

# Noises of War and Hearing Care

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**E**valuating disability claims for veterans and service members for hearing loss, tinnitus, hyperacusis, and auditory processing disorders (APD) is multifocal. This is because veterans and service personnel are exposed not only to noise and solvents but also to risks of developing head and neck injuries, upper respiratory diseases, cancers, multisystem illnesses, and more. Although noise is the primary focus, a medical disability examination takes into consideration all potential causations, interactions, and exacerbations. Military noise exposure is especially damaging because of the prevalence of high noise levels, especially from blast exposures, which are frequently encountered in all branches of the armed forces. To compound this difficulty, hearing protection was neither developed, available, nor effective, and hearing conservation programs were not instituted during earlier service eras.

For veterans returning from World War II (1941-1946), the Korean War (1950-1955), the Vietnam War (1961-1975), the Gulf War (1990 to present), the Afghanistan War (2001-present), and the Iraq War (2003-present), tinnitus is the number one compensated disability followed by hearing loss, and the "limitation of limbs (knees)."<sup>1</sup> In fact, in the veteran population, tinnitus and hearing loss is reported to affect 9.7 percent and 5.8 percent of servicemembers,<sup>2,3</sup> respectively, keeping in mind the average age of personnel is in the mid-30s, wherein hearing loss in this cohort is less than one percent.<sup>4</sup> These statistics reflect the preponderance of noise exposure encountered on an ongoing basis, whether in combat or not. For those in combat theatres, the prevalence rates of hearing loss are higher for those deployed (68.6%) when compared to those who are not (4.0%).<sup>5</sup> However, even in non-combat service, there is a high degree of noise exposure from training exercises, firearms, ordinances, ground support, transportation, communications, and operations and maintenance to name a few. In each case, noise exposure is evaluated on an individual basis, dependent upon the servicemembers' military occupational specialty, service history, medical records, and lay evidence.

The sources of noise in the military are as diverse as the different activities conducted by its members. This is because high noise levels in the military are constantly being generated by industrial level machinery, rifles, sidearms, Gatling guns, watercraft, land artillery, weapon systems, mines, tanks, rockets, improvised explosive devices, aircraft flight, takeoffs, and landings, ship engines and onboard missiles, guns and cannons, heavy-duty equipment and transport, vehicles maintenance and



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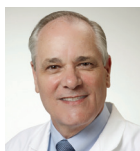
metal crafting, mortars, and more. To mitigate the noise exposure, hearing conservation programs and the use of hearing protection were developed over many years; however, the intensity of military noise and repeat exposures continue to take their toll.

## GENESIS OF HEARING CONSERVATION & PROTECTION IN THE MILITARY

Hearing protection and conservation programs started in 1948 when the Air Force issued the first regulations concerning hazardous noise. Before this, there were no regulations on noise, and hearing protection was limited to cotton, index fingers, a bullet in the canal, or nothing. In the early 1950s, about the time of the Korean War, the V-51R earplug made its debut in three different sizes. By the mid-1950s, the Navy "cranial earmuffs" were introduced to help those near the flight line<sup>6</sup> and in 1956, the Air Force started the first hearing conservation program.

As technology developed during the 1960s, conventional earplugs and muffs made their way into the armed forces, which is about the same time pure tone audiometry replaced the whisper test and the Vietnam War was in full swing. It was not until the 1970s when the OSHA noise regulations first appeared in the Federal Register that hearing conservation was taken to task in the military and industry. By this time, changes included the development of roll-down slow recovery foam earplugs; tanker and aircraft flight helmets with internal ear cups for noise attenuation went into use.

By the 1980s, hearing conservation programs in the military were firmly established with enlistment and separation audiograms being a universal theme, as well as periodic testing depending upon the service personnel's military occupational specialty (MOS). In the armed forces, MOS designations describe military activities used to define if an individual has a low, moderate, or high probability of being exposed to hazardous noise. In industry, these would be equivalent to job



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## HEARING MATTERS

descriptions with specific duties and activities that would identify the potential for hazardous noise exposure, such as metal workers.<sup>7</sup> As expected, those in combat are more at risk because of the variety of ordinances and machinery they encounter, such as the Abrams Tank, Howitzers, diesel generators, aircraft, and firearms.

Although hearing protection affords some benefit, noise reduction ratings and actual real-life attenuation characteristics have their limitations. Fit testing has shown noise reduction ratings (NRRs) in the laboratory provided by earplug manufacturers have little correlation with protection in the field. For this reason, OSHA derated NRRs suggesting real-life attenuation for earplugs is less than half of the laboratory findings, with earmuffs being moderately better. Double protection affords about 5 dB more attenuation than muffs alone, but this does not ensure complete protection, nor is it practical for soldiers in the field. In general, it has been accepted and conceded that real-world hearing protection has been inadequate, even with advances in technology.

Attempts at new technology are ongoing but have not been universally successful. Between 2003-2015, the level-dependent “combat arms” earplugs by 3M were sold to the military to protect soldiers from blast noise and still allow for general communication. This failed in the field because of fitting and performance issues resulting in an avalanche of lawsuits. In fact, 3M has paid the U.S. government 9.1 million in compensation so far. The 3M advanced ribbed and tapered construction and filtering still requires hearing protection to be fitted properly in the canal by the user, which makes it an earplug with similar problems like any other earplug, “fit and stability.”<sup>8</sup>

Starting in 2000, the Tactical Communication and Protective Systems (TCAPS) electrical systems became available, claiming improved protection from blasts and impulse noise while improving communication. The foam earplug and earbud design of TCAPS “pass-thru” normal levels of sounds below 85 dBA and can boost soft sounds better than normal hearing when out in the field. According to Captain Jennifer Noetzel, the audiology chief at Fort Drum, NY, “The Army’s focus with the TCAPS is to minimize training and battlefield related hearing loss, while improving overall situational awareness, increase mission effectiveness, safety, and survivability.”<sup>9</sup>

### NOISE ASSOCIATED WITH MILITARY EQUIPMENT

The risk of hearing loss, tinnitus, hyperacusis, synaptopathy,<sup>10</sup> and APDs comes from ordinances, explosives, and operational noise exposure. In addition to ordinances, a host of industrial-level military occupations also cause hearing loss and tinnitus. A look at some of the high-level noise exposures reveals the importance of looking at and beyond the ear.

According to the Military Analysis Network, the M1A2C Abrams main Army battle tank holds a crew of four, can travel at 41.5 MPH, weighs 66.8 tons, and can fire a round from its cannon producing a lower frequency impulse sound at 170 dBP. In addition to the cannon, the tank has three high-powered machine guns that produce impact noise at

153-155 dBP. The noise from the 1500 horsepower turbine engine, drive train, and track can produce cabin noise above 117 dBA at 40 miles an hour, down to 103 dBA at tactile idle.<sup>6</sup>

In addition to tanks, the levels of noise from a Howitzer cannon is 183 dBP, the MAAWS anti-tank rifle 190 dBP, the Javelin missile 172 dBP, and a grenade at 50 feet is 164 dBP. Firearms such as the M9 pistol and M16 rifle for shooters, and the M249 machine gun mounted on an HMMWV for “gunners” range from 157 to 160 dBP.

The Airforce, Navy, and Marines airpower is made up of fighters, attack aircraft systems, bombers, and specialized support aircraft for transportation, reconnaissance, and supplies. The Air Force has over 145 different airplanes.<sup>11</sup> Each branch of the service has its own versions and some specialty aircraft. Servicemembers fill a variety of occupations and capacities exposing them to loud noises from propeller planes, helicopters, and jets. For example, flight deck personnel on an aircraft carrier, such as the USS Kitty Hawk, would be exposed to 123 dBA on take-off, and below decks, the mechanical, impact, and aircraft noise could reach 106 dBA. In some areas on the flight deck, the sound from aircraft engines could range from 138 dBA to more than 146 dBA.<sup>12</sup> Furthermore, when aircraft carriers are running missions, the noise could be continuous with inadequate time for hearing recovery from TTS.

Helicopters are used universally for the transport of troops and supplies as well as for battle engagement. The Blackhawk Army Helicopter produces 105 dBA or more inside and outside of the craft.<sup>13</sup> The Chinook and Apache helicopters are a few decibels lower. Outside the helicopter, maintenance and transport personnel are frequently within an arm’s length of operating engines. Even with properly fitted hearing protection, auditory system damage occurs.

The Navy has over 150 different ships including aircraft carriers, command ships, amphibious assault ships, sea lifts transports, surface warfare cruisers, submarines, destroyers, and frigates. Other vessels include amphibious/landing craft, intelligence ships, submarine tenders, mine warfare, combat logistics, and supply ships. These ships carry both ordinances, troops, and supplies with repeat noise exposures from heavy equipment, aircraft, cannons, missiles, and .50 caliber machine guns capable of firing 850 rounds a minute. Ship engines produce high levels of noise which vary depending upon class and weight. Many engines use diesel, nuclear power, electrical propulsion, or steam and gas turbines. For reference, engine rooms have been measured between 108 dBA and 118 dBA. Another major area of noise exposure comes from ship maintenance, which requires a staff of firefighters, machinists, welders, electricians, diesel and other mechanics, metal workers, technicians, and more.

### MILITARY HEARING LOSS & TINNITUS

Gordon, et al., evaluated 100 recently separated veterans ( $\leq$  2.5 years) from the Army, Navy, Airforce, National Guard, and Marines for hearing loss, tinnitus, and associated disorders.<sup>14</sup> The investigation included the use of the LENS-Q - Lifetime

Exposure to Noise and Solvents and the HHIA. The participants were 84 men and 16 women with an average age of 33.5 years old (8.8 SD). Loud noise exposure was reported as weekly or daily by 79 percent of the veterans and 56 percent reported some noise exposure since their separation. In addition, 58 percent reported being exposed to one or more ototoxic solvents during their military service. Of the 100 participants, 12 percent had service-connected hearing loss, 67 percent reported tinnitus, 46 percent had a blast exposure, 27 percent had a TBI, and 47 percent screened positive for PTSD. The audiometric findings revealed the majority of participants had hearing within normal limits. In the hearing loss group (> 20 dB HL), 29 percent had mild hearing loss in the standard frequencies (250 – 8KHz) and 42 percent in the extended frequency range (9KHz – 16KHz) falling within mild to moderate range. Of the 76 percent who reported hearing difficulties, eight percent did not consider it to be a problem, 53 percent felt it to be a mild problem, 30 percent a moderate problem, and nine percent a “big to very big problem.” The finding of the study demonstrates a disconnect between the audiometry and the HHIA. The assumption is the differences are related to other sites of lesion such as APD or neural degeneration related to bTBI and blast exposures. According to Mezri, et al., of the 13,226 U.S. military deployed to Iraq between 2004 and 2008, 30.7 percent had ear blast injuries.<sup>15</sup>


**Audiologists should be mindful of how noise exposure, especially impact noise alters the auditory system, and also how TBI, PTSD, and depression are associated with increased rates of hearing loss and tinnitus and the effects thereof.**

High-level noise exposure has been known to be responsible for hearing loss and tinnitus, but also synaptopathy and APD from blast exposure. Characteristics of hearing loss are well known as primarily a high-frequency event and a noticeable noise notch. However, in cases of high-intensity repetitive noise and blast trauma, which can occur from firearms and other ordinances, the clinical signs are less sensory and more central with difficulty understanding the spoken word, hearing in background noise, and other signs of an APD. When evaluating a veteran or servicemember, audiologists should be mindful of how noise exposure, especially impact noise alters the auditory system, and also how TBI, PTSD, and depression are associated with increased rates of hearing loss and tinnitus and the effects thereof.<sup>16</sup>

A good example of this is the veteran with normal hearing who returns from the Gulf War with a complaint of tinnitus and reports “my eardrum keeps moving.” Although at first, normal hearing would suggest the absence of hearing damage, but the observance of tonic tensor tympani syndrome (TTTS), TBI, and processing abnormalities tells a different story.<sup>17</sup> “Combat-related head trauma is likely to include those exposed to blasts, as well as exposure to small arms fire, artillery, grenades, and physical assault.”<sup>15</sup> Even a single, unprotected loud impulse noise can cause irreversible damage.<sup>18</sup> In fact, injuries from a high-level blast result in 50 percent of tympanic membranes becoming perforate at 50 kPa.<sup>15</sup> As expected, this results in various degrees of hearing loss, tinnitus, otalgia, and vertigo.

The opportunities for high noise exposure in the military are considerable. Not all situations can be mitigated by hearing protection, administrative controls, or specialized helmets because of obvious limitations. At these levels of noise exposure, it would be realistic to suspect hearing loss, synaptopathy, bTBI, or an APD would occur in some servicemembers. The VA is sensitive to the needs of servicemembers exposed to noise and provides service-connected disability awards. The effects of noise on servicemembers go far beyond hearing loss and tinnitus.

Audiologists are the primary providers of Medical Disability Examinations for the Veterans Benefits Administration (VBA) in cases of hearing loss, tinnitus, and APDs. The important aspect of providing disability examinations is not for clinical treatment, but for medical-legal purposes assessing causation and quality of life changes. This requires not only an understanding of the noises of war both in combat and non-combat environments, but also how this affects the whole person as they relate to military environments and exposures during service. Furthermore, audiologists are required to opine on function using the VBA definition of a disability as conditions which infringe upon the ... “ability of the body as a whole, or of the psyche, or of a system organ of the body to function under the ordinary conditions of daily life, including employment.”<sup>19</sup>

Noises of war take a toll on our servicemen and women in a variety of ways, regardless of the branch of service. At some time in their career, all military service members encounter noise in the military, some more significantly than others. Regardless of the encounters, military noise exposure can either result in minimal sensorineural hearing loss, and/or tinnitus or develop into a more complex condition such as labyrinthine concussion, hyperacusis, synaptopathy, or an auditory processing disorder. Audiologists evaluating veterans should be aware of the dangers involved in service and the effects these experiences can have, especially the psychological aspect. 

References for this article can be found at <http://bit.ly/HJcurrent>.