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Clinical Application of Active Middle Ear Implants (AMEIs)

Elizabeth M. Adams, PhD, CCC-A
Associate Dean for Graduate Affairs &
Faculty Development
Covey College of Allied Health Professions



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Elizabeth M. Adams, PhD CCC-A

Dr. Elizabeth M. Adams has more than 20 years of service in the field of Audiology, with over 18 of those educating future Audiologists in the academic setting. Her areas of expertise include amplification systems, both traditional and implantable, and the assessment and management of vestibular system disorders. Dr. Adams recognizes the importance of understanding the theory and history of clinical concepts in order to positively impact the learner's ability to apply evidence-based best practices and to provide exceptional patient care.

Disclosures

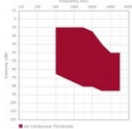
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- The course may not cover all possible risk factors, diagnostic methods, or treatment options, and complex cases may require additional considerations.
- Healthcare providers should apply cultural competence and sensitivity to ensure effective and respectful care based on their patients' diverse needs.
- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

Learning Outcomes

After this course, participants will be able to:

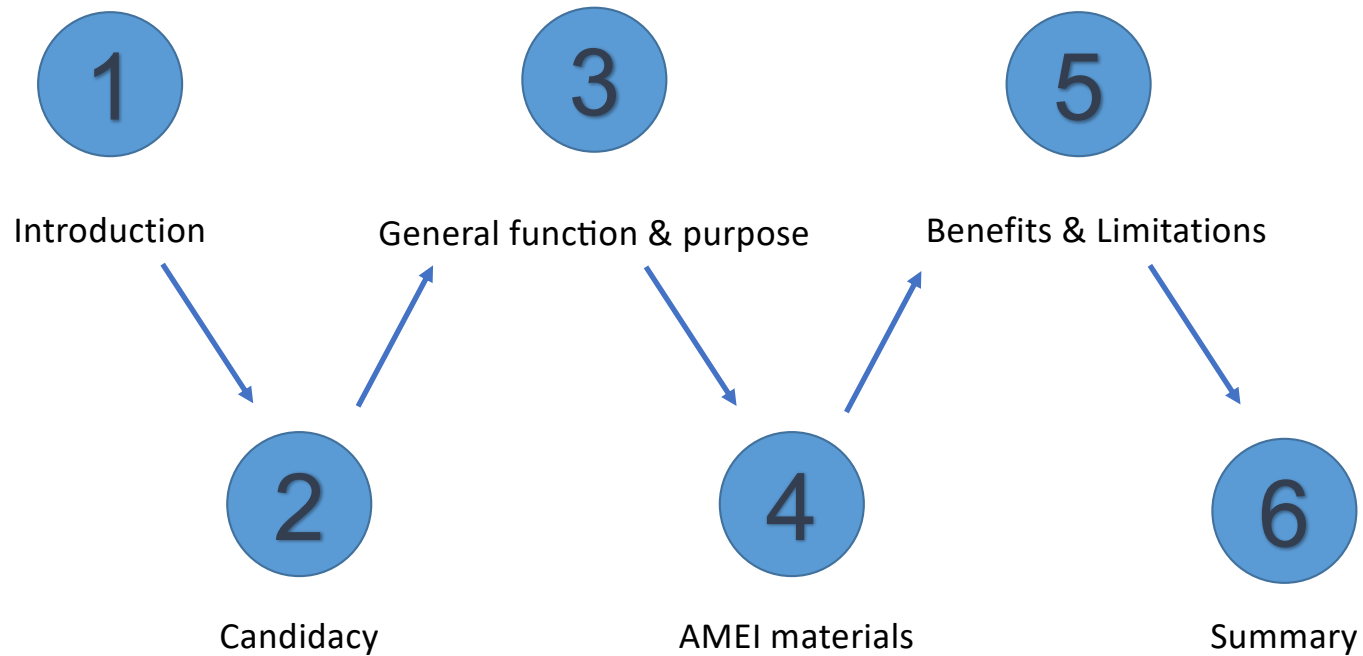


13
2



- Identify appropriate candidates for middle ear implant (MEI) technology, while considering hearing threshold level, middle ear status, previous amplification technology use, and otologic health of the patient.
- Distinguish between the various types of middle ear implant (MEI) technologies, including piezoelectric, electromagnetic, and electromechanical transducer types.
- Identify the potential benefits and limitations of middle ear implant technology in patients with hearing loss.

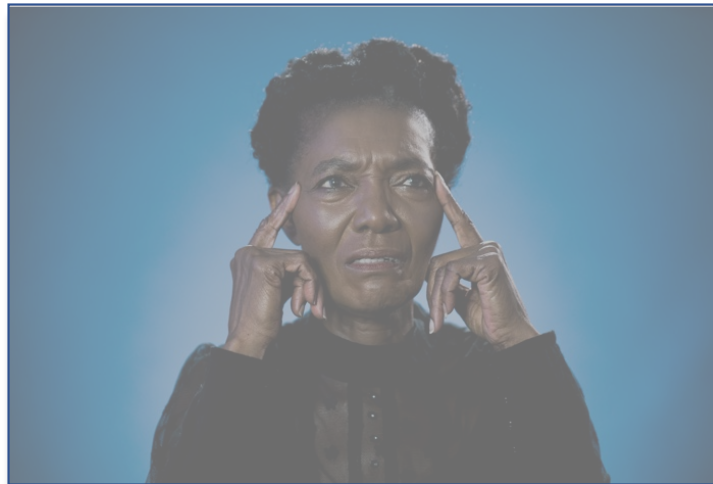
Agenda – Active Middle Ear Implant Technology



Assessing your knowledge

1. Which of the following most accurately describes **candidacy** for active middle ear implants?
2. Which of the following accurately describes the **typical input** to active middle ear implants and the **output** of the active middle ear implant to the patient?
3. Name one **completely implantable, commercially available AMEI**.
4. Which of the following **types** of active middle ear implants employs a **crystal material** that **changes shape** when electrical current is applied?
5. Which of the following active middle ear implant technologies requires a **magnet** and an **induction coil** located in close proximity to deliver the amplified signal to the patient?

Active Middle Ear Implant Technology



Quick thinking:
Who are candidates for
middle ear implants?

Photo by Shopify Photos from Burst

Active Middle Ear Implant Technology

Creates *mechanical motion* to *drive* the ossicular chain or *move* cochlear fluid



partially or fully implantable devices

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Middle Ear Implant Technology

Candidacy

01

age

> 18 years of age

02

hearing
thresholds

Mod to sev SNHL*

03

speech
understanding

>40 to 60%
(device specific)

04

amplification use

difficulty with
conventional
amplification

05

A&P

normal ME,
TM anatomy
normal ET function

Candidacy Evaluation

Audiometric evaluation

- Pure tone audiometric thresholds
- Speech reception thresholds
- Speech discrimination testing in quiet & noise
- Tympanometry
- Stapedial reflex threshold testing

Self-assessment

- COSI
- APHAB

Hearing aid amplification use

- Appropriately fit hearing aid amplification
- Consistent use for at least 3 months
- Full time use

Active Middle Ear Implant Technology

Contraindications



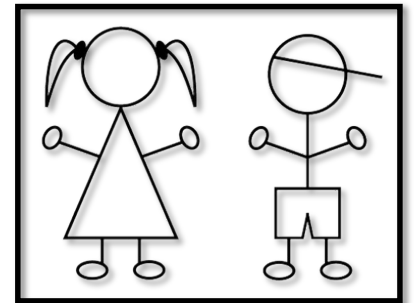
ME status

Recurrent otitis media



Mastoid status

Complete mastoidectomy



Age

<18 years of age

Active Middle Ear Implants

*Transduce acoustic energy
from the environment into
mechanical oscillatory energy*

Energy is transmitted to a **mobile structure** within the ME space
Movement of the **ossicular chain** and/or a **prosthesis**

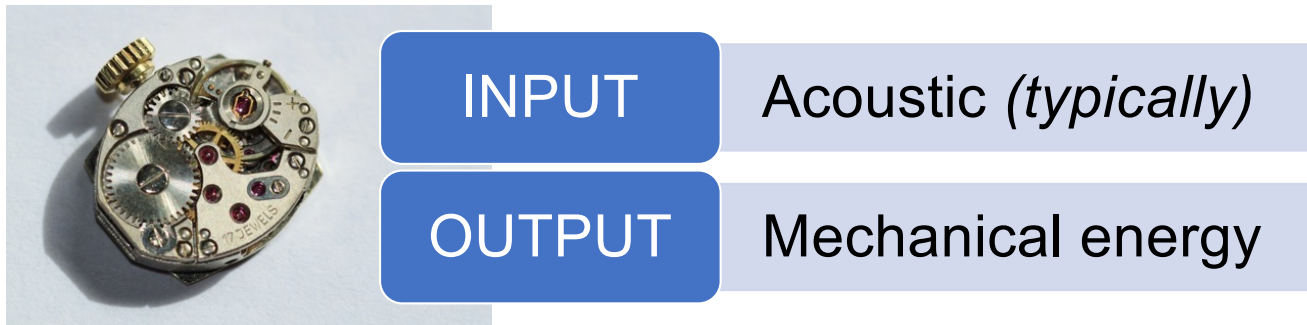
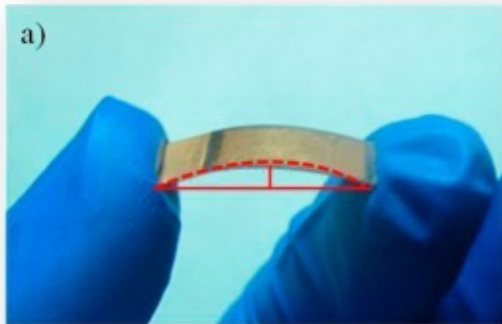


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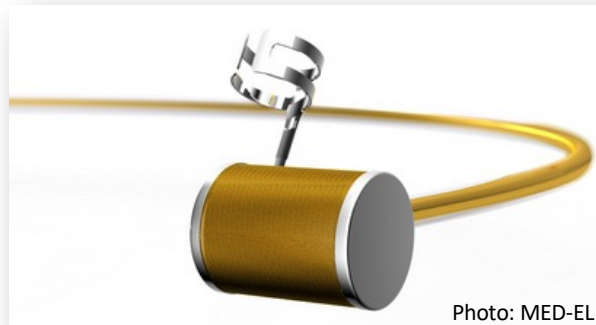
Active Middle Ear Implant Technology



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01
Piezoelectric

Transducer type



02
Electromagnetic

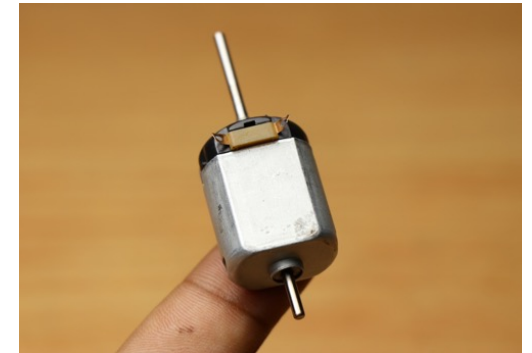
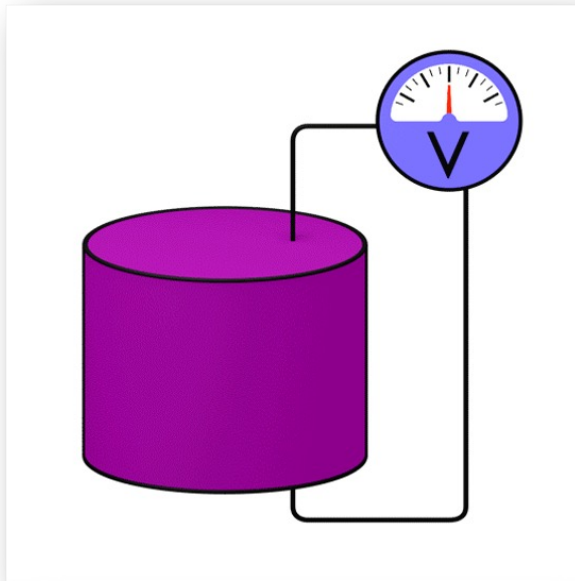


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03
Electromechanical

1. Piezoelectric Active Middle Ear Implant Technology



*Electrical current applied to
piezoelectric material
creates *mechanical motion**

Piezoelectric AMEI Technology

Electric current delivered to piezoelectric crystal (*lead titanium zirconate (PZT)*)

Piezoelectric materials:

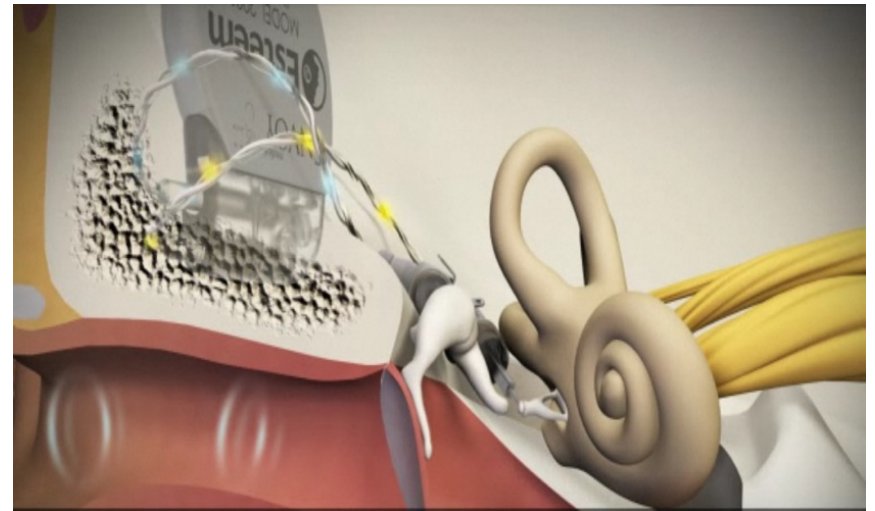
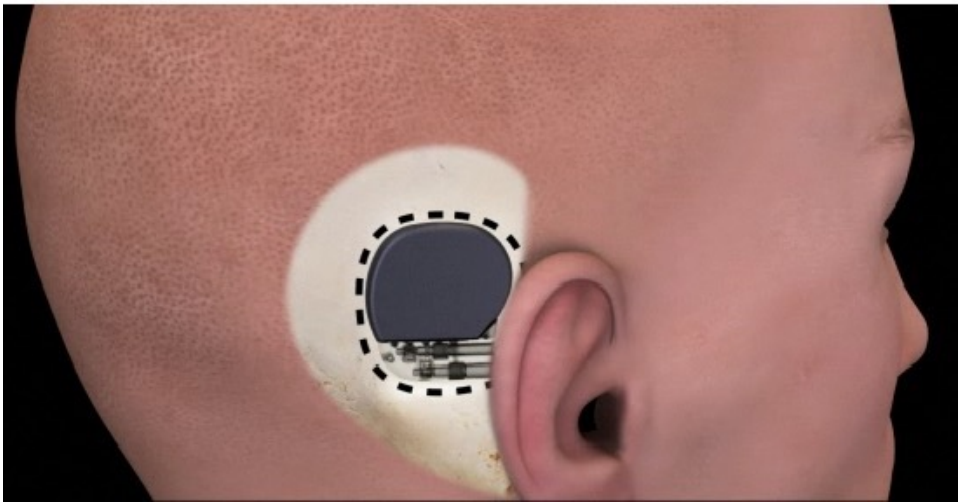
- When **voltage** is applied, **material** is **deformed**
- **Contraction & expansion** of material depends on **direction** of current (*- or +*)
- Voltage applied ultimately causes **mechanical motion**



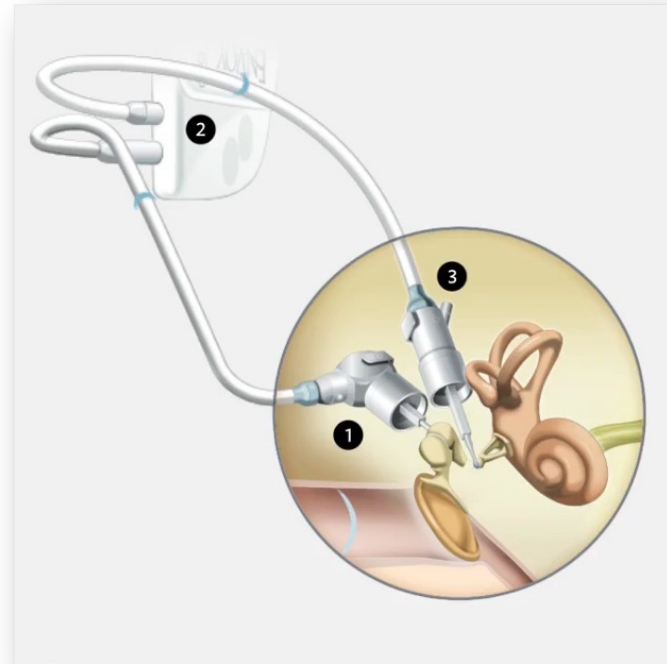
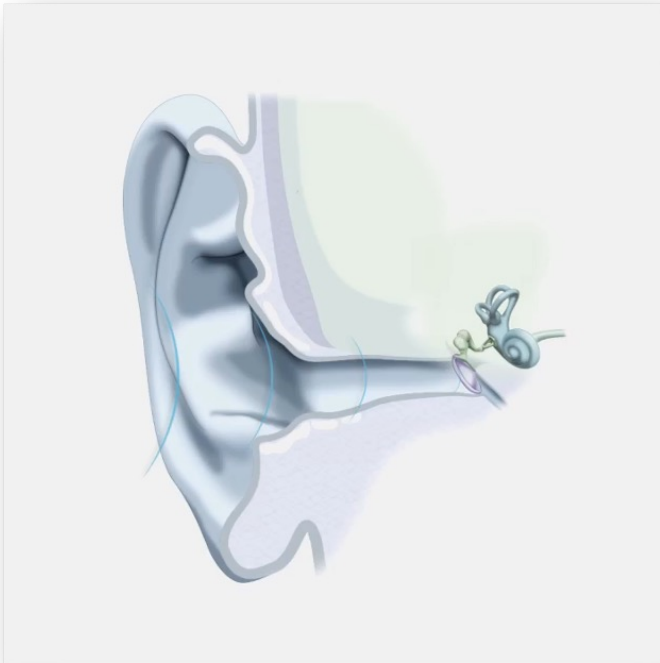
*Bimorph
piezoelectric
material*

Esteem

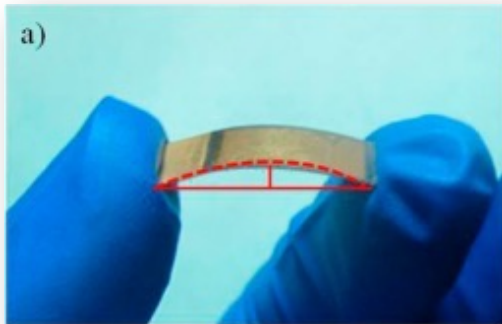
MEDICAL
ENVOY



Esteem



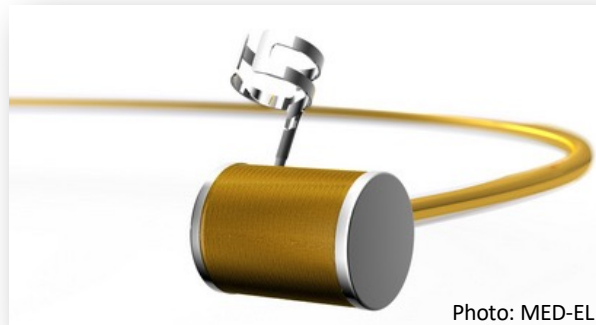
Active Middle Ear Implant Technology



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01
Piezoelectric

Transducer type



02
Electromagnetic

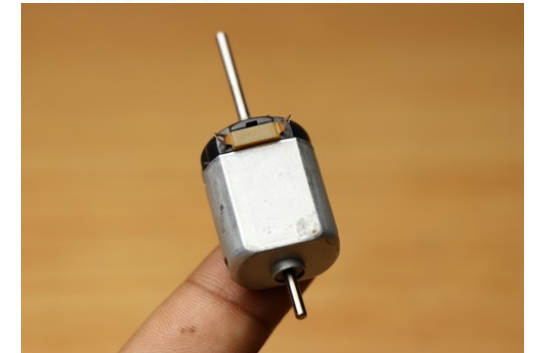
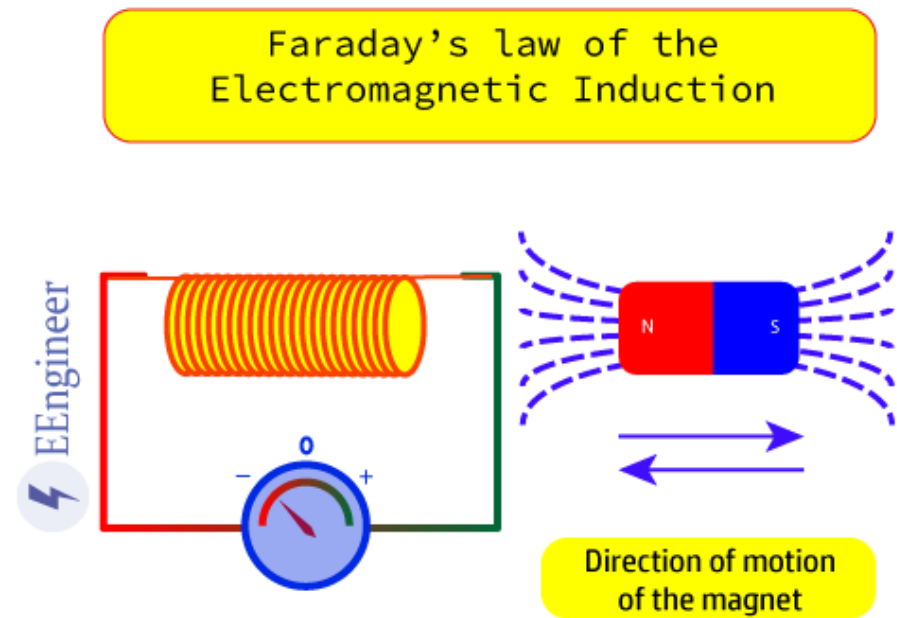


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03
Electromechanical

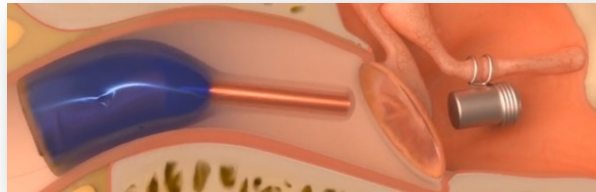
2. Electromagnetic AMEI

Induction is used to create **mechanical motion**



Electromagnetic AMEI

- ☐ Includes biocompatible magnet and induction coil

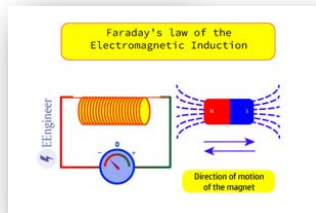


- ☐ Magnet is typically affixed to the ossicular chain
- ☐ Induction coil is placed in close proximity to the magnet

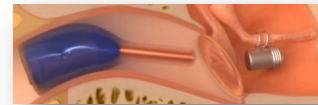
Photo: Ototronix MAXUM, used with permission.

Electromagnetic AMEI

Electrical current is delivered to an **induction coil**



Fluctuating electromagnetic field alternatively **attracts** and **repels** the **magnet**

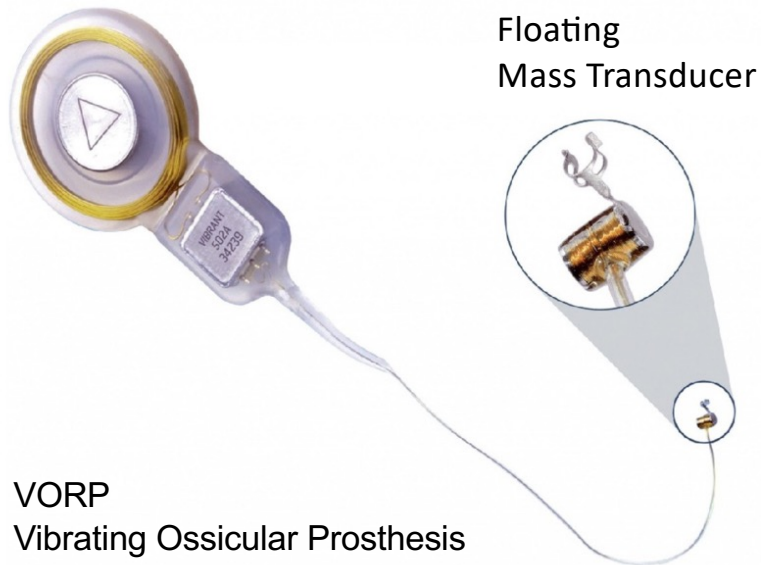


Movement of the magnet causes **movement** of the **ossicular chain** or prosthesis

Creates **fluctuating electromagnetic field** around the coil
proportional to the original acoustic signal

Causes the **magnet** to **oscillate**
proportional to the original acoustic signal

Vibrant Soundbridge



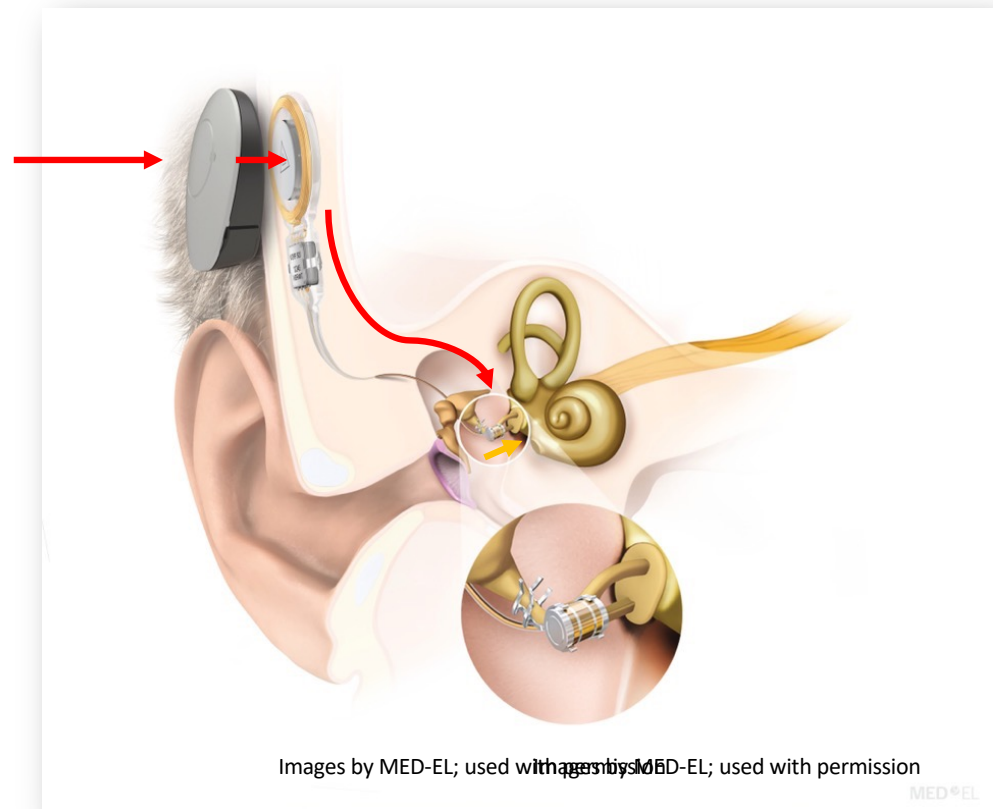
VORP
Vibrating Ossicular Prosthesis

The VIBRANT SOUNDBRIDGE system is not currently sold in the USA. The VORP 503 is not an FDA approved product.



SAMBA 2 processor

Vibrant Soundbridge



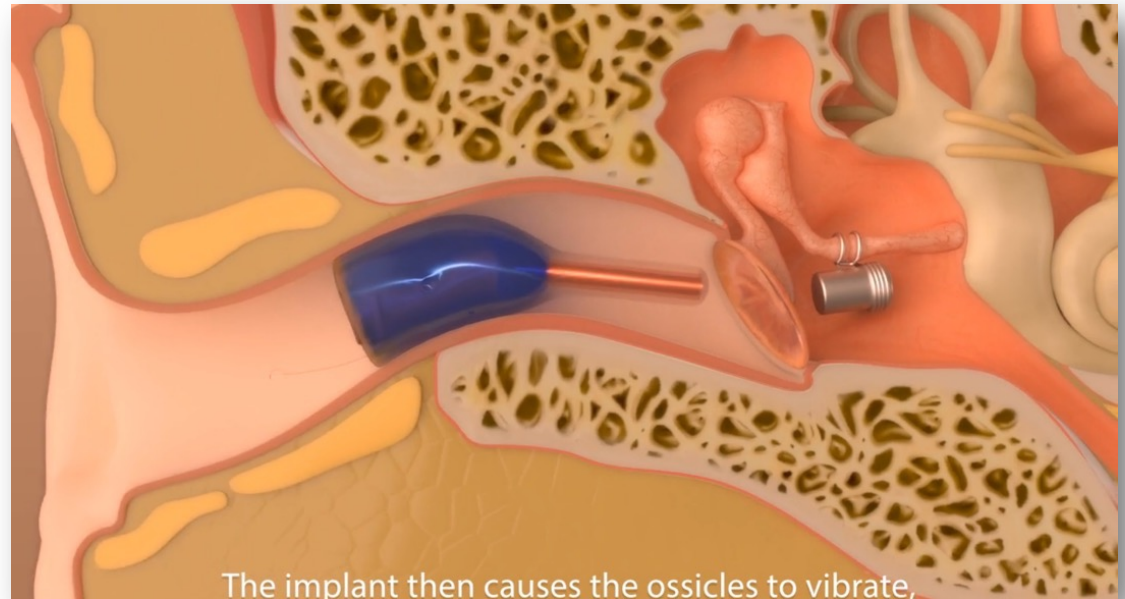
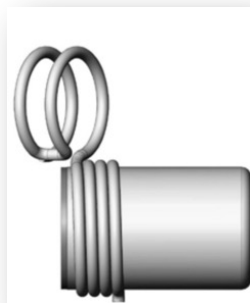
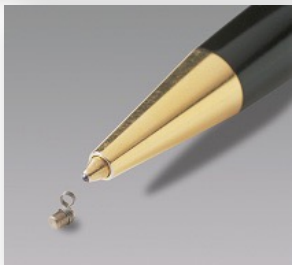
The VIBRANT SOUNDBRIDGE system is not currently sold in the USA. The VORP 503 is not an FDA approved product.

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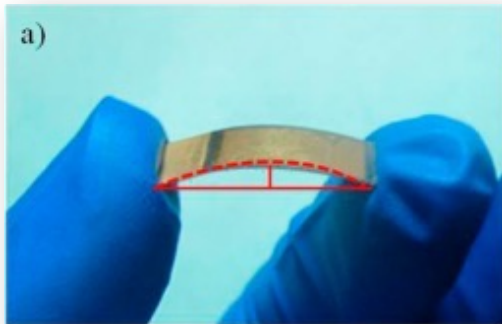
MED⁹EL



MAXUM System



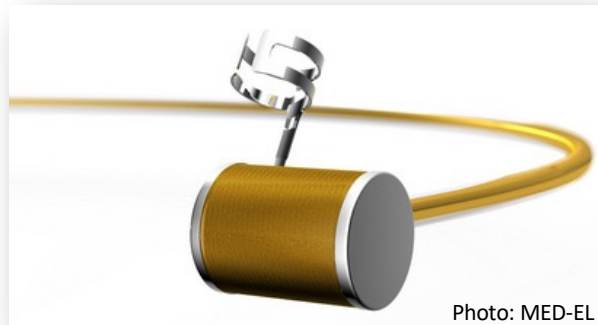
Active Middle Ear Implant Technology



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01
Piezoelectric

Transducer type



02
Electromagnetic

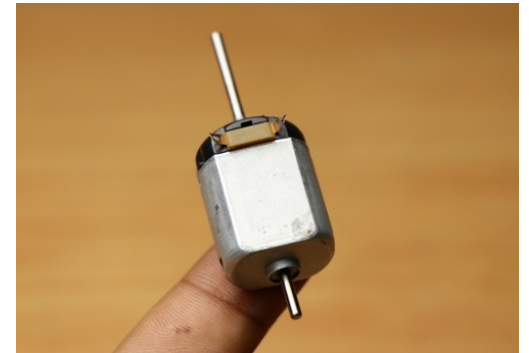
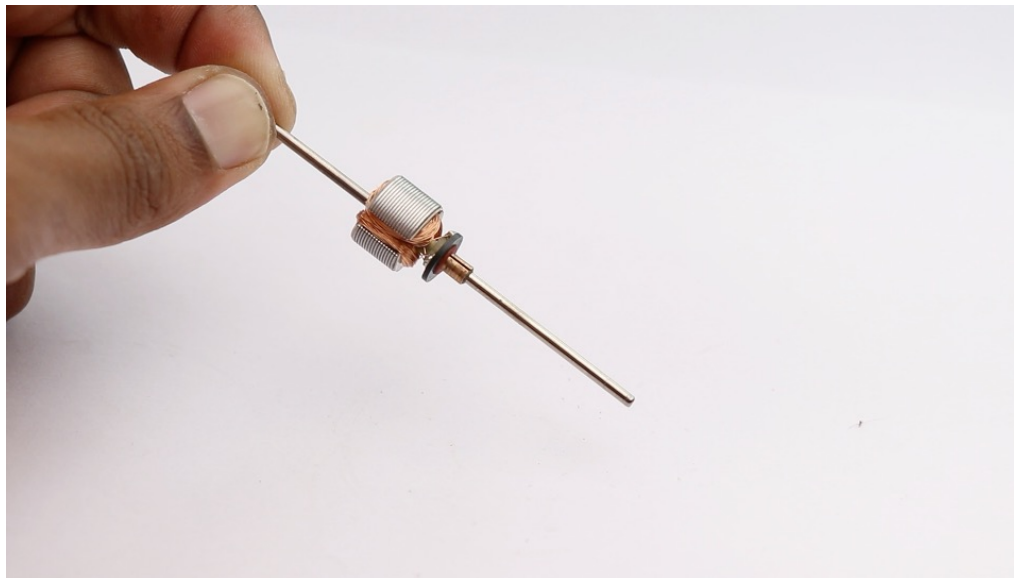


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03
Electromechanical

3. Electromechanical AMEI

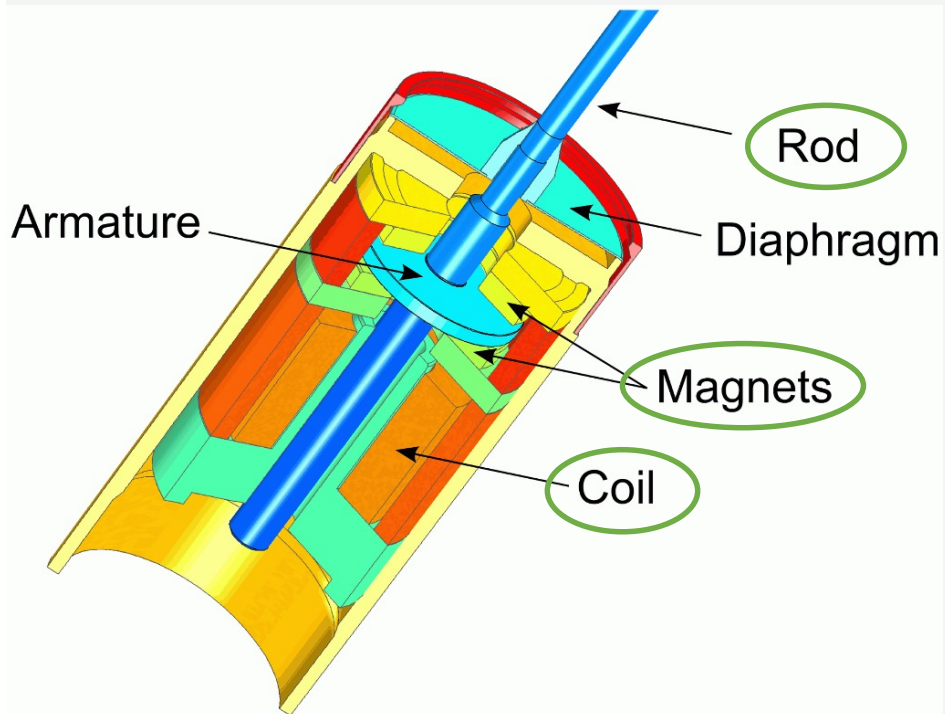
Electrical current applied to drive **mechanical motion**



3. Electromechanical AMEI

- ☐ Designed to eliminate the problem of *sub-optimal distance* between the **coil & magnet** of the electromagnetic devices
- ☐ All-in-one packaging
 - Biocompatible magnet
 - Surrounded by a coil of wire
 - Drives an artificial incus
- ☐ Transducer is affixed to the **ossicular chain** or **RW**

? Quiz Hint



Q5

3. Electromechanical AMEI

Electrical current is delivered to coil of wire

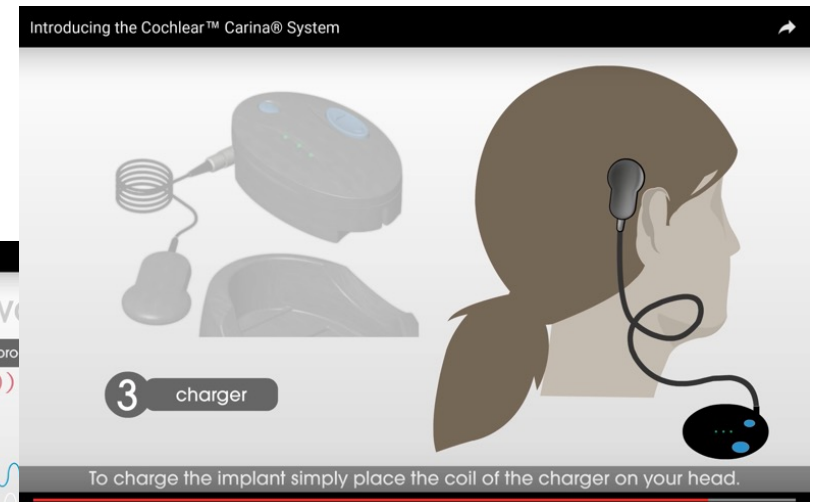
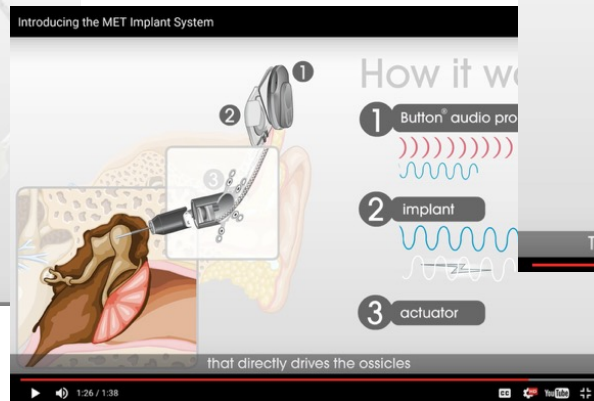
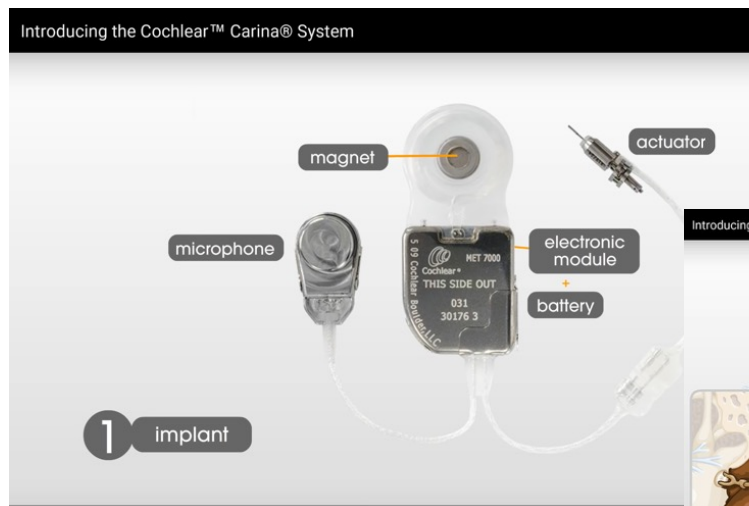
Generates electromagnetic field

Drives magnet inside casing

Movement of the magnet pushes and pulls a driver rod

Carina (Cochlear Ltd, Sydney, Australia)

- Not currently FDA approved for use in the US



Images by Cochlear; used with permission

Active Middle Ear Implants



Benefits

- Higher levels of gain
 - Less distortion
 - Less feedback
- Comfort
- Fully implantable options

Limitations

- Surgical procedure
- Other technologies typically meet or exceed expected outcomes
- Lack of flexibility if patient is dissatisfied with result
- Cost (financial, time, effort, other resources)
- Provider familiarity

Aural Rehabilitation

- ❑ Device activation: 3-4 weeks post-op

- ❑ Follow ups:

 - 1 week after activation

 - 1 month later

 - at least twice during the 1st year
annually

- ❑ Aural rehab to focus on

 - speech reception at phoneme, word, sentence level

 - re-evaluate with COSI or APHAB

 - counseling to address continued difficulties & realistic expectations

Summary

Esteem is FDA approved for moderate to severe SNHL

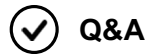
Piezoelectric, Electromagnetic, & Electromechanical AMEIs

Envoy Esteem currently available in the US;
Med-EL Vibrant Soundbridge not currently available in the US

Some studies suggest that outcomes are at least as good as
outcomes with traditional HAs

Limitations include surgery, lack of flexibility if patient is dissatisfied,
and cost

Benefits patients who have experienced difficulty with traditional
hearing aids



THANKS for spending your time with me!

Elizabeth M. Adams, PhD, CCC-A
Associate Dean for Graduate Affairs &
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Covey College of Allied Health Professions



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