Discover the Power and Flexibility of ZPower

Zpower®

Battery Life: Counseling patients about their wireless streaming hearing aids

Barry A. Freeman, Ph.D.
VP, Business Development

Zpower®

Historical Perspective

- First powered hearing aid in the U.S. produced by Miller Reese Hutchinson in 1902.
- Vacuum tubes with current drain approaching 60mA.
- Transistors drastically reduced battery drain and size. *(Lybarger 1988)*

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Hearing Instrument Advancements By the Decade

Hearing Aids
- Body Aids
- Monaural Fittings

- In-the-ear
- Binaural fittings
- Real ear

- Digital
- Deep Canal
- RICs

- Wireless Streaming
- Rechargeable

1960s | 1970s | 1980s | 1990s | 2000s

- Behind the Ear & Eyeglass
- Analog aids
- Earmold Acoustics

- CICs
- Programmables & early digitals

New Era in Hearing Care: Rechargeable Products

- *"Starkey offers rechargeable option thanks to ZPower"*
- *"Free yourself from the hassles of disposable batteries with Phonak Audéo™ B-R rechargeable hearing aid."*
- *"Signia Cellion. The hearing aid that lasts a whole day on a single charge."*
- *Unitron announces "Moxi Fit R, the world's smallest rechargeable hearing instrument"*

Battery Overview

Traditional Hearing Aid Batteries

Zinc-air

- Disposable battery
- High energy density, one time use, not recyclable

Nickel metal hydride (NiMH)

- Rechargeable
- Relatively short operating time with wireless
- Cycle limitations

New Rechargeable Hearing Aid Batteries

Lithium Ion

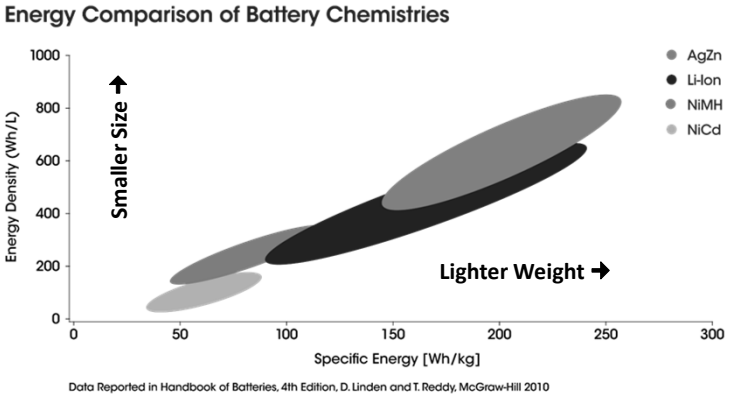
- Toxic
- Flammable
- Sealed case
- High voltage
- Size limitations
- Non-recyclable
- Shipping restrictions

Li-ion button battery lodged in esophagus causing injury to surrounding tissue in just 2 hours (Sharpe et al. J.Pediatrics, 2012)

New Rechargeable Hearing Aid Batteries

Silver-zinc

- Non-toxic, non-flammable and fully recyclable
- Highest energy density
- No size limitation, higher price for large batteries (e.g., automobiles, computers, phones) due to silver
- Interchangeable with zinc-air disposables
- No memory effects



Silver-Zinc: Historically Used in Space/Military

high **energy/power** density

safe **Water-based** chemistry

ZPower: Pioneers of the Silver-Zinc Rechargeable Microbattery

Since 1996, ZPower has pioneered the commercialization and innovation of rechargeable silver-zinc batteries, which provide:

- More Energy with Less Volume
- 400+ Recharges
- Safety (non-flammable and non-toxic)
- Environmental advantages

ZPower Batteries are proudly made at our headquarters in Camarillo, CA

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Understanding Battery Performance

- A battery's capacity:
  - Charge stored by the battery
  - Measure of the amount of energy that can be stored for a given weight or volume.
  - Measured in mAh
- Hearing aid drain
  - Amount of energy takes to operate hearing aid.
  - Measured in mA

What Do We Know?

- Battery life is getting shorter.
- ~88% of new hearing aids have wireless capabilities.
- Features and streaming consume batteries
  - Feedback and noise management
  - Ear-to-ear communication
  - Wireless programming
  - Streaming
- Patients are complaining about short battery life and the frequency at which they need to change batteries.

Comparison of Rechargeable Hearing Aid Batteries: Not All Are Created Equal

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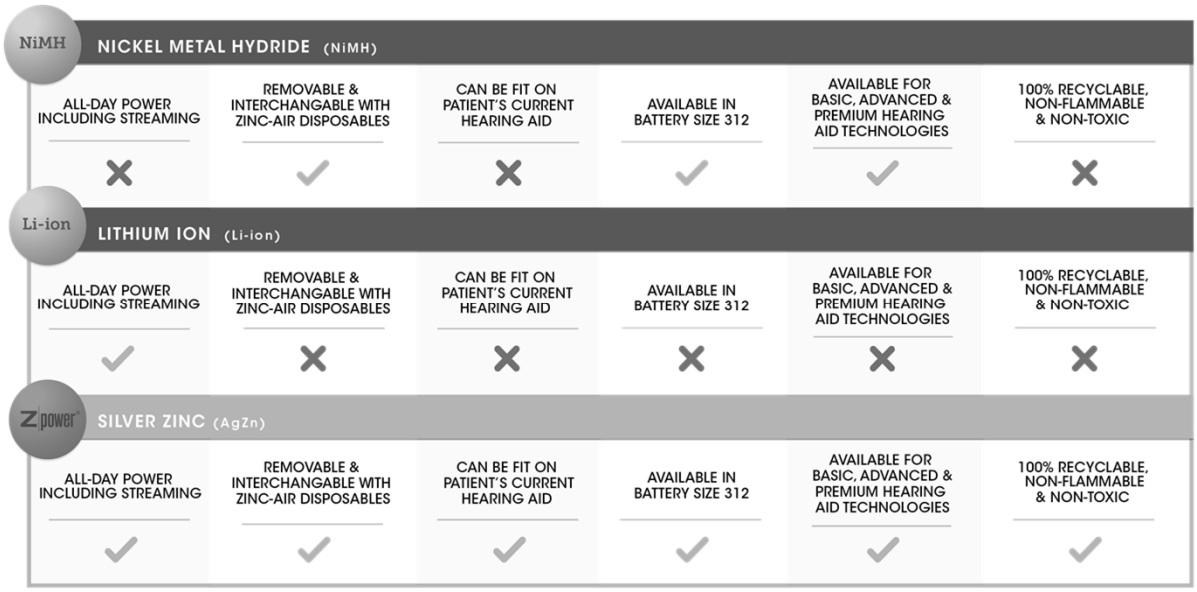

Consumer Perspectives

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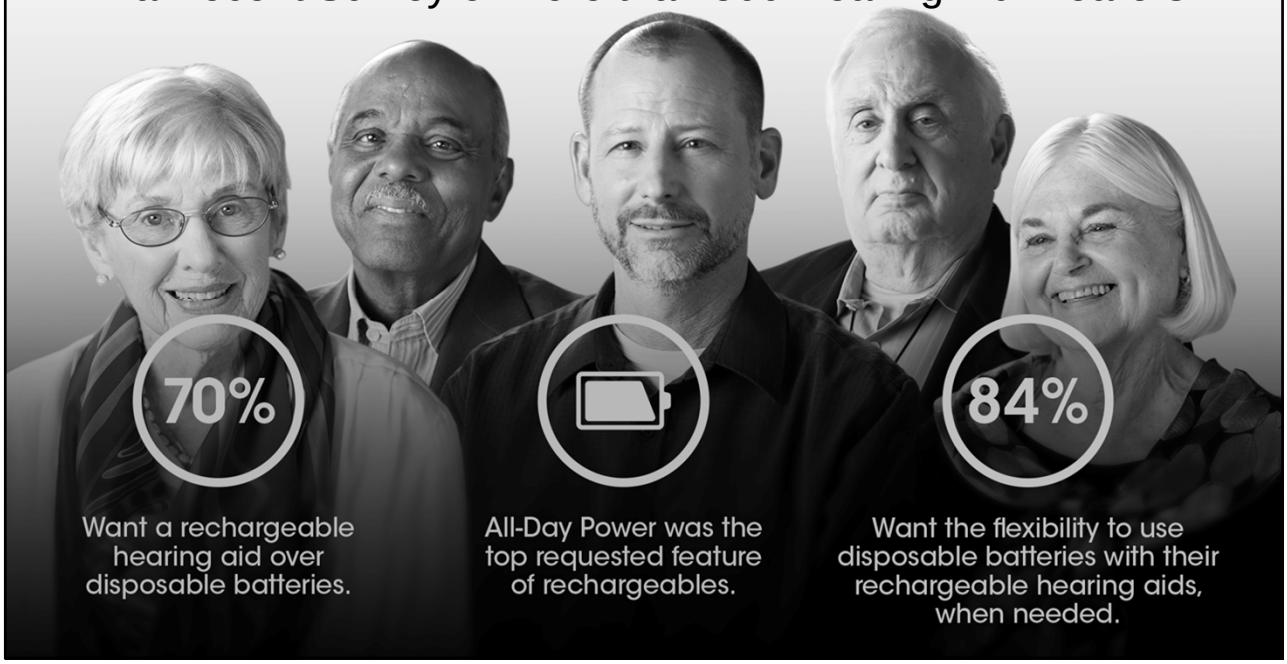
MarkeTrak 9 (2015)

Most Compelling Features Sought by Non-Owners of Hearing Aids:

1. Volume control on hearing aid
2. **A rechargeable hearing aid**
3. Program button for environments
4. **Rechargeable batteries for hearing aids**

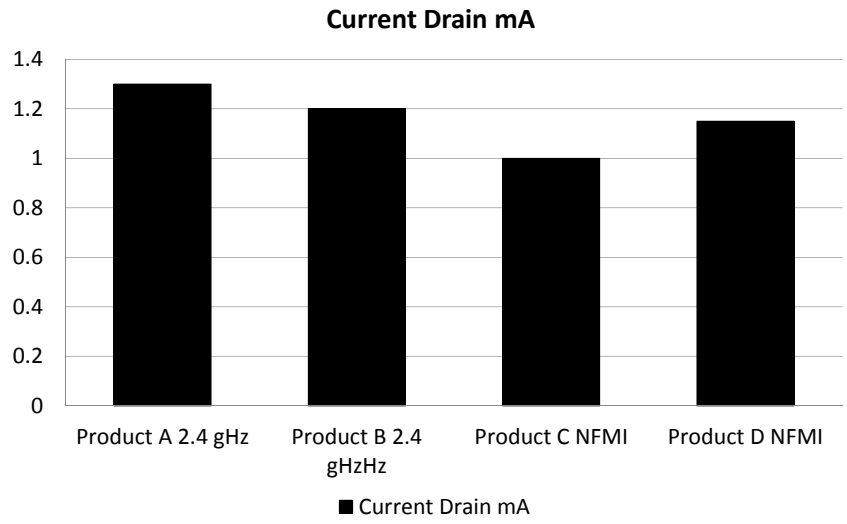
In a Recent Survey of more than 500 Hearing Aid Wearers:



Purpose of Study

- Measure power use and battery drain of a sample of wireless hearing aids.
- Compare reported battery drain from data sheets to actual measured battery drain.
- Report measured battery drain in varying listening situations and streaming scenarios.
- Understand the performance of hearing aids in different listening situations with different batteries to enhance patient counseling.

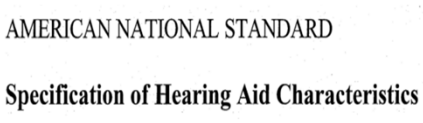
Manufacturer Data Sheets Current Drain



What do we know?
Inaccuracy of Data Sheets

- "…**little correlation between datasheet figures and measured real-life current consumption**, even when hearing aids are used without the wireless streaming options activated."
- "**Relying on the datasheet is difficult** and, in many cases, not sufficient when answering a hearing aid wearer's questions with regard to battery life." ***(Joergensen, Baekgaard, & Bendtsen, 2013)***

Performance Standards
(ANSI 3.22)



- **All adaptive features** (noise reduction, feedback suppression) should be **disabled.**

Calculating Zinc-Air Battery Life

Battery Life

=

Battery Capacity (mAh) / Device Consumption (mA) x 0.7

Digikey Electronics
www.digikey.com

How Do We Use Information?

- Run time for hearing aid:
  - Battery capacity/current drain
- Example:
  - Zinc air 312: 180 mAh Capacity
  - Current Drain: 2.0 mA
- Hearing aid run time: (180/2.0) * 0.7 = 63 hours or, at 12 hours/day, ~5 days.

Battery Life

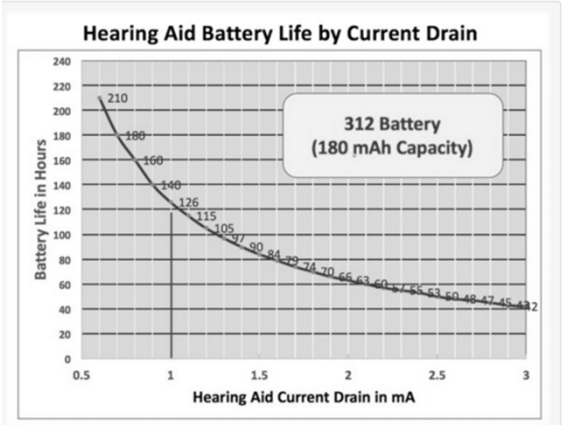


Figure 2. Calculated battery life in hours for a size 312 hearing aid battery when operating under different current drains. Any adaptive features performed by the hearing aid can be expected to result in a higher current drain (and hence, shorter battery life) when operating. The battery life of different sized hearing aid batteries will be different because their "storage tanks" (mAh Capacity) is different than the 180 mAh capacity in this example. Some have greater storage and others less, depending on the size of the battery, with smaller batteries having less storage.

From Staab, 2016

Not All Zinc Air Are The Same

Capacity **160 mAh**

Capacity **170 mAh**

Capacity **180 mAh**

How Do You Use This Information?

Counseling

- Mr. Jones, your zinc-air battery has 180 mAh of capacity and your hearing aid operates at 1.2mA; therefore, if you wear the aid 12 hrs. per day, you will get ~9 days of battery life.

Business

- You fit 1,000 hearing aids and provide a one year supply of batteries.
- Based on projections, you will need to order ~41 zinc-air batteries/hearing aid or 41,000 disposable zinc-air batteries.

Using the Information: Zinc Air

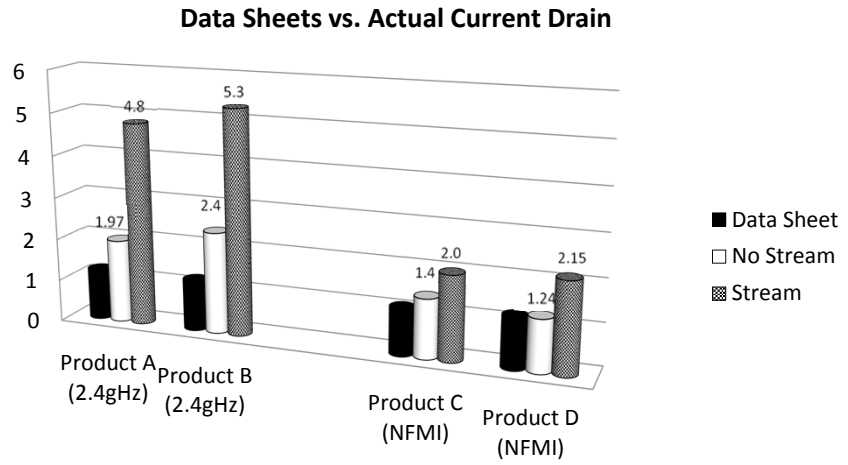
Counseling

- Mr. Jones returns complaining that zinc-air battery is not lasting 9 days as promised but 5 days.

Business

- You fit 1,000 hearing aids and provide a one year supply of batteries.
- Based on projections, you will need to order ~75 batteries/hearing aid or 75,000 disposable zinc-air batteries.

Typical Product Current Drain



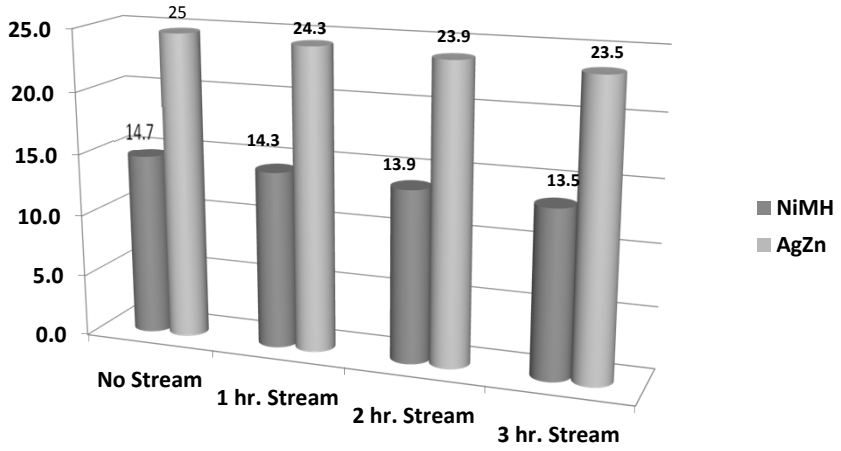
Rechargeable Batteries Size 312

	Silver-Zinc (AgZn)	Lithium-ion (Li-ion)	Nickel Metal Hydride (NiMH)
Effective Capacity (mAh)	37	--	22
Voltage (v)	1.6*	--	1.2

**Regulated to 1.4v*

NFMI Battery Life in Hours
312 Rechargeable Batteries

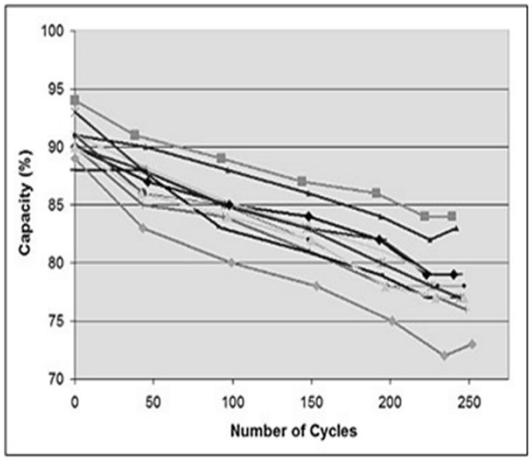
No Stream 1.5; stream 2.1



Rechargeable Batteries Size 13

	Silver-Zinc (AgZn)	Lithium-ion (Li-ion)	Nickel Metal Hydride (NiMH)
Effective Capacity (mAh)	45	42	30
Voltage (v)	1.8*	3.6*	1.2

**Regulated to 1.4v*



Courtesy of Cadex

Li-ion loses 25-35% capacity after ~200 charge cycles

Rechargeable Batteries After 300 Charge Cycles Size 13

	Silver-Zinc (AgZn)	Lithium-ion (Li-ion)	Nickel Metal Hydride (NiMH
Effective Capacity (mAh)	45	~29.5-32.0	--
Voltage (v)	1.8*	3.6*	--

**Regulated to 1.4v*

Rechargeable #13 Battery Life

New v. post-200 charges
NFMI

	AgZn	Li-ion
Capacity New (mAh)	**45 mAh**	**42 mAh**
No Stream (1.6mA)	28.2 hrs.	26.3 hrs.
Full-time Stream (2.1mA)	21.4 hrs.	20 hrs.
Capacity post-200 charges	**45 mAh**	**31.5 mAh**
No Stream (1.6mA)	28.2 hrs.	19.7 hrs.
Full-time Stream (2.1mA)	21.4 hrs.	15 hrs.

Rechargeable #13 Battery Life*

New v. post-200 charges
2.4 gHz

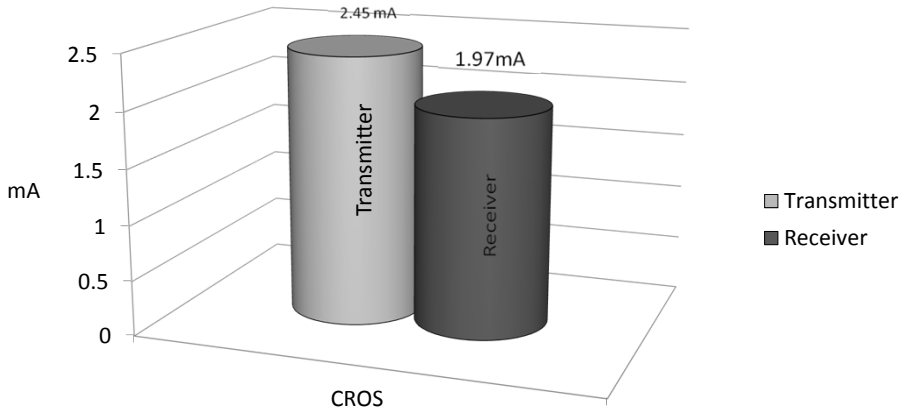
	AgZn	Li-ion*
Capacity New (mAh)	**45 mAh**	**42 mAh**
No Stream (2.0 mA)	22.5 hrs.	21 hrs.
Full-time Stream (4.5mA)	10 hrs.	9.3 hrs.
Capacity post-200 charges	**45 mAh**	**31.5 mAh**
No Stream (2.0 mA)	22.5 hrs.	15.75 hrs.
Full-time Stream (4.5 mA)	10 hrs.	7.0 hrs.

**Theoretical since Li-ion currently not available in 2.4 gHz*

Battery Current Drain: Special or Unique Cases

NFMI Wireless CROS

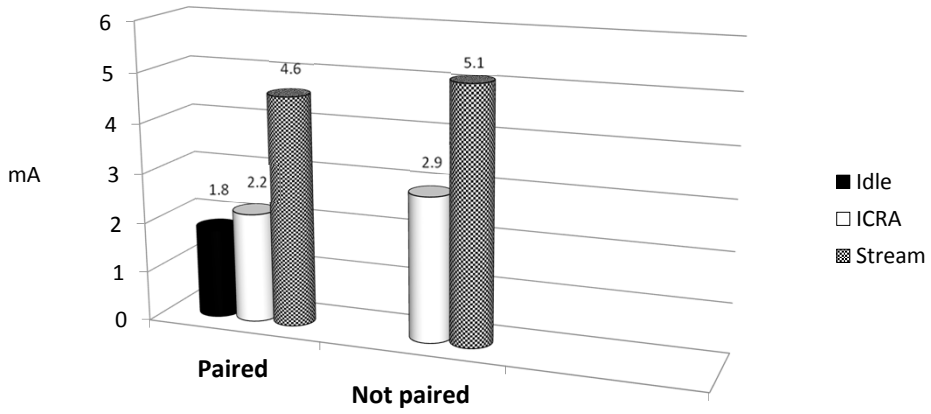
Transmitter (2.45mA): ~4 days zinc-air; Receiver (1.97mA): ~5 days (12 hr. days) zinc air



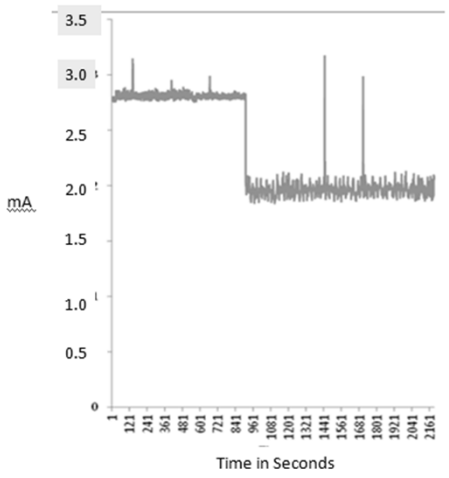
Counseling CROS Patients

- Shorter battery life on transmitter.
- Transmitting takes more energy than receiving.

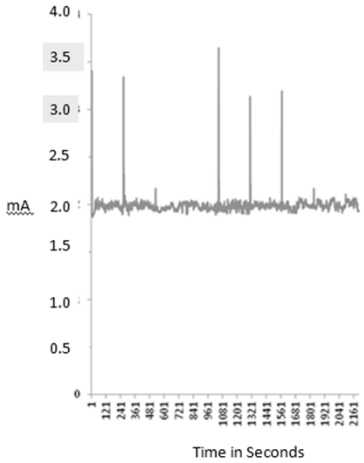
Patient wears binaural wireless streaming hearing aids (2.4gHz)



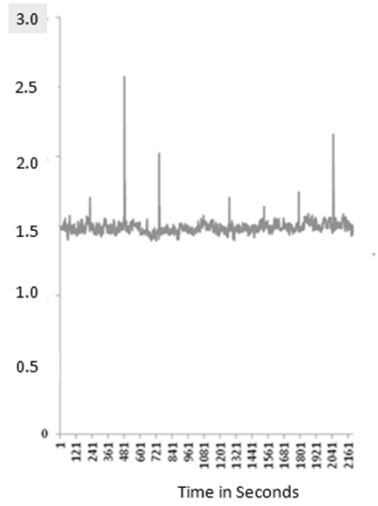
Programmed for Bilateral Processing (All Advanced Features ON/Maximum), Partner Aid **Missing** (Alexander, 2017)



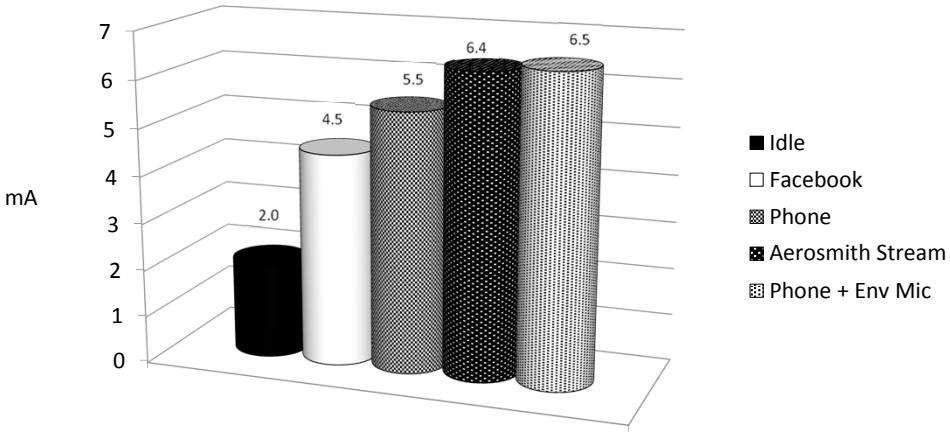
Programmed for Bilateral Processing (All Advanced Features ON/Maximum), Partner Aid **Present** (Alexander, 2017)



Programmed for Unilateral Processing (All Advanced Features OFF/Minimum (Alexander, 2017)



Battery Drain of Wireless Streaming Hearing Aids (2.4gHz)



Conclusions

- Don’t depend on datasheets.
- Assess your patient’s listening and use habits
  - Do they stream and, if so, how much?
  - What type of streaming, i.e., NFMI or 2.4gHz?
- Counsel and select a battery based on their usage habits.
- Battery life with NFMI hearing aids will be longer.
  - Additional battery in streamer
- It takes more energy to Transmit than to Receive.
- When patient wearing one hearing aid of a pair, battery life could be shortened unless turn off features like e2e.

Conclusions

- Building patient trust depends on giving patients accurate information.
- Not all zinc-air batteries are the same.
- Not all rechargeable batteries are the same.
- Know your products and the way they perform.
- Know your hearing aids
- Know your batteries

Thank you for listening!

Contact Us.
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