Review

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Review

Sedation Methods in Pediatric Auditory Electrophysiologic Tests: A Narrative Review

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Abstract: Background/Objectives: The implementation of neonatal hearing screening has significantly reduced the age at which hearing impairments are detected in children. Nevertheless, objective electrophysiological assessments, such as Auditory Brainstem Response (ABR) or Auditory Steady-State Response (ASSR) testing, are often necessary for children older than six months. To obtain accurate and interpretable results, these evaluations should be conducted while the child is asleep, as movement and muscle activity can introduce artifacts that compromise the quality of the recordings. **Methods**: This narrative review examines data of literature presenting various sedation strategies employed to facilitate sleep in pediatric patients undergoing different types of procedures. It focuses on the efficacy, safety, and practicality of different sedative agents and administration routes. **Results**: Several sedation methods are utilized in clinical practice to achieve the necessary sleep state for ABR and ASSR testing in children. Sedatives, such as intranasal dexmedetomidine, oral midazolam, and combinations like ketamine-midazolam, have also been used, each with varyind degrees of efficacy and safety profiles. General anesthesia is typically reserved for cases where less invasive sedation methods are contraindicated or have proven ineffective. **Conclusions**: While natural sleep is ideal for ABR and ASSR testing, sedation using agents that can be administered orally or intranasally provides a practical alternative, enabling testing outside the operating theatre. General anesthesia should be considered when non-invasive sedation is not feasible or contraindicated. The choice of sedation method should be individualized based on child's age, medical history, and specific needs, ensuring safety for the patient and reliability of the results.

Keywords: electrophysiological tests; ABR; ASSR; sedation; choral hydrat; dexmedetomidine; midazolam

1. Introduction

Hearing screening for newborns has significantly lowered the average age of detection for hearing loss. Young children who fail hearing screening, or older children who require audiological evaluation or re-evaluation, can be referred to specialised diagnostic centres. Early testing means timely diagnosis and intervention, leading to better results.

Audiological tests used to assess children's hearing include objective and behavioural methods. While behavioural tests require certain responses from the child, dependent on the child's age,

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objective audiological measures record various responses independent of the child's participation. These include electrophysiological and electroacoustic methods. Some techniques require a quiet, non-crying child, such as otoacoustic emissions and impedancemetry, while others require the child to sleep, such as auditory evoked potentials (ABR) and auditory steady-state response (ASSR) [1].

Through surface electrodes, electrophysiological tests collect small voltage changes generated by nerve structures that make up the auditory pathway in response to an auditory stimulus. Analysis of these responses allows assessment of the transmission and processing of auditory information. ABR can be used to objectively assess pathways from the peripheral to the central auditory system and has a major impact on the detection of hearing disorders in children [2]. The advantage of ABR is that it can be recorded at any age, regardless of attention or sleep state. Meanwhile, ASSR measures the response to modulated or repetitive acoustic stimuli and reflects the activity of the brainstem and auditory cortex; depending on modulation rates, the brainstem responds at higher rates than the cortex. ASSR is present at any age and can be performed independent of sleep state or anaesthesia [3]. However, even though these tests can be performed while awake, the relatively long duration of the procedure requires testing children in their sleep to obtain interpretable tracings.

ABR and ASSR are far-field recordings with a low amplitude, which are difficult to select from mixed EEG signals. Recording appropriate ABR waves requires amplification and noise reduction to maximise the signal-to-noise ratio, alongside fitting averaging and artefact rejection strategies. Sleep provides reduced EEG activity, improving the signal-to-noise ratio and allowing easier selection of ABR waves with reduced amplitude.

Muscle activity also has a negative effect on ABR recordings. Maruthy et al. (2015) showed that blinking and contraction of muscles of the face, jaw, neck, lips, and cheek can interfere with ABR recordings. [4] Movements of the body, especially of the head or mandibular will produce myogenic potentials or electrical artifacts [5]. As such, the patient should be as quiet and relaxed as possible, and neither talk nor move the head.

Ambient environmental noise can influence the recording of ABR traces and hinder the interpretation of the results, due to difficulties in separating signal from noise [6]. Noise can also elongate the latencies and reduce the amplitude of ABR waves [7,8]. Although, Richmond et al. [9] and Dzulkarnain, et al. [10] claim that up to 60 dBA ambient acoustic noise does not significantly influence ABR waves and latencies in adults, quieter environmentare still recommended, particularly for children, to ensure optimal recordings.

Electromagnetic interference from electrical equipment in operating rooms or testing environments can significantly compromise the quality of ABR recordings. To ensure accurate and reliable results, it's essential to implement strategies that minimize such interference. Proper grounding of equipment and the elimination of significant sources of electrical noise can reduce electromagnetic interference during ABR testing leading to more accurate assessments of auditory function [11].

ASSR results are also influenced by ambient noise, electromagnetic interferences or muscular activity. The higher the noise level, the lower the amplitude of the waves and the greater the difficulty in recognising the response [12]. It is therefore advisable to perform these tests on a quiet patient, preferably asleep, for the duration of the procedure.

Most children under the age of 6 months can be tested during natural sleep. However, at older ages, it may be necessary to sedate them to perform the auditory test. Several studies have addressed the use of different drugs, comparing factors including administration routes (oral, intranasal, or intravenous), and outpatient, inpatient, or operating room settings. However, no consensus has been achieved, and no guidelines have been published on appropriate means and conditions of sedation [13]. Here, we present a review of the literature regarding different sedation methods for auditory diagnostic testing. By synthesizing current evidence, this review aims to inform clinicians on optimizing sedation protocols to ensure effective, safe, and patient-centred care in pediatric procedural settings.

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2. Testing Conditions

2.1. Natural sleep testing

Younger children can most often be tested in natural sleep. In a study group of children with an average age of 4 months, Jenssen et al. (2010) report a natural sleep duration of 48.8 min, with 20% having a shorter duration of up to 33.1 min. One conclusion of the study was that the testing duration of around 60 min exceeded the average child's natural sleep duration, except in normal hearing cases, where the duration was shorter [14].

Natural sleep testing relies heavily on cooperation between the testing centre and the child's family. The likelihood of the child falling asleep for the duration of the testing can be increased through sleep deprivation prior to the session, changing the diaper, and feeding the child just before the procedure. Preparing the skin and applying the electrodes and insert earphones can often be done before the child falls asleep [15].

2.2. Drug-induced sleep testing

Sedation is a reduction in consciousness following the administration of certain drugs. It is also usually associated with reduced anxiety and can induce retrograde amnesia. Muscular relaxation caused by these drugs can cause breathing disturbances and cardiovascular reflexes such as bradycardia or hypotension. A wide range of drugs are used precisely because there is no ideal example that provides the necessary total sedation, avoids the risk of severe complications such as cardiorespiratory depression, and allows rapid awakening. The route of administration can be oral, intranasal, intrarectal, intravenous, or via inhalation; depending on the case, the latter can require respiratory support provided by a laryngeal mask or orotracheal intubation in an operating theatre. The advantage of oral or intranasal sedation is the possibility of administering it outside of the operating theatre, as it requires less complex monitoring than respiratory support. Patients with severe systemic conditions (classified as ASA III–V) and patients with special needs require monitoring by an anaesthesiologist during sedation [16]. Like any medical act, sedation has its risks, and these include breathing disorders—such as airway obstruction or hypoventilation—aspiration, and cardiovascular disorders [17]. Obesity increases these risks and requires special attention, especially when associated with sleep apnoea [18]. Presedation assessment of the child and physical examination are mandatory to identify possible risk factors so that the procedure can be performed as safely as possible.

2.2.1. Oral and intranasal administration

Paediatric procedural sedation (PPS) is a drug-induced depression of consciousness which helps patients tolerate unpleasant or prolonged medical procedures by reducing anxiety, discomfort, and pain. During PPS, the patient is maintained at a sedation level at which they are responsive to verbal commands, monitored either alone or in combination with light tactile stimulation. No interventions are required to maintain a patent airway, and cardiovascular function is usually maintained [19,20]. PPS includes sedation as well as analgesia and dissociation, depending on the nature of the procedure. In the case of electrophysiological tests, which are not painful, the primary goal is to provide adequate sedation to ensure the child remains asleep throughout the test.

Medications used for oral or intranasal sedation tend to have a slower onset, less predictable effects and may occasionally fail to achieve the desired level of sedation [21].

- **Melatonin** is a hormone (N-acetyl-5-methoxytryptamine) naturally produced by the pineal gland that plays a key role in controlling the sleep-wake cycle. Exogenous melatonin has been shown to reduce sleep onset latency and increase both the efficiency and duration of sleep [22]. No significant side effects have been reported in the literature in either adults or children, and its use does not require close medical monitoring [23]. The dosage of melatonin administered varies across studies; Anderson et al. [24] reported values ranging from 3 to 10 mg in a review,

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while in a separate systematic review, Behrman et al. noted dosages ranging from 0.25 mg in children under 3 months to 20 mg in children over 6 years [25]. The effectiveness of melatonin is highly variable. Behrman et al. reported a success rate between 65% and 86.7%, with more success in children under 1 year of age and lower rates in those over 3 years [25]. In a study by Hajjij et al., melatonin was administered to 247 children with a mean age of 2 years and 4 months. They found that 75.7% of the children completed full testing, while 24.27% experienced interrupted sleep, and most required additional doses [26]. Casteil et al. administered 5 or 10 mL of melatonin to 29 children aged between 1 and 6 years, achieving sufficient sleep for complete testing in 59% of the children, with a failure rate of 27% [27]. Meanwhile, Schmidt et al. reported a failure rate of only 4% in children under the age of 1 year and 25% in children older than 3 years [23]. In a group of 33 children aged between 5 months and 4 years (mean age of 2 years and 8 months), Chaouki et al. reported a failure rate of 27.3%. The onset of melatonin's effect was reported between 15 and 55 minutes, with a mean onset time of 30.39 minutes. Additionally, 48.5% of the children required an additional dose of melatonin to achieve the desired effect [28].

- **Chloral hydrate** is a non-opioid, non-benzodiazepine sedative and hypnotic drug. It is commonly used in paediatric audiology, as well as in neurological, imaging, and dental investigations or treatment. Although considered effective and safe in adequate doses, its use is banned in some countries because of the potentially severe adverse effects at higher doses; possible carcinogenic effects have also been observed in guinea pigs, but have not yet been confirmed in humans [29,30]. Despite these concerns, chloral hydrate is considered safe and effective for children undergoing painless diagnostic procedures [31]. Valenzuela et al., in a study of 635 children, used an average dose of 52 mg/kg and achieved a 95.9% success rate. Side effects were reported in 19.2% of patients, including 3.4% who had severe complications such as apnoea or bradycardia; 6.2% had minor complications, such as vomiting, hypoxemia, prolonged sedation, tachypnoea, and 5% suffered agitation [32]. Vomiting is the most common adverse effect. Avlonitou et al. recorded an incidence of 11.4% [31], similar to the 11.5% reported by Necula et al. [33], while Liu et al. reported a much lower incidence of 0.25% [34].

Agitation was the second most common adverse effect, with an incidence of 5% reported by Valenzuela et al. [32], 8% by Avlonitou et al. [31] and 3.1% by Necula et al. [33].

In a large study conducted by Xiangling Zhang et al. on a group of 6106 children, a failure rate of 3.11% was reported for a dose of 30 mg/kg, with a higher rate of 4.31% in the 0.5–3 years age group [35]. A meta-analysis published by Liu et al. included 23 studies on the use of chloral hydrate for paediatric sedation. The pooled sedation failure rate was 10.0%, and the overall incidence of adverse reactions was 10.32% [34].

A frequently mentioned negative aspect is the bitter and unpleasant taste of choral hydrate. It is also a gastric irritant, often causing vomiting, especially when administered in the large volumes needed for children with higher body weight [21].

- **Triclofos** is the active metabolite of chloral hydrate, specifically the sodium monophosphate salt of trichlorethanol [36]. It is better tolerated than chloral hydrate, as it causes less gastric irritation, but has a longer onset time [21]. The typical dose of triclofos is 50 mg/kg, with the option to administer an additional dose if sleep does not occur within 30 minutes. Jain et al. administered triclofos to a group of 160 children aged 14 to 36 months; 17.5% required an additional dose. The median sleep latency was 30 minutes, and the median sleep duration was 90 minutes. Reported side effects included dizziness, irritability, and vomiting, with no severe complications or respiratory disturbances. The success rate was 93.1% [37].

Studies have shown that triclofos can be safely used in children with congenital heart disease or neurological disorders. It is widely used in India, but has been banned in the United States since the 2000s.

- **Hydroxyzine dihydrochloride** (Atarax) is the hydrochloride salt of hydroxyzine, a first-generation antihistamine and H1 receptor agonist with antiallergic, antispasmodic, sedative, antiemetic, and anxiolytic properties. The recommended paediatric dose for children weighing

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less than 40 kg is 2 mg/kg. The onset of action is within 15 to 60 minutes, with a duration of effect of approximately 4 to 6 hours [38]. Reported side effects include prolonged QT/QTc intervals on echocardiogram, and the drug should be used with caution in patients with porphyria or pre-existing QT prolongation [36]. Overdose can lead to hypersedation, seizures, stupor, nausea, and vomiting. In such cases, gastric lavage, symptomatic management, and supportive care are indicated [39].

- **Midazolam** is a short-acting benzodiazepine widely used in paediatric hospital practice. It is used for its anxiolytic, sedative, anterograde amnestic, and muscle relaxant properties, and can be administered through various routes—intravenous, oral, or intranasal—each with specific advantages and limitations [40,41]. The oral bioavailability of midazolam in children has been reported to range between 15% [42] and 36% [43], while in adults, the values range from 31% to 72% [44]. The lower bioavailability in children suggests that higher doses are required compared to adults. According to Higuchi et al. [45], a dose of 0.32±0.10 mg/kg is appropriate for achieving sedation levels classified from drowsy, sleepy, and lethargic to asleep—corresponding to levels 2 and 3 on the sedation scoring system developed by Yuen et al. [46]. A deeper sedation level (level 4) is typically achieved only at higher doses. Manso et al. suggested that an optimal dose in children is 0.5/kg [47]. Adverse effects reported in the literature include paradoxical reactions, nausea, vomiting, and respiratory events, most commonly observed at doses exceeding 0.5 mg/kg [48]. A drawback of oral administration is the unpleasant taste, which is difficult to mask even with flavourings, often resulting in spitting or regurgitation by children [49]. The intranasal route offers the advantage of faster absorption into systemic circulation—resulting in a quicker onset, shorter duration of action, and faster recovery—due to its higher bioavailability compared to the oral route. It also confers anterograde amnesia [50]. However, intranasal administration is often poorly tolerated by children due to the tingling or burning sensation, as the concentrated solution has an irritant effect on the nasal mucosa. Side effects may include nausea, vomiting, cognitive, or respiratory problems [51,52]. Midazolam, whether administered orally or intranasally, is frequently combined with intranasal dexmedetomidine to enhance sedative efficacy.
- **Dexmedetomidine** (DEX) is a relatively new anxiolytic, sedative, hypnotic, and analgesic drug that acts as a selective agonist of alpha-2 adrenergic receptors in the central nervous system [53]. One of its major advantages appears to be its stronger safety profile, including a lack of respiratory depression [54]. The drug is absorbed through the nasal mucosa, which allows for intranasal administration as an alternative to the intravenous route. This is particularly beneficial in non-cooperative paediatric patients, as it avoids the pain and stress associated with intravenous catheter placement [55].

The onset time of sleep induction following intranasal DEX varies between 10 and 60 minutes, with an average of 22 minutes [54]. Reynolds et al. report a success rate of 89% following a single intranasal dose, with a mean onset time of 25 minutes [56]. While the success rate of DEX is comparable to that of chloral hydrate, the longer sleep onset time is often considered a disadvantage, ranging from 20 to 40 minutes, which can be a limitation in a busy clinical environment [57].

In a 2022 review, Marra et al. identified six studies using intranasal DEX from 2015 to 2021. Doses ranged from 2 to 4 μg/kg, with 3 μg/kg the most common. Reported success rates varied from 82.5% [58] to 100% [54]. Gupta et al. reported that 14% of children (out of a cohort of 203) required dose supplementation, 6% needed oxygen support, and the failure rate was 2% [59]. Giordano et al. reported a success rate of 96.6% in a group of 59 children (mean age 3.0±1.6 years) following an initial dose of 2.5 μg/kg, with an additional 1 μg/kg administered at 30 minutes if sedation was incomplete. The mean onset of sedation was 32.4±18.3 min. In their cohort, 48.3% experienced hypotension and 53.5% bradycardia, although medical intervention was not required [60]. Tug et al. also reported mild bradycardia and hypotension, without necessitating treatment [61]. In a larger cohort of 578 children, Tsze et al. supplemented sedation with oral or intranasal midazolam in 39.3% of cases, achieving

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complete procedural success in 91.3% of children. Reported adverse effects included bradycardia in 1.9% and oxygen desaturation in 0.9%, with no severe complications [62].

A meta-analysis by Tervonen et al. concluded that intranasal DEX has a comparable success rate to chloral hydrate, but with a lower incidence of nausea and vomiting. Moreover, DEX demonstrated a higher success rate than midazolam [63]. Li et al. found that the combination of intranasal DEX and midazolam produced a higher success rate (97.5%) compared to DEX alone [58].

- **Pentobarbital** has been more widely used in procedural sedation, particularly via intravenous administration. Common side effects include hypotension, respiratory disturbances, prolonged recovery time, and paradoxical reactions [64]. Oral administration has a high reported success rate, 82% in the study conducted by Andreson et al., with a low rate of complications aside from a longer sleeping time [65]. An oral dose of pentobarbital (50 mg/mL) reported by some authors is 4 mg/kg, with an additional 2 mg/kg administered as needed, up to a maximum dose of 8 mg/kg [64]. Pentobarbital with or without **alimemazine** was used by François et al. in a group of 180 children aged between 2 and 5 years. They administered intrarectal pentobarbital or intrarectal pentobarbital and oral alimemazine with a success rate of 89.8%. The mean sleep onset time was 64±40 minutes [66]. Intrarectal pentobarbital at a dose of 5 mg/kg was also used by Baculard et al. (2007) in a group of 68 children under the age of 8 years. The average time to sleep onset was 36.1 minutes, with a success rate of 89.7%. Adverse effects were reported in 15.9% of cases [67].

2.2.2. Deep sedation and general anesthesia: Intravenous and/or inhalation administration, with or without respiratory support

Deep sedation is a drug-induced depression of consciousness during which patients cannot be easily aroused, but may respond purposefully to repeated or painful stimulation. In contrast, general anaesthesia is a drug-induced loss of consciousness, during which patients are not rousable, even by painful stimulation. The ability to independently maintain ventilation is often impaired, and patients may therefore require assistance in maintaining a patent airway. Monitored anaesthesia care (MAC) refers to a specific anaesthesia service performed by a qualified anaesthesiologist during a diagnostic or therapeutic procedure, encompassing the full range of sedation levels, up to and including the transition to general anaesthesia [68].

General anaesthesia requires the presence of qualified personnel who are capable of administering the necessary pharmacological agents and promptly intervening to secure the airway in case of complications [69].

Procedural sedations are achieved through the administration of sedatives, with or without analgesics, depending on the nature of the procedure. The most commonly used combination includes benzodiazepines and opioids, although other drug combinations may also be employed. The route of administration is usually intravenous or inhalational. The main advantages of this method lie in the rapid onset of sedation and the ability for the process to be closely monitored and adjusted by an anaesthesiologist, who is trained to promptly identify and manage adverse effects or complications [70].

- **Midazolam** can be administered intravenously, initially in a higher dose of 2–2.5 mg, followed by supplementary doses of 1 mg every 2–5 minutes, depending on the effect. Its onset is rapid, typically occurring within 2–3 minutes [71].
- **Fentanyl** is a synthetic opioid, administered intravenously with an initial dose of 1–1.5 μg/kg, followed by a maintenance dose of 1 μg/kg every 3 minutes. The onset of action occurs within 1–2 minutes and lasts between 30 to 60 minutes [70].
- **Ketamine** can be administered intravenously at a dose of 1–3 μg/kg or intramuscularly at 5–10 μg/kg. Its onset of action is rapid, within 1 minute, and the duration of effect ranges from 15 to 30 minutes, depending on the route of administration.[72] An advantage of ketamine is the maintenance of haemodynamic stability and spontaneous respiration, with only a mild bronchodilatory effect [73]. Common side effects include nausea, vomiting, hypersalivation,

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dizziness, diplopia, drowsiness, dysphoria, confusion, and hallucinations [74]. Respiratory complications such as laryngospasm and apnoea have also been reported [75].

- **Propofol** is an intravenously administered sedative-hypnotic drug. The recommended dose for children is 2–3 mg/kg, which can be repeated as needed. The onset of action occurs within 15–30 seconds and lasts between 1 and 3 minutes [76]. Recovery is rapid, and the medication is generally well tolerated [77]. The risk of apnoea and desaturation is highest during induction [78]. Levit et al. administered propofol for ABR testing in a group of 126 children over 24 months of age, using an initial bolus dose of 0.8 mg/kg followed by a continuous infusion at a rate of 0.1 mg/kg/min [79].
- **DEX**, when administered intravenously at a dose of 1 μg/kg, has a rapid onset of action, inducing sleep within 3–5 minutes and lasting approximately 15 minutes, with the advantage of not causing respiratory depression [80].
- **Nitrous oxide** (N_2O) is an analgesic and anxiolytic gas with rapid onset and quick recovery. It is administered via a face mask, mixed with oxygen and typically at a flow rate of 5–6 L/min [81].
- **Sevoflurane** is administered via a face mask and does not require intubation. After induction, the maintenance dose can be reduced to a level that sustains the sleep state. [82] Various studies have shown that sevoflurane may favour false positive responses, resulting in ABR responses at higher intensities than those obtained through behavioural testing or with other drugs such as propofol [83,84].
- The combination of **propofol and ketamine** is considered more effective than propofol alone, with fewer side effects. The addition of low-dose ketamine reduces the required dose of propofol, thereby decreasing the risk of respiratory complications [85].

Auditory testing under general anaesthesia with endotracheal intubation (EET) or a laryngeal mask airway (LMA) is recommended when the airway cannot be maintained by less invasive means. This is typically the case for children with multiple comorbidities, when there is a risk of aspiration, or in the presence of cardiovascular instability [86]. In such cases, testing should be performed in the operating room, in the presence of an anaesthesiologist team. Throughout the procedure, the anaesthesiologist monitors blood pressure, oxygen saturation, and heart rhythm. General anaesthesia involves a combination of drugs, such as midazolam for premedication, sevoflurane for induction, followed by propofol and fentanyl, with sevoflurane for maintenance [87]. The main disadvantage of this setting is the use of higher drug doses, which may prolong both induction and recovery times and increase the risk of side effects [21]. Additionally, higher doses of anaesthetic agents may result in longer ABR wave latencies and reduced amplitudes, making interpretation more difficult, increasing the risk of false positives and overestimation of the severity of hearing loss [84]. This effect has been demonstrated in several studies. Norrix et al. analysed the depressant effect of anaesthetic agents on brainstem neural activity in response to click stimuli and found prolonged I–III, II–V, and I–V latencies [88]. Similar findings have been reported elsewhere. Furthermore, interpretation is complicated in this context by background noise and electromagnetic interference from operating room equipment [87,89].

4. Discussion

Hearing testing in children using electrophysiology is best performed while the child is asleep, as this provides optimal conditions for obtaining interpretable results and ensuring accurate diagnosis. The methods available for inducing sleep each have their own advantages and limitations, and healthcare teams must carefully select the safest and most effective approach based on the specific needs of the child and the resources available.

Natural sleep offers the significant benefit of avoiding pharmacological side effects. However, it is frequently interrupted in children and may not last long enough for the completion of tests. Achieving natural sleep requires close cooperation from the child's caregivers, including adherence to specific preparation protocols—something that may not always be feasible, particularly when families travel long distances to the clinic. While natural sleep can typically be induced more easily

 doi:10.20944/preprints202505.1185.v1

in infants below 6 months of age, it becomes increasingly challenging as the child grows older, often necessitating extended testing time.

Oral or intranasal sedation is a non-invasive option that does not require the presence of an anaesthesiologist and involves minimal monitoring. This makes it feasible outside the operating room. However, it demands personnel who are trained to recognise and manage potential side effects, are skilled in resuscitation, and can access intensive care support if necessary. The onset of sedation is slower and less predictable, and the success rate varies depending on the drug used. Chloral hydrate has historically demonstrated a high success rate, but its use is declining and is even banned in some countries. Intranasal DEX shows a similarly high efficacy, with the added benefits of lower dosage requirements and fewer side effects, such as vomiting. Although there is some risk associated with these sedatives, they allow testing to be performed in more favourable acoustic and electromagnetic environments compared to the operating room, and at a lower cost.

Deep sedation, administered by an anaesthesia team, provides more predictable and controlled sedation, with continuous monitoring and support for resuscitation if needed. This approach allows for a stable testing window and better control over the procedure's duration. However, it typically must be carried out in an operating room, where the presence of medical equipment can increase acoustic and electromagnetic noise, potentially affecting the quality of the recordings. Although the risk of side effects exists, it is mitigated by the presence and expertise of the anaesthesia team. The disadvantages of this method include its invasiveness, the need for specialised personnel and equipment, and significantly higher costs.

5. Conclusions

Electrophysiological testing in children requires the patient to be asleep to minimize artifacts caused by muscle activity and movement. Natural sleep is ideal due to the absence of pharmacological side effects; however, it is often unpredictable and may not provide the necessary immobility for accurate testing, Therefore, pharmacologically induced sleep is frequently employed to ensure a calm and still patient, facilitating a more predictable and efficient testing process. Oral or intranasal sedation techniques allow for ABR and ASSR testing to be conducted outside the operating room, offering the advantage of discharging the patient home once they have fully awakened. Testing within the operating room should be reserved for cases where oral or intranasal sedation is contraindicated or has proven ineffective.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, V.N. and S.S.P.; methodology, M.C.S.; software, C.M.B.; validation, M.D., R.O. and F.I.M.; formal analysis, A.A.M.; investigation, M.D.; resources, R.O.; data curation, C.M.B.; writing—original draft preparation, V.N.; writing—review and editing, V.N. and S.S.P.; visualization, A.A.M.; supervision, M.G.; project administration, V.N. All authors have read and agreed to the published version of the manuscript." Please turn to the CRediT taxonomy for the term explanation. Authorship must be limited to those who have contributed substantially to the work reported.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

ABRI	Auditory Brainstem Response
ASSR	Auditory Steady-State Response
DEX	Dexmedetomidine

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