

HEARING AIDS AND DEVICES INCLUDING WEARABLE, BONE-ANCHORED AND SEMI-IMPLANTABLE

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| Related Policies |
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INSTRUCTIONS FOR USE

This Clinical Policy provides assistance in interpreting Oxford benefit plans. Unless otherwise stated, Oxford policies do not apply to Medicare Advantage members. Oxford reserves the right, in its sole discretion, to modify its policies as necessary. This Clinical Policy is provided for informational purposes. It does not constitute medical advice. The term Oxford includes Oxford Health Plans, LLC and all of its subsidiaries as appropriate for these policies.

When deciding coverage, the member specific benefit plan document must be referenced. The terms of the member specific benefit plan document [e.g., Certificate of Coverage (COC), Schedule of Benefits (SOB), and/or Summary Plan Description (SPD)] may differ greatly from the standard benefit plan upon which this Clinical Policy is based. In the event of a conflict, the member specific benefit plan document supersedes this Clinical Policy. All reviewers must first identify member eligibility, any federal or state regulatory requirements, and the member specific benefit plan coverage prior to use of this Clinical Policy. Other Policies may apply.

UnitedHealthcare may also use tools developed by third parties, such as the MCG™ Care Guidelines, to assist us in administering health benefits. The MCG™ Care Guidelines are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

Note: This policy does not address assistive listening devices, computers, transmitters or similar products.

CONDITIONS OF COVERAGE

| | |
|--|---|
| Applicable Lines of Business/Products | This policy applies to Oxford Commercial plan membership. |
| Benefit Type | General Benefits Package ¹ Hearing Aid Rider ² |
| Referral Required (Does not apply to non-gatekeeper products) | No ^{2,3} |
| Authorization Required (Precertification always required for inpatient admission) | Yes ^{1,2,3} |
| Precertification with Medical Director Review Required | Yes ^{1,2,3} |
| Applicable Site(s) of Service (If site of service is not listed, Medical Director review is required) | All |

Special Considerations

¹Precertification with review by a Medical Director or their Designee is required for placement/provision of implantable and semi-implantable hearing devices and bone-anchored Hearing Aids.

²Precertification is not required for wearable Hearing Aids and/or the fitting or testing of a Hearing Aid.

³Coverage for Hearing Aids, where available as a benefit or rider, varies by plan and product. Refer to the Member's specific certificate of coverage, summary of benefits, and/or health benefits plan documentation for additional information.

BENEFIT CONSIDERATIONS

Before using this policy, please check the member specific benefit plan document and any federal or state mandates, if applicable.

The following Hearing Aids may not be covered for certain benefit plans. Refer to the member specific benefit plan document to determine if coverage applies.

- Wearable Hearing Aids (including non-implantable bone conduction Hearing Aids utilizing a headband)
- Semi-Implantable Electromagnetic Hearing Aids (SEHA)
- Fully or Partially Implantable bone anchored Hearing Aids
- Totally implanted middle ear hearing systems
- Intraoral bone conduction Hearing Aids
- Laser or light based Hearing Aids

Frequency Modulated (FM) Systems can be used as an extension or accessory of Hearing Aids. FM Systems are excluded from coverage. These do not prevent, diagnose or treat a sickness or injury, and are not integral to the Hearing Aid itself.

Essential Health Benefits for Individual and Small Group

For plan years beginning on or after January 1, 2014, the Affordable Care Act of 2010 (ACA) requires fully insured non-grandfathered individual and small group plans (inside and outside of Exchanges) to provide coverage for ten categories of Essential Health Benefits ("EHBs"). Large group plans (both self-funded and fully insured), and small group ASO plans, are not subject to the requirement to offer coverage for EHBs. However, if such plans choose to provide coverage for benefits which are deemed EHBs, the ACA requires all dollar limits on those benefits to be removed on all Grandfathered and Non-Grandfathered plans. The determination of which benefits constitute EHBs is made on a state by state basis. As such, when using this policy, it is important to refer to the member specific benefit plan document to determine benefit coverage.

COVERAGE RATIONALE

Wearable Hearing Aids (Including Non-Implantable Bone Conduction Hearing Aids Utilizing a Headband)

Hearing Aids required for the correction of a hearing impairment (a reduction in the ability to perceive sound which may range from slight to complete deafness) are proven and medically necessary.

Bilateral or unilateral bone-anchored Hearing Aids utilizing a headband (without osseointegration) are proven and medically necessary for hearing loss in an individual who is not a candidate for an air-conduction Hearing Aid and when used according to U.S. Food and Drug Administration (FDA) labeled indications, contraindications, warnings and precautions.

[See the FDA section for more information.](#)

Semi-Implantable Electromagnetic Hearing Aids (SEHA)

A semi-implantable electromagnetic Hearing Aid is proven and medically necessary for Sensorineural Hearing Loss in an individual who is not a candidate for an air-conduction Hearing Aid and when used according to U.S. Food and Drug Administration (FDA) labeled indications, contraindications, warnings and precautions.

[See the FDA section for more information.](#)

Bone Anchored Hearing Aids

Implantable Bone-Anchored Hearing Aid (BAHA) for Sensorineural Hearing Loss

A unilateral fully or partially implantable bone-anchored Hearing Aid is proven and medically necessary for Sensorineural Hearing Loss in one ear in an individual who is not a candidate for an air-conduction

Hearing Aid and when used according to U.S. Food and Drug Administration (FDA) labeled indications, contraindications, warnings and precautions.

[See the FDA section for more information.](#)

Implantable Bone-Anchored Hearing Aid (BAHA) for Conductive or Mixed Hearing Loss

A unilateral fully or partially implantable bone-anchored Hearing Aid is proven and medically necessary for Conductive or Mixed Hearing Loss in one or both ears in an individual who is not a candidate for an air-conduction Hearing Aid and when used according to U.S. Food and Drug Administration (FDA) labeled indications, contraindications, warnings and precautions.

[See the FDA section for more information.](#)

Bilateral fully or partially implantable bone-anchored Hearing Aids are proven and medically necessary for Conductive or Mixed Hearing Loss in both ears in an individual who is not a candidate for an air-conduction Hearing Aid and when used according to U.S. Food and Drug Administration (FDA) labeled indications, contraindications, warnings and precautions.

[See the FDA section for more information.](#)

Totally Implanted Middle Ear Hearing Systems

Totally implanted middle ear hearing systems are unproven and not medically necessary for hearing loss.

There is inadequate evidence demonstrating the efficacy of totally implanted middle ear hearing systems for treating hearing loss or deafness. Well-designed studies with larger study populations and longer follow-up are required to demonstrate the safety and benefits of these devices.

Intraoral Bone Conduction Hearing Aids

An intraoral bone conduction Hearing Aid is unproven and not medically necessary for treating hearing loss.

There is insufficient evidence to support the use of an intraoral bone conduction Hearing Aid to treat hearing loss. The quality of the studies was low due to small study populations, short follow-up, and lack of randomization and appropriate control groups.

Laser or Light Based Hearing Aids

[Laser or light based Hearing Aids](#) are unproven and not medically necessary for treating hearing loss.

The evidence assessing the effectiveness of this device is limited. Additional studies with larger populations and long-term follow-up are needed to evaluate improvement of hearing with Hearing Aids that use light to transmit sound.

DEFINITIONS

Conductive Hearing Loss: Occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and the tiny bones (ossicles) of the middle ear. Conductive Hearing Loss usually involves a reduction in sound level or the ability to hear faint sounds. This type of hearing loss can often be corrected medically or surgically.

Degree of Hearing Loss:

| Degree of Hearing Loss | Range (dbHL = decibels hearing level) |
|------------------------|---------------------------------------|
| Normal Hearing | -10 to 15 dBHL |
| Slight Loss | 16 to 25 dBHL |
| Mild Loss | 26 to 40 dBHL |
| Moderate Loss | 41 to 55 dBHL |
| Moderately Severe Loss | 56 to 70 dBHL |
| Severe Loss | 71 to 90 dBHL |
| Profound Loss | 91 dBHL or more |

(ASHA, Type, Degree and Configuration of Hearing Loss; Clark, 1981)

Frequency Modulated Systems (Auditory Trainers): A wireless connection to the listener's amplification system.

Hearing Aids: Hearing Aids are sound-amplifying devices designed to aid people who have a hearing impairment. Most Hearing Aids share several similar electronic components, and technology used for amplification may be analog or digital. (Semi-implantable electromagnetic Hearing Aids and bone-anchored Hearing Aids are classified by the U.S. Food and Drug Administration (FDA) as Hearing Aids. Some non-wearable hearing devices are described as hearing devices or hearing systems. Because their function is to bring sound more effectively into the ear of a person with hearing loss, for the purposes of this policy, they are Hearing Aids).

Mixed Hearing Loss: Occurs when a Conductive Hearing Loss occurs in combination with a Sensorineural Hearing Loss (SNHL). In other words, there may be damage in the outer or middle ear and in the inner ear (cochlea) or auditory nerve.

Sensorineural Hearing Loss (SNHL): Occurs when there is damage to the inner ear (cochlea), or to the nerve pathways from the inner ear to the brain. Most of the time, SNHL cannot be medically or surgically corrected. This is the most common type of permanent hearing loss.

APPLICABLE CODES

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by the member specific benefit plan document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies may apply.

| CPT Code | Description |
|---|--|
| Fitting and Testing of Hearing Aids | |
| 92590 | Hearing aid examination and selection; monaural |
| 92591 | Hearing aid examination and selection; binaural |
| 92592 | Hearing Aid check; monaural |
| 92593 | Hearing Aid check; binaural |
| 92594 | Electroacoustic evaluation for hearing aid; monaural |
| 92595 | Electroacoustic evaluation for hearing aid; binaural |
| Semi-Implantable Electromagnetic Hearing Aids (SEHA) | |
| 69799 | Unlisted procedure, middle ear |
| Bone Anchored Hearing Aids (BAHA) | |
| 69710 | Implantation or replacement of electromagnetic bone conduction hearing device in temporal bone |
| 69711 | Removal or repair of electromagnetic bone conduction hearing device in temporal bone |
| 69714 | Implantation, osseointegrated implant, temporal bone, with percutaneous attachment to external speech processor/cochlear stimulator; without mastoidectomy |
| 69715 | Implantation, osseointegrated implant, temporal bone, with percutaneous attachment to external speech processor/cochlear stimulator; with mastoidectomy |
| 69717 | Replacement (including removal of existing device), osseointegrated implant, temporal bone, with percutaneous attachment to external speech processor/cochlear stimulator; without mastoidectomy |
| 69718 | Replacement (including removal of existing device), osseointegrated implant, temporal bone, with percutaneous attachment to external speech processor/cochlear stimulator; with mastoidectomy |

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| HCPCS Code | Description |
|--|---|
| Fitting and Testing of Hearing Aids | |
| S0618 | Audiometry for hearing aid evaluation to determine the level and degree of hearing loss |
| V5010 | Assessment for hearing aid |
| V5011 | Fitting/orientation/checking of hearing aid |
| V5014 | Repair/modification of a hearing aid |
| V5020 | Conformity Evaluation |
| V5264 | Ear mold/insert, not disposable, any type |
| V5265 | Ear mold/insert, disposable, any type |
| V5275 | Ear Impression, each |

| HCPCS Code | Description |
|---|--|
| Semi-Implantable Electromagnetic Hearing Aids (SEHA) | |
| S2230 | Implantation of magnetic component of semi-implantable hearing device on ossicles in middle ear |
| V5095 | Semi-implantable middle ear hearing prosthesis |
| Bone Anchored Hearing Aids (BAHA) | |
| L8690 | Auditory osseointegrated device, includes all internal and external components |
| L8691 | Auditory osseointegrated device, external sound processor, excludes transducer/actuator, replacement only, each |
| L8692 | Auditory osseointegrated device, external sound processor, used without osseointegration, body worn, includes headband or other means of external attachment |
| L8693 | Auditory osseointegrated device abutment, any length, replacement only |
| L8694 | Auditory osseointegrated device, transducer/actuator, replacement only, each |
| Wearable Hearing Aids | |
| V5030 | Hearing aid, monaural, body worn, air conduction |
| V5040 | Hearing aid, monaural, body worn, bone conduction |
| V5050 | Hearing aid, monaural, in the ear |
| V5060 | Hearing aid, monaural, behind the ear |
| V5070 | Glasses, air conduction |
| V5080 | Glasses, bone conduction |
| V5100 | Hearing aid, bilateral, body worn |
| V5120 | Binaural, body |
| V5130 | Binaural, in the ear |
| V5140 | Binaural, behind the ear |
| V5150 | Binaural, glasses |
| V5171 | Hearing aid, contralateral routing device, monaural, in the ear (ITE) |
| V5172 | Hearing aid, contralateral routing device, monaural, in the canal (ITC) |
| V5181 | Hearing aid, contralateral routing device, monaural, behind the ear (BTE) |
| V5190 | Hearing aid, contralateral routing, monaural, glasses |
| V5211 | Hearing aid, contralateral routing system, binaural, ITE/ITE |
| V5212 | Hearing aid, contralateral routing system, binaural, ITE/ITC |
| V5213 | Hearing aid, contralateral routing system, binaural, ITE/BTE |
| V5214 | Hearing aid, contralateral routing system, binaural, ITC/ITC |
| V5215 | Hearing aid, contralateral routing system, binaural, ITC/BTE |
| V5221 | Hearing aid, contralateral routing system, binaural, BTE/BTE |
| V5230 | Hearing aid, contralateral routing system, binaural, glasses |
| V5242 | Hearing aid, analog, monaural, CIC (completely in the ear canal) |
| V5243 | Hearing aid, analog, monaural, ITC (in the canal) |
| V5244 | Hearing aid, digitally programmable analog, monaural, CIC |
| V5245 | Hearing aid, digitally programmable analog, monaural, ITC |
| V5246 | Hearing aid, digitally programmable analog, monaural, ITE (in the ear) |
| V5247 | Hearing aid, digitally programmable analog, monaural, BTE (behind the ear) |
| V5248 | Hearing aid, analog, binaural, CIC |
| V5249 | Hearing aid, analog, binaural, ITC |
| V5250 | Hearing aid, digitally programmable analog, binaural, CIC |
| V5251 | Hearing aid, digitally programmable analog, binaural, ITC |
| V5252 | Hearing aid, digitally programmable, binaural, ITE |
| V5253 | Hearing aid, digitally programmable, binaural, BTE |

| HCPCS Code | Description |
|------------|---|
| V5254 | Hearing aid, digital, monaural, CIC |
| V5255 | Hearing aid, digital, monaural, ITC |
| V5256 | Hearing aid, digital, monaural, ITE |
| V5257 | Hearing aid, digital, monaural, BTE |
| V5258 | Hearing aid, digital, binaural, CIC |
| V5259 | Hearing aid, digital, binaural, ITC |
| V5260 | Hearing aid, digital, binaural, ITE |
| V5261 | Hearing aid, digital, binaural, BTE |
| V5262 | Hearing aid, disposable, any type, monaural |
| V5263 | Hearing aid, disposable, any type, binaural |
| V5267 | Hearing Aid or assistive listening device/supplies/accessories, not otherwise specified (Note: For plans that cover hearing aids, this code requires manual review to determine what the item is before a coverage determination can be made.) |
| V5298 | Hearing aid, not otherwise classified |

DESCRIPTION OF SERVICES

Hearing Aids are electronic amplifying devices designed to bring sound more effectively into the ear. A Hearing Aid consists of a microphone, amplifier and receiver. Wearable Hearing Aids including air-conduction Hearing Aids (ACHAs) are the standard treatment for hearing loss that cannot be medically or surgically corrected.

Non-Implantable Bone Conduction Hearing Aids Utilizing a Headband

While Conductive Hearing Loss can often be treated with ACHAs, in some cases (e.g., those resulting from the congenital malformation of the external ear canal, pinna and middle ear structures) the use of ACHAs is not possible. In these cases, a standard non-implantable bone conduction Hearing Aid (BCHA) is required. These bone conduction or bone-anchored Hearing Aids may be held in place by a headband, with the amplified vibrational sound transmitted transcutaneously to the bones of the skull for transmission to the cochlea. In this application there is no implantation surgery; rather, the sound processor is attached firmly to the head using either a hard or soft headband, and the amplified vibrational sound is transmitted transcutaneously to the bones of the skull for transmission to the cochlea. Children may use a headband until their temporal bone is mature enough for implantation of a bone anchored Hearing Aid. For adults, a headband is often used to determine whether they might benefit from bone anchored implant systems.

Semi-Implantable Electromagnetic Hearing Aids (SEHA)

Semi-implantable electromagnetic Hearing Aids use the periodic attraction and repulsion of two magnetic fields, one electromagnetic and the other static magnetic, to cause vibration of the ossicles and transmission of sound to the inner ear. When the external sound processor receives sound, it is transformed into electrical signals, which are then amplified and transmitted to a magnetic device that is surgically implanted into the middle ear. The implant's vibrations directly drive the ossicles' movement, producing amplified sound perception. By mimicking the natural vibrations of the ossicular chain, an enhanced signal is sent to the cochlea, resulting in a clearer sound that can be increased without the volume amplification required by ACHAs. In addition, since the air pressure on each side of the sound processor is the same, the wearer does not experience the feeling of occlusion that is common with standard Hearing Aids. Currently, there are three commercially available semi-implantable electromagnetic hearing devices: 1) the Vibrant[®] Soundbridge[™] System (Symphonix Devices Inc.; later acquired by Med-El GmbH), 2) the Maxum[™] System (Ototronix) that was originally called the Soundtec Direct System, and 3) the Middle Ear Transducer (MET) Ossicular Stimulator System (Otologics LLC). The Soundtec Direct device was voluntarily removed from the market in 2004 while the manufacturer attempted to eliminate a rattling sound some individuals experienced, primarily when the sound processor was not used. The Maxum System represents an upgrade over the Soundtec Direct System. The two systems use the same technology and components, although the designs differ.

Semi-implantable electromagnetic Hearing Aids are classified by the U.S. Food and Drug Administration (FDA) as Hearing Aids.

Bone Anchored Hearing Aids are surgically implantable systems to treat hearing loss through bone conduction of sound vibrations. An implantable bone-anchored or implantable bone conduction Hearing Aid is an alternative to a wearable Hearing Aid. The fully implantable bone-anchored Hearing Aid is a percutaneous BCHA involving the surgical implantation of a titanium screw into the mastoid process of the skull (osseointegration). In contrast to traditional BCHAs, bone-anchored Hearing Aids transmit sound vibrations directly to the skull instead through the skin. After a

waiting period to allow for complete osseointegration, a sound processor is linked to the skull through an abutment attached to the osseointegrated screw.

Partially implantable transcutaneous bone conduction Hearing Aids using magnetic coupling or magnetic attraction such as the Sophono[®] Otomag Alpha 1 System and the Sophono Alpha 2 MPO[™] Magnetic Bone Conduction Hearing System (Medtronic, formerly Sophono, Inc.), the BAHA[®] Attract System (Cochlear[®] Corporation), and the Bonebridge[™] (MED-EL) feature completely subdermal magnetic implants and do not require an abutment. Rather, the external sound processor is attracted by the magnetic implant and rests on top of the skin.

Bone-anchored Hearing Aids are classified by the FDA as Hearing Aids.

Totally Implanted Middle Ear Hearing Systems

Totally implantable middle ear hearing systems are also being evaluated in individuals with hearing loss. The Esteem prosthetic hearing restoration device (Envoy Medical Corporation) is totally implanted behind the outer ear and in the middle ear. Unlike Hearing Aids, the Esteem device does not use a microphone or a speaker. Three implanted components comprise the system: a sound processor, a sensor and a driver that converts electrical signals transmitted by the sound processor to the inner ear, where they are perceived as sound. The device is powered with a maintenance-free battery that may last up to nine years and requires no recharging. The Carina Fully Implantable Hearing Device (Cochlear, Ltd) is another totally implantable active middle ear device that was in development in the United States by Otologics, LLC but did not receive FDA approval. In September of 2012, Cochlear, Ltd, an Australian based company, purchased the hearing related assets of Otologics LLC.

Intraoral Bone Conduction Hearing Aids

The SoundBite[™] Hearing System is a non-surgical intraoral bone conduction Hearing Aid that was developed for individuals with single-sided deafness. It consists of a behind the ear device (which houses the receiver, wireless transmitter, and microphone) and a removable, custom-fit oral retainer-like device. According to the manufacturer, the device allows sound to travel via the teeth, through the bones, to both cochleae, bypassing the middle and outer ear. As of January 1, 2015, Sonitus Medical, Inc. is no longer manufacturing the Soundbite Hearing System. There is no new information concerning production of this or a similar device.

Laser or Light Based Hearing Aids

Laser or light based Hearing Aids such as the Earlens Contact Hearing Device (CHD) uses light to transmit sound, unlike traditional Hearing Aids that simply amplify air-conducted sound. The Earlens CHD consists of 2 components: a light-based behind-the-ear (BTE) sound processor; and a removable, custom-made tympanic membrane transducer, which is nonsurgically placed deep in the ear canal. The BTE processor uses a microphone and a digital signal processor to pick up sound and convert it to infrared light. Light pulses are transmitted to the transducer and are converted into vibrations that are directly applied to the tympanic membrane and perceived as sound. The Earlens CHD was cleared by the FDA via the de novo regulatory pathway. The de novo process provides a pathway to classify low- to moderate-risk devices for which general controls or general and special controls provide reasonable assurance of safety and effectiveness, but for which there is no legally marketed predicate device.

CLINICAL EVIDENCE

Wearable Hearing Aids (Including Non-Implantable Bone Conduction Hearing Aids Utilizing a Headband)

Wearable Hearing Aids

In a Cochrane review, Ferguson et al. (2017) evaluated the effects of hearing aids for mild to moderate hearing loss in adults. The authors included five randomized controlled trials (RCTs) involving 825 participants in the review. The authors concluded that the available evidence concurs that hearing aids are effective at improving hearing-specific health-related quality of life, general health-related quality of life and listening ability in adults with mild to moderate hearing loss. The authors indicated that the evidence is compatible with the widespread provision of hearing aids as the first-line clinical management in those who seek help for hearing difficulties. According to the authors, greater consistency is needed in the choice of outcome measures used to assess benefits from hearing aids.

Non-Implantable Bone Conduction Hearing Aids Utilizing a Headband

Wang et al. (2018) evaluated the auditory development and hearing improvement in patients with bilateral microtia-atresia using softband and implanted bone-anchored hearing devices. The subjects were divided into two groups: the softband group (40 infants, 3 months to 2 years old, Ponto Softband) and the implanted group (6 patients, 6-28 years old, Ponto). The Infant-Toddler Meaning Auditory Integration Scale was used to evaluate auditory development at baseline and after 3, 6, 12, and 24 months, and visual reinforcement audiometry was used to assess the auditory threshold in the softband group. In the implanted group, bone-anchored hearing devices were implanted combined with the auricular reconstruction surgery. Auditory threshold and speech discrimination scores of the patients with implants were measured under the unaided softband and implanted conditions. Total Infant-Toddler Meaning Auditory

Integration Scale scores in the softband group improved significantly and approached normal levels. The authors concluded that the use of softband bone-anchored hearing devices is effective for auditory development and hearing improvement in infants with bilateral microtia-atresia. According to the authors, wearing softband bone-anchored hearing devices before auricle reconstruction and combining bone-anchored hearing device implantation with auricular reconstruction surgery may be the optimal clinical choice for these patients, and results in more significant hearing improvement and minimal surgical and anesthetic injury.

Ramakrishnan et al. (2011) retrospectively reviewed bone-anchored and Softband-held conductive hearing aids in 109 children and young adults. Criteria for the selection of the implanted device or the Softband were not described; however, the authors did note an uneven distribution by mean age, gender, and syndromic co-morbidity. The authors conclude that this population benefits from bone-anchored and Softband-held conductive hearing aids based on mean scores.

Nicholson et al. (2011) determined the benefit of the BAHA Softband for infants and children with bilateral conductive hearing loss; and verified the audibility of the speech spectrum for octave frequencies 500 through 4000 Hz. Twenty-five children aged 6 months to 18 years with craniofacial disorders and bilateral conductive hearing loss participated in the study. Participants were consistent, full-time unilateral BAHA users with the BAHA Compact bone-conduction amplifier coupled to the head via the Softband. Results revealed an improvement in sound field thresholds with BAHA amplification for the four octave frequencies. Percentages of thresholds meeting target levels were significant at all frequencies, exceeding the 80% criterion. According to the investigators, this study demonstrates the benefit of the BAHA in providing audibility of the speech spectrum for infants and children with bilateral congenital conductive hearing loss.

Semi-Implantable Electromagnetic Hearing Aids

Bruchhage et al. (2017) conducted a systematic review to determine the efficacy/effectiveness and patient satisfaction with the Vibrant Soundbridge (VSB) active middle ear implant in the treatment of mild to severe Sensorineural hearing loss (SNHL). A search of electronic databases, investigating the safety and effectiveness of the VSB in SNHL plus medical condition resulted in 24 studies meeting inclusion criteria. Data was searched on safety, efficacy and economical outcomes with the VSB. Safety-oriented outcomes included complication/adverse event rates, damage to the middle/inner ear, revision surgery/explant rate/device failure and mortality. Efficacy outcomes were divided into audiological outcomes, including hearing thresholds, functional gain, speech perception in quiet and noise, speech recognition thresholds, real ear insertion gain and subjective outcomes determined by questionnaires and patient-oriented scales. Data related to quality of life (QALY, ICER) were considered under economical outcomes. The authors concluded that VSB turns out to be a highly reliable and a safe device which significantly improves perception of speech in noisy situations with a high sound quality. In addition, the subjective benefit of the VSB was found to be mostly significant in all studies. Additionally, implantation with the VSB proved to be a justified health care intervention.

Butler et al. (2013) conducted a systematic review to evaluate the effectiveness of the active middle-ear implant in patients with sensorineural hearing loss, compared with external hearing aids. Fourteen comparative studies were included. Nine studies reported on the primary outcome of functional gain: one found that the middle-ear implant was significantly better than external hearing aids, while another found that external hearing aids were generally significantly better than middle-ear implants. Six of the seven remaining studies found that middle-ear implants were better than external hearing aids, although generally no clinically significant difference (i.e., ≥ 10 dB) was seen. The authors concluded that the active middle-ear implant appears to be as effective as the external hearing aid in improving hearing outcomes in patients with sensorineural hearing loss.

Implantable Bone-Anchored Hearing Aids (BAHAs)

Fully Implantable Bone-Anchored Hearing Aids

Liu et al. (2017) systematically reviewed the literature on the audiological and/or quality of life benefits of a bone conduction hearing aid (BCHA) in children (age <18 years) with congenital unilateral conductive or sensorineural deafness. Eight studies were included in the review. Four studies examined the audiological outcomes associated with bone conduction hearing aid implantation. There was a consistent gain in speech reception thresholds and speech discrimination, especially in noisy environments. Results pertaining to sound localization was inconsistent. The studies that examined quality of life measures reported a high usage rate of BCHAs among children. Quality of life improvements are reported with suggested benefit in the subdomain of learning. The authors concluded that given the potential benefits of a BCHA, along with the fact that it can be safely trialed using a headband, it is reasonable to trial a BCHA in children with congenital unilateral deafness. If the trial offers audiological and/or quality of life benefits for the individual child, then BCHA implantation can be considered.

In a systematic review, Kim et al. (2017) analyzed the capabilities of bone-anchored hearing aids (BAHAs) in the context of single-sided deafness (SSD), and evaluated the efficacy of BAHAs in improving speech recognition in noisy conditions, sound localization, and subjective outcomes. A systematic search was undertaken until August 2015 by

two independent reviewers, with disagreements resolved by consensus. Among 286 references, 14 studies were analyzed that used both subjective and objective indicators to assess the capabilities of a total of 296 patients in the unaided and aided situations. Although there was "no benefit" of BAHA implantation for sound localization, BAHAs certainly improved subjects' speech discrimination in noisy circumstances. In the six studies that dealt with sound localization, no significant difference was found after the implantation. Twelve studies showed the benefits of BAHAs for speech discrimination in noise. Regarding subjective outcomes of using the prosthesis in patients with SSD (abbreviated profile of hearing aid benefit [APHAB] and the Glasgow hearing aid benefit profile [GHABP], etc.), an improvement in the quality of life was noted. According to the authors, this systematic review has indicated that BAHAs may successfully rehabilitate patients with SSD by alleviating the hearing handicap to a certain degree, which could improve patients' quality of life. This report has presented additional evidence of effective auditory rehabilitation for SSD and will be helpful to clinicians counseling patients regarding treatment options for SSD.

Bilateral Fitting of Bone-Anchored Hearing Aids (BAHA)

Janssen et al. (2012) systematically review the outcomes of bilateral versus unilateral bone-anchored hearing aids (BAHA) for individuals with bilateral permanent conductive hearing loss (CHL). Studies were included if subjects of any age had permanent bilateral CHL and bilateral implanted BAHAs. Outcome measures of interest were any subjective or objective audiologic measures, quality of life indicators, or reports of adverse events. Eleven studies met the criteria for data extraction and analysis. All 11 studies were observational. In most studies, comparisons between unilateral and bilateral BAHA were intra-subject. Bilateral BAHA provided audiologic benefit compared to unilateral BAHA (improved thresholds for tones [2 studies], speech in quiet [5 studies] and in noise [3 studies], and improved localization/lateralization [3 studies]) and patients' perceived subjective benefit from bilateral BAHA (3 studies). Disadvantages of bilateral BAHAs included listening in noise in some conditions (3 studies) and presumed increase in adverse event risk.

Colquitt et al. (2011) performed a systematic review to assess the clinical effectiveness of BAHAs for people with bilateral hearing impairment. Nineteen electronic resources were searched from inception to November 2009. Twelve studies were included. Studies suggested audiological benefits of BAHAs when compared with bone-conduction hearing aids or no aiding. A mixed pattern of results was seen when BAHAs were compared to air-conduction hearing aids. Improvements in quality of life with BAHAs were found by a hearing-specific instrument but not generic quality of life measures. Issues such as improvement of discharging ears and length of time the aid can be worn were not adequately addressed by the studies. Studies demonstrated some benefits of bilateral BAHAs. The authors concluded that the available evidence is weak. As such, caution is indicated in the interpretation of presently available data. However, based on the available evidence, BAHAs appear to be a reasonable treatment option for people with bilateral conductive or mixed hearing loss. Further research into the benefits of BAHAs, including quality of life, is required to reduce the uncertainty.

Partially Implantable Bone-Anchored Hearing Aids with Magnetic Coupling

Cooper et al. (2017) systematically review the literature on currently available passive transcutaneous bone conduction hearing implants (pTCBI) with regard to complications, audiological outcomes, and quality-of-life scores. All identified English-language articles reporting on the implantation of currently available pTCBI's and their complications. Both pediatric and adult patients were included. No limitation was placed on study design or level of evidence. Twenty-six articles were included in the review. Most of these articles were small retrospective case series. Four hundred eighty-two pTCBIs have been reported in the literature. Major complications including skin breakdown, wound dehiscence, hematoma, seroma, and inability to use the device occurred in 5.2% of patients. Minor complications including pain and self-resolving erythema at the implant site occurred in 13.1% of the patients. The weighted mean pure-tone average gain of the two included devices was 28.4 ± 2.1 dB and the mean speech reception threshold gain was 32.9 ± 3.9 dB. Favorable quality-of-life scores have been demonstrated with pTCBIs. The authors concluded that pTCBIs are a viable alternative to percutaneous devices in a carefully selected group of patients. According to the authors, these devices have demonstrated good audiological outcomes, low morbidity, and high patient satisfaction. The authors stated that the study has several limitations. As a systematic review, it is limited by the methodology of the individual articles included. There is heterogeneity across studies regarding the follow-up period, measured audiological and quality-of-life outcomes, and reporting of complications. Considerable heterogeneity was shown statistically in calculating the mean pure-tone average (PTA) and speech reception threshold (SRT) gains. This was partially mitigated by the use of a random effects model in the analysis. There is no validated scale of soft tissue complications arising from transcutaneous devices. As such, it is difficult to define which minor complications such as erythema or implant site pain are clinically significant. Although there is high frequency attenuation through soft tissue, lower rates of postoperative complications and the aesthetics of a transcutaneous hearing device may outweigh this limitation which can also be mitigated through careful patient selection.

Dimitriadis et al. (2016) conducted a systematic review of the indications, surgical technique and audiological, clinical and functional outcomes of the BAHA Attract which is a transcutaneous bone conduction hearing aid device. Ten studies and 89 reported cases were included in the review. The vast majority of implanted patients were satisfied with the aesthetics of the device scoring highly at the Abbreviated Profile of Hearing Aid Benefit, Glasgow Benefit Inventory

and Client Oriented Scale of Improvement. Overall, hearing outcomes, tested by various means including speech in noise, free field hearing testing and word discrimination scores showed a significant improvement. Complications included seroma or hematoma formation, numbness around the area of the flap, swelling and detachment of the sound processor from the external magnet. The authors concluded that the functional and audiological results presented so far in the literature have been satisfactory and the complication rate is low compared to the skin penetrating Bone Conduction Devices. According to the authors, further robust trials are needed to study the long-term outcomes and any adverse effects.

In a prospective data collection and patient review, Dimitriadis et al. (2017) assessed outcomes with a novel passive transcutaneous bone conduction device (t-BCD). One hundred five patients were implanted with the BAHA Attract. Numbness superior to the incision was commonly noticed. Four patients (3.8%) developed skin tenderness and redness that settled with conservative measures. Among those patients who had a conversion from a percutaneous Bone Conduction Hearing Device (BCHD) to the t-BCD (n=15), 1 (0.9%) developed seroma and 2 (1.9%) developed skin dehiscence at the edge of the implant magnet. Significant improvement in Client Oriented Scale of Improvement and Glasgow Benefit Inventory scores with a global satisfaction of 84% and 77.4% was observed for those previously aided and unaided respectively, with use of the device. A 22% improvement in Speech, Spatial and Qualities of Hearing scale (SSQ-12) mean score was observed in the pediatric population. The authors concluded that The t-BCD is a good solution for hearing rehabilitation in carefully selected patients.

Hougaard et al. (2017) examined the objective as well as subjective outcomes with a new transcutaneous bone-anchored hearing aid device. The study was designed as a prospective multicenter consecutive case-series study involving tertiary referral centers at two Danish University Hospitals. A total of 23 patients were implanted. Three were lost to follow-up. Patients had single-sided deafness, conductive or mixed hearing loss. Aided and unaided sound field hearing was evaluated objectively using (1) pure warble tone thresholds, (2) pure-tone average (PTA4), (3) speech discrimination score (SDS) in quiet, and (4) speech reception threshold 50% at 70 dB SPL noise level (SRT50%). Subjective benefit was evaluated by three validated questionnaires: (1) the IOI-HA, (2) the SSQ-12, and (3) a questionnaire evaluating both the frequency and the duration of hearing aid usage. The mean aided PTA4 was lowered by 14.7 dB. SDS was increased by 37.5% at 50 dB SPL, SRT50% in noise improved 1.4 dB. Aided thresholds improved insignificantly at frequencies above 2 kHz. 52.9% of the patients used their device every day, and 76.5% used the device at least 5 days a week. Mean IOI-HA score was 3.4, corresponding to a good benefit. In SSQ-12, "quality of hearing" scored especially high. Patients with a conductive and/or mixed hearing loss benefitted the most. This device demonstrates a significant subjective hearing benefit 8 month post surgery. In patients with conductive and/or mixed hearing losses, patient satisfaction and frequency of use were high. Objective gain measures showed less promising results especially in patients with single-sided deafness (SSD) compared to other bone conduction devices.

Denoyelle et al. (2015) evaluated the gain and cutaneous tolerance of the Sophono Alpha1 implant, used for unilateral hearing rehabilitation in children with ear atresia to demonstrate non-inferiority compared to the referral closed skin device, BAHA® on a test-band. Fifteen children included in this prospective clinical trial. Patients' ages ranged from 61 to 129 months. Sophono Alpha1 demonstrated non-inferiority compared to BAHA on a test-band. At M12, mean aided ACPTA was 2.94dB higher but the mean SRT variation was not significantly different. At M12, all children used the implant 5 to 12h daily without cutaneous complications. Both children and parents reported being satisfied or very satisfied. The score for 7/10 questions in silence or noisy environment was statistically improved when wearing the device. According to the investigators, this prospective study demonstrated non inferiority, good cutaneous tolerance, satisfaction of children and parents and improvement of the quality of life with the Sophono Alpha1 compared to BAHA on a test-band.

Rigato et al. (2016) conducted an early observational study to compare transcutaneous bone conduction implant (BCI) and bone-anchored hearing aid (BAHA) groups of patients over several audiometric measurements, including speech audiometry and warble tones thresholds with and without the device. Additionally, questionnaires were used to assess the general health condition, benefit, and satisfaction level of patients. Six patients wearing BCI and six BAHA users were included in the study with a matched-pairs design. No statistically significant difference was detected in any of the audiological measurements. The outcome of patient-related measurements was slightly superior for BCI in all subscales. According to the authors, these results confirm the initial hypothesis of the study: the BCI seems to be capable of providing as good rehabilitation as percutaneous devices for indicated patients.

Gawęcki et al. (2016) evaluated surgical, functional and audiological results of the Baha® Attract system, in which the sound processor is attached by magnetic force. Twenty patients implanted with a Baha Attract system were divided into two groups: A-bilateral mixed and conductive hearing loss, B-single-sided deafness, and evaluated during a 6-month follow-up. Parameters analyzed comprised: (1) surgery and wound healing, (2) postoperative functional results (GBI, APHAB and BAHU questionnaires), (3) audiological results (free field speech in noise audiometry in two situations: with signal from implant side and from contralateral side). Obtained results revealed: mean time of surgery-44 min, soft tissue reduction-30%, bone polishing-20%, haematoma-10%. Functional results showed: GBI

total score-29.6 points, APHAB global score mean gain-23.5%, BAHU 'good or very good' score for: aesthetic-85%, hygiene-100%, ease of placing the processor-100%, stability of attraction-75%. Audiological results-mean gain for the two analyzed situations: 32.9% (group A-36.5%, group B-27.5%). The authors concluded that the data obtained prove the safety and effectiveness of the Baha Attract system in patients with conductive and mixed hearing loss as well as in patients with single-sided deafness.

Totally Implanted Middle Ear Hearing Systems

In a systematic review, Pulcherio et al. (2014) reviewed the outcomes of the fully implantable middle ear devices Carina and Esteem for treatment of hearing loss. Twenty-two studies and two literature reviews in English directly demonstrating the results of Carina and Esteem were included in the review. There were a total of 244 patients ranging from 18 to 88 years. One hundred and 10 patients were implanted with Carina and with 134 Esteem. There were registered 92 males and 67 females. Five studies provided no information about patients' age or gender. From the data available, the follow-up ranged from 2 to 29.4 months. The comparison of the results about word recognition is difficult as there was no standardization of measurement. The results were obtained from various sound intensities and different frequencies. The outcomes comparing to conventional hearing aids (HAs) were conflicting. Nevertheless, all results comparing to unaided condition showed improvement and showed a subjective improvement of quality of life. According to the authors, the use of fully implantable middle ear devices (MED) is promising for those dissatisfied with their current conventional air-conduction hearing aids. The authors concluded that due to the relatively few publications available and small sample sizes, one must be careful in extrapolating these results to a broader population. Additionally, none of these studies represented level high levels of evidence (i.e., randomized controlled trials).

Klein et al. (2012) conducted a review to examine the safety and effectiveness of fully implantable middle ear devices in the treatment of hearing loss. Thirty articles were selected for full review, of which, 7 articles on the Esteem (n=105 patients) and 13 on the Carina (n=68 patients) met the study's eligibility criteria. Because of heterogeneity across studies, meta-analysis was not performed, and comparisons were made by structured review. The majority of studies were quasi-experimental, pre-post comparisons of aided and unaided conditions. Complication rates with the Esteem were higher than with the Carina. The most common adverse effects with the Esteem were chorda tympani nerve damage or taste disturbance, occurring in 30 percent of patients. Facial weakness was also reported in eight percent of the patients and was permanent in two patients. Seven explants and five revision surgeries were reported with the Esteem device. Device failure was common with the Carina, predominately related to charging difficulties. For both devices, clinically significant improvements in functional gain, speech reception, and speech recognition over the unaided condition were found. In studies comparing the Esteem or Carina to hearing aids, findings were mixed. Although improvements in functional gain were similar to those for hearing aids, speech recognition and quality of life were greater with the implants. According to the authors, despite limited evidence, these devices seem to offer a relatively safe and effective treatment option, particularly for patients who are physically unable to wear conventional hearing aids.

Shohet et al. (2018) conducted a prospective, nonrandomized, multicenter, single-subject-as-own-control design study to provide long-term hearing outcome measures of a totally implantable hearing system (implant) and compare to the baseline unaided (BLU) and baseline aided (BLA) conditions, and to discuss relevant safety measures. Fifty-one subjects with mild to severe sensorineural hearing loss were implanted between 2008 and 2009 and enrolled in this postmarket approval study in the setting of private and hospital-based practices. Forty-nine of these subjects completed the 5-year study, which included annual follow-ups. Primary effectiveness endpoints were speech reception threshold (SRT) and word recognition scores at 50 dB (WRS50s). Secondary effectiveness endpoints were WRSs and the Abbreviated Profile of Hearing Aid Benefit (APHAB) scores. Adverse Device Effects (ADEs) and Serious Adverse Device Effects (SADEs) reported during the study period and a comparison of bone conduction scores are submitted as safety measures. The results showed that compared to the BLA condition, SRT scores were improved at every annual follow-up; WRS50s were better in 49%, and the same in 41% at the 5-year follow-up; WRSs were improved by 17% at the 5-year follow-up; and APHAB scores were improved in most subscales at every annual follow-up. There were three SADEs in three subjects and 15 ADEs in 11 subjects. Bone conduction scores increased by 3.7 dB at the 5-year follow-up. Average battery life was 4.9 years. The authors concluded that the implant compared favorably to the subjects' hearing aid throughout the 5-year period in all of the areas measured and was found to be safe. Further research with randomized controlled trials is needed to validate these findings.

Barbara et al. (2018) evaluated the long-term benefits of a totally implantable active middle ear implant (AMEI) that has been used in a single implanting center for over 10 years. Forty-one subjects who underwent implantation with an Esteem AMEI during a 10-years period were evaluated on the auditory benefits, as derived from pure tone and speech audiometry tests. The analysis included a comparison with a conventional hearing aid, the problematics related to the battery duration and surgical replacement and, finally, the complication rate. Over 80% of the implanted subjects maintained over time a satisfactory auditory gain, ranging from 10 to over 30 dB in respect to the unaided situation, as mean at 0.5, 1, 2 and 4 kHz. In more than 60% of them, an improvement has also been found at 4 and 8 kHz. Battery duration varied according to the severity of the hearing loss and to the daily use of the device. No major post-

operative complications were recorded, while explantation was necessary in five subjects, although none for device failure. The authors concluded that the Esteem can be considered a reliable device for rehabilitation of sensorineural hearing loss in alternative to conventional hearing aids. The findings of this study need to be validated by well-designed controlled studies with larger sample sizes.

Intraoral Bone Conduction Hearing Aid

Moore and Popelka (2013) compared the effectiveness of two types of treatment for unilateral hearing loss (UHL), bone-anchored hearing instruments (BAHI) and a dental device (SoundBite). Nine adult BAHI wearers with UHL were included in the study. Either BAHI or SoundBite were worn for 30 days, and then the devices were swapped and the second device was worn for 30 days. Measures included unaided and aided sound-field thresholds, sound localization, and perception of speech in babble. The APHAB questionnaire was administered for each trial period. Mid-frequency aided thresholds were lower for SoundBite than for BAHI. Both devices gave benefits for localization after 30 days, but there was no difference between devices. Speech perception was better for both devices than for unaided listening when the target speech came from the poorer hearing side or in front, and the interfering babble came from the better-hearing side. There was no consistent difference between devices. APHAB scores were better for SoundBite than for BAHI. The authors concluded that speech perception and sound localization were similar for the two types of device, but the SoundBite led to lower aided thresholds and better APHAB scores than the BAHI. The significance of this study is limited by small sample size and short follow-up period.

In a prospective cohort study, Gurgel et al. (2015) assessed the safety and efficacy of an intraoral bone conduction (IOBC) hearing prosthesis (SoundBite) after 12 months of use. At the end of 6 months and 12 months, patients were asked to complete the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire and SSD questionnaire in addition to audiometric testing. Eighty-one patients aged 18 years or older with single-sided deafness (SSD) completed the study. Hearing thresholds remained the same throughout the study. APHAB results showed a significant benefit in categories of ease of communication, reverberation, background noise, and global score. The SSD questionnaire showed a high satisfaction among participants, with 93.8% of patients likely to recommend the IOBC. Dissatisfaction was highest with regard to patient's ability to eat with device, with only 55.6% satisfied. No serious adverse events were reported during the study. The authors concluded that the IOBC is a safe and effective alternative to percutaneous osseointegrated hearing implants for patients with SSD. Patient satisfaction and improved hearing benefit are observed after 1 year of using the device. According to the authors, the IOBC significantly benefitted patients in APHAB categories of ease of communication, reverberation, background noise, and the overall global hearing score. The authors stated that the in-the-mouth transducer is the least-liked feature for some patients, particularly with regard to eating; however, the majority of patients are willing to deal with the size of the device for the hearing benefit gained. [The lack of a control group limits the validity of the results of this study. Author reported study limitations include the following: 1) Despite the APHAB being a well-validated way to assess the benefit of hearing prosthesis, the questionnaire responses are subjective and subject to bias. 2) When comparisons were made between the 6- and 12-month APHAB results, 65 and 80 patients filled out the two questionnaires, respectively. The 6-month visit was not a required follow-up time, which explains the difference in participation. The study results have some potential to be skewed because of the differential participation at the two time points, but the 6- and 12-month APHAB results were very similar, with no statistically significant differences. 3) A selection bias is also possible in those patients who were willing to participate in the study as well as providers who have incorporated the IOBC into their practice. These patients and providers may feel more strongly for or against the device than more objective users. 4) More than 90% of patients responded that they preferred the device compared with no device and would likely recommend the device. This percentage may be artificially high because nine subjects withdrew from the study secondary to device-related problems and did not complete the evaluation.]

Laser or Light Based Hearing Aids

In a single-arm, open-label investigational-device clinical trial, Gantz et al. (2017) evaluated the safety and effectiveness of the light-driven contact hearing aid to support FDA clearance. The trial included 43 subjects (86 ears) with mild-to-severe bilateral sensorineural hearing impairment. The intervention was treatment of the hearing impairment using amplification provided by the Earlens contact hearing aid (CHA) for a duration of 120 days. The primary safety endpoint was a determination of "no change" (PTA4 < 10dB) in residual unaided hearing at the 120-day measurement interval. The results for the 86 ears in the study determined a mean change of -0.40dB in PTA4, indicating no change in residual hearing. There were no serious device- or procedure-related adverse events, or unanticipated adverse events. Word recognition aided with the Earlens improved significantly over the unaided performance, by 35% rationalized arcsine units on average. Mean functional gain was 31 dB across 2 to 10kHz. The average speech-recognition threshold improvement over the unaided case for the Hearing in Noise Test was 0.75dB and 3.14dB for the omnidirectional and directional microphone modes, respectively. The authors concluded that the safety and effectiveness data supported a de novo 510(k) submission that received clearance from the FDA. According to the authors, future studies should perform careful comparisons between other devices and the CHA, to establish whether the broad-spectrum amplification of the CHA provides additional benefits over those devices in terms of sound quality and speech understanding.

Fay et al. (2013) conducted a single site research and development facility feasibility study to assess the safety, stability, and performance of the broad-spectrum, light-based contact hearing device (CHD) on listeners with hearing impairment. Thirteen participants with symmetric mild-to-severe sensorineural hearing impairment had the CHD placed bilaterally, and a custom-molded light-activated tympanic contact actuator (TCA) was placed into each ear by a physician, where it stayed in contact with the umbo and a portion of the medial wall of the ear canal for 4 months. Each CHD was calibrated and programmed to provide appropriate broad-spectrum amplification. The following were measured to characterize system performance as well as the benefits of amplification via the CHD: Aided and pre-TCA-insertion unaided audiometric thresholds (functional gain), maximum gain before feedback, tympanic membrane damping, Reception Threshold for Sentences (RTS), and Abbreviated Profile of Hearing Aid Benefit (APHAB) measurements. Safety was determined through routine otologic examinations. The results of this feasibility study showed the TCAs remained on participants' ears for an average total of 122 days, without causing signs of inflammation or infection, and there were no serious device-related adverse events. Measured average maximum output of 90 to 110 dB SPL in the range of 0.25 to 10 kHz, average maximum gain before feedback of 40 dB, and functional gain through 10 kHz show extended-bandwidth broad-spectrum output and gain. RTS results showed significant aided improvements of up to 2.8 dB, and APHAB results showed clinically significant aided benefits in 92% of participants (11/12). The authors concluded the safety, stability, and performance demonstrated in this initial 4-month study suggest that the CHD may offer a feasible way of providing broad-spectrum amplification appropriate to treat listeners with mild-to-severe hearing impairment. This is a small feasibility study with only 13 participants. Larger scale, high quality studies are needed to determine clinical utility of laser and light based hearing. This is an uncontrolled study with a small sample size.

Professional Societies

The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS)

The AAO-HNS considers active middle ear implants as appropriate treatment for adults with moderate to severe hearing loss when performed by a qualified otolaryngologist-head and neck surgeon. Based on available literature demonstrating that clinically selected adults receive substantial benefit, implanting active middle ear implants is accepted medical practice in those who benefit from amplification but are unable to benefit from the amplification provided by conventional hearing aids. Use of active middle ear implants, which have been Food and Drug Administration (FDA)-approved for these indications, should adhere to the restrictions and guidelines specified by the appropriate governing agency, such as the Food and Drug Administration in the United States and other similar regulatory agencies in countries other than the United States (AAO-HNS, Active Middle Ear Implants Position Statement 2016)

The AAO-HNS considers bone conduction hearing devices, including implantation of a percutaneous or transcutaneous device and use of a bone conduction oral appliance or bone conduction scalp device to be acceptable, and in many cases preferred, procedures in the treatment of conductive or mixed hearing loss and single-sided deafness when performed by a qualified otolaryngologist-head and neck surgeon. Use of these devices, which have been Food and Drug Administration (FDA)-approved for these indications, should adhere to the restrictions and guidelines specified by the appropriate governing agency, such as the FDA in the United States and other similar regulatory agencies in countries other than the United States. (AAO-HNS, Bone Conduction Hearing Devices Position Statement 2016)

U.S. FOOD AND DRUG ADMINISTRATION

Semi-Implantable Electromagnetic Hearing Aid

Two semi-implantable, electromagnetic, direct drive, middle ear hearing devices have received FDA approval.

Vibrant® received FDA approval on August 31, 2000. According to the FDA, Vibrant Soundbridge is utilized for providing a useful level of sound perception to individuals via mechanical stimulation of the ossicles.

According to the professional labeling information on the FDA Web site, the selection criteria for Vibrant Soundbridge includes the following:

- Adults aged 18 or older
- Audiologic results consistent with moderate to severe sensorineural hearing loss
- Pure tone air conduction threshold levels within the following ranges: 500 Hz: 30-65 dB; 1000 Hz: 40-75 dB; 1500 Hz: 45-80 dB; 2000 Hz: 45-80 dB; 3000 Hz: 50-85 dB; 4000 Hz: 50-85 dB
- Word recognition score of 50% or better using recorded material
- Normal middle ear anatomy
- Psychologically and motivationally suitable with realistic expectations of the benefits and limitations of the device.

See the following website for more information:

https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpm/pma_template.cfm?id=p990052.

(Accessed July 26, 2018)

Maxum Hearing Implant[®] was approved by the FDA on September 7, 2001. This device was manufactured initially under the name Soundtec Direct System by Ototronix, and is currently manufactured under the name Maxum Hearing Implant[®]. According to the professional labeling information on the FDA Web site, the selection criteria for Maxum Hearing Implant[®] include the following:

- Adults aged 18 or older
- Audiologic results consistent with moderate to severe sensorineural hearing loss
- Patients with a desire for an alternative to an acoustic hearing device
- Patients should have experience with appropriately fit hearing aids

See the following website for more information:

https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpma/pma_template.cfm?id=p010023s013.

(Accessed July 26, 2018)

Bone-Anchored Hearing Aid

Fully Implantable Bone Anchored Hearing Aids

In 1995, the FDA granted approval to Nobelpharm USA to market the Branemark Bone-Anchored Hearing Aid (BAHA) System. Note: Since 1995, the device was acquired by Entific Medical Systems and then in 2005, it was acquired by Cochlear Corp. The device was approved for adult patients with malformations of the external ear, chronically draining ear, a pure tone threshold hearing loss of ≥ 45 decibels (dB), and/or inability or unwillingness to use an air conduction hearing aid. In 1999, this approval was extended for use in children 5 years of age or older. See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf/K984162.pdf.

(Accessed July 26, 2018)

The indications for the BAHA System have broadened since the initial FDA approval. In 2001, the BAHA system was approved for bilateral implantation. For bilateral implantation of bone-anchored hearing aids, patients must have moderate to severe bilateral symmetrical conductive hearing loss (defined as less than 10 dB difference in average or less than 15 dB in bone-conduction thresholds at 500, 1000, 2000, and 4000 Hz) or mixed hearing loss with average bone conduction thresholds better than 45 dB hearing loss.

In 2002, the BAHA system was approved for single sided deafness (SSD) or unilateral sensorineural hearing loss. According to the FDA, the use of BAHA hearing aid for SSD is intended to improve speech recognition. The SSD indication for BAHA hearing aid is intended for patients who suffer from unilateral sensorineural deafness on one ear while the other ear has normal hearing. Normal hearing is defined as PTA AC threshold equal to or better than 20dB measured at 0.5, 1, 2 and 3 kHz. BAHA for SSD is also indicated for patients who are indicated for an AC Contralateral Routing Of Signals (CROS) but who for some reason cannot or will not use an AC CROS. See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf2/k021837.pdf.

(Accessed July 26, 2018)

BAHA System models include the following:

- BAHA BP100 (2009). See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf9/K090720.pdf.
- BAHA Cordelle II (2008). See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf8/K080363.pdf.
- BAHA Intenso (2008). See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf8/K081606.pdf.
- BAHA Divino (2004). See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf4/K042017.pdf.
- BAHA auditory osseointegrated implant system using model B31300 implant and model BA300 abutment (2010). See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf10/K100360.pdf.

(Accessed July 26, 2018)

In November 2008, the OBC Bone Anchored Hearing Aid System (Oticon Medical) was cleared by the FDA for marketing through the 510(k) process. The FDA determined that this device was substantially equivalent to existing devices. See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf8/k082108.pdf.

(Accessed July 26, 2018)

In July 2009, the Pronto Pro Bone Anchored System (Oticon Medical) was cleared by the FDA for marketing through the 510(k) process. See the following website for more information:

http://www.accessdata.fda.gov/cdrh_docs/pdf9/K090996.pdf. (Accessed July 26, 2018)

Other bone anchored hearing aid devices have also been approved by the FDA. See the following website for more information (Use product code LXB or MAH): <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm>. (Accessed July 26, 2018)

Partially Implantable Bone-Anchored Hearing Aids or Devices

The partially implanted Otomag Alpha 1 (M) Bone Conduction Hearing System (Sophono, Inc.) received FDA approval in May 2011 as a bone conduction hearing aid. The Otomag Alpha 1 Sound Processor is intended for use with the Otomag Headband or Otomag Sofiband (no age limitations), or with the Otomag Magnetic Implant (patients 5 years of age and up) for the following patients and indications:

- Patients with conductive or mixed hearing loss, who can still benefit from amplification of sound. The pure tone average (PTA) bone conduction (BC) threshold for the indicated ear should be better than 45 dB HL (measured at 0.5, 1, 2, and 3 kHz).
- Bilateral fitting is applicable for most patients having a symmetrically conduction or mixed hearing loss. The difference between the left and right sides' BC thresholds should be less than 10 dB on average, measured at 0.5, 1, 2, and 4 kHz, or less than 15 dB at individual frequencies.
- Patients who have a profound sensorineural hearing loss in one ear and normal hearing in the opposite ear, who for some reason will not or cannot use an AC CROS. The pure tone average (PTA) air conduction (AC) threshold of the hearing ear should be better than 20 dB HL (measured at 0.5, 1, 2, and 3 kHz).

See the following websites for more information about FDA clearances for Sophono hearing systems:

- http://www.accessdata.fda.gov/cdrh_docs/pdf10/K102199.pdf.
- http://www.accessdata.fda.gov/cdrh_docs/pdf15/K153391.pdf.
- <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K132189>
- <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K123962>.

(Accessed July 26, 2018)

The Cochlear Baha Attract System (Cochlear Americas, Centennial, CO) received FDA approval on November 7, 2013. The Cochlear Baha Attract is intended for the following patients and indications for use:

- Patients aged 5 and older
- Patients who have a conductive or mixed hearing loss and can still benefit from sound amplification. The pure tone average bone-conduction hearing threshold (measured at 0.5, 1, 2, and 3kHz) should be better than or equal to 45 dB3 HL for use with the BP1 00 sound processor, and 55 dB HL for use with the BP1IO0 sound processor.
- Bilateral fitting is intended for patients who meet the above criterion in both ears, with bilaterally symmetric moderate to severe conductive or mixed hearing loss.
- Symmetrical bone-conductive thresholds are defined as less than a 10 dB3 average difference between ears (measured at 0.5, 1, 2, and 3 kHz), or less than a 15dB difference at individual frequencies.
- Patients who suffer from unilateral sensorineural deafness in one ear with normal hearing in the other ear (i.e. Single-sided deafness: SSD). Normal hearing is defined as a pure tone average air-conduction hearing threshold (measured at 0.5, 1, 2, and 3 kHz) of better than or equal to 20d13 HL.
- Baha for SSD is also indicated for any patient who is indicated for an air conduction contralateral routing of signals (AC CR08) hearing aid, but who for some reason cannot or will not use an AC CR08.

See the following website for more information:

http://www.accessdata.fda.gov/cdrh_docs/pdf13/K131240.pdf. (Accessed July 26, 2018)

The Bonebridge, a transcutaneous bone-conduction hearing device was cleared by the FDA via the de novo regulatory pathway on July 20, 2018. The de novo process provides a pathway to classify low- to moderate-risk devices for which general controls or general and special controls provide reasonable assurance of safety and effectiveness, but for which there is no legally marketed predicate device. The Bonebridge bone conduction hearing implant system is intended for the following patients and indications:

- Patients 12 years of age or older
- Patients who have a conductive or mixed hearing loss and still can benefit from sound amplification. The pure tone average (PTA) bone conduction (BC) threshold (measured at 0.5,1, 2, and 3 kHz) should be better than or equal to 45 dB HL
- Bilateral fitting of the Bonebridge is intended for patients having a symmetrically conductive or mixed hearing loss. The difference between the left and right sides' BC thresholds should be less than 10 dB on average measured at 0.5, 1, 2, and 3 kHz, or less than 15 dB at individual frequencies
- Patients who have profound sensorineural hearing loss in one ear and normal hearing in the opposite ear (i.e., single-sided deafness [SSD]). The pure tone average air conduction hearing thresholds of the hearing ear should be better than or equal to 20 dB HL (measured at 0.5, 1, 2, and 3 kHz)
- The Bonebridge for SSD is also indicated for any patient who is indicated for an air-conduction contralateral routing of signals (AC CROS) hearing aid, but who for some reason cannot or will not use an AC CROS

- Before receiving the device, it is recommended that an individual have experience with appropriately fit air conduction or bone conduction hearing aids.

See the following website for more information: https://www.accessdata.fda.gov/cdrh_docs/pdf17/DEN170009.pdf. (Accessed August 20, 2018)

Non-Implantable Bone-Anchored Hearing Aids

In 2000, the FDA approved the BAHA headband. The BAHA with headband is intended for patients who suffer from moderate to severe conductive hearing losses. BAHA with headband may be particularly useful for conductive losses compounded by congenital or secondary obstruction of auditory air conduction mechanisms. See the following website for more information: <http://www.accessdata.fda.gov/scripts/cdrh/devicesatfda/index.cfm?db=pmn&id=K002913>. (Accessed July 26, 2018)

In 2009, the FDA approved the Cochlear Baha BP100 sound processor that is intended for use with the Baha auditory osseointegrated implant (for children aged 5 and older, or adults), or with the Baha Headband or Baha Softband (no age limitations) for the following patients and indications:

- Patients who have a conductive or mixed hearing loss and can still benefit from sound amplification. The pure tone average bone-conduction hearing threshold (measured at 0.5, 1, 2, and 3 kHz) should be better than or equal to 45 dB HL.
- Bilateral fitting of the BP100 is intended for patients who meet the above criterion in both ears, with bilaterally symmetric moderate to severe conductive or mixed hearing loss. Symmetrical bone-conduction thresholds are defined as less than a 10 dB average difference between ears (measured at 0.5, 1, 2, and 3 kHz), or less than a 15 dB difference at individual frequencies.
- Patients who suffer from unilateral sensorineural deafness in one ear with normal hearing in the other ear (i.e., single-sided deafness or "SSD"). Normal hearing is defined as a pure tone average air-conduction hearing threshold (measured at 0.5, 1, 2, and 3 kHz) of better than or equal to .20 dB HL.
- Baha for SSD is also indicated for any patient who is indicated for an air conduction contralateral routing of signals (AC CROS) hearing aid, but who for some reason cannot or will not use an AC CROS.

See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf9/K090720.pdf. (Accessed July 26, 2018)

In May 2010, the FDA approved the Otomag Alpha 1(S) Sound Processor for use with the Otomag Headband or Otomag Softband (no age limitations) for the following patients and indications:

- Patients with conductive or mixed hearing losses, who can still benefit from amplification of sound. The pure tone average (PTA) bone conduction (BC) threshold for the indicated ear should be better than 45 dB HL (measured at 0.5, 1, 2, and 3 kHz).
- Bilateral fitting is applicable for most patients having a symmetrically conductive or mixed hearing loss. The difference between the left and right sides' BC thresholds should be less than 100dB on average measured at 0.5, 1, 2, and 4 kHz, or less than 15 dB at individual frequencies.
- Patients who have a profound sensorineural hearing loss in one ear and normal hearing in the opposite ear who for some reason will not or cannot use an AC CROS. The pure tone average (PTA) air conduction (AC) threshold of the hearing ear should be better than 20 dB H-IL (measured at 0.5, 1, 2 and 3 kHz).

See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf10/K100193.pdf. (Accessed July 26, 2018)

Other non-implantable bone anchored hearing aid devices have also been approved by the FDA. See the following website for more information (use product code LXB):

<http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm>. (Accessed July 26, 2018)

Totally Implanted Middle Ear Hearing System

On March 17, 2010 the FDA announced approval of the Esteem[®] prosthetic hearing restoration device, the first completely implanted hearing system used to treat moderate-to-severe sensorineural hearing loss.

According to the FDA, the Esteem is intended to alleviate hearing loss in patients by replicating the ossicular chain and providing additional gain. The Esteem is indicated for patients with hearing loss that meet the following criteria:

- 18 years of age or older;
- Stable bilateral sensorineural hearing loss;
- Moderate to severe sensorineural hearing loss defined by pure tone average (PTA);
- Unaided speech discrimination test score greater than or equal to 40%;
- Normally functioning eustachian tube;
- Normal middle ear anatomy;
- Normal tympanic membrane;
- Adequate space for esteem implant determined via a high resolution computed tomography (ct) scan; and

- Minimum 30 days of experience with appropriately fit hearing aids.

See the following websites for more information:

- <https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm?id=P090018>.
- https://www.accessdata.fda.gov/cdrh_docs/pdf9/p090018c.pdf
- https://www.accessdata.fda.gov/cdrh_docs/pdf9/p090018b.pdf

(Accessed July 26, 2018)

Intraoral Bone Conduction Hearing Aid

The SoundBite Hearing System received FDA approval in January 2011 as a bone conduction hearing aid. (K100649).

The SoundBite prosthetic device is intended for the following patients and indications:

- Patients who are 18 years or older and have moderately severe, severe, or profound sensorineural hearing loss in one ear and normal hearing in the other ear (i.e., single sided deafness or "SSD"). Normal hearing is defined as a pure tone average (PTA) air conduction (AC) hearing threshold (measured at 0.5, 1, 2, and 3 kHz) of better than or equal to 25 dB HL.

Additionally, use of SoundBite is intended for patients with:

- At least two contiguous molar or premolar teeth with no untreated tooth decay. Patients with tooth decay present are to first have restorations before being fitted for Sound Bite;
- Healthy attachment to those teeth with tooth pockets limited to no more than 5mm;
- No mobile teeth;
- Bone loss no greater than a 34% average on the mesial and distal sides of the tooth as measured on X-ray on the teeth on which the device will be worn.

See the following website for more information: http://www.accessdata.fda.gov/cdrh_docs/pdf10/K100649.pdf.

(Accessed July 26, 2018)

The SoundBite Hearing System (K110831) received clearance on June 21, 2011 (K110831) for a second indication. In addition to the SNHL indication described for K100649, this clearance includes a second indication for patients with conductive hearing loss where the PTA bone-conduction hearing threshold (measured at 0.5, 1, 2, and 3 kHz) is \geq 25 dB hearing level. Its components are a BTE microphone unit and an in-the-mouth hearing device. Accessories include a system charger and programming software. See the following website for more information:

http://www.accessdata.fda.gov/cdrh_docs/pdf11/K110831.pdf. (Accessed July 26, 2018)

As of January 1, 2015, Sonitus Medical, Inc. ceased operations and are no longer manufacturing the SoundBite Hearing System. There is no new information available concerning production of this or a similar device.

Laser or Light Based Contact Hearing Aid

The Earlens CHD was cleared by the FDA via the de novo regulatory pathway on September 29, 2015. The de novo process provides a pathway to classify low- to moderate-risk devices for which general controls or general and special controls provide reasonable assurance of safety and effectiveness, but for which there is no legally marketed predicate device. The FDA identifies this generic type of device as a tympanic membrane contact hearing aid. According to the FDA, a tympanic membrane contact hearing aid is a prescription device that compensates for impaired hearing. Amplified sound is transmitted by vibrating the tympanic membrane through a transducer that is in direct contact with the tympanic membrane. See the following websites for more information:

- <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/denovo.cfm?ID=DEN150002>.
- http://www.accessdata.fda.gov/cdrh_docs/pdf15/DEN150002.pdf.

(Accessed July 26, 2018)

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The foregoing Oxford policy has been adapted from an existing UnitedHealthcare national policy that was researched, developed and approved by UnitedHealthcare Medical Technology Assessment Committee. [2018T03967]

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POLICY HISTORY/REVISION INFORMATION

| Date | Action/Description |
|------------|---|
| 01/01/2019 | <ul style="list-style-type: none"> • Updated instructions for use; added language to indicate this policy does not address assistive listening devices, computers, transmitters or similar products • Updated coverage rationale: <ul style="list-style-type: none"> ○ Modified language to clarify the listed services are: <ul style="list-style-type: none"> ▪ Proven and medically necessary (as described) ▪ Unproven and not medically necessary (as described) ○ Replaced reference(s) to: <ul style="list-style-type: none"> ▪ "Patient" with "individual" ▪ "<i>Patient</i> populations" with "<i>study</i> populations" ○ Modified language pertaining to clinical evidence/study findings for intraoral bone conduction Hearing Aids; removed language indicating future studies with larger populations of patients wearing the device for longer periods are needed to evaluate hearing benefits and device safety ○ Removed reference to specific product name for laser or light based hearing aid (Earlens Contact Hearing Device); added reference link to the <i>Description of Services</i> section of the policy for applicable details • Updated list of applicable HCPCS codes for: <ul style="list-style-type: none"> ○ Bone anchored hearing aids (BAHA); added L8694 ○ Wearable hearing aids to reflect annual code edits: <ul style="list-style-type: none"> ▪ Added V5171, V5172, V5181, V5211, V5212, V5213, V5214, V5215, and V5221 ▪ Removed V5170, V5180, V5210, and V5220 ▪ Revised description for V5190 and V5230 • Updated supporting information to reflect the most current description of services, clinical evidence, FDA information, and references • Archived previous policy versions ENT 007.23 T2 |