eustachian tube.

Need for Specialist Advice

In acute otitis media, need for otological advice may arise under the following circumstances. Meningitis arising during the first two weeks of acute otitis media is a rare complication, heralded by a sudden rise of temperature, headache, and neck stiffness; it is usually pneumococcal. While waiting for admission to hospital, sodium penicillin should be given intramuscularly. A sulphonamide, sulphathiazole or sulphadimidine, in full doses, must be given in addition, as penicillin does not pass the blood-brain barrier. As a complication of acute exacerbations of chronic otitis, meningitis may occur at any time. In such cases chloramphenicol, which passes the blood-brain barrier, should be given in preference to sulphonamides.

At any time from the second week onwards, gross signs of mastoiditis—post-aural oedema or abscess—may appear. As noted above, some cases may respond to antibiotics, but it is advisable for such treatment to be carried out under daily specialist observation. Less obvious signs of mastoid disease (see Fig. 3), apparent from the third week onward, again call for otological attention.

After an attack of acute otitis media hearing should return in the second or third week. Persisting deafness, which may be due to Eustachian obstruction, middle-ear effusion, or to destructive processes, calls for examination by an otologist.

Next article on Emergencies in General Practice.—"Dangerous Reactions to Sulphonamides and Antibiotics," by Professor A. Kekwick.

Refresher Course Book.—Copies of the second volume of collected articles from the Refresher Course for General Practitioners are still available at 25s. (postage—inland 1s. 6d., overseas 1s.) each. The first volume is now sold out.

Clinical Pathology Book.—"Clinical Pathology in General Practice," a collection of 39 articles on clinical pathology that appeared in the *Journal* as part of the Refresher Course for General Practitioners, is now available, price 21s. (postage—inland 1s. 3d., overseas 9d.).

Both these volumes are obtainable from the Publishing Manager, B.M.A. House, Tavistock Square, London, W.C.1, or through any bookseller.

*Young, A., and Hall, I. Simson, *J. Laryng.*, 1948, 62, 551.

IMMUNOLOGICAL TOLERANCE

A DISCUSSION AT THE ROYAL SOCIETY

Sir MACFARLANE BURNET, F.R.S., the Australian virologist, opened a discussion at the Royal Society, London, on March 8 with the assertion that investigation of tolerance phenomena represented a new flowering of immunology. Certainly their prominence in such diverse fields as cancer research, radiation illness, haemolytic disease of the newborn, and tissue transplantation makes their understanding of the greatest importance for clinical medicine.

Nature of Tolerance

Professor P. B. MEDAWAR, F.R.S. (University College, London), introduced the subject. If an adult animal were subjected to an antigenic stimulus, an immune response occurred which might take the form, he said, of antibody production, development of hypersensitivity, or some other protective reaction, the mechanism of which was often not fully understood. On the other hand, if embryos or very young animals were injected with antigenic substances, not only did they fail to give immune responses but when they grew up they might never acquire the ability to respond to an antigenic stimulus. This was known as immunological tolerance.

Tolerance could certainly affect the usual immune response provoked by red cells, and that occasioned by homologous tissue antigens—the homograft reaction seen in grafting when the donor was of the same species as the recipient. These two reactions differed in a number of ways: red-cell antigens were cytoplasmic, tissue antigens wholly nuclear substances; red-cell antigens were stable to heat, freezing, and drying, whereas tissue antigens were not; red-cell antigens caused the production of free antibodies in the serum, some of which were γ -globulins, but tissue antigens so far as were known did not—but if they did the antibodies produced were not γ -globulins. Immunity to red cells was short-lived and could be transferred passively by serum, while that to tissue homografts was semi-permanent and transferable only by activated cells. But tolerance also occurred with heterologous antigens, and there were good reasons for believing that it was of general application in all immunological phenomena. From his experiments with Billingham and Brent on tissue homografts Professor Medawar concluded that tolerance was a specific central failure of the mechanism of immune response. Normal reactivity could be restored to a tolerant animal by injecting it with immunologically activated cells from a normal donor. This distinguished tolerance from, on the one hand, immunological paralysis which was due to the persistence of an antigen in an animal's tissues, and on the other from enhancement, which he thought was due to inactivation of the antigens issuing from the tissue grafts.

Turning to the relationship between mother and foetus in mammals, Professor Medawar instanced the transference from the mother to the foetus of malignant melanomatosis, to which the foetus responded by immunological tolerance; in consequence it suffered widespread invasion by the tumour. The time during which it was possible to induce tolerance in animals varied both from species to species and from one immunological system to another: one immune reaction might be well developed, while it still remained possible to induce tolerance in another system. The concept of tolerance clarified auto-antibody formation. Animals became tolerant of most of their own body constituents in the course of development. But there were some complex body constituents to which they could not become tolerant because these substances developed after the animal had become immunologically mature. Examples were milk proteins and spermatozoa. These substances should therefore be able to produce auto-antibodies, and it was well known that they did so.

Sir MACFARLANE BURNET pointed out in discussion that patients with agammaglobulinaemia did not show the normal response to a homograft. Professor MEDAWAR agreed, but