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Original Article

Low cost multi-use hearing aid

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Abstract:

Aim: The aim was to develop a low cost multi use body level hearing aid (HA) targeting the Asian population.

Method: The study began with need identification. In this stage the researcher wanted to identify the changes which the parents and professionals thought would improve the functionality of the present say body level hearing aids. A survey of 106 hearing aid users, parents and professionals was done. All had been exposed to hearing aids since five years or more. They were asked to name one change which can be incorporated into the present day HA aids to increase its functionality and utility. Six major changes were significantly (pd" 0.05) recommended. The changes were considered to develop a prototype which was then field tested for its efficacy.

Results: the six changes which were identified by the 106 participants included incorporating better cords, better battery backup, easy repair facilities, low battery indicator, torch facilities along with a vibrating alert. A prototype was developed at a very low cost of 936 rupee with facilities of a strong class HA, vibrating doorbell alert, rechargeable battery, torch light and a vibrating doorbell alert and a low battery indicator. It was found to function satisfactorily and won the prestigious Sushrut Innovation award by the Department of Science and Technology, India for year 2011.

Conclusions: the developed prototype can be considered for large scale production. It would bring down the cost of the prototype and beneficiaries would get an advantage of assistive devices along with the hearing aid.

Key words: *Hearing aids.*

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Introduction:

WHO (2003) reports suggest "Hearing Aids are needed for 4 to 6 percent of the population of South East Asia which is estimated to be about 60 to 75 million. At present the need remains far from being met"[1]. Among the currently used hearing aids, the pocket type is dominant in India, Bangladesh, Pakistan and many Africa countries. The Government of India (1996) in the PWD Act recognizes hearing Impairment as a disability which needs to be attended to[2]. The Government provides Body level hearing aids to the individuals with hearing loss under a scheme called Scheme of Assistance to Disabled Persons for Purchase/Fitting of Aids/ Appliances (ADIP Scheme) [3].

The communication efficiency of a hearing impaired individual is dependent on upon the efficacy of the hearing aids they use. This necessitates a need to develop efficient hearing aids for the population which is estimated to be around 70.07 million people of whom approximately 38 million can be treated by proper surgical intervention and others need hearing aids[4]. Rejection and dissatisfaction with hearing aids is a common clinical feature and is as well reported internationally[5,6]. Developing a body level hearing aid as per the needs of the hearing impaired would facilitate the acceptance of hearing aids. Acceptance of aids facilitates implementation of the various provisions of the PWD act and achieving the goals of audiological rehabilitation, consistent with the model of International Classification of Functioning (ICF)[7]. Targeting a body level HA in this era of digital"Invisible" hearing aids may seem out dated. But ground realities along with WHO (2003), Government of India ADIP schemes and the data of the number of body level HA manufactured yearly by Indian companies like Elkon Pvt Ltd, ALPS International and Arphi Pvt Ltd indicate usage of body aids dominate the scenario. Hence there is a need to target research towards improving the functionality, efficiency and utility of body level HAs.

Method:

The study was done in collaboration of two apex institutes of India, School of Biomedical Engineering, Institute of Technology, Banaras Hindu University, Varanasi and Ali Yavar Jung National Institute for the Hearing Handicapped at Kolkata West Bengal which is dedicated towards rehabilitation of the individuals with hearing impairments and speech disorders.

Participants:

The participants included 87 participants (30 adult hearing Aid users along with 30 Parents of children with HI and 27 Special educators) and 19 audiologists in Stage I. The authors designed the prototype in stage II. In stage III (field trail) the prototype was tried on thirty one adults in the age range of 18- 70 years (mean 46.7; ± SD 17 years) with bilateral moderately severe to profound hearing loss. Twenty three participants were males and others eight were females. All resided in the state of West Bengal and belonged to a low socio economic status (monthly Income of 6500 rupees and below). The participants were explained the purpose of the study and agreed to participate in it. All had been fit with a strong class HA supplied at AYJNIHH (ERC) under the AIDP scheme. Eleven Participants were prescribed Arphi Strong class and 20 with Elkon Strong Class Hearing Aids.

Tools used:

The tool used for the study included: A20 MHz CRO (Cathode Ray Oscilloscope). Variable DC power supply, Miultimeter, LCR meter, Hearing aid Analyzer (FP40D), Soldering iron, Soldering flux, Soldering, Maico MA 52 Dual channel diagnostic audiometer wire and Elkon and Arphi Make Strong class hearing aids.

Procedure:

The study was accomplice in three phases.

Phase I: Survey and Identification changes/ facilities to be incorporated in the present body worn supplied free of cost under ADIP scheme. Data for Phase I was collected in two stages: stage-I, included 87 participants who had experience with body level HA and HA users. The participants were asked the question "We are planning to incorporate some changes in the HA (Body level HA was indicated), kindly tell one change which you would like to have in the hearing aid. The change should increase the hearing aids functionality and utility". For example you may suggest, changes in the shape, size, color, power supply or changing or modifying any part of the aid or adding a new facility which would increase the efficiency and utility of the hearing aid etc. The suggested recommendations were tabulated and six major recommendations were identified.

Stage-b: The six identified recommendations were presented to 19 audiologists. The audiologists were asked to rate if the recommendation was important (1) or unnecessary (0) for a hearing aid user. The binary rated opinions about the six recommendations were obtained and were subjected to a test of significance.

Phase II: Development of a prototype incorporating the suggested changes. The prototype was developed in three steps as Prototype I, Prototype II and Prototype III (Figure 3). The prototype III was put in as moulded case the other casing (Figure 6).

Phase III: field test of the prototype to identify if it functions significantly at par the standards recommended for hearing aids Indian **Standards Institution** (ISI) for strong class hearing aids on electroacoustic measurements (figure 4). It was also evaluated if the aided thresholds obtained by the Low cost multi use hearing aid significantly correlate with the state of art strong class body level hearing aids distributed under ADIP scheme.

Results:

Phase I: Identification of users needs

Six core modifications were suggested by 87 participants (figure 1). All the six suggested modifications were rated to be significantly important (pd" 0.5) by 19 audiologists (figure 2). The Six modifications included, incorporating better cords, better battery backup, easy repair facilities, low battery indicator, Torch facilities along with a vibrating alert. Audiologists found all items to be significantly (pd" 0.5) important and should be considered during modifying a body level hearing aid.

Phase II: Preparation of the Low cost Multi-use hearing aid

The six modifications included better battery, better cords, low battery indicator, torch, easy to repair and a vibrating alert facility (figure 3). All the recommended facilities, except for

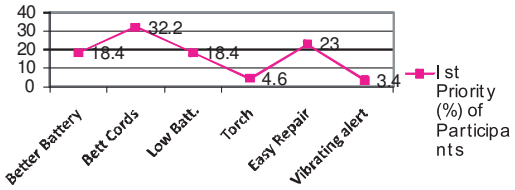

Figure-1: *Modifications recommended by Adult hearing aid users, parents and Sp Educators.*

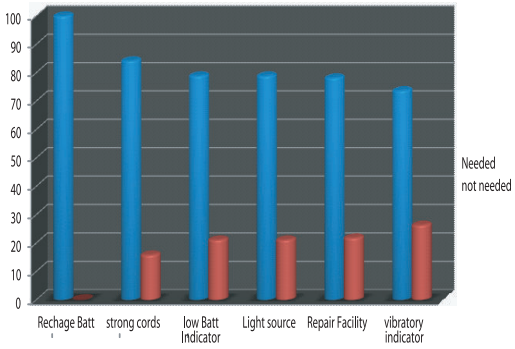

Figure 2: *Perceptions of 19 audiologists about the changes/ facilities to be added in the Body level hearing aids as recommended by the 87 participants.*

the suggestion to have a durable cord were considered (figure 4,5 and 6).

The modification of the cord was dropped as it required some work beyond the electronic laboratories. Tasks like selecting a good polymer to protect the cords, manufacture of angleflex and andiflex ends of the cords were beyond the available facilities at AYJNIHH (ERC) and BHU. Further a durable cord is available in the market. Unlike cheap cords which have a lifespan of 1.5-3 months, off late some companies have manufactured cords which last for 6 months and more.

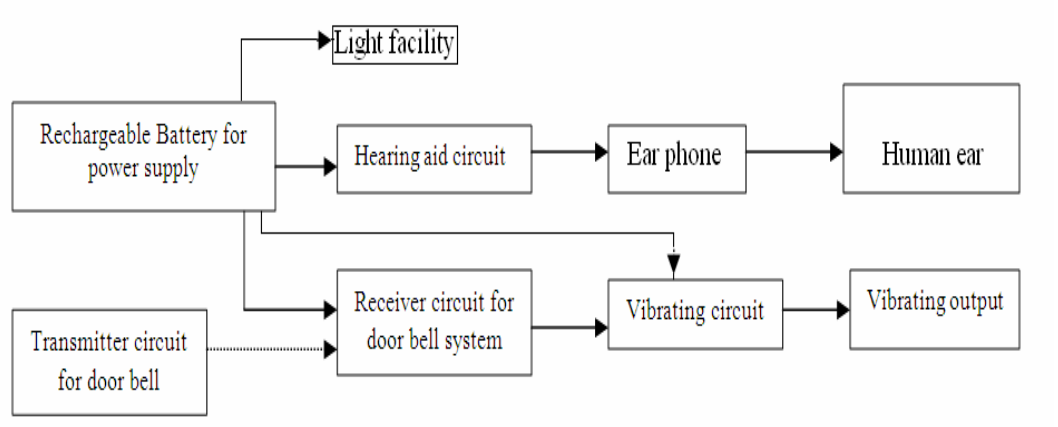

Figure 3: *Block Diagram and Its brief description of the low cost multi use hearing aid.*

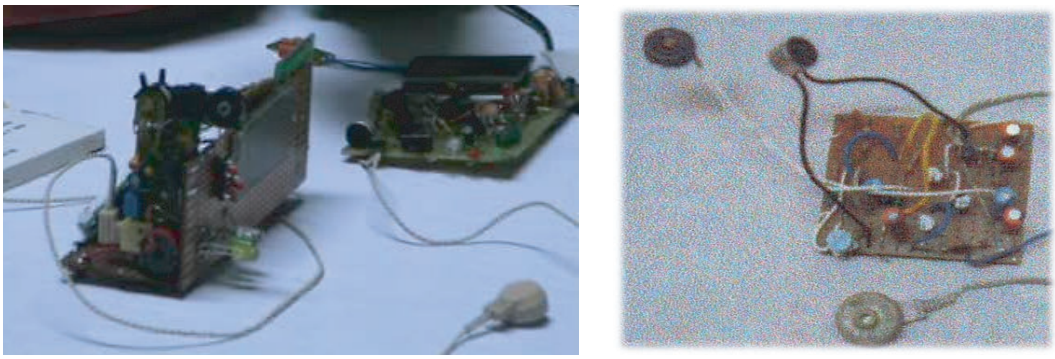

Figure4: Prototype 1 and Prototype 2 and Prototype 3.

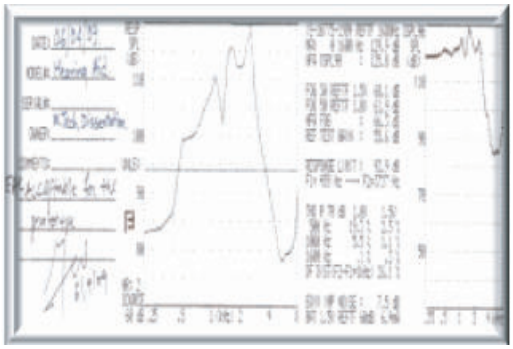

Figure 5: *Electroacoustic characteristics of the Low Cost Multi-use Hearing Aid (Prototype III) which is as per a strong class hearing aid.*

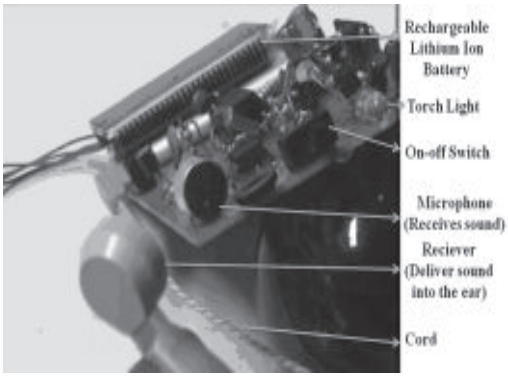

Figure 6: *Indicating the different parts of the Low cost multi use hearing aid.*

Figure 7: *A client being tried with the Low Cost Multi-use Hearing Aid (final prototype in case)*

Phase III: Field Tests on 30 adult hearing impaired adults.

The participants included 30 adults were prescribed a strong class hearing aid. Twenty participants were prescribed Elkon Strong class aids and 11 Alps strong class hearing aids. The performance of the prescribed hearing aids was compared with the aided thresholds obtained by the prototype. Statistical test of significance indicated the performance of the Low cost Multi-use hearing aid was significantly (pd" 0.5) at par the performance of the strong class body aids prescribed under ADIP scheme as indicated by the ÷2 test. The total cost initial cost of making a low cost multi use hearing aid is rupees. 936.00 only. The rechargeable battery, torch facilities and the vibrating door bell alert functioned satisfactorily. The vibrating door bell alert incorporated in the hearing aid could reliably alert the user about someone pressing the doorbell from a distance of 50-60 feet. The torch could provide sufficient illumination to help the hearing aid user to speech reed the speaker in case of power failure and the 3.7 volt rechargeable battery cut short the recurring cost of changing a battery approximately after 70 hours of usage. The low battery indicator went red to signal a need for recharging the battery.

Discussion:

The low cost multi use hearing aid is a first of its kind and is truly "Low Cost and user friendly". It's made based on the user's perspective and hence will be accepted better. Rejection of hearing aids is a common issue about 30 percent of hearing aid owners is dissatisfied with their instruments[6], and approximately 16 percent of hearing aid owners report never using their hearing aids[5]. The Prototype is indigenously developed hence is cheaper and would be uncomplicated to repair. Its initial cost of rupees 936 is expected to go down if manufactured on a large scale. The strong class hearing aid was targeted as the majority of population attending various government organized hearing aid distribution camps needs the strong class hearing aid[8]. The present strong class hearing aids are commercially available @ Rs 2000 and above. The vibrating alarms marketed by Widex and made by Phonic Ear are at least@ Rs 3000 per assistive devise. There is a recurring cost of the hearing aid is the battery @ Rs 7 every 5-7 days. The rechargeable cell and the low battery indicator take off the recurring cost and the worry of an unnoticed low battery especially in children. The Prototype provides various facilities together unlike any available instrument. Thus its "Economic" in terms of the initial cost, recurring cost of batteries and would avoid repair cost because of the Lithium Ion battery which oxidizes the circuit to a much lesser extent as compared to the metal hydride cells (pencil cells) used in hearing aids. The prototype is truly "Multi Use". The vibrating indicators which can be used as a door bell or as a signaling devise to call the deaf adults or children who are within 50-60 feet. The torch would promote communication by providing a scope for speech reading and sign language in the dark (power cut leading to isolation is a common phenomenon). The

torch also increases the utility of the hearing aid. The work recently won the prestigious Sushrut Innovation award by the Department of Science and Technology, India for year 2011.

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