Performance of Reconditioned Hearing Aids

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Twenty-five malfunctioning hearing aids were analyzed electroacoustically after being repaired by the manufacturer to determine if they could meet ANSI requirements established for the manufacture of new hearing aids. The results indicated that, after repair, the percentage of hearing aids within tolerance limits increased by a significant amount for each of the 10 electroacoustic characteristics measured; however, only 12% of the repaired aids met all 10 standards. As a result, it is recommended that repaired hearing aids be carefully tested to determine if their performance characteristics are adequate for user needs.

Hearing aid repair is a common need of hearing aid users. The percentage of malfunction varies from approximately 30% to over 60% (Gaeth & Lounsbury, 1966; Zink, 1972; Bess, 1977). Electroacoustic measuring equipment allows for a precise determination of hearing aid characteristics. Simple listening checks, referred to as troubleshooting by Hodgson (1981), can also be effective. In a residential school for the deaf, Porter (1973) found a 77% malfunction rate with this method. Combining both troubleshooting and electroacoustic analysis has proven useful for identifying hearing aid problems which cannot be identified by either method alone (Porter, 1973).

Warren and Kasten (1976) compared hearing aid repairs done by manufacturers and other repair facilities. They found little difference between repair sources in the completeness of repairs done, but only 39% of the hearing aids were acceptably repaired according to their established criteria. As a result, these investigators recommended that audiology clinics keep records of the performance of each hearing aid when new, when malfunctioning, and when repaired.

Even newly manufactured hearing aids are known to malfunction. Since 1976, hearing aids have been manufactured in compliance with ANSI S3.22-1976 specifications (American National Standards Institute, 1976). This standard specifies tolerances relative to the manufacturer's written specifications for each hearing aid model. Townsend and Olsen (1982) tested 100

new hearing aids to determine their compliance with ANSI S3.22 - 1976. They reported that only 68% of the new hearing aids passed all measurements.

The purpose of the present study was to determine the acceptability of hearing aid repairs done by the manufacturer. The basis of the evaluation was the 1976 hearing aid standard and tolerance limits.

PROCEDURE

Pre-repair

Twenty-five behind-the-ear hearing aids identified as needing repair during inspections conducted in an audiology clinic were included in this study. All were manufactured since the 1976 standard for hearing aid characteristics went into effect and represented various models from a single manufacturer. All repairs were completed by the original hearing aid manufacturer rather than an alternative repair lab to assure the best quality control (Warren & Kasten, 1976). The manufacturer was unaware of the study. Each aid belonged to the original purchaser and was 2 - 6 years old. Sixteen (64%) of the aids were used by children aged 13 years or younger. The remainder were used by adults.

Each hearing aid underwent electroacoustic analysis using a Phonic Ear, Model HC2000, Hearing Aid Test System with a Phonic Ear, Model HC 2200, Graphic Level Recorder. The test microphone and the test chamber were calibrated according to the manufacturer's recommendations prior to measurement of each hearing aid.

All measurements were made according to ANSI S3.22 - 1976 procedures. The 10 test measures included: a) maximum saturation sound pressure level (SSPL90), b) high frequency average (HFA) SSPL90, c) HFA full on gain (FOG), d) reference test gain (RTG), e) low frequency cutoff (F1), f) high frequency cutoff (F2), g) total harmonic distortion (THD) at 500 Hz, h) THD at 800 Hz, i) THD at 1600 Hz, and j) equivalent input noise level (Ln).

The pre-repair hearing aid performance data were compared to the manufacturer's specifications for that specific model to identify the discrepancies warranting repair. In addition, each hearing aid was checked by a troubleshooting method proposed by Hodgson (1981). The troubleshooting procedure was included to detect malfunctions of the hearing aid, such as intermittent output and internally generated noise, that might not have been detected by the electroacoustic analysis.

Post-repair

When each instrument was received from the repair laboratory a post-repair electroacoustic analysis was completed identical to the pre-repair analysis. The performance characteristics of the repaired aid were compared to the ANSI tolerance limits. A post-repair troubleshooting check was also completed and compared to the pre-repair inspection.

RESULTS AND DISCUSSION

Pre-repair versus Post-repair Performance Characteristics

Before repair, each of the 25 aids tested had output problems that exceeded tolerances as measured by the electroacoustic system. Thirteen of the aids (52%) failed to meet any of the 10 measured performance characteristics due to lack of acoustic output. Including the 13 dead hearing aids, a total of 20 aids (80%) failed to meet 7 or more of the 10 measured acoustic parameters before repair. Following repair, the distribution shifted in the opposite direction as indicated in Table 1.

Table 1
Number of ANSI Tests Passed by 25 Hearing Aids Before and After Repair

Number of Tests Passed	0	1	2	3	4	5	6	7	8	9	10
Before Repair	13	2	3	2	0	1	0	2	2	0	0
After Repair	0	0	0	0	0	0	0	6	10	6	3

One hundred percent of the repaired aids passed 7 or more of the 10 performance measures. Before repair, an average of 2 of the 10 electroacoustic measures were passed. Following repair, the average number of ANSI tests passed increased to eight.

Only three of the repaired aids (12%) passed all 10 ANSI tests. A study of new aids by Townsend and Olsen (1982) indicated that 68% of newly manufactured hearing aids met all ANSI tolerance limits.

Table 2
Percentage of Hearing Aids Meeting 10 ANSI Tolerance Limits Before and After Repair

ANSI Test	Before Repair	After Repair
SSPL90 HFA	28	92
SSPL90 Maximum	48	100
Full On Gain HFA	12	84
Reference Gain Test	16	88
THD @ 500 Hz	24	96
THD @ 800 Hz	24	100
THD @ 1600 Hz	20	96
Equivalent Input Noise Level (Ln)	20	96
Low Frequency Limits (F1)	4	44
High Frequency Limits (F2)	0	28

The pass/fail results for each of the 10 test measurement categories are presented in Table 2. Before repair, fewer than 30% of the aids could meet the electroacoustic requirements in any test category except maximum SSPL90 which was passed by 12 aids (48%). In contrast, a high percentage of repaired aids passed all categories of the electroacoustic tests except frequency range limits (F1 and F2). The repaired aids' pass rates for F1 and F2 were 44% and 28% respectively. With the exception of the F1 and F2 measures, the repaired aids had a 94% average pass rate with a range of 84% to 100% for the other eight electroacoustic test categories.

Before repair, 21 of the 25 malfunctioning aids (84%) were identified as such by the troubleshooting procedure. This finding agrees closely with Porter's (1973) troubleshooting results which detected 77% of aids with output problems. All 25 repaired aids in the present study were considered satisfactory by the subjective troubleshooting procedure.

SUMMARY AND CONCLUSIONS

The findings of this study indicate that hearing aids repaired by the manufacturer pass the majority of ANSI standards and tolerance limits although only 3 of the 25 aids studied here (12%) passed all 10 ANSI tests. Previous investigation indicated that approximately two-thirds of new hearing aids meet all ANSI electroacoustic requirements. This difference in compliance with ANSI tolerance limits for new versus repaired hearing aids suggests that hearing aid professionals need to carefully test repaired hearing aids to assure that specific electroacoustic characteristics of the repaired aid are adequate for the user. An informal troubleshooting procedure may be helpful in performing this check but is likely to be insufficient for recognizing some hearing aid problems.

REFERENCES

American National Standards Institute. (1976). *Specification of hearing aid characteristics.* New York: Acoustical Society of America.

Bess, F.H. (1977). Condition of hearing aids worn by children in a public school setting. In F.B. Withrow (Ed.), *The condition of hearing aids worn by children in a public school program* (PHS Report No. OE 77-05002). Washington, D.C.: US Department of Health, Education, and Welfare.

Gaeth, J.H., & Lounsbury, E. (1966). Hearing aids and children in elementary schools. *Journal of Speech and Hearing Disorders, 31,* 283-289.

Hodgson, W.R. (1981). Learning hearing aid use. In W.R. Hodgson & P.H. Skinner (Eds.), *Hearing aid assessment and use in audiologic habilitation* (pp. 212-225). Baltimore: Williams & Wilkins.

Porter, T.A. (1973). Hearing aids in a residential school. *American Annals of the Deaf, 118,* 31-33.

Townsend, T.H., & Olsen, C.C. (1982). Performance of new hearing aids using the ANSI S3.22-1976 standard. *Journal of Speech and Hearing Disorders, 47,* 376-382.

Warren, M.P., & Kasten, R.N. (1976). Efficacy of hearing aid repairs by manufacturers and by

alternative repair facilities. *Journal of the Academy of Rehabilitative Audiology, 9,* 38-47.
Zink, G.D. (1972). Hearing aids children wear: A longitudinal study of performance. *Volta Review, 74,* 41-51.