DEVICE THEORY

Précis

Peripheral Nerve Stimulators aid anaesthetists detect and monitor neuromuscular function. They can also be used to assess neuromuscular block during surgery, and the reversal of neuromuscular block during the recovery period. The clinician can determine the effects of neuromuscular-blocking drugs and adjust the dosage accordingly, by observing muscular response to different patterns of electrical nerve stimulation.
The degree of neuromuscular relaxation is important in determining the timing of intubation and extubation.

DETAILS

Principals of Operation

The Microstim delivers electrical current to a peripheral nerve, typically the ulnar nerve at the wrist; when the peripheral nerve is stimulated sufficiently, the muscle fibres supplied by the nerve contract. If the intensity is increased further, the stimulus is described as supramaximal, but muscular contraction does not increase. By delivering the same amount of supramaximal stimulation before and after administration of neuromuscular-blocking drugs, the clinician can determine the effect of neuromuscular block.

The Microstim is battery powered
It has four types of stimulation:

- Twitch
- Train-of-Four (TOF)
- Tetanic
- Double Burst

These techniques produce specific responses or patterns of muscle contraction. The level or type of block is assessed by observing visually, or tactilely, the degree to which the affected muscle contracts.

- **Twitch:** consists of a single supramaximal current and is applied repetitively at a frequency of 0.1 to 0.2 hertz (Hz). The pulses are typically rectangular and have durations of 0.2 milliseconds (msec) or less to avoid repetitive nerve firing. Single twitch stimulation is the least sensitive method of demonstrating a partial neuromuscular block. The twitch response is not reduced until at least 75% to 80% of the nerve endings are blocked, and it disappears completely when 90% are blocked.

- **Train-of-Four (TOF):** consists of four supramaximal stimuli (2Hz) at half-second intervals. The amplitude of the fourth response in relation to the first gives the TOF ratio, which begins to decrease when more than 70% of the receptors are blocked. TOF stimulation can be repeated every 8 to 12 seconds.
  Some neuromuscular blocks cannot be evaluated using single-twitch or TOF stimulation during deep relaxation, because the associated response can disappear for extended periods e.g. greater than 5 minutes.

- **Tetanic:** can consist of pulses at a much higher rate (30 to 100 Hz). The Microstim supplies 50Hz applied for 5 seconds then 1Hz for 30 seconds. Greater sensitivity is possible at higher frequencies, but at 100Hz for 5 seconds, a lack of appropriate response develops when 50% of the receptors are blocked; and at 200Hz for 5 seconds, there is insufficient response, when only 30% of the receptors are blocked. Tetanic stimulation can be painful however, and under certain conditions may influence the course of the neuromuscular block in the investigated muscle.

- **Double Burst:** consists of two trains of three pulses. The neuromuscular response consists of two short muscle contractions, the second of which is significantly less forceful than the first. The ratio of these contractile forces indicates the degree of patient drug induced muscular relaxation. The Microstim consists of 3 pulses at 50Hz followed by a 0.75 second pulse, then two pulses at 50Hz.

Motor fibres are stimulated before pain fibres, and low stimulating currents are used for regional anaesthesia so the patient feels minimum discomfort.

Conventional EKG disposable electrodes are most commonly used as they provide good contact with low impedance. Burns are unlikely to occur with peripheral nerve stimulators because they use low current, and typically have only brief contact with the skin.
The Microstim was designed to be battery driven, as this eliminates many of the perceived risks in relation to burns, particularly with earth leakage currents and alternative paths via electrosurgical units.
Some competitive models are also equipped with ball electrodes mounted on the stimulator. This method was rejected due to the possibility of varying skin impedance.

Problems have been reported with the use of peripheral nerve stimulators during surgical procedures, e.g. pacemaker during surgery. Pacemaker function returned to normal upon cessation of peripheral nerve stimulation. Suitable warnings are given in the instructions.

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About the Chart Specifications

The following terms are used in the chart.

Train-of-Four, Hz: a stimulation pattern consisting of four supramaximal stimuli at 2 Hz.
Double Burst, 3.3/3.2: a stimulation pattern consisting of either two trains of three pulses (designated 3.3) at approximately 50 Hz, separated by approximately 0.75 msec, or an initial train of three pulses followed by a train of two pulses (designated 3.2).
Typical current into 1,000 Q,mA: the current measured against 1,000 ohms of resistance. Note: some of the listed currents may also be valid for higher resistances.
Terminal polarity indication: indicates the positive and negative bipolar electrodes.
Battery and ball electrodes are standard; other leads optional. Part number 00-105 leads comply with FDA "protected" lead set requirements

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OUTPUT MODES
Twitch, Hz
Train-of-Four, Hz
Repeat Time, Sec
Double Burst, 3.3 / 3.2
Repeat Time, Sec
Tetanic, Hz
Post-Tetanic Count

TYPICAL CURRENT into 1,000 ohms, mA

PULSE WIDTH, msec

PULSE INDICATOR

TERMINAL POLARITY, INDICATION

BATTERY TYPE
Charge Level Indicator
Capacity, Hr

H x W x D, cm (in)

Weight, g (oz)

The Anaestim version can be used to accurately locate peripheral nerves when performing regional anaesthesia. Surface or needle electrodes transmit the electrical pulses from the stimulator to the nerve. Needle electrodes, sterile probes and alligator clips attached to needles are typically used to locate peripheral nerves during regional anaesthesia; needle electrodes and alligator clip electrodes can be helpful in monitoring neuromuscular block in obese patients. The correct application of electrodes is very important because even slight displacements can result in considerable changes in stimulation current requirements. In addition, the electrodes must be placed so that the device stimulates the nerve, not the muscle.

Many Stimulators deliver a constant current set by the operator. Current settings typically range from 0.5 to 10 milliamperes (mA) – levels that can stimulate or depolarise a nerve without causing tissue trauma. The stimulators compensate for variations in tissue resistance, or may include a meter to monitor the current, and allow the operator to adjust the current output manually.