TOF 3D

Quick Guide

Content

- Neuromuscular Transmission Monitoring (NMTM) in Clinical Practice
- TOF3D
- Trouble shooting

Terms

- Acetylcholine (ACh): Neurotransmitter responsible for stimulus transfer in the synaptic cleft at the neuromuscular end plate
- NMBA: Neuromuscular Blocking Agent
- Paralysis: relaxation of muscles due to application of NMBA
- TOF: Train of Four
- PTC: Post Tetanic Count
- AMG: Acceleromyography
- MMG: Mechanomyography
- EMG: Electromyography

Why NMTM?

- Residual paralysis may lead to severe complications for the patient.
  - pharyngeal dysfunction
  - increased risk for aspiration and pneumonia
  - Acute respiratory events
  - Residual paralysis increases patients discomfort in general.
- Tracheal extubation only if TOF Ratio **>0.9**
- Effective management of NMBA administration
  - Economic reason for NMTM

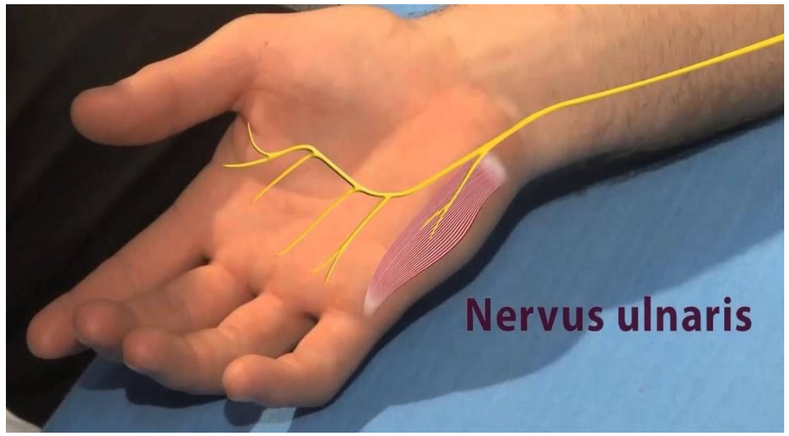
NMT Monitoring in clinical practice

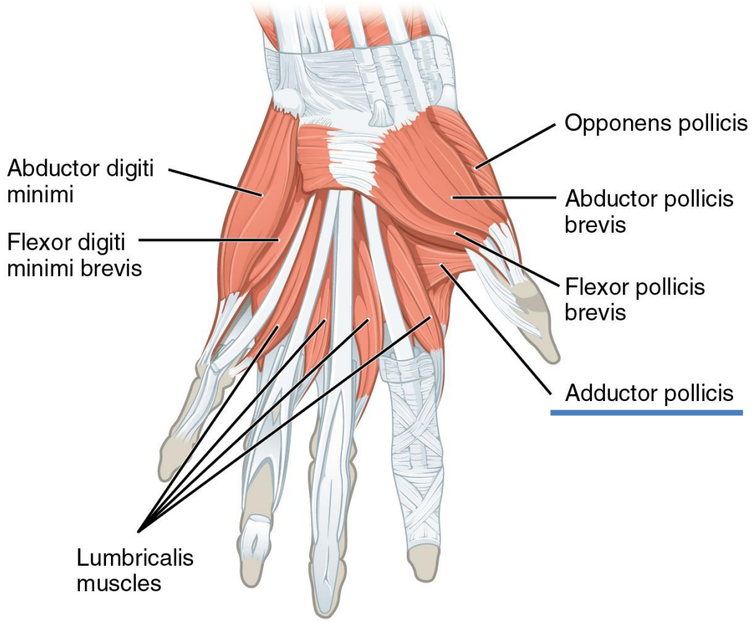
- TOF (Train Of Four) as reference for muscular paralysis and recovery condition of the patient

- PTC (Post Tetanic Count) for monitoring of deep muscular blockade

TOF Stimulation - TOF Count/Ratio

- Nervus ulnaris is innervated with 4 impulses
- Depending on muscular block, 0 - 4 responses of Musculus adductor pollicis are received by TOF monitor
- TOF Ratio = T4/T1
- TOF ratio can only be calculated if 4 responses are detected. Otherwise TOF Count 0 - 4
- If 4 responses are detected TOF ratio is shown as "percentage of recovery"

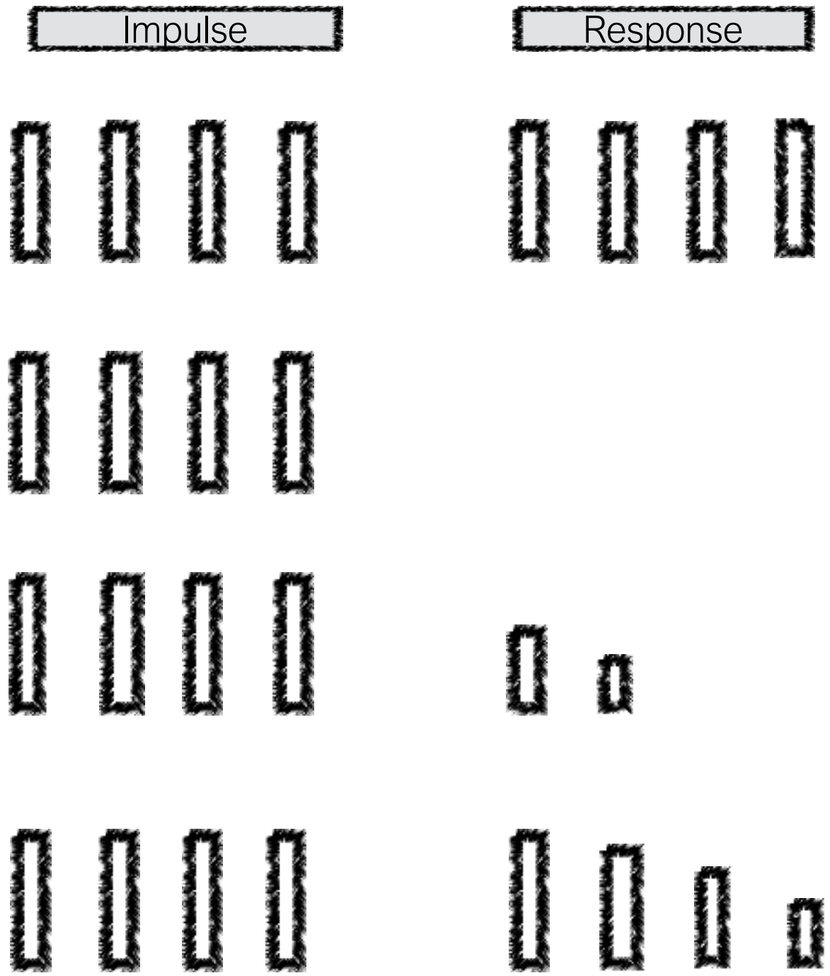




TOF Count / Ratio - Examples

- Non relaxed patient / full recovery
- Full neuromuscular block
- Recovery: early stadium -

  (e.g. TOF count 2)
- Recovery: medium stadium - (e.g. TOF ratio 50%)



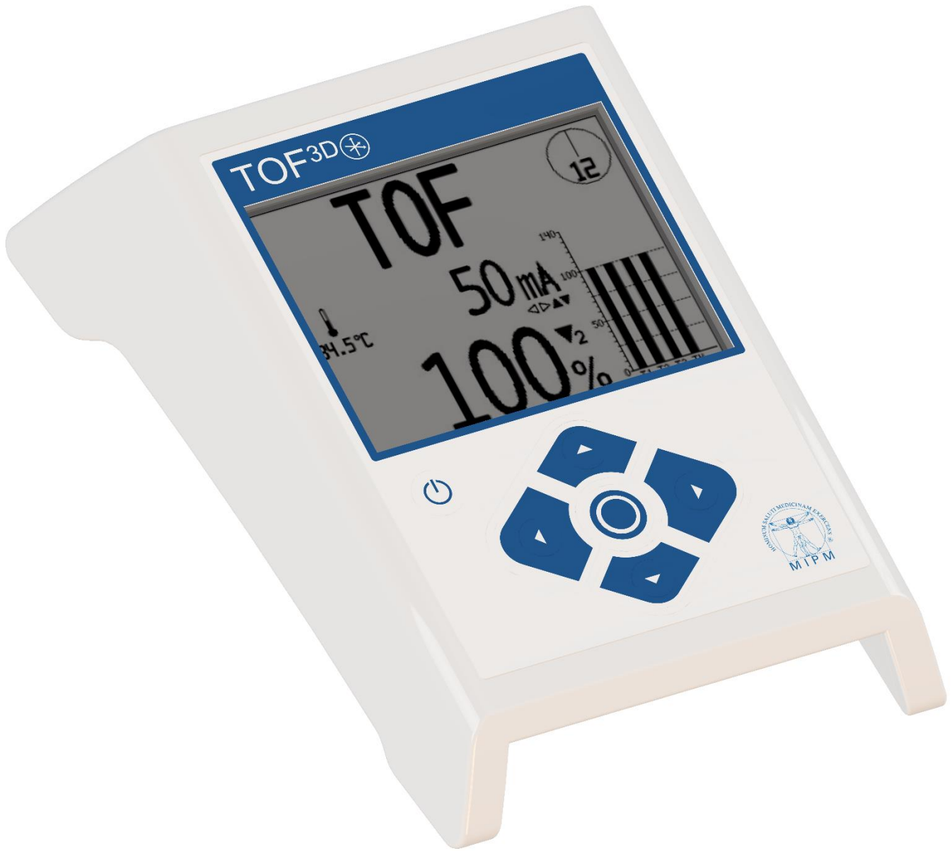
NMT Monitoring in clinical practice

TOF3D

- Using TOF3D is an easy method to monitor the degree of neuromuscular blockade

- AMG: a piezo crystal produces an impulse if accelerated by contraction of the Musculus adductor pollicis (thumb). Impulses are processed and displayed as TOF ratio or single impulse response

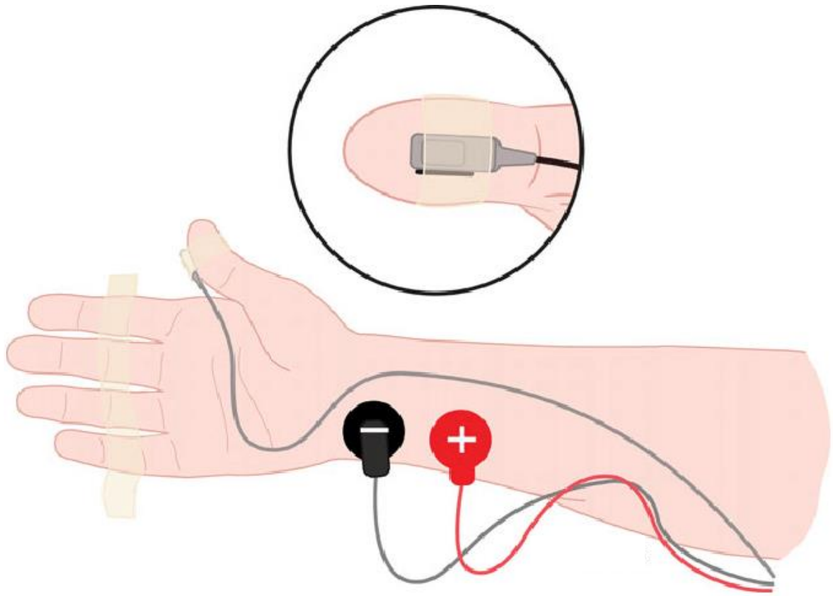
TOF3D

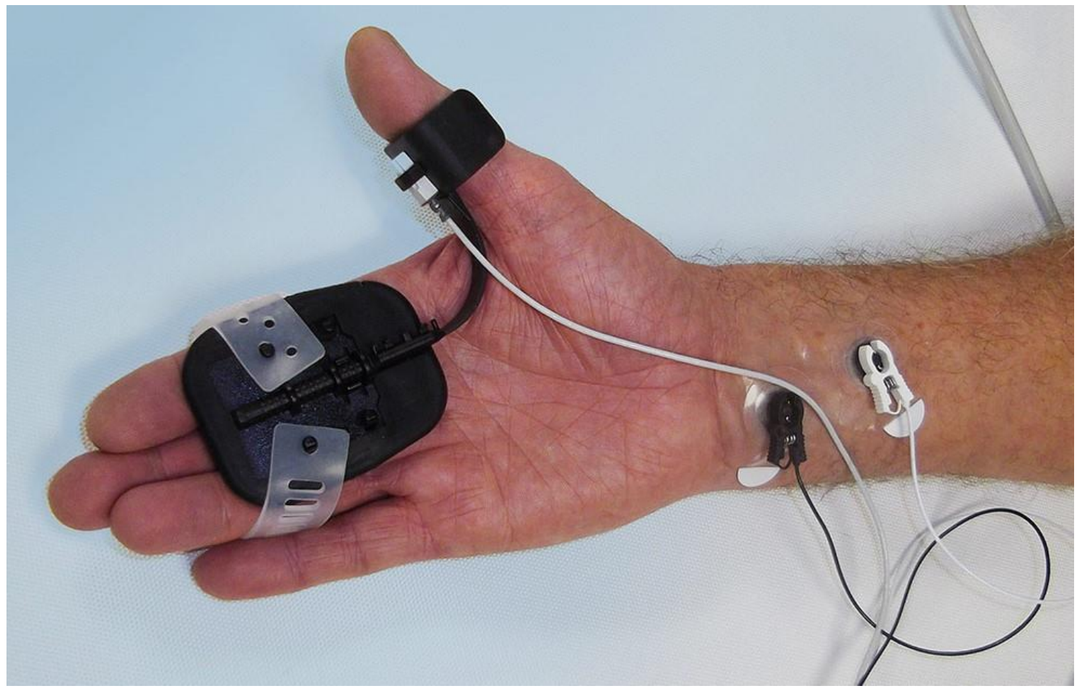


- Various stimulation modes
  - TOF, PTC, TC, DBS, Single Twitch
- Adjustable continuous measurement
- Calibration Mode

NMT Monitoring - Basics

It all starts with the correct setup of stimulation electrodes and acceleration sensor! The hand should be fixed to the OR table or the hand adapter should be used.





NMT Monitoring - Basics

The more distal the acceleration sensor is placed on the thumb, the stronger the acceleration signal. This effect can be used to adjust the signal strength.

NMT Monitoring - Basics

The shortcoming of AMG technology is that the observed muscle (e.g. adductor pollicis) requires space to move.

Only the movement (acceleration) of the muscles can be picked up by the sensor.

If hands are tucked to the body in an unfavorable way or if the free movement of the muscle is blocked by blankets or surgical drapes AMG will not work!

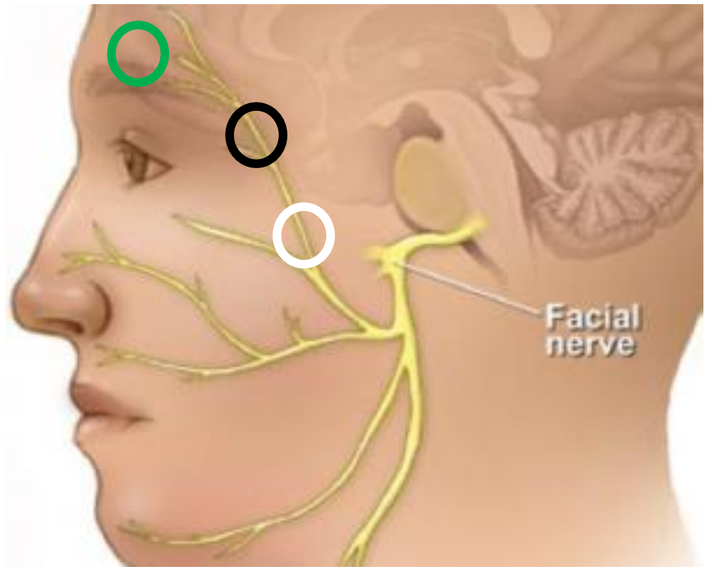
Using the hand adapter improves the performance by holding up the thumb providing space to move.

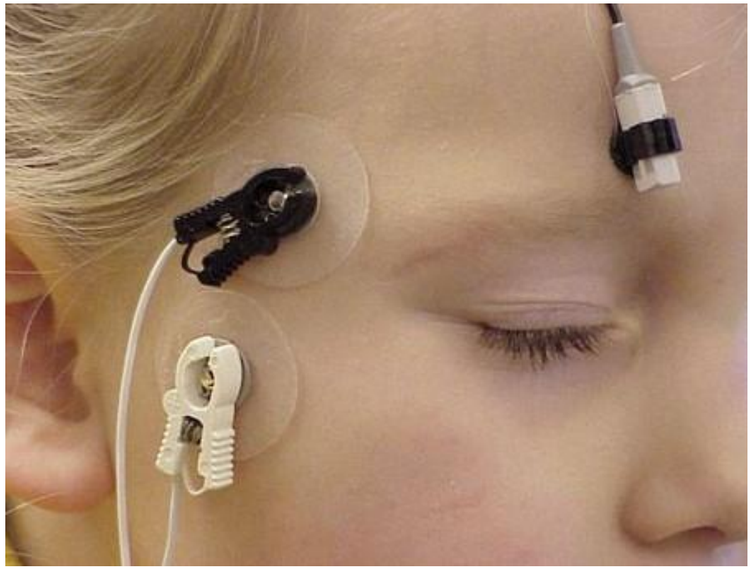
If the monitor cannot be used on adductor pollicis (thumb) you may try different setups:

NMT Monitoring - Basics

Stimulation: Facial nerve
place positive electrode (white) near ear lobe and the negative electrode (black) 2 cm's from the eyebrow (along facial nerve inferior and lateral to the eye)

Response:
Orbicularis occuli muscle – Eyebrow twitching



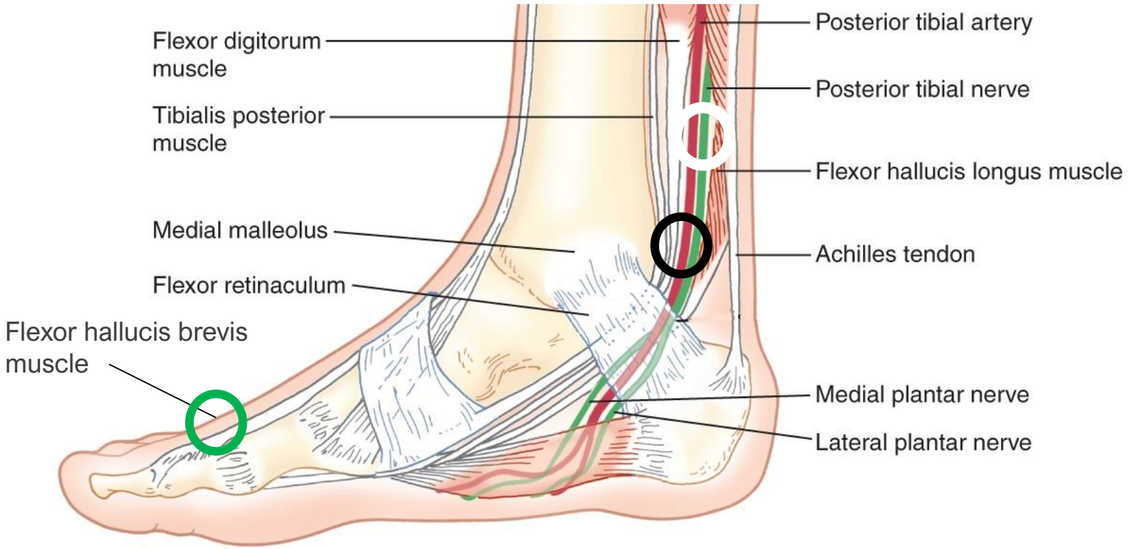


Use the Eye adapters to fix the acceleration sensor to the eyebrow

NMT Monitoring - Basics

Stimulation: Posterior tibial nerve
place the negative electrode (black) over inferolateral aspect of medial malleolus (palpate posterior tibial pulse and place electrode there) and positive electrode (white)
2 – 3 cm proximal to the negative electrode.

Response:
Flexor hallucis brevis muscle – planter flexion of big toe

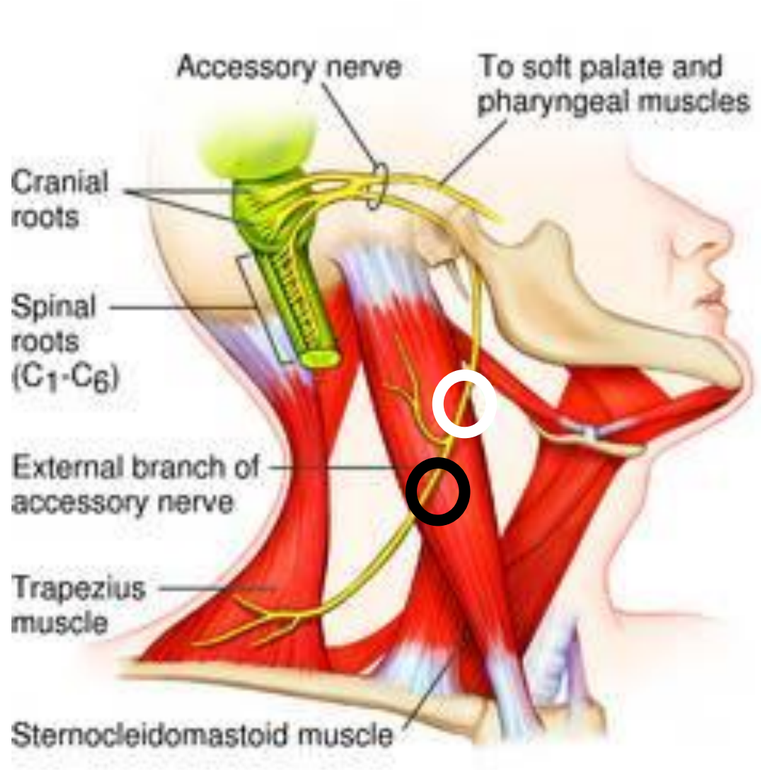


Use the thumb adapter or plaster to fix the acceleration sensor to the toe.

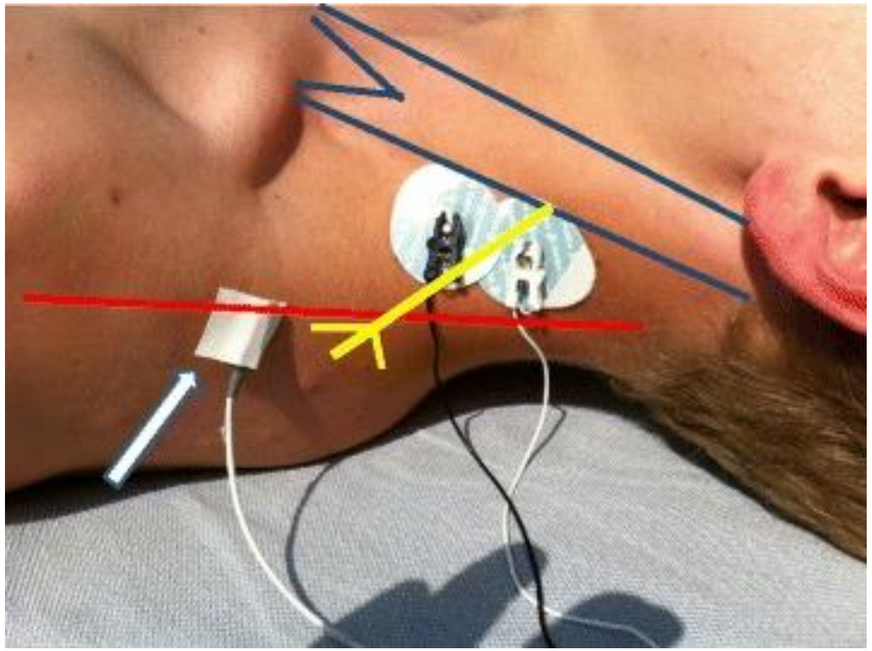
NMT Monitoring - Basics

A study conducted by Dormagen hospital in Germany showed a good correlation between using a setup at the trapezius muscle and using the adductor pollicis setup.

However so far there is no evidence about clinical use of this setup!



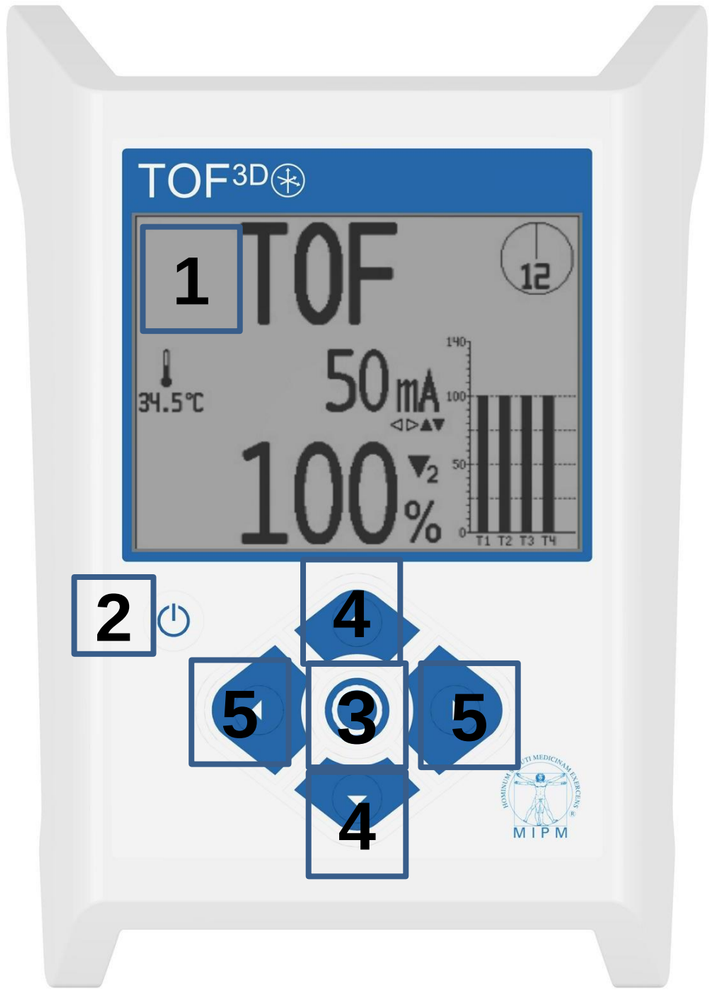
In this setup the Accessory nerve is stimulated provoking a shrug.
Fix the acceleration sensor with tape to the patient's shoulder.



TOF^{3D}

Front View

1. Display
2. On / Off key
3. Center Key
4. Up / Down keys
5. Right / Left keys



TOF^{3D}

Back

1. Adapter for IV pole holder
2. Socket for Patient cable
3. Battery Compartment
4. USB Interface

TOF^{3D} - Quick Guide

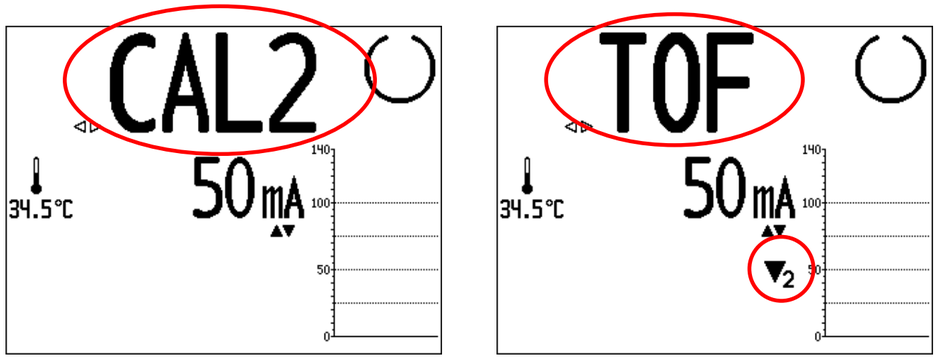
Place the stimulation electrodes and acceleration sensor to the patient as explained before.
Turn ON the monitor.
After a completed self test the monitor automatically goes to CAL Mode.

1. Inject sedative (wait for appropriate sedation)
2. Calibrate TOF3D.

   Press and hold the center key for at least 1 second to initiate Calibration.

   Wait until monitor returns to TOF mode and

   “calibration successful” is displayed



3. Inject blocking agent (NMBA)
4. Start single TOF stimulation by pressing the Center Key once

   (Start continuous TOF stimulation by pressing the Center Key for more than one second)

TOF^{3D} - Quick Guide

<u>If</u> TOF count = 0

Use PTC to monitor deep muscular block

- **Select PTC Mode using the Right – Left Keys**
- **Press and hold Center Key to activate PTC**
- **TOF3D displays number of responses (max. 15)**
- **PTC may only be used every 2 minutes!**

TOF^{3D} - Quick Guide

If patient is already relaxed do not calibrate device as this may lead to wrong results!

Use TOF3D without calibration. Keep in mind that the results may not be exact.

Since amplification of the signal and stimulus strength haven't been normalized by calibration process TOF ratio may be above 100%.

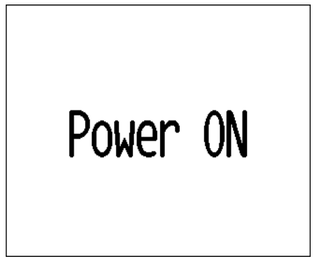
Additional functions

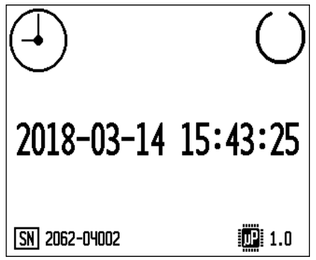
TOF3D offers a variety of functions.

TOF3D can be used for single twitch stimulus and different other stimulation modes.

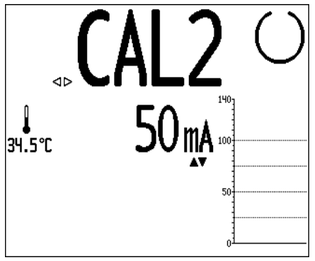
However the most common function is TOF stimulation. TOF has biggest practical evidence.

A typical TOF Session

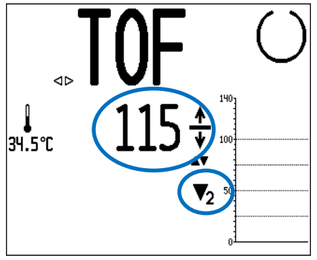




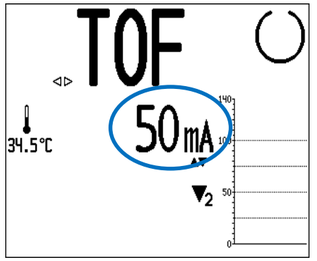
Self Test
Check Date/Time



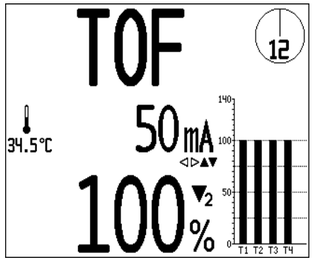
Initiate Calibration with Center Key >1 sec.



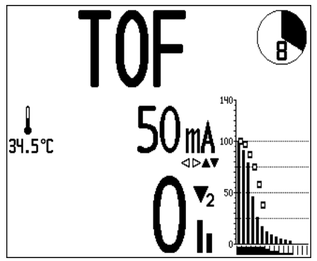
Base line adjustment and CAL confirmation are displayed



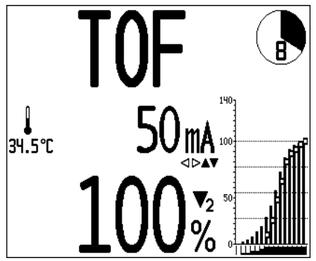
Stimulation current is displayed



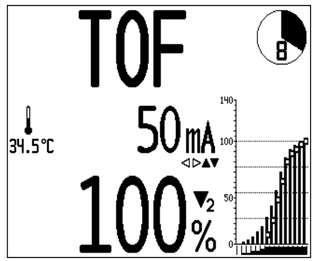
Start continuous TOF Measurement using Center Key > 1 sec.



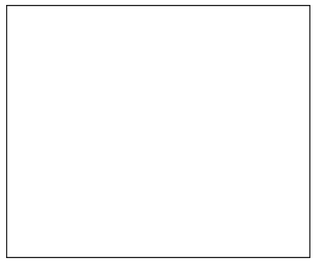
Observe effect of NMBA Bolus



Observe recovery until **FULL** recovery



Stop TOF measurement using Center Key



Turn Off Device

If unit is turned on again within two hours (from last measurement) you can add new data to the patient. If more than two hours have elapsed the patient has to be released and stored data must be transmitted via interface or deleted.

TOF^{3D}

Calibration

The monitor should always be calibrated before use!

This ensures accurate measurements.

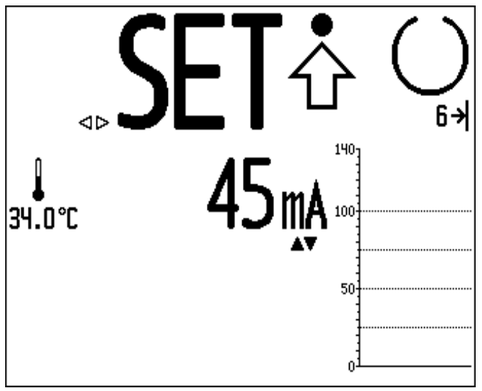
CAL 1: The monitor determines the base line (muscle response in the absence of NMBA) for the respective patient.

CAL 2: The monitor determines the base line (muscle response in the absence of NMBA) for the respective patient as well as the supra-maximal stimulation current

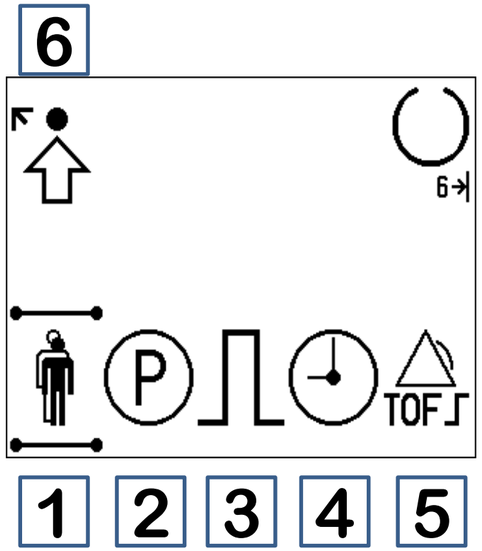
Select CAL1 or CAL2 in the Settings menu.

TOF^{3D} - In Detail

Setup and Alarms



Go to Setup Menu using the Left – Right Keys

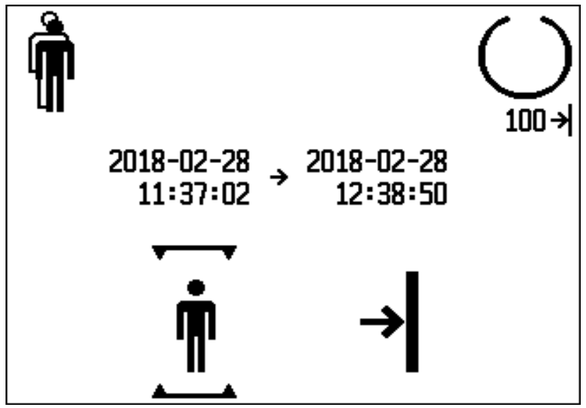


1. Data Management
2. Parameter Menu
3. Stimulation settings
4. Date / Time Settings
5. TOF Alarm Settings
6. Exit Setup Menu

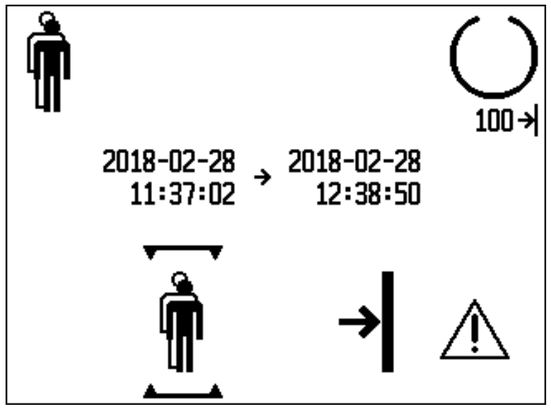
Use Left – Right and Up – Down Keys to navigate in the menu and change settings.
Use Center Key to enter or exit menus.

TOF^{3D} - In Detail

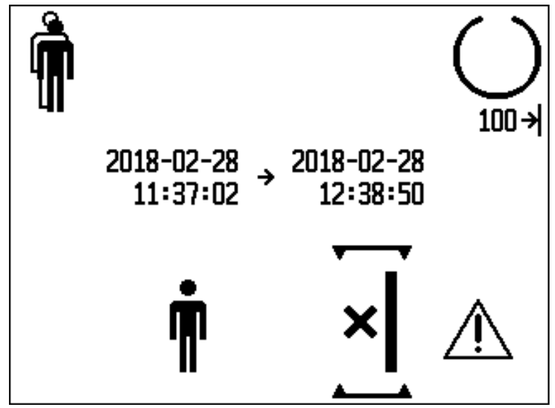
Data Management



New Data will be added to data in memory



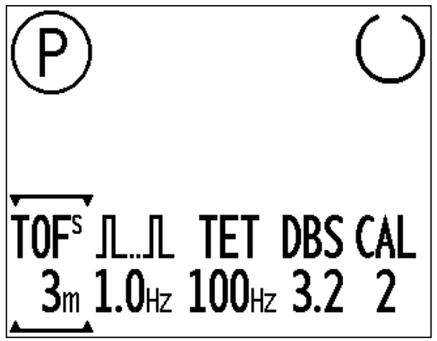
Existing Data will be erased – New Patient



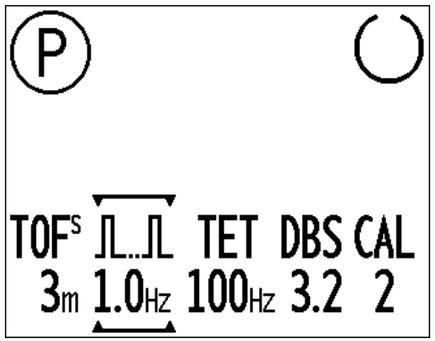
Activate / Deactivate data logging

TOF^{3D} - In Detail

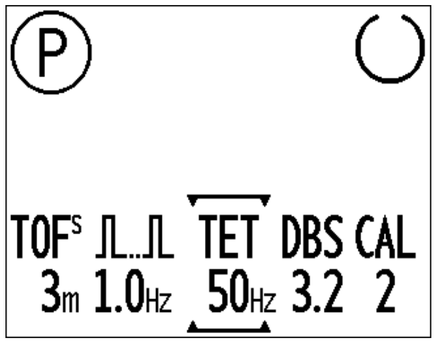
Parameter Menu



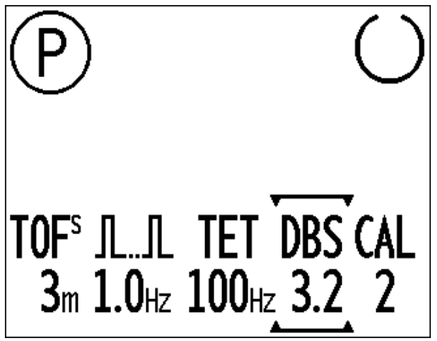
Select interval for continuous TOF Measurement in minutes.



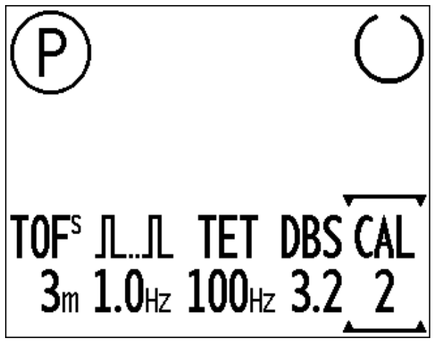
Select frequency for single twitch stimulation



Select frequency for tetanic stimulation



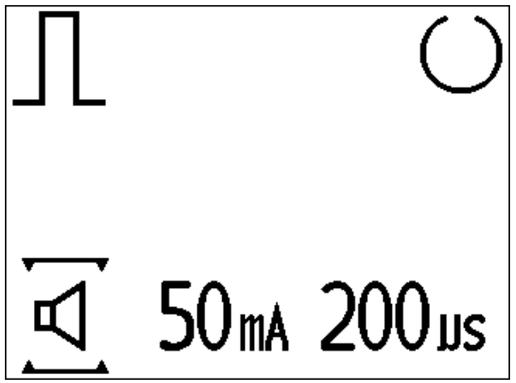
Select between Double Burst 3.2 and 3.3



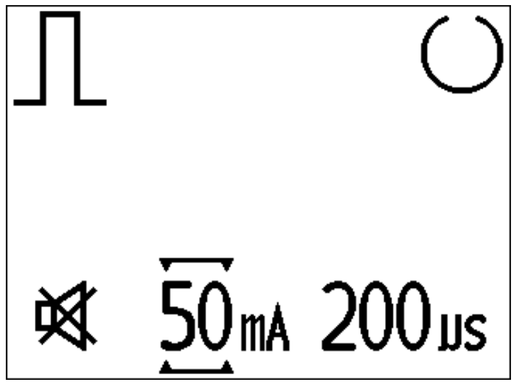
Select CAL 1 or CAL2

TOF^{3D} - In Detail

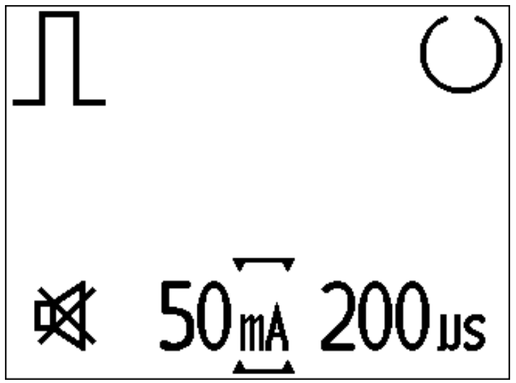
Stimulation Settings



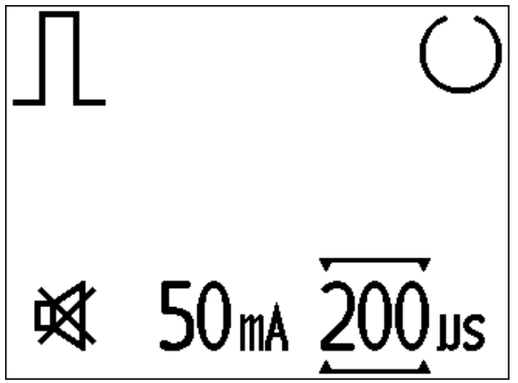
Activate or deactivate stimulation Beep.



Change default stimulation current



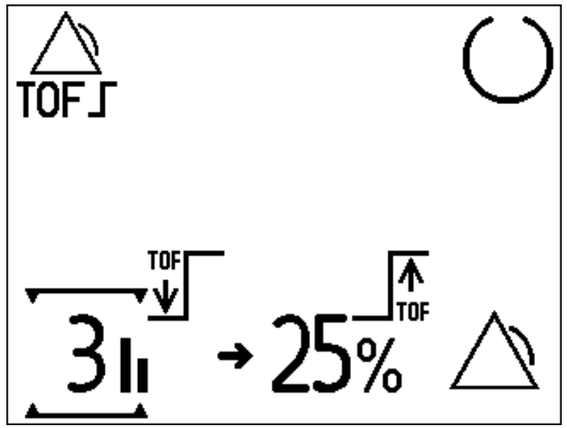
Change measurement unit for stimulation current. mA / µC



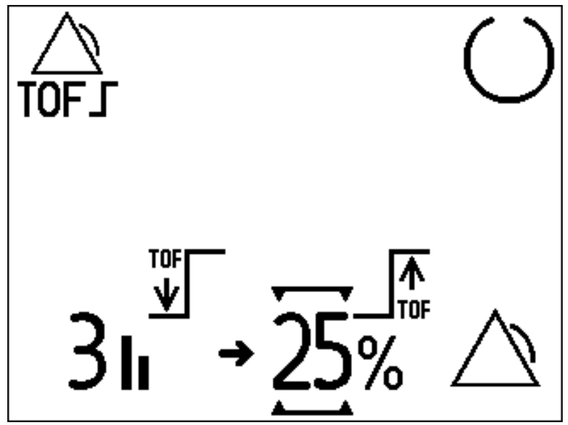
Chose stimulation pulse width. 200/300 µs.

TOF^{3D} - In Detail

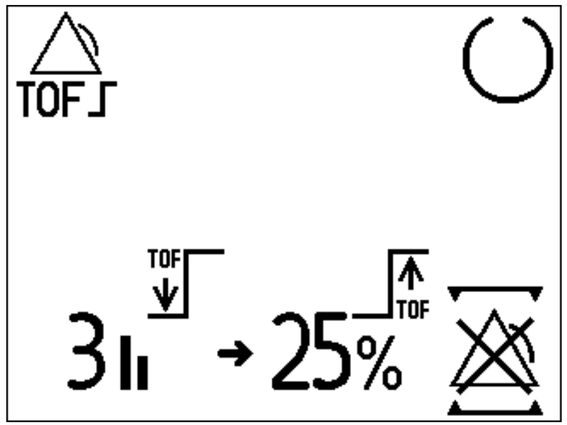
TOF Alarm Settings



Set Lower Alarm Limit



Set Upper Alarm Limit



Active / Deactivate TOF Alarm sound.

TOF^{3D} - Specs

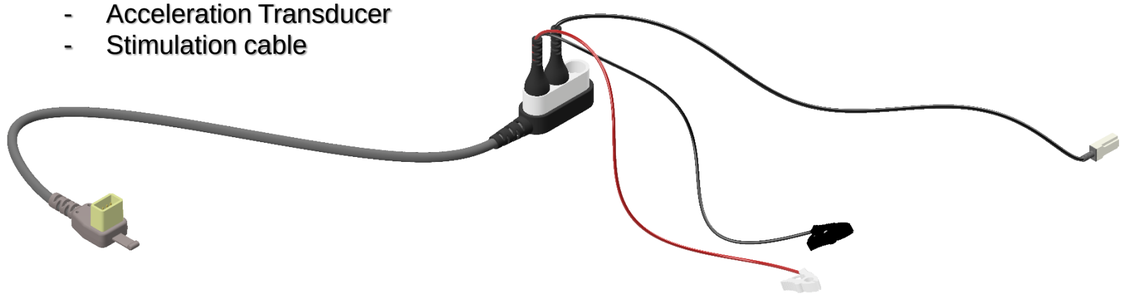
Technical Specifications	
Device Dimensions	Height : 198 mm Width : 141 mm Depth : 65 mm
Display	Size: 4,4‘‘ – 90 x 67 mm Type: LCD Resolution: 240 x 320
Battery	Technology: Alkaline, NiCd/NiMH Type: 4 x 1,5V AA Operating Time: ≈ 1500 hours of constant TOF monitoring
Electrical Specification	Internally powered handheld device Continous operation IPX3 Operating Voltage: 4 – 6 Volt Max. current: 500 mA Power consumption: max. 2,5 Watt
Stimulation	Waveform: Monophasic rectangular wave Pulse width: 200 µs or 300 µs Constant Current: 0 – 60 mA Load: 100 Ω – 5kΩ
Data Storage	Online Data dump: Yes Data storage in device: Yes Memory capacity: ≈ 45,000 records (e.g. 180 hours of TOF recording)

TOF3D - In Detail

Accessories

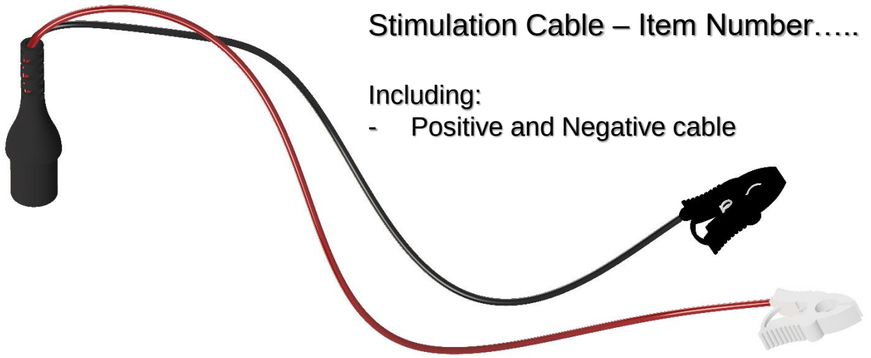
Complete Patient Cable – Item Number…..

Including:
- Main cable
- Acceleration Transducer
- Stimulation cable

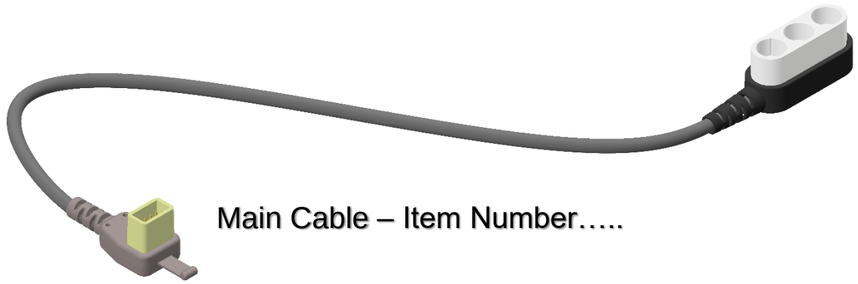


Stimulation Cable – Item Number…..

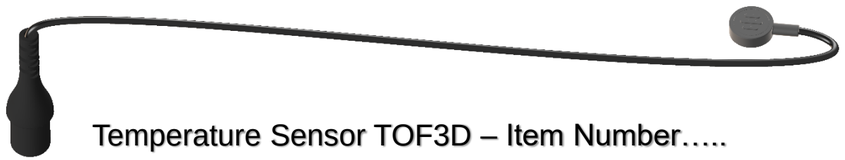
Including:
- Positive and Negative cable



Acceleration Sensor TOF3D – Item Number…..



Main Cable – Item Number…..



Temperature Sensor TOF3D – Item Number…..

TOF3D - In Detail

Accessories

Hand Adapter TOF3D – Item Number ….

Data Interface Plug TOF3D – Item Number ….

Eye Adapter TOF3D – Item Number ….

Thumb Adapter TOF3D – Item Number ….

Trouble shooting

Calibration didn't work.

- Check placement of acceleration sensor and stimulation electrodes
  - Maybe the acceleration sensor isn't placed correctly
  - Maybe the electrodes are not placed over Nervus ulnaris

- Maybe the skin resistance is too high
  - Observe messages in display
  - Clean skin with an abrasive gel or isopropyl alcohol solution

Trouble shooting

PTC doesn't start

- Before TOF3D starts the Post Tetanic Count an additional check for muscle relaxation is performed.

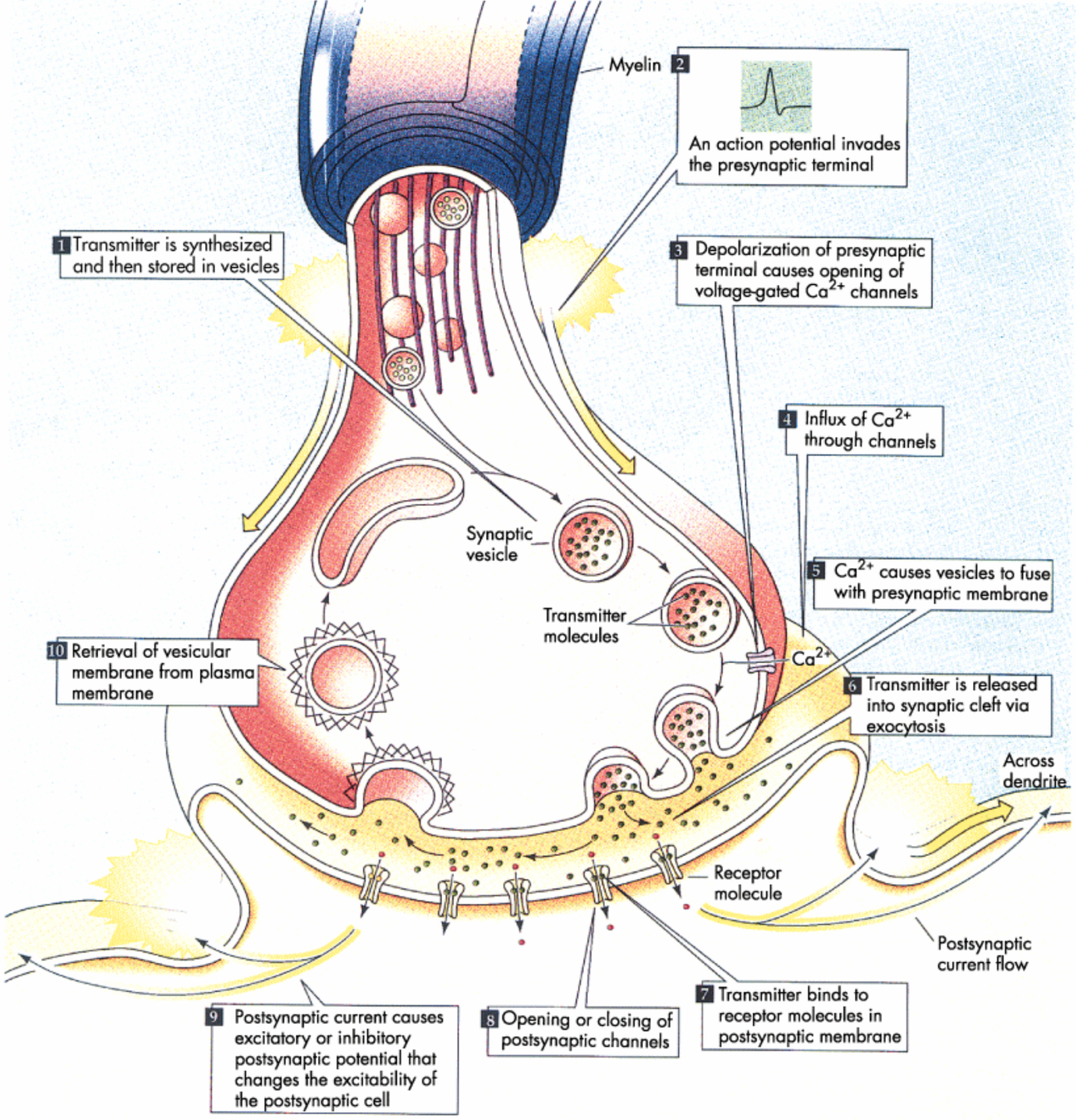
  If the check gives a stimulus response the PTC is not carried out.

- Has PTC been performed within the last 2 minutes?

Trouble shooting

Calibration worked but TOF is not displayed.

- check if patients' hand is still fixed
- check if the thumb is free to move
- check if stimulation cables are still connected to the electrodes
- check if transducer is still positioned correctly



Fade of Acetylcholine - An explanation for the decreasing response strength

- ACh is "consumed" in the synaptic cleft.
- It has to be reproduced in the pre synaptic end of the motor neuron.
- The TOF stimulus takes 2 seconds to complete.
- Within the 2 seconds the ACh concentration in the synaptic cleft decreases as it cannot be reproduced quick enough.

Back to Slide 11

Fade of Acetylcholine - An explanation for the decreasing response strength

- In the same time the concentration of NMBA in the synaptic cleft remains constant
- From the first to the fourth impulse the relative concentration of NMBA increases.

➪ More muscle cells are blocked due to relative higher concentration of NMBA in every response.

➪ Strength of the responses fades from first to fourth response.