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### **Paper:**

Arthur, J., Jones, P., Davies, R., Julie, S. & Watts, T. (2017). An analysis of hearing aid use: Data-logging as an adjunct with the Glasgow Hearing Benefit Profile Questionnaire. *Journal of the Academy of Rehabilitative Audiology*, 48, 27-33.

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## **An Analysis of Hearing Aid Use: Data-logging as an Adjunct with the Glasgow Hearing Benefit Profile Questionnaire**

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### **Abstract**

#### **Introduction**

There is significant variability in the ways in which hearing aid use is reported. In part, this is because there is no agreed method of reporting hearing aid use. A recent review by Perez and Edmonds (2012) concluded that a dual-stage approach using data-logging and self-reported outcome measures is preferable to an approach that uses one method alone. A dual-stage approach may provide a comprehensive understanding of hearing aid use and help further develop a detailed understanding of some of the problems associated with non-use or under-use.

#### **Objective**

This study aimed to compare the relationship of self-reported hearing aid use using the Glasgow Hearing Aid Benefit Profile questionnaire (GHABP; Gatehouse, 1999) to hearing aid data-logging information, and to establish whether the GHABP can be used to accurately measure hearing aid use.

#### **Methods**

This was an observational cohort study conducted in Wales, United Kingdom. A total of 119 participants were recruited at their hearing aid follow-up appointments. The length of time between hearing aid fitting and follow-up was variable. With participants' consent, data were collected using the Glasgow Hearing Aid Benefit Profile part 2 questionnaire and data-logging information stored in the hearing aid. Correlational analyses were used to assess the relationships between the two measures of hearing aid use.

#### **Results**

Mean data-logging use was 5.87 hours per day ( $SD=5.15$ ) and the mean GHABP use was 67.34% ( $SD=32.98$ ). Both "use" variables failed a Shapiro Wilks test of normality. There was a strong positive Pearson rho correlation between data-logging use and GHABP use ( $r_s = .645, p < 0.01$ ). Analysis of the GHABP questionnaire revealed that 53 participants stated that they used their hearing aids between 81% and 100% of the time. There were some low levels of use when examining data-

logging in the context of variable GHABP results.

#### **Conclusions**

In participants who present higher GHABP use scores with lower levels of data-logging use, some plausible reasons include: 1) Inadvertent overestimation of their use by patients (recall error), 2) The GHABP questionnaire may not be sufficiently sensitive or structured in such a way to effectively measure use. For example, "listening in a quiet environment" is not captured in a GHABP question, or 3) The reporting of use as a percentage may not be an appropriate measure of use. For this reason, in keeping with Perez and Edmonds (2012), both self-reported measures of use and data-logging should be used together and audiologists are reminded to consider both measures with some level of caution.

### **Introduction**

In Wales, United Kingdom all National Health Service (NHS) audiology departments adhere to the Scottish Government's Quality Standards for Adult Hearing Rehabilitation Services (2008). These standards were jointly developed by Scottish and Welsh audiologists and have been mandated by the Welsh Government with a view to improving hearing aid services. These standards are important in Wales as they underpin successful hearing rehabilitation and can measure whether additional rehabilitative support is required. Although the detail of these standards are beyond the scope of this paper, a key point is that a validated outcome measure, for example, the Glasgow Hearing Aid Benefit Profile (GHABP; Gatehouse, 1999), the International Outcome Inventory for Hearing Aids (IOI-HA; Cox & Alexander, 2002) or the Client Orientated Scale of Improvement (COSI; Dillion, James, & Ginis, 1997) should be

used to evaluate the outcome of the hearing aid intervention. The selection and implementation of appropriate rehabilitative interventions and improved patient outcomes requires detailed understanding of subjective and objective hearing aid use. It has been suggested that a dual-stage approach employing self-reported outcome measures conjoined with objective measures should be used in the investigation of hearing aid use (Perez & Edmonds, 2012). The purpose of this study was to compare the effectiveness of self-reported hearing aid use using the Glasgow Hearing Aid Benefit Profile questionnaire (GHABP; Gatehouse, 1999) with data-logging information and to establish whether the GHABP questionnaire can be used to accurately measure hearing use as a percentage score. The study employed a dual-stage approach for measuring hearing aid usage. The GHABP was selected as it was originally developed to measure patient and service centred effectiveness.

### Literature Review

Low use and non-use of hearing aids amongst adults is a long standing concern. Dawes, Maslin and Munro (2014) suggested that low use of hearing aids has not changed for over 30 years. McCormack and Fortnum (2013) recently suggested that factors surrounding low or non-use may include complex psychosocial issues, situational issues and device stigma, perceived value of the device and health professionals' attitudes towards hearing aids. Further evidence suggests that low use and non-use are not solely related to the effectiveness of the devices, and recently it has been suggested that satisfaction with the devices can be linked to use (Williger & Lang, 2015). Hearing aid interventions are generally highly effective and may improve health related quality of life (HRQoL) but, some hearing aid users do not always use them consistently with some never using them (Chisolm et al., 2007).

### Data-Logging

The data-logging concept originated with the work of Mangold and Rising, (1990) and Mangold, Ringdahl and Eriksson-Mangold (1993). It has been suggested that data-logging has four primary uses in relation to hearing rehabilitation: 1) Explaining the benefit of the process during the initial hearing aid fitting, 2) In follow-up counselling in conjunction with patient reported outcome measures and real ear measurements, 3) Using information in trouble shooting to help solve problems, and 4) Changing the fittings, such as deleting unwanted programmes or altering gain or the frequency response of the hearing aid.

### Hearing Aid Use and Data-Logging

Several international studies have analysed hearing aid

use through data-logging and self-reported measures. Gaffney (2008) found that self-reported usage (measured retrospectively using a series of questions) was reasonably consistent with data-logging use. Overall, there were significant correlations between self-reported use and data logged use even though half of the participants were new and inexperienced hearing aid users. These findings are supported by a recent study conducted in the Netherlands using a group of 228 participants (Laplante-Lévesque, Nielsen, Jensen, & Naylor, 2014). The average daily use was approximately 10.8 hours per day and the researchers identified 2 types of users — “regular” users who used their hearing aids for between 12 and 20 hours each day, and “on off” users who regularly switched their hearing aids on and off during the day. The “on off” users generally gave less accurate reports of use, which resulted in a lower daily use. However, findings reported by Taubman, Palmer, Durrant and Pratt (1999) were quite different. They conducted a smaller study with experienced hearing aid users. The participants ( $n=24$ ) were split randomly into 2 groups. The experimental group was informed that their self-reported estimation of use would be confirmed by a computer (data-logging), whereas the control group was not given that information. The experimental group reports were more accurate than the control group and there was a statistically significant difference between the two groups. However, there was both an overestimation and underestimation in the self-reported hearing aid use in the control group. Other studies by Maki-Torkko, Roine, and Laukli (2001) and Humes, Halling, and Coughlin (1996) found that around one-third of participants rarely used their hearing aids. This supports the work of Perez and Edmonds (2012) who concluded that both objective and subjective hearing aid measures are required to measure usage accurately.

### Method

This was an observational cohort study, conducted in an the audiology department within a district hospital in Wales, UK and sought to compare GHABP (Gatehouse, 1999) scores with data-logging scores in hearing aid users. Ethical approval was granted by the South Wales Ethics Committee (reference 13/WA/0001). Eligible participants included patients who had been fitted initially with either a GN Resound Danalogic IFIT71 or an IFIT81 digital hearing aid and had not worn hearing aids previously. At their initial hearing aid fitting, real ear measurements were carried out to a prescription of National Acoustical Laboratories, Non-Linear 1 (NAL-NL1). In addition, the participants were given standard advice regarding hearing aid use and care, and part I of the GHABP was administered.

The GHABP is a two-part validated patient reported outcome measure that may be used to assess the success of hearing aid interventions. The GHABP measures self-reported auditory disability and handicap in part 1. In part 2 the questionnaire measures hearing aid use, benefit, satisfaction, and residual disability. Specifically, the GHABP examines patients' responses in four pre-defined situations: 1) Listening to television when with other family or friends when the volume is adjusted to suit the other people, 2) Having a conversation with one other person when there is no background noise, 3) Carrying on a conversation in a busy street or shop, and 4) Having a conversation with several people in a group. Patients are asked to answer "yes" or "no" to having difficulty in hearing in each of these listening environments. If patients answer "yes", they are then asked to grade how much difficulty they have in that situation from 'not applicable', 'not at all', 'only a little', 'a moderate amount', 'quite a lot', through to 'very much indeed'.

The GHABP is flexible enough to make additional, customised scenarios specific to individual patient listening needs. It also examines the extent of difficulty experienced by a patient, which corresponds to overall disability and the subsequent impact on a patient's life. The impact on a patient's life will correspond with level of handicap experienced by the patient. This section of the questionnaire is usually completed either before the hearing aid fitting or at the first contact when the hearing assessment takes place. At the follow-up appointment, the above questions are asked again, to measure the effect of the hearing aid and its real-life benefits. It should be noted that the GHABP does not appear to cover all listening options, such as listening to the television in quiet environments, or listening in situations where there is very little sound. The use measure is given in a percentage scores and for some situations could be problematic because the exact meaning of 100% use could be questioned. Essentially, it could mean using the hearing aid when the patient requires help with their hearing in the standard or customised listening scenarios.

Eligible participants were selected chronologically from the waiting list for hearing aid appointments. The length of time between hearing aid fitting and follow-up was variable due to service demands. Information about the study together with an invitation to participate was sent with the appointment letters. This study information advised participants that information stored in the hearing aid (data-logging) would be extracted from the hearing aid at the appointment for the study. A total of 119 people, with both monaural and binaural hearing aids, agreed to participate. At the follow-up appointment with an audiologist, and with the participants' consent, the hearing aid data-logger was

examined to collect the average hours of use per day. If the participant wore binaural hearing aids, the data-logging variable was derived by averaging the right and left data-logging figures. In addition, the GHABP part 2 questionnaire was completed to establish use in percentage.

Data analyses included non-parametric correlations and descriptive statistics.

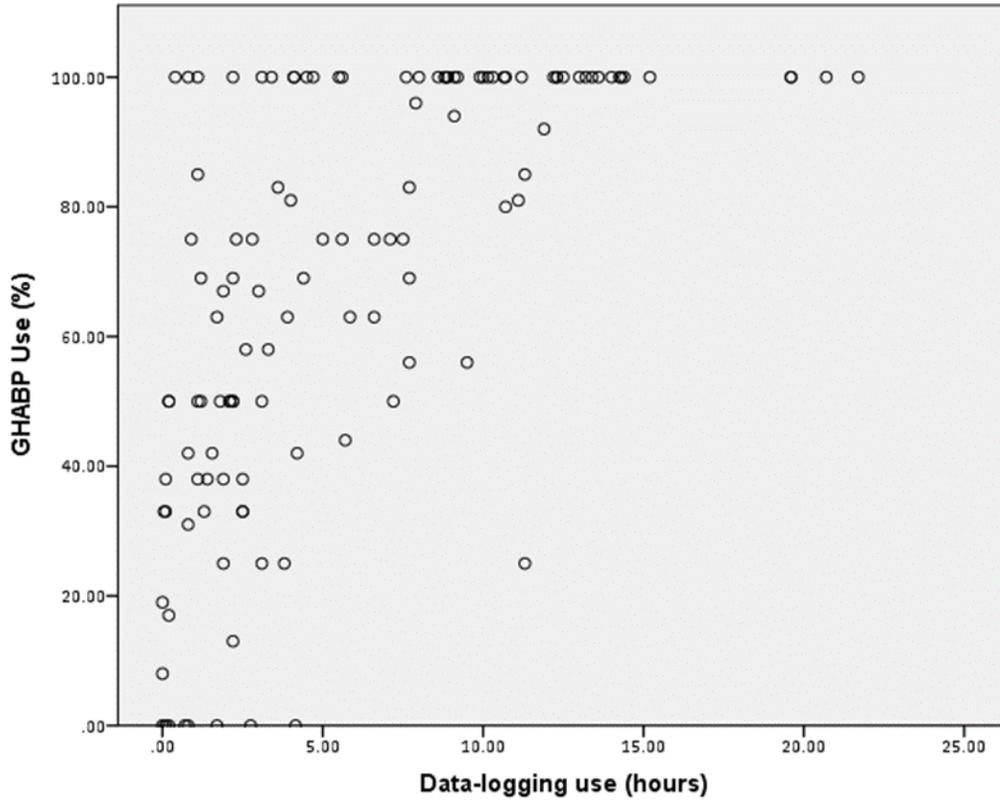
## Results

Of the 119 participants, 57 were female and 62 were male. The mean data-logging use was 5.87 hours per day ( $SD=5.15$ ) and the mean GHABP use was 67.34% ( $SD=32.98$ ). Both use variables failed a Shapiro Wilks test of normality. There was a strong positive Pearson rho correlation between data-logging use and GHABP use, which was statistically significant ( $r_s = .645, p < .01$ ). Figure 1 shows a scatterplot of the self-reported hearing aid use (GHABP) versus average daily use from the data logs ( $n=119$ ). Forty-four participants reported using their hearing aids for 100% of the time and 9 participants reported using their hearing aids for 0% of the time according to the GHABP. Closer inspection of the data showed that only 1 of the 9 participants who reported 0% use with the GHABP had a recorded data-logging use of 0 hours. Among the 44 participants who reported 100% use, the associated data-logging mean was 9.94 hours ( $SD=5.27$ ), with a maximum of 21.70 hours and a minimum of 0.40 hours.

As can be seen in Figure 1, there was a general positive relationship between the two variables. There also are a number of observations that require comment. First, the participants with 100% GHABP scores are displayed at the top of the graph. These participants stated on all GHABP questions that they wore their hearing aid constantly. Second, there are three data points to the top right-hand corner of the scatter graph. These participants stated on the GHABP questionnaire that they wore their hearing aids constantly, and the associated data-logging scores were equally very high. Third, there is one outlier on the bottom end of the scatterplot for whom the GHABP score was low and the data-logging score was higher than expected.

Table 1 shows the data-logging results with the GHABP use scores separated into five separate groups. The table shows the associated data-logging information, such as mean, maximum, minimum, range, standard deviation, variance and the total number of participants in the group. These results are displayed even more diagrammatically in Figure 2.

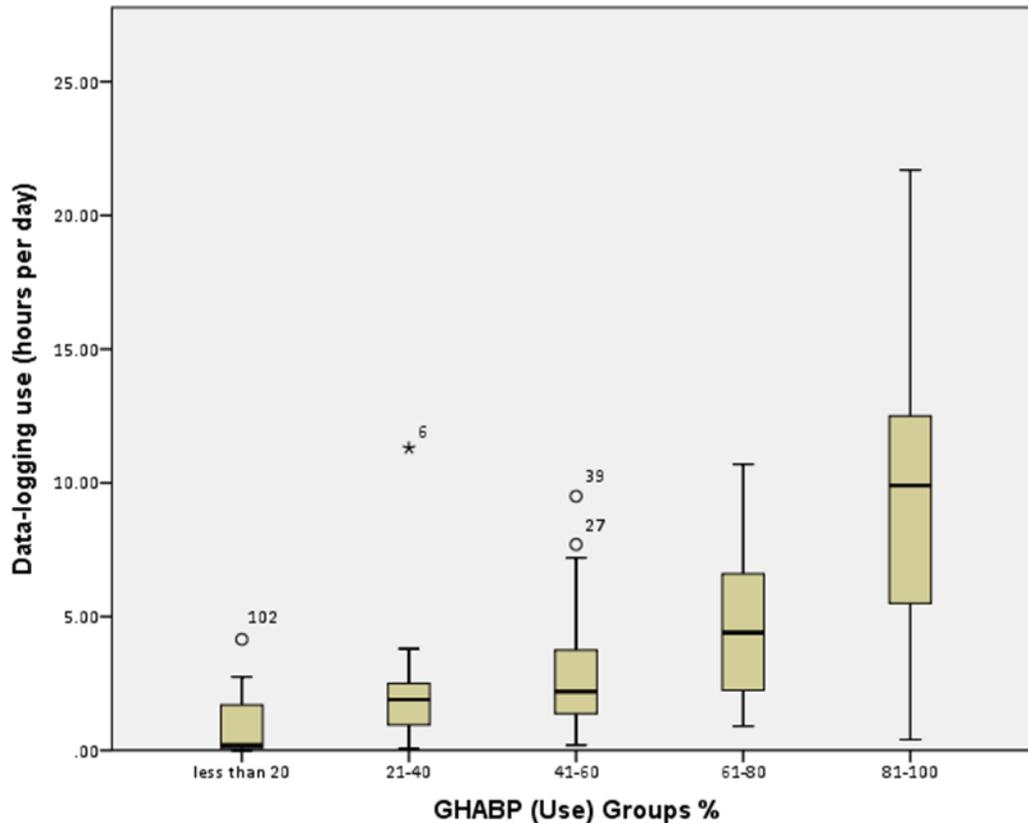
Figure 2 shows grouped hearing aid use as measured using GHABP versus hearing use as recorded by the data-logger. Over half the participants used their hearing aids from



**Figure 1. Scatterplot of data-logging versus the GHABP (Use)**

**Table 1. GHABP (Use) groups and related data-logging statistics**

Data-Logging Use (hrs per day)	GHABP Use Groups %				
	< 20	21-40	41-60	61-80	81-100
Mean	0.99	2.29	3.09	4.58	9.54
Maximum	4.15	11.30	9.50	10.70	21.70
Minimum	0.00	0.05	0.20	0.90	0.40
Range	4.15	11.25	9.30	9.80	21.30
Standard Deviation	1.32	2.73	2.63	2.69	5.11
Variance	1.75	7.47	6.92	7.25	26.10
Total N	13	15	19	19	53



**Figure 2. Box and whisker chart showing grouped percentage GHABP scores versus data-logging**

between 0 and 5 hours per day, and 4 participants used their hearing aids from between 20 and 24 hours per day. This extended use may be due to leaving the hearing aids on even when not in use.

### Discussion

This study sought to measure hearing aid use in participants who recently had been fitted with hearing aids. A total of 119 participants were recruited during hearing aid follow-up clinics. We used two ways of measuring hearing aid use. The first was self-reported use with the GHABP questionnaire and the second was information recorded by the hearing aids (data-logging). This study showed a very good association between GHABP use and data-logging use ( $r_s = .645, p < 0.01$ ). Of interest is that the relationship was calculated between different units — percentage of use in various listening environments, with average hours of use. When participants reported 100% use on the GHABP it was important to understand the limitations of this result because 100% use did not always correspond with the data-logging results in this group of participants. Regardless of the

methodological limitations, and based upon the correlational analysis, the findings reported here correspond with those reported by Gaffney (2008). However, some participants clearly over-estimated use with the GHABP as compared to the data-logging information. It is possible that these participants were the “on/off” type of hearing aid users described by Laplante-Lévesque et al. (2014). Forty-four participants reported 100% use time with the GHABP with an associated mean data-logging use of 9.94 hours, but there was some variation in the data-logging use. For example, one participant reported 100% use but the data-logging use was just 0.4 hours, indicating minimal use. The mean data-logging use was in keeping with the results of Laplante-Lévesque et al. (2014) who reported a mean of 10.8 hours per day. Furthermore, in Figure 1 there were few outliers, demonstrating a good association between the two variables. However, Table 1 shows the data-logging descriptive statistics per GHABP groupings, and it can be seen from the standard deviations and ranges that there was more variability in self-reported use in the groups with lower data-logging hours. Table 1 also is concerned with separating the data-logging

information relative to GHABP use groups, for example, < 20%, and 21 to 40%. The largest group was the 81-100% group with 53 participants. The remaining groups included 13, 15, 19 and 19 participants in the <20%, 21-40%, 41-60% and 61-80% groups respectively, suggesting that participant reports of use with the GHABP questionnaire was high. It likely was that participants who reported higher levels of use with the GHABP and lower levels of data-logging may have needed extra rehabilitative input or further counselling. For example, they may have benefited from further discussion of the results of these measures. Another factor to consider is that some participants may have needed their hearing aids only for watching television, and meeting that need may have satisfied a 100% criterion for the GHABP questionnaire. Yet, the associated level of use could have been 5 hours, for example, when measured with data-logging.

### Conclusions

This work showed the potential of the data-logging feature on hearing aids to assist with hearing aid fitting and rehabilitation. The initial aim of this research was to compare GHABP scores with data-logging scores in a cohort of hearing aid users that had recently been fitted with hearing aids. The two measures generally correlated well as there was a good association between them. However, there were some participants who reported a high overall level of use with the GHABP, but the associated data-logging use was relatively low. In general, there were a high number of participants who reported using their hearing aids for 81-100% of the time ( $n=53$ ).

However, it also is important to consider the auditory environment in which hearing aid users find themselves. Life-styles vary considerably, which in turn impacts on the demands made of the hearing aid. As an example, a hearing aid user working in a quiet office would have different demands than someone working in a busy public place. Also, people may choose not to use their hearing aids when alone, even for listening to music or watching the television, preferring instead to raise the volume of the appliance. In participants who present higher GHABP use scores with lower levels of data-logging use, we suggest some plausible reasons: 1) Inadvertent overestimation of reported use (recall error), 2) The GHABP questionnaire may not be sufficiently sensitive or it may not be structured in such a way to effectively measure usage. For example, "listening in a quiet environment" is not captured in a GHABP questionnaire, or 3) The reporting of usage as a percentage may not be an appropriate measure of use. For this reason, we suggest that, in keeping with the reports of Perez and Edmonds (2012), both self-reported measures of use and data-logging should

be used together and that audiologists are reminded to consider both measures with some level of caution. Where appropriate audiologists should always look to establish whether there has been a reduction in hearing disability and handicap and specifically, in the context of use for this would be central to hearing rehabilitation. We suggest that further research is needed to determine the optimum way of assessing use, benefit and patient satisfaction and that a standard technique could be derived. This might include further qualitative approaches aimed at seeking patients' views and perspectives on hearing aid usage.

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### **Acknowledgments and Declaration of Interest**

This research was part supported by a research grant from Cwm Taf University Healthboard. The authors report no conflicts of interest. We would like to acknowledge two anonymous reviewers who reviewed the original manuscript for their helpful comments.

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