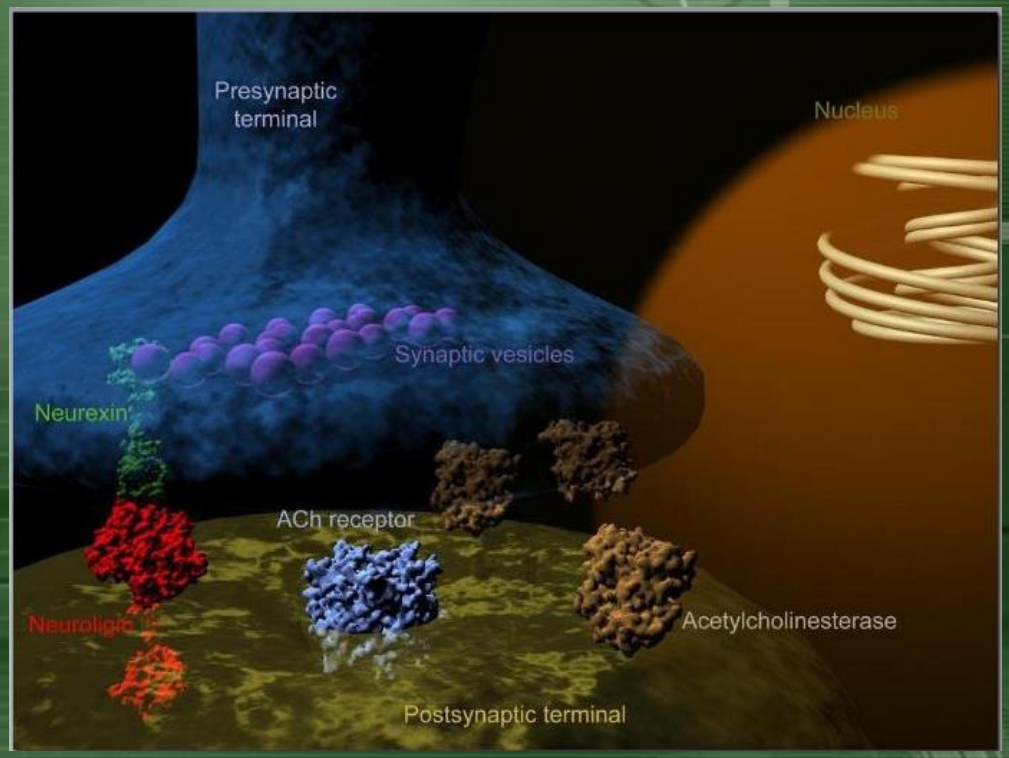
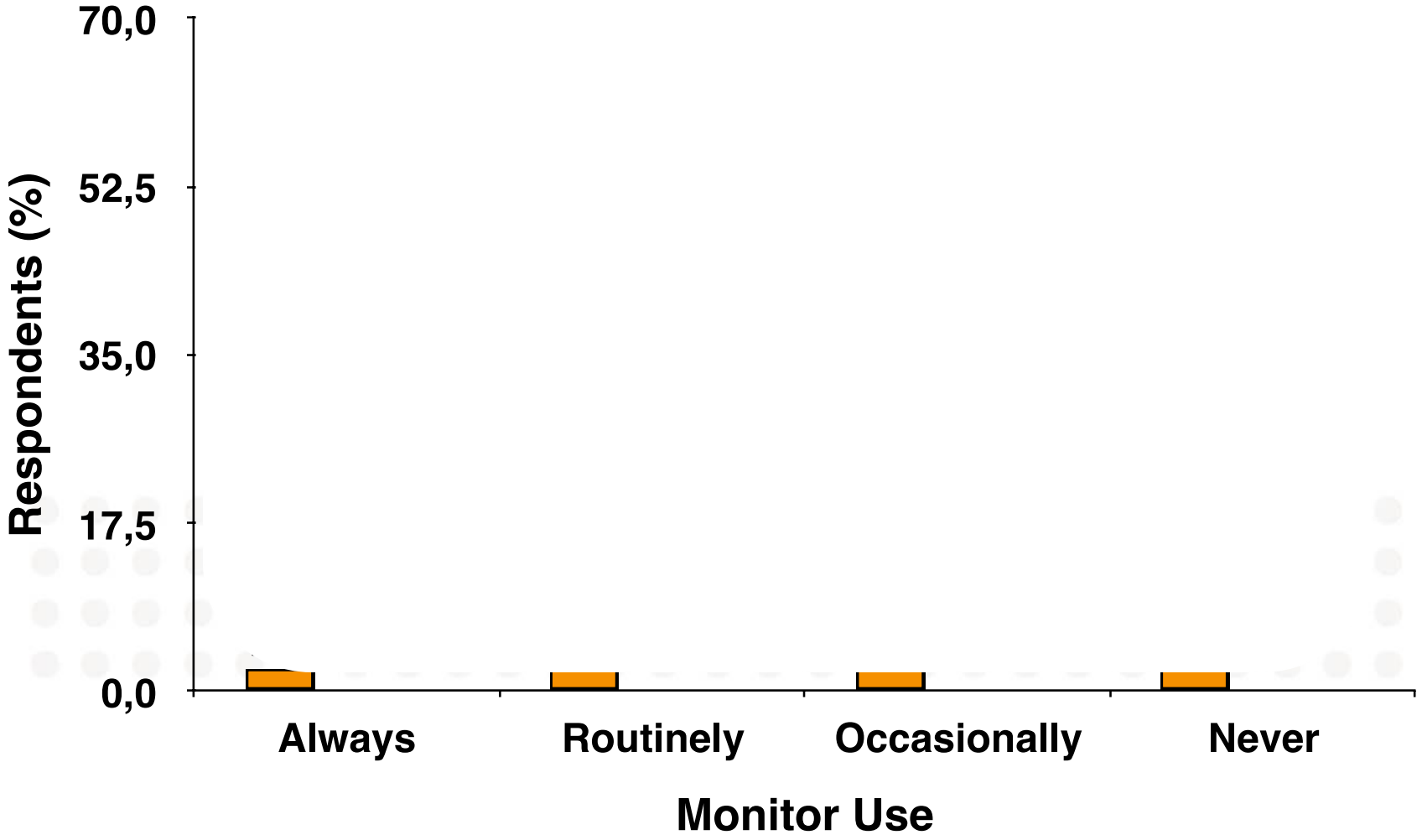

THE
SECRET
OF
STRENGTH
AND
MUSCLE

Monitorizarea blocului neuromuscular



M.Păpurică
UMF"Victor Babes" Timisoara

Limited Use of Quantitative Monitoring: UK Data



UK, United Kingdom.

Grayling M, Sweeney BP. *Anaesthesia.* 2007;62:806-809.

Vlassakov KV, Kissin I, A quest to increase safety of anesthetics by advancements in anesthesia monitoring: scientometric analysis Drug Design, Development and Therapy 2015 Volume 2015:9 Pages 2599—2608

Table 6 Anesthesia-related mortality vs anesthesia monitoring and training of anesthesiologists

Period	Anesthesia mortality[a] (per million, 95% CI)		Anesthesia monitoring[b]		Anesthesiologists' training[c]	
	Sole mortality	Contributory mortality	Number of new articles	% of total (11,292)	Number of new board certificates	% of total (47,053)
Pre-1970s	**357** (324–394)	**684** (642–729)	128[d]	1%	6,859[e]	15%
1970s–1980s	**52** (42–64)	**234** (200–275)	2,024	18%	12,780	27%
1990s–2000s	**34** (29–39)	**85** (75–96)	9,140	81%	27,414	58%

Notes: [a]Mortality in developed countries solely attributable to anesthesia across a mixed surgical population who had undergone general anesthesia.[3] [b]Number of articles published during the indicated periods. [c]Number of American Board of Anesthesiology diplomas awarded during the indicated periods, data from American Board of Medical Specialties.[40] [d]1960–1969 period. [e]1940–1969 period. Bold values indicate the most important changes.
Abbreviation: CI, confidence interval.

7x

2x

Abstract: The aim of this study was to assess progress in the field of anesthesia monitoring over the past 40 years using scientometric analysis.

We suggest that rapid growth in the field of anesthetic monitoring was one of the most important developments to compensate for the intrinsically low margins of safety of anesthetic agents.

SUBIECTUL

Blocanti neuromusculari - curare

Droguri anestezice sintetice utilizate de anesteziologi cu scopul de a realiza relaxarea musculara (BNM).

CLASIFICARE:

- **Mecanism de actiune :**
  - **Depolarizante (BNMD): Succinilcolina**
  - **Non depolrizante (BNMND): Rocuronium**

- **Structura chímica:**
  - **Metonium: Suxametoniu (succinilcolina), decametoniu**
  - **Steroidiene: Pancuroniu, vecuroniu, rocuroniu, etc.**
  - **Benzilquinoline: Atracurium, cisatracurium, mivacurium, etc.**

Contraindicatii ale BNM

DA, exista !!!!

Contraindicatii de monitorizare a BNM

NU, nu exista !!!!

Monitorizarea blocului neuromuscular

De CE?

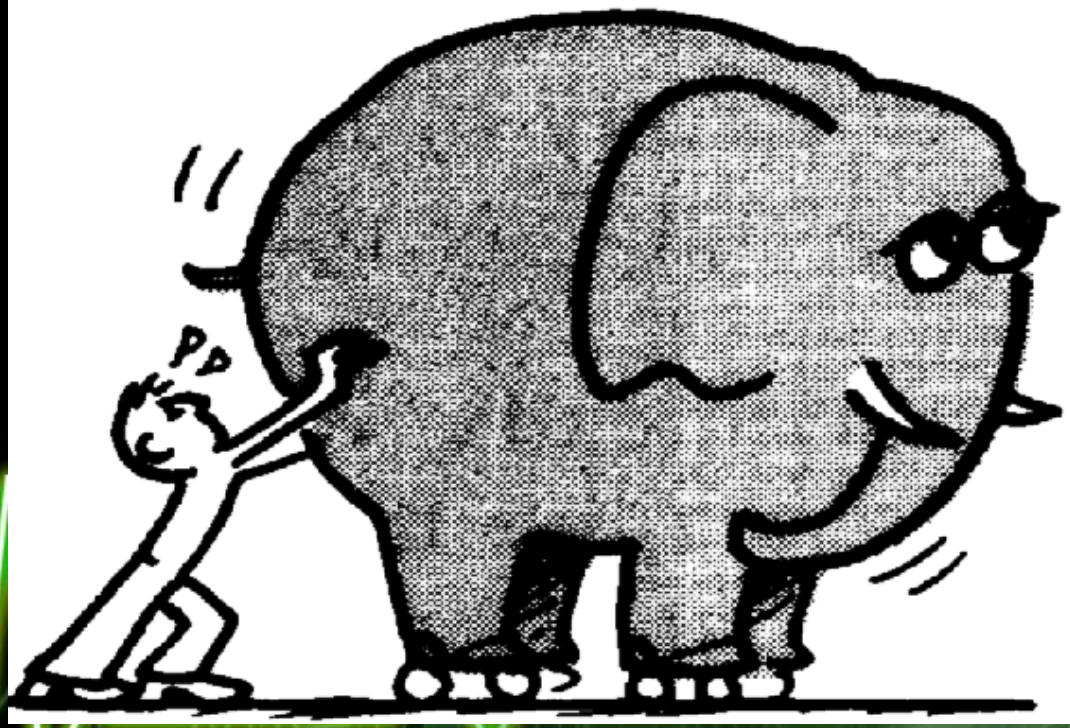
- Variabilitate individuala la BNM
- Relaxare musculara adecvata
- Reversia BNM
- Complicatii postoperatorii
  - Curarizare reziduala
  - Recurarizare
  - Bloc de faza II
- Reduce mortalitatea si morbiditatea perioperatorie
- Cost-eficienta

Monitorizarea blocului neuromuscular

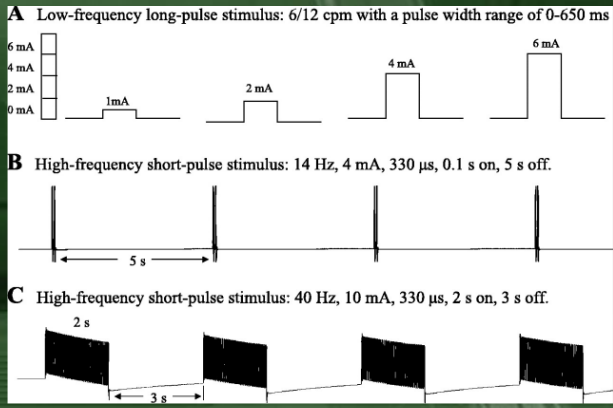
Abilitati ???

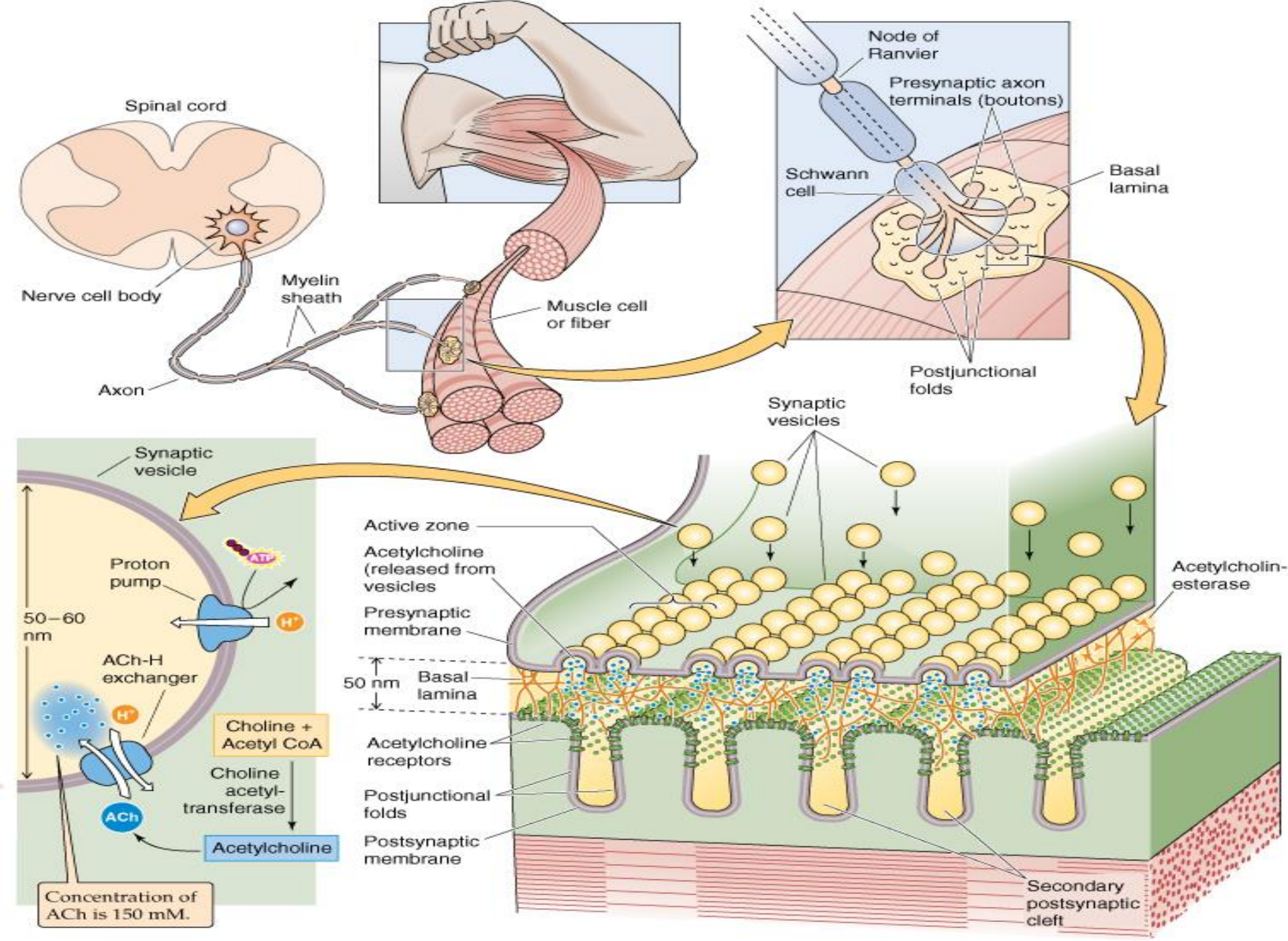
- Fizica medicala
- Fiziopatologie
- Farmacologie
- Anestezice
- Practice

Newton's Second Law of Motion



Love Hz





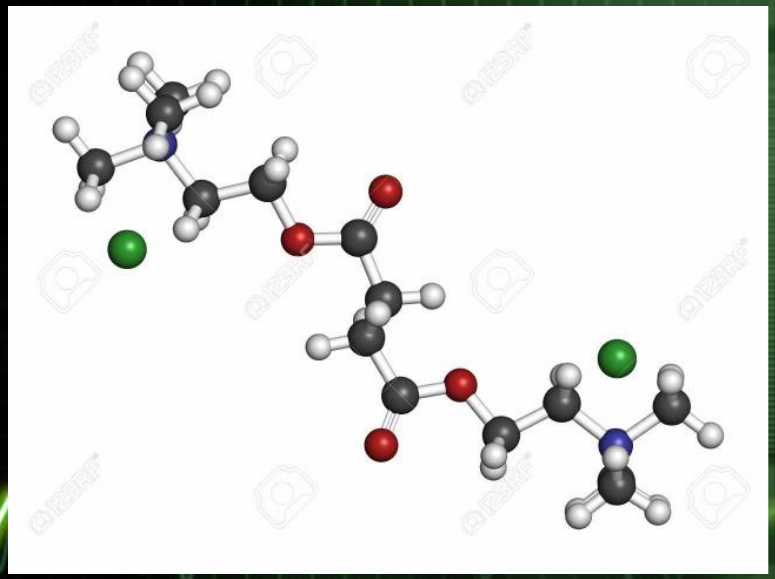
Biotransformación

Pseudocolinesterasa

Succinilcolina

Succinilmonocolina

Acido succínico — Colina




SpO2 66%
1721
BP 150/97

Monitorizarea blocului neuromuscular

Când ???

- Anestezie
  - intraoperator
  - postoperator
- TI
- Intubatie traheala

Monitorizarea blocului neuromuscular

Cum ?

√ **Subiectiv - semne clinice**

√ **Obiectiv – aparate monitorizare**

- **tonusul muscular**
- **miscarilor cutiei toracice**
- **TV, $ETCO_2$, Pmax, FC**
- **urmarirea sondei IOT**
- **observarea plagii operatorii, camera de lucru**
- **comunicarea cu echipa chirurgicala**

Teste clinice

Nerelevante

Deschiderea ochilor
”Scoaterea limbii”
Ridicarea mainii
Volume curente normale
Capacitate vitala normala sau aproape..

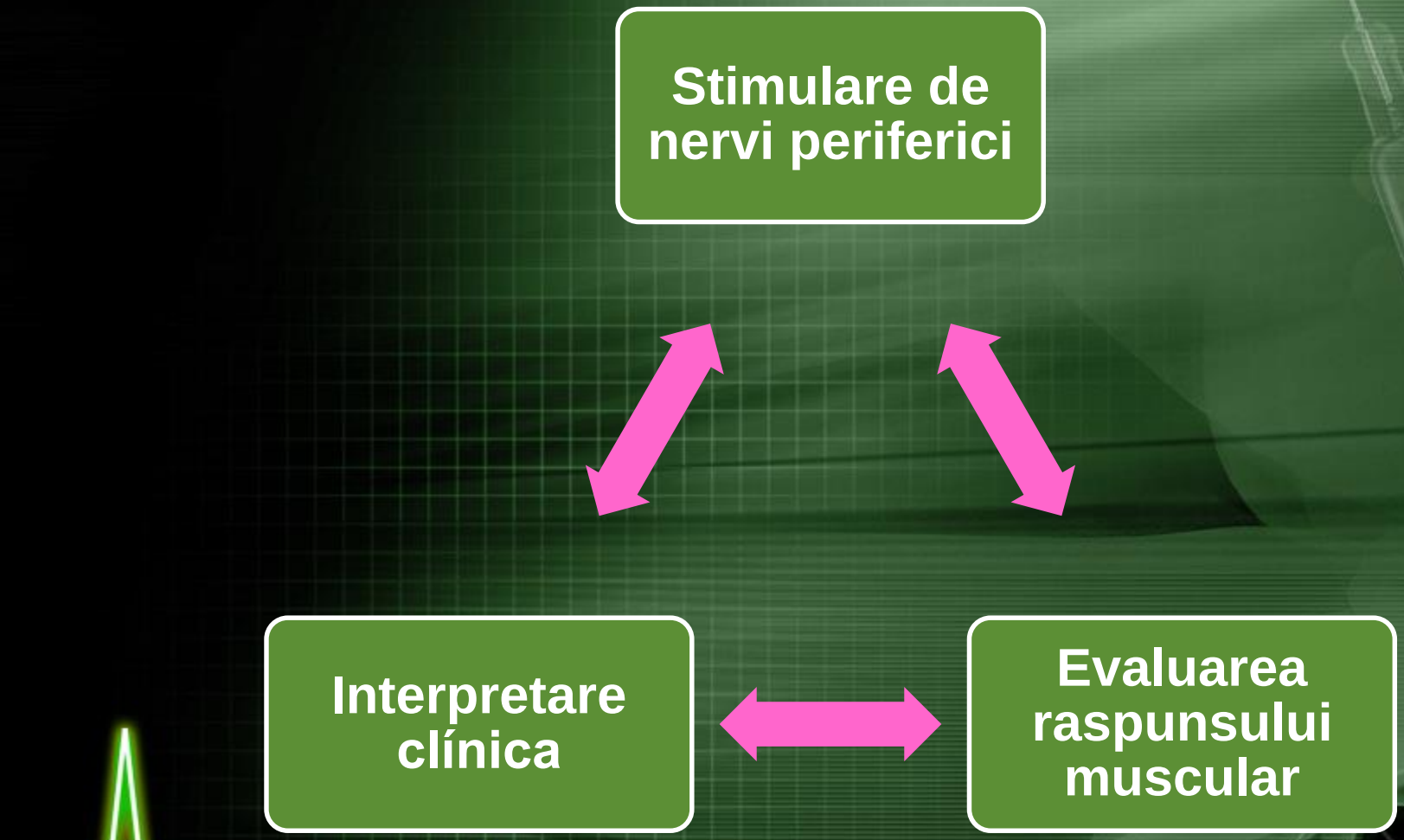
Presiune de inspir mai mica de 40 cm H_2O

Probabil sigure

Sustinerea capului pentru 5 secunde
Ridicarea piciorului pentru 5 secunde
Strangerea mainii pentru 5 secunde
Mentinerea limbii ”protruzionata”

Presiune de inspir 40 - 50 cm H_2O

Monitorizarea neuromusculara



Stimuli nervosi periferici

ELECTRICI

- utilizati clinic
- stimulare dureroasa, variabila
- usor de aplicat
- stimuli supramaximali
- echipament ieftin

MAGNETICI

- non invaziv
- putin dureros
- echipament costisitor
- greu reprodus stimul supramaximal
- boli neurologice

Stimulul electric

- ✓ **intensitate** → **de minim *60 mA*, preferabil *80-100 mA***
- ✓ **durata fiecarui stimul individual sa fie intre *0,1 - 0,2 msec***
- ✓ **stimuli *SUPRAMAXIMAL***
- ✓ ***transdermal***

Principiu fiziologic al SNP

- Fibra musculara

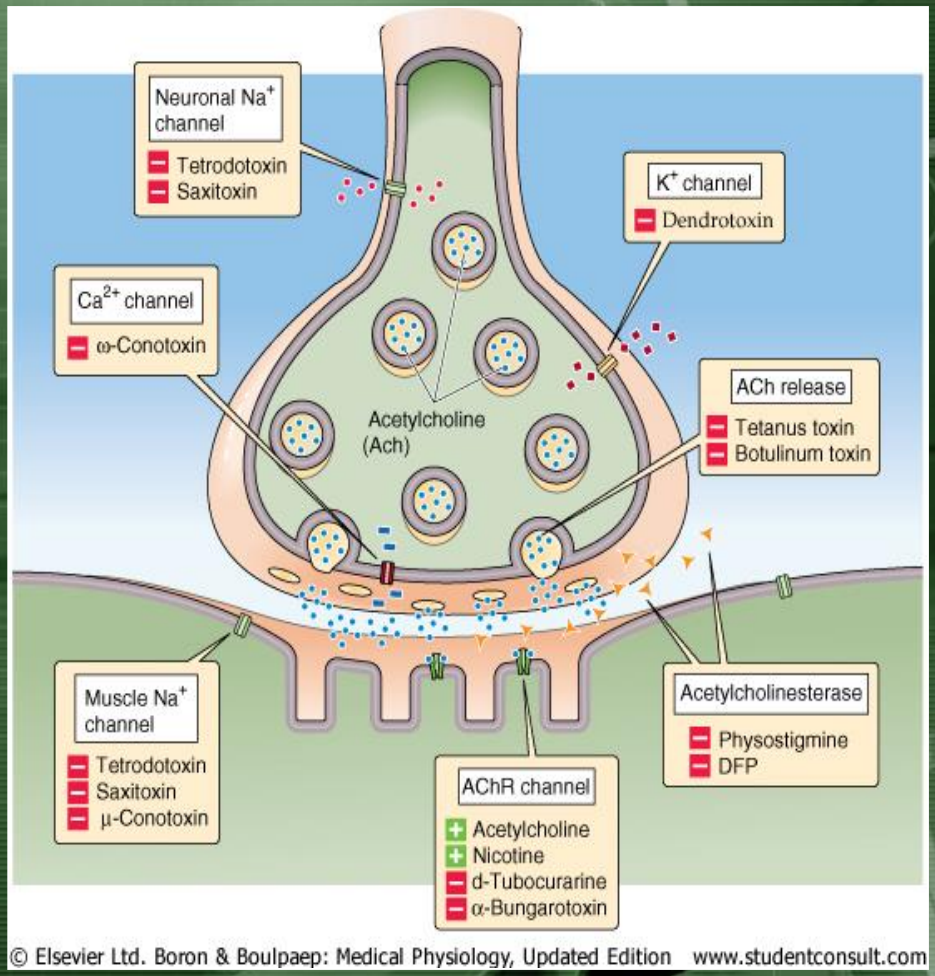
  ”Totul sau nimic”

- Raspunsul muscular
  - funct. de nr de fibre implicate
  - descreste paralel cu nr.de fibre blocate

- gradul de BNM dependent de RAch

- Stimul **supramaximal**

  (25-30%)

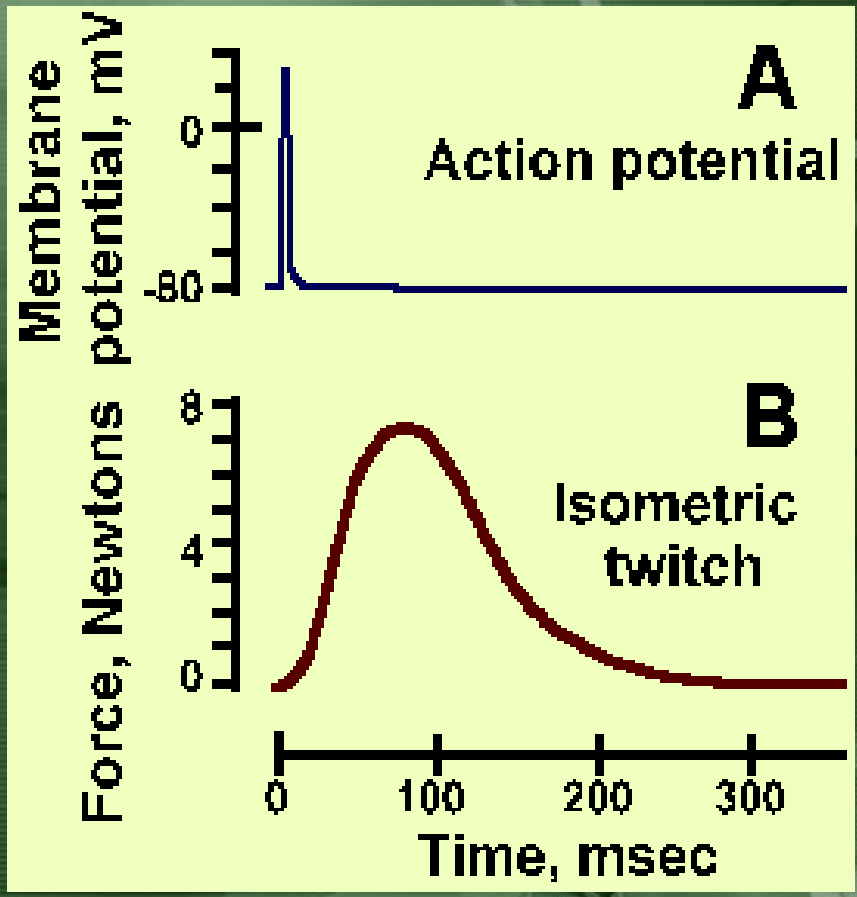


Tipuri de stimulari electrice

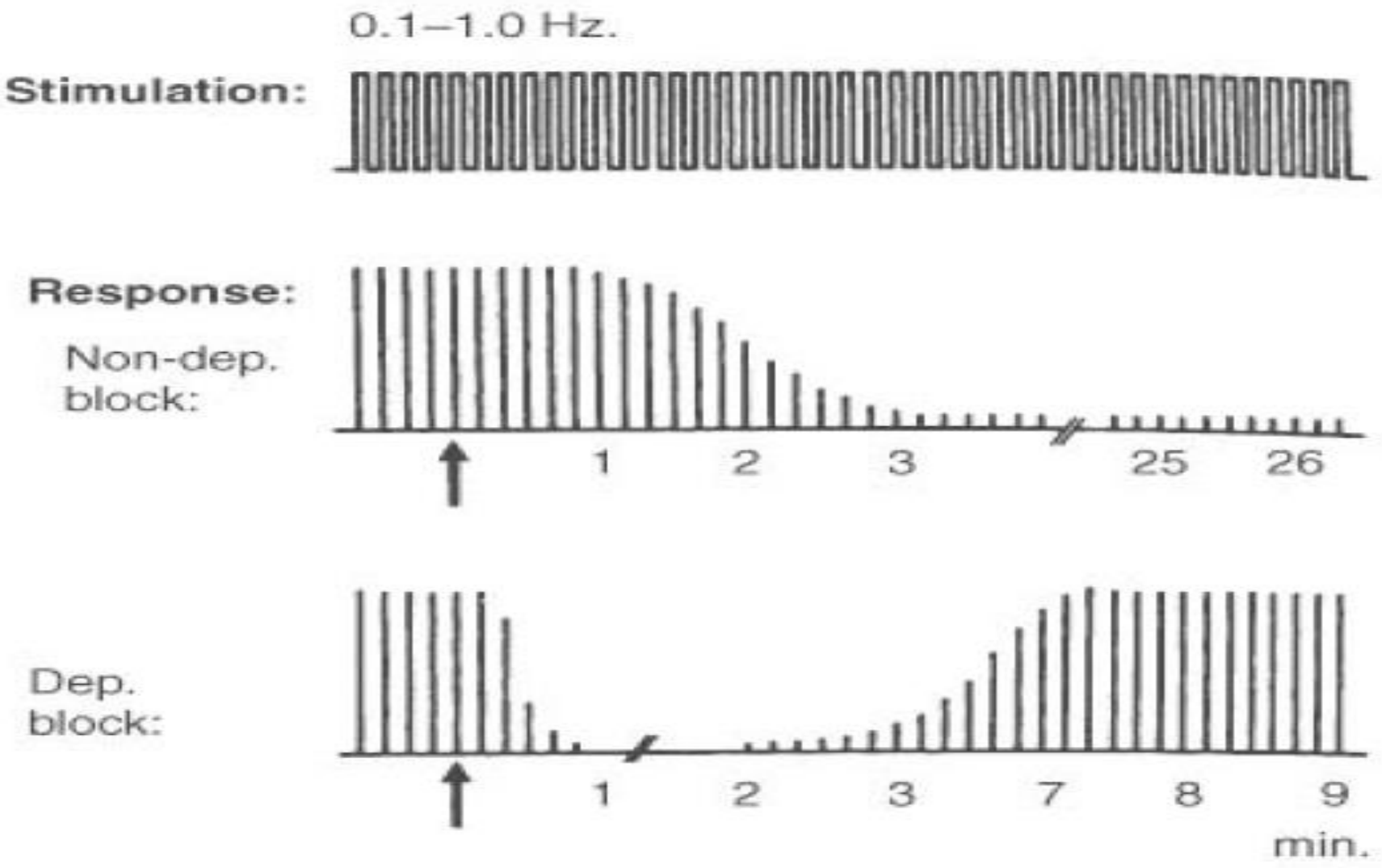
- Single twitch stimulation (ST)
- Train of Four (TOF)
- Stimulare tetanica (STe)
- Post tetanic count (PTC)
- Double burst stimulation (DBS)

ST – Stimulare unica de tip secusa

- stimul electric supramaximal
- frecventa de 0,1 Hz (la fiecare 10 sec pana la 1 Hz (fiecare sec.)

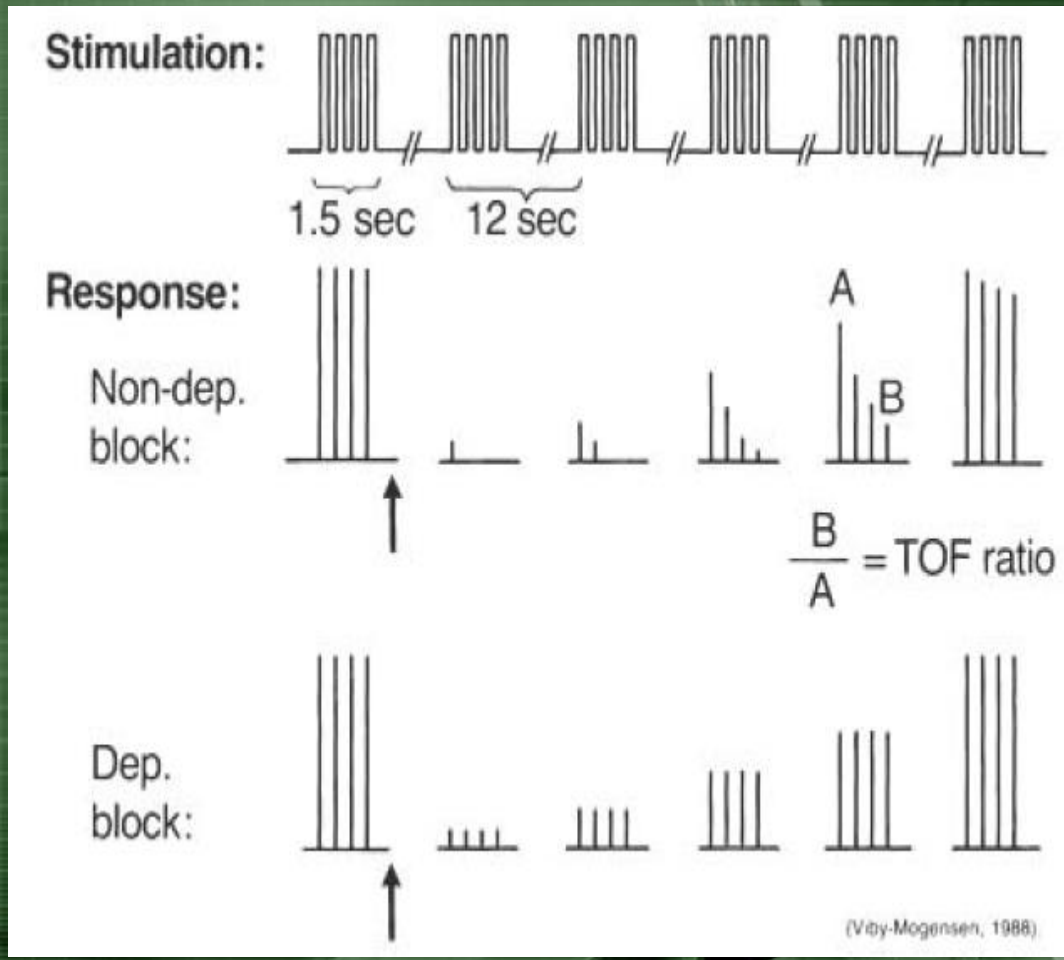


- **raspunsul la ST influentat de**
  - **temperatura musculara**
  - **intensitatea stimulului**
  - **pozitia segm. stimulat**
- **calibrarea inainte de relaxare**
- **utilizare ocazionala**


0.1–1.0 Hz.
Stimulation:
Response:
Non-dep. block:
1
2
3
25
26
Dep. block:
1
2
3
7
8
9
min.

TOF – Train of four

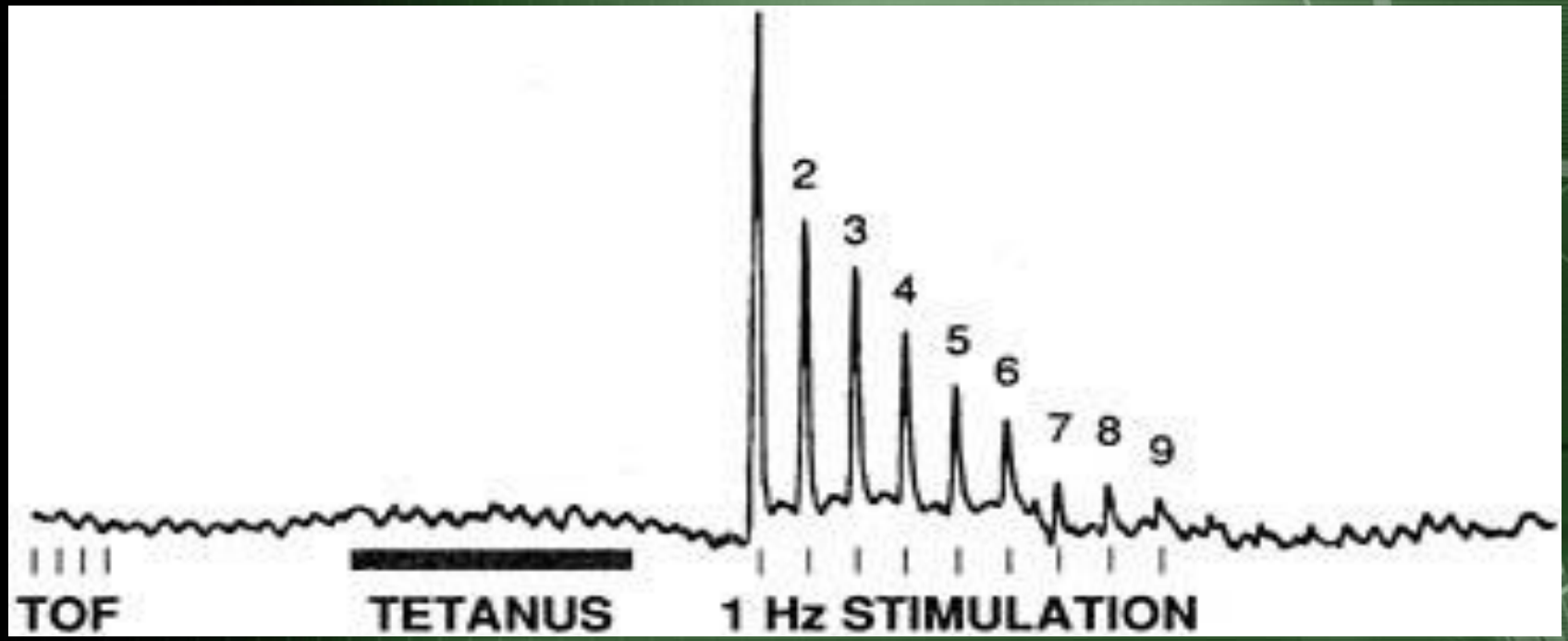
- 4 stimuli supramaximali la 0,5 sec. (2 Hz)
- continuu - se repeta la 10 – 20 sec.
- fen. de oboseala musculara - “fade”
- TOF - 0 → 4
- T_4/T_1 - 0,1 → 1



TOF – Train of four

% receptors blocked	T1 % normal	T4 % normal	T4/T1 ratio	Tetanus
100				
95				
	0		T1 lost	
90	10		T2 lost	
	20		T3 lost	
80	25	0	T4 lost	Onset of fade at 30 Hz
	80–90	55–65	0.6–0.7	
	95	70	0.7–0.75	
75	100	75–100	0.75–1	
	100		0.9–1	Onset of fade at 50 Hz
50				Onset of fade at 100 Hz
30				Onset of fade at 200 Hz

PTC – Post Tetanic Count Stimulation

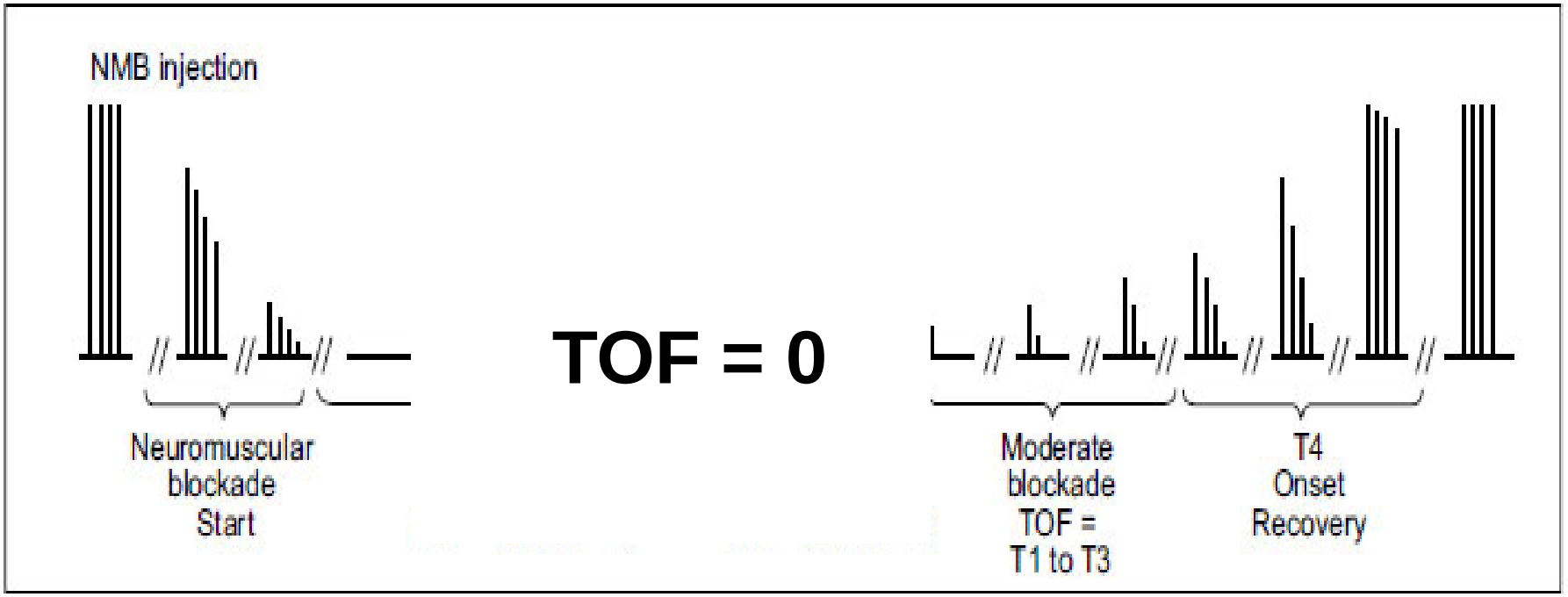


TOF=0 → STe (5 sec. 50 Hz) → 3 sec → ST (1Hz) → PTC

Repetare la 6 min. - antagonizare bloc

PTC – Post Tetanic Count Stimulation

Chart 1 – Levels of Neuromuscular Blockade After Administration of Non-Depolarizing NMB at a Single Intubation Dose [20](D).
NMB: neuromuscular blockade, TOF: T4/T1 ratio; PTC: post-tetanic counting



Ofera TIMP !!

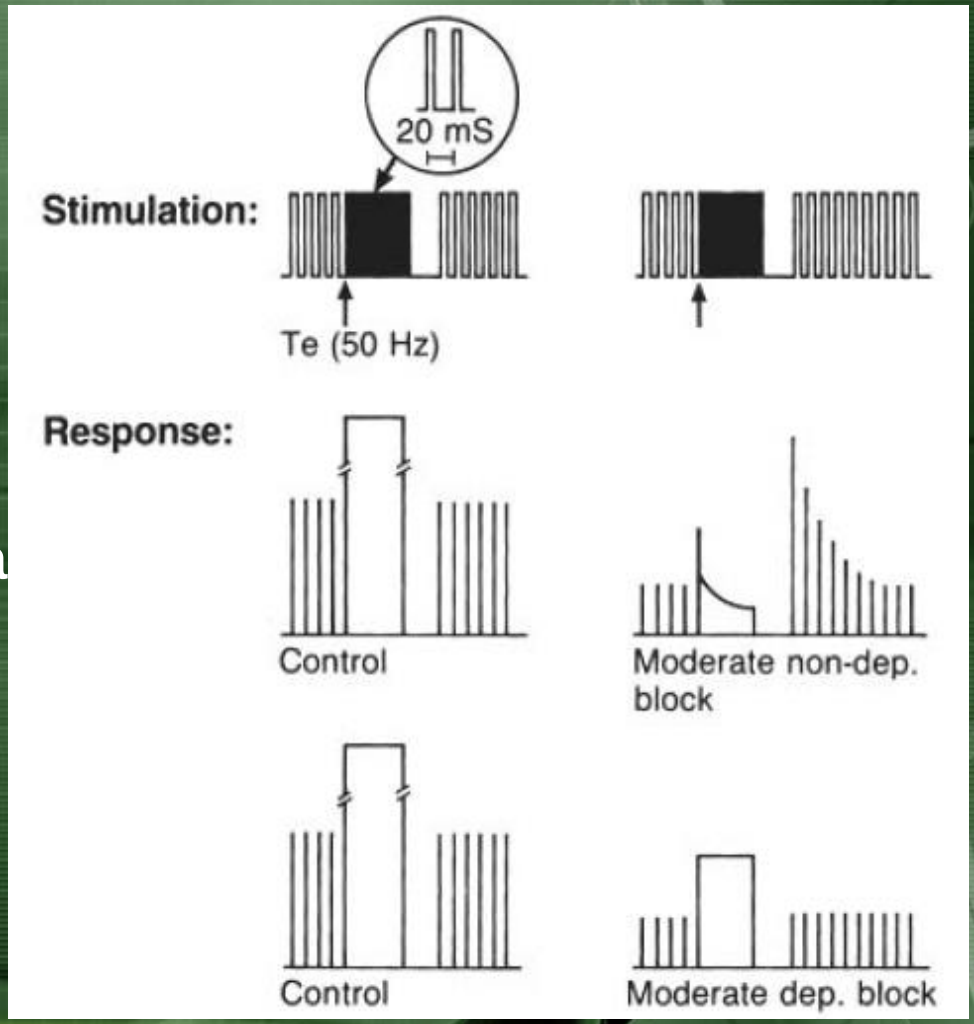
STe – Tetanic Stimulation

- stimularea electrica foarte rapida
  - la 20 milisec
  - frecventa 50 Hz (30-100)
  - timp de 5 sec.

BNMDep. – contractie sustinuta

BNM nonD - oboseala

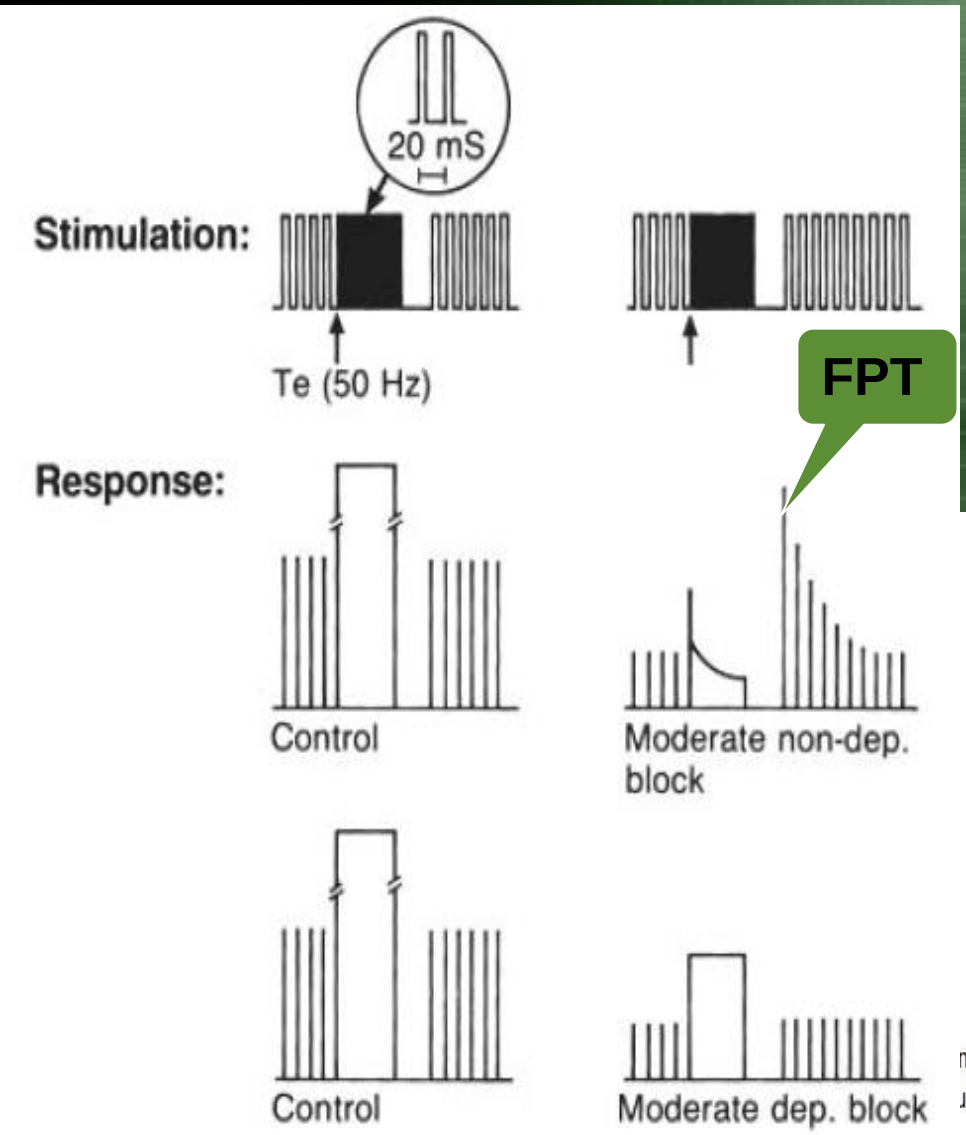
Bloc dual - oboseala

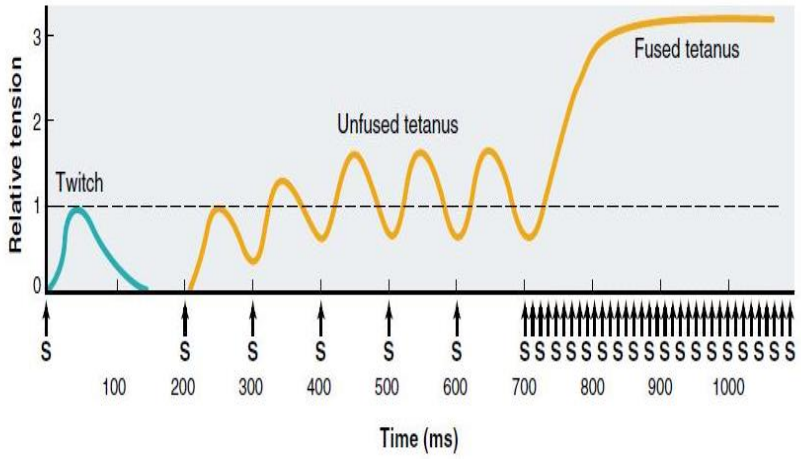


TETANUS – contractie sustinuta la stimulari repetate

durata = 5sec

frecventa = 50Hz





ntractions produced by multiple stimuli at 10 stimuli per second (unfused tetanus) and 100 stimuli per second
ıs), as compared with a single twitch.

STe – Tetanic Stimulation

Dupa aplicarea unei stimulari repetate (tetanus), in cazul BNM nonD partial

Facilitare posttetanica

- rezultat al mobilizarii si eliberarii ↑ de Ach cu eliberarea receptorilor postsinaptici din legatura cu BNM

- dispare la 60 sec. de STe

Mobilizarea Ach determinata de STe, persista putin timp si dupa incetarea stimulului - o posibila explicatie

Acest fenomen poate fi evidentiat in tipul de monitorizare PTC

STe – Tetanic Stimulation

Utilitate

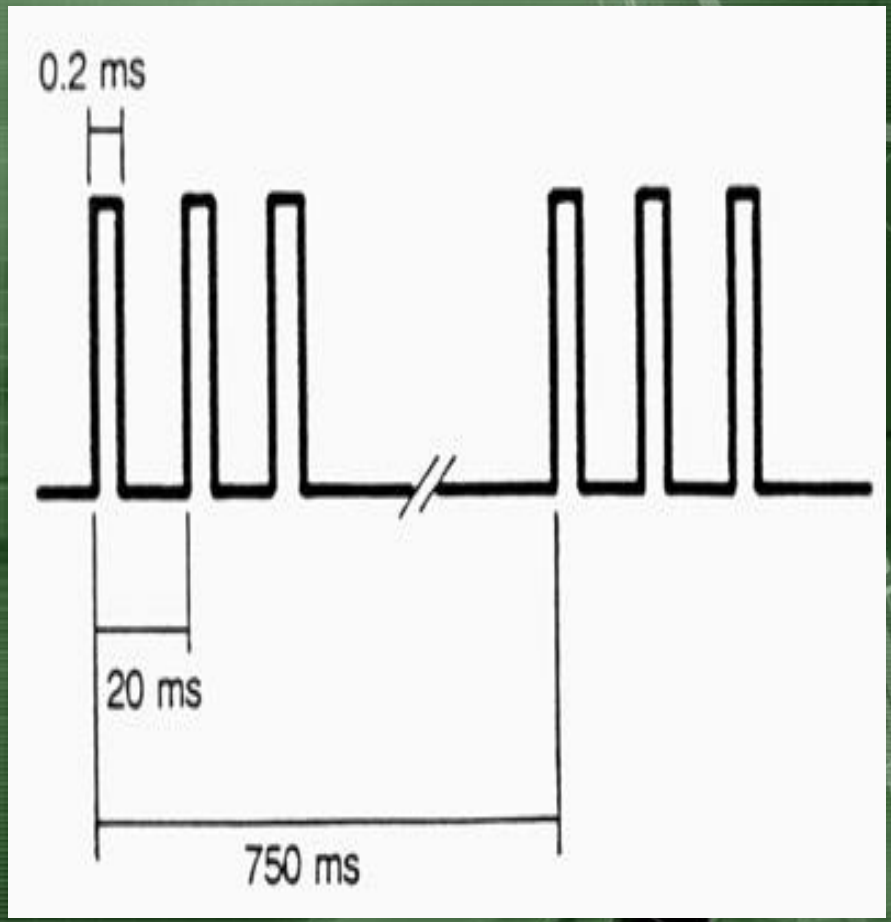
- evaluarea blocului rezidual
- monitorizare PTC
- evaluarea blocului de faza II

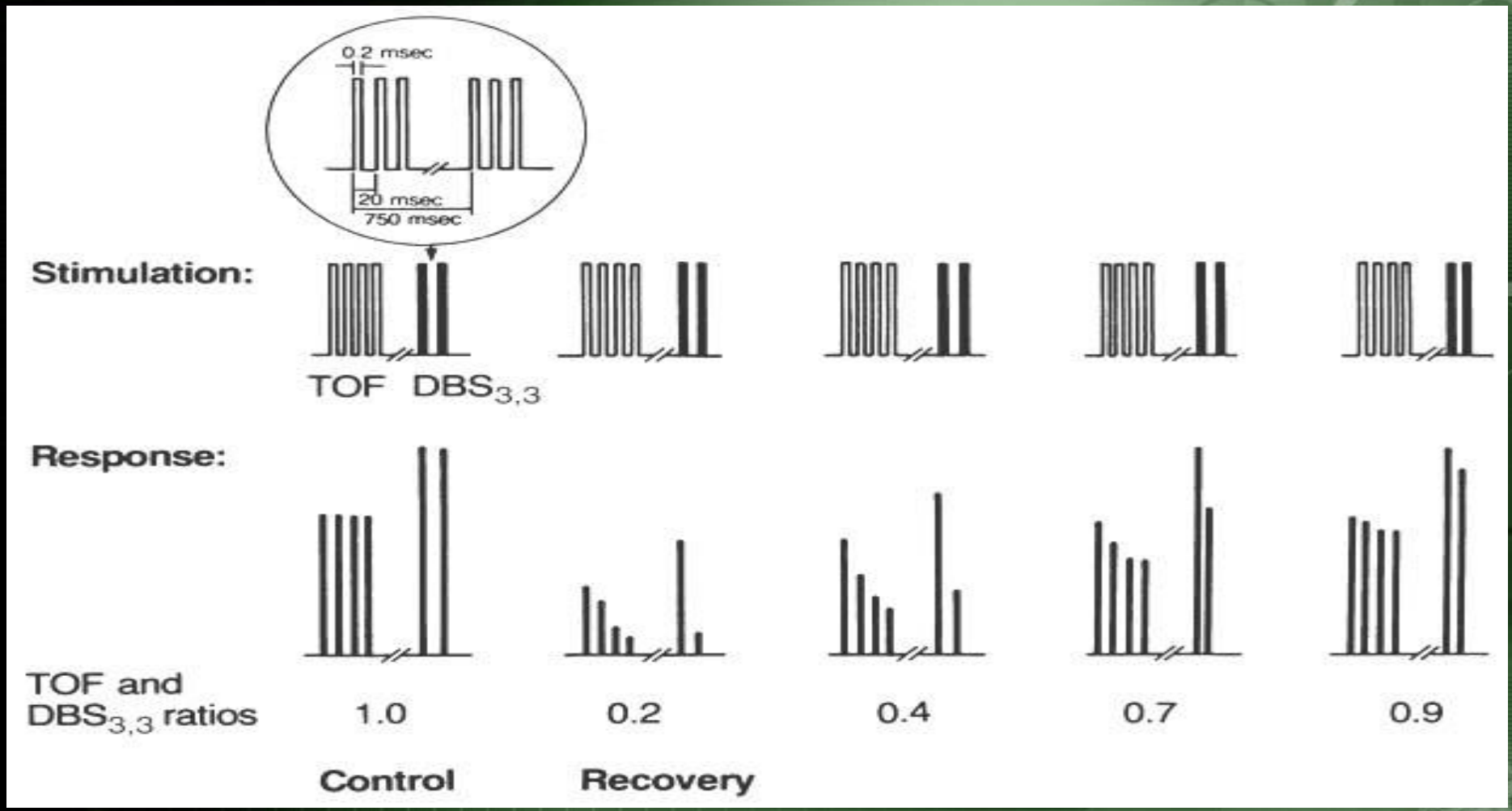
Limitari

- dureros
- efect antagonist al BNM la muschiul stimulat

DBS – Bouble Burst Stimulation

- ***2 stimulari tetanice*** **scurte de 50 Hz, separate de 750 milisec.**
- **1 stimulare tetanica *are 3 impulsuri***
- ***1 unda de impuls*** **este 0,2 milisec, apoi pauza de 0,75 sec.**
- **se aplica DBS cu 3 impulsuri la fiecare stimulare – $DB_{3,3}$**



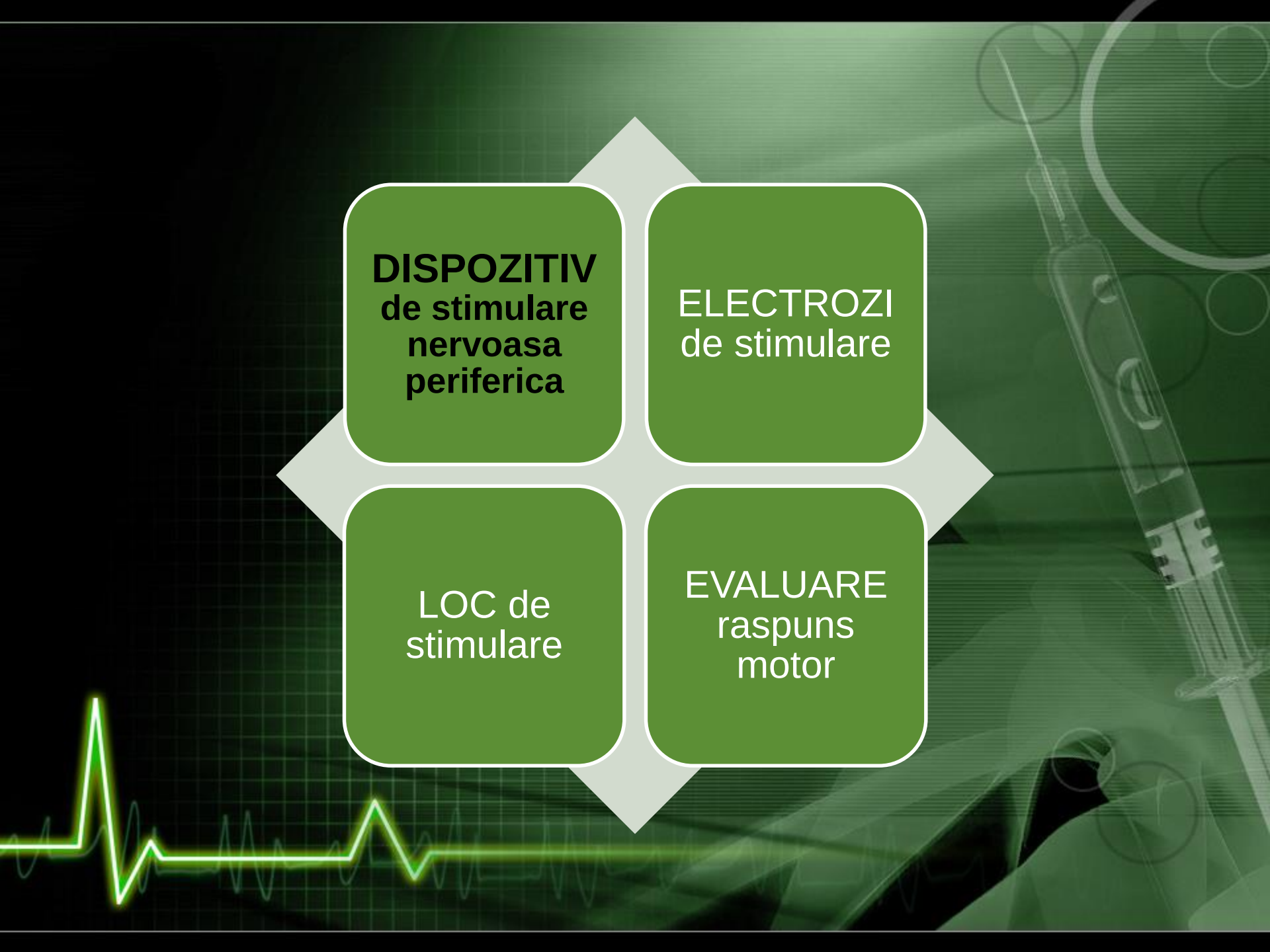


2 raspunsuri de amplitudini diferite – fade

Evaluare tactila

DBS r = R_2/ R_1

TOFr

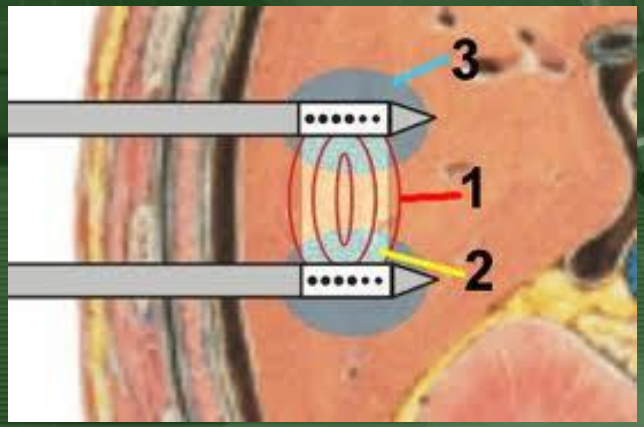

DISPOZITIV
de stimulare nervoasa periferica
ELECTROZI de stimulare
LOC de stimulare
EVALUARE raspuns motor

Caracteristici Ideale:

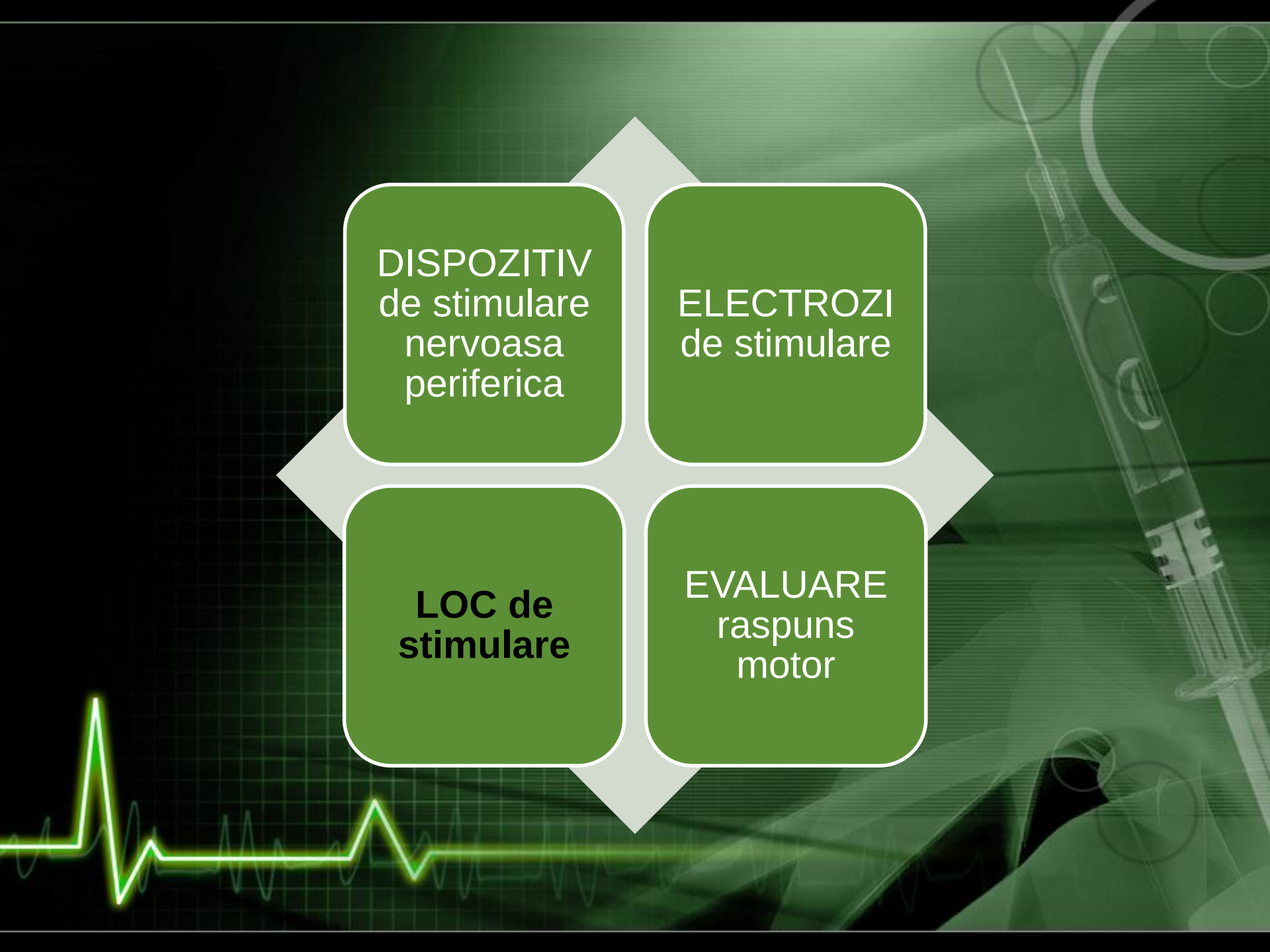
- **Portabilitate**
- **Produce unda monofazica, rectangulara de 0,2 a 0,3 ms.**
- **Curent constant de 60 - 70 mA , dar sub 80 mA.**
- **Emita curent pentru o rezistenta cutanata 2,5 – 5 kΩ**
- **Sistem de avertizare**
- **Capacitate de a stimula ST, TOF, STe, DBS, PTC**


DISPOZITIV de stimulare nervoasa periferica
ELECTROZI de stimulare
LOC de stimulare
EVALUARE raspuns motor

Electrozi de stimulare



- **De suprafata**
  - adezivitate buna
  - Ag/AgCl
  - 7-8mm diam.
  - negativ distal
- **Ace**
  - subcutanat
  - evita impedanta cutanata (200 Ohmi)


DISPOZITIV de stimulare nervoasa periferica
ELECTROZI de stimulare
LOC de stimulare
EVALUARE raspuns motor

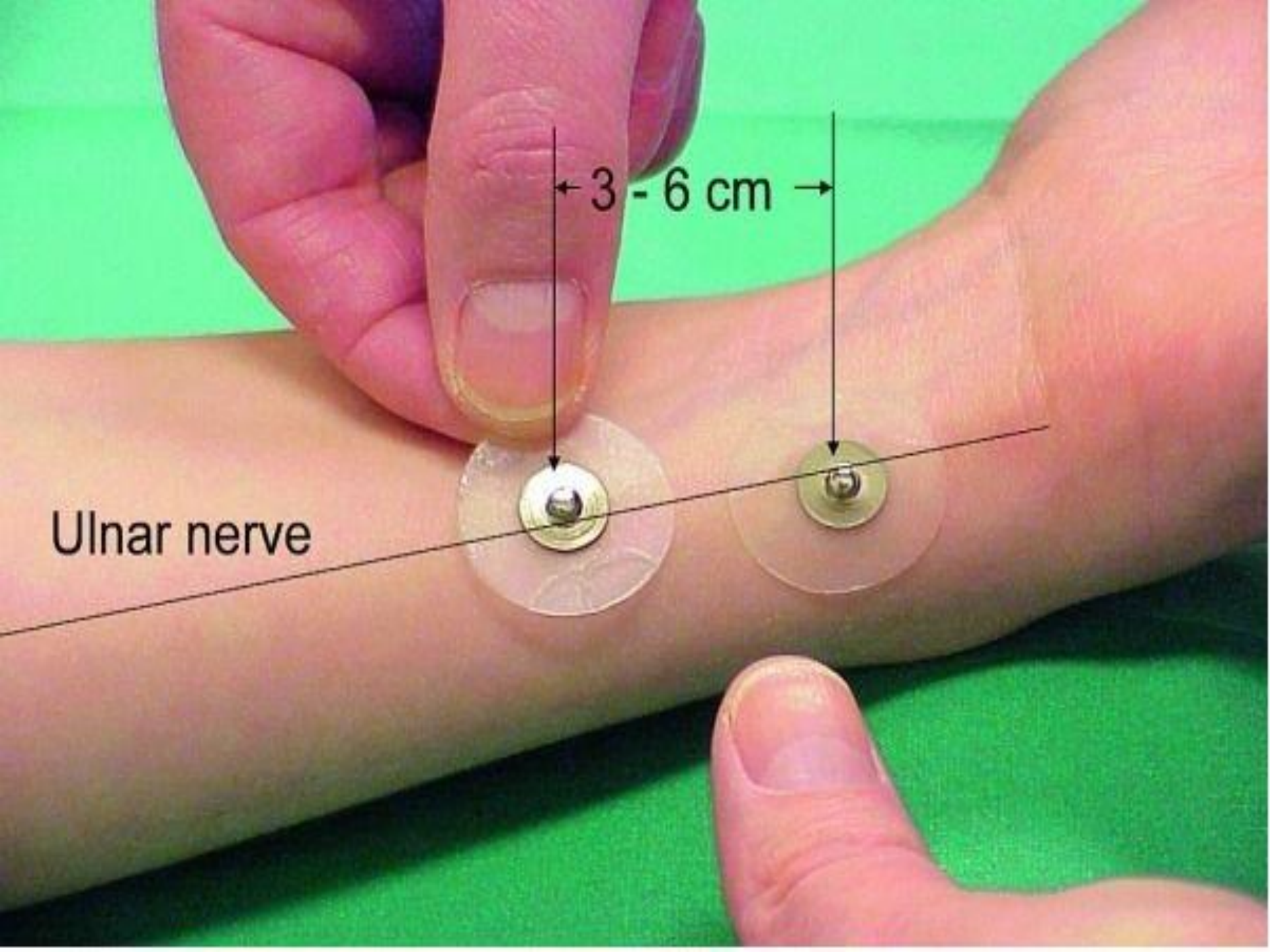
Factori ce influnteaza monit. BNM

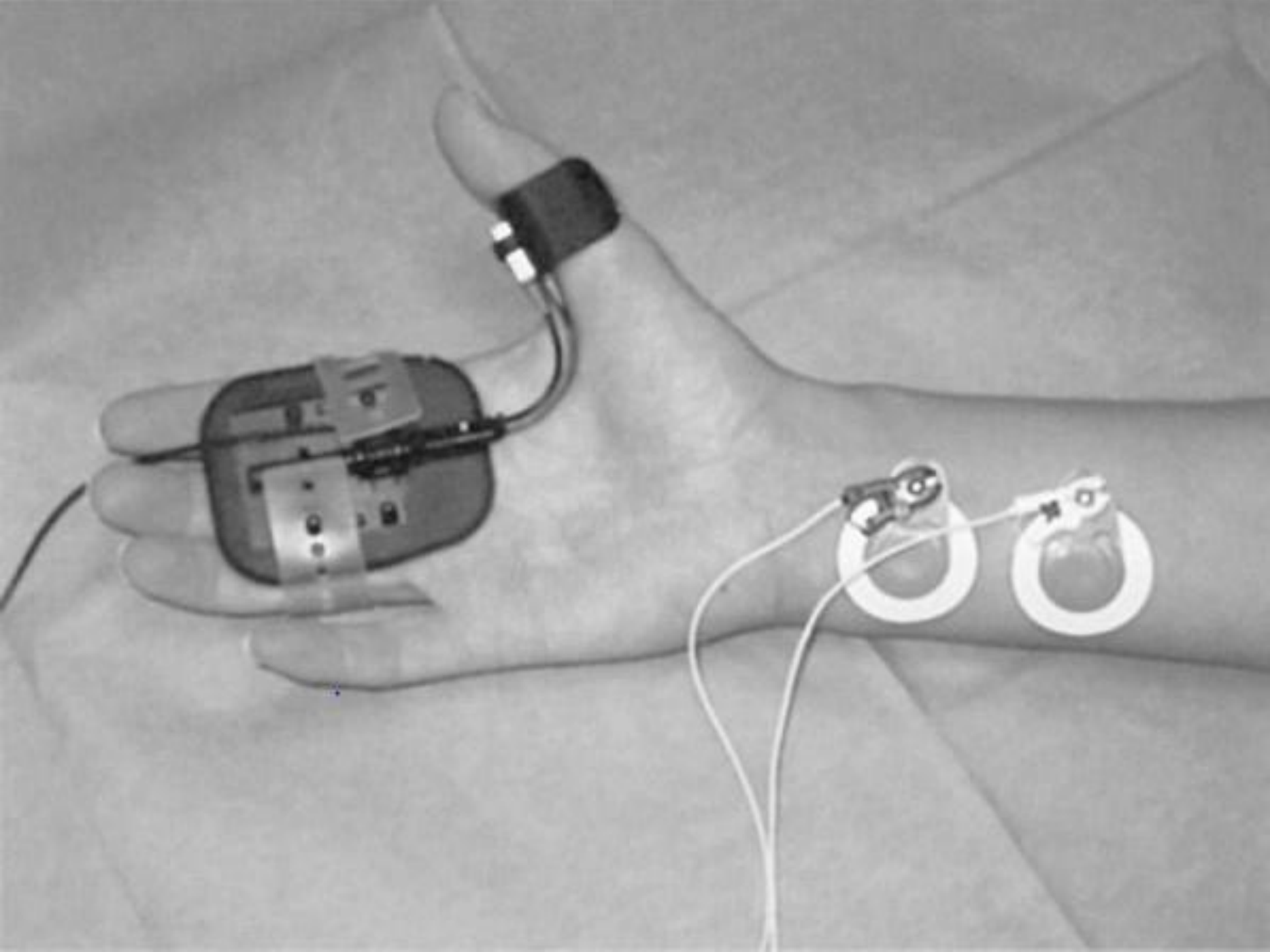
- Temperatura
- Fluxul sangvin
- Activitatea colinesterazei
- Densitatea de receptori Ach.
- Concentratia de Ach.

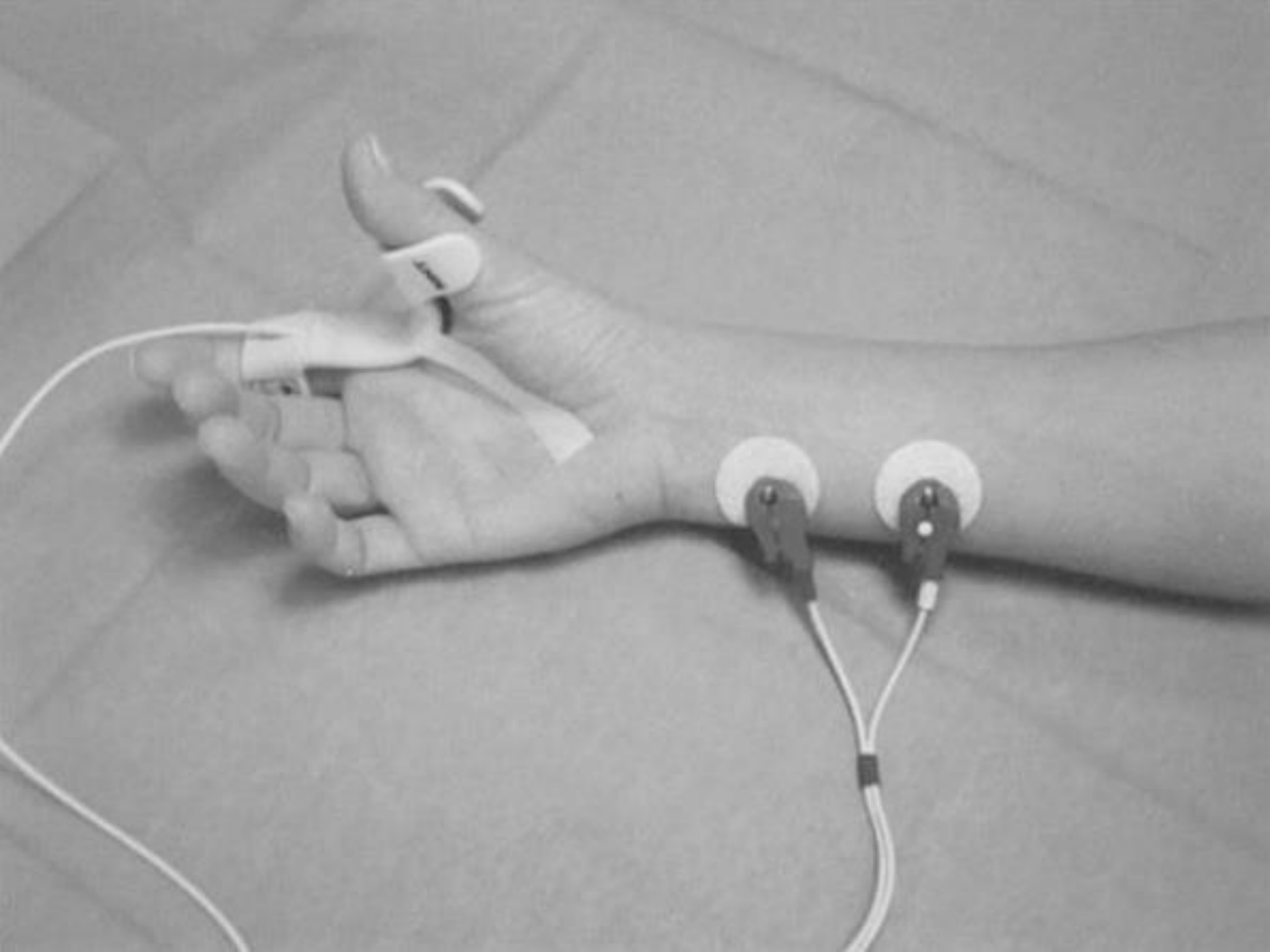
MUSCHI	**SENSIBILITATE LA BNM**
Vocal cord	**Foarte rezistent**
Diaphragm	
Orbicularis oculi	
Abdominal rectus	
Adductor pollicis	
Masseter	
Pharyngeal	
Extraocular	**Foarte sensibili l**

NERV ULNAR

- ✓ Cel mai frecvent utilizat in monitorizarea BNM in perioada perioperatorie
- ✓ **Inerveaza** adductor pollicis, abductor digiti mimimi, abductor pollicis brevis si dorsal interosseous
- ✓ Electrodul negru 2cm proximal de plica de flexie a palmei deasupra olecranului
- ✓ Electrodul alb (inregistrare) aproprierea muschiului
- ✓ **Raspuns** : flexia policelui


3 - 6 cm
Ulnar nerve



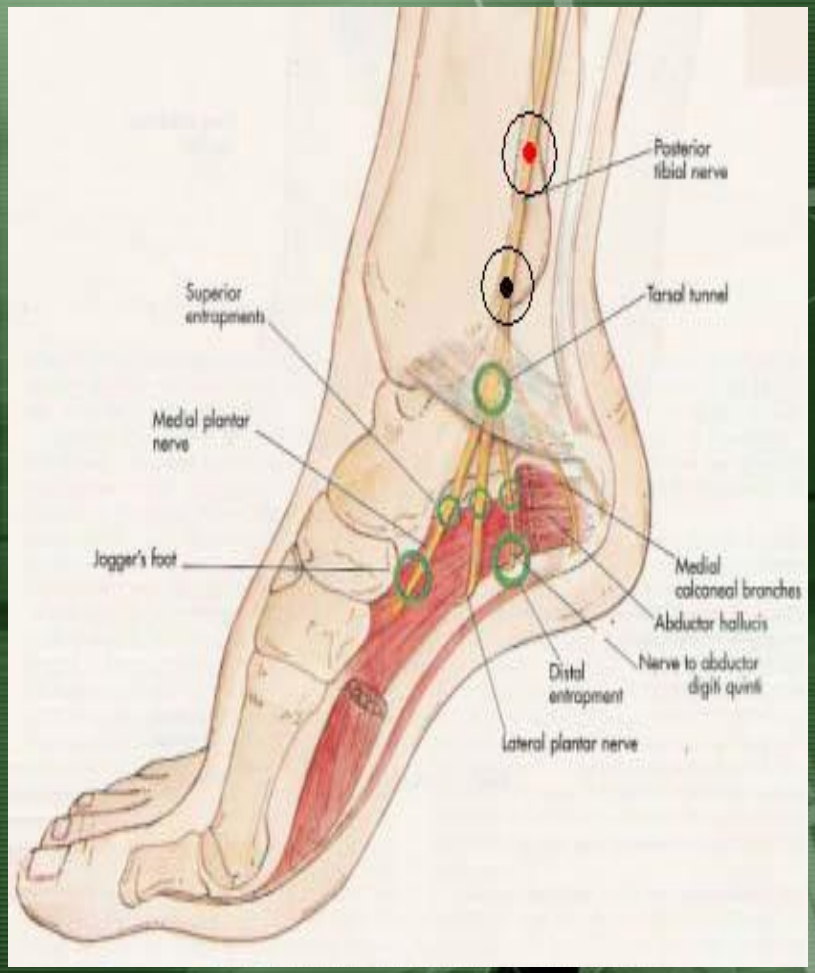


NERVUL FACIAL

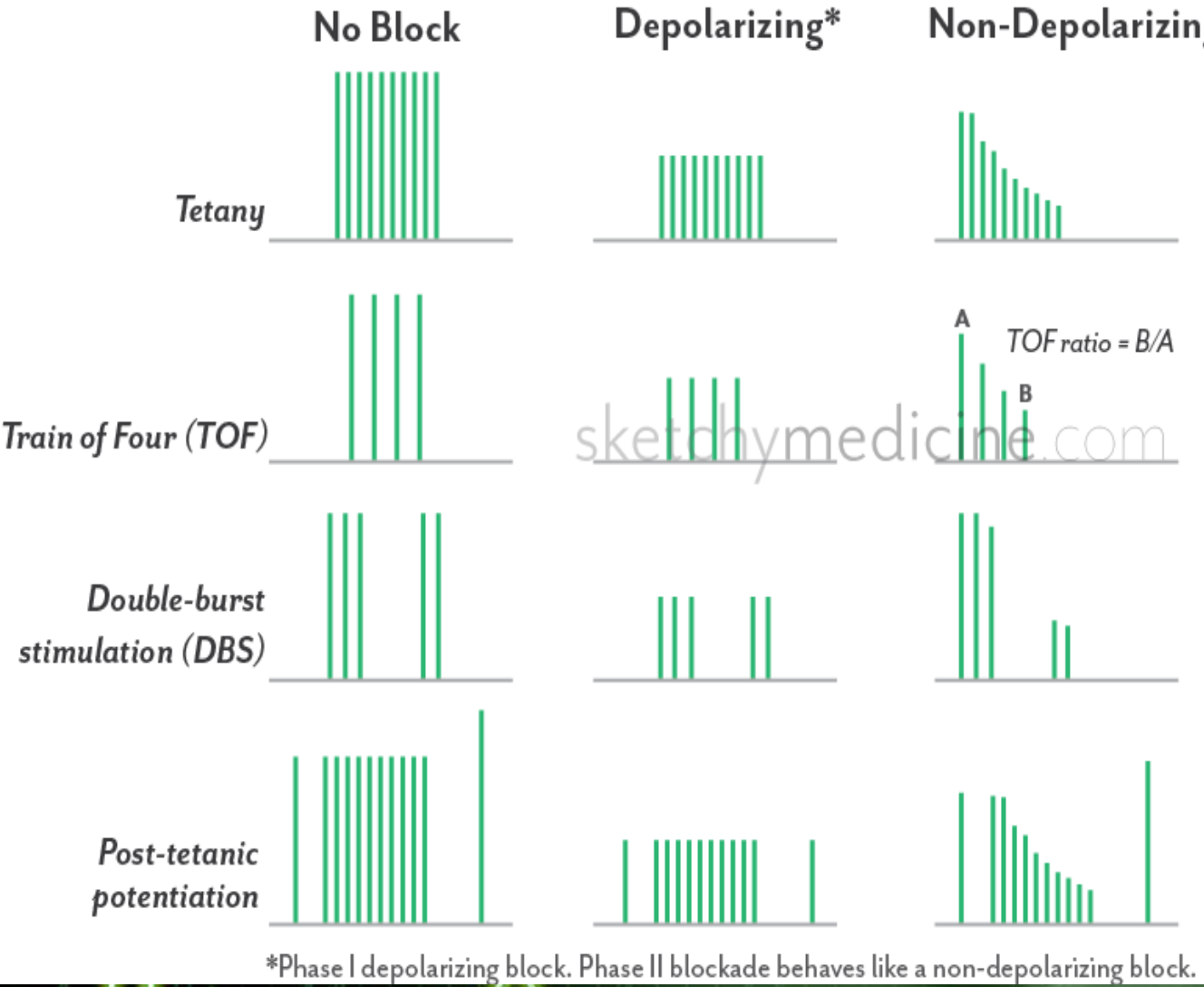
- **Raspunsul la stimulare este urmarit la muschi** orbicularis oculi (contractia sprancenei) si orbicularis oris (contractia buzei)

Nervul tibial posterior

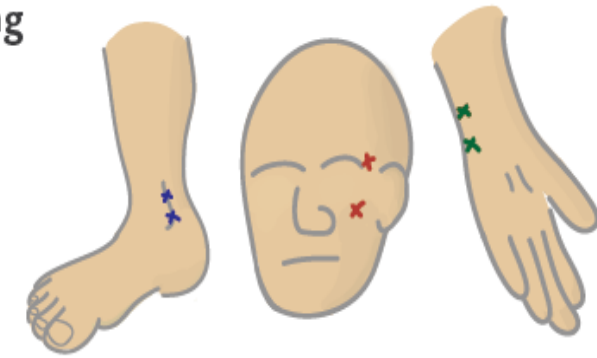
- ✓ electrodul negative (negru) deasupra de maleola mediala
- ✓ electrodul pozitiv (rosu) 2-3cm proximal de cel negativ
- ✓ **Raspuns**: flexie plantara a degetului mare



Neuromuscular Blockade



*Phase I depolarizing block. Phase II blockade behaves like a non-depolarizing block.



Common Monitoring Sites

Ulnar nerve

Adductor pollicis

- Adducts thumb

Facial nerve (CN VII)

Orbicularis occuli

- Closes eyelid

Corrugator supercilii

- Furrows brow

Posterior tibial nerve

Flexor hallucis brevis

- Flexes big toe

Fuchs-Buder T. 2010. Neuromuscular monitoring in clinical practice and research. Springer.

Inductie

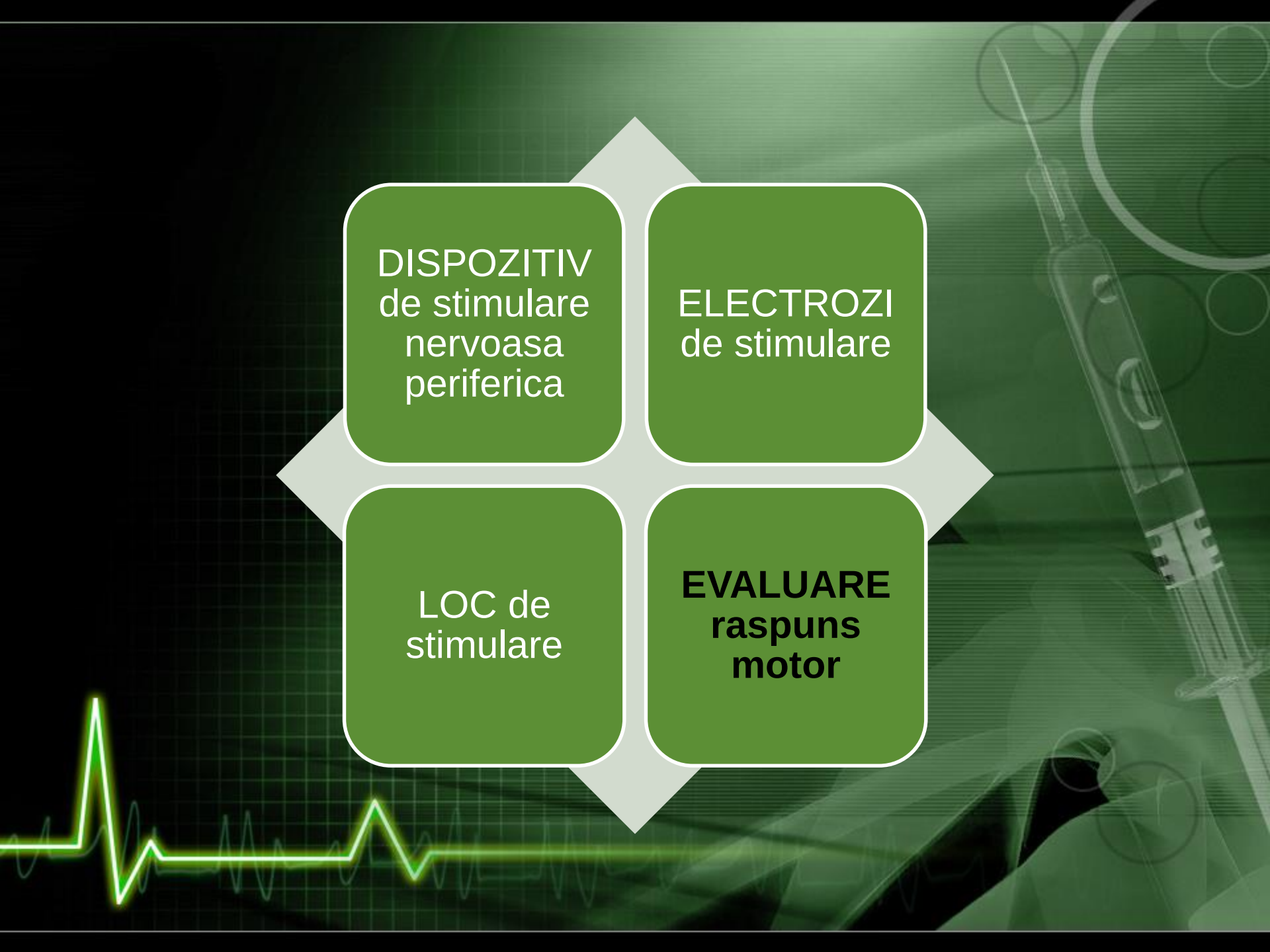
- monitorizarea m. adductor police
- *reflecta rezistenta m.laringieni*
- *ST, TOF*

Intraoperator

- m. orbicularul ochiului
- *in corelatie cu m.diafragm*
- *PTC , cand NU apare raspuns la TOF, ST*

Trezire

- *m. adductorul police*
- *m. cailor aeriene superioare*
- *TOF , DBS*

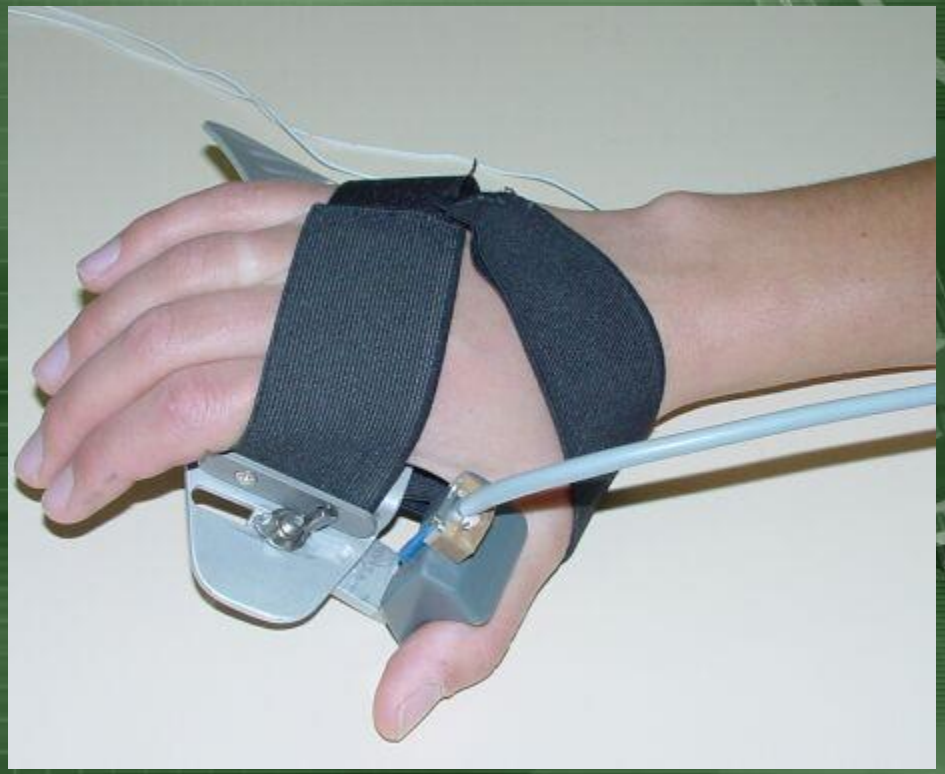

DISPOZITIV de stimulare nervoasa periferica
ELECTROZI de stimulare
LOC de stimulare
EVALUARE raspuns motor

Metode evaluare

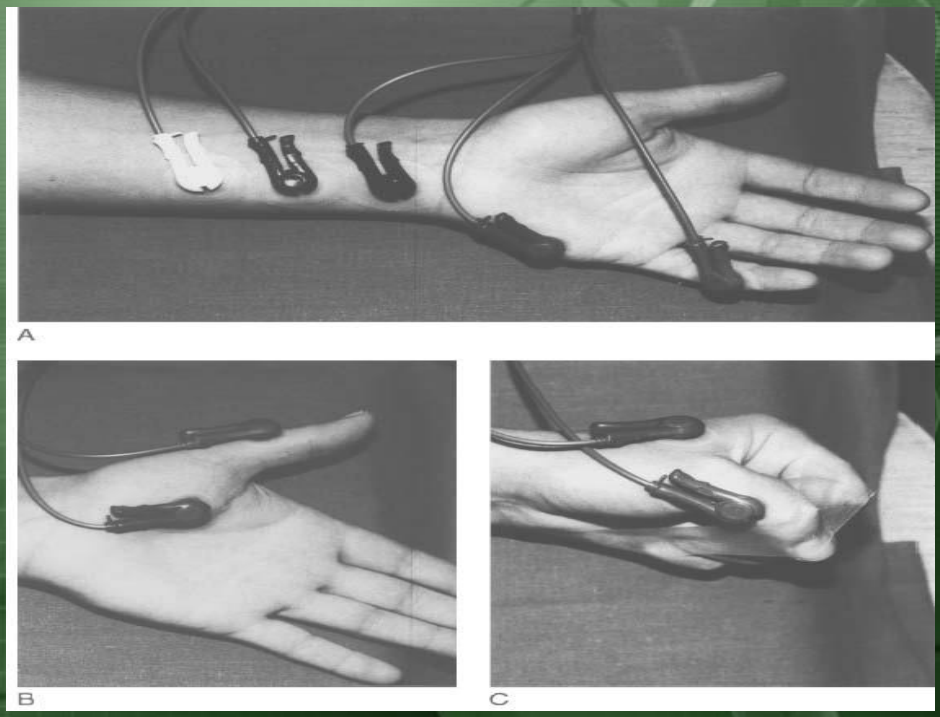
1. Masurarea raspunsului muscular **mecanic** evocat (mecanomiografie - MMG)
2. Masurarea raspunsului muscular **electric** evocat (electromiografie – EMG)
3. Masurarea **acceleratiei** raspunsului muscular evocat (acceleromiografie – AMG)
4. Masurarea raspunsului muscular evocat electric printrun **senzor piezoelectric** atasat muschiului [P_ZEMG]
5. **Fonomiografie** [PMG]

MECANOMIOGRAFIA

Forta musculara



ELECTROMIOGRAFIA



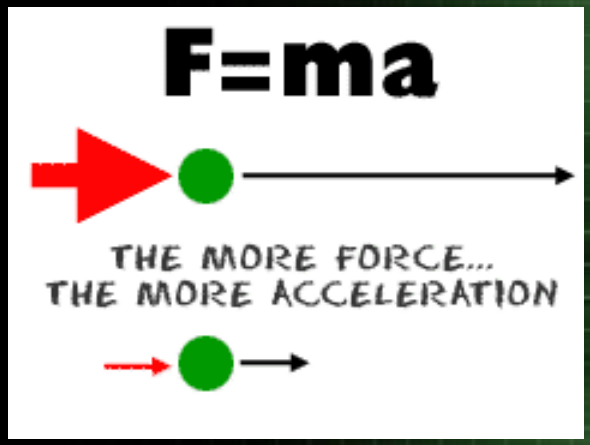
Potentiale de actiune

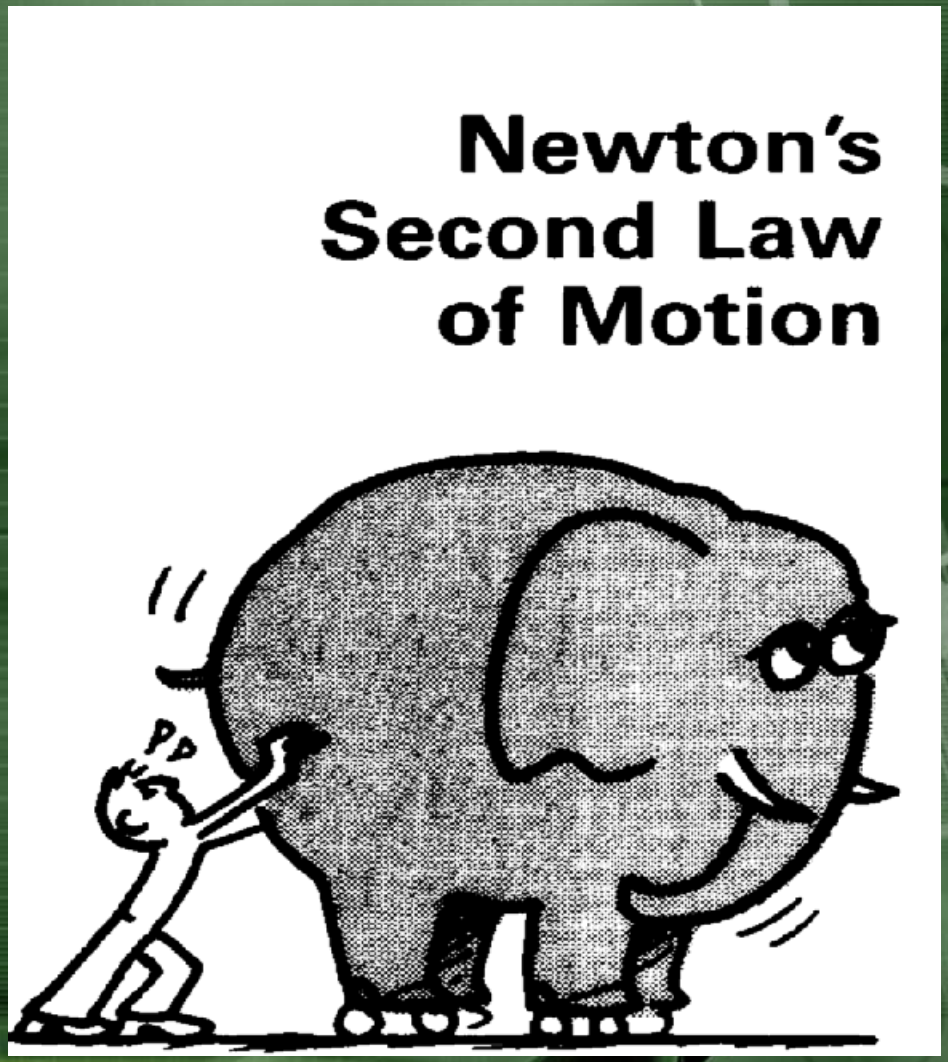
Osciloscop

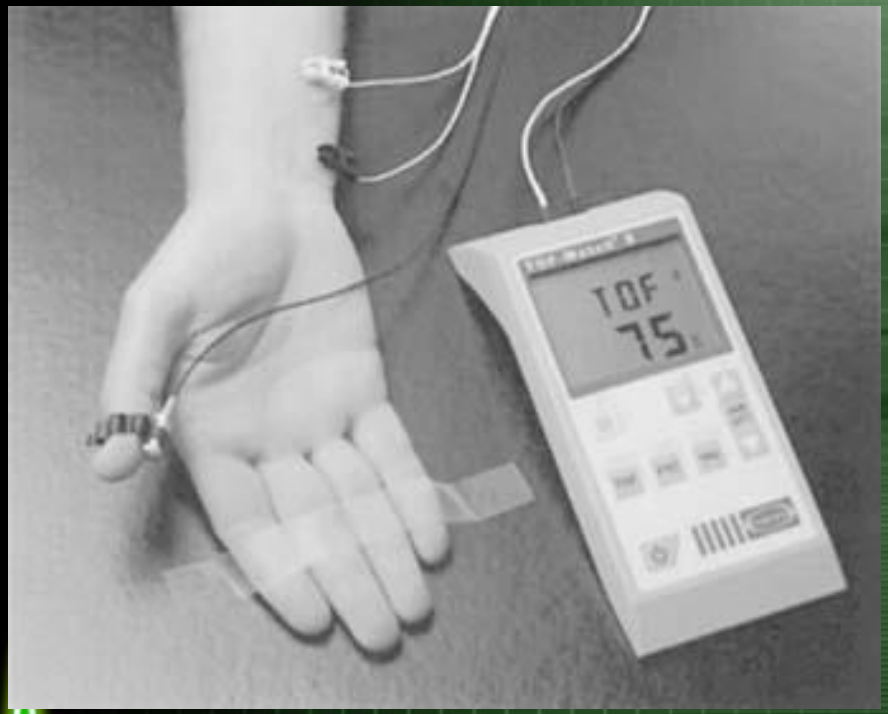
Nv.Median si ulnar

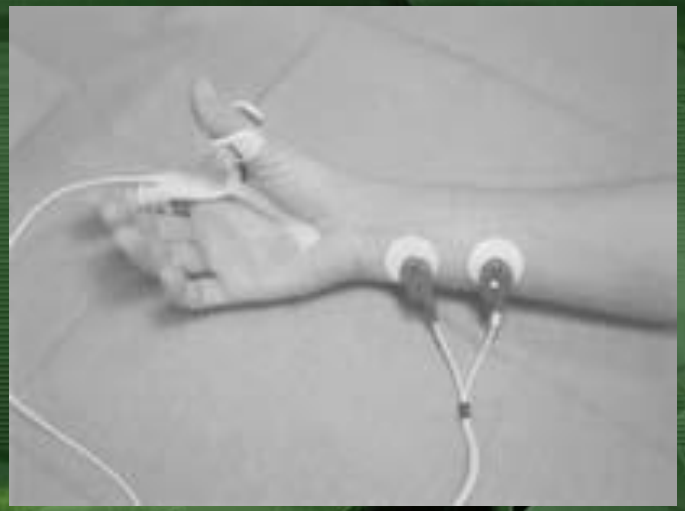
Diafragmul – plasarea de electrozi T1-T2 dreapta

ACCELEROMIOGRAFIA

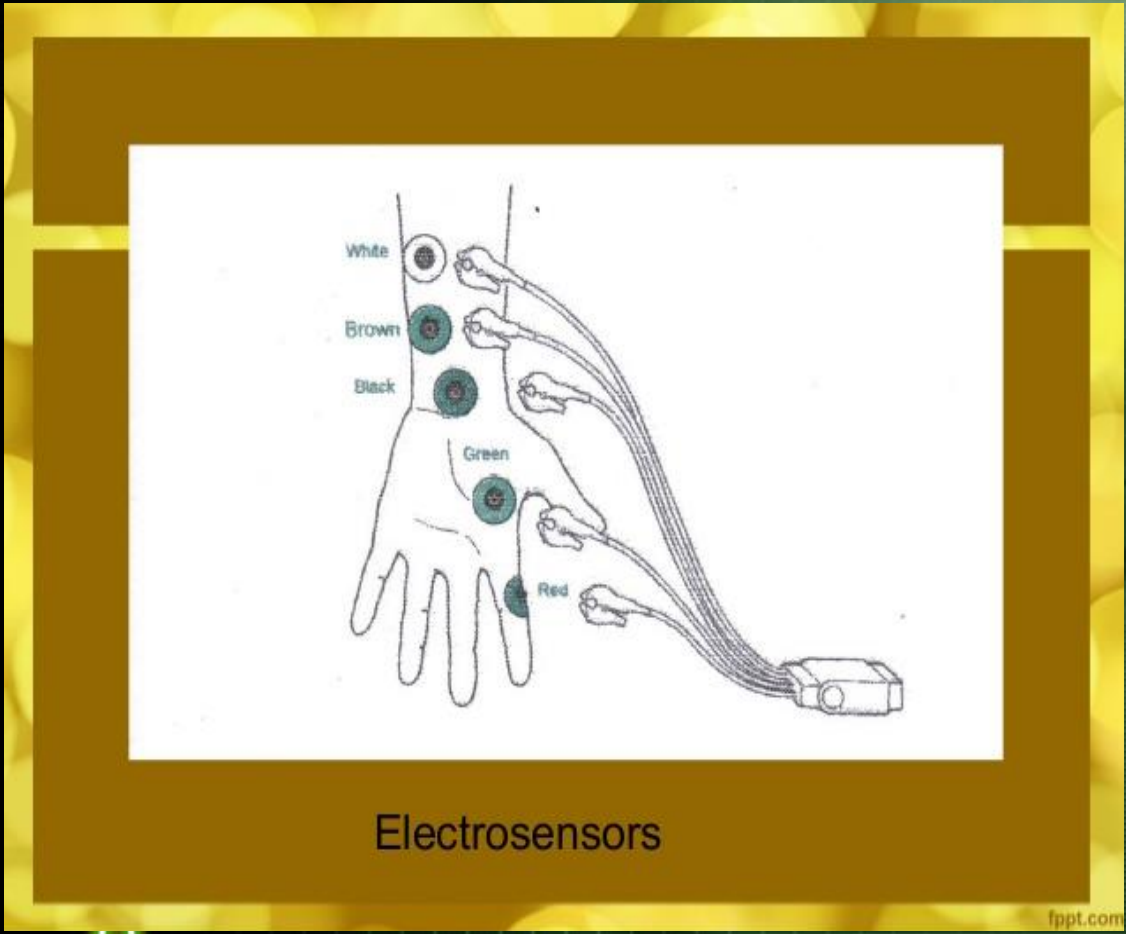





TOF
75



MONITOR PIEZOELECTRIC

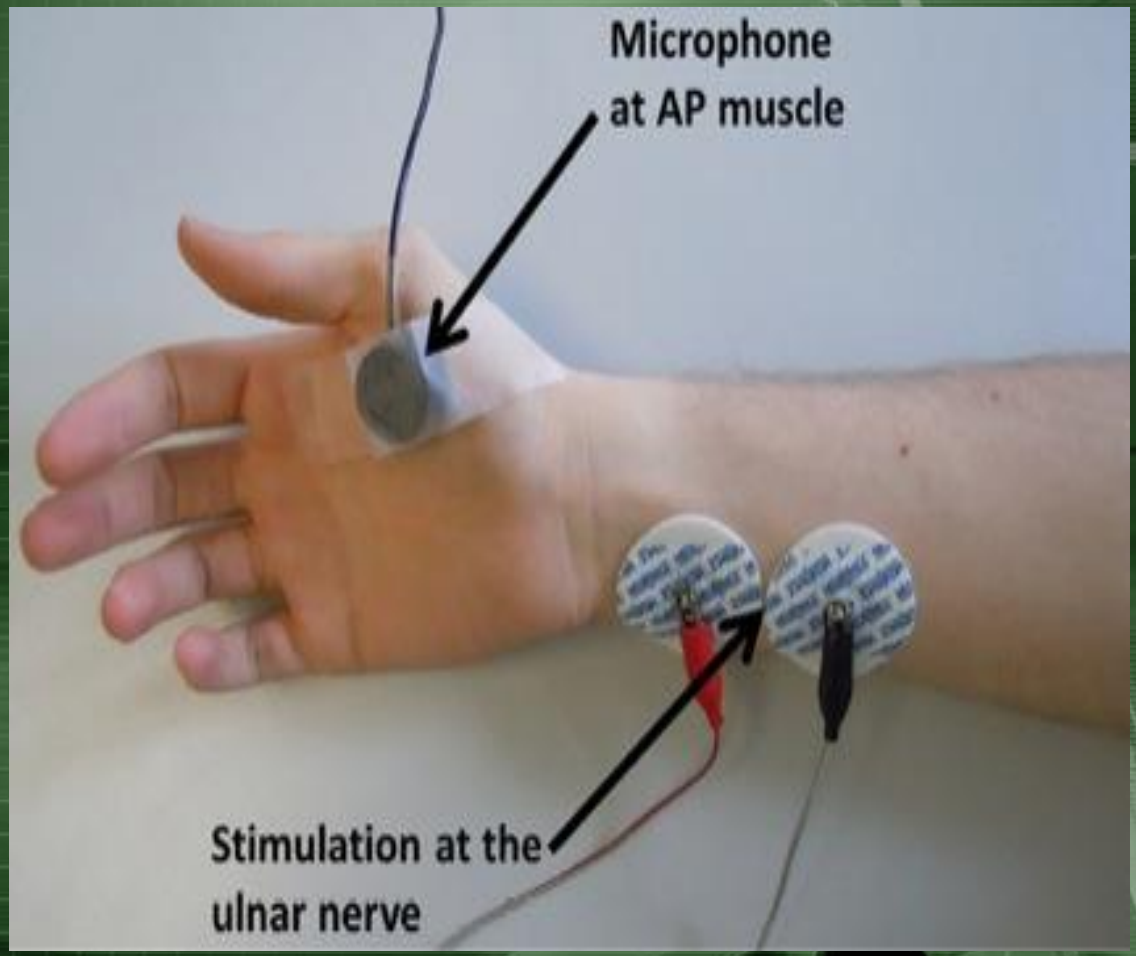


The ParaGraph Neuromuscular Blockade Monitor (Vital Signs, Totowa, NJ)

M-NMT MechanoSensor, which is a part of the Datex AS/3 monitoring system (Datex-Ohmeda, Helsinki, Finland)

FONOMIOGRAFIA

Diafragm, laringe, ochi



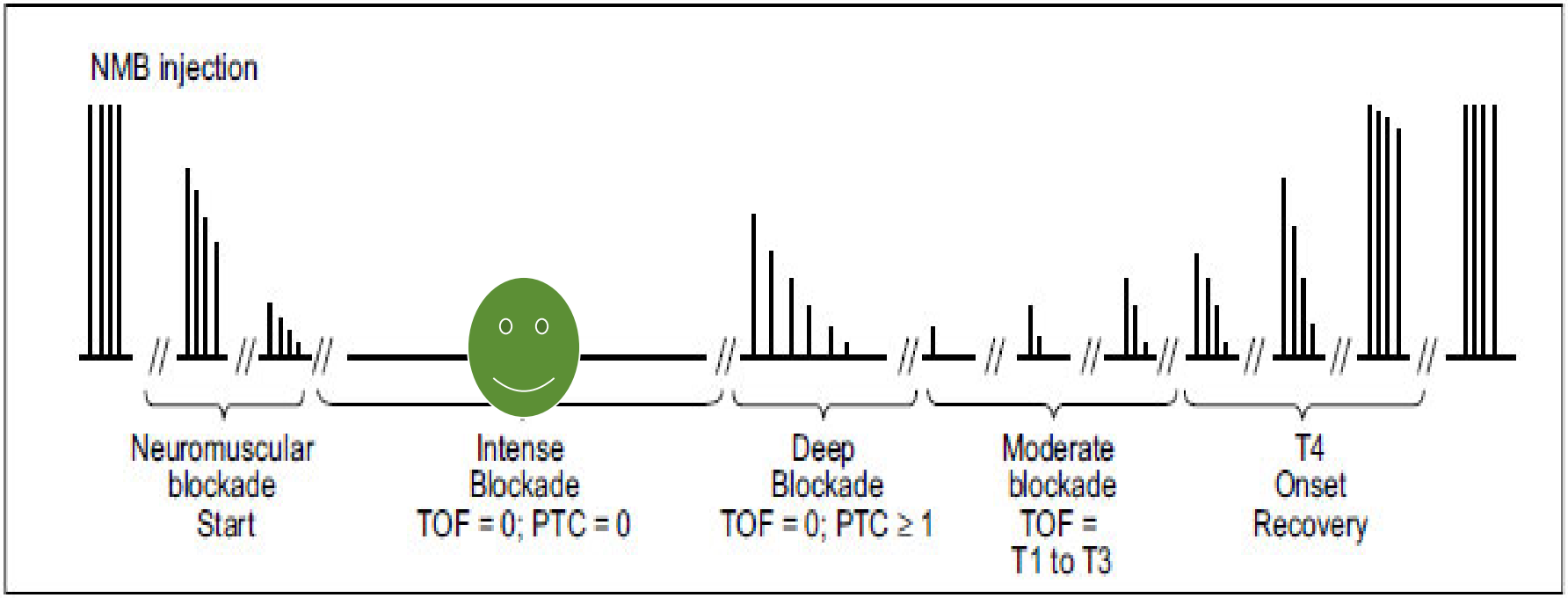
Hemmerling TM, Babin D, Donati F: Phonomyography as a novel method to determine neuromuscular blockade at the laryngeal adductor muscles.
Anesthesiology 2003; 98:359.

Aplicatii clinice

- Bloc intens
- Bloc moderat (chirurgical)
- Bloc superficial (recuperare)

Bloc profund (foarte intens)

Chart 1 – Levels of Neuromuscular Blockade After Administration of Non-Depolarizing NMB at a Single Intubation Dose [20](D).
NMB: neuromuscular blockade, TOF: T4/T1 ratio; PTC: post-tetanic counting



- **Permite aprecierea timpului necesar pana la o viitoare adm. BNM (3-6min.)**

  “ Perioada de relaxare”…..a anestezistului!

- **Durata depinde de timpul de actiune a BNM, si de doza**

- **Reversie farmacologica la bloc profund????**

Bloc moderat (chirurgical)

TOF 1 = bloc a recept. 90-95%

TOF 4 = bloc a recept. 65-80%

TOF 1-2 = BNM adecvat chirurgical

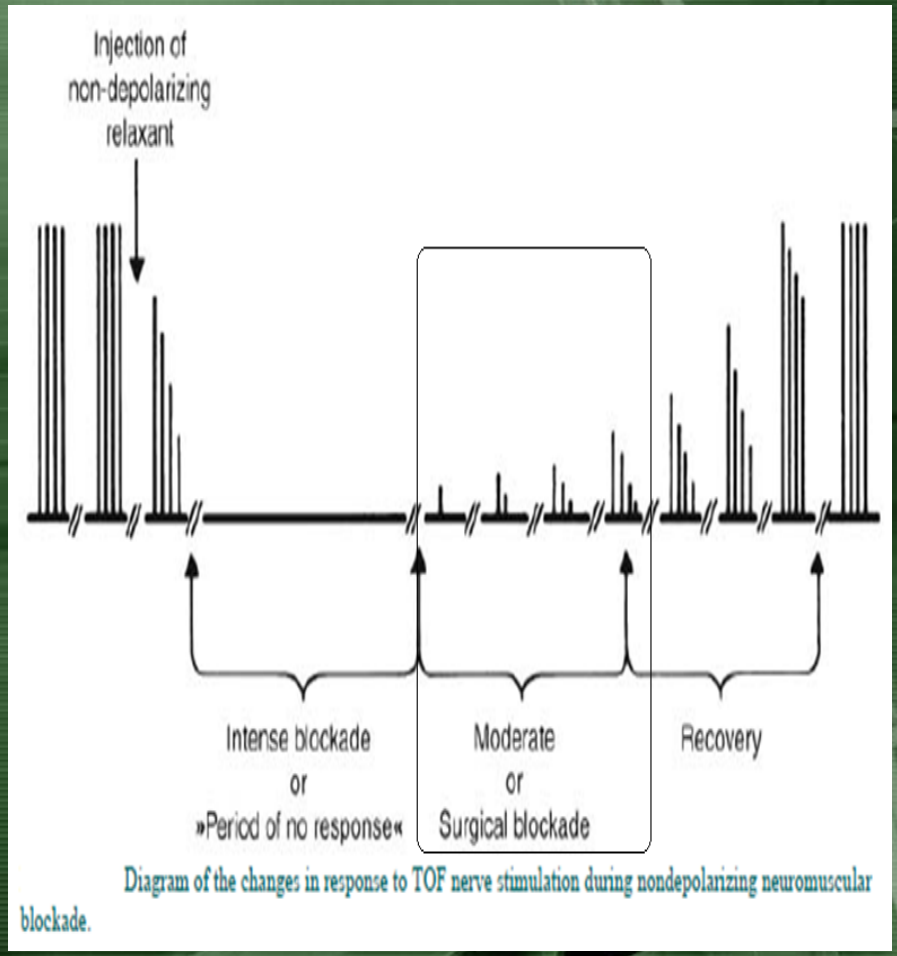


Diagram of the changes in response to TOF nerve stimulation during nondepolarizing neuromuscular blockade.

Bloc superficial (recuperare)

Prezenta a 4 stimului = BNM superficial

TOFr < 0,4: incapacitate de a ridica capul, CV redusa, reflexe faringo-laringiene abolite

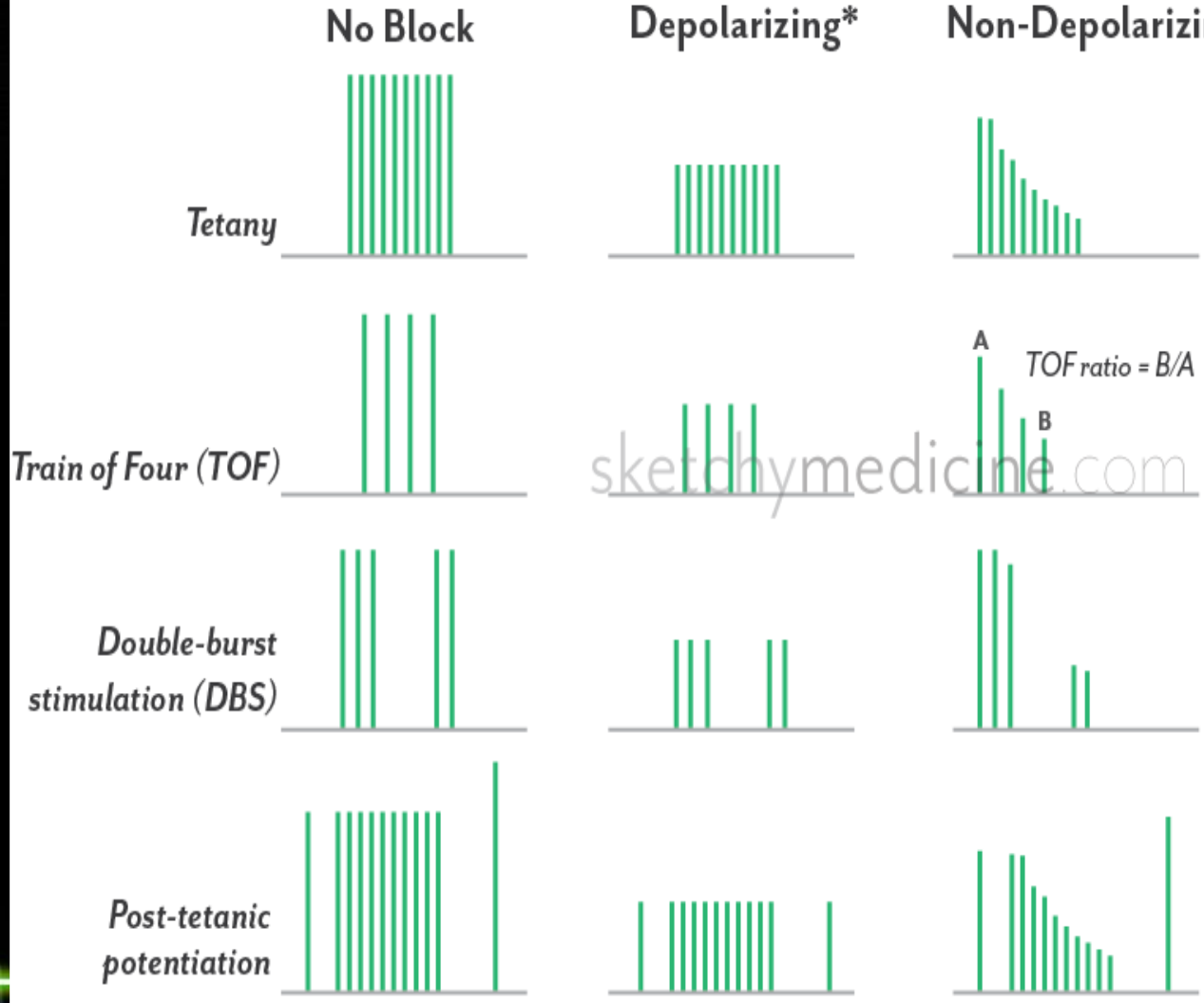
TOFr 0,4 - 0,6: ridica capul 3 sec, deschide gura, scoate limba, CV redusa

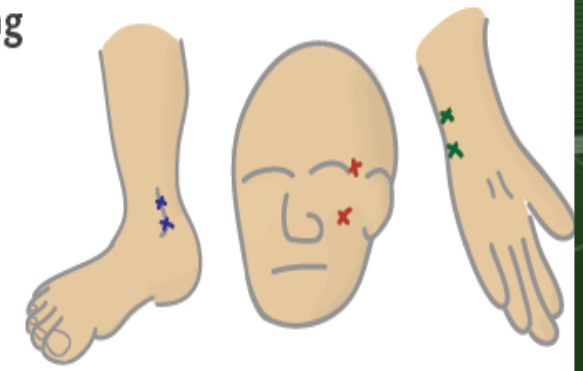
TOFr 0,7 - 0,75: ridica capul 5 sec, tuseste.

TOFr > 0,8: volume pulmonare normale.

TOFr > 0,9 : PACU

Neuromuscular Blockade





Common Monitoring Sites

Ulnar nerve

Adductor pollicis

- Adducts thumb

Facial nerve (CN VII)

Orbicularis occuli

- Closes eyelid

Corrugator supercilii

- Furrows brow

Posterior tibial nerve

Flexor hallucis brevis

- Flexes big toe

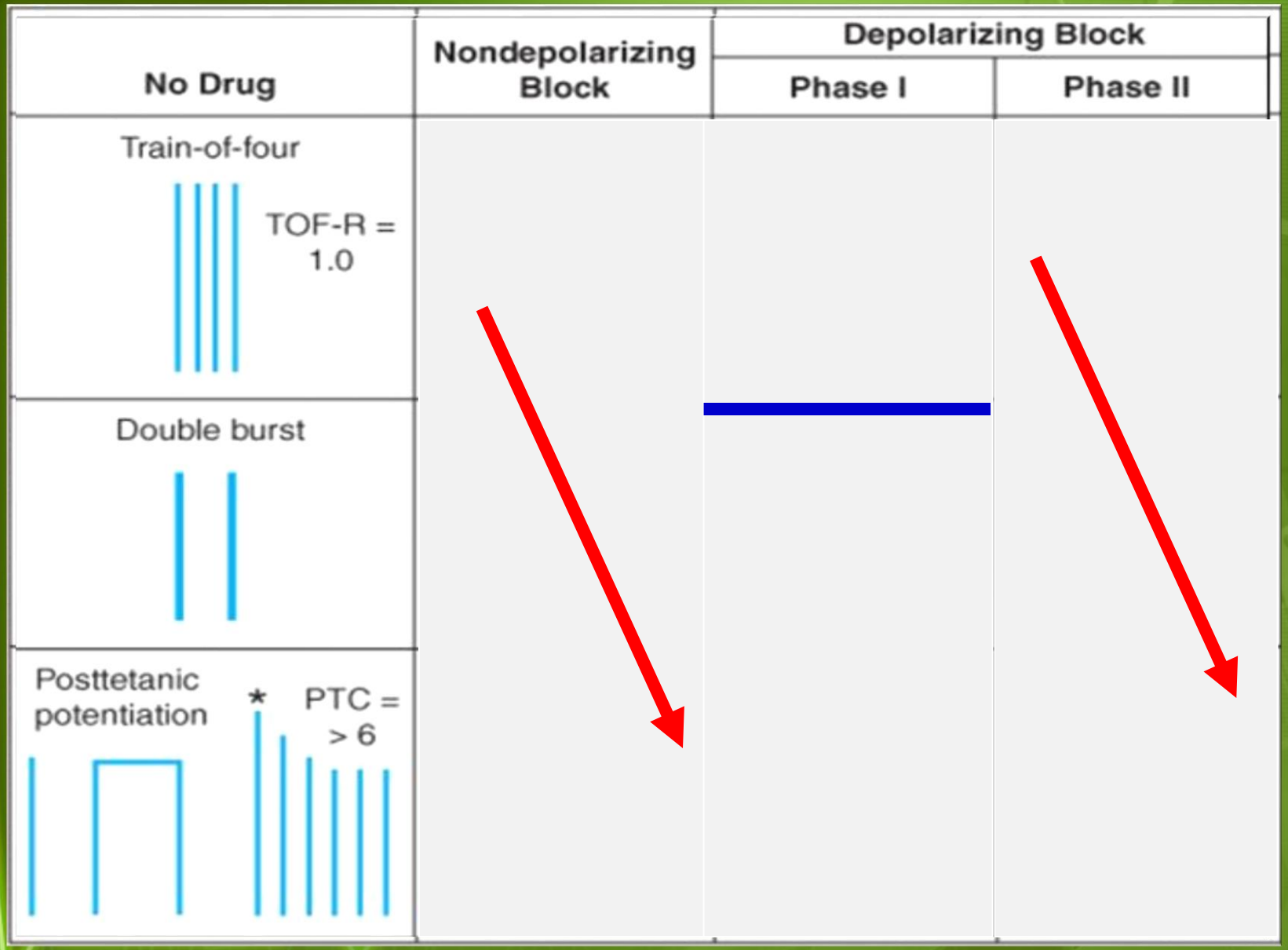
*Phase I depolarizing block. Phase II blockade behaves like a non-depolarizing block.

BNM D

- Prezenta fasciculatiilor
- Nu fenomenul de fade
- Nu fenomenul de FPT
- Anticolinesterazicele *amplifica* blocul
- Poate dezvolta faza II a blocului

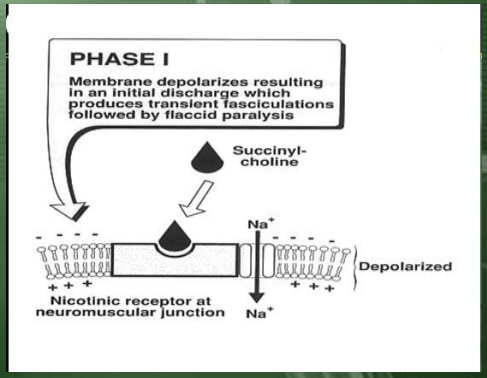
BNM nonD

- Fara fasciculatii
- Oboseala si FPT
- Anticolinesterazicele reduc blocul
- **Dozele nu** influenteaza caracterul blocului


No Drug
Nondepolarizing Block
Depolarizing Block
Phase I
Phase II
Train-of-four
TOF-R = 1.0
Double burst
Posttetanic potentiation
*
PTC = > 6

FAZELE BNM DEPOLARIZANT

Faza I



- nu apare oboseala a raspunsului (fade) la TOF, TS
- nu exista facilitarea posttetanica
- recuperare rapida
- fasciculatii

ATENTIE

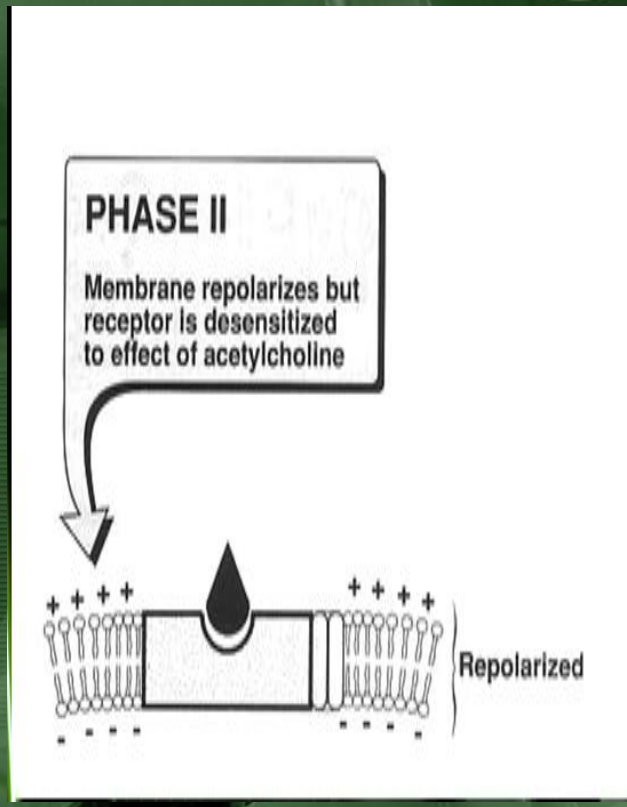
la adm BNM nonD

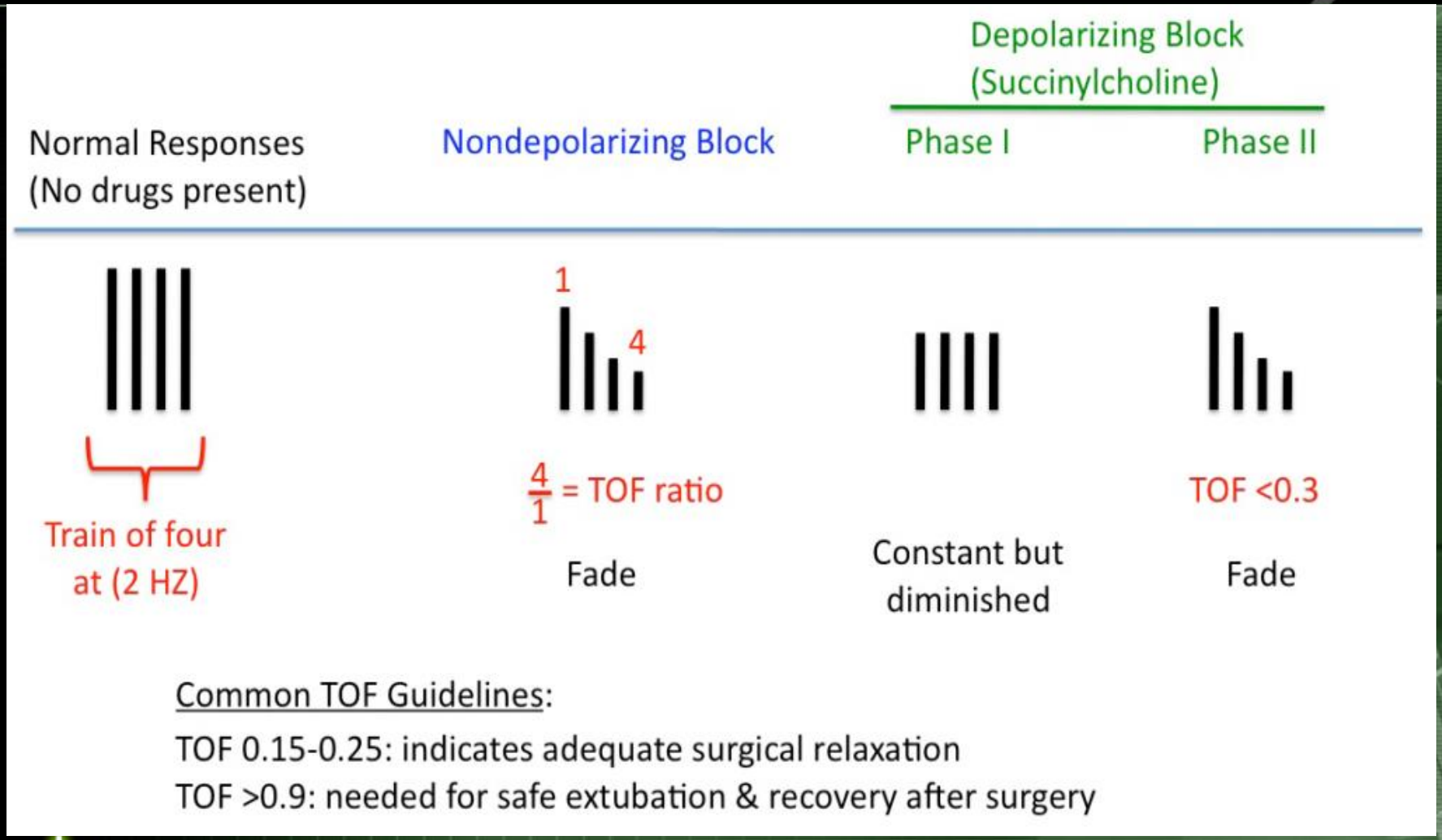
No Drug	Nondepolarizing Block	Depolarizing Block	
		Phase I	Phase II
Train-of-four TOF-R = 1.0	Fade TOF-R = 0.4	Constant but diminished TOF-R = 1.0	Fade TOF-R = 0.4
Double burst	Fade	No fade	Fade
Posttetanic potentiation * PTC = > 6	Present PTC = 3 *	Absent *	Present PTC = 3 *

FAZELE BNM DEPOLARIZANT

Faza II (dual,mixt)

- ✓ membrana postsinaptica se repolarizeaza, dar este **nerăspunsivă la ACh**
- ✓ prezent in **boli genetice**
- ✓ explicatie: **prelungita de Succinylcholina**
- ✓ dupa doze mari de Succinylcholina
- ✓ **reversie** cu inhibitorii colinesterazei
- ✓ pare ”fade” la TOF, STe
- ✓ apare **facilitare posttetanica**





Sloan, Tod B.; Heyer, Eric J. Anesthesia for Intraoperative Neurophysiologic Monitoring of the Spinal CordJournal of Clinical Neurophysiology:

RECOMANDARI


Wake Up
and Be Fabulous