Hearing Aid Wear Times for Planning and Intervention in Aural Rehabilitation

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In order to provide more definitive information for planning and intervention in aural rehabilitation, reported hearing aid wear times were analyzed for 397 patients who had been fitted with their initial aids and 432 patients who had been fitted with replacement aids. The reported hours of wear were inserted into one of four hearing aid experience-employment status matrices. Each matrix was defined by five hearing loss levels and four age categories. In most comparisons, significant differences in median wear times were found within and between the four hearing aid experience-employment status patient groups. Employed patients fitted with replacement aids reported 14-16 hours of wear whether they had slight or severe hearing losses in the better ear. Employed patients receiving their initial aids and unemployed patients receiving replacement aids reported their hours of wear increased from approximately nine hours to 16 hours as hearing loss increased. Unemployed users who had received their initial fittings reported substantially less use in all five hearing loss categories. Shorter wear times were reported by those under age 50 and over 65. The medians of the 80 cells are proposed as wear time targets for planning rehabilitation programs. In addition, the 25th percentiles are proposed as thresholds for post-fitting intervention.

The use of hearing aid wear time data as an instrument for planning and intervention in rehabilitation is receiving increasing attention. As summarized by Stephens (1977), a large amount of information has been generated using scales consisting of the terms "never, sometimes, often, always". A second procedure for estimating wear time involves techniques such as Brook's (1980) measurement of battery use or Haggard's, Foster's, and Iredale's (1981) clocking of hearing aid wear times. A third procedure is to ask the patient to report the number of hours s/he wears the aid (Kodman, 1961; Carstairs, 1973; Kapteyn, 1977a; Hutton, 1980). Estimates of wear times ob-

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tained via these procedures have been used to evaluate patient variables (e.g., amount of hearing loss, employment status, age) and program variables (e.g., training in aid utilization and following-up of underusers).

Each of the above procedures for estimating wear times has identifiable strengths and weaknesses. For example, use of three or four category semantic scales is likely to facilitate evaluation of clinical variables only when the variable of interest is known to fall in the tail portion of the distribution; e.g., patients who never wear their aids. Examples of such information loss can be found in the data of Brooks (1972), Stephens (1977), and Surr, Schuchman, and Montgomery (1978). In contrast, the physical measurements of Brooks (1980) and Haggard et al. (1981) provide the best estimates of hours of wear, even though measurement of the amount of aid or battery use would be costly if done routinely on every patient. Fortunately, Brooks (1979) and Haggard et al. (1981) have reported high agreement between physical measures and reports of hours of wear by patients, except for patients who wear their aids only an hour or two a day. In addition, Hutton (1980) reported a high correlation between estimates of pre- and post fitting wear times by patients. Thus, it appears that patient estimates of hours of use can provide valid and reliable targets for planning and intervention.

Of the many variables which appear to influence hours of wear, amount of hearing loss seems to have the largest effect (Hutton, 1980; Foster, Haggard & Iredale, 1981). Hearing aid use also appears to vary according to the patient's experience wearing an aid. Thus, the data of Carstairs (1973) and Hutton (1980) show that patients with mild losses who received their initial fittings reported 7-8 hours of wear, while those with severe losses reported 14-16 hours. In contrast, replacement (experienced) users reported small increases in wear times as hearing loss increased (Hutton, 1980). Given differences in wear time of this magnitude, it appears unrealistic to use the same short term targets for initial and replacement users. On the other hand, one of the long term goals for the initial user should be to increase her/his wear time to match that of the corresponding replacement user.

Examination of other wear time data discloses a range of values which appears to further complicate their use in rehabilitation. For example, Kodman and Fein (1959) and Kodman (1961a) reported that employed, experienced hearing aid users with moderate losses wore their aids about 12 hours a day. In contrast, Kodman (1961b) found an average wear time of only three hours of unsuccessful users. Similarly, all the underusers identified by Haggard et al. (1981) reported wearing their aids fewer than 10 hours daily, and the majority for only 0-2 hours. Kodman (1961a, b) recommended follow-up for patients who report low wear times and counseling to help them cope with their problems.

Probably the most disparate wear time data comes from reports of retirees fitted with their initial aids. For patients with moderate losses, Brooks (1979)

reports only 1-2 hours of wear; Carstairs (1973), Ward, Tudor, and Gowers (1978) and Haggard et al. (1981) report 6-7 hours of use; Kapteyn (1977a) and Hutton (1980) report 9-11 hours of wear for similar patients. Like Kodman, the foregoing investigators express concern about the limited aid use by some patients and attribute their use problems to psycho-social factors (Kapteyn, 1977b). All of these investigators recommend more counseling in aid utilization. Further, they suggest that follow-up of patients who report low use will result in increased aid utilization.

The longest wear times have been reported by patients who have worn aids more than one year and who are employed (Kapteyn, 1977a; Hutton, 1980). Median wear times of 14-16 hours were found among employed, replacement users. Unemployed, initial users wore their aids 4-5 fewer hours across all hearing loss categories. Commenting on the wear time differences between initial and replacement users, Hutton (1980) recommended that rehabilitation strategies focus on problems that interfere with maximum aid wear time.

The effects of age and sex on hours of wear appear to be small. Extrapolations from the data of Carstairs (1973), Kapteyn (1977a) and Hutton (1980) indicate that people over 60 wear their aids about one hour less than those under 60. Similarly, Kapteyn (1977a) and Ward (1981) report that females wear their aids an hour a day less than males. Assuming that a smaller portion of both males over 60 and females are employed, it is probable that the one hour decrease in use by these populations results from decreased need to communicate.

The foregoing studies provide some data on the magnitude of the effects of selected variables on the amount of hearing aid wear, including successful vs. unsuccessful users, experience wearing an aid, follow-up services, employment, hearing loss, age and sex. However, in order to get an estimate of the effects on one variable, these studies usually posted, but did not balance the data on other variables. The confounding effects introduced by pooling can lead to problems in interpretation. For example, Kapteyn (1977a) reported that replacement users wore their aids 2-3 hours a day longer than did initial users. However, the replacement users in his study had greater hearing loss, which could account for their longer wear times. Similarly, the data from Ewertsen (1974) are interpreted as showing increasing aid use as age increases; however, these age increases are accompanied by increases in hearing loss. In order to provide more definitive information for planning and intervention in rehabilitation, the present investigation was designed to provide relatively independent estimates of the effect on hours of wear of four variables: hearing loss, experience wearing an aid, employment status, and age.

METHOD

Subjects

The subjects for this study consisted of 829 patients seen between February,

1977, and May, 1980, for rehabilitation counseling, audiometric testing, and hearing aid fitting and orientation. All testing was done in IAC double walled suites equipped with Grason-Stadler 1701 audiometers calibrated to ISO standards. Clinical adaptations of the method of limits were used to obtain air conduction and bone conduction data. In addition, prior to their initial appointment and approximately six weeks after the fitting of an aid and completion of the rehabilitation program, patients were mailed a questionnaire (Hutton, 1980, 1982) which contained a question about hours of daily wear. Patients who were seen 1978-80 and who did not return the Hearing Problem Inventory or HPI were sent a follow-up form.

Procedure

After the HPI was returned, audiometric and hours of wear data were entered in one of four aid experience-employment status matrices. Each of the four matrices contained data from patients who were either experienced or inexperienced in hearing aid use and who were either employed or unemployed at the time of their initial appointment. Patients who reported having no prior experience wearing an aid were designated initial users. Patients who had requested a replacement aid were considered experienced users. The experienced users had worn an aid at least one year. Each matrix contained five hearing loss levels and four age categories. The five hearing loss levels were based on the patient's air conduction average in the better ear at 500, 1000, and 2000 Hz. The levels ranged from 26 dB or less (I) to 71 dB or more (V). Patients' ages at the time the hearing aid was issued determined in which age level they were entered. The four age categories ranged from under 50 (A) to over 65 (D) years. Thus, each of the four matrices contained 20 cells which were defined by patients' hearing loss and age. Distributions were made of the date in the 80 cells. The 25th, 50th (median) and 75th percentiles were calculated for each distribution with an N of four or more.

RESULTS

Median hours of wear for each hearing loss × age cell in the four user groups are presented in Table 1. Also, the median for each hearing loss level and for each age category are given as column and row medians respectively. The N's are limited for some cells: hearing loss category I for unemployed replacement users and categories IV and V for initial users, both employed and unemployed. Results pertaining to patients in these categories must be considered tentative.

Three major trends can be seen in the data of the four user groups: (a) employed replacement users reported long wear times, typically 15 hours a day, while unemployed users reported wearing their aids substantially less (i.e., 10-14 hours a day); (b) only two patient groups, employed initial and unemployed replacement users, reported large increases in hearing aid wear times

Table 1

Median Hours of Wear for Employed and Unemployed Patients Receiving a Replacement or an Initial Hearing Aid. Numbers of Patients are Shown in Parentheses.

	Hearing Loss (dB) in the better ear					
Age	I 26 or less	II 27-40	III 41-55	IV 56-70	V 71 or more	
	Employed Replacement: N=250					
						Median*
A under 50	9.8 (9)	11.8 (22)	15.5 (20)	15.0 (13)	16.2 (7)	15.0
B 50-57	14.8 (15)	12.1 (17)	15.0 (18)	16.3 (20)	16.0 (7)	15.0
C 58-65	15.7 (9)	11.9 (20)	12.1 (32)	16.1 (14)	15.5 (8)	15.5
D over 65		8.0 (7)	15.6 (5)	15.0 (5)	14.5 (2)	14.8
Median*	14.8	11.8	15.2	15.6	15.8	
	Employed Initial: N=196					
						Median*
A under 50	9.8 (30)	9.7 (30)	11.0 (11)	14.0 (2)		10.4
B 50-57	10.2 (32)	11.9 (21)	12.5 (4)		17.0 (1)	11.9
C 58-65	10.0 (18)	12.2 (21)	10.2 (7)	8.5 (4)	15.5 (2)	10.2
D over 65	8.5 (2)	6.0 (8)	6.0 (3)			6.2
Median*	9.9	10.8	10.6	11.2	16.2	
	Unemployed Replacement: N=182					
						Median*
A under 50	16.6 (2)	8.0 (2)	13.0 (5)	14.0 (2)	13.0 (6)	13.0
B 50-57	8.5 (2)	10.0 (6)	15.8 (9)	14.5 (12)	16.0 (7)	14.5
C 58-65	5.5 (6)	11.0 (20)	10.2 (11)	15.8 (18)	16.0 (11)	11.0
D over 65		9.0 (10)	11.9 (26)	14.2 (22)	17.7 (5)	13.2
Median*	8.5	9.5	12.4	14.4	16.0	
	Unemployed Initial: N=201					
						Median*
A under 50	7.2 (11)	7.5 (6)	11.0 (2)			7.5
B 50-57	7.0 (13)	8.2 (17)	10.5 (12)	15.8 (3)	4.0 (1)	8.2
C 58-65	5.3 (17)	8.8 (39)	12.1 (18)	11.0 (6)	10.0 (1)	10.0
D over 65	14.5 (10)	8.0 (17)	10.3 (19)	7.8 (7)	12.0 (2)	10.3
Median*	7.1	8.1	10.8	11.0	10.0	

* The effects of dissimilar N's on row and column medians were minimized by calculating the medians from the cell medians.

as hearing loss increased; and (c) the wear times for all groups are longer than would be predicted from previous reports. Prior to statistical analyses of the differences in wear times between the four user groups, the medians (Table 1) were compared with the 25th and 75th percentiles in Table 2. These comparisons revealed that cells with medians of less than 9 or more than 15 hours have distributions which are skewed in opposite directions in most instances. Also, in Table 2 the matrices for replacement users show systematic decreases in interquartile ranges as hearing loss increases. Since more

Table 2

Percentiles of hours of wear for employed and unemployed patients receiving a replacement or an initial aid. The upper number in each cell is the 75th percentile for that cell. The lower number is the 25th percentile. Cells with an asterisk have an N of 3 or less. Cells with a dash have no data.

	Hearing Loss (dB) in the better ear				
Age	I 26 or less	II 27-40	III 41-55	IV 56-70	V 71 or more
Employed Replacement: N=250					
A under 50	11.8 5.8	14.0 9.2	16.3 8.0	16.2 10.8	17.1 15.2
B 50-57	16.0 8.2	14.4 9.6	16.8 10.0	17.7 15.5	16.8 13.2
C 58-65	16.0 10.2	15.5 8.3	15.7 7.8	17.2 15.0	16.5 13.5
D over 65	—	8.4 7.2	16.1 12.8	16.2 12.8	*
Employed Initial: N=196					
A under 50	14.0 4.2	15.6 6.3	15.1 8.4	*	—
B 50-57	14.7 7.0	14.1 9.6	16.5 7.5	—	*
C 58-65	13.0 6.2	14.4 9.8	14.8 6.2	14.0 5.5	*
D over 65	*	8.5 4.5	*	—	—
Unemployed Replacement: N=182					
A under 50	*	*	16.2 8.8	*	14.0 12.0
B 50-57	*	14.0 6.0	16.9 9.8	16.5 13.0	16.8 15.4
C 58-65	6.2 4.0	15.8 7.8	14.8 6.4	16.4 13.2	16.6 15.2
D over 65	—	12.0 7.0	14.8 6.8	16.4 10.8	18.1 15.8
Unemployed Initial: N=201					
A under 50	11.8 1.4	15.8 3.0	*	—	—
B 50-57	9.9 5.6	12.4 4.2	15.0 8.0	*	*
C 58-65	11.9 2.9	12.0 5.7	13.8 9.0	14.2 7.8	*
D over 65	15.7 8.2	12.1 6.1	12.8 9.2	11.6 3.9	*

Table 3

Analysis of differences in wear times attributable to employment status, or experience wearing an aid. Wilcoxin signed-ranks test using 25th, 50th, and 75th percentiles.

Patient Groups	Number of Matched Pairs	W+	Probability
Employed Replacement vs. Employed Initial	37	3.6	.001
Employed Replacement vs. Unemployed Replacement	47	3.1	.001
Employed Replacement vs. Unemployed Initial	41	5.3	.001
Employed Initial vs. Unemployed Replacement	31	0.96	.17+
Employed Initial vs. Unemployed Initial	38	2.8	.003
Unemployed Replacement vs. Unemployed Initial	35	3.5	.001

+ = not significant

than half of the cells display skewed distributions and/or hetereogeniety of variability, nonparametric statistics were selected. In order to prevent the outcome of the analyses from being determined by cells with large N's, only the 25th, median, and 75th percentiles in each cell were used; i.e., data in Tables 1 and 2. Thus, the number of matched pairs of data available for the Wilcoxin signed-ranks test ranged from a high of 47 to a low of 31. The results of the comparisons between any two user groups can be found in Table 3. It is seen that employed and unemployed replacement users reported significantly longer wear times than comparable initial users. In addition, the wear times reported by employed replacement and initial users are significantly longer than those reported by their unemployed counterparts. The only difference between the four user groups which did not meet the .01 level of significance is that between the reported wear times for employed initial and unemployed replacement users.

Experience

The influence of hearing aid experience on hours of wear can be examined by comparing the cell medians of corresponding initial and replacement users

in Table 1. There are 15 pairs of cells with medians for both initial and replacement users who are employed (upper two matrices). The median of the 15 replacement cell medians is 15.0 hours as compared to 11.0 hours for initial users. Similarly, comparisons can be made with 17 corresponding cell medians in the bottom two matrices for unemployed patients. The hours of wear median for 17 corresponding cells are 13.0 hours for replacement users and 8.5 for initial users. Thus, experienced users reported wearing their aids approximately 4 hours a day longer than initial users. This conclusion is consistent with the initial vs. replacement comparisons in Table 3, where three of four differences exceed the .01 level of significance.

Employment

The effects of employment status on hours of wear can be examined in Table 1 by the same process of comparing corresponding cell medians of employed and unemployed users. There are 19 corresponding cells containing medians for both employed and unemployed replacement users. The overall medians of the 19 cells are 15.0 hours for employed and 13.0 for unemployed replacement users. For initial users, the medians of 15 corresponding cells are 10.2 hours for employed and 8.8 hours for unemployed users. Thus, employed users wear their aids about two hours a day longer than unemployed users. This conclusion is consistent with employed vs. unemployed comparisons in Table 3, where 3 of the 4 differences exceed the .01 level of confidence.

Hearing Loss

The effects of hearing loss on wear time within each experience-employment group can be seen in Table 1 by comparing the median of each hearing loss column (I-V) with other column medians within the same matrix. As hearing loss increases from slight (I) to severe (V), the column medians for employed replacement users show only a one hour increase, from 14.8 to 15.8. The relatively constant and long hours of wear reported by employed replacement users would seem to indicate maximum hearing aid utilization. In the matrix for employed initial users, the column medians increase from 9.9 hours to 16.2 hours as hearing loss increases. For unemployed replacement users in the next matrix, the column medians increase from 8.5 hours for slight loss to 16.0 for severe loss. Thus, employed initial or unemployed replacement users with hearing losses less than 27 dB reported wearing their aid 5-6 hours less than employed replacement users in the same hearing loss category. However, for patients with hearing loss of 71 dB or more the hours of reported wear are similar. In other words, as hearing loss increases, use of aids by employed initial and unemployed replacement users tend to "catch up" to that of employed replacement users. There are a number of possible explanations as to why only employed replacement users reported long hours

of wear for all hearing loss categories. Among the apparent reasons are: (a) employed users have greater need for communication than unemployed users; (b) replacement users have learned how to maximize benefit from the aid; and (c) patients who have encountered success with their initial aid are more likely to request a replacement than those who have gained little or no benefit. Although knowledge of the relative contributions of these or other causes may be of value to those planning rehabilitative programs, it is not possible to ascertain such information from the present study. The value of such information for rehabilitation planning is also illustrated in the hearing loss medians for unemployed initial users which appear in the bottom matrix.

In 14 of 15 comparisons, the hearing loss (column) medians are smaller than the corresponding medians of the other three user groups. Further, increases in reported wear times occurred only over the lowest three hearing loss categories. Thus, reported wear time lengthened with increasing hearing loss by approximately 7 hours for the employed initial and unemployed replacement users, by 3 hours for the unemployed initial aid users, and by only 1 hour for employed replacement users.

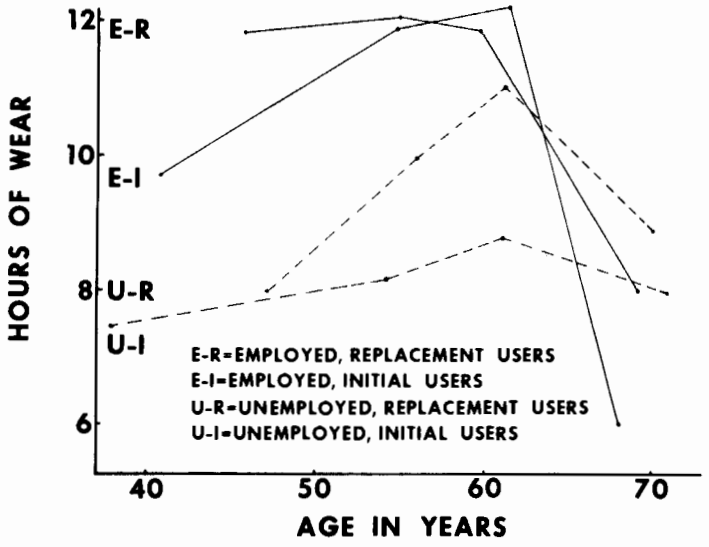

Figure 1. Reported hours of wear as a function of amount of hearing loss for four user groups (N = 829).

Examination of the increases in wear times from one hearing loss category to another across all matrices discloses that the smallest increases occur

between those with least loss (I-II) and those with most loss (IV-V). The largest increases in hours of wear occur between those with mild and moderate losses (II-III). The relationships between median hours of wear and hearing loss can also be seen in Figure 1. Overall, the curves are rising; the steepest rises are displayed by the curves for employed initial and unemployed replacement users. The curves of the employed initial and unemployed replacement users with losses of 71 dB or more rise steeply to catch up to the employed replacement users. The difference of 4-5 hours between the curves for employed replacement users and unemployed initial users suggests the necessity for separate rehabilitation planning and goals for these user groups.

Evidence of an interaction between the effects of hearing loss and experience on hours of wear was explored by comparing the magnitude of the differences between the medians of initial and replacement users. In order to quantify this interaction, a matrix was made of the differences between the cell medians of initial and replacement users. Medians of the differences were then calculated for each hearing loss category, I-V. The results were as follows:

	I	II	III	IV	V
Employed R-I	4.6	1.1	3.5	4.3	0.5
Unemployed R-I	1.5	1.4	0.2	4.8	6.0

These medians do not display a consistent increase or decrease as hearing loss increases, among either the employed or unemployed. The probability of an interactive influence by experience and hearing loss on wear times can also be examined in Figure 1. Comparisons of the initial and replacement curves show there is no consistent coming together or going apart of R-I curves as hearing loss increases. Thus, there is no evidence that differences between experienced and unexperienced users in hearing aid use decrease as hearing loss increases.

Evidence of an interaction between the effects of hearing loss and employment on hours of wear was also explored. A matrix was constructed of the differences between cell medians of employed and unemployed users. Medians of the differences were again calculated for each hearing loss category I-V, with these results:

	I	II	III	IV	V
Replacement E-U	6.3	1.5	2.2	0.9	0.2
Initial E-U	4.0	3.6	1.0	2.2	9.0

For replacement users, these data show a lessening of the differences between employed and unemployed users as hearing loss increases. For initial users, the differences decrease over the lower three hearing loss categories. Wide fluctuations are found at the highest two hearing loss categories when the Ns are small. Again, the curves in Figure 1 can be examined for systematic changes in the relationship between employed and unemployed users. In

general, the distance between the two narrows as hearing loss increases. Thus, the influence of employment status appears to be greatest at the lowest hearing levels.

Age

The effects of age on wear time can be examined in Table 1 by comparing the cell medians in the age rows. In most instances, the longest wear times are found in the rows of those aged 50-57. The next longest medians are found among those aged 58-65. The shortest wear times were reported by those over 65. When matching cells are compared, the data on 50-65 year olds consistently show wear times longer by 0.5 hours than those under 50 or over 65.

To study the combined effects of age and hearing loss on reported wear times, the medians in each age row can be compared with the medians for the next greater hearing loss. The four age rows of users under age 50 show increases in median wear times as hearing loss increases in 69% (9/13) of the comparisons. The age 50-57 rows show increases in 73% (11/15) comparisons; the age 58-65 rows in 56% (9/16); and the over 65 rows in 54% (6/11). Thus, the wear time increases accompanying increased hearing loss were smaller for older patients.

The effects on wear times of the interactions between hearing aid experience, employment status, and age are displayed in Figure 2 for patients with losses of 27-40 dB in the better ear. The curve for employed replacement users again reflects the longest wear times; the curve for unemployed initial users again shows the shortest wear times. All four curves in Figure 2 display a small peak in wear time in the fifth decade or the first half of the sixth decade, followed by decreases at higher ages. Graphs for the other four hearing loss categories show a pattern similar to the above. It is possible that the small peak and following decline reflects first an increased need, as perceived by the patient, for more effective communication after which her/his vocational and social needs diminish. Unfortunately, it is not possible to determine from the data available whether the decreases in wear times above age 65 are attributable to diminished need for communication or due to physiological changes associated with aging. It does not seem likely that the decline evident in all four curves is related to the hearing aids fitted. A wide range of aids, as described by Causey and Beck (1976) was available for trial. Selection of aids for trial was not predetermined on the basis of age or other psycho-socio-vocational factors.

Within each experience-employment group, the variability attributable to age and hearing loss were examined using the Kruskal-Wallis two way, distribution free analysis of main effects and interactions (Bradley, 1968, pp. 138-141). The percentile data in Tables 1 and 2 were used to obtain a set of rank orders for columns (hearing loss) and blocks (age) for each matrix. The resultant computations are presented in Table 4. In this analysis, the hours

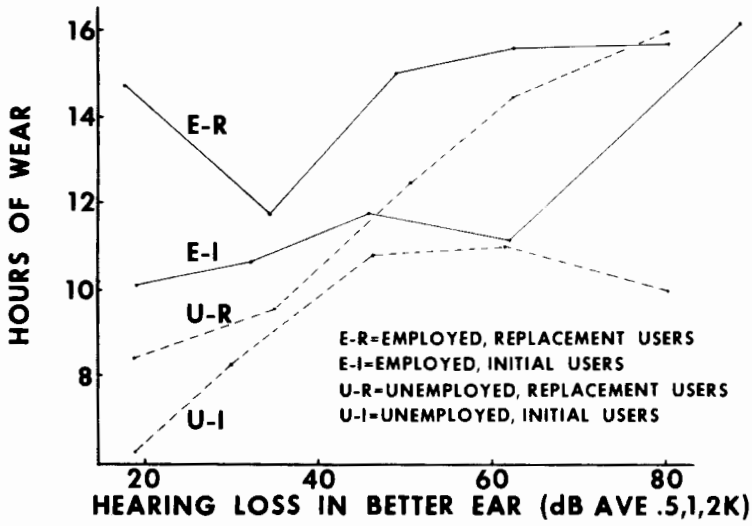

Figure 2. Reported hours of wear as a function of age for patients with losses in the better ear of 27-40 dB (N = 263).

of wear for three of four user groups were found to lengthen significantly as hearing loss increased; in the two matrices for employed users, wear times differed significantly as a function of age level. The hearing loss × age interaction was significant beyond the .05 level for three of the four matrices.

Table 4

Analysis of differences in wear times attributable to hearing loss and age. Kruskal-Wallis analysis of rank differences based on 25th, 50th, and 75th percentiles.

	Hearing Loss (df=4)		Age (df=3)		Interaction (df=12)	
Patient Group	**Chi Square**	**Probability**	**Chi Square**	**Probability**	**Chi Square**	**Probability**
Employed						
Replacement	10.9	.03	8.2	.03	26.1	.01
Initial	8.5	.07+	7.4	.05	23.7	.02
Unemployed						
Replacement	10.7	.03	7.0	.06+	29.8	.01
Initial	9.3	.05	1.8	.68+	14.9	.25+

+ = not significant

Dispersion

Systematic differences in the skewness of the distributions and in the amounts of variability as a function of wear times can be seen by comparing the data in Tables 1 and 2. When the cell medians in Table 1 are less than 9 hours, they are closer to the 25th percentile. In other words, the tail of the distribution is skewed toward the high end. For medians between 9 and 15 hours, the distributions are generally symmetrical. When the medians are longer than 15 hours, the skewness tends to be reversed, i.e., toward the low end. In addition, variability is decreased. These generalizations are illustrated in Figure 3 for two user groups. In the upper display, the medians are closest to the 75th percentile in four of five comparisons. In the lower

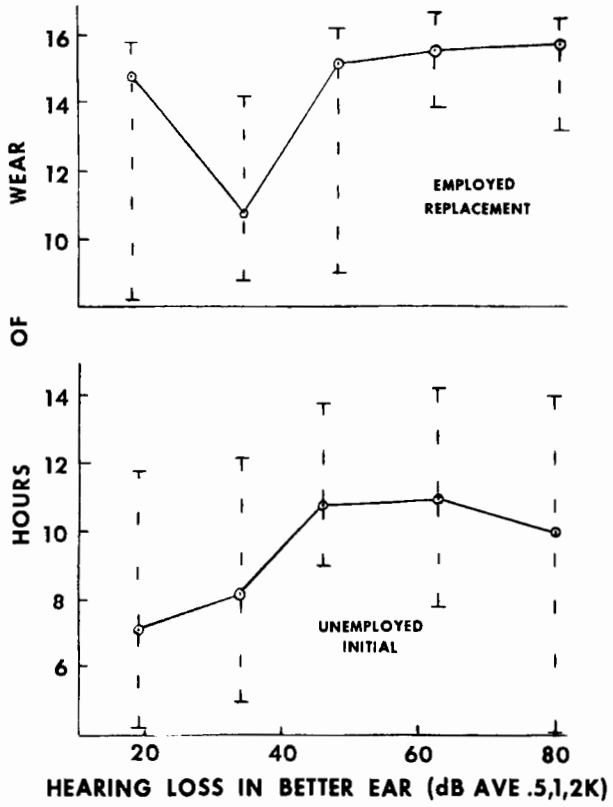

Figure 3. Interquartile ranges of employed replacement and unemployed initial hearing aid users for each of five hearing loss categories. Each vertical line contains the 25th percentile (lower bar), median (circle), and 75th percentile (upper bar). Ns for hearing loss category I are 33 (ER) and 51 (UI); for category II 66 (ER) and 79 (UI); for III 75 (ER) and 51 (UI); for category IV 52 (ER) and 16 (UI); and for category V 24 (ER) and 4 (UI).

display, only one median is closer to the 75th percentile. The explanation for this contrast appears to be the difference in wear times between employed replacement and unemployed initial users. In addition to the difference in skewness, variability is seen to decrease at the highest two hearing loss levels for employed replacement users, but not for the unemployed initial users. Thus, three-fourths of the cells within a range of six hours or less are found among replacement users. Of the cells with ranges of eight hours or more, three-fourths appear in the cells of unemployed users.

In this study, significant differences in median hours of wear were found in five of six comparisons between four hearing aid experience-employment status groups. Employed patients fitted with replacement aids reported the longest wear times: 14-16 hours a day. Employed patients fitted with initial aids and unemployed patients fitted with replacement aids reported 9-10 hours of wear for those with slight loss in the better ear, increasing to 16 hours for those with severe loss. Unemployed patients fitted with their initial aids reported only 7 hours wear (slight loss) to 10 hours (severe loss). Thus, reported wear times increased significantly as hearing loss increased, except for employed replacement users. Shorter wear times were reported by those under age 50 and over age 65. Patients fitted with replacement aids exhibited less dispersion than users fitted with their initial aids. Finally, most of the wear times found in this study are substantially longer than those previously reported.

DISCUSSION

Until now, the lack of a systematic body of wear time data may account for the limited use of this information as a tool for planning and intervention in rehabilitation. In this study, the magnitude of the differences between the four user groups as well as the differential effects of hearing loss and age make clear the need to incorporate these variables in tables of wear time targets. Also, analysis of previous data in this "matrix of medians" framework can facilitate comparisons between different groups of patients.

Hours of wear data from patients who appeared to be mainly employed, replacement (experienced) users were extrapolated from six other studies for comparison. The mean or median wear times from these six studies, which are presented in Table 5, are all shorter than the corresponding cell medians from the present study. The median wear time for the six studies is 10.9 hours and for the corresponding 6 cells in the present study 13.4 hours. The 6 studies parallel the finding in the present study relating to amount of loss in that the four samples with the most loss contain the longest wear times.

Data pertaining to employed initial users were identified in only one other study. Kapteyn (1977a) reports 13 hours of use in comparison to our median of 11.0 hours. The reason for the lack of additional data is that most investigators have waited for more than a year to follow-up employed initial users.

Table 5

Comparisons of mean and median wear times reported in previous studies and in the present study.

HL & Age Cell*	Previous Studies	Present Study*
	Employed Replacement	
I B	8.8 (3)	14.8
II B	4.5 (1)	12.1
III A	13.0 (2)	15.5
III A	11.9 (4)	15.5
III C	11.8 (5)	12.1
III C	10.0 (6)	12.1
	Employed Initial	
III A	13.0 (2)	11.0
	Unemployed Replacement	
I B	8.8 (3)	8.5
III C	11.8 (5)	10.2
IV C	12.0 (2)	15.8
V D	13.0 (2)	17.7
	Unemployed Initial	
III D	9.0 (2)	10.3
III D	11.0 (2)	10.3
III D	7.4 (7)	10.3
III D	6.3 (8)	10.3
III D	6.1 (9)	10.3
IV D	2.1 (10)	7.8
IV D	8.2 (11)	7.8

* from Table 1.

1. Lund and Hoyvik (1979)
2. Kapteyn (1977a)
3. Gelfand (1979)
4. Kodman & Fein (1959)
5. Kodman (1961b)
6. Kodman (1961a)
7. Ward et al. (1978)
8. Ward (1981)
9. Haggard et al. (1981)
10. Brooks (1979)
11. Carstairs (1973)

In contrast, unemployed initial users tend to be seen again rather soon after receiving their aids.

Wear times for unemployed replacement users were found in four studies, The median of these four is 11.9 as compared to 13.0 for the four matching cells. Again, wear times are seen to increase as hearing loss increases.

The largest amount of data available relate to unemployed initial users. The median of the seven previous reports is 7.4 hours and for the present report is 10.3. Thus, in the two user groups for which the largest number of

comparisons are available, the wear times from the present study are typically 2-3 hours longer. Supportive evidence for greater utilization can be found in the fact that the number of initial users who reported zero hours of wear was only 7 out of 397; the number of replacement users reporting zero hours was 1 of 432.

The reasons for the longer hours of wear found in the present study may be attributed to: (a) the wide range of aids used by patients in this study; (b) improved acoustical characteristics of aids used in this study as compared to those used in earlier studies; and (c) the larger amount of time allotted for a comprehensive rehabilitation program. Brooks (1972), Stephens (1977)[1], and Ward, et al. (1978) are among those who have commented on low usage in Britain. Brooks attributes this finding mainly to the fact than only body aids were available to NHS personnel for fitting. Stephens (1977), and Ward et al. (1977) attribute low wear to limitations in NHS follow-up services. However, Stevenson and Dowtrey (1980) did not find any substantial differences in use by NHS and private users in Britain. The large body of wear time data recently reported by Kapteyn (1977a) is compatible with the hours of wear reported by patients in this study. In the six comparisons found in Table 5 the medians in the present study differ from the means of Kapteyn (1977a) by less than 1 hour. One explanation for this close agreement between the two studies may be the similarities in the three factors noted above (wide range of aid models, improved acoustical properties, comprehensive rehabilitation program).

As previously stated, wear times for unemployed initial users are consistently less than those of the other user groups. Also, initial users do not show the systematic decrease in dispersion displayed by the replacement users. The fact that the unemployed initial users fall short of the other groups at the two highest hearing loss categories can be interpreted as a need for a more effective rehabilitation program for these patients. The data in this report also suggest that employed initial users would profit from a rehabilitation program designed to decrease the time needed to catch up to employed replacement users. A large number of American and European investigators have called for more comprehensive rehabilitation programs including: (a) counselling the patient and family prior to fitting an aid; (b) training in care and utilization of the aid under a variety of conditions; and (c) follow-up of post-fitting problems.

The wear time differences between the employed and unemployed may be a reflection of their differences in need for communication. Brooks (1972) states that use is based in part on fulfillment of patient needs. The retired

[1]Stephens' (1977, p. 393) statement that "the results of a US Government study made in the early 1960s indicate that only 28.7% of patients who have ever used a hearing aid continue to use them" is backwards. The report cited by Stephens states that approximately 1,214,000 persons had ever used an aid . . . (and) that 882,000 were (still) using them.

person who lives alone may communicate infrequently with others, and thus has less need for amplification than a salesperson whose livelihood depends on her/his ability to communicate. Haggard et al. (1981) reported that patients' life-styles have significant influences on hours of use. For example, it is possible that the communication needs of replacement users are greater than those of initial users. At the present time we can only speculate about the causes of the differences in wear times between initial, replacement, employed, and unemployed users. Clearly, benefit from hearing aids is a multidimensional concept influenced by psycho-social factors (Kapteyn, 1977b) and employment status. Therefore, the relationship between benefit and an undimensional scale; e.g., hours of wear is likely to be complex.

Haggard et al. (1981) state that there are few alternatives to using wear time as a measure of outcome. Therefore, it is proposed that smoothed out versions of the medians in Table 1 be used as first approximations of minimum wear time goals. Cell selection would be based on the patient's experience wearing an aid, employment status, the amount of her/his hearing loss, and age. The patient's minimum wear time goal would be used by the clinician as the central theme of the rehabilitation program. For the replacement user whose daily wear time in the past has been lower than the minimum goal, an intervention program could be planned to identify and modify the factors which interfere with maximum hearing benefit and utilization.

Not only does it appear to be appropriate to use wear time medians as rehabilitation targets, but also it appears appropriate to establish a set of minimum wear times. Precedence for this can be found in the data of Kodman (1961a) for unsuccessful users and in Haggard et al. (1981) for underusers. In both of these studies, follow-up is recommended when post-fitting wear times are low. The unsuccessful users (Kodman) reported 0-7 hours of wear; the underusers (Haggard et al.) reported 0-10 hours of wear, depending on lifestyle. In this latter study, 26% of the patients reported wear times which were less than those projected from their lifestyles. On this basis, the 25th percentiles of the data in the present study were used to estimate minimum wear times which appear as Table 6. These proposed criteria for post-fitting intervention range from 3 hours for certain unemployed initial users to 15 hours for certain employed replacement users. Again, to find the threshold for intervention, it is necessary to identify the cell corresponding to the patient's hearing aid experience, work status, hearing loss, and age. The effects, if any, of other psycho-socio-vocational factors would be subtracted from this value. The resulting value would constitute a criterion for follow-up. As with other criteria for post-fitting intervention, when the wear time reported by the patient fails to meet this pre-determined value, the patient's folder is referred to her/his clinician for follow-up (Hutton, 1982). Use of 25th percentiles for post-fitting intervention would provide a tool not heretofore available to clinicians.

Table 6

Proposed minimum hours of wear for post-fitting intervention. Data based on interpolation of 25th percentiles derived from patient reports six weeks after fitting.

	Hearing Loss (dB) in the better ear				
Age	I 26 or less	II 27-40	III 41-55	IV 56-70	V 71 or more
Employed Replacement: N=250					
A under 50	6	8	10	12	14
B 50-57	8	9	10	13	15
C 58-65	8	9	10	12	15
D over 65	6	7	8	11	13
Employed Initial: N=196					
A under 50	5	6	8	11	13
B 50-57	7	8	9	12	14
C 58-65	6	8	9	12	14
D over 65	6	7	8	10	12
Unemployed Replacement: N=182					
A under 50	5	6	8	11	12
B 50-57	6	7	9	12	14
C 58-65	5	7	9	12	14
D over 65	5	6	8	10	12
Unemployed Initial: N=201					
A under 50	3	4	6	9	11
B 50-57	4	5	7	11	13
C 58-65	4	5	7	9	13
D over 65	3	4	6	7	8

The data obtained in this study demonstrate that if hours of wear are used in rehabilitation programs, certain characteristics of the patient must be matched or equated. This step can be achieved by using matrices of wear times which make it possible to match the characteristics of the patient with the parameters of the matrix. Another approach would be to construct an equation which contains these parameters. In either case, in order to use hours of wear as a rehabilitation goal or for post-fitting intervention, it is necessary to take into account the patient's experience wearing an aid, the amount of her/his hearing loss, employment status, age and other psycho-socio-vocational factors which can be quantified. Finally, it should be emphasized that the results, interpretations, and proposed utilization of the data presented are limited by the fact that 15 of the 80 cells have an N of 3 or less and an additional 8 cells contain no data. Until more data can be collected, especially for initial users, the findings of the present study must be

considered tentative. Also, further research may provide additional insight into the reasons why some patients are able to wear their aids for long periods each day while other patients wear their aids for only short periods several days a week.

SUMMARY

Data on hearing aid wear times were abstracted from a questionnaire routinely mailed to patients six weeks after being fitted with a hearing aid. Reports from 829 patients were inserted into one of four matrices in order to examine the influence of experience wearing an aid and employment status on hours of wear. Each matrix contains 20 cells defined by five hearing loss categories and four age levels.

Significant differences in wear times were found between the four hearing aid experience-employment status patient groups. Employed patients who had been fitted with replacement aids reported wearing their aids 14-16 hours. Employed patients receiving their initial aids and unemployed patients receiving replacement aids reported median wear times of 9-10 hours for those with slight loss in the better ear increasing to 16 hours for those with severe loss. Unemployed patients receiving their initial aids reported 7 hours of wear for those with slight loss and 10 hours for those with severe loss. Thus, within each of the four user groups, the influence of hearing loss on wear times varied substantially. Shorter wear times were reported by those under age 50 years and over 65. Most of the median wear times in the four user groups are longer than those previously reported.

It was advocated that the medians for each hearing loss × age cell within each of the four employment aid experience groups be used as tools for planning rehabilitation programs. In addition, it was proposed that the 25th percentiles be used as thresholds for post-fitting intervention.

Due to the fact that 23 of the 80 cells contain little or no data, the findings and conclusions of this report must be considered tentative.

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