

## Review Article

Ms K Conroy takes responsibility for the integrity of the content of the paper

Presented at the British Society for the History of ENT Annual Meeting, 3 December 2015, London, UK.

**Cite this article:** Conroy K, Malik V. Hearing loss in the trenches – a hidden morbidity of World War I. *J Laryngol Otol* 2018;**132**:952–955. <https://doi.org/10.1017/S0022215118001755>

Accepted: 13 May 2018

First published online: 29 October 2018

### Key words:

Warfare; Hearing Loss, Sensorineural; Hearing Loss, Noise-Induced; Otitis Media, Suppurative; Otitis Externa

### Author for correspondence:

Ms Katherine Conroy,  
Department of Otolaryngology,  
Royal Preston Hospital, Sharoe Green Lane,  
Fulwood, Preston PR2 9HT, UK  
E-mail: [katherine.conroy@cantab.net](mailto:katherine.conroy@cantab.net)

# Hearing loss in the trenches – a hidden morbidity of World War I

K Conroy<sup>1</sup> and V Malik<sup>2</sup>

<sup>1</sup>Department of Otolaryngology, Royal Preston Hospital and <sup>2</sup>Department of Otolaryngology, Blackpool Victoria Hospital, UK

## Abstract

**Background.** One hundred years ago, millions of British and Allied troops were fighting in the trenches of the Great War. With a tenth of soldiers losing their lives, hearing loss seemed a low priority; however, vast numbers of troops sustained significant hearing loss.

**Method.** A review was conducted of literature published between 1914 and 1925.

**Results.** Soldiers were exposed to up to 185 dB of sustained noise from new, high-energy weapons, which caused ‘labyrinthine concussion’. Traumatic injuries, non-organic hearing loss and malingering were also common. One source estimated that 2.4 per cent of the army was disabled by hearing loss. However, many British doctors viewed this ‘soldier’s deafness’ as a temporary affliction, resulting in soldiers being labelled as malingerers or ‘hysterical’.

**Conclusion.** Today, one can recognise that a scant evidence base and misconceptions influenced the mismanagement of hearing loss by otolaryngologists in World War I. However, noise-induced hearing loss is still very much a feature of armed conflict.

## Introduction

‘Modern warfare exercises its evil influence more on the hearing organ than on any other special sense.’<sup>1</sup>

One hundred years ago, millions of British and Allied troops were fighting in the trenches of the Great War. In a conflict where more than a tenth of soldiers lost their lives, hearing loss was a low priority in an environment where fatal injuries and diseases were rife. However, in the decades that followed, it became apparent that vast numbers of troops had sustained significant hearing loss.

Soldiers experienced aural pathology at twice the rate of the civilian population.<sup>2</sup> They were exposed to up to 185 dB of sustained noise from new, high-energy weapons,<sup>3</sup> which caused ‘labyrinthine concussion’. Blast injuries to the tympanic membrane and direct trauma were also common, as well as non-organic hearing loss and malingering. One source estimated that 2.4 per cent of the army sustained a disabling level of hearing loss, and a further proportion went unreported because of other morbidities, or the prevailing sentiment of ‘getting on with it’.<sup>4</sup>

In the chaotic theatre of war, with few otolaryngologists in the field, it was difficult to assess and evaluate hearing loss. Many British doctors viewed this ‘soldier’s deafness’ as a temporary affliction (as evidenced in the literature of the time), and felt that a large number of soldiers were malingerers or ‘hysterical’.

We will demonstrate how noise-induced sensorineural hearing loss, and other causes of deafness, were prevalent in the trenches of World War I. We argue that, because of a lack of understanding of pathophysiology, and the culture of the army at that time, hearing loss was underreported and underdiagnosed, to the detriment of the soldiers.

A century after the conclusion of World War I, with a wealth of peer-reviewed evidence available to us, it is difficult to appreciate how these misconceptions evolved without examining the context in which they were formed. However, it is clear that noise-induced sensorineural hearing loss is still a major cause of morbidity in the armed forces, as well as in the general population.

## Materials and methods

A review of the literature from 1914 to 1925 was performed, and personal accounts of the war and the Proceedings of the Royal Academy were examined.

It appears that the main conditions recognised in field hospitals were: ‘labyrinthine concussion’ – opinions differed on whether this was an organic, noise-induced injury or hysterical in nature; malingering; trauma; and chronic suppurative otitis media, often secondary to traumatic perforations of the tympanic membrane, and compounded by poor sanitation and malnutrition.

Published evidence at this time was restricted to anecdotes, professional opinion, case reports and observational studies at best. Crowded field hospitals and a pressing need for

patients to be expedited back to the front resulted in a fast turnover of patients, making it difficult to track and record patients' progress or lack thereof. Furthermore, otolaryngologists were sparse, especially in British field hospitals.

## Analysis and discussion

### Physical and psychological effects of noise exposure

'The angry hiss of 77s, the ponderous whirr of 5.9s, the dull empty whack of bombs and the whipping crack of shrapnel all merged into a sea of noise. Ten minutes of this drove us into a stupor of fear, and fear brought its terrible thirst; there was nothing to do but sit still, half crouched against the wall of the trench, waiting, waiting'.<sup>5</sup>

There is no doubt that troops on the front line of the First World War were exposed to high-intensity, sustained noise. New advances in technology and the development of trench warfare meant that large numbers of high-energy weapons were deployed in lengthy bombardments.<sup>6</sup> It is estimated that artillery rounds produced sounds of up to 140 dB, exploding grenades 164 dB and mortars 185 dB.<sup>3</sup> Anecdotal evidence suggests that guns on the Western Front were audible from the English coast; the Lochnagar mine, detonated at the Somme in 1916, was at the time the largest sound known to man, and could be heard in London.<sup>7</sup>

British otolaryngologists were aware of noise-induced hearing loss termed 'shell deafness' or 'labyrinthine concussion'. It was categorised as a sudden hearing loss inflicted by a nearby explosion, or a more gradual onset hearing loss secondary to sustained noise.<sup>8</sup> Various theories were put forward to explain the phenomenon; however, without a distinction between psychosomatic afflictions and noise-induced sensorineural hearing loss, a satisfactory conclusion could not be drawn.

'Is there such a thing as bilateral deafness due to shell-shock? Personally, I have not seen such a case'.<sup>9</sup>

Many otolaryngologists at the time felt that virtually every case of bilateral deafness was due to hysteria and other non-organic causes. This opinion was heavily influenced by Milligan and Westmacott, who ran the ENT department at Manchester Royal Infirmary and the neighbouring Second Western General Military Hospital, admitting thousands of patients.<sup>10</sup>

Milligan and Westmacott questioned whether 'concussion of the auditory nerve' was caused by invisible molecular changes, but noted that the loudest sounds at the front were often associated with danger to life, loss of comrades and physical exhaustion.<sup>10</sup> This led them to conclude that without evidence of peripheral physical damage, hearing loss was caused by either 'an element of hysteria' or 'a subconscious manifestation of sheer fright', which temporarily suppressed sound processing by the central nervous system. In their opinion, this theory was confirmed by their observation that patients with pre-existing ear pathology seemed to be affected more, because they were more susceptible to the notion of deafness.

Milligan and Westmacott's ideas seemed to be supported by Hurst and Peters, who claimed to have cured two soldiers of their hysterical deafness using sham surgery. The secret to success, they advised, was to be able to convince the soldier that the procedure would be effective.<sup>11</sup> Further evidence was the speedy recovery of patients when they were subjected to faradisation (electrotherapy) through the mastoids, which seemed to be an established treatment.<sup>12</sup>

Fraser pointed out that conscripts were recruited hurriedly at the outbreak of war, without thorough medical screening, and therefore it was conceivable that many had long-standing hearing loss which was simply picked up on more in-depth evaluation for unrelated injuries. In addition, he estimated that 70 per cent of his patients had a defect of the middle ear or nose, not attributable to their acute complaint. Fraser also felt that it would be impossible to sustain inner-ear damage severe enough to impair hearing, without it also affecting vestibular function; that is, a soldier with reduced hearing but normal balance must be hysterical.<sup>13,14</sup>

Jones-Phillipson described a case series of over 100 patients, and concluded that shell deafness was 'temporary and curable'.<sup>15</sup>

Patients were tested for a 'dead ear' (i.e. loss of all cochlear vestibular function) using cold water or air in the ear. Once nystagmus was observed, the patient was given rest, and attempts were made to coax them back into hearing. Colonel Birkett described:

'Often, however, those methods do not succeed, and then we try to shame the men out of their disability before their companions-in-arms. Sometimes those means are successful. One method was letting off an alarm apparatus suddenly: this shook one man so much that he eventually heard'.<sup>14</sup>

Fraser and Fraser examined cross-sections of the temporal bones of deceased soldiers who had suffered noise-induced hearing loss.<sup>14</sup> The results were variable, and the authors conceded that difficulties in preparing the slides made interpretation difficult. They hypothesised that sound energy 'paralyses delicate nerve endings'. They also wondered whether loud noise caused paresis of the organ of Corti in a similar mechanism to presbycusis.<sup>14</sup>

Jobson and Dub were more convinced that a pathophysiological process was at work.<sup>16</sup> They studied soldiers in a field hospital using tuning forks, and found that many who perceived themselves to have normal hearing had sensorineural hearing loss of varying degrees. Surely hysteria could not account for this?

Communications debating noise-induced hearing loss as organic versus non-organic were sent back and forth across 'Letters' in *The Lancet*. However, without conclusive proof either way, both sides were convinced of their position.

### Malingers

Faulder and Colledge described malingers as being easily identifiable by their 'furtive and shifty demeanor'.<sup>17</sup> Their main concern was to identify malingers so that these individuals could resume their front-line duties. They made use of the cochleo-palpebral reflex, described by the French, whereby sneaking up behind a patient and banging a metal tongue depressor on a tin would elicit a blink. Failing that, chloroform could remove a patient's inhibitions sufficiently to extract a confession. In extreme cases, the chaplain was called.

### Trauma

Traumatic perforation of the tympanic membrane was a recognised problem for soldiers. Around 30 per cent of these perforations became infected.<sup>8</sup> The incidence was reduced when steps were taken to keep the ear clean and dry.<sup>4</sup>

Traumatic injuries to the ears were common. Perichondritis secondary to pinna trauma that became infected was treated

with excision, to promote prompt healing. Most direct hits to the internal ear were unsurvivable. However, many temporal bone fractures are recorded. There was also a case study of a soldier hit by a bullet entering by the zygoma and exiting lateral to the second cervical vertebra (C2); this caused a cerebrospinal fluid leak, vertigo, deafness and laryngeal nerve palsy.<sup>8</sup> Despite suspected meningitis shortly afterwards, the soldier is documented to have made a good recovery, by 1917 standards at least.

Interestingly, Davis presented a trauma case at the Royal Society of Medicine in 1918.<sup>18</sup> His soldier had sustained a shell wound immediately anterior to the left ear; however, the audience felt that the resultant hearing loss was likely to be functional, despite the injury being severe enough to also cause trismus and blindness in the left eye.

### Chronic suppurative otitis media

Many soldiers presented with infected cholesteatomas due to the dirty environment of the trenches, and malnutrition exacerbating a pre-existing condition. They were given the option of surgery or returning to the front. Faulder and Colledge describe how they saved a young patient, accused of falling asleep on duty, from a court martial by insisting on surgery.<sup>17</sup> However, although the French surgeons operated quite readily on mastoids, the British shied away from this surgery as their results were not as good (51 per cent incidence of dead ear and 48 per cent incidence of continued discharge), and they were concerned about prolonged recovery time leaving them short at the front line.<sup>2</sup>

### Other infective ear conditions

In the early years of the war, impetigo of the ear was common, attributed to the filthy conditions of the trenches where vermin control had not yet been established.<sup>2</sup> Otitis media not secondary to trauma was a common complication of the various communicable diseases rife in the trenches; outbreaks of measles and mumps in particular caused problems in Egypt. Otitis externa was also a problem in the desert environment.<sup>9</sup>

### Scale of the problem

The French otolaryngologist Bryant recognised hearing loss to be a significant problem for his troops.<sup>4</sup> An observational study carried out across various field hospitals in 1917 described ear conditions as accounting for 3–9 per cent of patients and estimated that 80 per cent of these individuals would not be able to return to their former occupations after the war because of hearing loss. From these calculations, Bryant believed that 24 in every 1000 troops would require a disability pension for hearing loss after the war, which is a huge economic burden for a country that sent over 8 million troops to fight.<sup>19</sup>

Bryant felt that even these figures underestimated the scale of the problem. He described how many soldiers did not report hearing loss, as they felt it to be a normal part of warfare, or had distracting injuries such that the extent of their hearing loss was not realised. He warned it was unlikely that a soldier would recover from a gradual onset hearing loss induced by noise.

Bryant also pointed out that the British otolaryngology presence on the front line was weak, especially compared to French and Italian medical organisations.<sup>20</sup> In fact, Barrett noted on his

arrival in Egypt that there was not a single ENT surgeon amongst the medical personnel there.<sup>9</sup> This possibly accounts for British doctors' differing attitudes towards hearing loss.

McKenzie also wrote of his concerns. In a letter to the *Lancet*, he stated:

'Modern armies ought to be equipped with a sufficient body of specialists to cope with this unlooked-for development. Unfortunately, this does not seem to be the case, for... with the English speaking allies, the organisation of the special service of oto-rhino-laryngology is still very weak, and thus many more men must be lost to both the Army and the civil life who might otherwise be saved'.<sup>1</sup>

However, McKenzie's warnings seem to have fallen on 'deaf ears'. Dickie, a British otolaryngologist, also bemoaned the fact that the British did not realise until quite late on in the war that otolaryngology was such a vital part of the medical service; even when specialist centres were set up, the equipment and organisation were inadequate.<sup>2</sup> This appeared to be most detrimental to the men suffering from middle-ear pathology. Without readily available specialist assessment, treatment was often delayed and substandard, and many suffered from debilitating or even fatal complications.

Dickie also pointed out that most of those with middle-ear disease would have never even been allowed to enlist in the army before the war, and therefore they were being done even more of a disservice from deficient management.

### Prevention

Noise-induced hearing loss in troops was first described in the sixteenth century, although the importance of ear protection was not widely understood until after the Second World War.<sup>21</sup>

As discussed above, Bryant was keen that World War I soldiers should have ear protection, to limit the economic burden of war pensions given to those who lost their hearing. The Italians also established a well-run, heavily resourced otolaryngology service for similar reasons.

Captain Marriage suggested that Plasticine<sup>®</sup> wrapped in gauze made a good ear protector. (A particular formulation of Plasticine, designed to be used as an earplug, was patented in 1915.) However, he warned against the use of celluloid, as he had heard reports of it being ignited by nearby explosions.<sup>8</sup> Some recommended forming an 'artificial drum' with Vaseline and cotton wool.<sup>17</sup> However, there is no clear evidence that any ear protection was provided over the course of the First World War.

### Rehabilitation

Provisions for deaf soldiers seemed poor. *The Journal of Laryngology and Otology* noted, in 1917, that many had written to the Surgeon General Sir Alfred Keough to say that they were struggling to find work. A hostel that opened up to support those affected was full almost immediately. *The British Medical Journal* reported that a lip-reading course had been set up in Edinburgh; however, *The Times* reported that there were very few soldiers applying for or accepting places on other courses around the country.<sup>22</sup> By 1918, deafness was the listed reason for 2 per cent of military pensions.<sup>23</sup>

### Conclusion

Soldiers in World War I were exposed to noise levels (and conditions) unprecedented in human history, at a time when

noise-induced sensorineural hearing loss was not yet an established concept, and attitudes towards 'shell shock' varied greatly. A poor understanding of the pathophysiology of hearing loss, and the mental health of the soldiers in the trenches, must have impeded the treatment and prevention of a wide range of aural pathology in World War I. This would have been compounded by treacherous conditions and the lack of a coherent otolaryngology service on the front line.

In 2018, it is clear that otolaryngologists underestimated a huge burden of morbidity in a large population. This prompts the question, how will our practice be viewed in 2118? Despite increased awareness and surveillance, sensorineural hearing loss and post-traumatic stress disorder are still major causes of morbidity in the armed forces.

**Competing interests.** None declared

## References

- McKenzie D. Letter to the editor, war deafness. *Lancet* 1917;**190**:729
- Dickie JK. Experiences of an otologist in France, 1915–1919. *Can Med Assoc J* 1921;**11**:893–9
- Hearing Health and Technology Matters. Hearing Loss in the Trenches of World War I. In: <http://hearinghealthmatters.org/hearinginternational/2014/hearing-loss-trenches-wwi/> [5 December 2017]
- Bryant WS. Prevalence of ear injuries and diseases in the French Army. *The Journal of Laryngology, Rhinology and Otology* 1917;**32**:338–40
- Griffith LW. *Up To Mametz – and Beyond*. Barnsley: Pen and Sword Military, 2010;Chap 2:5
- British Library. Weapons of World War One. In: <http://www.bl.uk/world-war-one/articles/weapons-of-world-war-one> [5 December 2017]
- The First World War East Sussex. The Sound of Guns. <http://www.eastsussexww1.org.uk/sound-guns/> [5 December 2017]
- Marriage HJ. Special discussion of warfare injuries and neuroses. *Proc R Soc Med* 1917;**10**(Otol Sect):47–56
- Barrett J. Summary of report on diseases of the ear, nose, and throat in Egypt from 1915. *J Laryngol Otol* 1918;**33**:100–6
- Milligan W, Westmacott FH. Warfare injuries and neuroses: introductory paper. *Proc R Soc Med* 1915;**8**(Laryngol Sect):109–14
- Hurst AF, Peters EA. A report on the pathology, diagnosis, and treatment of absolute hysterical deafness in soldiers. *Lancet* 1917;**190**:517–19
- Adrian ED, Yealland LR. Treatment of some common warfare neuroses. *Lancet* 1917;**189**:867–72
- Fraser JS. Hysterical deafness in soldiers. *Lancet* 1917;**190**:872–3
- Fraser JS, Fraser J. Special discussion on warfare injuries and neuroses: the morbid anatomy of war injuries of the ear. *Proc R Soc Med* 1917;**10**(Otol Sect):56–90
- Jones-Phillipson CE. An analysis of 100 cases of war injuries of the ear. *Proc R Soc Med* 1917;**10**(Otol Sect):96–110
- Jobson TB, Dub MD. Normal gun-deafness. *Lancet* 1917;**190**:566
- Faulder TJ, Colledge L. Injuries to the ear in modern warfare. *Proc R Soc Med* 1921;**14**(Otol Sect):41
- Davis ED. A war injury of the ear. *Proc R Soc Med* 1918;**11**(Otol Sect):8–9
- Spartacus Educational. French Army and World War I. In: <http://spartacus-educational.com/FWWfrenchA.htm> [17 November 2017]
- Bryant WS. The oto-rhino-laryngological service in Italy. *The Journal of Laryngology, Rhinology and Otology* 1918;**33**:97–100
- Centers for Disease Control and Prevention. Severe hearing impairment among military veterans--United States, 2010. *MMWR Morb Mortal Wkly Rep* 2011;**60**:955–8
- Notes and queries. *The Journal of Laryngology, Rhinology and Otology* 1917;**32**:272
- Work of Ministry of Pensions. In: <https://api.parliament.uk/historic-hansard/commons/1918/may/28/work-of-ministry-of-pensions> [5 December 2017]