BRAINSTEM AUDITORY EVOKED RESPONSE (BAER)

Surgical Specialty:	ENT or Audiology
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Background:

- General Considerations
  - Brainstem auditory evoked response (BAER) also known as auditory brainstem response (ABR) testing is often performed in the operating room (OR) under general anesthesia in young patients who are unable to cooperate. The test uses acoustic stimuli to test hearing.
  - Electronic auditory brainstem response (eABR) might also be used to assess patients who may have a cochlear malformation. This uses electrical stimuli instead of acoustic stimuli to obtain response thresholds. Some eABR testing may require a needle electrode to be placed transtympanically for better assessment, and this may result in a very brief period of painful stimulus.
  - This testing is used for two purposes on patients with sensorineural hearing loss (SNHL)
    - Test hearing thresholds to assess the functional status of the auditory neural pathway, which is used to determine the cause of hearing loss
    - Determine candidacy for hearing loss treatment such as cochlear implants.[1]
  - These tests may be coordinated with other procedures.
  - Recent studies show that ABRs performed under propofol infusions yield superior results, leading to fewer false positives for hearing loss when compared to inhalational anesthetics.[2]
- Patient Considerations
  - Congenital hearing loss may be associated with congenital syndromes, maternal infection, meningitis, and prematurity or low birth weight.[2]
  - Ninety-eight percent infants born in US hospitals undergo a hearing screen before the age of 1 month and the incidence of hearing loss is about 1-3 per 1000 children.
    - Up to 60% of congenital hearing loss is genetic and approximately 20-30% of these are associated with a syndrome. Most patients that present with genetic hearing loss will also have a genetic evaluation.
    - Some genetic syndromes associated with hearing loss and other anesthetic concerns include[2]
      - Usher syndrome-SNHL and retinitis pigmentosa leading to blindness.
      - Alport syndrome- SNHL, kidney disease, and renal failure .
      - Treacher Collins syndrome- conductive hearing loss and mandibulofacial dystosis with possible difficult airway.

        - Pendred syndrome- euthyroid goiter in school-aged children and SNHL.
        - Jervell and Lange-Nielsen syndrome- profound SNHL and cardiac arrythmias due to prolonged QT interval and sudden cardiac death.
        - Waardenburg syndrome- 3 types where type III is the most severe and may be associated with facial and skeletal abnormalities, as well as microcephaly.
    - Patients who have low to no hearing may also present with higher anxiety due to an unknown environment. A well thought out and executed plan for both preoperative and postoperative care must be made to decrease this unfamiliarity. In such cases, parental presence during induction of anesthesia may need to be considered.

Anesthetic Planning:

- Pre-Anesthetic Evaluation
    - Medical history review should include any genetic work-up, family history of prolonged QT syndrome and past anesthetic experience.
    - Focused physical exam should include a thorough airway exam.
    - Review co-morbidities that may be associated with a congenital syndrome and consider preoperative testing for those patients. These may include review of echo for patients with congenital heart disease or preoperative labs in a patient with potential renal failure associated with the syndrome.
- Specific or Unique Room Set-Up Requirements
    - Airway
        - General anesthesia can be with endotracheal tube or supraglottic airway
        - Sedation can be done with a natural airway and $EtCO_2$ monitoring.
            - Have oral airway, nasal cannula and/or face mask available
    - Quiet environment improves study accuracy
    - Drugs/Infusions
        - Total intravenous anesthesia (TIVA), but may need inhalational induction for IV placement
            - Propofol infusion with 100-250 mcg/kg/min *titrated to effect* but patient may need more.
            - May consider EEG monitoring, if available, to monitor the depth of anesthesia. This may help guide propofol titration and avoid deep anesthetic state which may also effect results.
            - Significant changes to infusion rates or boluses may theoretically affect results and should be reported to the audiologist.
        - This test is a non-painful procedure and typically does not need opioids.
    - Monitors
        - Use standard American Society of Anesthesiologists monitors

Intraoperative Considerations:

- Anesthetic Management
    - Can be performed under general anesthesia or sedation.
    - Electrode placement may be stimulating, keep the patient deep for this portion.
- Induction
    - ~~e~~ Either an inhalation or intravenous induction may be used. ~~To take advantage of TIVA allow sevoflurane to washout if used for IV placement~~
- Positioning

  - Supine
  - Does not generally require turning of the bed away from anesthesia machine.
- Maintenance
  - TIVA with a propofol infusion is commonly used. This may provide superior data when compared to inhalational agents. [3]
  - Patient movement will interfere with study results, careful titration with EEG monitoring can be helpful.[4]
- Hemodynamic/Physiologic Goals
  - Maintain stable hemodynamics which may be affected due to minimal stimulation
- Surgical Considerations
  - Decrease volumes on monitors, alarms, and in room to improve testing conditions
  - Inform staff in the OR to maintain low noise levels.
  - Consider posting signs in and outside the OR to encourage low noise levels.
  - Hypothermia can affect brainstem response, much like other neuromonitoring for surgical cases. Maintain patient temperature with a warm room and potentially a convective warmer.
  - Ambient noise from a convective warmer will very minimally affect results and can be used to maintain normothermia while still obtaining accurate results. However, the 60-cycle electrical interference radiated by the plugged in warmer can cause electrical interference when measuring an eABR, therefore, the warmer may need to be turned off.[4]
- Emergence/Disposition
  - Per normal routine.
- Post-op Care
  - Non-opioid adjuncts usually suffice and opioids are typically not needed.

Case Specific Complications/Pitfalls

- OR noise can affect results.
- Propofol yields lower response suppression for potentially more accurate results. [2]

References

1. Young A, Cornejo J, Spinner A. Auditory brainstem response. In: StatPearls (Internet). Treasure Island (FL): StatPearls Publishing; 2022.
2. Allen SB, Goldman J. Syndromic Sensorineural Hearing Loss. [Updated 2022 Jul 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan
3. Subramanyam R, Mahmoud MA, McAuliffe JJ 3rd. Why a Propofol Infusion Should Be the Anesthetic of Choice for Auditory Brainstem Response Testing in Children. *Anesth Analg*. 2022;134(4):802-809.
4. Kileny, Paul R. The Audiologist's Handbook of Intraoperative Neurophysiological Monitoring. San Diego, Plural Publishing Inc. 2018

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