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## Cost Effectiveness of Hearing Conservation Programs

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In 1999, The Department of Veterans Affairs (VA) reported \$291,622,148 for 56,792 veterans receiving hearing loss as a major disability. Civilian hearing loss compensation in that year was \$35,346,392 for 6,406 Federal employees. The medical community has often qualified such data, noting that these monetary outlays do not reflect the more important factors of decreased job performance and loss in the quality of life. The reality of decreasing workforces and decreasing budgets have forced us, though, to market hearing conservation programs on the basis of economic benefits. Medical outcomes, spanning 20-years of rigorous program implementation, have been translated into over \$500 million of projected training cost savings. Comparisons among the services have also been used to demonstrate cost avoidance for civilian hearing loss and VA disability. Explanations for differences among the services are presented. For example, the National Institute for Occupational Safety and Health (NIOSH) has made what they are calling a paradigm shift in their program focus from the agent (noise hazard) to preventing hearing loss. The Army Occupational Health and Industrial Hygiene leadership made this shift over 29 years ago.

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Hazardous noise pervades our military and industrial environments. The increasing demand for weapon systems with greater speed, range and firepower confounds the problem with higher and more hazardous noise levels. A soldier's ability to hear can be assaulted and damaged even before the completion of basic training. Prevention of noise-induced hearing loss in the U.S. Army is predicated on the fact that most hazardous noise exposure over a soldier's career occurs during such training exercises, not combat.

**Readiness Benefits**

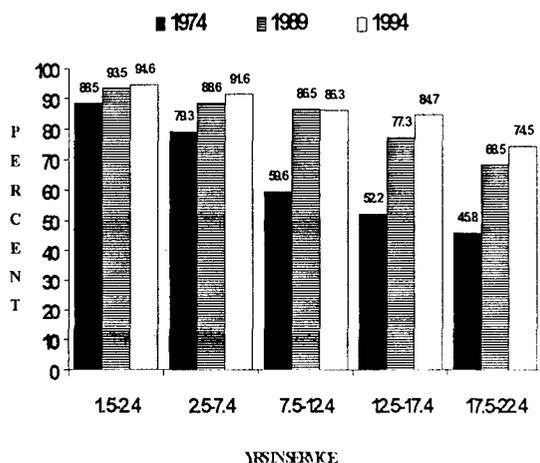
On today's high-technology battlefield, good hearing is an essential attribute of an effective soldier. Preserving a soldier's ability to hear low-intensity sounds or speech is critical to readiness and soldier survivability. Veterans of conflict value hearing as a 360 degree warning sense.

**Monetary Benefits**

In addition to a crucial role in soldier readiness and soldier survivability, there are also monetary benefits to be derived from effective hearing conservation programs. Commanders are saving more than nerve cells of the inner ear when they enforce the use of hearing protectors and ensure that troops report for scheduled health education briefings and hearing evaluations. Substantial reductions in hearing loss among U.S. Army combat arms personnel can be translated into reduced training costs and reduced hearing loss disability.

In 1974, Walden et al conducted a landmark study designed to determine the prevalence of hearing loss within U.S. Army infantry, armor and artillery enlisted branches that were at high risk for noise exposure.<sup>1</sup> Within each branch, soldiers were divided into five time-in service categories (see Figure 1).

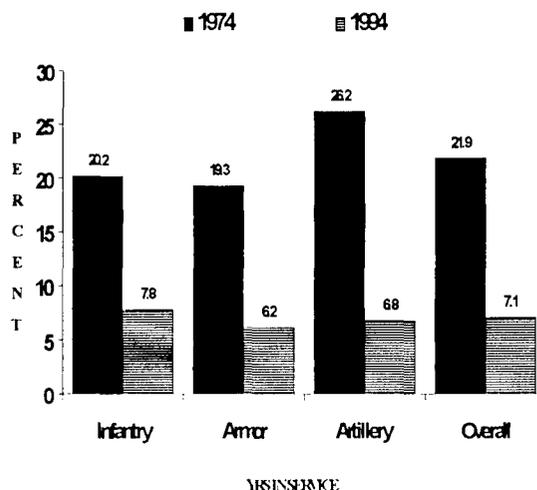
Figure 1. Prevalence of Acceptable Hearing Among Armor, Artillery and Infantry Enlisted Personnel



On two occasions since, the Walden study was revisited.<sup>2,3</sup> In 1989 and 1994, soldiers were evaluated through an Army-

wide, automated surveillance system [Hearing Evaluation Audiometric Reporting System (HEARS)]. The most significant findings were a 19 and 24 percent increase respectively in H-1 profiles (indicators of acceptable hearing).<sup>4</sup> This trend was consistent across all time-in-service categories in both studies indicating fewer soldiers with impaired hearing. Accordingly, there were corresponding reductions in H-2 and H-3 or greater hearing profiles (See Figure 2).<sup>5,6</sup>

Figure 2. Prevalence of H-3 or Greater Hearing Profiles in Enlisted Combat Arms



A hearing loss profile of H-3 or greater could be sufficient cause to remove a soldier from a Military Occupational Specialty (MOS) or an Area of Concentration (AOC) involving routine exposure to hazardous noise. They could even be vulnerable to an early discharge from the service. Depending on their experience and rank, a significant investment in their training could be lost. On the other hand, hearing loss prevented could translate into training costs saved. Based on Fiscal Year (FY) 1996 dollars, average training costs were computed for the level of training our enlisted soldiers would attend in a career progression (Table 1).

Table 1. Average Training Costs per Soldier for Enlisted Combat Arms Personnel (Direct and Indirect Costs with Student Pay)\*

BT (Basic Training)	AIT (Advanced Individual Training)	BNCOC (Basic Non-Commissioned Officer Course)	ANCO (Advanced Non-Commissioned Officer Course)
\$8,743	\$26,656	\$22,205	\$18,647

\*Source: HQ TRADOC, Deputy Chief of Staff for Resource Management, Resource Analysis Division

Since the range of costs between schools varied up to \$40,000, the cost averages were weighted based on the

number of soldiers reported in a particular MOS at that training level.

Differences between 1974 and 1994 in the prevalence of hearing loss by rank with strength data in June 1995 (101,080) were then used to calculate "cases of hearing loss prevented" at three pay-grade ranges in Table 2.

Table 2. Projected Training Costs Saved from Reduced Hearing Loss in Enlisted Combat Arms Personnel

Pay Grade	Training Level	Cases of Hearing Loss Prevented	Savings
<E05 (53.2%)	AIT (\$26,656)	1,559	\$41,556,704
E05-07(43.4%)	AIT+BNCOC (\$48,861)	8,554	\$417,956,994
>E07 (3.4%)	AIT+BNCOC+ANCO (\$67,508)	708	\$47,795,664
Totals		10,821	\$507,309,362

Because of the possibility that a soldier could be retained in the Army in an MOS without hazardous noise exposure, basic training costs were not included in these cost savings estimates. Otherwise, training costs were added as a soldier progressed from AIT to BNCOC to ANCO training levels.

The weakest assumption in the aforementioned estimates is that everyone's calculated hearing profile is the same as the assigned profile. The last time this was checked on a large scale (over 20 years ago), approximately 65 percent of enlisted combat arms were assigned their appropriate hearing profile. Although the proportion has improved with reduced hearing loss prevalence and automated testing and calculation procedures, it would be naive to assume that appropriate hearing profile assignment is 100 percent. By default, based on the prevalence of H-1 profile, it is at least 89 percent.

For the purposes of this discussion, the savings reported are assumed to have occurred over an unspecified time at a consistent rate. In 1989, however, a replication of the 1974 prevalence study found an 11.0 percent prevalence in H-3 or greater profiles versus the 7.1 percent found in 1994.<sup>2</sup> Prevalence rates, therefore, were not consistent over time. The difficulty of specifying a time frame for the reported savings is also confounded by different turnover rates among MOS's. Such turnover rates were not available for these calculations.

As considerable as the projected half billion dollar savings, there are also other training cost savings not reported here. For example, there are also costs saved for training replacements and for re-training the individual profiled out of a noise-hazardous MOS for another MOS. Moreover, if we assume that the Hearing Conservation Program has had a similar positive impact among other enlisted personnel in the more technical MOS's as well as among officers and warrant officers, there is the strong possibility that training costs are being saved among them as well. Finally, basic training costs could also be saved for those who may have been medically boarded for hearing loss.

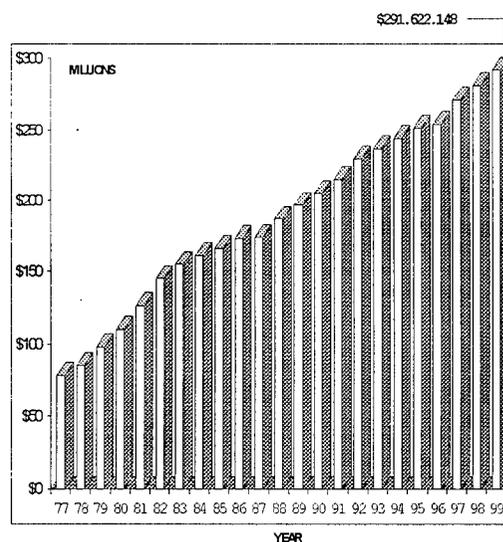
The reduced prevalence of H-3 hearing profiles reported above is consistent with a 15.1 percent decrease in major hearing loss disability cases for Army veterans since 1986. In this year, the Department of Veterans Affairs (VA) began to report hearing loss disability cases and cost by individual service. See Table 3 for the change in the percentage of cases since 1986 by service.

Table 3. Percentage of Change in the Number of Cases Reported from 1986 to 1999 for Major and Lesser Hearing Loss Disability by Service

	Major Cases	Lesser Cases
Army	-15.1	+38.6
Marines	+12.0	+77.1
Navy	-6.2	+109.1
Air Force	+21.0	+33.0

Monetary expenditures are reported by major disability, which is defined as the sole disability or the highest percentage disability in instances of multiple disabilities. See Figure 3 for total VA expenditures over the past 23 years.

Figure 3. Cost of Hearing Loss for All Veterans (Major Disability Only)  
1977-1999 Total = \$4,346,946,916



In 1999, the Army accounted for 61 percent (34,609) of the total major cases (56,792) and 54 percent (149,885) of all major and lesser cases (278,700). This accounting is roughly equivalent to the total Army numbers served since and including World War II, i.e., 60 percent of all service members.

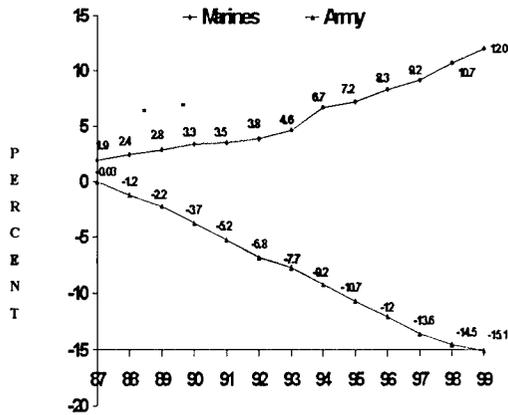
In 1987, the VA changed their disability formula to include hearing test frequencies more affected by hazardous noise. Despite a liberalization of the disability formula, the data in Table 3 suggest a shift toward less severe hearing losses.

Comparisons among the services may not be appropriate in all cases. For example, the Air Force, created in 1947, does not have decreasing numbers of World War II veterans to affect their data. A comparison between the Marines and the Army is most tenable because of the similarity of our noise

exposures.

If the Army's percentage of change in the number of major cases had increased the same as the Marines (see Figure 4), the VA would be accounting for the additional Army major cases as shown in Table 4. When these "additional cases" are multiplied by the average costs of Army major disability cases, the estimated cost avoidance is notable, e.g., \$333,159,418 from 1987-1999.

Figure 4 Army/Marine VAMJ for Hearing Loss Disability Cases (Percent of Change Since 1989)



\*Updated

Table 4. Cost Avoidance Under Army vs Marine Percentage of Change in VA Major Hearing Loss Disability Cases

Yr	Additional Major Cases	Average Cost X	Estimated Cost =	Cost Avoidance
87	786	\$2,923		\$2,297,478
88	1,484	\$3,157		\$4,684,988
89	2,031	\$3,343		\$6,789,633
90	2,837	\$3,518		\$9,980,566
91	3,562	\$3,724		\$13,264,888
92	4,336	\$4,026		\$17,456,736
93	5,021	\$4,179		\$20,982,759
94	6,475	\$4,338		\$28,088,550
95	7,309	\$4,528		\$33,095,152
96	8,277	\$4,606		\$38,123,862
97	9,276	\$4,965		\$46,055,340
98	10,274	\$5,174		\$53,157,676
99	11,046	\$5,365		\$59,261,790

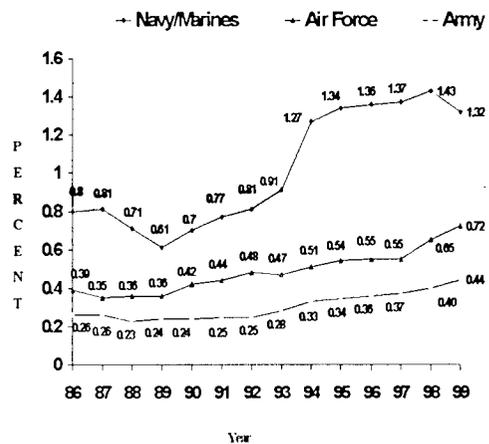
Total = \$333,239,418

Total expenditures for civilian hearing loss compensation are considerably less than for VA disability. Moreover, the loss of a training investment is less of an issue with civilians. Such expenditures, however, are closer to home for installation commanders because of the charge back process. For example, the Department of Labor bills each government

agency for the claims that the Office of Workers' Compensation Program (OWCP) have adjudicated. As each Army major command is billed for their share, installations are billed in turn.

Fortunately for Army installation commanders, the incidence of civilians awarded hearing loss compensation has been notably lower over the last 14 years than for the other services (Figure 5). For example, in FY 1997, the Army incidence of claims was almost two-thirds that of the Air Force and a quarter of those in the Navy. Direct hire populations (salaried and wage-board) were used to compute incidence from 1986 to 1999.<sup>7-20</sup>

Figure 5 Incidence of Civilian Hearing Loss Compensation Cases Awarded



These favorable trends can also be translated into considerable cost avoidance. If the Army had the same incidence rates as the Navy, the OWCP would have had to account for 30,755 additional cases between 1986-1999. When the average costs in each year of Army civilian compensation cases are multiplied by the projected increase in cases under the Navy rate, the overall estimated cost avoidance for 14 years is \$181 million.

Comparisons to the other services are considered valid under the following assumptions: (a) civilians enter employment among the services with comparable hearing levels; (b) the OWCP adjudicates hearing loss claims equitably among the services; and (c) tank and aircraft refurbishing operations are no less noise hazardous than shipyard operations.

Conclusions

The issue of differences between the services may not lie with the validity of the aforementioned assumptions, but rather with what the Army and Air Force hearing conservation programs do differently. It is no coincidence that the Audiology and Occupational Health elements of the Army and Air Force hearing conservation programs have traditionally focused on the exposed individual and the prevention of hearing loss rather than the noise hazard per se.

Recently, the National Institute of Occupational Safety and Health (NIOSH) has made what they are calling a paradigm shift from a focus on the agent (noise hazard) to preventing hearing loss. The Army made this shift over 30 years ago.

Although elimination or reduction of the hazard is the most desirable option, it was not technically or economically feasible to engineer noise down to safe levels in tanks or 155 howitzers, etc. The industrial hygiene focus on measuring the noise and hoping for noise abatement was shifted to more pragmatic strategies for preventing hearing loss.

In the Army and Air Force, the use of hearing protection is enforced regardless of duration of exposure when noise hazardous thresholds are reached. In some cases, personnel are overprotected but more susceptible individuals are better protected and off-the-job noise exposures are more readily accounted for. Sufficient numbers of military audiologists have also facilitated an increased capability for monitoring audiometry and health education in the Army and Air Force. Until recently, the Army had more than three times as many military audiologists than the Navy and twice as many as the Air Force. In addition, the Army has had a mainframe data base of audiometric records for the last 15 years which was based on an existing Air Force model. Through these corporate data bases, the Army and Air Force have been able to report measures of program participation, quality assurance and program effectiveness. In addition, the Army successfully automated audiometric data collection from the field 12 years ago and the Air Force is following suit.

Neither adequate audiology staffing or the availability of these essential management tools would have been possible without enlightened leadership among senior Army and Air Force Occupational Health and Industrial Hygiene personnel.

The bottom line for effective hearing conservation programs, however, is command support at all levels. The bottom line for value added, though, may not reside in cost benefit analyses of over one billion.

No matter how substantial, such monetary projections do not reflect the more important factors of decreased soldier readiness, decreased job performance and the loss in the quality of life associated with noise-induced hearing loss.

Doug Ohlin is the Program Manager of the U.S. Army Hearing Conservation Program at the U.S. Army Center for Health Promotion and Preventive Medicine. He is currently chairman of a DoD Hearing Conservation Working Group and President-Elect of the National Hearing Conservation Association. For the last 28 years he has provided technical and administrative assistance to the Office of The Surgeon General and the Army Medical Department.

3. Doug Ohlin, "U.S. Army Hearing Conservation Program Yields Cost Avoidance from Reduced Veterans Hearing Loss Disability", *USACHPPM Today*, Vol 2, No. 2 (July 1995).
4. H-1 Army Hearing Profile. Audiometric average level in each ear not more than 25 dB at 500, 1000, and 2000 Hz, with no individual frequency greater than 30 dB. Not over 45 dB at 4000 Hz. Military hearing profiles are determined from audiometric test results of pure tone hearing thresholds.
5. Poor Hearing. Equivalent to the upper limit hearing thresholds of H-2 military hearing profile, e.g., audiometric average level not more than 30 dB at 500, 1000, and 2000 hertz (Hz) with no frequency greater than 35 decibels (dB) and no greater than 55 dB at 4000 Hz; or better ear must be better than 30 dB at 500 Hz, 25 dB at 1000 Hz, 25 dB at 2000 Hz and 35 dB at 4000 Hz.
6. H-3 or greater Army Hearing Profile. Greater hearing loss than an H-2.
7. *Defense 86* (September/October) pg 35.
8. *Defense 87* (September/October) pg 37.
9. *Defense 88* (September/October) pg 35.
10. *Defense 89* (September/October) pg 35.
11. *Defense 90* (November/December) pg 35.
12. *Defense 91* (September/October) pg 35.
13. *Defense 92* (September/October) pg 35.
14. *Defense 93* (Almanac) pg 35.
15. *Defense 94* (Almanac) pg 35.
16. *Defense 95* (Almanac) pg 25.
17. *Defense 96* (Almanac) pg 25.
18. *Defense 97* (Almanac) pg 25.
19. Department of Defense Website.
20. Department of Defense Website, <http://web1.whs.osd.mil/mmid/civilian/sep99.htm>.

#### Notes

1. Brian E. Walden, Richard A. Prosek and Donald W. Worthington, *The Prevalence of Hearing Loss Within Selected U.S. Army Branches* (Washington, DC: U.S. Army Medical Research and Development Command, 1975) Interagency IOA 4745.
2. Doug Ohlin, Kenneth B. Aspinall and William H. Monk, "Hearing Conservation in the U.S. Army", *The Journal of the U.S. Army Medical Department* (Fall, 1994) pp 38-42.