

Special Edition

New Frontiers in Tinnitus, Hearing Loss and Hyperacusis

Mini Review**Rechargeable Battery Solutions for Digital Hearing Aids: A Mini Review****Neha Taneja, MASLP, BSc***

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Everyday all of us use rechargeable solutions either its smartphones, televisions, or any other electronic devices. Faster streaming of these electronic devices to other external devices may be facilitated through wireless connectivity. Wireless streaming demands much more battery backup. With advancement of hearing aid technology many features exists in hearing aids which may facilitate better spectral information, improved speech understanding in presence of background noise and thus improving communication and quality of life of the users. The use of these advanced features often requires continuous uninterrupted power supply. Traditional disposable hearing aid batteries cannot be assured of their performance due to their inopportune time discharge. Recently rechargeable solutions in hearing aids have been discovered that can support long-lasting wireless streaming. Modern day rechargeable batteries are expected to be easy to charge which can last for longer duration with more reliability and durability. Rechargeable as a feature is added on over and boon. Rechargeable battery solutions based on its various benefits may support as boon for environment, hearing aid users and professionals (better counseling and more satisfied users). The aim of this article is to highlight the awareness of these different rechargeable solutions for the users and professionals. In addition mentioning in brief the superiority of Lithium ion battery which is widely accepted in rechargeable hearing aids.

Keywords

Rechargeable hearing aids; Wireless streaming; Batteries for hearing aids; Li-ion batteries.

INTRODUCTION

World at present is technology driven where everyone is highly dependent on use of electronic devices such a smartphones, music systems, televisions, etc. Faster streaming of these devices has been accelerated through the wireless streaming. In a similar trend the hearing aid users also demand the wireless connectivity to use these electronic devices which can provide more battery backup. Compatibility of digital hearing devices to these external electronic devices especially cellphones is added convenience for hearing aid users.¹ Wireless streaming demands use of more battery backup.² Traditional disposable hearing aid batteries cannot be assured of their performance due to their inopportune time discharge.³ Recently rechargeable solutions in hearing aids have been discovered that can support long-lasting wireless streaming.³ This

may primarily support for no replacement of disposable batteries very often. Hearing aid users now may not have to wait every minute to hear low battery alarm or to excuse them in a conversation for a change of battery to hear any more. Digital hearing aids come with variety of different features and form factors³ to allow for quality of hearing for hearing aids users. Such features and working is based on various algorithms which are real time based and situation specific and requires faster processing which can aid the required good battery backup.³ Rechargeable batteries have replaced the traditional disposable batteries almost everywhere in our daily use.

Hearing aids as described helps to amplify sound for a person with hearing loss.⁴ In milliseconds of time they have ability to process signal and analyze the environment.⁴ Traditionally

hearing aids run on disposable batteries (zinc air) due to several limitations of the same, for the ease and time save rechargeable options in hearing aids have been developed.⁵ With advancement of hearing aid technology it has become possible to recognize speech more precisely in presence of background noise, with better spectral information.⁶ Advanced hearing aid technology may support for better communication and better quality of life.^{7,8} Rechargeable as a feature is added on over and boon.

LITERATURE REVIEW

Rechargeable Hearing Aid Battery Solutions

In a present modern day world everything is demanded in miniature size and time saving option hence hearing aids with advanced technology have become small and fast in processing. Modern day rechargeable batteries are expected to be easy to charge which can last for longer duration with more reliability and durability. With the discovery of wireless streaming in hearing aids traditional zinc air batteries are to be consumed in high amount due to their more use while in streaming mode.² Rechargeable batteries can offer longer battery backup for longer time but depending on degree of hearing loss, duration of streaming and wireless devices in use. Once charged overnight can be used longer than traditional zinc air batteries. Rechargeability has become one of the key reason for hearing aid users to opt rechargeable hearing aids over traditional zinc air batteries.²

Historically, idea of rechargeable batteries came long back when the first patent was filed in 1939 in the United States by Grant Wheat "Storage batteries for hearing aids". The patent emphasized the expectations from rechargeable batteries such as it should be of greater reliability, small in size, easy to recharge and must not go in inopportune time.⁹ Almost around 43-years later the first rechargeable battery was then discovered⁹ but due to its more limitations in terms of size, long hours of charging it could not meet the expectations as per required for demand of more battery backup.⁹ They could support only for 5-6-hours of average wearing⁹ as against 10-11-hours required as an average time by hearing aid user. Henceforth, Zinc batteries-disposable batteries were still into existence. Overall, such discoveries related to rechargeable batteries could not sustain for longer wireless streaming, long charging tenure and has size and weight constraints of being heavy.^{9,10}

Moving to present there are mainly three types of rechargeable batteries available today.

Nickel-Metal Hydride (Ni-MH)

These rechargeable batteries were initially used in automobiles¹¹ and cameras.³ They are very different from disposable batteries such as Zinc air which used to get discharge after coming in contact with air around after seal is opened.³ The chemical process involved in it keeps the cell sealed which further facilitates in maintenance. The advantages of Ni-MH batteries were that they show constant voltage rate over time and can be interchangeably are

used with Zinc air cells owing to its similar size in standard hearing aid battery.³ The limitations of Ni-MH batteries for which they could not be used as a rechargeable solution for long was for its high self-discharge especially in high temperature and risk of over-charging.^{3,12} These challenges could not support the wearers for a longer time.³ It requires a charging time of 6-hours for which wearers could not rely on them if the power goes anytime in between.³

Silver Zinc (AG-ZN)

These are next generation of batteries which operates at higher energy density and requires higher capacity.^{3,11} This requires charging of 4-hours that and support battery life cycle of 1-year. These are fully recyclable and non-inflammable.³ It works on high voltage (1.85 V).³ For the Ag-Zn batteries to be used in hearing aids a mechanical converter is needed to reduce the voltage from 1.85 V to 1.3 V.³ Good part of these batteries is that they are recyclable¹¹ as compared to traditional Zn batteries. These battery types had been in existence since long time and were used in aerospace applications and military purpose.¹³ These battery types are rechargeable batteries. For its operation they require higher density and higher capacity when compared to Ni-MH battery. The average battery life cycle is 1-year and requires 4-hours for charging itself.¹⁴ The limitation can be due to its requirement for higher voltage. To compensate for higher voltage as to not affect the electronic parts in hearing aid the battery door is attempted to include voltage regulator or down regulator to reduce the effects of higher voltage on nearby electronic parts.³ This limits the small size of these batteries and they look big in size. Less cosmetic appeal and due to limitation that it cannot be interchangeable with disposable and regular batteries so the end user are bound to carry additional battery as a backup along.^{3,11}

Lithium Ion

With the discovery of wireless technology and improved signal processing the hearing aid devices has become much faster and puts a faster demands on battery usage. Traditional hearing aid users were dependent on disposable batteries which had to be replaced very often in a week's time, non-recyclable and among others rechargeable batteries. Several benefits of Li-ion battery include better ease of usage and comfort as they just require the hearing aids to just slide in the charger and get charged smoothly. The rechargeable options are smoother and may be much advantageous for the patients with dexterity concerns.¹⁵ Additionally its more economical and cost effective, users don't have to remember as too often change it during their important conversations.^{3,11} Owing to its appropriate size it can be traced well for its usage as compared to small disposable batteries. These support longer working capacity and can be charged very fastly. These batteries find its use with almost all sizes and form factors and often very wide spread in use for electronic devices such as laptops, camera etc. in day to day life.

DISCUSSION AND CONCLUSION

Deming in his book *Out of Crisis*^{16,17} has clearly stated that the

happy customers share their experience of happiness with 8 friends whereas angry customer shares the same to their 16 friends.¹⁷ In a similar trend hearing aid users shares their experience as well.¹⁷ Research highlight several reasons that can influence the hearing impaired users to avoid wearing their hearing aids. Among such include problems such as whistling, feedback, over amplification, repair cost too high, no benefits in speech understanding, inappropriate counseling from dispenser and inefficient battery backup from hearing aids.¹⁷

Digital hearing aids in the present modern world offers a variety of features, factors and connectivity options through wireless way for hearing aid users.¹⁸ Wireless hearing instrument provides comfort for the use of hearing aid in multiple ways.¹ Wireless connectivity facilitates to use several electronic devices streamed to their hearing instruments. In addition, it also facilitates use of features such as change in program and volume switch remotely. It provides the ease for the use of binaural fitting¹⁹ which can work as a system rather as independent hearing aid unit. Connectivity through wireless way facilitates the exchange of information between binaural devices which can provide an ease for automatic microphone setting and improves signal to noise ration through improved noise reduction setting.¹⁹ This minimizes the use of manual adjustments for volume, program, and microphone settings and overall it may help to enhance hearing aid performance.¹

Rechargeable technology has become a commonly use technology in day-to-day lifestyle. The reason for this can be its reliable and consistent performance. Though rechargeable solutions have been into existence since long but couldn't be generalized for its usage owing to its very many limitations such as big size, insufficient battery life, high voltages, etc. Though several of such batteries came into existence such as Ni-Mh, Silver Zinc, and Li-ion. Amongst all Li-ion batteries was the most promising for use due to many advantages.³ It fulfills customers' expectations in supporting full day battery life with minimum charging of 3-hours considering hearing aid usage streamed with other devices, users finds it easy to just slide hearing aid in charger case instead struggling if they have add on dexterity concerns. The mode of charging in Li ion provides ease of handling and hassle free hearing aid use for longer time. The various challenges with use of disposable batteries in past such as memory effect, persons with dexterity problems face a huge challenge, less reliability as they can go off at any time in mid of important conversation and were time³ consuming. These all limitations were taken care of with use of lightweight, more reliable, environmental friendly and user friendly Li-ion battery.

With the advancement in technology it facilitated hearing aid user to connect to the environment in a quality way. This may help to improve the communication while appreciating the auditory cues around. This provided sense of trust among hearing care professionals while confidently¹⁰ recommending hearing devices to their consumers in a more innovative way through these rechargeable hearing aids. Professionals may trust for more assured satisfied customers.¹⁰ This may provide them as a platform to render services in a more professional manner than mere finding rechargeable batteries as retail business. Hearing aid users of disposable batter-

ies can find it easy to upgrade their devices into rechargeable hearing aids. Considering from environmental aspects disposable batteries used to go in landfills in huge numbers and cause a waste.¹⁰ Rechargeable solutions follows the concept of recyclability hence boon for environment too. Thus supporting the use of rechargeable hearing solutions for present era.

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