NEUROMUSCULAR BLOCKADE & MONITORING by Nick Mark MD

ONE
onepagericu.com
@nickmmark
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RATIONALE:

- Neuromuscular blockade can be a useful adjunct in caring for patients with severe ARDS and *may* reduce mortality (or not)
- There are several mechanisms by which NMB can benefit patients with severe ARDS:
  - Improved ventilator synchrony / prevention of patient induced lung injury (e.g. doublestacking)
  - Decreased oxygen consumption (respiratory muscles use <2% of VO_2 at rest but 10-20% in extremis)
- However, NMB can also be harmful:
  - Prolonged/excessive NMB is associated with neuromuscular weakness/muscle loss (ICU-AW)
  - Prolonged/deeper sedation is associated with increased risk of delirium, neurocognitive impairment
  - NMB is associated with increased risk of pressure injuries, corneal abrasions, & DVTs
- Thus, NMB should only be administered in patients ***likely to benefit*** & ***only for the shortest time required***.

CHOICE OF NEUROMUSCULAR BLOCKER (NMB)

- All NMBs are non-depolarizing and administered by continuous infusion.
- ***Cisatrocurium*** – Metabolized by esterases/spontaneously in plasma (Hoffman elimination); not renally or hepatically cleared. More expensive.
- ***Rocuronium*** – Mostly hepatic metabolism, though with renal/biliary excretion of metabolites. Avoid in renal failure.
- ***Vecuronium*** – 40% renal, 60% biliary clearance. Avoid in liver/renal failure.
- Call them "NMBs," "paralytics" sounds scary to patients/families

Severe hypoxemia? (P/F < 120)
Significant dysynchrony?
(NMB is **NOT** required for prone positioning)

→ Increase sedation/analgesia (typical goal RASS -5)

→ Titrate neuromuscular blocker (goal vent synchrony)

→ Attempt to stop NMB daily; reassess if still indicated

→ STOP
(many patients will only require NMB for 24 hrs)

Use EEG/BIS monitor to ensure sedation depth is adequate

Use TOF monitor to ensure NMB is at lowest dose possible

*(NMB does **not** affect smooth muscles, however gut motility may be decreased)*

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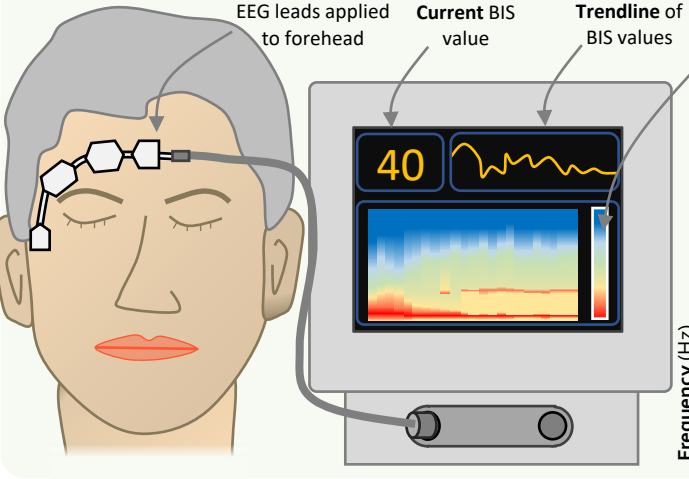
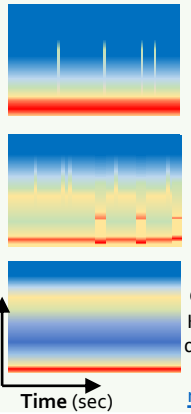
EEG/BISPECTRAL INDEX (BIS) MONITORING:

- The principle is that EEG monitoring provides an quasi-empiric measure of anesthesia depth, which is used to titrate sedation during NMB. ***Theoretically this prevents both oversedation & undersedation.***
- Bispectral index is an algorithmic technique to combine multiple EEG parameters, providing a single numeric output:
  - 80-100 Awake
  - 60 – 80 Moderate sedation
  - 40 – 60 Deep sedation/general anesthesia (**typical goal during NMB**)
  - <40 very deep sedation
- There is no evidence that BIS monitoring reduces awareness of NMB, nor that it simplifies sedations (one study found ***similar*** sedative doses with ***more*** frequent dose adjustments using BIS monitoring)



2D EEG spectragram shows **EEG frequency** (vertical) vs **time** (horizontal) with **power** (color scale)



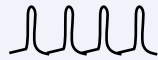
WAKEFULNESS
Predominantly low frequency energy

UNCONSCIOUSNESS due to propofol or BZD infusion.

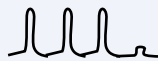
UNCONSCIOUSNESS due to ketamine. Ketamine boluses can increase alpha power ***falsely*** raising BIS values.

TRAIN OF FOUR (TOF) MONITORING:

- Muscles are are electrically stimulated 4 times in rapid succession & the number of contractions are noted. Used to titrate NMB to the minimum effective dose.
  - After achieving adequate sedation, electrodes are applied and the nerve is stimulated using a low current (10-20 mA); the current is increased until 4 vigorous twitches are seen. Further increasing the current should not lead to more forceful contraction (**supramaximal stimulation**).
  - Once the supramaximal stimulation is documented, NMB is initiated
  - Titrate NMB according to the number of twitches seen at the prior current: **decrease NMB infusion if fewer than goal twitches seen**

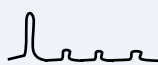


4/4 TWITCHES (no need to increase NMB infusion if synchronous)
<75% of receptors blocked



3/4 TWITCHES (typical GOAL level)
~75% of receptors blocked

2/4 TWITCHES (**decrease** NMB)
~80% of receptors blocked



1/4 TWITCHES (**decrease** NMB)
~90% of receptors blocked

0/4 TWITCHES
~100% blocked

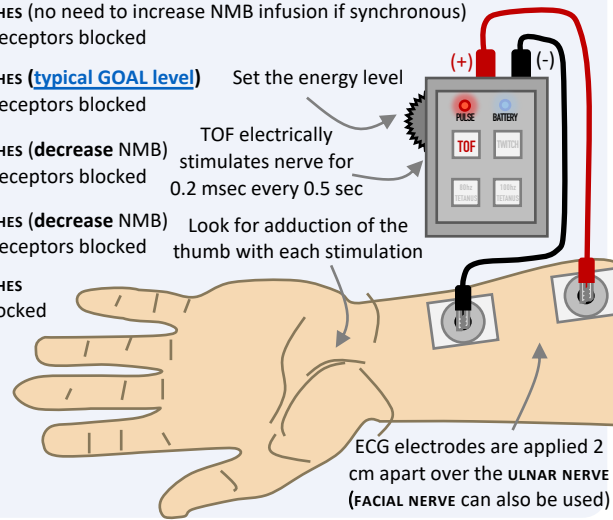
TWITCHES observed

TRAIN OF FOUR electrical stimuli

Set the energy level

TOF electrically stimulates nerve for 0.2 msec every 0.5 sec

Look for adduction of the thumb with each stimulation



ECG electrodes are applied 2 cm apart over the **ULNAR NERVE** (**FACIAL NERVE** can also be used)