TOF 3D

NEUROMUSCULAR MONITORING IN CLINICAL PRACTICE

Possible solutions and practical realization

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NMT MONITORING BASICS

NEUROMUSCULAR BLOCKING AGENTS

Curare has been known and used by many cultures for centuries. It is a toxin produced by plants that has been used for poisoned arrows.

Today NMBA belong to the most frequently used agents in general anesthesia

+ Support Intubation
+ Maintain surgical conditions
+ Improve compliance on the ICU

NMT MONITORING BASICS

NEUROMUSCULAR BLOCKING AGENTS

- Onset as well as duration depend on the condition of the respective patient.
- Duration of relaxation as well as muscular recovery depend on several external factors
  - Accompanying disease, Interaction with other drugs, pharmacogenetic factors*

*Fuchs-Buder

Residual Paralysis

What if the patient wakes up while blocking agents still have an effect on the patient's muscles?

- Risk for pulmonary events
- Impaired ability to swallow
- Post operative malaise of patients

NEUROMUSCULAR MONITORING

WHAT'S DONE IN THE CLINICAL ROUTINE?

- "No Monitoring" (Duration of effect)
  - "Clinical signs"
- Subjective Neuromuscular monitoring
  - Tactile / visual evaluation
- Objective (quantitative) Neuromuscular monitoring

In many cases NMBA are administered without proper monitoring.

Survey (2018) Use of NMT monitoring

Europe: 20%
US: 10%
Australia: 10%

Never use NMT Monitoring!

Subjective monitoring in < 40% of all patients
Objective monitoring in < 20% of all patients

NEUROMUSCULAR MONITORING

“NO MONITORING”

- In 12% of hospitals and 67% of private centers NMT monitoring is not available.
- In 44% of hospitals and 63% of private centers decisions about additional relaxation are based on clinical signs! (Coughing, Bear Down) or „fixed time intervals“.
- Even if reversal agents are administered the incidence of residual blockade is between 20-40%
- In 54% of hospitals and 70% of private centers clinical signs are the most frequently used criteria for the decision of neuromuscular reversal
- Evaluation of residual paralysis based on clinical tests
  - Tongue spatula test
  - Head Lifting >5 Sec. (possible at TOF = 0,5!)
  - The tests can only be applied in the very late phase of anesthesia. Only AFTER extubation!

NEUROMUSCULAR MONITORING

METHODS

Mechanomyography - MMG

- Measures the muscle force (pressure sensor)
- Preload of muscle is necessary
- Sensitive technical setup
  - Small changes in the positioning of the patient may influence measurement results
- Mostly used for research and studies
- Reference method for NMT monitoring

Electromyography – EMG

- Measures the electric action potentials of the muscle
- Digital signal processing
- Provided a low noise level the signal quality and measurement results are close to MMG
- Susceptible to electric interferences, temperature and movement

Acceleromyography - AMG

- Measures acceleration of the muscle
- 2. Newtons law: F = m x a (force = mass times acceleration)
- Mass is constant – Force proportional to acceleration
- Piezo crystal changes potential during acceleration. Changes are measured and amplified
- Free movement of the respective muscle is necessary!

NEUROMUSCULAR MONITORING

SUBJECTIVE MONITORING

- Peripheral nerve stimulator is used to stimulate the nerve.
  - Evaluation of the muscle response is done visually / tactile.
  - Depended on subjective / personal skills
- Single Twitch, DBS, TOF

Studies have shown that when using TOF stimulation, even experienced physicians cannot tell the difference between muscular response if TOF > 0,5.

Using DBS the result is improved to TOF > 0,6.

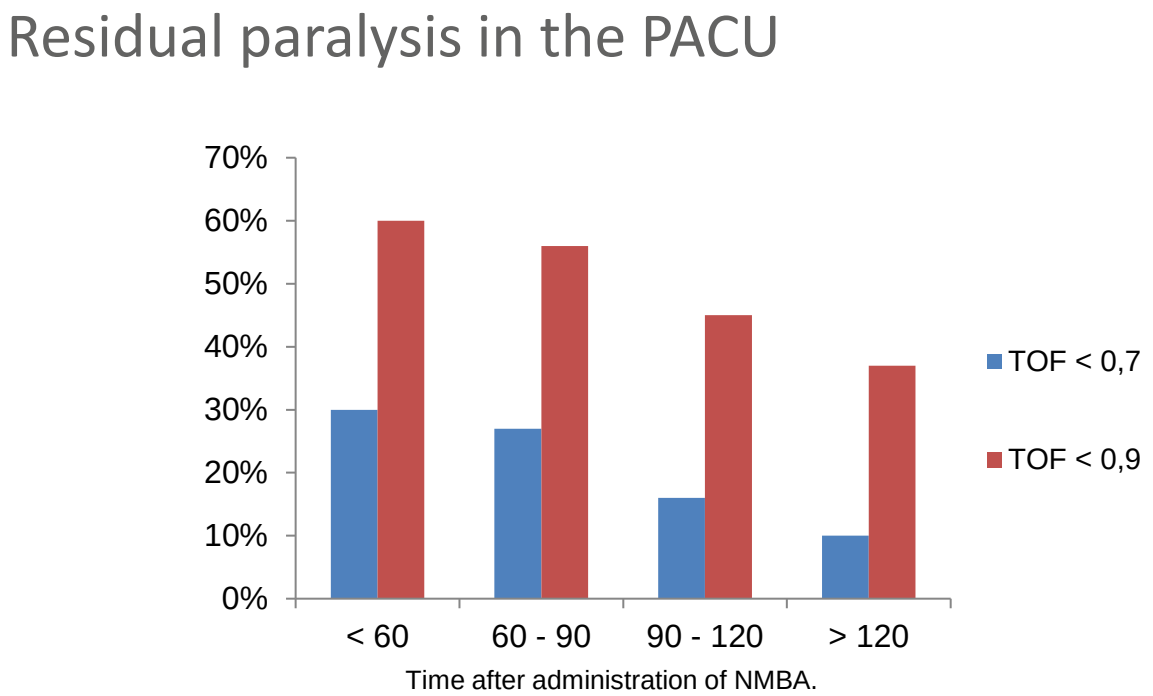
DBS is better than TOF if subjective monitoring is done.

A study recently conducted in the USA showed that the assessment of TOF = 0,9 has a 47% hit rate.

= 50 : 50

NEUROMUSCULAR MONITORING

SUBJECTIVE MONITORING



Residual Paralysis in the PACU after a Single Intubating Dose of Non-depolarizing Muscle Relaxant with an Intermediate Duration of Action (Debaene et al.)

NEUROMUSCULAR MONITORING

VITAL FUNCTIONS DURING RECOVERY

	TOF 0,5	TOF 0,8	TOF 1
Tidal volume	Normal	Normal	Normal
Forced Vital capacity	Often compromised	Often normal	Normal
Pharyngeal Function (Swallowing)	Certainly compromised	Often compromised	In general normal
Integrity of upper Airway	Certainly compromised	Often compromised	In general normal
Hypoxic breathing response	Often compromised	Often normal	Normal

NEUROMUSCULAR MONITORING

OBJECTIVE MONITORING

AMG has shown to be a practical method for NMT monitoring in clinical practice.

Measurement of muscle acceleration using an acceleration transducer (Piezo Crystal)

Quantifiable!

Strength of the muscle response can be measured by transducer.

Can be used on different muscles – Adductor pollicis is most suitable.

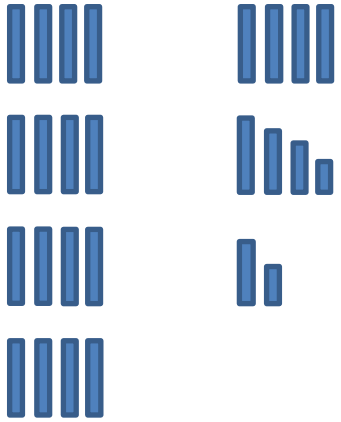
NEUROMUSCULAR MONITORING

TOF RATIO

- Calculation of TOF ratio: 4 Stimulation impulses
  0-4 Responses.

TOF Ratio = T4 / T1

- No block
- Partly NM block
- Deep NM block – TOF Count
- Complete NM block



NEUROMUSCULAR MONITORING

OBJECTIVE MONITORING

There are some objective NMT monitors on the market.

Modules:

+ GE
+ Philips
+ Nihon Kohden

Handheld devices:

+ TOF3D
+ TOFScan
+ Stimpod
+ TetraGraph
+ Twitch View

NEUROMUSCULAR MONITORING

REFERENCES

+ Neuromuskuläres Monitoring in Klinik und Forschung (Fuchs-Buder)
+ Einsatz des Neuromuskulären Monitorings in Deutschland (Der Anästhesist – 09/2008 pp. 908-914)
+ Residual Paralysis in the PACU after a Single Intubating Dose of Nondepolarizing Muscle Relaxant with an Intermediate Duration of Action (Debaene et al. Anesthesiology 2003; 98:1042–8)
+ A Survey of Current Management of Neuromuscular Block in the United States and Europe (Naguib et al. International Anesthesia Research Society, 2009)