RNs in the most neutral way, and themselves in between at all three stages. This finding tended to become even more pronounced over time. The two characteristics which emerge as most intense for all three occupations at all stages of the study are intelligence and competence. These findings suggest that the PA holds a positive image of the medical team members with whom he interacts. The attitude noted indicates that continued effective team work is highly probable and not likely to detract from the quality of service rendered. It should be kept in mind, however, that the nature of this research has been preliminary, and long-term conclusions must await further study.

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Hearing Loss and the High Speed Dental Handpiece

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Abstract: A pure tone air conduction audiometric evaluation was administered to 137 dentists and 80 physicians. The physicians were found to have better hearing threshold levels, notably in the 4000Hz center frequency range. The left ear of right handed dentists showed a greater loss of hearing ostensibly related to proximity to the noise source. Dental specialists showed a loss pattern similar to those of the general dentists. The findings suggest that there may be a cause and effect relationship between hearing loss and use of the highspeed dental handpiece. (*Am J Public Health* 70:633-635, 1980.)

Ever since the development and use of the air driven high speed dental handpiece some 25 years ago, concern has been expressed and reported in the literature of a possible cause and effect relationship between use of the drill and loss of hearing in dentists. Previous studies have noted the existence of complaints of tinnitus, and a few have shown some minimal degree of high frequency sensorineural loss, dismissing it as either a temporary phenomenon or so minimal in degree as to cause no significant alteration in communicative function.[1,9]

Robin[1] concluded that so long as noise exposure was intermittent and of short duration, the dentist would run a low risk of experiencing a permanent loss of hearing. Cantwell, Tunturi, and Manny[4] found that limited exposure to noise produced by the high speed drill could produce a temporary loss of hearing, but that such exposure could not be considered a hazard to the operator's auditory mechanism.

Schubert and Glorig[5] devised a table to reflect the maximum daily levels of noise exposure, based on the conservative daily exposure time of 12 minutes a day. They stated that a dentist using a high speed drill for 12 minutes a day could be exposed to noise levels of up to 101dB and not experience a hearing loss above 600Hz.

Kryter[6] has indicated that exposure to sound intensity levels in excess of 80dB for eight hours a day of continuous exposure five days per week would cause permanent loss of hearing. In contrast, the Occupational Health and Safety Act of 1969[10] used 90dB for eight hours a day of continuous exposure as safe and unlikely to be injurious to hearing.

Taylor, et al,[8] in a controlled study of 45 dentists over a period of several years demonstrated that an exposed group of dentists experience high frequency hearing loss. Weatherton, et al,[9] studied dental students and dental school faculty members and found that no damage was done to the hearing of the students, but that faculty members did show some minimal hearing loss in the 4000Hz to 6000Hz range. They concluded that hearing loss would be expected to develop gradually, and almost always be expected to begin in the 4000Hz to 6000Hz range. With this background, it was felt that an additional study was warranted.

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This paper, submitted to the Journal August 23, 1979, was revised and accepted for publication February 14, 1980.

TABLE 1—Average Age for Three Comparison Groups

Comparison Group	Age (years)	Number Tested
Exposed Dentists	47.6	111
Dental Specialists	34.8	26
Physicians	45.3	80
TOTAL		217

Methods

Prior to the annual Yankee Dental Conference in Boston, Massachusetts, an announcement was sent to each member informing them that hearing testing was being offered as a part of a health screening program which also included cardiovascular and glaucoma testing. At the convention hall site, a large placard was placed opposite the testing area which was located in a large suite immediately adjacent to the main exhibition area. An Industrial Acoustic Corporation single wall mini test booth was set up in a far corner of the suite and screened from the reception and interview area. The ambient noise level inside the test booth with the blower on measured 36dBA on the sound level meter. This quiet atmosphere allowed for 0dB HTL air conduction measures at 500Hz, 1000Hz, 2000Hz, 4000Hz, 6000Hz, and 8000Hz on ten control subjects known to have normal hearing. The testing was performed on a Grason-Stadler, Model 17 pure tone audiometer calibrated to meet current (ANSI, 69) standards. The audiometer was calibrated daily using a Bruel and Kjaer, Type 2203 sound level meter, and a Type 4152 artificial ear. Calibration factor did not change during the study.

Prior to testing, each dentist-participant was asked to fill out a questionnaire seeking information relative to age, handedness, previous history of ear disease, exposure to noise other than that related to the drill, dental specialty,* year of graduation from dental school, and an estimate of the number of minutes per day their highspeed handpiece was in use. Examiners were unaware of subject's dental specialty. All testing was performed in the morning. Left-handed subjects and subjects who had used the handpiece on the test day were not accepted for the study.

A comparison group of physicians was then tested using the same experimental procedure. Physician participants were obtained from a pool of 500 names. Each physician was sent a letter announcing a program of free hearing tests being conducted in conjunction with a research study on hearing loss in dentists. All of those solicited for the study were in active medical or surgical practice of medicine. Exclusion was based on the same criteria as that applied to the dental group. Special care was taken to eliminate any subjects exposed to toxic levels of noise including firearms, chain saws, and various types of construction equipment. As a result of the screening, 14 physicians and 45 dentists were eliminated from the study.

Results

Table 1 shows the age breakdown for the three subject groups. Since the age of the three groups were not comparable, it was decided that the appropriate statistical treatment would be analysis of covariance with hearing threshold in dB as the variate and age as the covariate, a technique which provides an adjustment of group means that takes the age differences into account.

Table 2 shows the results of the hearing threshold level

TABLE 2—Average Age Adjusted Hearing Threshold Levels in dB at Specific Frequencies for Left and Right Ears for Three Subject Groups

Comparison Groups	Frequency in Hertz					
	500Hz	1000Hz	2000Hz	*4000Hz	*6000Hz	*8000Hz
Right Ear						
Exposed Dentists	5**	5	10	20	20	20
Dental Specialists	10	10	10	20	25	25
Physicians	5	5	10	10	15	15
Left Ear						
Exposed Dentists	5**	5	10	35	25	25
Dental Specialists	10	10	10	30	30	25
Physicians	5	15	10	15	15	15

*Average dB level is significantly different for three comparison groups $P < .01$
**Average dB level rounded to the nearest 5 dB

*For the purposes of the study, the following specialities were considered as "unexposed": orthodontics, periodontics, oral surgery, public health dentistry, and some dental educators.

TABLE 3—Mean Hearing Threshold Differences in dB between Right and Left ears (Right ear level minus Left ear level)

	Group		
	Exposed Dentist	Dental Specialist	Physician
500Hz	.27	−.42	.88
1000Hz	.41	1.67	−.06
2000Hz	−1.7	1.67	−.88
4000Hz	14.6*	−10.00*	−1.37
6000Hz	−4.9**	−1.25	−1.18
8000Hz	−2.4	−1.67	−1.06

*Significant difference $p < .01$
**Significant difference $p < .05$

in dB for the three comparison groups as sampled at each of six discreet frequencies for the right and left ears. Beginning at 4000Hz, group differences become apparent with physicians having hearing threshold levels better than dental specialists and exposed dentists. Both exposed dentists and the dental specialists show a greater loss of hearing in the left ear. Table 3 provides a comparison of right and left ear hearing threshold levels for the three groups. It may be noted that the exposed dentists, who were all right handed, had statistically poorer hearing in the left ear at 4000Hz and 6000Hz. The dental specialists, a younger age group, also demonstrated statistically poorer hearing at 4000Hz in the left ear. In the physician control group, there was no statistically significant difference between right and left ears.

Discussion

The results of the study suggest that there was a statistically significant difference in hearing sensitivity between both groups of dentists and the group of physicians. In the design of the study it was not anticipated that both the exposed dentists and the dental specialists would show high frequency hearing loss. Hearing loss in the dental specialist group was unexpected, as it was felt originally that their exposure to a high speed handpiece would be so minimal as to render their hearing comparable to that of a non-exposed, physician comparison group. It would on the surface appear that a major factor operating here is an underestimate of the amount of noise exposure the dental specialists receive either prior to their postgraduate specialty training or in their office environment.

Since it was impossible to control or account for all the possible differences between the physician and dental subject group, a further indictment of the handpiece is the comparison of intrasubject right and left ear hearing thresholds. The results demonstrated that right handed dentists exhibited greater hearing loss in the left ear. No such difference was seen among physicians who were also all right handed. It is generally agreed that the left ear is closer to the drill and its apparent toxic noise level in right handed operators.

The hearing loss, as expected, was found to be in the high frequency range, and consistent with the overall pattern associated with noise trauma. Most of the subjects had what would be considered a mild loss of hearing. Many of the subjects, however, had a loss of hearing which by their own statement was sufficient to prove a nuisance in certain communicative situations. Typically, these individuals had threshold erosion which extended to include 2000Hz, a significant segment of the critical speech range which extends from 500Hz through 4000Hz.

At present it is not clear whether the major problems associated with the loss of hearing stems from the output level in dB produced by the various handpieces, the spectral characteristics of the noise coupled to the intensity, the overall duration and/or the frequency of exposure, or whether the OSHA intensity vs duration of exposure standard is set too high or too long for safe operation of noise producing equipment. Additional research is being conducted in these areas.

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