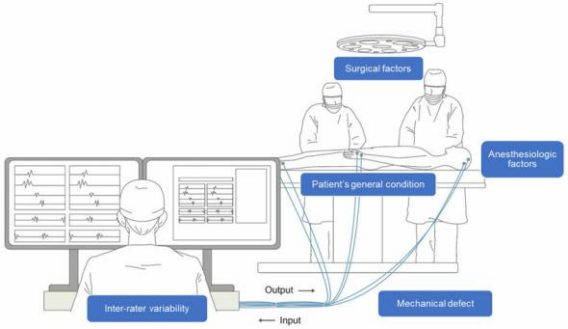
Challenges During Intraoperative Neurophysiologic Monitoring in Children



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Conflict of Interect
Declaration

Introduction

Intraoperative neurophysiologic monitoring (IONM)

- Definition
  - Technique used to monitor the functional integrity of neural structures during surgery
- Purpose
  - Prevent or reduce the postoperative neurological deficits by providing real-time feedback

Two functions of IONM

- 2 distinct functions; monitoring and mapping
  - Monitoring indicates continuous acquisition of neural signals to assess the integrity of the nervous system
  - Mapping identifies neural structures within the surgical field to avoid or minimize neural damage

Application

- Brain surgery
  - Complex surgeries involving the motor and sensory cortex, brainstem, cranial nerves
  - Epilepsy surgeries
- Spinal surgery
  - Deformity corrections
  - Spinal dysraphism
  - Spinal cord tumors

Challenges of IONM in Children

Techniques of IONM

- The same techniques of IONM used in adults
- Modification is needed
  - Amplitude
  - Latency standards
  - Interpretation

Anatomical and physiological differences

- Thin calvarium, open fontanelles, smaller brain size, thinner cortical layers, and increased vascularity
  - Challenges with electrode placement
- Incomplete myelination
  - Affects waveform morphology and latency
  - Higher thresholds due to incomplete myelination in young children

Developmental considerations

- Developing brain
  - Characterized by ongoing neuroplasticity and reorganization
    - making it difficult to accurately localize eloquent cortex using traditional IOM techniques
- More susceptible to anesthesia

Monitoring Modalities

- Somatosensory Evoked Potentials (SSEPs)
  - Assess the functional integrity of the sensory pathways, particularly the dorsal columns of the spinal cord.
- Motor Evoked Potentials (MEPs):
  - Assess the functional integrity of the motor pathways, particularly the corticospinal tracts, during surgery
- Electromyography (EMG)
  - Monitor cranial and spinal nerves

Anesthetic considerations

Anesthetic goal

- Minimizing anesthetic interference for IONM while maintaining appropriate anesthesia during the surgery
  - Selection and dosing of anesthetic agent
  - Monitoring of anesthetic depth
  - Detailed preoperative assessment to identify the potential risk factors

Preoperative assessment

- General preoperative assessment
- Careful reviewing the patient's medical history
  - Any neurological or developmental abnormalities to identify potential risk factors for complications during IONM

Equipment & general

- Use an anesthesia circuit and monitoring equipment that is specifically designed for pediatric patients
- Other factors
  - Temperature control
  - Surgical position
  - Preparation to manage potential complications, such as seizures, hemodynamic instability, and airway compromise

Anesthetic plan

- Anesthetic plan
  - Discuss the anesthesia plan with the surgical team to ensure the minimal impact of anesthesia on IONM and safety of the patients.

Choice of anesthetics

- Total intravenous anesthesia
  - Intravenous (propofol) >> inhalational agent
    - metabolism is reduced in neonates, maturing over the initial 6 months of life and clearance increases throughout infancy to reach almost adult values by 6 months
  - Dexmedetomidine
    - minimal impact on SSEPs
  - Ketamine
    - less inhibitory effect on MEPs when used as the main hypnotic agent with remifentanil
  - Opioids (remifentanil)
    - volume of distribution and clearance in infants is approximately twice that of adults

Depth of Anesthesia

- Maintain appropriate anesthesia to minimize interference with IONM data
  - Use of monitoring
    - ✓ Bispectral index
    - ✓ Patient sedation index
    - ✓ Qcon, etc
  - Titrate the anesthesia based on the patient's response to stimulation and the IONM data

Neuromuscular monitoring

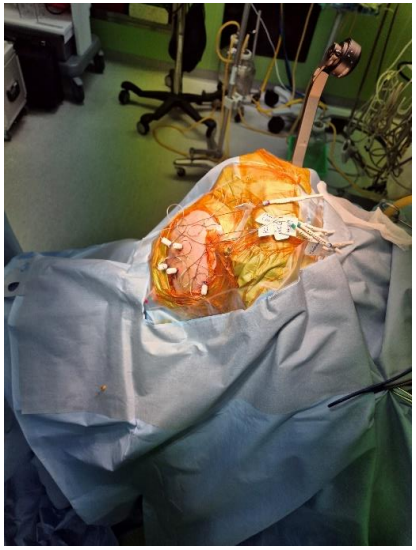
- Cautious during MEP monitoring
- Rocuronium
  - Intermediate-acting
  - Antidote
    - Sugammadex
    - Label ; over 2 years
- Monitoring
  - EMG >> AMG

Other conditions

- Hypothermia, hypoxia, hypotension, cerebral ischemia or hyper- and hypocapnia
  - can suppress nerve conductions resulting in the decrease or disappearance of IONM amplitudes

Minimal invasive electrodes placement

- Robotic Stereotactic Assistance (ROSA)



Take home messages

- While IONM in pediatric patients presents significant challenges, careful planning, coordination with the surgical team, and the use of appropriate techniques and anesthetic agents can lead to successful outcomes.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