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A COMPUTER BASED AUDIOMETRIC ANALYSIS SYSTEM

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INTRODUCTION

Availability of high speed digital microprocessors has increasingly stimulated the development of both computer assisted hearing testing and audiogram entry, retrieval, and analysis systems. An additional benefit derived from a large data-base of audiologic records concerns analysis of the criteria utilized to determine a significant threshold shift (STS). This paper will describe the design of a program for group hearing testing, computer input, classification and report generation. Additionally, two methods of determining STS will be contrasted.

THE HEARING CONSERVATION PROGRAM

The audiometric testing aspects of a hearing conservation program consists of several significant features. Employees are required to wear hearing protection 14 hours prior to testing. Audiometric tests are administered in a mobile unit consisting of six stations within a double wall sound attenuated room. Each employee supplies information concerning previous otologic problems and noise exposure. Before actual testing a technician inspects the ear canal and tympanic membrane for any visible abnormalities. Audiometric testing is accomplished with six Grason-Stadler 1703B automatic audiometers, and a manual audiometer should additional testing be necessary. Each audiogram is reviewed by the technician and audiologist supervising the program. Following this review procedure the audiograms are forwarded for data processing and entry into the analysis system.

COMPUTER ANALYSIS OF AUDIOMETRIC RESULTS

Multiple reports can readily be generated once the audiometric information has been entered into the analysis system. The system consists of a number of data entry terminals, a mass storage device and a high

speed printer. A summarization of employees tested, the otologic history, and the resulting hearing status classification, facilitates management of the program. The summary reports classify employees as to existing hearing level and provide comparison with previous test results. In addition, reports listing employees requiring medical attention are generated. Those employees experiencing a STS and their percentage of hearing handicap (AAO) is determined. Other reports are produced as specially requested to accommodate to individual program requirements for various types of industry. In addition, personalized employee reports are generated to explain test results and recommendations.

DATA BASE ANALYSIS OF REGULATORY DEFINITION (29 CFR 1910) FOR STS

Recently the federal government of the United States has enacted a regulation that defines STS. This definition considers the difference between a baseline and current audiogram at 2, 3, and 4 kHz. If the average threshold difference is 10dB or greater then the employee is considered to have a STS. Prior to this regulation the OSHA Field Operations Manual (Vol. 5; 1979) had provided a STS definition. This definition considered the frequencies .5, 1, 2, 3, 4 and 6 kHz. If the threshold at any frequency had decreased 20dB or greater from baseline to current, a STS was determined. The current regulation may then be considered an average [Average(10dB)] and the previous criteria an overall [Overall(20dB)] measure.

The audiometric records of 6530 employees in the southwest United States were examined using each STS criteria. Each employee had a baseline and current audiogram with the time interval of one year. The data were analyzed using both STS criteria. Figure 1 is a description of the number of threshold shifts for each frequency from 5 to 40dB. The highest percentage of shifts occurred at 6 kHz and the lowest at .5 and 1 kHz. Table 1 shows data averaged at 2, 3, and 4 kHz and illustrates the number of shifts occurring for different criteria (0 to 40dB). Figure 2 illustrates the cumulative shifts at each frequency (2, 3 and 4 kHz) for those employees with shifts 10dB or greater [Average(10dB)]. Table 2 shows the actual shift that was the average for right and left ear for each criteria. Table 3 considers each ear separately comparing the two criteria. The final table (Table 4) is a contingency table illustrating the number of employees that were detected by each STS criteria. The table shows that less than half of those employees determined by the Overall(20dB) method would be determined to have a STS by the new regulation [Average(10dB)]. However, a number of employees (165) would be missed by the Overall(20dB) method.

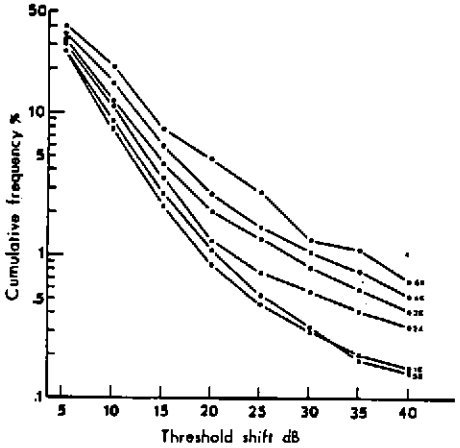

Figure 1. The cumulative occurrences for threshold shifts at each test frequency (N = 13060)

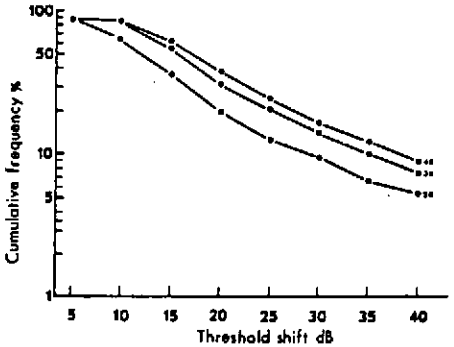

Figure 2. The cumulative occurrences for those ears determined to have an average (2, 3, 4, kHz) of 10dB or greater (N = 745)

Table 1. Cumulative distribution for right and left ear average of 2, 3, and 4 kHz

	Threshold Shift								
	0	5	10	15	20	25	30	35	40
Right	4283	1281	400	157	83	46	28	21	14
Left	4202	1382	345	124	66	43	25	10	11
Total	8485	2663	745	281	149	89	54	35	25

Table 2. Means and standard deviations for those employees with an average shift (2, 3, 4 kHz) of 10dB or greater

	Mean	S.D.	N
Right	15.92	9.25	400
Left	15.75	9.07	345
Total	15.84	9.16	745

Table 3. Occurrence of STS for Overall(20dB) and Average(10dB) for each ear

	Overall(20dB)	Average(10dB)
Right	584	400
Left	542	345
Total	1126	745

Table 4. Contingency Table illustrating the number of employees determined to have a STS for the Overall(20dB) and Average(10dB) methods

		Overall(20dB)		
		Yes	No	
Average(10dB)	Yes	(7.0%) 458	(2.5%) 165	623
	No	(7.5%) 488	(83.0%) 5419	5907
		946	5584	6530

SUMMARY

The utilization of a computer system greatly simplifies the management of audiological information, therefore enhancing the hearing conservation program. Specific reports can be rapidly and precisely generated. Finally, analysis of group data can be important in understanding the consequences of different STS criteria.