

ACOUSTIC TRAUMA AS AN OCCUPATIONAL HAZARD IN INFANTRYMEN

Major B. LIVESEY
M.B., Ch.B., D.L.O., R.A.M.C.

THE early recognition of nerve deafness resulting from acoustic trauma in certain industries e.g., rivetters, drop forge workers and many others is accepted as an important contribution to preventative medicine. It was established many years ago, that repetitive noise, particularly of 4000 cycles per second and upwards is a potent factor in the cause of cochlea end organ degeneration and consequent nerve deafness. The selective deafness which results, almost invariably affects the frequencies of 3000-6000 cps. irrespective of the spectrum of sound to which the ear is exposed.

Simple hearing tests using a conversational or whispered voice are of little value in the early detection of acoustic trauma since the frequencies involved initially are those above, or at the upper end of the range normally used in the production of speech. For the same reason the use of tuning forks of frequencies below 4096 cps. will fail to demonstrate the reduction in bone conduction which is a feature of nerve deafness.

There is little indication to the individual that he is acquiring a high frequency deafness unless previously he had possessed a sophisticated ear for music. As progression of the degenerative change occurs with step-wise involvement of lower frequencies he gradually becomes aware of his impaired discrimination for speech. It is of interest in this context that the cases of undiagnosed acoustic trauma found in this short survey frequently admitted that they had experienced more difficulty in hearing a female than a male voice under similar circumstances, although they attached no significance to this. Failure to hear the ticking of their watches had also been noticed by many but had not been regarded as of any importance.

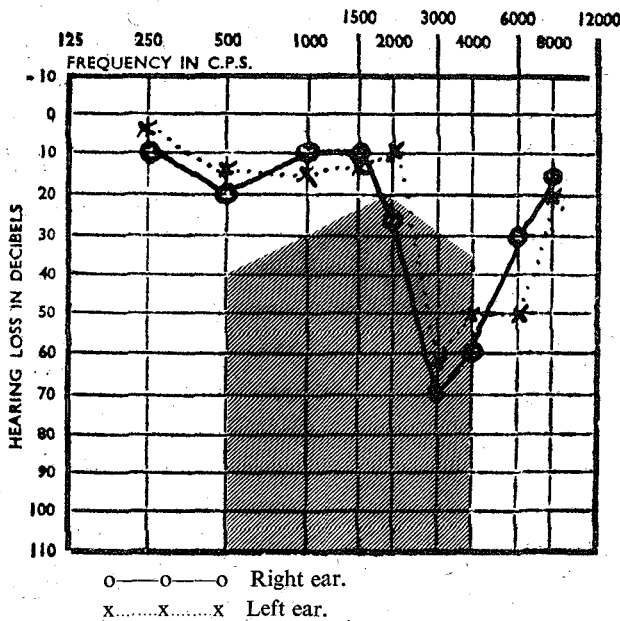
One of the predominant features of any infantryman's acoustic environment is repetitive loud noise in weapon training. In view of the common experience that affected individuals will only seek advice when the condition is sufficiently severe to interfere with hearing for speech or because of the presence of persistent tinnitus, a survey of infantrymen was undertaken. The object of the survey was to establish the frequency of acoustic trauma amongst men who had no subjective reason to seek otological advice. Investigation was restricted to those who regarded themselves as having normal hearing and who had not at any time reported to a medical officer with ear trouble of any type. Infantrymen were taken at random from the general medical, surgical wards and outpatient departments of the British Military Hospitals in Munster and Rinteln. Each individual was examined to exclude wax, evidence of old or current middle ear disease and a specific enquiry made to elicit any previous symptomatology suggestive of a labyrinthine dysfunction. Audiometry was performed in each instance using the Amplivox Audiometer Model 51 in a quiet room. The lack of sound proof facilities gave a constant apparent loss of up to 10 decibels for frequencies of 250, 500 and 1000 cps., but for frequencies above this range (i.e., those of particular interest in this study the thresholds corresponded with the calibration of the instrument.

Individuals classified as cases of acoustic trauma were defined as those who had been exposed to weapon noise and sustained a high frequency deafness which was demonstrable audiometrically as the V-shaped notch or general high frequency fall-off which characterises the condition.

Classification : A simple grading has been utilised as follows :-

GRADE I	loss of up to 30 decibels at 3000—6000 cps.		
II	loss of 31-50	„	„
III	loss of 51-70	„	„
IV	loss of over 70	„	„

Audiogram of a typical case of acoustic trauma—



L/Cpl. D.
 1 Bn. Lancashire Fusiliers
 Age 26 yrs.
 Rifleman for 6 yrs.
 Regards his hearing as normal.
 Grade III bilateral.

The shaded portion represents the critical area for speech loss and it is apparent that although his hearing falls off rapidly between 2000 cps and 8000 cps., the effect on hearing for speech is disproportionately small since only a number of sibilants will be unheard. If this man were presented with a previously experienced sentence e.g., Sally sells sea shells on the sea shore—he would hear— . ally . ell . . ea . . ell . etc., and would fill in the missing sounds from his knowledge of the context of the sentence. He therefore assumes that his hearing is within normal limits. Should he be re-employed in his battalion as a signaller and be required to receive messages lacking context, the impairment of his hearing would become apparent.

Results.

It was anticipated that a large number of men would require investigation in order to detect a modest number of unrecognised cases of acoustic trauma in the group at

risk. In the event, the condition was found in far greater incidence than had been suspected previously.

Examination of the first 100 men yielded the surprisingly high number of 54 cases of acoustic trauma.

Of the total of 200 ears examined, acoustic trauma was demonstrable in 93 ears. From the data below it is seen that 32 ears are in Grades III or IV, i.e., representing a minimum of 50 decibels loss for the frequencies 3000-6000 cps. Five men with deafness of doubtful origin were excluded from the cases of acoustic trauma.

Bilateral cases. Total 39.

Case No.	GRADE	
	Left ear	Right ear
L/Cpl. 3	I	II
4	III	IV
8	IV	II
Cpl. 13	III	IV
14	III	III
15	I	I
L/Cpl. 18	III	II
20	I	I
21	III	III
C/Sgt. 23	III	III
27	I	I
31	III	III
L/Cpl. 33	III	I
35	IV	I
38	III	III
Sgt. 40	I	I
L/Cpl. 43	IV	III
45	IV	II
46	I	I
48	II	I
50	I	I
52	IV	IV
S/Sgt. 55	III	II
Cpl. 62	IV	II
65	I	I
67	I	I
68	I	I
69	I	II
72	II	I
75	I	IV
77	I	I
L/Cpl. 78	I	I
79	II	I
80	I	I
86	I	I
Cpl. 91	I	I
95	I	I
99	IV	II
100	III	III

Unilateral cases. Total 15.

Case No.	Grade
left ear only	I
12	I
16	I
28	III
Cpl. 44	IV
60	I
63	I
66	I

Acoustic Trauma

	S/Sgt.	81	....	....	....	I
		88	....	....	....	I
		89	....	....	....	II
		94	....	....	....	I
		97	....	....	....	II
	L/Cpl.	98	....	....	....	III
right ear only		24	....	....	....	I
	L/Cpl.	41	....	....	....	II

It is of interest that a record of the side most severely involved in the bilateral cases shows a preponderance towards the left ear—i.e., left ear predominant in 12 and the right ear in 5 cases.

In the 15 unilateral cases, 13 were confined to the left ear and 2 to the right ear. In one of the 2 right-sided unilateral cases it transpired that the infantryman was left-handed with his weapon. This would support the contention that an infantryman tends to suffer more from the effects of a weapon fired by his immediate left-hand neighbour than from his own. The right-handed individual, when firing, inclines his head in such a manner as to direct his left ear towards the weapon being fired by his left-hand neighbour whilst his right ear is directed posteriorly.

Rank

It is striking to find that 18 men in the group of 39 bilateral cases were N.C.O's. In contrast—only 6 N.C.O's were to be found amongst the 46 men with normal hearing. The concentration of N.C.O's in the group with bilateral acoustic trauma is presumably related to their more frequent employment as instructors on weapon ranges.

There is no evidence to suggest that an incidence of approximately 50% is peculiar to one garrison area since the men came from a variety of infantry battalions from two widely separated areas.

Tinnitus

Transient tinnitus is an almost invariable phenomenon in infantrymen after firing practice. No correlation seems to exist between its duration and intensity on the one hand, and presence or absence of acoustic trauma on the other, although in clinical practice it is not uncommon to see patients with tinnitus persisting for weeks or months. In this series, several men with Grade IV acoustic trauma had never experienced tinnitus whilst others with normal hearing complained of tinnitus of several hours or even days following training. The immediate post-firing deafness for speech similarly showed no relationship in severity or duration to the ultimate audiometric findings in a given individual.

Prevention of acoustic trauma

An unspecified amount of recovery may occur during the first few weeks following exposure to the damaging frequencies. However, once the degeneration in the organ of Corti is established the condition will either remain static or progress depending on the individual's future acoustic experiences. Regeneration in the end organ is as unlikely as it is in any other form of highly specialised nervous tissue.

No therapeutic agent or procedure has been demonstrated to exert a beneficial effect on the course of this condition. It follows, therefore, that the protection of individuals at risk is the only practical method by which the incidence can be reduced.

Simple ear plugs may be used but have the great disadvantage of interfering with the hearing of the wearer for speech. This may not constitute a great handicap for the industrial user but it is an important bar to their use by infantrymen firing live ammunition either operationally or on exercise. Furthermore, the commander of a section or platoon may be required to receive instructions via a headset receiver and relay them by voice to his men. Any form of ear plug interfering with hearing for speech necessarily impairs his function. The handicap and potential hazard of reducing the hearing for the word of command in men firing live ammunition requires no elaboration.

In practice, the wearing of ear plugs by infantrymen appears to be on a rather casual basis except when firing weapons with a particularly high acoustic output e.g., anti-tank rocket launchers or small arms in enclosed spaces.

The current procedure applied to overt cases of acoustic trauma presenting in Army E.N.T. departments consists of their withdrawal from contact with weapon noise and reclassification in a Pulheems employment standard of LE. If this prophylactic measure were applied to those cases detected by routine audiometric screening the number of weapon firing men in any given Infantry Battalion would fall to an intolerable level i.e., *by 50 per cent.* Whilst this is unacceptable from a military point of view it is equally unacceptable by any other standards that such a high rate of permanent damage to hearing should be permitted to exist. Since it is of importance to promote rather than hamper intensive weapon training, a more thorough investigation of possible methods of prevention would seem to be indicated.

The ideal solution to the problem would be the development of an ear plug with the capacity to filter sound on a selective basis. Should this be a technical possibility, an ear plug capable of damping the passage of frequencies from 4000-6000 cps. would, whilst reducing the incidence of acoustic trauma, offer the considerable advantage of permitting a much greater ease of voice communication between troops in the presence of small arms fire. That this should be so is concluded by reference to the frequency spectrum of speech.

Vowels occupy the range between 100 and 1000 cps. whilst consonants occupy the range 1000-4000 cps.

The facilitation of communication by speech even in a background of small arms noise would be a more effective encouragement for their regular use by infantrymen than regulations or medical propaganda.

Unfortunately, the fact remains that in order to be effective, any type of insert ear plug is also uncomfortable. It can also be demonstrated mathematically that a passive device which would give sharp attenuation for the damaging frequencies would be of an unmanageable length.

It seems therefore that the most fruitful lines of investigation are those concerning the mechanics of sound production by the weapons themselves and the conditions under which they are fired.

Range Shelters

There is justification for an assessment of the relative merits of the various types of material employed in the construction of range shelters. Corrugated iron and other sound reflecting materials can only serve to potentiate the damaging effect of high

frequency weapon noise. Their replacement by a sound absorbing material of equal durability would be a worthwhile contribution.

Weapon Development

It has been suggested that the rate of rise of the wave front emerging from a given weapon is critical in determining the traumatic effect of sound on the cochlea.

As small arms weapons with increasing muzzle velocity are developed it is likely that the incidence of acoustic trauma will increase unless some mechanical device is incorporated in the muzzle to delay the rate of rise of the wave front presenting at the weapon users' ear.

Summary

A short survey of 100 infantrymen who regard their hearing as normal is described. 54 of these men were found to have audiometric evidence of acoustic trauma.

Memorial to Captain Henry J. Andrews

V.C., M.B.E., M.D., I.M.S.

ON Monday 29th March 1965 Sir George McRobert, C.I.E., M.D., F.R.C.P., late I.M.S., unveiled a painting by Miss J. Fairfax-Whiteside in the V.C. Room, R.A.M.C., H.Q. Mess. Sir George sketched out the life history of Captain Andrews and spoke in praise of his contribution to the Army in battle, to India and to medicine. Lieutenant-General Sir Harold Knott as D.G.A.M.S. accepted the painting into the care of the Corps as a fitting companion to those now in the V.C. Room which had been briefly described by Major-General A. N. T. Meneces, College Commandant. He also welcomed the presence of so many relatives of Captain Andrews.

Colonel (Dr.) Anderson of the Salvation Army then spoke of Captain Andrews upbringing and service in that Army and welcomed the recognition given to one of their former officers.

To complete the account of the circumstances surrounding the award of this Victoria Cross, Brigadier The Right Hon. Sir John Smyth, Bt., V.C., P.C., M.C., M.P., who was then a Brigade Major, spoke of the parlous military conditions under which Captain Andrews lost his life in completing the task of treating and evacuating the wounded under the intense, well directed rifle fire which was a feature of such frontier actions.

Mrs. Andrews (daughter in law) briefly returned thanks for the occasion and for the commemoration of Captain Andrews courage and devotion to duty.

The guests who also included other relatives, the artist, former officers of the Indian Medical Service and serving officers of the Salvation Army, were subsequently entertained to lunch in the H.Q. Mess.