Title page

Title: How successful is the fitting of digital hearing aids? Implications for the allocation of resources within national health systems.

Running Title: Success rate and cost-effectiveness of digital hearing aid fitting.

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How successful is the fitting of digital hearing aids? Implications for the allocation of resources within national health systems.

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Abstract

Aim: To determine the success rate of initial fittings in digital hearing-aid (dHA) users. Implications for their continuing provision through national health systems are also addressed.

Materials/Methods: 1597 consecutive adult patients, who underwent first/new fittings of behind-the-ear dHAs within 1 year, were identified using the Practice Navigator™ tool. All nominal reprogram appointments which took place up to 6 months from the initial fitting of each patient were further assessed.

Results: 460 (28.8%) nominal reprogram appointments were identified. 419 were for routine "normal" reasons (i.e. further hearing loss, faulty/lost HAs, poor hearing, problems with speech-in-noise, unbalanced function between two HAs, uncomfortable loudness). Only 41 first/new fittings (2.5%) were considered less than acceptable/not satisfactory to patients on the basis of findings/actions at their reprogramming appointments.

Conclusion: dHA fitting was found generally successful, as the majority of patients (71.2%) did not require any follow-up appointment in the period studied. However, a significant percentage of patients were not satisfied requiring a follow-up appointment. Cost-effectiveness principles dictate the maximum practicable efficiency in the utilisation of resources, to ensure the continuous delivery of high-quality audiological services through national health systems in the future. This may be achieved through group appointments, in order to reduce the associated costs, and increase the time allocated for fitting and training of patients.

Key-words: digital, hearing aid, hearing loss, amplification, cost-effectiveness

Introduction

Sensorineural hearing loss (SNHL) is an insidious and potentially devastating chronic condition, which may have a serious impact on both physical and social function of the affected individuals [1]. Hence, the importance of SNHL treatment is well-acknowledged and the restoration of normal hearing has been intensively pursued. Although gene manipulation and stem cell therapy represent exciting new alternatives in the treatment of SHNL, which can favourably modify the biology of hearing, they cannot be currently applied in clinical practice [2, 3]. Therefore, the provision of amplification and the associated rehabilitation remain the only effective means for treating SNHL [4-6].

Hearing aids have been shown to significantly improve the quality of life of hearing impaired individuals by reducing the psychological, social and emotional effects of SNHL [7-9]. The incorporation of digital technology in the hearing aid devices has promised additional benefits for users, including improved speech perception, especially in adverse listening environments [10], and a more natural and comfortable listening experience [11]. The latter expectations, however, need to be realistic, as additional research and technology development are still needed [12, 13], and the available data so far only mildly support the aforementioned contentions.

It has been consistently reported, however, that only about 30 – 40% of the people reporting hearing difficulties possess hearing aids in Western Europe, whereas the respective percentage in the USA is even lower [14-17]. Furthermore, 5 – 7% of people with hearing loss in Western Europe have tried but (sooner or later) rejected hearing aids. Stigmatization, financial constraints (when they are not provided free of charge), uncomfortable sensation, and the subjective perception of hearing well enough in most situations pose as the main barriers for hearing aid adoption amongst the hearing impaired [14], and a considerable number of hearing aid users finally stop wearing them [18].

Conventional wisdom suggests that optimal fitting can lower the rejection rate of hearing aids, and prove cost-effective to health care systems that provide them free of charge. Moreover, data from non-national health systems indicate an average of two to three visits before patients become satisfied with the sound quality of a digital

hearing aid, and two visits before they gain competence in caring for their hearing instrument [19]. However, little is known about the exact success rate of fitting digital hearing aids in national healthcare settings, and the proportion of users that may require follow up appointments to ensure their successful use, due to less-than-acceptable first fittings.

The aim of this study is to determine the success rate of initial fittings in digital hearing aid users, which in turn may prove important for planning health services for the hard-of-hearing, and allocating the appropriate resources within national health systems.

Materials & Methods

A study was performed using the fitting data of 1597 consecutive adult patients, who had undergone first or new (i.e. upgraded, from analogue hearing aids, first or second ear) fittings of digital hearing aids in a single centre, during a time period of one year. The patients were identified through the Practice Navigator™, an office management platform comprising a suite of programs for fitting a range of hearing aids, and keeping records of hearing aid-related patient contacts, or events. The review was part of a Departmental audit, which aimed to monitor both group and individual performance, and improve performance continuously, in direct line with the principles of Clinical Governance, which has been introduced in the British health system. Since the audit was mandated by the Trust (the public sector corporation which runs the

Hospital), and the processing of the audited data was anonymous, the study did not require Ethical Approval by the Ethics Committee of the Trust.

All reprogramming appointments which had taken place up to 6 months from the initial fitting of each patient were subsequently identified. This period was considered appropriate, as it is adequate for patient acclimatization [4], while significant further hearing loss, which can render the initial fitting unsatisfying, is not very likely to occur.

The digital hearing aids included in this study were behind-the-ear (BTE) models from internationally-known manufacturers, supplied via the National Health Service (NHS) central buying system, with good performance specifications. The latter included Feedback and Noise Reduction features, user-controllable Volume and Directional Microphone possibilities, telecoil applications, music and TV listening programs, appropriately enabled for each patient. The amplified sound was delivered to the ear canal either via "open fit" (fine tube and soft tip inserted in ear canal) or custom-made earmoulds, according to individual patient requirements, and/or technical constraints. The upgraded analogue aids were linear/compression limiting.

The default fitting prescription was the NAL-NL1 (National Acoustics Laboratory-Non Linear 1), which is built-in to all the hearing aid programming software, but with NAL-NL2 (National Acoustics Laboratory-Non Linear 2) and DSL I/O (Desired Sensation Level-input/output) options for use, when appropriate. The "fitting

protocol" had been set out in the British Government's "Modernising Hearing Aid Services" (MHAS) programme at the time of introduction of digital hearing aids into the NHS [26], followed to the extent possible in the Trust (taking equipment, staff, and time restrictions into account). In more detail, first and new fittings were carried out using the hearing aid manufacturers' software "First Fit" settings, with Audiologist selection of Acclimatisation/Adaptation Level, according to patients' amounts of experience with hearing aid use, and anticipated ability to acclimatise over a reasonable period (usually 3-6 months). While instructing the patient about the correct use of controls (where appropriately enabled), and the essentials of basic maintenance (i.e. cleaning, battery insertion, supplies), and discussing acclimatisation expectations, any adjustments judged appropriate were made, taking the patients' comments into account. The salient verbal information was reinforced by a "take-home" explanatory booklet ["How to Use Your Hearing Aid" (NHS)], and/or a locally-issued information sheet ["Getting Used to a New Hearing Aid"], with advice that any problems reported in the future could be easily addressed on request.

Patient follow-up visits were scheduled on a per-required basis. Self-questionnaires for assessing hearing aid fitting (in terms of hearing aid benefit/patient satisfaction) were not used as a standard. Patients who were fitted with anything other than air conduction hearing aids were excluded from the study.

Results

From the initial population of 1597 hearing aid users there were 871 first digital

hearing aid fittings with an earmould, 209 open first digital fittings, 398 upgrades from analogue to digital hearing aids, 88 second ear digital fittings, and 31 upgrades from analogue to digital and second ear fittings (Fig. 1).

Four hundred and sixty nominal reprogram appointments (28.8%) were identified. The reasons for these appointments were further perceived hearing loss, faulty or lost hearing aids, poor hearing, problems with speech in noise, unbalanced function between two hearing aids, and uncomfortable loudness. The mean age of the respective patients was 78.27 years.

Forty one first/new fittings (2.5%) were considered less than acceptable/not satisfactory to patients on the basis of their reprogramming appointments. Criteria to analyse the goodness of the respective fittings were the patients' comments after a reasonable period of familiarisation with the digital hearing aid (mostly from 3 to 6 months). Among the analysed patients, 16 were males and 23 females (gender data for two patients were unavailable); the mean patient age was 78.3 years. Thirty-five patients necessitated one reprogramming appointment, five required two, and one three reprogram follow-ups.

Among the analysed digital hearing aid fittings, 11 represented first fittings and 30 upgrades from analogue to digital hearing aids. The reported problems are summarised in Table 1.

Discussion

Hearing impairment refers to a limitation of function at organ-level as measured by a persistently raised hearing threshold, compared to the hearing in the normal population. Hearing disability/handicap refers to the limitation in performing everyday tasks, which may come as an outcome of the impaired hearing function, and can include the social impact of that dysfunction. Overall, clinically significant hearing impairments requiring rehabilitation are found in approximately 10% of the population [20]. Regardless of the severity of hearing impairment, hearing problems can place considerable strain on interpersonal relationships [21], as they usually make communication more difficult and affect social interaction. According to the Canadian Hearing Society Survey, 41% of people with hearing loss find communication so difficult that they typically withdraw from social situations [8].

However, only about one in three to four people reporting hearing difficulties possess hearing aids [14-17], although their use is associated with general improvements in health-related quality of life [4, 22]. The respective number of hearing aid users in the UK is approximately three million people, which, though seemingly impressive, means in effect that as many as seven million adults with hearing loss delay or avoid a hearing solution [23]. The main reasons given by hearing impaired individuals for not acquiring a hearing aid are primarily psychosocial in nature [24, 25]. Indeed, more than half of the people with hearing loss choose not to try hearing aids due to potential stigmatization [14]. In addition, the introduction of digital wireless technologies has set potential new barriers to the accessibility of hearing aid wearers to the available

information, because of the audible electromagnetic interference (EMI) which is generated by their combined use [1, 26, 27]. As a result, as many as 20% of people, who return their hearing aids, are reportedly driven to do so by the inability to use them while talking on the telephone [15].

These findings highlight the importance of focusing rehabilitation on improving satisfaction with aided listening across a range of environments [28], by taking advantage of features addressing situation-specific and user-related amplification. The introduction of digital hearing aids had aimed at utilizing these features more efficiently, and has been associated with an increase in the daily use of hearing aids [29], and advantages in terms of both objective and subjective outcomes [30]. However, digital hearing aids may incur larger costs to the national health services, due to their increased price, and the need for more staff resources [18]. Indeed, up to 36.5% of patients fitted with digital hearing aids required follow up in the study of Parving et al, compared to 21.6% of users of older analogue technology [18]. In addition, historic data from our Department indicated that the wholesale price of purchasing a typical hearing aid has risen from a cost of £40 per analogue aid to £70 for every digital one.

The results of the present study suggest that almost 30% of first/new digital hearing aid fittings may require follow up and/or reprogramming. However, only 2.5% of reprogramming appointments are due to suboptimal initial fitting, on the basis of the patients' respective comments after a reasonable period of familiarisation with the digital hearing aid. These observations are very important when taking into account

government policies to restrict public expenditure, which have been adopted for tackling the deficits in many European countries. Hence, the present outcomes indicate that a significant percentage of services (28.8%) which have been purchased and paid for are not finally used in a completely satisfying way.

This reality goes beyond academic field exercises, taking into account that the average cost of a single referral for audiological services by the General Practitioner, and the provision of a digital hearing aid in the English NHS is close to £220. Based on our study, approximately £101,200 worth of services have been paid but are at risk of not having been used in a completely satisfying way in our Trust, within a time period of only one year. Extrapolating these data on the 296 Acute and Foundation Trusts in England, we can get a moderate estimate of almost 30 million pounds worth of jeopardised audiological services within a single year. This fact in combination with the increasing demand for hearing aid services, may, in turn, challenge the delivery of high-quality cost-free audiological services in the future.

In comparison to the older analogue technology, fitting a digital hearing aid is not really easier or more difficult than fitting an analogue one; it is merely just different. Indeed, preparing a patient for the much more precise "targeted" amplification of digital hearing aids, which initially usually sounds much more high frequency-biased, perhaps takes longer, but produces much better hearing in noise, which is possibly the most sought-for outcome. On the other hand, with analogue fittings the audiologist's "educated prescription" plus immediate "screwdriver" adjustment to suit patients' perceived preferences may not take as long to produce happily-tolerated amplification

in clinic, but will likely result in much less useful aiding in “real life” situations, which very frequently involve noise.

Drawing on the actions taken for the 41 fittings, which were considered less than acceptable/not satisfactory to patients (Table 1), these always included obtaining new pure-tone thresholds. Patient management was then individualized to comprise either full hearing aid reprogramming, or partial reprogram with an increase in the high frequency (not hearing well enough group), or mid frequency gain (not hearing loud enough group) until patients reported satisfactory sound in Clinic. Enabling the volume control did not prove necessary in the majority of cases. Problems with increased loudness were addressed with a revision in the uncomfortable listening levels (UCLs) and a reduction in the overall gain, according to the new audiogram. Speech-in-noise problems were addressed with an increase in the mid-frequency gain, and corresponding adjustments in the high frequency and low frequency gains. Bilateral balance was accomplished by performing any necessary adjustment to achieve equal volume in both ears and overall patient satisfaction. Finally, patients belonging to the other/non-specific category were managed in a number of different ways (fine tune of the hearing aid, adding noise, converting the open-fit to a custom-made earmould), while two patients were referred to the ENT surgeons for further assessment. It is important to note that all 41 patients obtained benefit or satisfaction in the long term, and therefore retained use of their devices.

Pre-fitting hearing aid counselling may positively affect patient expectations, resulting in more successful hearing aid outcome [31]. In addition, auditory training may

favour improvement in auditory processing abilities, and benefit the hearing aid fitting process [32]. Such training may add to the practitioner's burden, but this drawback should be weighed against the additional patient satisfaction that can be anticipated from selecting the most cost-effective patient-centred solution [33]. Hence, if the answer to more cost-effective fitting of digital hearing aids is to increase the appointment time, the related costs can be restrained by offering group visits which would improve the clinical capacity of Audiology Departments, allowing more patients to be seen with the same amount of resources.

Indeed, preliminary findings have shown that group hearing aid visits do not worsen hearing aid outcomes, but may improve them (at least in the short-term) compared with individual visits [34]. And although group visits have not yet been established in our Department, experience in group follow up of hearing aid patients exists in the British NHS. Indeed, a comparison of group and individual follow up sessions had demonstrated that new NHS hearing aid users attending group follow up were generally more positive about their hearing aid, required fewer additional follow up appointments and reported more benefit in various listening situations, compared to their individual follow up counterparts [35]. The obtained results were indicative that group follow up is a cost effective method of following up typical new hearing aid users and may convey distinct advantages to patients that attend, albeit being a less attractive option than individual follow up appointments for some new hearing aid users. Extrapolating these results in the context of the parameters of the present study, we can recommend that since group follow up visits result in lower costs (despite the minor capital cost in setting them up), they could provide a means

for reducing the strain on resources and waiting times, while maintaining or improving care for more hearing impaired people.

Moreover, as the vast majority of reprogramming appointments in the present study were not because of suboptimal initial fitting, but due to routine ("normal") reasons, follow-up appointments may further reduce the cost of providing audiological services, by avoiding a repeated involvement of the General Practitioner, with its associated delays, taking also into account that elderly people need their time in training and getting used to new technologies.

Limitations of the present study include the retrospective design, and its single-centre setting. Nevertheless, it was conducted in a busy Audiology Department, which serves a catchment population of around 1 million people.

Unfortunately, some patients will also not be able to report unsatisfying fittings, and/or attend reprogramming appointments for various reasons (age, health problems, disability, and/or disposition). Although the proportion of these patients is not expected to be significant within 3-6 months of their fittings, they may continue using their hearing aids, gaining whatever benefit they can derive, or simply abandon their use without the Trust knowing. While the exact proportion of these patients is virtually impossible to be determined, the present study sought to find ways for the provided (and paid) services in these patients to be used in a satisfying way, thus improving their health status and quality of life.

Conclusion

The provision of HAs can undoubtedly improve the quality of life of hearing impaired individuals. Digital hearing aid fitting is generally successful, as the majority of patients (71.2%) did not require any follow-up appointment in the period studied. However, a significant percentage of patients may require follow up and/or reprogramming. Nevertheless, only 2.5% of reprogramming appointments seem to be due to suboptimal fitting, on the basis of the patients' respective comments after a reasonable period of familiarisation with the digital hearing aid. Cost-effectiveness principles dictate efficient utilisation of resources, to ensure the continuous delivery of high-quality audiological services through national health systems in the future. This may be achieved through group appointments, in order to reduce the associated costs, and increase the time allocated for fitting and training of the patients.

References

1) Vlastarakos PV, Nikolopoulos TP, Manolopoulos L, et al. Quantifying the bystander-effect of 2.5G mobile telephones on the speech perception of digital hearing aid users. *B-ENT* 2012; 8(2): 95-101.
2) Vlastarakos PV, Nikolopoulos TP, Tavoulari E, Papacharalambous G, Tzagaroulakis A, Dazert S. Sensory Cell Regeneration and Stem Cells: What We Have Already Achieved in the Management of Deafness. *Otol Neurotol. 2008*; 29(6):758-68.

3) Vlastarakos PV, Nikolopoulos TP, Tavoulari E, Kiprouli C, Ferekidis E. Novel approaches to the therapy of sensorineural hearing loss. Auditory genetics and necessary factors for stem cell transplantation. *Med Sci Monit* 2008; 14(8):RA114-125.

4) Gatehouse S. Electronic aids to hearing. *Br Med Bull*. 2002; 63: 147-56.

5) Kricos P, Holmes A, Doyle D. Efficacy of a communication training program for hearing impaired elderly adults. *J Acad Rehabil Audiol.* 1992; 25: 69-80.

6) Kricos PB, Holmes A. Efficacy of audiologic rehabilitation for older adults. *J Am Acad Audiol*. 1996; 7: 219-29

7) Chisolm TH, Johnson CE, Danhauer JL, et al. A systematic review of health-related quality of life and hearing aids: final report of the American Academy of Audiology Task Force On the Health-Related Quality of Life Benefits of Amplification in Adults. *J Am Acad Audiol*. 2007; 18(2): 151-83.

8) No authors listed. Research News. United Way Newsletter: Hearing Impairment. Canada, Sept 2006.

9) Noble W, Gatehouse S. Effects of bilateral versus unilateral hearing aid fitting on abilities measured by the Speech, Spatial, and Qualities of Hearing Scale (SSQ). *Int J Audiol*. 2006 Mar; 45(3): 172-81.

10) Oliveira JR, Lopes ES, Alves AF. Speech perception of hearing impaired people using a hearing aid with noise supression algorithms. *Braz J Otorhinolaryngol*. 2010 Jan-Feb; 76(1):14-7.

11) Bentler R, Wu YH, Kettel J, Hurtig R. Digital noise reduction: outcomes from laboratory and field studies. *Int J Audiol*. 2008 Aug; 47(8):447-60.

12) Kaplan-Neeman R, Muchnik C, Hildesheimer M, Henkin Y. Hearing aid satisfaction and use in the advanced digital era. *Laryngoscope*. 2012 Sep;122(9):2029-36.

13) Saunders GH, Lewis MS, Forsline A. Expectations, prefitting counseling, and hearing aid outcome. *J Am Acad Audiol*. 2009 May; 20(5):320-34.

14) Hougaard S, Ruf S. EuroTrak I: A Consumer Survey About Hearing Aids in Germany, France, and the UK. *Hear Rev*. 2011 Feb; 18(2): 12, 14, 16, 18, 23-8.

15) Kochkin S. MarkeTrak VII. Obstacles to adult non-user adoption of hearing aids. *Hearing J*. 2007; 60(4): 24-51.

16) Cox RM, Alexander GC, Gray GA. Who wants a hearing aid? Personality profiles of hearing aid seekers. *Ear Hear*. 2005; 26(1):12-26.

17) Stephens SD, Callaghan DE, Hogan S, Meredith R, Rayment A, Davis AC. Hearing disability in people aged 50-65: effectiveness and acceptability of rehabilitative intervention. *BMJ*. 1990; 300(6723):508-11.

18) Parving A, Sibelle P. Users' experiences with modern hearing aids. An audit. *Ugeskr Laeger*. 2001; 163(13):1857-62. [article in Danish/abstract]

19) Kochkin S. MarkeTrak VIII: 25-Year Trends in the Hearing Health Market. *Hearing Rev*. 2009 Oct; 16(11): 12, 14, 16, 18-20, 22-24, 26, 28, 30, 31.

20) Sorri M, Piiparinen P, Huttunen K, Haho M, Tobey E, Thibodeau L, et al. Hearing aid users benefit from induction loop when using digital cellular phones. *Ear Hear*. 2003; 24(2):119-32.

21) Bento RF, Penteado SP. Designing of a digital behind-the-ear hearing aid to meet the World Health Organization requirements. *Trends Amplif.* 2010; 14(2):64-72.

22) Ivory PJ, Hendricks BL, Van Vliet D, Beyer CM, Abrams HB. Short-term hearing aid benefit in a large group. *Trends Amplif.* 2009; 13(4):260-80.

23) No authors listed. The latest hearing technologies: uptake and evaluation [confidential report for NHS innovations]. The Ear Foundation, 2011:1-9

24) Meister H, Walger M, Brehmer D, von Wedel UC, von Wedel H. The relationship between pre-fitting expectations and willingness to use hearing aids. *Int J Audiol.* 2008 Apr; 47(4):153-9.

25) Cienkowski KM, Pimentel V. The hearing aid 'effect' revisited in young adults. *Br J Audiol.* 2001 Oct; 35(5):289-95.

26) No authors listed. FCC: Cell phones must work with hearing aids. *Consumer Reports.* 2003; 68(10): 7

27) Ross M. Wireless telephones and hearing aids: an overview. *J Am Acad Audiol.* 2001; 12(6): 286-9.

28) Hickson L, Clutterbuck S, Khan A. Factors associated with hearing aid fitting outcomes on the IOI-HA. *Int J Audiol.* 2010; 49(8):586-95.

29) Arlinger S, Billermark E. One year follow-up of users of a digital hearing aid. *Br J Audiol.* 1999; 33(4):223-32.

30) Wood SA, Lutman ME. Relative benefits of linear analogue and advanced digital hearing aids. *Int J Audiol.* 2004; 43(3):144-55.

31) Saunders GH, Lewis MS, Forsline A. Expectations, prefitting counseling, and hearing aid outcome. *J Am Acad Audiol*. 2009; 20(5):320-34.

32) Megale RL, Iório MC, Schochat E. Auditory training: assessment of the benefit of hearing aids in elderly individuals. *Pro Fono.* 2010; 22(2):101-6.

33) Cox RM, Schwartz KS, Noe CM, Alexander GC. Preference for One or Two Hearing Aids among Adult Patients. *Ear Hear*. 2011; 32(2):181-97. Erratum in: *Ear Hear*. 2011; 32(3):409..

34) Collins MP, Souza PE, O'Neill S, Yueh B. Effectiveness of group versus individual hearing aid visits. *J Rehabil Res Dev.* 2007; 44(5):739-49.

35) Brickley GJ, Cleaver VCG, Bailey S. An evaluation of a group follow-up scheme for new NHS hearing aid users. *Br JAudiol*. 1996; 30(5): 307-12

Tables

Stated reason/problem	*Number of cases (n)*	*Percentage of cases (%)*
Not hearing well enough	10	25
Not loud enough	3	8
Too loud	10	25
Not clear enough	2	4
Problem with speech in noise	1	3
Bilateral balance	1	3
Uncomfortable loudness	2	4
Other /Non-specific	12	28

Table 1

Reasons given by patients for reprogramming appointments

Figures

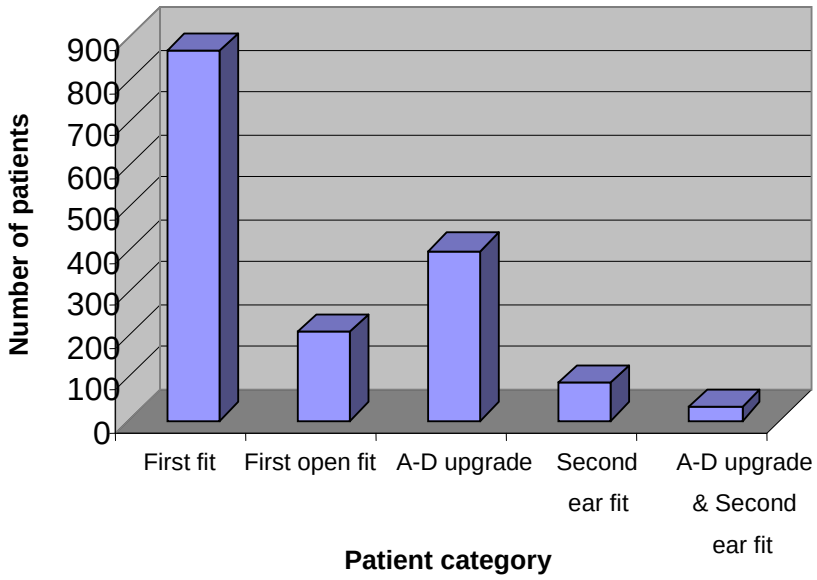

Figure 1

First/New Hearing Aid Fitting by Category of Patient