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An Evaluation of the U.S. Air Force's Detailed Follow-Up Audiometric Examination Program

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The authors used information on individuals demonstrating permanent threshold shifts contained in the United States Air Force Hearing Conservation Data Registry to evaluate the effectiveness of detailed follow-up audiometric examinations as part of the USAF Hearing Conservation Program. Analysis yielded a relative risk of 1.00 with a 95% confidence interval of 0.97–1.03, which indicates a high probability that the true effect of these audiograms on the results of the next annual exam is minuscule, if not zero.

Introduction

This report presents the results of an analysis of information contained in the Hearing Conservation Data Registry (HCDR‡) with regard to detailed follow-up (DFU) audiometric examinations.

The United States Air Force (USAF) Hearing Conservation Program (HCP) was established to prevent occupationally related noise-induced hearing loss.[1] There are three integral parts to an effective HCP.[2,3] First, one must identify the hazardous noise source and employ abatement procedures designed to reduce the noise, if possible, to manageable or safe levels. Second, personnel working in hazardous noise environments must be apprised of the presence of the hazard and provided with approved and effective hearing-protection devices. The third leg of the HCP is to periodically monitor the hearing of the work force. Noise-free baseline reference audiograms are accomplished before personnel are assigned to duty in hazardous noise. Monitoring audiograms are performed annually for the purpose of tracking any change in hearing thresholds from baseline.[4] This periodic monitoring attempts to detect hearing loss early, before it becomes a communication handicap.[1] A significant threshold shift§ in hearing on an annual examination is reevaluated following noise-free periods of 15 and 40 hours. When a threshold shift is detected at the 40-hour noise-free examination, the individual is either placed on DFU or referred to a Hearing Conservation Diagnostic Center or a Hearing Conservation Center (HCDC/HCC‖).[1] DFU, as its name implies, was conceived as a method for acquiring more detailed hearing test data on personnel showing permanent changes in hearing thresholds. Under DFU, audiometric examinations are administered 3 and 6 months after the individual's 40-hour noise-free audiogram. The results of the 40-hour examination are used as the interim baseline for the 3- and 6-month tests.

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‡The HCDR is a central database containing all hearing conservation data on USAF personnel exposed to hazardous noise in the normal course of their duty.

§A significant threshold shift prior to July 1, 1990, was a change of 20 dB or more from baseline at any frequency 1,000, 2,000, 3,000, or 4,000 Hz in either ear. A significant threshold shift after July 1, 1990, is an average change of 10 dB or more at 2,000, 3,000, and 4,000 Hz in either ear.

‖Minimal staff for an HCDC is an audiologist and an otolaryngologist and for an HCC is an audiologist and an occupational medicine physician.

Individuals demonstrating additional significant threshold shift at the 3- or 6-month DFU examinations are referred to an HCDC/HCC for evaluation. If a significant threshold shift is not detected at either of the DFU examinations, the 40-hour examination results become the individual's new baseline and a DD Form 2215, Reference Audiogram, is completed and coded as a re-established reference. Any other change in baseline is supposed to be at the direction of an HCDC/HCC.

Based on the pervasive feeling that DFU hasn't accomplished enough to justify the time expended to manage it, we decided to use information from the HCDR to address the issue. Our study question was: Of the individuals demonstrating shifts at the 40-hour noise-free audiometric examination, do the individuals placed on DFU demonstrate better audiograms at the next annual audiogram than those who were not placed on DFU?

Materials and Methods

In evaluating DFU with data from the HCDR, we have assumed that the data accurately reflect any given individual's condition at the time of the examination. That is, we are assuming that the audiometric hardware used was in optimal condition, that any variance in technician skill had no effect on the exam results, that there was no learning bias (e.g., hold the button for 5 seconds and release for 5 seconds to pass), and that test results were accurately entered into the HCDR.

We decided to use the results of the next annual audiogram as the study end point. An annual audiogram not yielding a significant threshold shift with respect to the reference audiogram was considered a successful or stable outcome for the course of action (DFU or no DFU) used with the individual. On the other hand, a significant threshold shift was considered a negative outcome for the course of action.

The archived portion of the HCDR was not evaluated. We selected only current records with valid Social Security Account Numbers (SSANs) having beginning numbers from 0 to 5, significant threshold shifts on the 40-hour noise-free audiogram, and annual audiograms following the 40-hour noise-free audiogram date. For those records meeting these criteria, we asked for the SSAN, date of birth, sex, rank, 40-hour noise-free exam date, and reference date for the 40-hour noise-free exam. We also asked for the exam date, reference date, and results for the annual exam, 3-month DFU, and 6-month DFU. This request yielded a data set with 40-hour noise-free exam dates from January 1989 to November 1991.

Our request generated all combinations of 40-hour noise-free exams, 3-month DFUs, 6-month DFUs, and annual audiograms. The data had to be manually edited. For each SSAN in the raw data, only the first 40-hour noise-free audiogram, the next annual audiogram following the 40-hour noise-free audiogram, and any 3- and 6-month DFUs (a 3-month exam had to be present for a 6-month exam to be accepted for the study) falling between the two dates were selected.

The edited data were loaded into a personal computer database. A data field was created to indicate if the reference audiogram date for the annual audiogram was the same as the reference date for the 40-hour noise-free audiogram, if the annual reference date was the same as the 40-hour noise-free audiogram, or if the annual reference date was some other date.

Even though HCDR personnel maintain the HCDC/HCC referral forms, they don't have the capability of flagging the database entries of those individuals referred to an HCDC/HCC. A computer program was written to flag the corresponding record within our study data set when the SSAN was entered. The SSAN on each HCDR referral form for the period involved was manually entered. The program was written to require verification before a record was flagged as being referred to an HCDC/HCC. To eliminate variability between data editors, the same individual edited the database and entered the SSANs of the HCDC referrals. The data set was evaluated with the Analysis portion of Epi Info.[5]

Results

Table I shows the breakdown of the study population with respect to HCDC/HCC referral and placement on DFU. Particularly noteworthy is the large proportion (1,744/2,706 or 64%) of the study population that was neither referred to an HCDC/HCC nor placed on DFU. Since the study population had already demonstrated a 40-hour noise-free shift, we expected most, if not all, of the individuals to have been placed on DFU and/or referred to an HCDC/HCC for evaluation.

Table II represents only those cases in which the reference audiogram was not reestablished for the next annual. We were not surprised to find that most of these cases (555/670 or 83%) were neither placed on DFU nor referred to an HCDC/HCC.

Table III is composed of the records in which the 40-hour noise-free audiogram was used as the reference audiogram for the next annual audiogram. The values in Table IV represent those individuals for whom the annual audiogram reference was not the same reference as was used on the 40-hour noise-free audiogram and the reference was not the noise-free audio-

TABLE I

CONFIRMED SIGNIFICANT THRESHOLD SHIFTS AT 40-HOUR EXAM, U.S. AIR FORCE, JANUARY 1989–NOVEMBER 1991, HCDC OR HCC REFERRAL VS PLACEMENT ON DFU

	HCDC/HCC Yes	HCDC/HCC No	Total
DFU yes	140	469	609
DFU no	353	1,744	2,097
Total	493	2,213	2,706

TABLE II

REFERENCE AUDIOGRAM NOT REESTABLISHED, U.S. AIR FORCE, JANUARY 1989–NOVEMBER 1991, HCDC OR HCC REFERRAL VS PLACEMENT ON DFU

	HCDC/HCC Yes	HCDC/HCC No	Total
DFU yes	1	10	11
DFU no	104	555	659
Total	105	565	670

gram result. In both Tables III and IV, we find a disconcerting number (793/1,377 or 58% in Table III and 396/659 or 60% in Table IV) of reference audiograms being re-established without the benefit of DFU or HCDC/HCC referral.

We selected only those records with baseline re-established using the 40-hour noise-free exam results. This decision was based on our desire to evaluate the effect of increased monitoring frequency rather than the effect of re-established baselines. Table V shows the annual exam results of these individuals by their exposure to DFU. The layout of this 2 × 2 table is based on the assumption that "exposure" to DFU increases the "risk" of having stable results on the next annual exam.

The relative risk for this study is the incidence of stable results in the DFU population compared to the incidence of stable results in the group that wasn't placed on DFU. A relative risk greater than 1 would indicate that being on DFU produces a higher proportion of annual audiograms without significant threshold shift than not being on DFU. The data yielded a relative risk [(464/496)/(821/881)] of 1.00 and a Taylor Series 95% confidence interval of 0.97 to 1.03. That is, we are 95% confident that the true relative risk lies somewhere between 0.97 and 1.03. This relative risk of 1.00 and the very narrow 95% confidence limits (1.03–0.97 = 0.06) indicates a high probability that the true effect of DFU on the results of the next annual exam is minuscule, if not zero. At the alpha = 0.05 level, we conclude that DFU adds no value to the Hearing Conservation Program.

TABLE III

FORTY-HOUR NOISE-FREE AUDIOGRAM USED AS REFERENCE FOR NEXT ANNUAL AUDIOGRAM, U.S. AIR FORCE, JANUARY 1989–NOVEMBER 1991, HCDC OR HCC REFERRAL VS PLACEMENT ON DFU

	HCDC/HCC Yes	HCDC/HCC No	Total
DFU yes	120	376	496
DFU no	88	793	881
Total	208	1,169	1,377

TABLE IV

REFERENCE FOR NEXT ANNUAL AUDIOGRAM REESTABLISHED BUT 40-HOUR NOISE-FREE AUDIOGRAM NOT USED AS THE REFERENCE, U.S. AIR FORCE, JANUARY 1989–NOVEMBER 1991, HCDC OR HCC REFERRAL VS PLACEMENT ON DFU

	HCDC/HCC Yes	HCDC/HCC No	Total
DFU yes	19	83	102
DFU no	161	396	557
Total	180	479	659

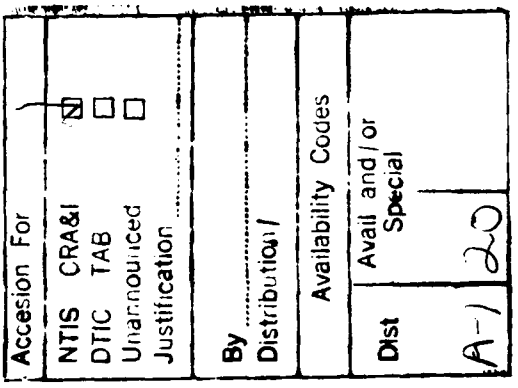

TABLE V

FORTY-HOUR NOISE-FREE AUDIOGRAM USED AS REFERENCE FOR NEXT ANNUAL AUDIOGRAM, U.S. AIR FORCE, JANUARY 1989–NOVEMBER 1991, PLACEMENT ON DFU VS RESULTS OF THE NEXT ANNUAL EXAM

	Stable[a] Yes	Stable No	Total
DFU yes	464	32	496
DFU no	821	60	881
Total	1,285	92	1,377

[a]Stable exam results are those in which significant shifts from the reference were not observed.

Conclusions

Of the workforce identified with a significant shift in hearing at the 40-hour audiogram, only 36% are receiving DFU and/or HCDC/HCC referrals. This figure suggests dismal compliance across the field. Program managers at base level report that often, due to temporary duty commitments and changing work schedules, it may be 9 months to 1 year before personnel enrolled in DFU actually have the 3- and 6-month tests completed. It is then time to complete another annual test. While compliance can be improved with increased Command and program monitor attention, the questions remain whether DFU is sound and whether it provides added value to the USAF HCP.

Our findings indicate that whether the individuals are enrolled in DFU or not has no effect on the identification of those individuals with a greater propensity to develop additional hearing threshold shift following a permanent threshold shift on the 40-hour exam. The bottom line is that DFU is a "no value added" process of the USAF HCP.

Acknowledgments

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References

1. United States Air Force: Air Force Occupational Safety and Health Standard 161-20, Hearing Conservation Program, 1991.
2. Lipscomb DM: Three little words. In Hearing Conservation in Industry, Schools and the Military, edited by Lipscomb DM, pp 3–6. Boston, College-Hill Press, 1988.
3. Suter AH: Hearing conservation. In Noise and Hearing Conservation Manual, Ed 4, edited by Berger EH, Ward WD, et al, pp 9–17. American Industrial Hygiene Association, 1986.
4. Morrill JC: Hearing measurement. In Noise and Hearing Conservation Manual, Ed 4, edited by Berger EH, Ward WD, et al, pp 284–5. American Industrial Hygiene Association, 1986.
5. Dean AG, Dean JA, et al: Epi Info, Version 5: A Word Processing, Database, and Statistics Program for Epidemiology on Microcomputers. Stone Mountain, GA, USD, Incorporated, 1990.