Anaesthesiology for beginners

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Praha

Anesteziologie a neodkladná péče

Studijní materiály pro mediky a postgraduální studenty

Karel Cvachovec, Martin Filaun a spolupracovníci

Klinika anesteziologie a resuscitace UK 2. Lékařská fakulta v Praze

Projekt vznikl na základě grantu FRVŠ1753

Obsah

http://www.lf2.cuni.cz/Projekty/mua/obsah.php

Poslední modifikace stránky [14. 1. 2010]

Prim. Michael Stern

„Anesthesia is a waiting for trouble!“

LN, July 4th, 2009

4 reasons, why

anaesthesiology and intensive care medicine

- you as young surgeons
- you as young internists
- you as young anaesthesiologists
- you as patients

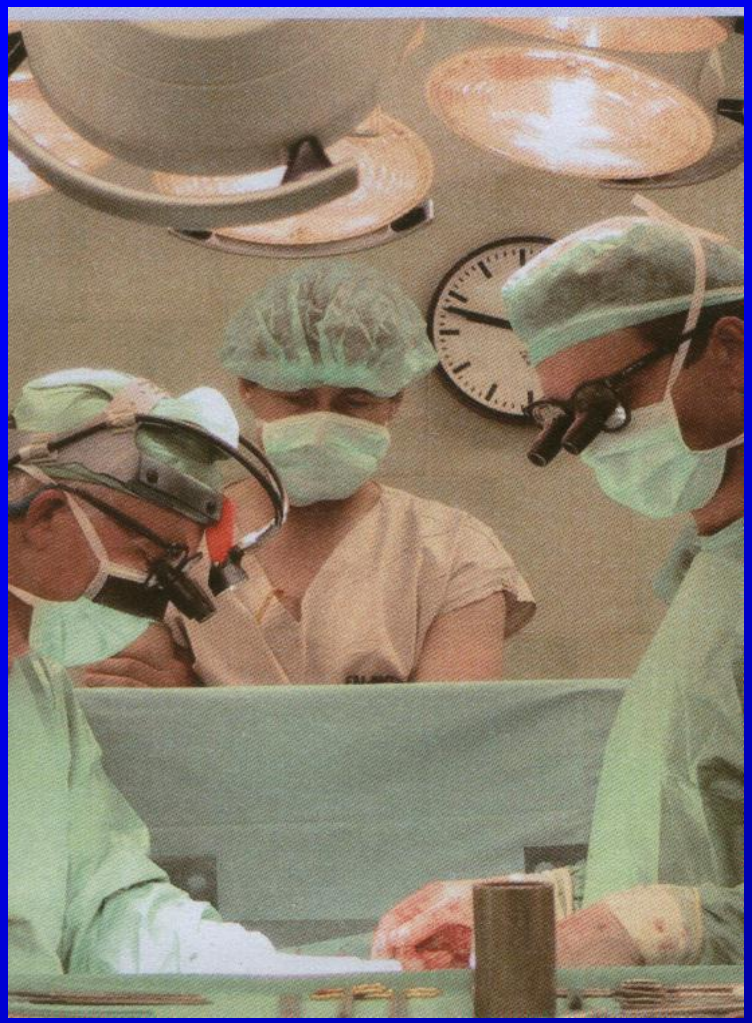
How many surgeries all over the world?
in Czech Republic?
in Motol?

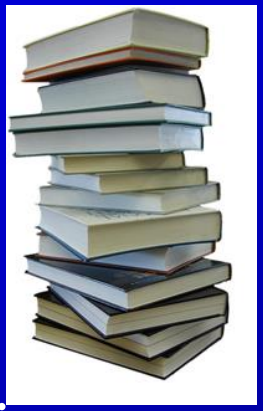
- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- management of anaesthesia
- monitoring
- preoperative and preanaesthetic evaluation

Components of AIC

- perioperative care including anaesthesiological care
  - before surgeries preoperatively
  - intraoperative management
  - postoperative care incl. pain management
- intensive care
  - in pts with disturbed vital functions = resuscitation
  - in pts. threatened by vital function disturbances = IC
- cardio-pulmonary resuscitation in cardiac arrest
- prehospital care, urgent admission
- chronic pain treatment
- obstetrical analgesia

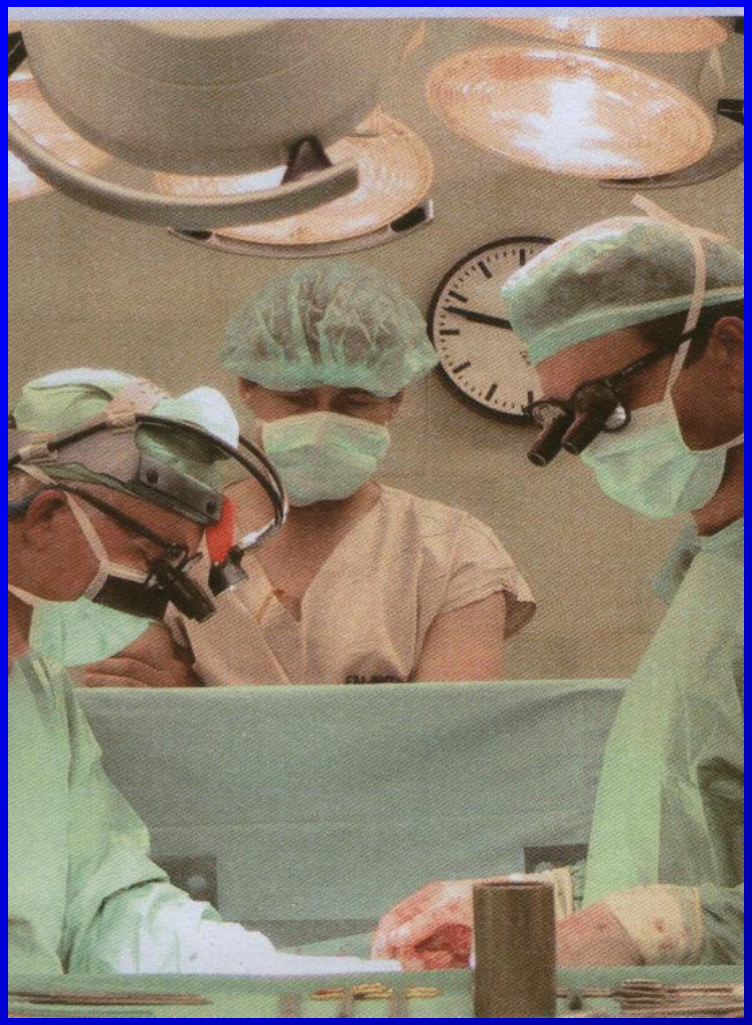
How to become an anaesthesiologist?

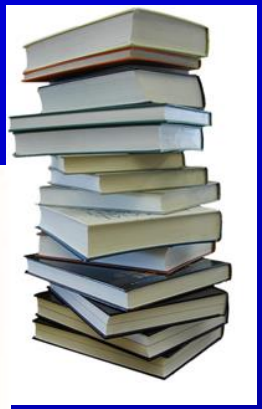




- medical faculty
  - 6years
    EU: ≥ 5500 hours, i.e.
    6 years
    = 12 terms à 15 weeks
    = 180 weeks à 5 days à 6 h
    = 5400 hours
- state examinations
- postgraduate studies ≥ 3 y

How to become an anaesthesiologist?

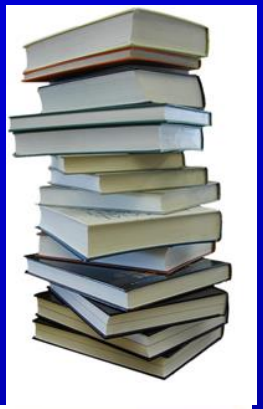




/2009)

	2000
a	250
	250
	75
	2575

How to become an intensivist?



- medical faculty 6 y
- postgrad. studies ≥ 7 y
  (law 95/2004, 67/2017, regul. 185/2009)
  - specialization in AIC, internal m., surgery, pe
    neurology, TBC+respiratory disease
  - education in intensive care med. 2 y
- examination

- definition
- **what is anaesthesia?**
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- management of anaesthesia
- monitoring
- preoperative and preanaesthetic evaluation

Anaesthesia is …

…science

…thinking

…art

Rembrandt:

- Scientist (1631)
- Artist in his studio (1626-8)
- Philosopher (1632)

What is anaesthesia?

Boston, MGH,
October 16th, 1846

> 165 years

Prague, 12.5.2015

What is anaesthesia?

- the biggest gift to the art of medicine
  S.B.Nuland: Lékařství v průběhu staletí, Knižní klub, Praha 2000
- one of 10 of the most fortituous discoveries
  http://www.21stoleti.cz
- a behavioral state enabling to tolerate surgery without any long-lasting adverse effects on the patient
  R.Larsen: Anestezie, Grada, Praha 2004
- **iatrogenic intoxication, pharmacologically induced coma**
  E. Brown et al.: General anesthesia, sleep and coma. (free full-text) NEJM 2010 Dec 30;363(27):2638-50.

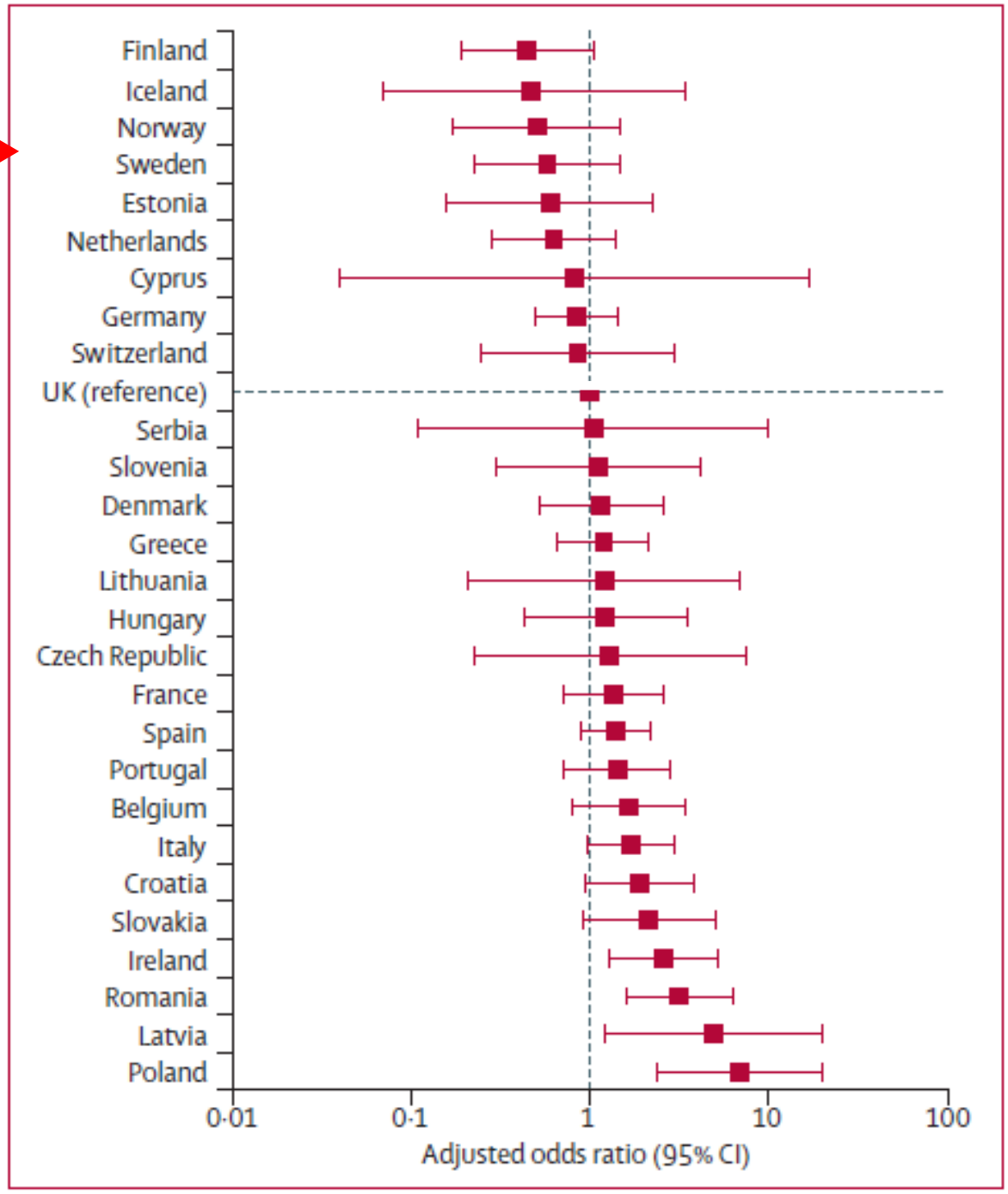

• I will survive
• I will have no pain
• I will have no memories


• she will survive (hopefully)
• she will not move (to be able to operate)
• she will have no memories (to come again)

Anesthesia requirements

- to survive
  - anaesth. death 1:1560[1] → 2:10 000 → 1:200-300 000[2]
  - death within 1 y 5-14 % in seniors or high-risk pts.[3]
- safety
- w/o pain
- analgesia
- w/o memories
- amnesia
- w/o movement
- immobilization

1. Ann Surg 1954; 140:2–35
2. Anesthesiology 2002;97:1609-17
3. Anesth Clin N Amer 2006;24:255-278



Pears RM et al.:
Mortality after surgery in Europe:
a 7 day (4.11.4.2011) cohort study.
Lancet **2012**; 380:1059–1065

Swedish surgical outcomes study (SweSOS)

An observational study on 30-day and 1-year mortality after surgery

Monir Jawad, Amir Baigi, Anders Oldner, Rupert M. Pearse, Andrew Rhodes, Helen Seeman-Lodding and Michelle S. Chew

BACKGROUND The European Surgical Outcomes Study (EuSOS) revealed large variations in outcomes among countries. In-hospital mortality and ICU admission rates in Sweden were low, going against the assumption that access to ICU improves outcome. Long-term mortality was not reported in EuSOS and is generally poorly described in the current literature.

OBJECTIVE To describe the characteristics of the Swedish subset of EuSOS and identify predictors of short and long-term mortality after surgery.

DESIGN An observational cohort study.

SETTING Six universities and two regional hospitals in Sweden.

PATIENTS A cohort of 1314 adult patients scheduled for surgery between 4 April and 11 April 2011.

MAIN OUTCOME MEASURES 30-day and 1-year mortality.

RESULTS A total of 303 patients were lost to follow-up, leaving 1011 for analysis; 69% of patients were classified as American Society of Anesthesiologists' physical status 1 or 2, and 68% of surgical procedures were elective. The median length of stay in postanaesthesia care units (PACUs) was 175 min (interquartile range 110–270); 6.6% of patients had PACU length of stay of more than 12 h and 3.6% of patients were admitted to the ICU postoperatively. Thirty-day mortality rate was 1.8% [95% confidence interval (CI) 1.0–2.6] and 8.5% (CI 6.8–10.2) at 1 year ($n = 18$ and 86). The risk of death was higher than in an age and sex-matched population after 30 days (standardised mortality ratio 10.0, CI 5.9–15.8), and remained high after 1 year (standardised mortality ratio 3.9, CI 3.1–4.8). Factors predictive of 30-day mortality were age, American Society of Anesthesiologists' physical status, number of comorbidities, urgency of surgery and ICU admission. For 1-year mortality, age, number of comorbidities and urgency of surgery were independently predictive. ICU admission and long stay in PACU were not significant predictors of long-term mortality.

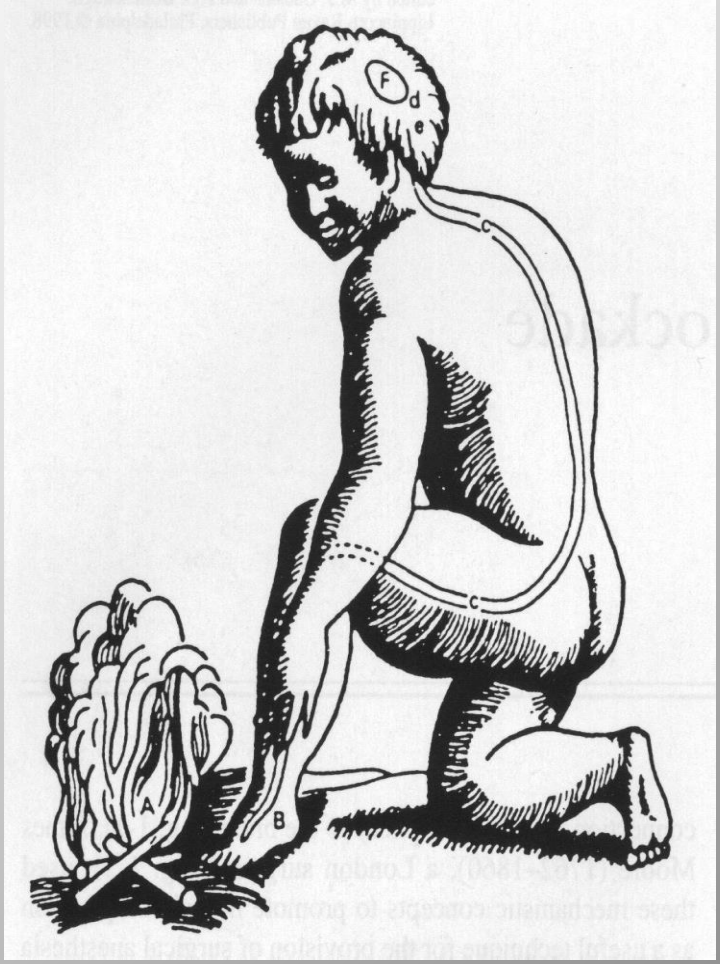
CONCLUSION Mortality rate increased almost five-fold at 1 year compared with 30-day mortality after surgery, demonstrating a significantly sustained long-term risk of death in this surgical population. In Sweden, factors associated with long-term postoperative mortality were age, number of comorbidities and surgical urgency.

Published online xx month 2015

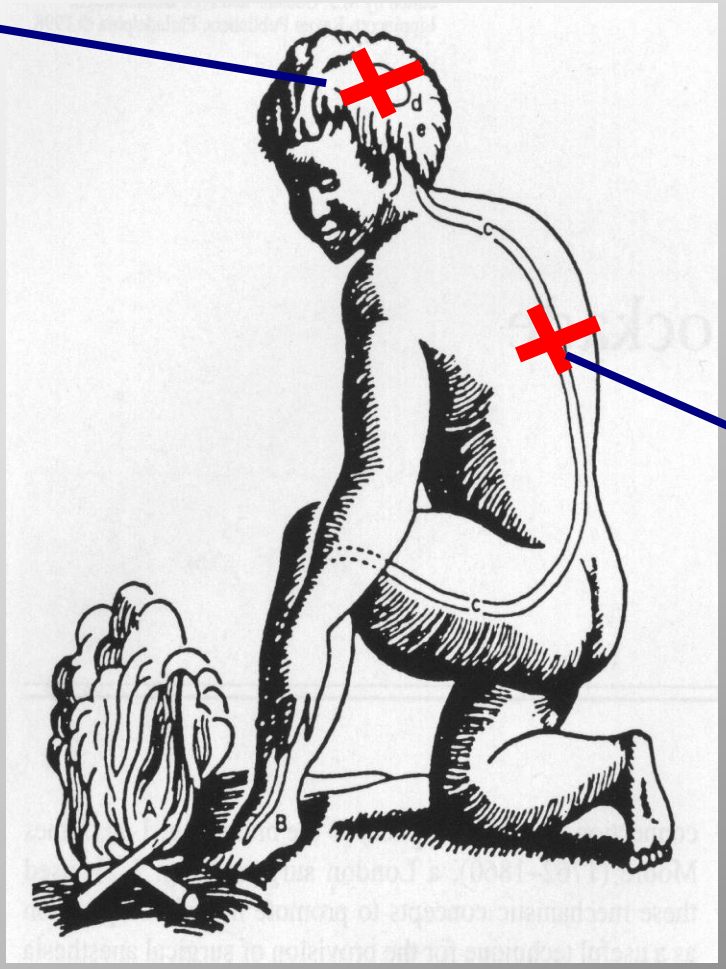
Definitions of anaesthesia

- **reversible inhibition of central nervous system activity (brain and spinal cord) enabling to tolerate surgery.**
  modif. from R. Larsen: Anestezie

- general anaesthesia is manifested by loss of consciousness and by loss of perception and reaction to nociceptive stimuli
- local anaesthesia is caused by the blockade of conduction of nociceptive impulses into the brain


F
d
c
C
A
B

- **amnesia**
- **analgesia**

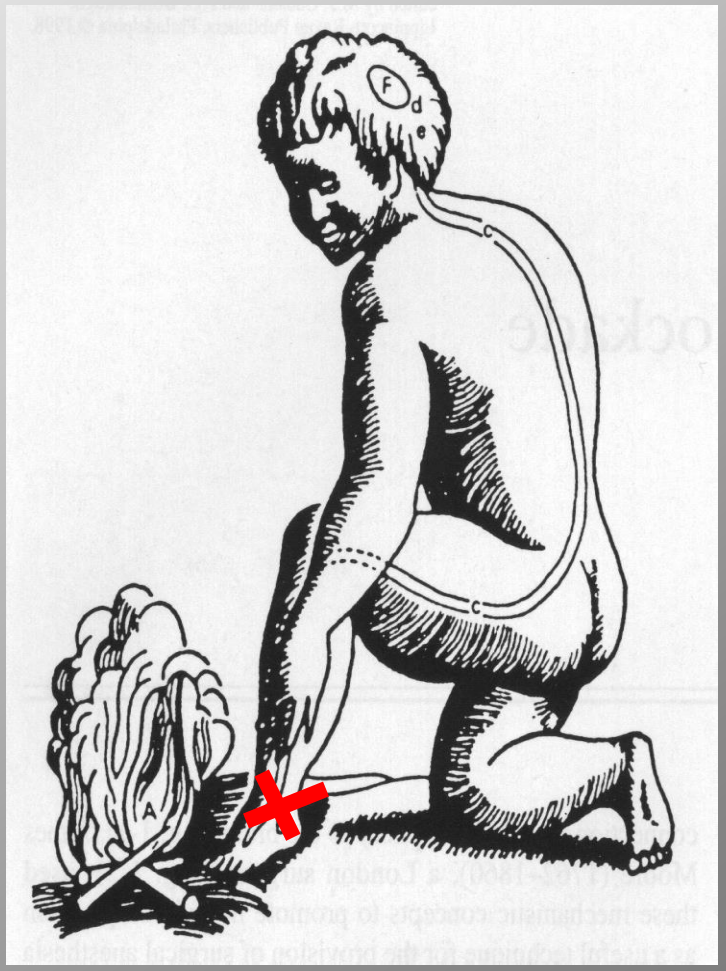


- **immobilization**

General anaesthesia

„The idea to induce anaesthesia
by blockade of conduction
via sensitive nerves
by suitable means
should spread in minds
of progressive doctors.“

James Leonard Corning 1886



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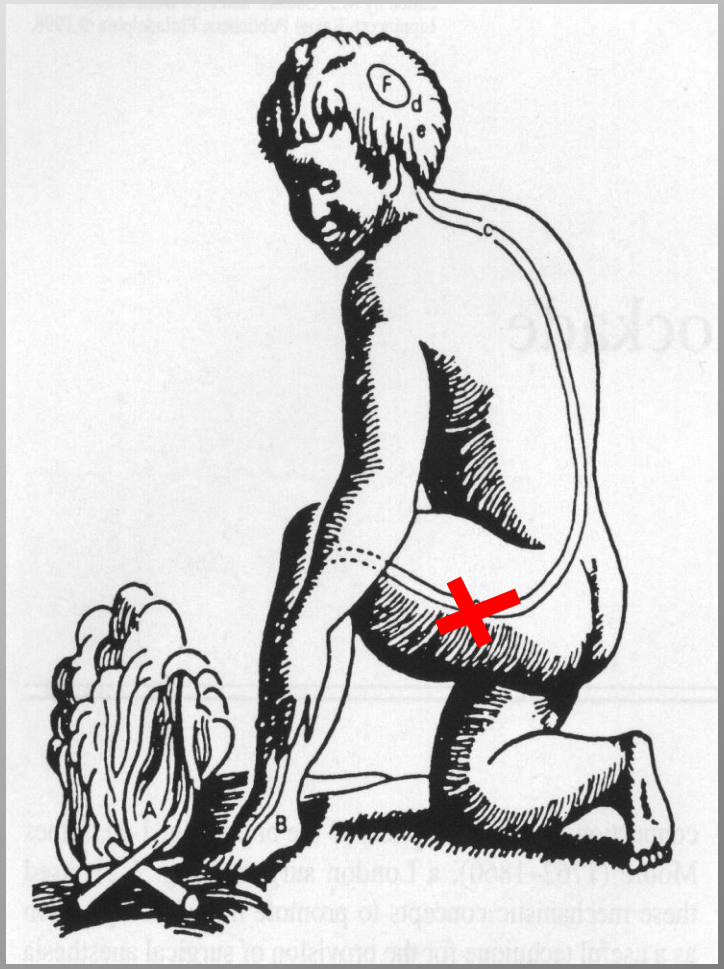

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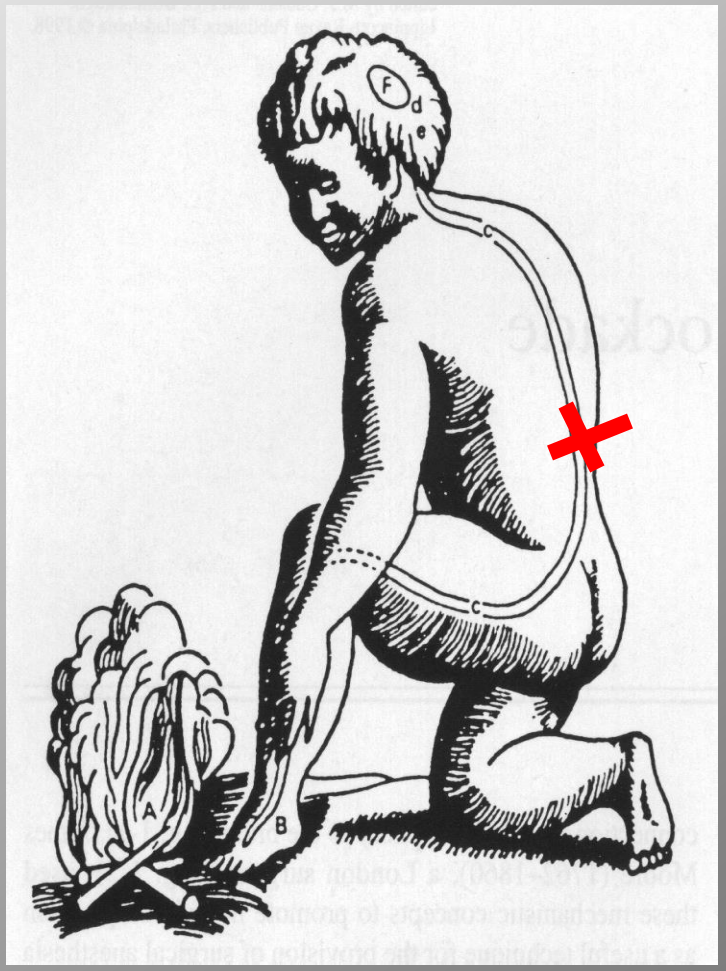


- definition
- what is anaesthesia?
- **techniques of anaesthesia**
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- management of anaesthesia
- monitoring
- preoperative and preanaesthetic evaluation

Classifications of techniques

- general anaesthesia
  - one drug = monoanaesthesia
  - more drugs = balanced anaesthesia
    - based on inhalational anaesthetics (Ventil. Induction + Mainten. A. VIMA)
    - based on intravenous anaesthetics (Total ly IntraVenous Anaesth = TIVA)
- local anaesthesia
  - central blocks (epidural and caudal, spinal)
  - peripheral nerves blocks
  - IVRA, IARA
  - local anaesthesia in strict sense (infiltrational and topical)
- combined = more techniques together

Classifications of techniques

- **general anaesthesia**
  - **one drug = monoanaesthesia**
  - **more drugs = balanced anaesthesia**
    - **based on inhalational anaesthetics (VIMA)**
    - **based on intravenous anaesthetics (TIVA)**
- local anaesthesia
  - central blocks (epidural and caudal, spinal)
  - peripheral nerves blocks
  - IVRA, IARA
  - local anaesthesia in strict sense (infiltrational and topical)
- combined = more techniques together

Components of general anaesthesia

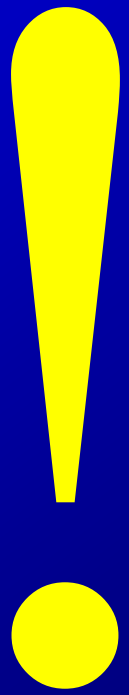
Beneficial:

- unconsciousness, amnesia, anxiolysis
- suppresion of reaction to painful stimuli (antinociception or analgesia)
- immobilization, muscle relaxation

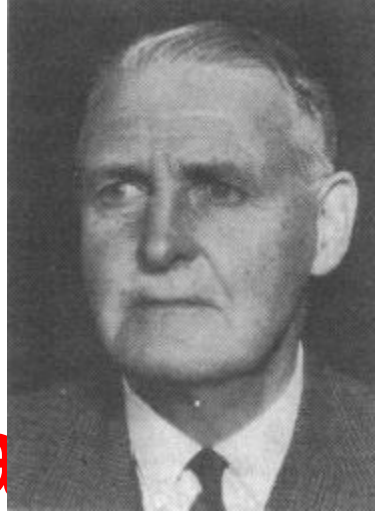
Adverse:

- circulatory instability
- excitation, convulsions
- nausea, vomitting
- tremor etc.

Anaesthesia is a iatrogenic controlled intoxication of the patient.



General anaesthesia



-iatrogenic, controlled intoxication
-pharmacologically induced coma

„Each substance is a poison,

only its dose makes

the substance not poisonous. “

Theophrastus Bombastus
von Hohenheim - Paracelsus
(1493-1541)

„Anaesthesia must be:

- **as deep, as needed,**
- **as shallow, as possible,“**
  Michael D. Nosworthy (1902-1980)
- **and should last only**
  for the necessary time.

„Each anaesthetic has its own spectrum of effects.“

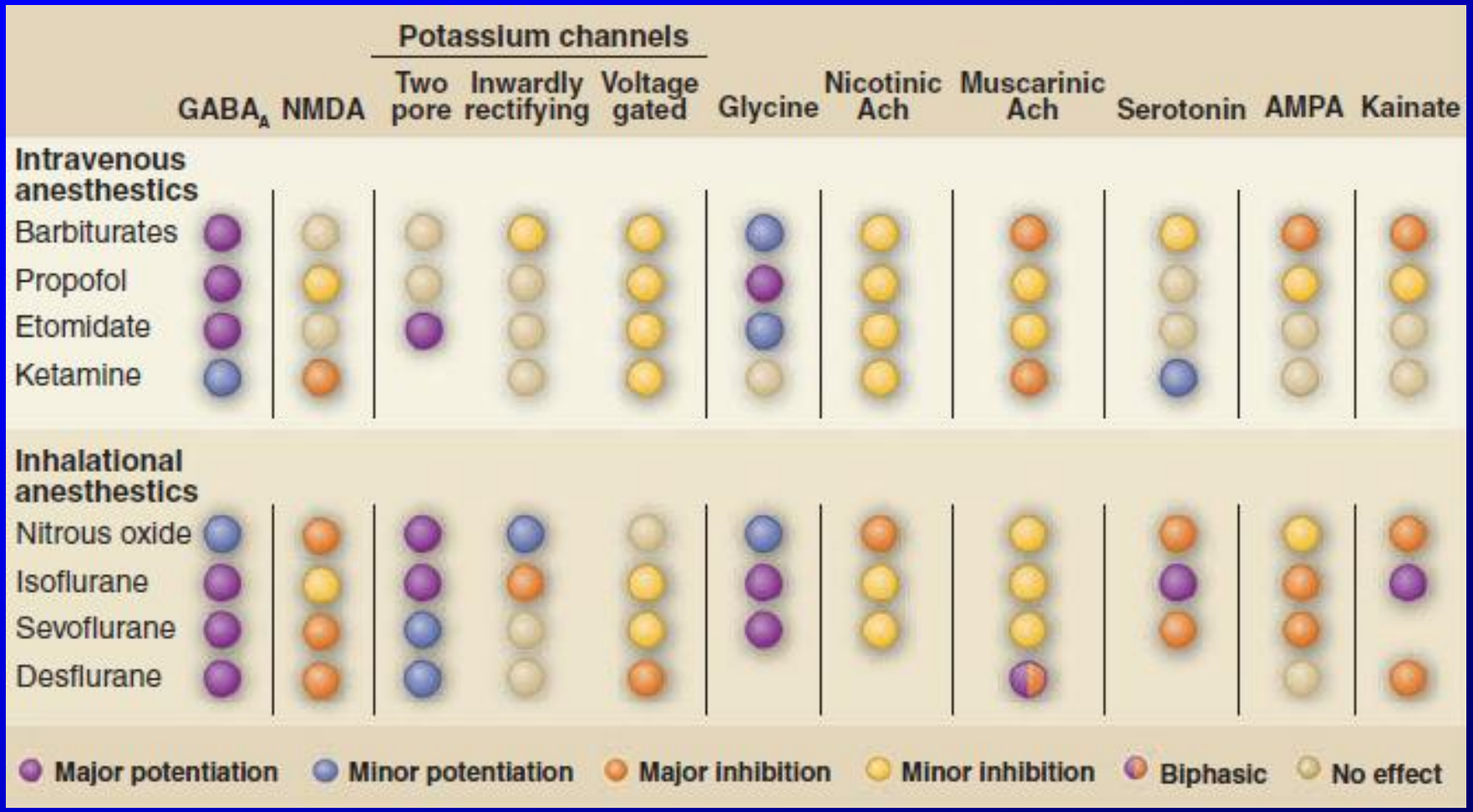
B. Antkowiak

	$GABA_A$	NMDA	Potassium channels: Two pore	Potassium channels: Inwardly rectifying	Potassium channels: Voltage gated	Glycine	Nicotinic Ach	Muscarinic Ach	Serotonin	AMPA	Kainate
Intravenous anesthetics											
Barbiturates	Major potentiation	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition	Major potentiation	Minor inhibition	Major inhibition	Minor inhibition	Major inhibition	Major inhibition
Propofol	Major potentiation	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition	Major potentiation	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition
Etomidate	Major potentiation	Minor inhibition	Major potentiation	Minor inhibition	Minor inhibition	Major potentiation	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition
Ketamine	Minor potentiation	Major inhibition		Minor inhibition	Minor inhibition	Minor inhibition	Minor inhibition	Major inhibition	Major potentiation	Minor inhibition	Minor inhibition
Inhalational anesthetics											
Nitrous oxide	Minor potentiation	Major inhibition	Major potentiation	Minor potentiation	Minor inhibition	Minor potentiation	Major inhibition	Minor inhibition	Major inhibition	Minor inhibition	Major inhibition
Isoflurane	Major potentiation	Minor inhibition	Major potentiation	Major inhibition	Minor inhibition	Major potentiation	Minor inhibition	Minor inhibition	Major potentiation	Major inhibition	Major potentiation
Sevoflurane	Major potentiation	Major inhibition	Minor potentiation	Minor inhibition	Minor inhibition	Major potentiation	Minor inhibition	Minor inhibition	Major inhibition	Major inhibition	
Desflurane	Major potentiation	Major inhibition	Minor potentiation	Minor inhibition	Major inhibition			Biphasic		Minor inhibition	Major inhibition

Major potentiation · Minor potentiation · Major inhibition · Minor inhibition · Biphasic · No effect

Naturwissenschaften 2001; 88: 201-13 Alkire MT: *Science* ***322, 876 (2008)***

„Is it really possible to change them without consequences?“ B. Antkowiak



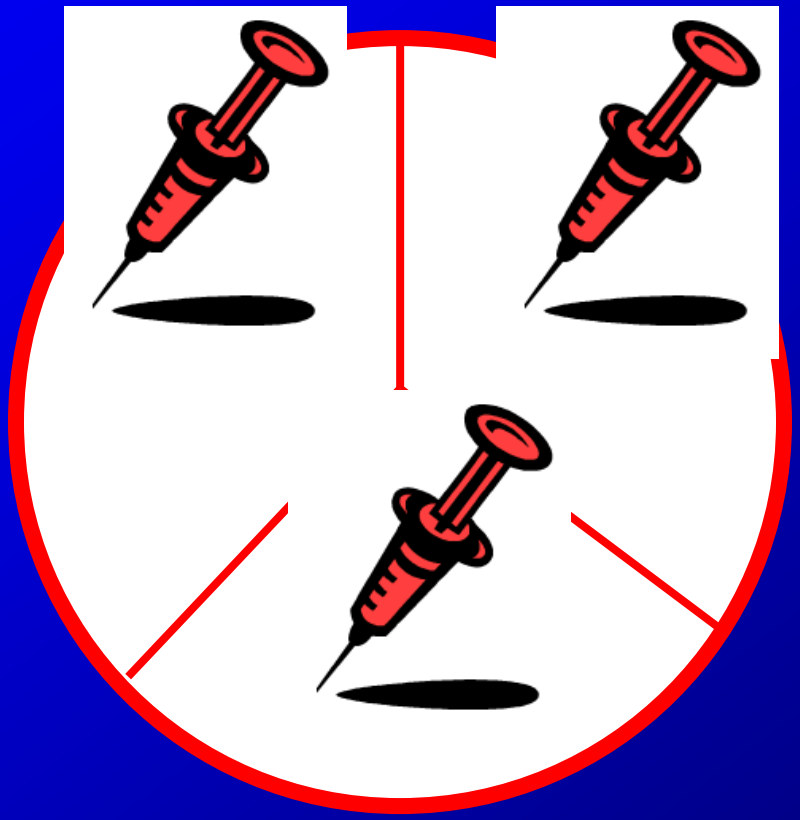
Naturwissenschaften 2001; 88: 201-13 Alkire MT: *Science* ***322, 876 (2008)***

How to induce anaesthesia?

- one drug - monoanaesthesia
- more drugs – balanced anaesthesia
- more techniques – combined anaesthesia

Anaesthesia

Analgesia



Amnesia

Immobilization

Classification by the way of administration

- inhalational anaesthesia
- intravenous anaesthesia
- intramuscular anaesthesia

Schimmelbusch´s mask

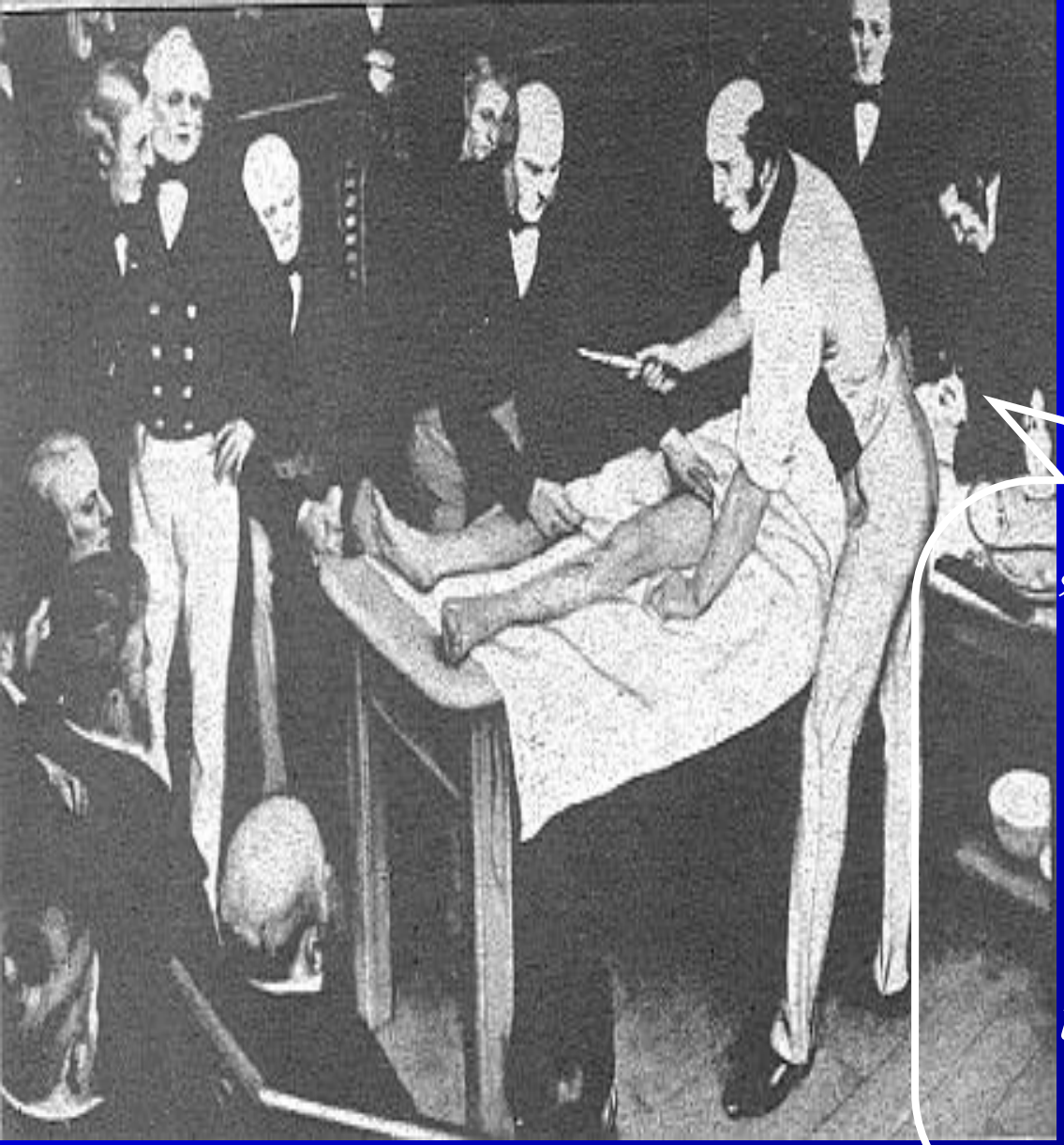
Classification by time

- induction/coinduction into anaesthesia
- maintenance
- emergence from anaesthesia

Time - out

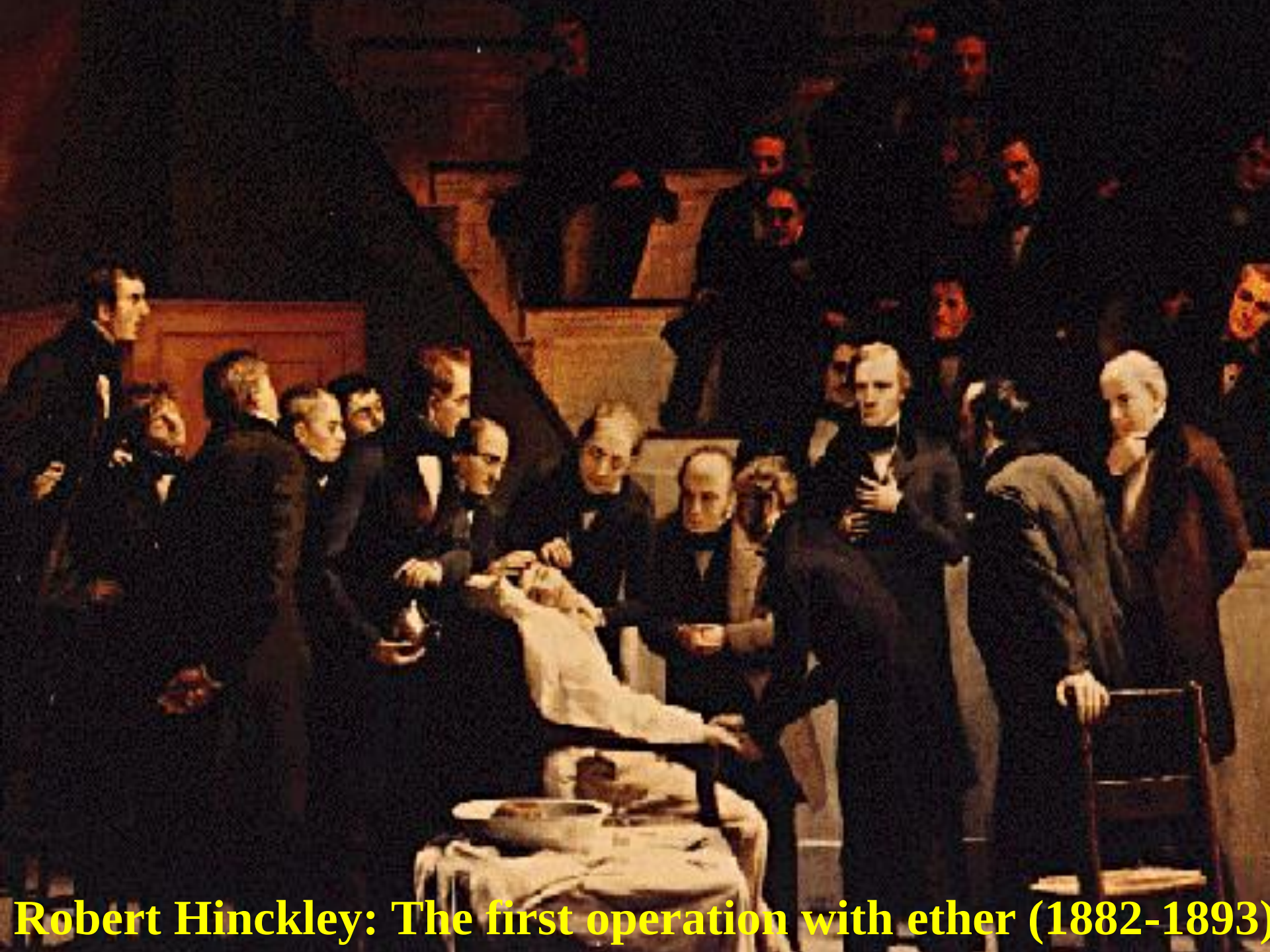
Тайм аут

Beginnings



Robert Liston amputates a leg in 1846

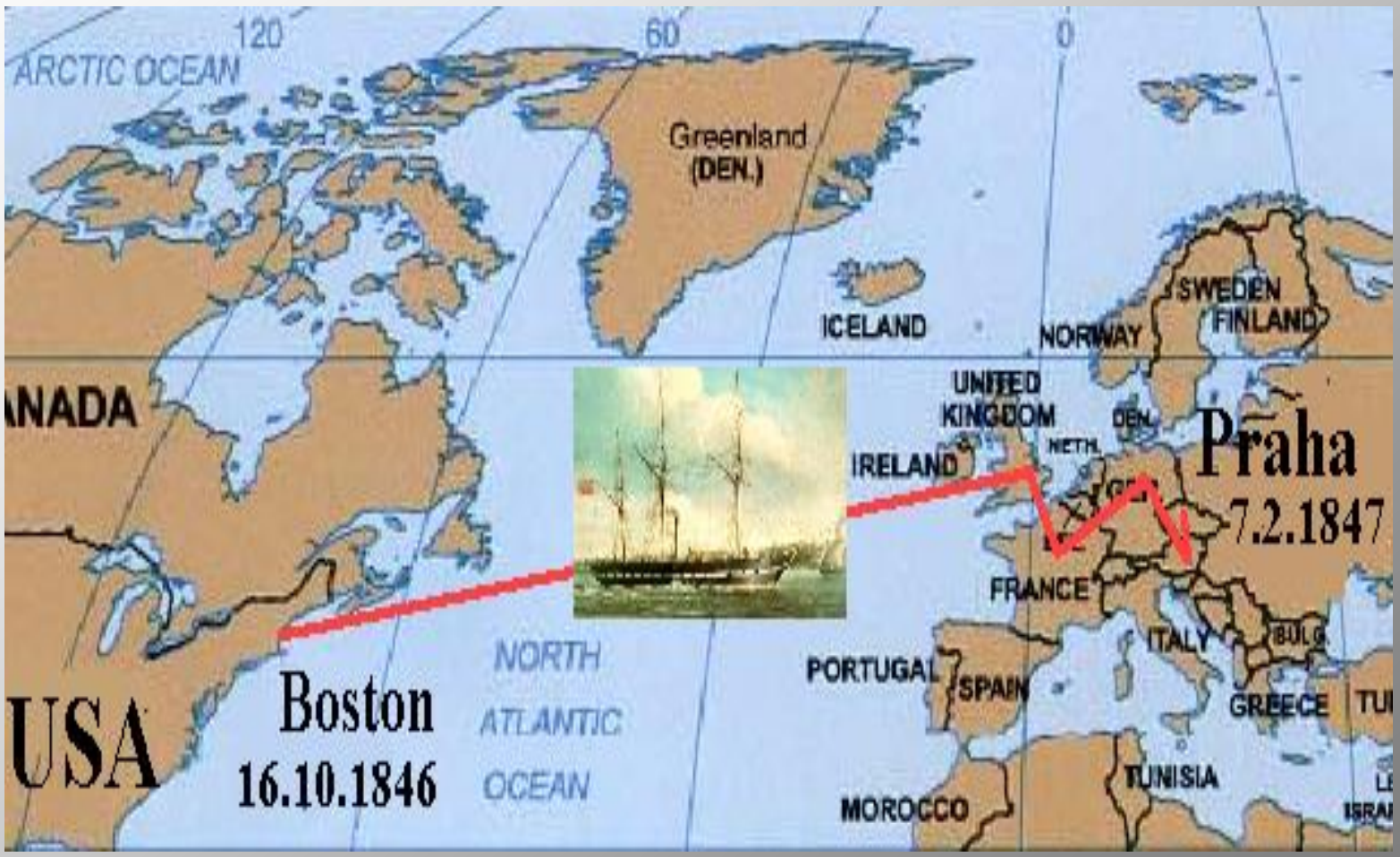
„Utrpení tak velké, jaké jsem prodělal, nelze vyjádřit slovy. Nikdy nezapomenu hrůzu z temnoty a pocit, že mne opustil Bůh i člověk, vířil mou myslí a drtil mé srdce.“



Robert Hinckley: The first operation with ether (1882-1893)

Robert Hinckley: The first operation with ether (1882-1893)

Dissemination of ether anaesthesia



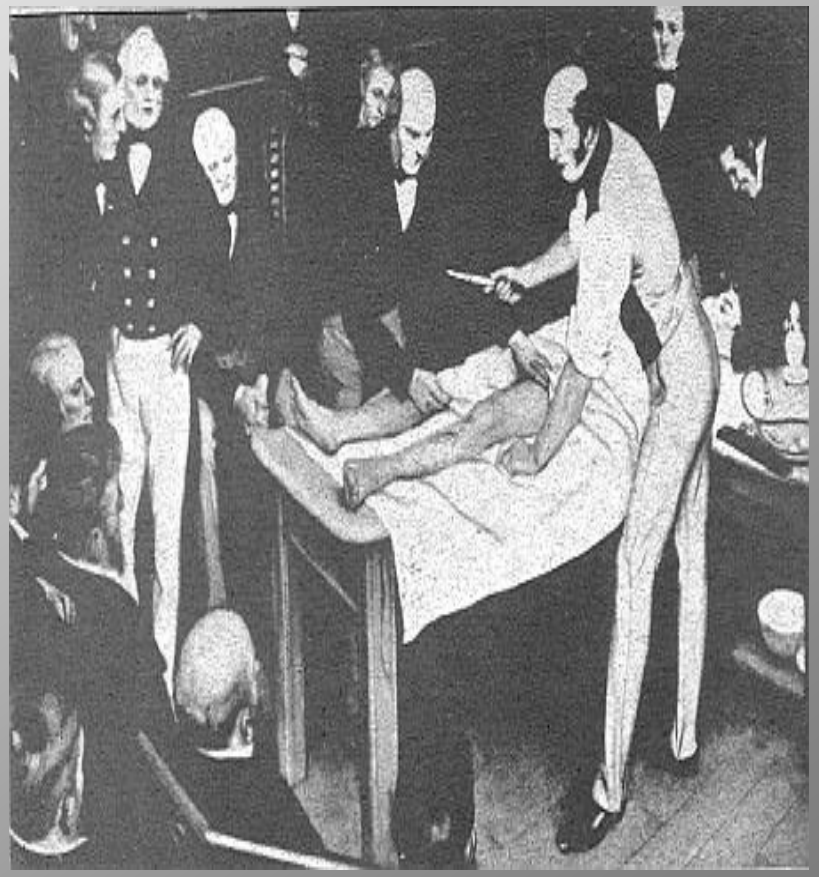
First anaesthesia in Europe

London

- 18.12.1846

  William Fraser
- 21.12.1846

  Robert Liston lower extremity amputation



Czechia - 7.2.1847

Celestýn Opitz (1810-1866)

16 weeks after Boston

11 days after Vienna

no safety tests

no randomized trials

without registration

By newspaper article only

The first anaesthesiologists

„men with bottle and cloth “

Ether inhalator

Available anaesthetics in 1880s

- N_2O since1845
- Ether since 1846
- Chloroform od 1847
- The first „mors in tabula“ in anesthesia 1848
- Surgery contraindicated in patients > 50 years

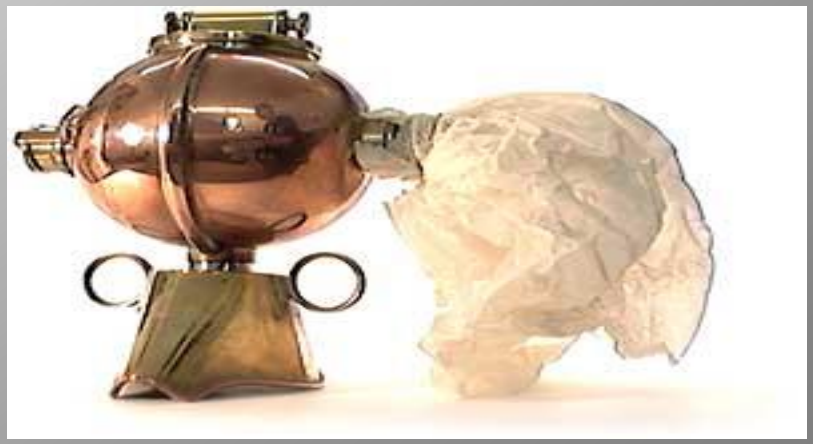
Further development

- ether and chloroform
- nurses and orderlies

  Bulovka – Mr. Müller

  Orthopedics – Mr. Václav

Schimmelbusch´s mask



Ombredann´s device 1908

Further development

„Dana, how much time have we?“

Time - out

Тайм аут

- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
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Multimodal approach

- Key factor of postoperative morbidity:
  stress reaction
- Factors determing success:
  - preoperative information and optimization of the patient
  - minimally invasive approach, centralization of procedures
  - perfect analgesia at rest, during cough and movement
  - early enteral nutrition
  - early mobilization

Kehlet, H.: Multimodal approach to control postoperative patho-physiology and rehabilitation.

British Journal of Anaesthesia 1997;78: 606-17

Choice of anaesthesia technique

- Which technique is safer for the patient?
- Which technique is more effective (cost/benefit)?
- Which technique is preferred by the patient?
- Which technique is preferred by the anaesthesiologist?

- definition
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Anaesthesiological drugs

- general anaesthetics
- opioids
- muscle relaxants
- local anaesthetics
- other drugs

General anaesthetics

- inhalational
- intravenous

General anaesthetics

- **inhalational**
  - gaseous
  - liquid
    - ethers
    - alcanes
- **intravenous**

General anaesthetics

- inhalational
  - gaseous — **nitrous oxide**
  - liquid
    - ethers — **isoflurane, sevoflurane, desflurane**
    - alcanes — **halotane**
- intravenous

Celková anestetika

- inhalational
  - gaseous **nitrous oxide**
  - liquid
    - ethers **isoflurane, sevoflurane, desflurane**
    - alcanes **halothane**
- intravenous
  - barbiturates
  - non-barbiturates

Intravenous general anaesthetics

- barbiturates — thiopentone
- non-barbiturates
  - steroids
  - eugenols — propanidid
  - halucinogens — ketamine
  - neurotransmitter analogs
  - benzodiazepines — midazolam
  - other — etomidate, propofol

Comparison of inhalational anaesthetics

- **minimal alveolar concentration MAC**
  prevents movement to skin incision in 50% of patients
- **blood/gas partition coefficient**
  determines the onset and offset of effect

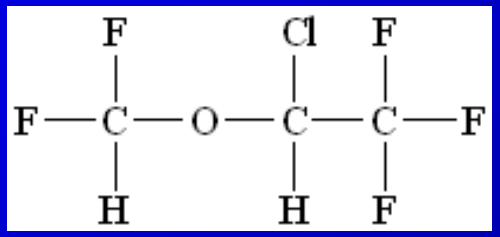
N_2O

Nitrous oxide

- weak anaesthetic, analgesic - cca Mo 10 mg
- MAC 105 % BG 0,47
- part of gas mixture in a conc. of 50-70%
- changes for nitrogen
- indication: analgesic in gas mixture
  decreases MAC of other inhal. anaesthetics

$CF_3CHClOCF_2H$

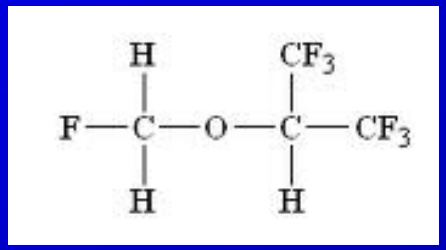
Isoflurane



- halogenated ether, w/o analgesic potency
- MAC 1,15 BG 1,4
- supresses breathing
- peripheral vazodilatation, steal phenomenon?
- minimal metabolism 0,2 %
- use: with/without N_2O 1,0-2,5 %

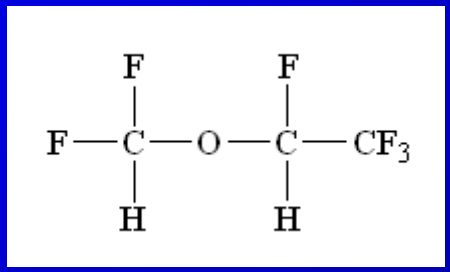
$CF_3CF_3CHOCH_2F$

Sevoflurane



- halogenated ether, without analgesic potency?
- MAC 2 % BG 0,69
- non-irritable for airways
- easily controlable
- circulation stable
- is not organotoxic, but organoprotective
- environmentally gentle

CF2HOCFHCF3



Desflurane

- halogenated ether, without analgesic potency
- MAC 6 % BG 0,42
- easily controlable
- circulation stable, stimulates sympathetic n.s.
- boiling point 23,5^{o} C, special vaporizer

Intravenous general anaesthetics

- barbiturates
- non-barbiturates
  - steroids
  - eugenols
  - halucinogens
  - neurotransmitter analogs
  - benzodiazepines
  - other

Intravenous general anaesthetics

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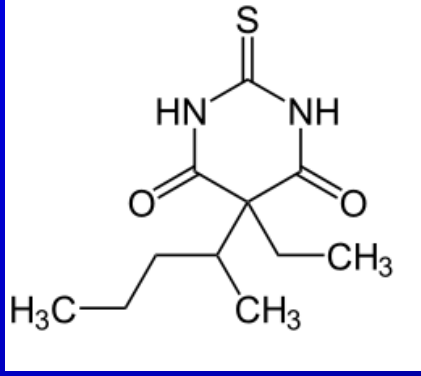
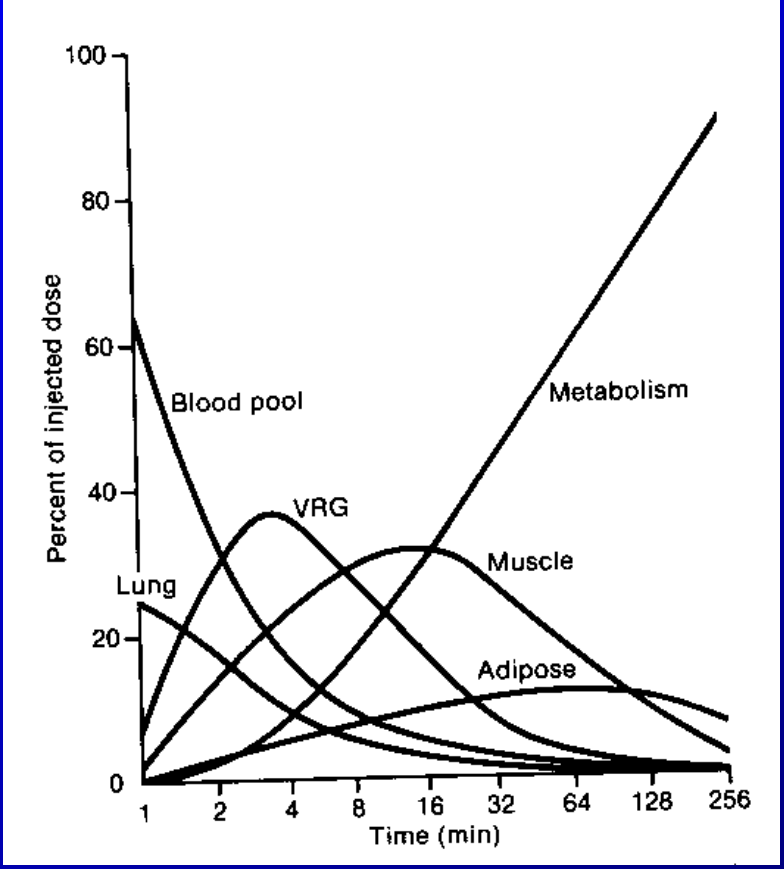
  - steroids
  - eugenols — propanidid
  - halucinogens — ketamine
  - neurotransmitter analogs
  - benzodiazepines — midazolam
  - other — etomidate, propofol

Thiopentone (thiopental)



- widely used general i.v. anaesthetic
- negativ inotropic effect + peripheral vazodilatation
- transient irritation, apnoe, decrease of MV laryngospasm, bronchoconstriction,
- effect ends by redistribution
- dose 5 mg/kg
- pH 9.5, strictly intravenously

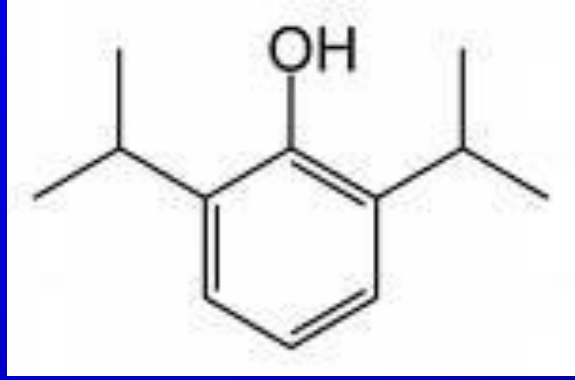
Thiopentone (thiopental)



Attack on Pearl Harbour 7.12.1941

Deadly easy, but easily dead!

Diprivan (propofol)



- quick and short-term general i.v. anaesthetic for induction and maintenance of anaesthesia
- negativ inotropic + peripheral vazodilatation
- transient apnoe
- ends by metabolism (elimination $t_{1/2}$ 2 hours)
- dose:
  - 2,0-2,5 mg/kg for induction
  - 6-12 mg/kg/hod = 0,1-0,2 mg/kg/min maintenance

Conrad Murray

† 25.6.2009

- **1:30 – valium**
- **2:00 – lorazepam i.v.**
- **3:00 – midazolam**
- **other durgs taken by M.J. himself**
- **10:40 – propofol**

Conrad Murray † 25.6.2009

Propofol je součástí celkových intravenózních anestetik určených k uspání pacienta při chirurgických výkonech. Přípravek by měli používat výhradně profesionálové v lékařském prostředí.

www.lidovky.cz

Propofol je určen především k tlumení pacientů před operacemi. Má také negativní účinky, které vedou ke zpomalení srdečního tepu a snížení krevního tlaku. V blízkosti pacienta užívajícího propofol by měl být přístroj na monitorování srdeční činnosti a dýchací přístroj – ani jeden z těchto přístrojů se ale v Jacksonově domě po jeho smrti nenašel. www.tn.nova.cz

European Society of Gastrointestinal Endoscopy, European Society of Gastroenterology and Endoscopy Nurses and Associates, and the European Society of Anaesthesiology Guideline: Non-anaesthesiologist administration of propofol for GI endoscopy

Dumonceau, JM1,*; Riphaus, A2,*; Aparicio, JR3; Beilenhoff, U4; Knape, JTA5; Ortmann, M6; Paspatis, G7; Ponsioen, CY8; Racz, I9; Schreiber, F10; Vilmann, P11; Wehrmann, T12; Wientjes, C8; Walder, B13; and the NAAP Task Force Members

December 2010 - Volume 27 - Issue 12

Guidelines on non-anaesthesiologist administration of propofol for gastrointestinal endoscopy: a double-edged sword

Werner, Christian; Smith, Andrew; Van Aken, Hugo

August 2011 - Volume 28 - Issue 8

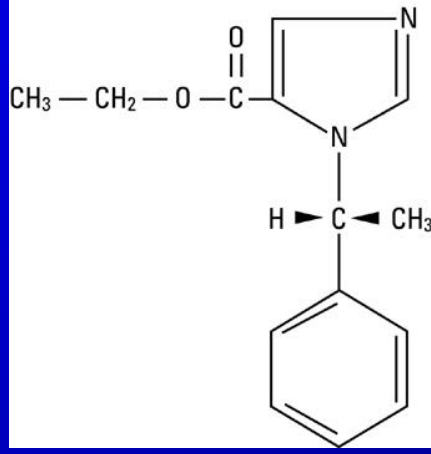
Non-anaesthesiologists should not be allowed to administer propofol for procedural sedation: a Consensus Statement of 21 European National Societies of Anaesthesia

Perel, Azriel

August 2011 - Volume 28 - Issue 8

Guidelines approval withdrawn during ESA congress in Amsterdam 2011!

Hypnomidate (etomidate)

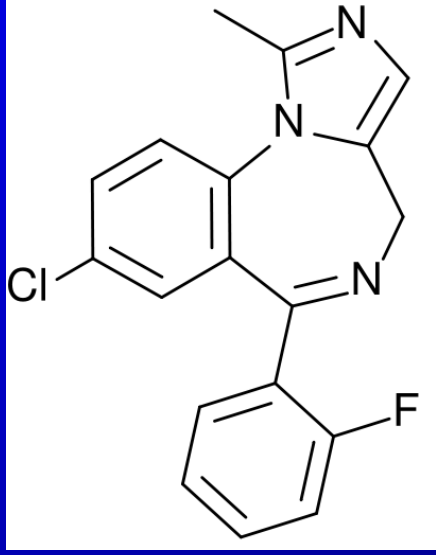


- general i.v. anaesthetic
- minimal influence on circulation
- ventilation lower, but no apneic pause
- myoclonical movements
- suppresses synthesis of corticoids
- dose 0,3 mg/kg
- for induction in patients with heart disease

Ketamine

- general i.v. anaesthetic and analgesic
- increases blood pressure and heart rate
- stimulates breathing
- does not suppress visceral pain
- doses:
  - 1.0-2.0 mg/kg i.v. as anaesthetic
  - 5-10 mg/kg i.m. as anaesthetic
  - 0.25-0.5 mg/kg i.v. jako analgesic

Dormicum (midazolam)

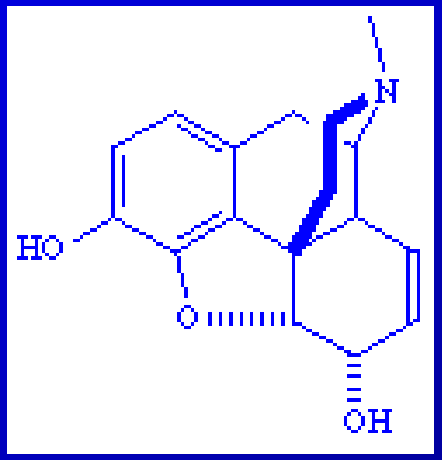


- effects by the dosage
  - anxiolysis
  - amnesia
  - euphoria
  - sedation , hypnotic effect
- very small cardiovascular effects
- light suppression of breathing
- dose – always titrate!

Anaesthesiological drugs

- general anaesthetics
- opioids
- muscle relaxants
- local anaesthetics
- other drugs

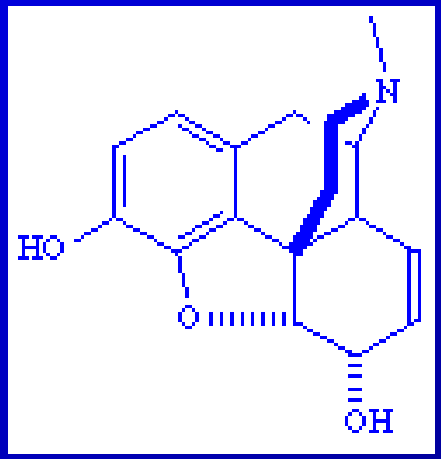
Opioids



morphine

- alkaloids from opium
  - morphine
  - codeine (metylmorphine)
- semisynthetic opioids
  - heroine (diacetylmorphine)
- synthetic opioids

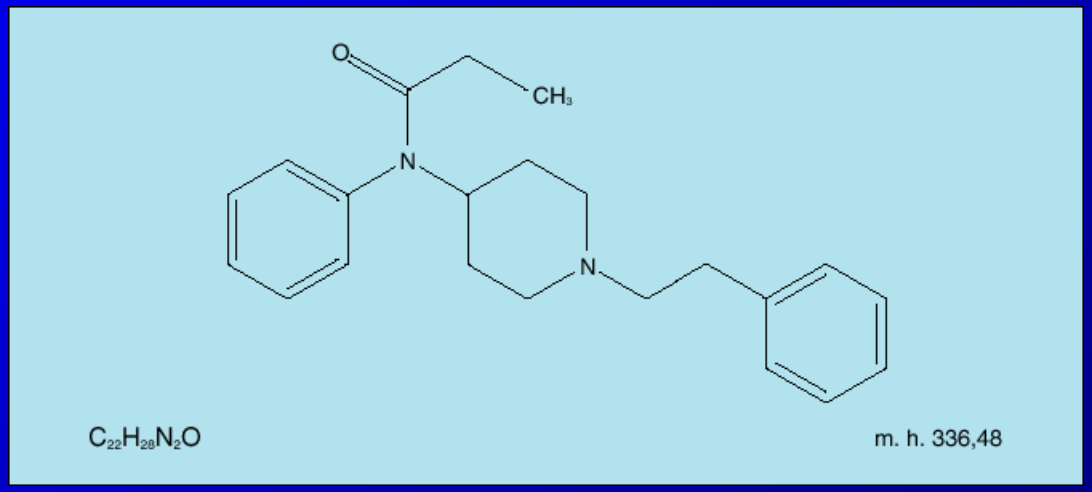
Opioids



- morphine derivatives,e.g. heroine
- morphine analogs, e.g. etorfine
- morfinans (-E circle), e.g. butorphanol
- benzomorphanes (- C,E circles), e.g. pentazocine
- 4-phenylpiperidines, e.g. pethidine, FNT group
- drugs with open chain – methadone group

Fentanyl group

- fentanyl
- sufentanil
- alfentanil
- remifentanil



fentanyl

Opioids´ effects

- opioid receptors
  - μ, κ, δ
  - G proteins
  - effectors

- analgesia
- suppression of breathing
- suppresion of cilliated epithelium

Indication of opioids

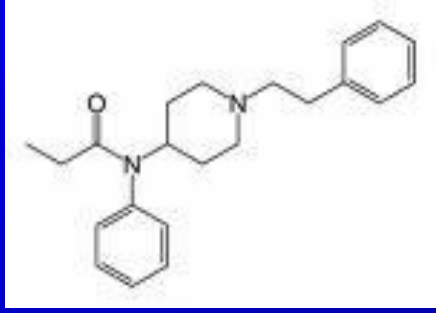
- premedication
- analgesia in balanced anaesthesia
- monoanaesthesia with highly dosed opioids, e.g. in cardiac surgery
- analgesia in regional anaesthesia
- postoperative analgesia - systemic/regional

Antagonization of opioids

naloxone (Intrenon)

- competetive opioid antagonist w/o intrinsic activity
- antagonizes breathing depression, sedation, hypotension
- effect onset within 2 minutes
- duration 1 hour
- doses: 0.4 - 2 mg i.v. nebo i.m.

Fentanyl (fentanyl)



- 100* stronger than morphin
- fast onset within 30 seconds

  maximum effect 3 minutes

  duration 30 minutes

  effect still felt 3 hours **rebound!**
- for premedication
- analgesic component of anaesthesia:
  - 2-5 μg/kg i.v.
  - 50 μg/kg in cardiac anaesthesia
  - 50-100 μg in regional anaesthesia

V Česku se objevil nový zabiják: Droga čtyřicetkrát silnější než heroin

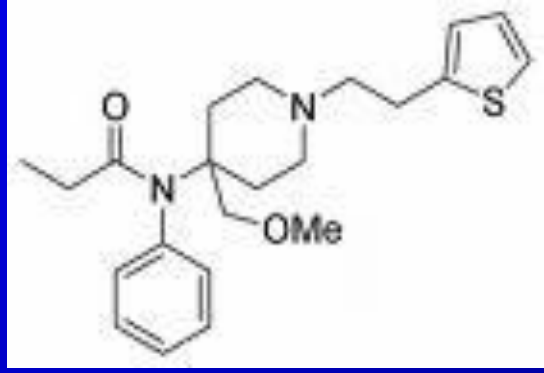
Novinky.cz

Na český drogový trh se z východu dostává nový syntetický opiát, který s sebou podle policie nese smrtící hrozbu. Proti heroinu je totiž až čtyřicetkrát silnější a uživatelům tak hrozí nebezpečné předávkování. Úřady už v souvislosti s fentanylem, jak se extrémně účinná droga jmenuje, evidují tři úmrtí.

pátek 30. září 2011, 2:39

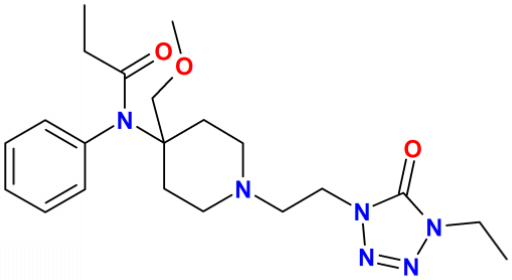
▲ FOTO: fotobanka Profimedia

Sufenta (sufentanil)



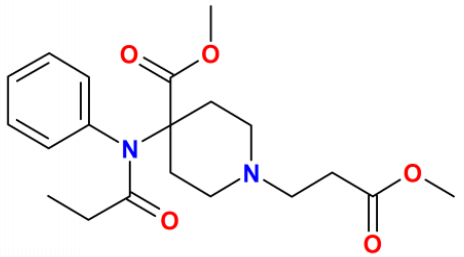
- 10x stronger than fentanyl
- analgesic component of general anaesthesia
- analgesic component in regional anaesthesia
- doses:
  - 0.5-5 µg/kg i.v. **bolus**
  - 1 µg/kg/hour **continuously**
  - 10-30 µg epidurally with LA, up to 50 µg w/o LA

Rapifen (alfentanil)



- analgesic for short procedures or on-top, or in continuous administration for long procedures
- doses:
  - 7-15 µg/kg i.v. **bolus** **for op. within** 10 min
  - **1 µg/kg/min i.v.** **continuously**

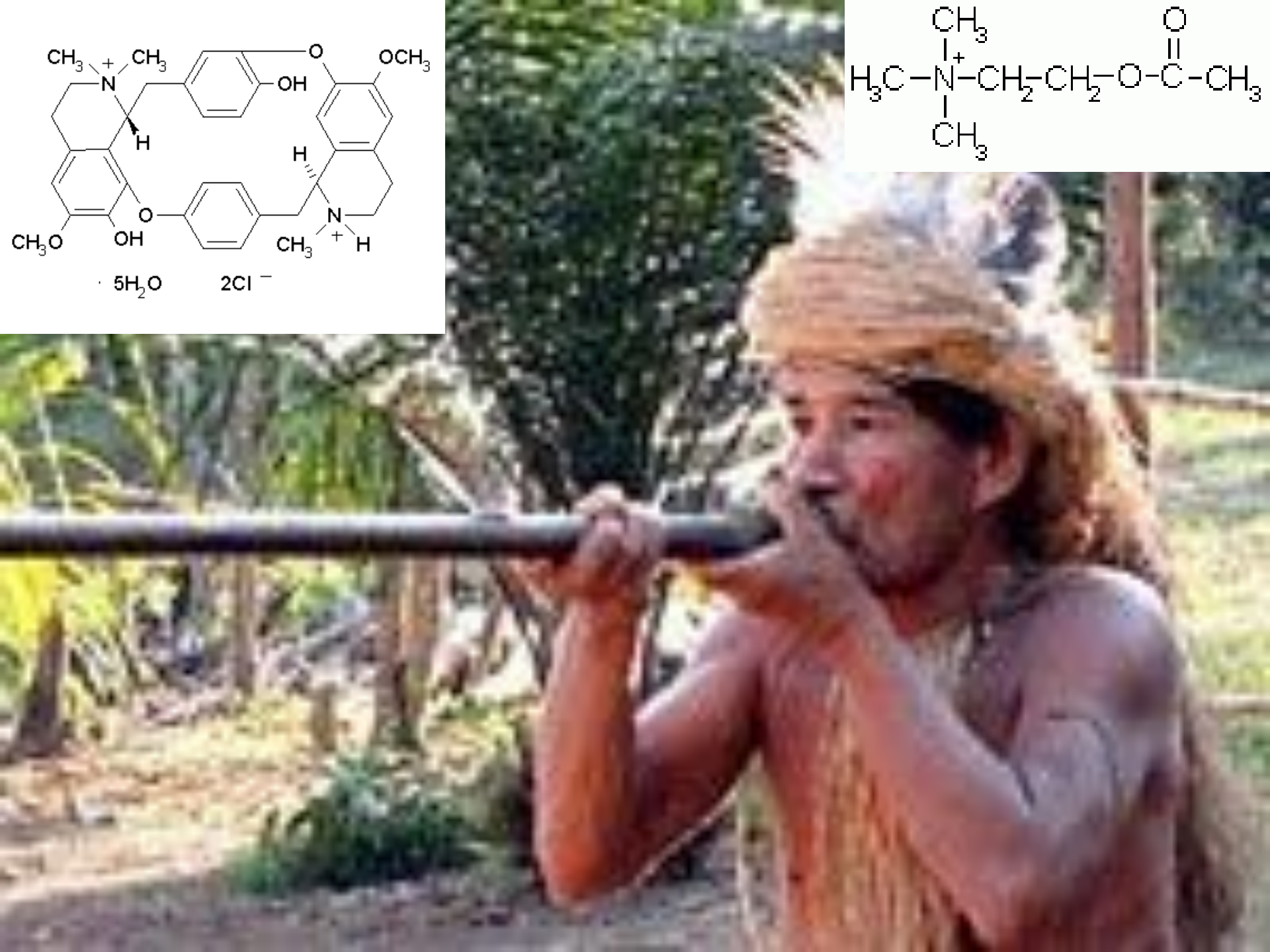
Ultiva (remifentanil)



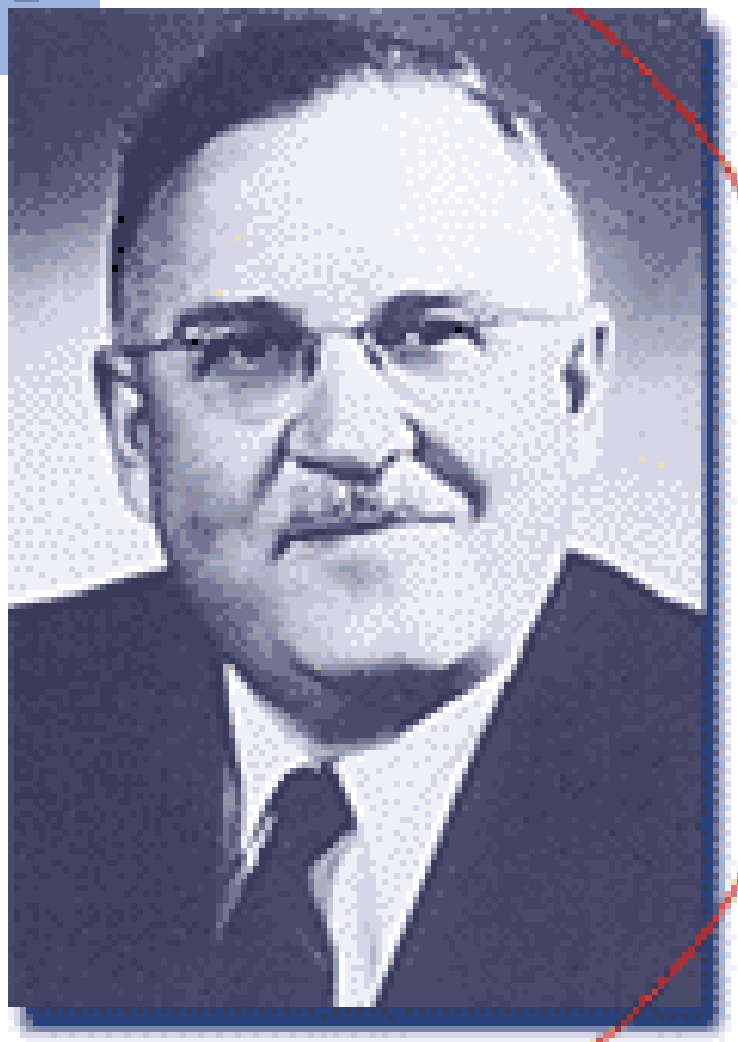
- very fast onset and short duration of effect
- mtb: nonspecific esterases in plasma/tissues
- $t_{1/2}$ 3-10 minutes
- to assure continuous analgesia !
- doses: 0.1-2.0 ug/kg/min

Anaesthesiological drugs

- general anaesthetics
- opioids
- muscle relaxants
  - depolarizing
  - non-depolarizing
- local anaesthetics
- other drugs


CH3
CH3
N
+
O
OCH3
OH
H
H
O
N
+
CH3
H
CH3O
OH
· 5H2O
2Cl −
CH3
H3C
N
+
CH2
CH2
O
C
O
CH3
CH3

HAROLD RANDALL GRIFFITH



1894-1985

Muscle relaxants - mechanism of effect

- **Depolarizing block**

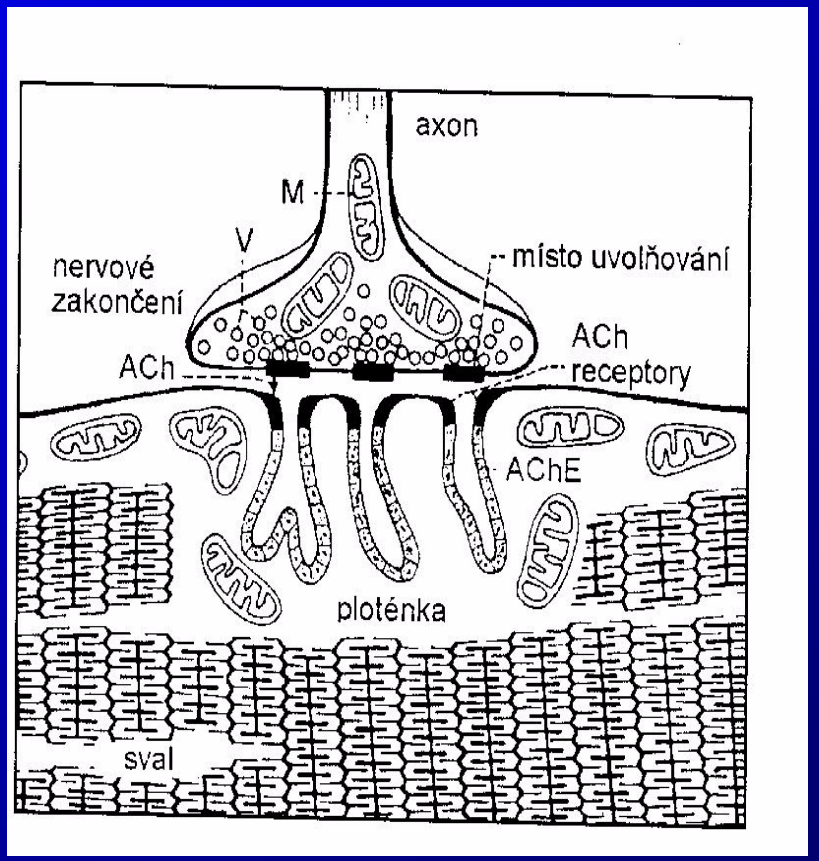
agonistic depolarization + receptor occupation

antagonization impossible

- **nondepolarizing block**

antagonism of ACh

antagonization of the block possible



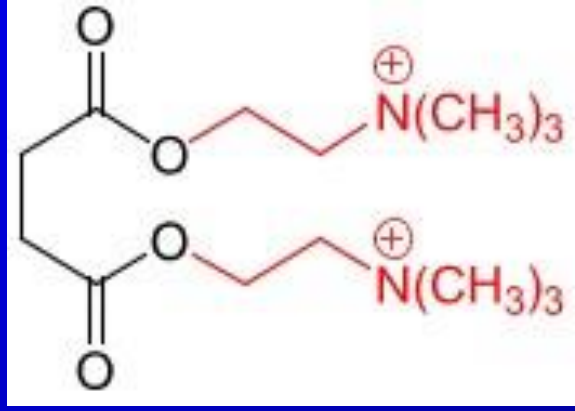
Muscle relaxants

- epolarizing — suxamethonium
- nondepolarizing
  - steroids
    - pancuronium (Pavulon)
    - pipecuronium (Arduan)
    - vecuronium (Norcuron)
    - rocuronium (Esmeron)
  - benzylisochinolines

Svalová relaxancia

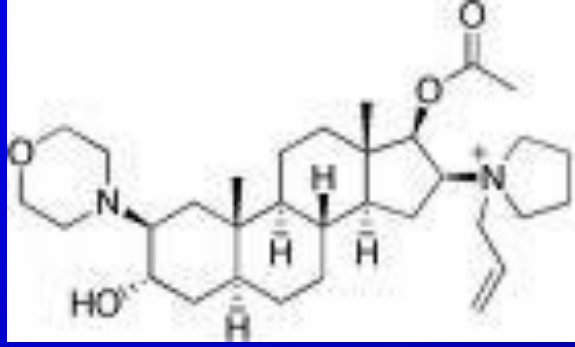
- depolarizing — suxamethonium
- nondepolarizing
  - steroids
  - benzylisochinolines
    - atrakurium (Tracrium)
    - cis-atrakurium (Nimbex)
    - mivacurium (Mivacron)

Suxamethonium



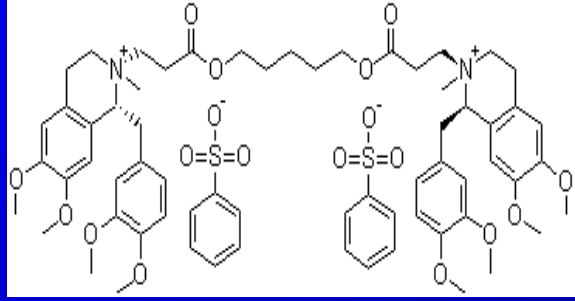
- depolarizing muscle relaxant with short effect (5-10 min)
- for intubation, esp. rapid sequence intubation
- metabolism: plasmatic cholinesterases
- onset within do 30-60 s (fasciculations)
- dose: 1 mg/kg i.v., exceptionally in infusion

Esmeron (rocuronium)



- nondepolarizing muscle relaxant of the steroid type with fast onset and medium duration of effect (20-40 min)
- for intubation and muscle relaxation during surgery
- circulation stable
- metabolism in liver
- intubation dose: 0.6 mg/kg
- maintenance dose : 0.15 mg/kg

Nimbex (cisastracurium)



- nondepolarizing muscle relaxant of benzylisochinoline type with medium duration of the effect (20-30 min)
- Hoffmann´s spontaneous elimination
- lower histamine liberation than Tracrium
- intubation dose: 0.15 mg/kg i.v.
- maintenance dose: 0.03 mg/kg

Pharmacological decurarization

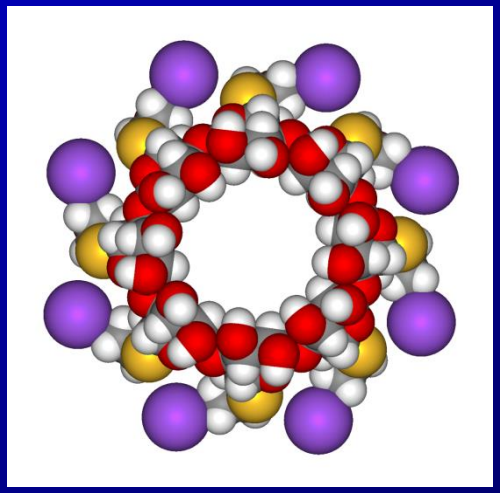
Atropin (atropine) + Syntostigmin (neostigmin)

- neostigmin = Psymimetic blocking cholinesterase
- indication: persisting effect of nondep. relax.
- doses:
  - Atropin 0.5-1.0 mg i.v.
  - Syntostigmin 0.5-2.5 mg i.v.

Antagonists in anaesthesia

- benzodiazepines
- opioids
- muscle relaxants

- flumazenil - Anexate
- naloxone - Intrenon
- neostigmin – Syntostigmin
- sugammadex - Bridion



Anaesthesiological drugs

- thiopentone
- propofol, midazolam, etomidate, ketamine
- isoflurane, sevoflurane, desflurane
- nitrous oxide
- suxamethonium
- vecuronium, rocuronium, atracurium, cis-atracurium
- fentanyl, sufentanil, alfentanil, remifentanil

Where to find information?

- pharmacology
- SPC
  (Summary of Product Characteristic)
- AISLP
  (Automated informational system of curative substances)

Danger of anesthesiological drugs

- anaesthetics
  - suppression of consciousness, loss of airway patency, depression of breathing and circulation
- opioids
  - depression of breathing
- muscle relaxants
  - muscle paralysis

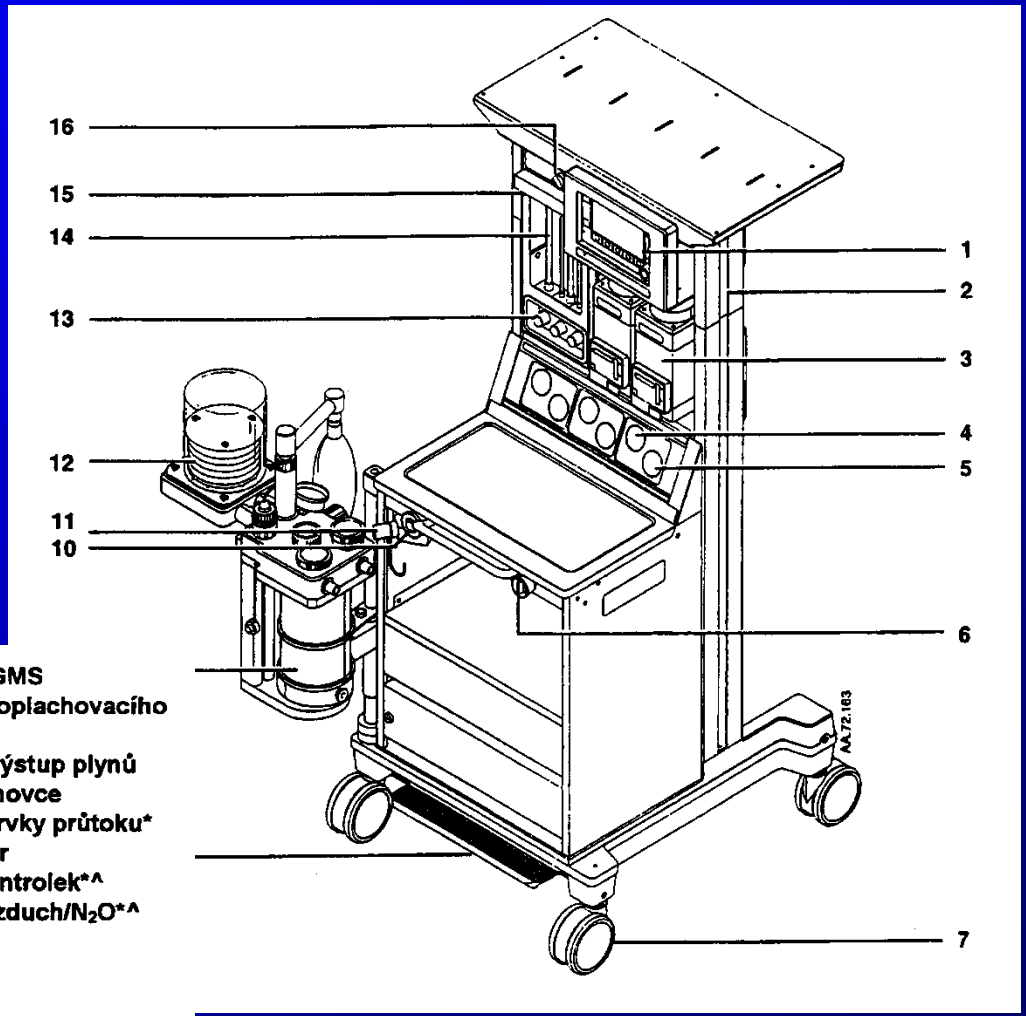
Danger of anaesthesiological drugs

- Thiopentone
  - depression of consciousness, loss of airway patency, depression of breathing
- opioides
  - depression of breathing
- Pavulon
  - muscle paralysis
- Potassium
  - cardiac arrest in diastole

- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- **anaesthesiological machine**
- management of anaesthesia
- monitoring
- preoperative and preanaesthetic evaluation

Anaesthesiological machine

EXCEL SE 210

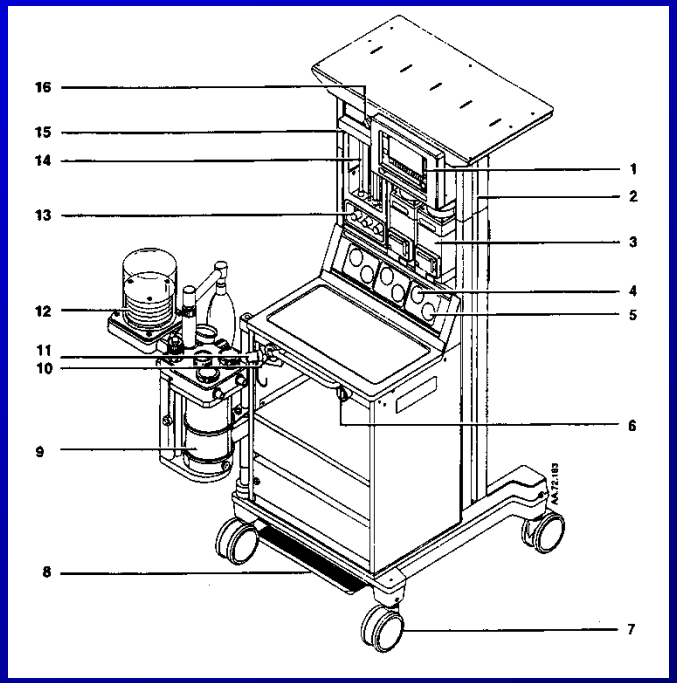


1. Ventilátor 7900
2. Rybinová kolejnička
3. Odpařovače
4. Manometr (pro tlak v potrubí)
5. Manometr (pro tlak v láhvi)^
6. Systémový vypínač*
7. Kolečka
8. Brzda*
9. Absorbér GMS
10. Tlačítko proplachovacího průtoku*
11. Společný výstup plynů
12. Sestava vinovce
13. Ovládací prvky průtoku*
14. Průtokoměr
15. Vypínač kontrolek*^
16. Přepínač vzduch/N_2O*^

^ Použito u některých modelů
* Viz popis v této kapitole

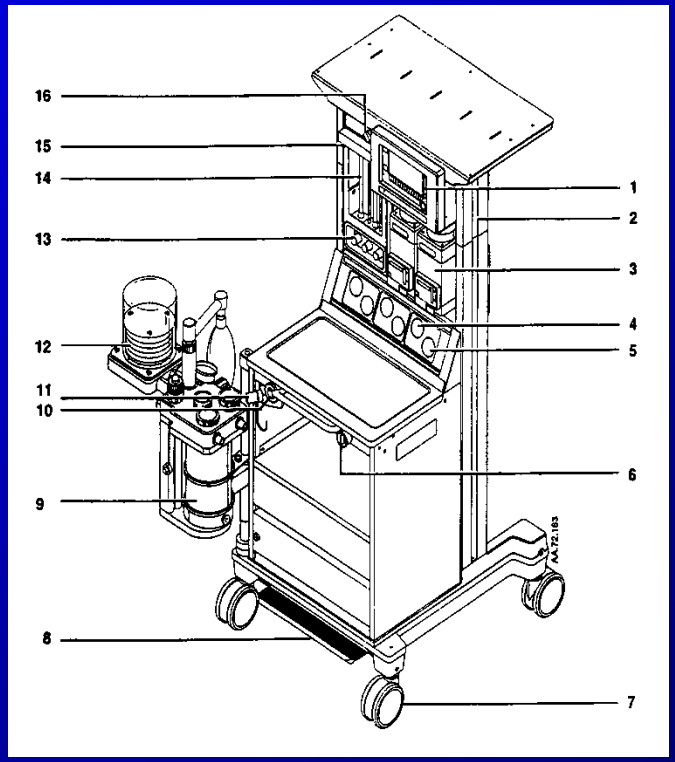
Anaesthesiological machine

- sources of gases
- rotameters
- vaporizers
- breathing system
- CO_2 absorber
- breathing bag, ventilator
- suction



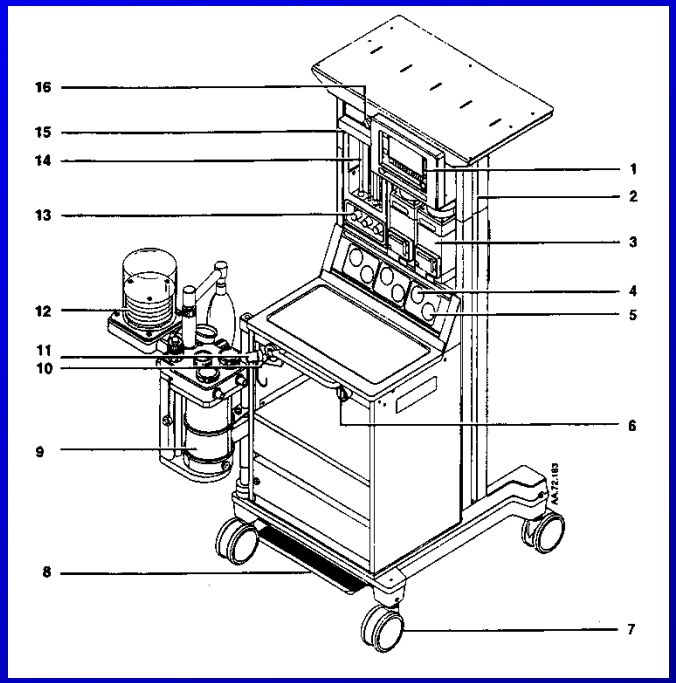
Anaesthesiological machine

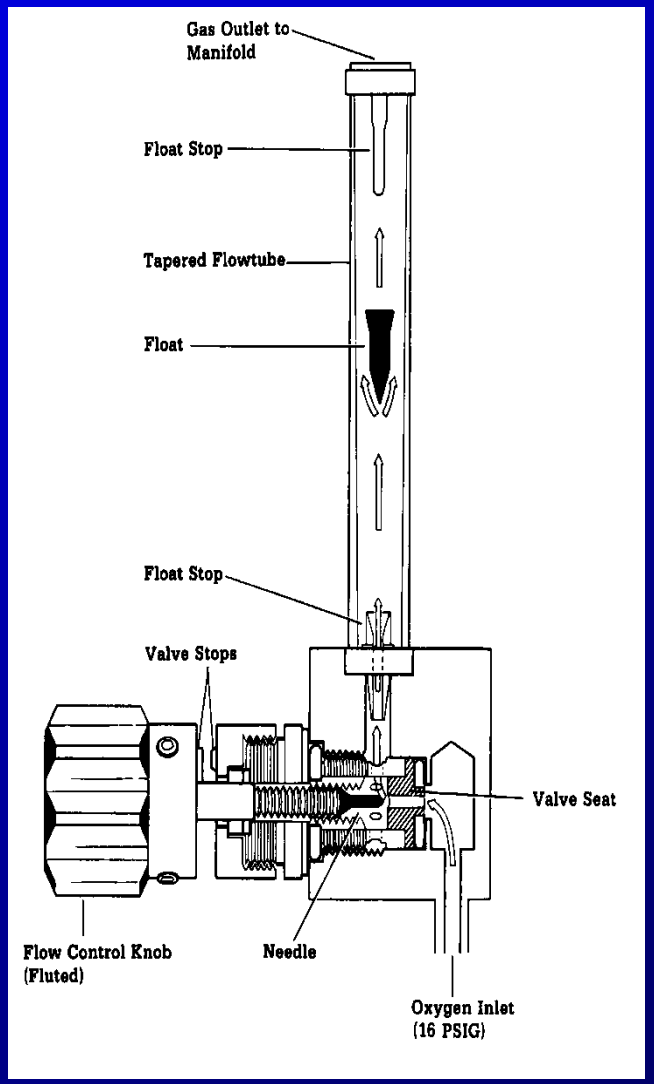
- sources of gases
  - pressure cylinders
    - oxygen 12,2 MPa, 20,2 Mpa
    - nitrous oxide 5 MPa
  - central gas system
    - non-interchangeable connections



Anaesthesiological machine

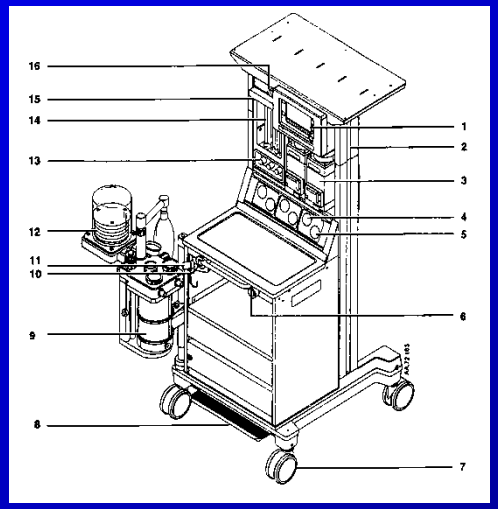
- rotameters
  - needle ventil - rotametr
  - bypass ventil
    - 70 l/min

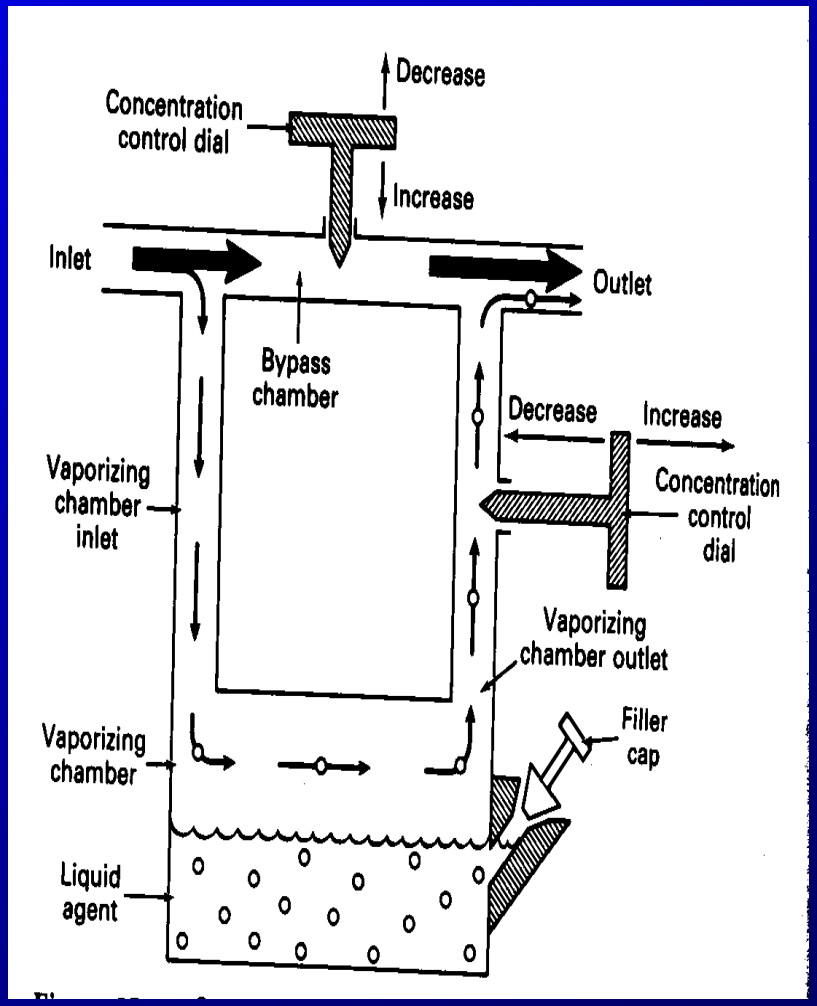




Anaesthesiological machine

- vaporizers
  - thermostable
    - constant temperature of an.
  - termocompensated
    - constant concentration of an.





Vaporizer Tec 5

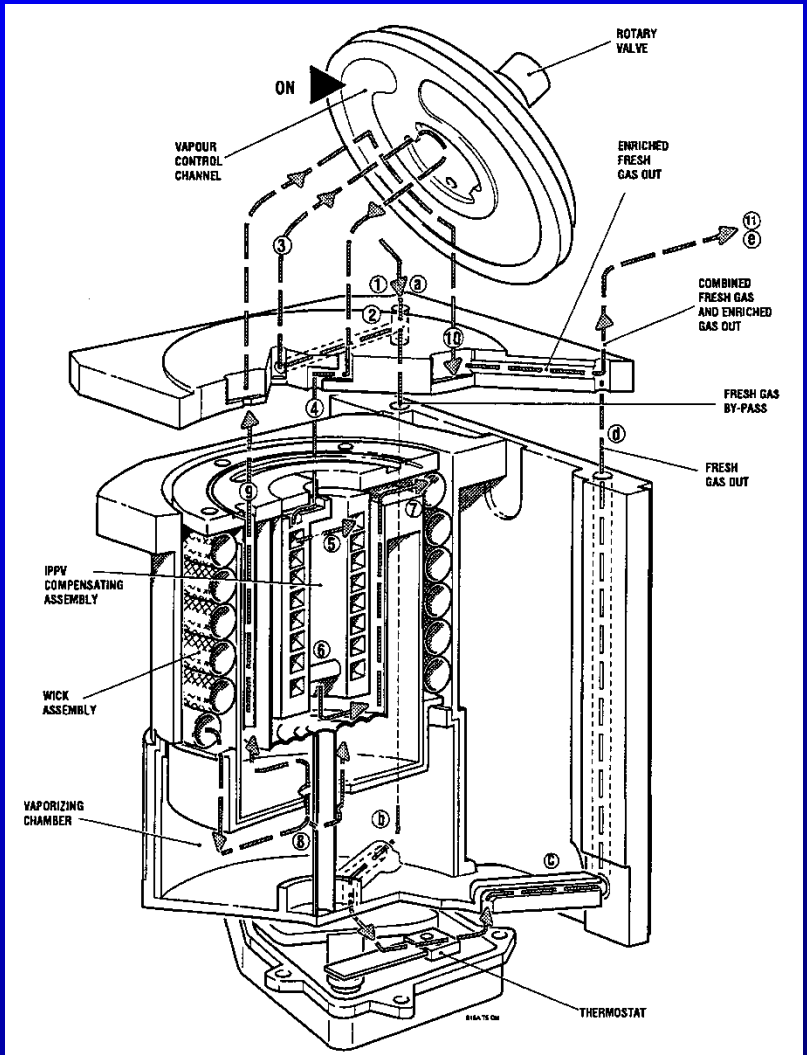
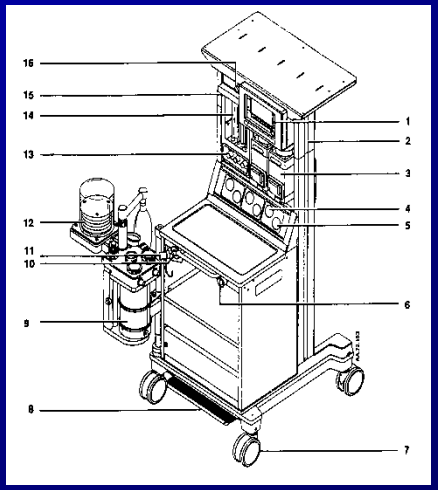


Fig. 17 Tec 5 Vaporizer Gas Flow

Anaesthesiological machine

- breathing system connects anesth. machine with patients´ airwys
- tubings
- ventils (one-way, pressure release v.)
- connecting element (Y connector, angle connector)
- classification
  - one-way systems
  - circles



Breathing systems

system	bag	rebreathing
open	none	none
semi-open	yes	none
semi-closed	yes	partial
closed	yes	full

classification according Moyers

Breathing systems

- re-breathing:
  - none
  - partial
  - full

Classification according Pokorný

- one-way x circle

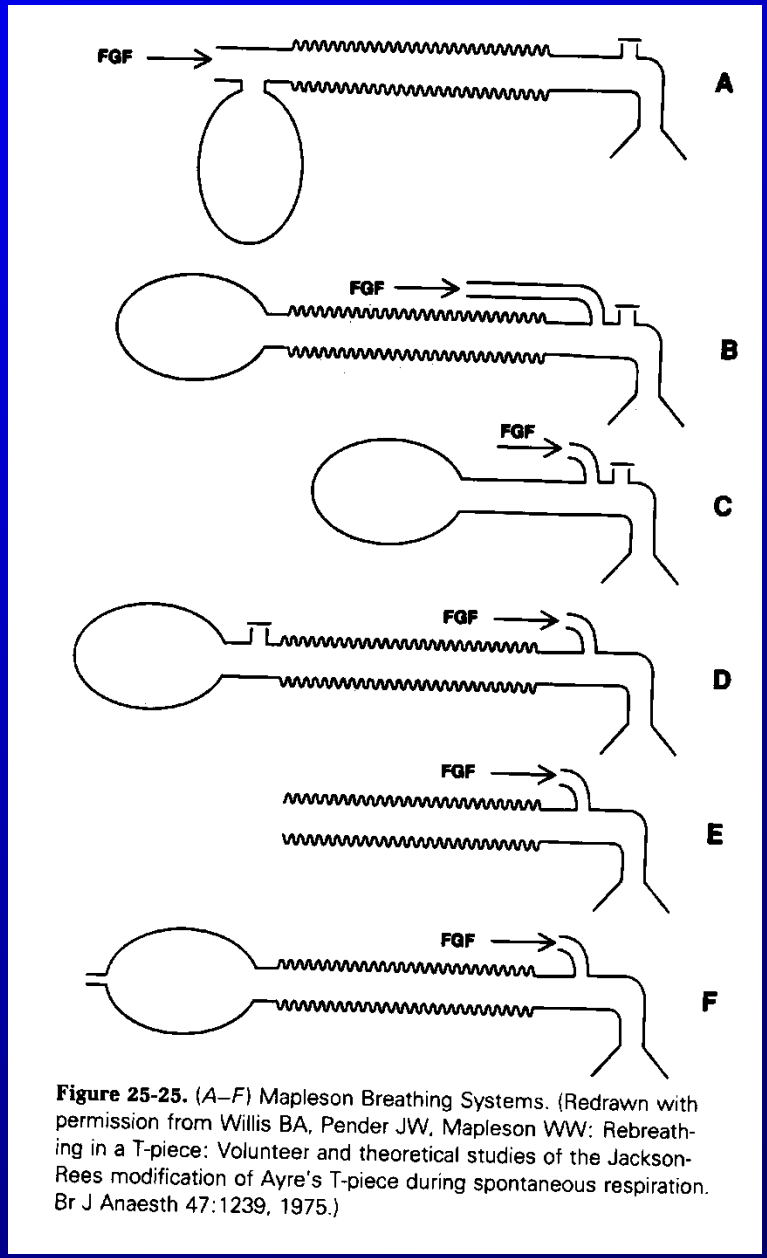


Figure 25-25. (*A–F*) Mapleson Breathing Systems. (Redrawn with permission from Willis BA, Pender JW, Mapleson WW: Rebreathing in a T-piece: Volunteer and theoretical studies of the Jackson-Rees modification of Ayre's T-piece during spontaneous respiration. Br J Anaesth 47:1239, 1975.)

Breathing systems

- rebreathing:
  - none
  - partial
  - full

classification according Pokorný

- one-way x circle

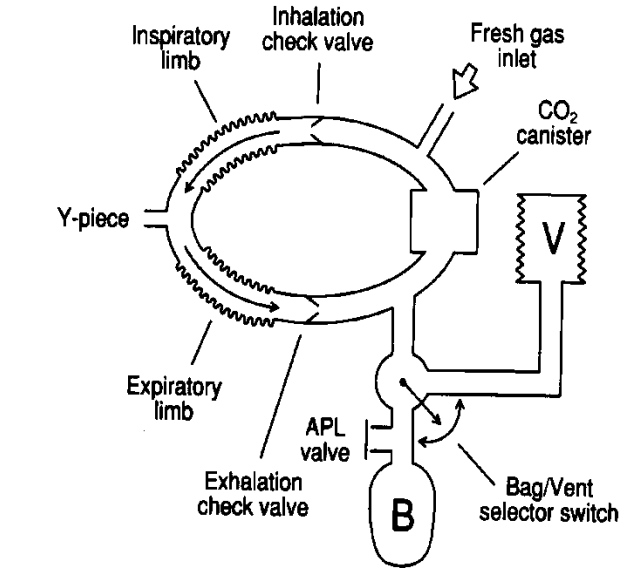


Figure 25-28. Components of the circle system. (Reprinted with permission from Andrews JJ: Inhaled anesthetic delivery systems. In Miller RD (ed): Anesthesia, 3rd ed, p 171. New York, Churchill Livingstone, 1990.)

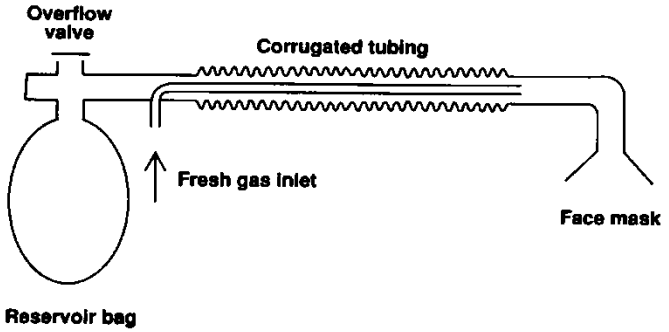


Figure 25-27. The Bain Circuit. (Redrawn with permission from Bain JA, Spoerel WE: A streamlined anaesthetic system. Can Anaesth Soc J 19:426, 1972.)

Anaesthesiological machine

- CO_2 absorber

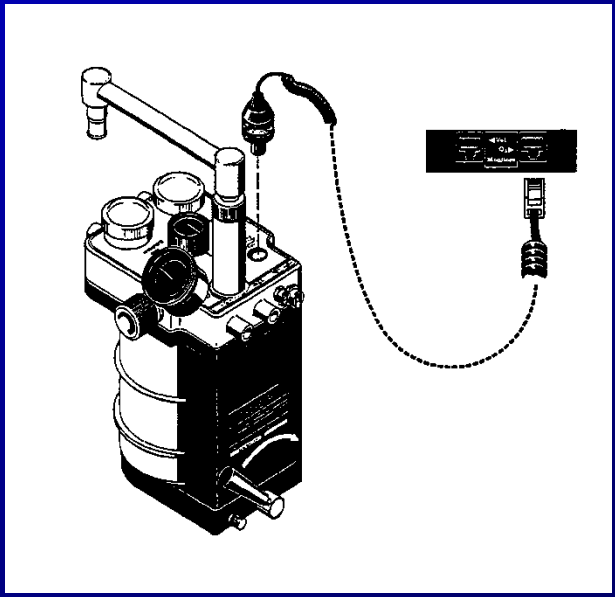
  (Sodasorb: 94 % $Ca(OH)_2$, 5 % NaOH, 1 % KOH)

  – $2\ NaOH + H_2CO_3 = Na_2CO_3 + H_2O$

  $Ca(OH)_2 + Na_2CO_3 = 2\ NaOH + CaCO_3$

max. capacity:

26 l CO_2 / 100 g of absorbent

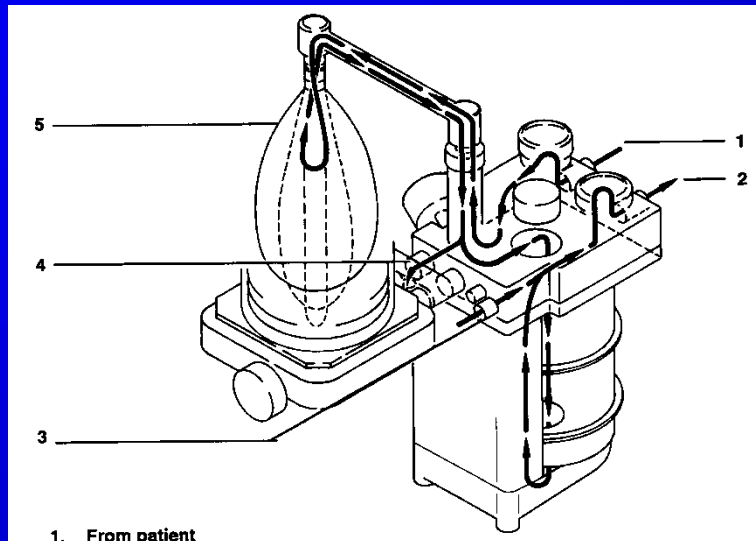


Anaesthesiological machine

- CO_2 absorber

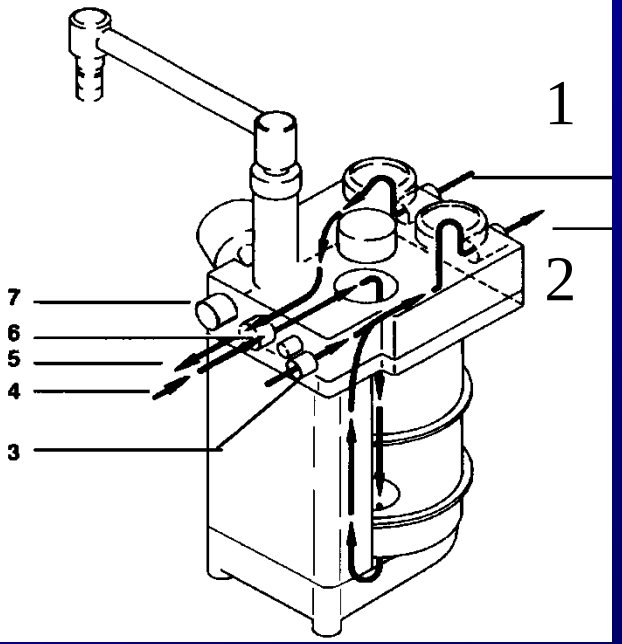
  max. capacity : 26 l CO_2 / 100 g of absorbent

  volume of absorbent 2 * 1.35 kg



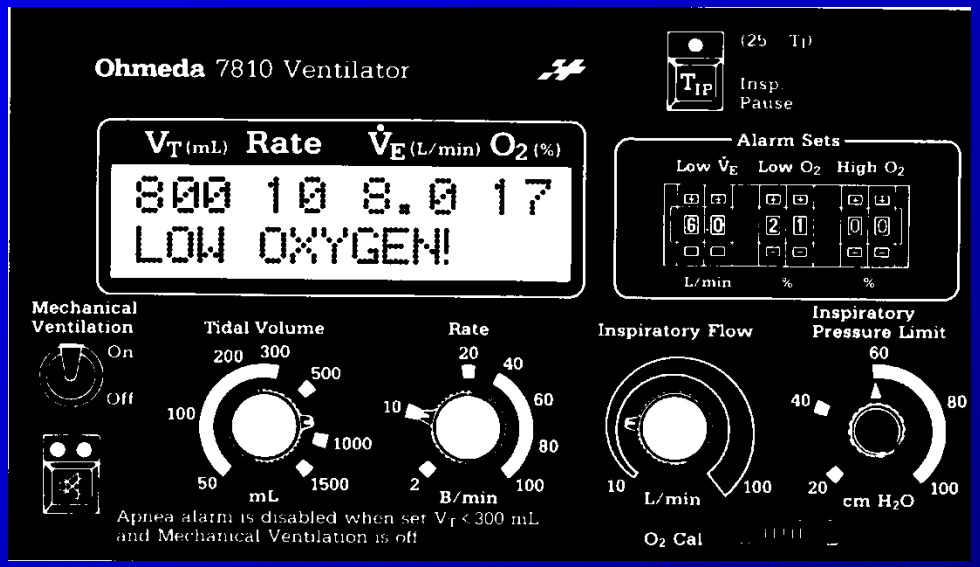
1. From patient
2. To patient
3. Common gas inlet
4. Excess gas outlet, pressure controlled by APL valve
5. Breathing bag

1. From patient
2. To patient
3. Common gas inlet
4. From ventilator bellows
5. To ventilator bellows
6. Ventilator port
7. Excess gas outlet



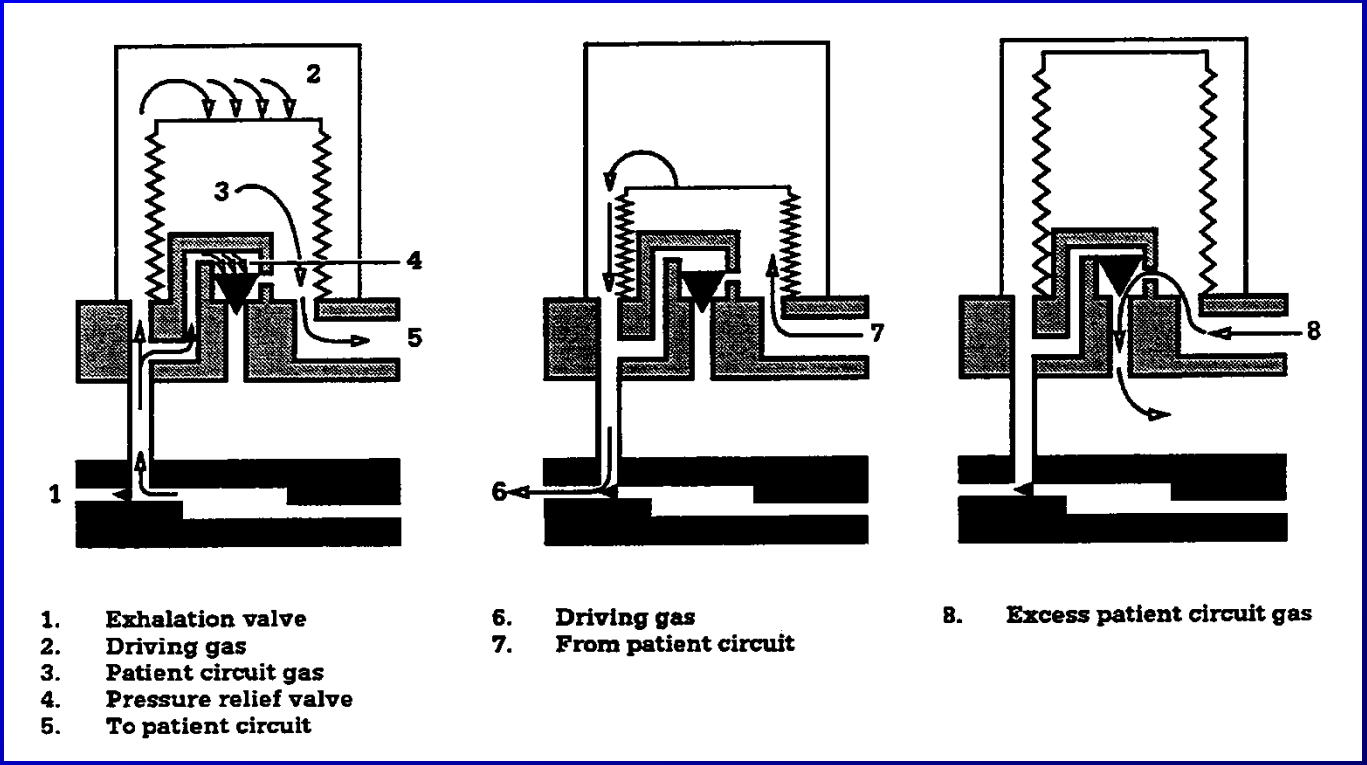
Anaesthesiological machine

- breathing bag and ventilator



Anaesthesiological machine

ventilator bag in column

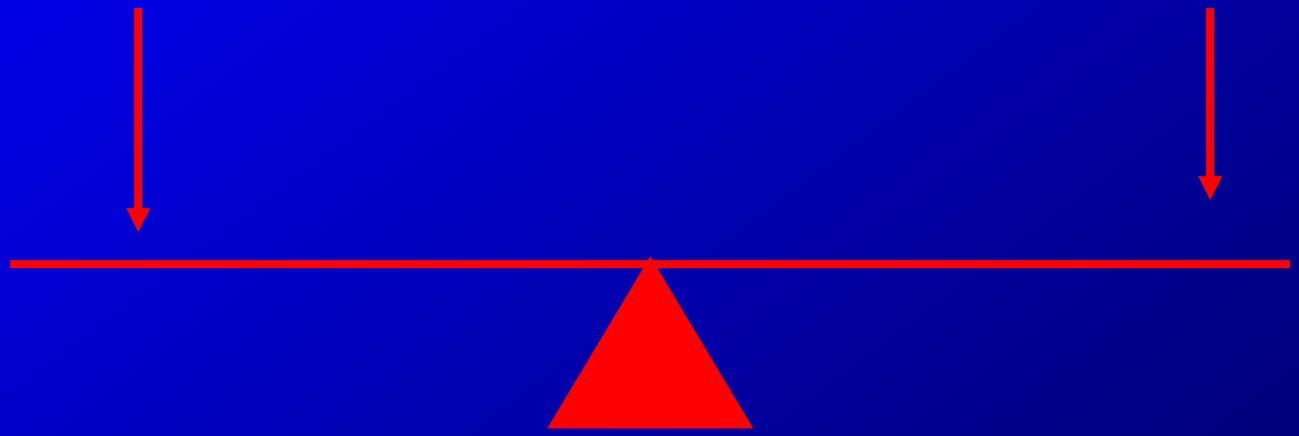


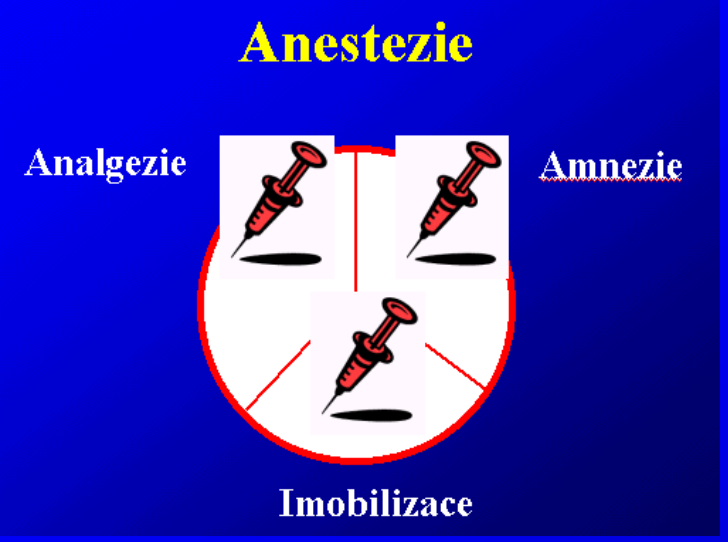
- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- **management of anaesthesia**
- monitoring
- preoperative and preanaesthetic evaluation

Maintenance

Depth of anesthesia

Stimulation





Anaesthesia maintenance

- balanced anaesthesia
  - – based on inhalational anaesthetics – hypnotic eff..
  - – boluses or continually – analgesia and relaxation
  - → control of the depth of an. by needs of surgery
- main problems
  - – depresison of breathing
  - – depression of circulation

Anaesthesia maintenance - prerequisites

- patent airways
- sufficient ventilation
- reliable venous access
  - to administer drugs
  - to cover blood and fluid losses, tj. to maintain euvolemia

Intubation

Laryngeal mask

Airways patency

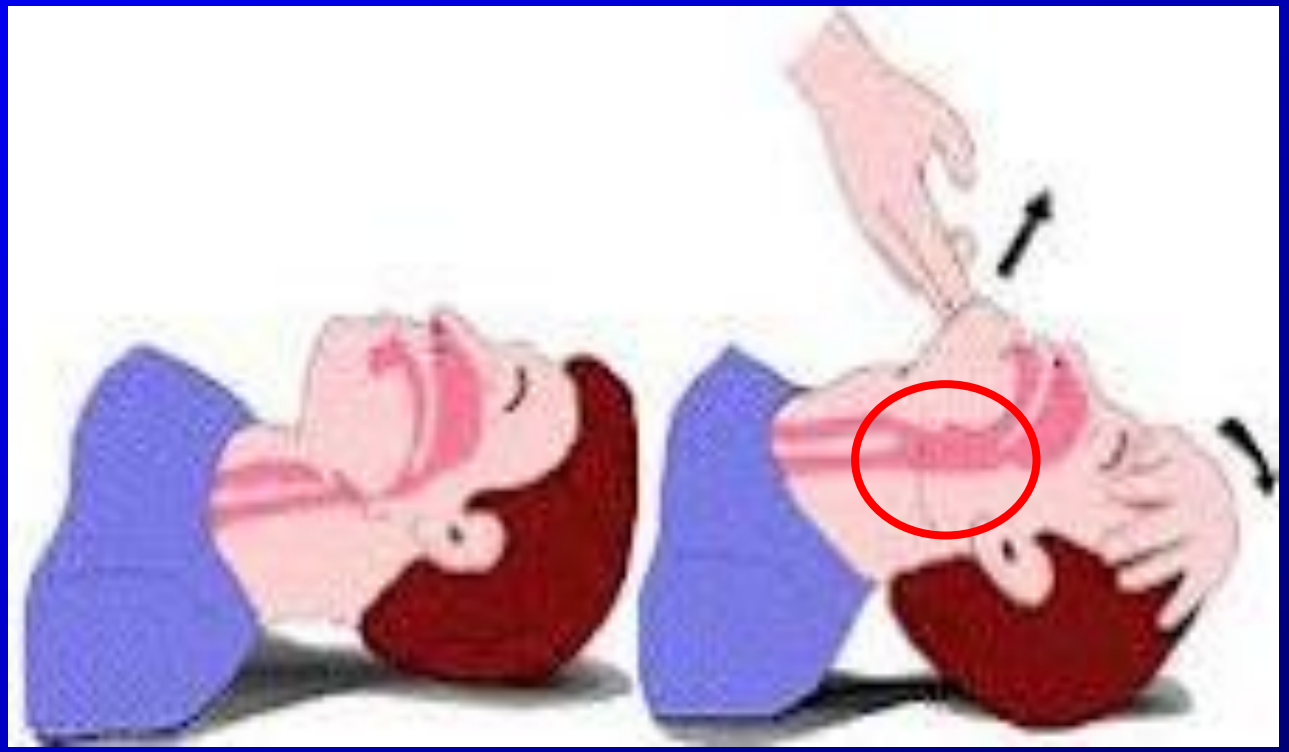
Nasal catheter

Face mask for oxygen inhalation

Airways patency

Face mask

Airways patency

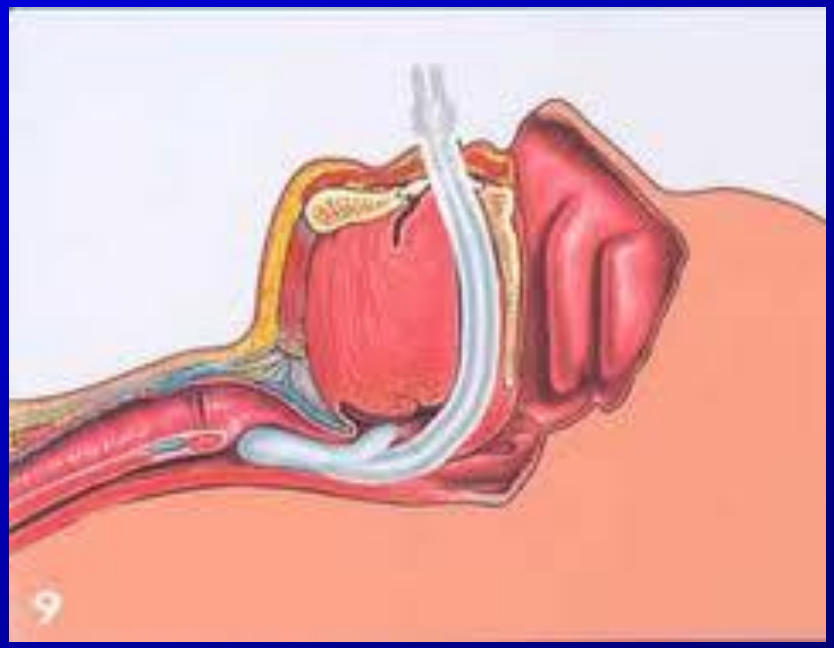


Airways

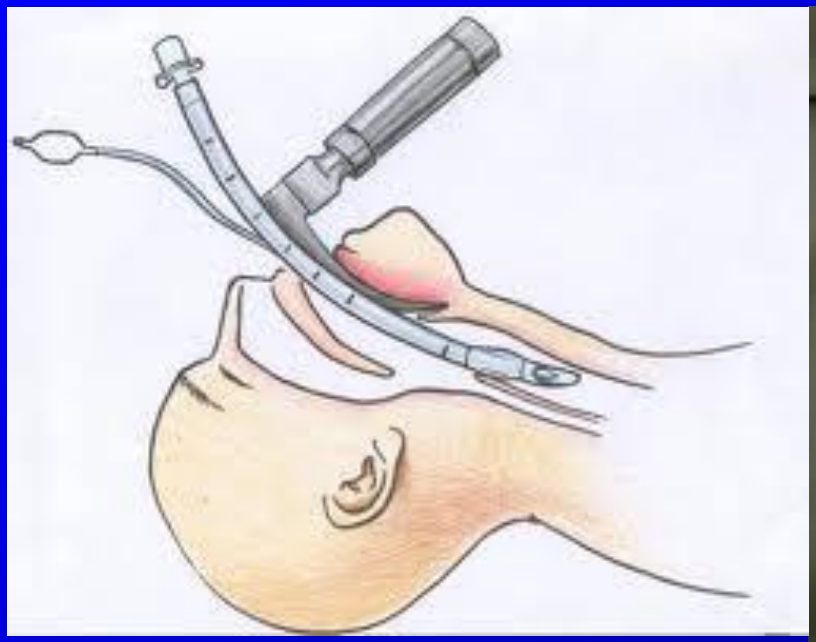
Nasal

Oral

Laryngeal mask



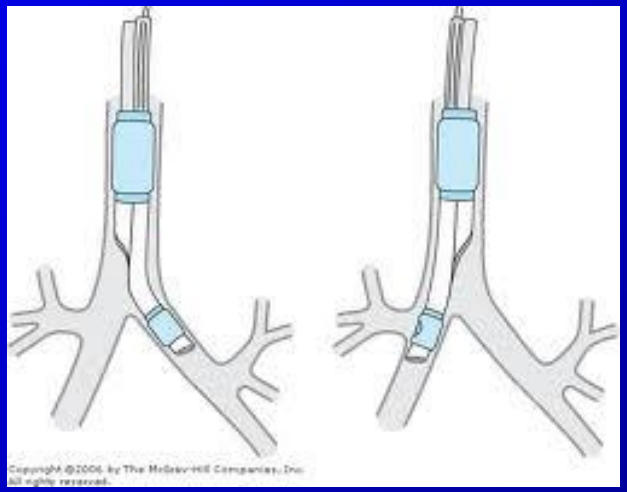
Intubation

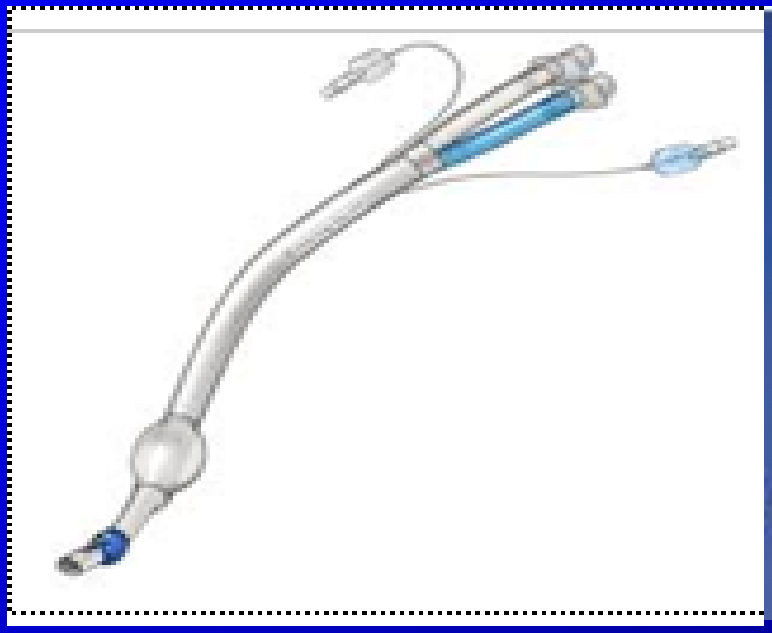


Intubation – oral or nasal – golden standard

Airways

Endobronchial intubation enables selective lung ventilation





Biluminal tube

Bronchial blocker

Venous access

Indication

- immediate/planned drug administration
- maintenance of hydration,
  correction of dehydration
- parenteral nutrition
- transfusion administration
- diagnostics
  (pressure measurements, blood specimens)
- therapy (extracorp. elimination, cardiac pacing)

Site of access

- peripheral veins incl. external jugular vein
- central veins
  - subclavian vein
  - internal jugular vein
  - from peripheral veins (PICC, half-way)
- intracardiac?
- intraosseal

Indications of venous access

	central	peripheral
• high volumes	+	+
• effective drugs	+	?
• irritant drugs (osmo, pH)	+	-
• long-lasting treatment	+	-
• elimination	+	-
• pulmonary cath.	+	-
• cardiac pacing	+	-

Possibilities

- metal needle
- plastic cannula over the needle
- catheter through the needle
- Seldinger´s method
- Desillet-Hoffman´s method
- implantable ports

Hagen-Poisseuille´s law

$$Q = \frac{\pi R^4}{8 \mu l} \left(- \frac{dp}{dx} \right)$$

Q =flow, R = tube radius, μ = viscosity, dp/dx = pressure change along the tube, l = length of the tube

Comparison

cannula	size (mm)	flow (ml/min)
12 G		
14 G	2,1 * 45	330
16 G	1,7 * 45	215
18 G	1,3 * 45	97
20 G	1,1 * 40	55
22 G		36
24 G		18

Peripheral i.v. access

pH

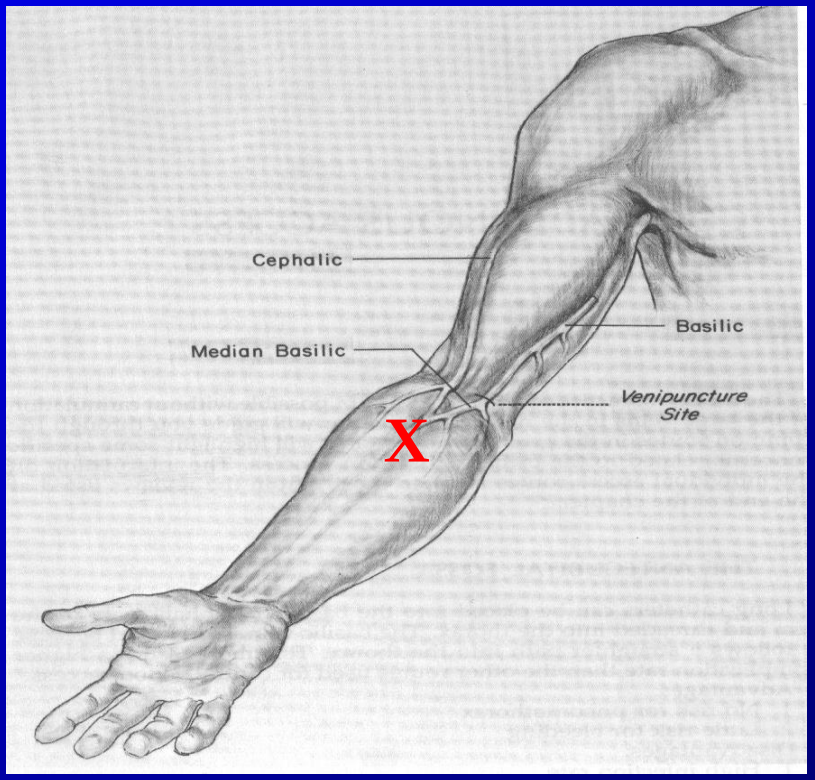
- dobutamine 2,5-5,0
- vancomycine 3,2
- naloxone 3,4
- SCHJ, cerucal 3,5
- frusemide 9,0
- thiopentone 10,5
- metohexital 11,5

osmolality (mosmol/l)

- F 1/1 290
- 5% glukose 290
- 4% aminoacids 460
- 10% manit 550
- 10% glucose 600
- 20% glucose 1250
- 10% lipids 280

Central access

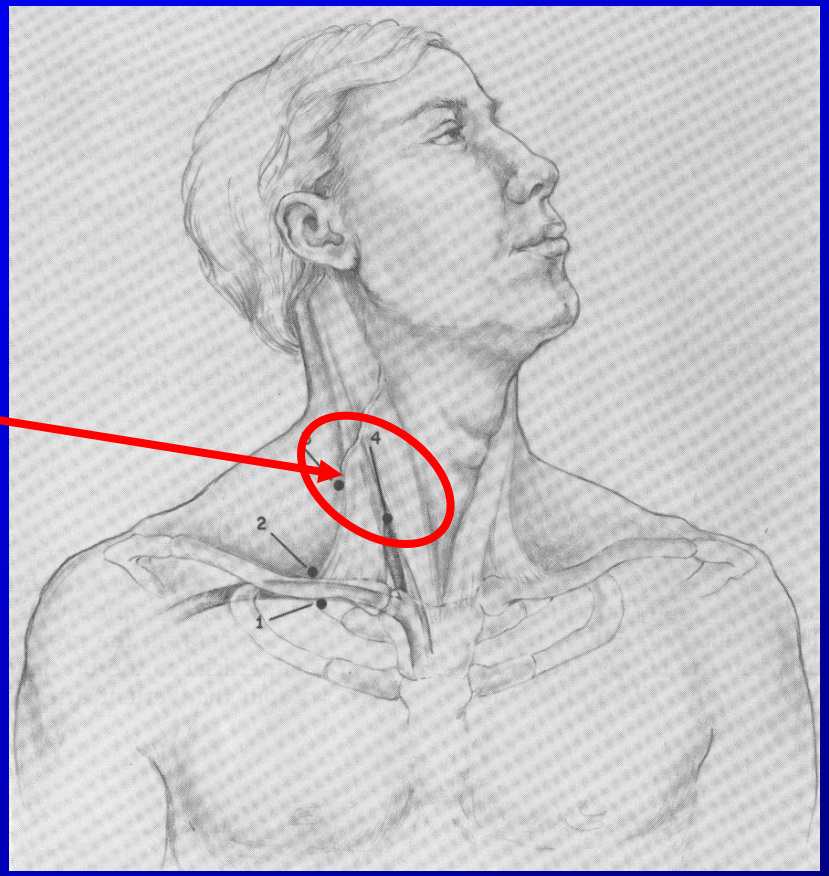
1 – v. subclavia infraclav.
2 – v. subclavia supraclav.
3 – v jugularis int. posterior appr.
4 – v. jugularis int. middle appr.



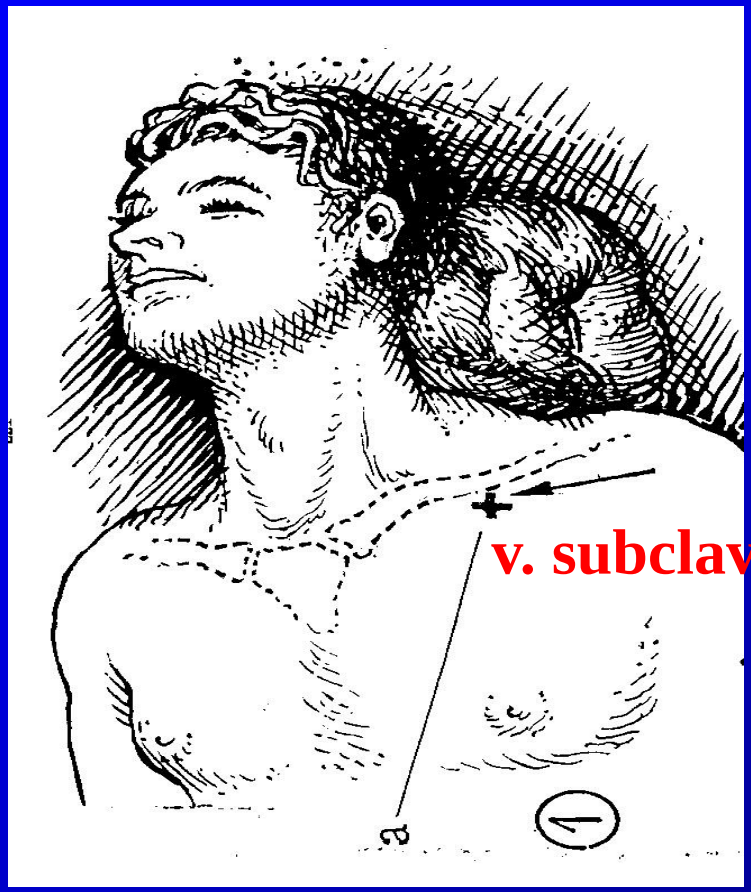
1 – central catheters from periphery
2 – „half-way“ catheters

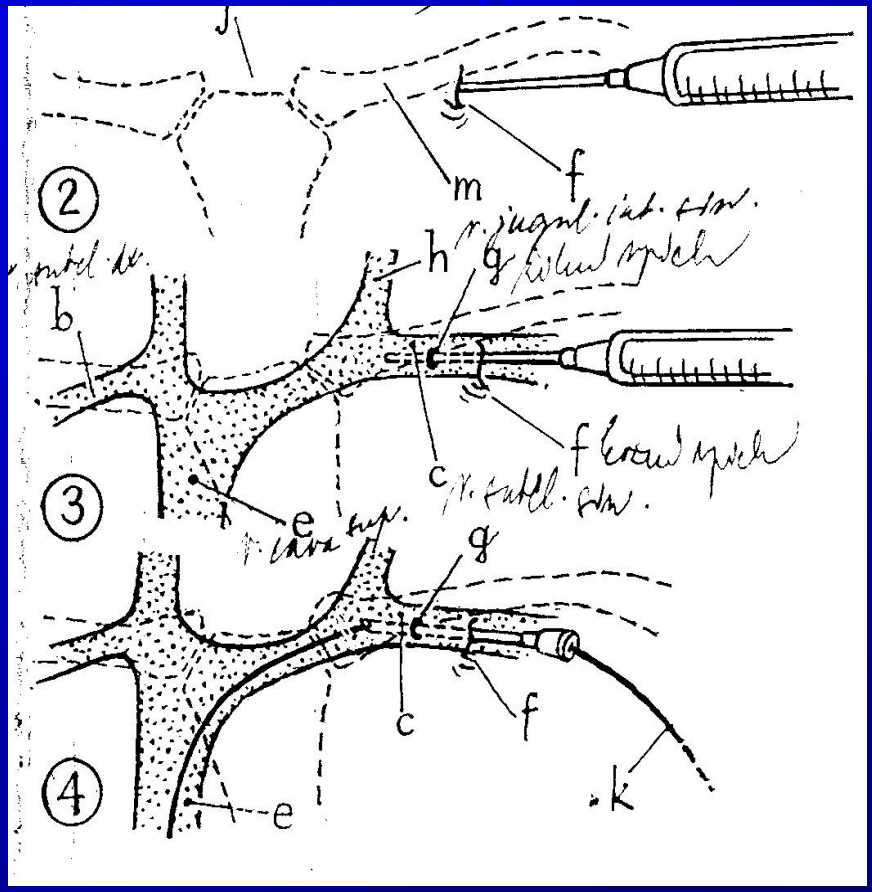
Internal jugular vein

Posterior approach

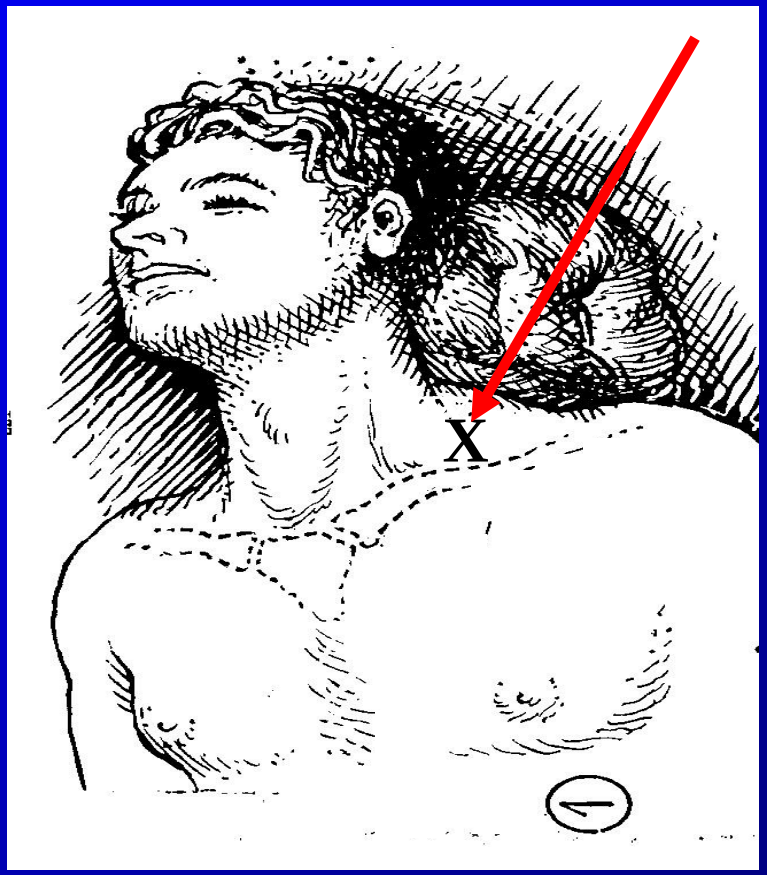


Subclavian vein infraclavicularly

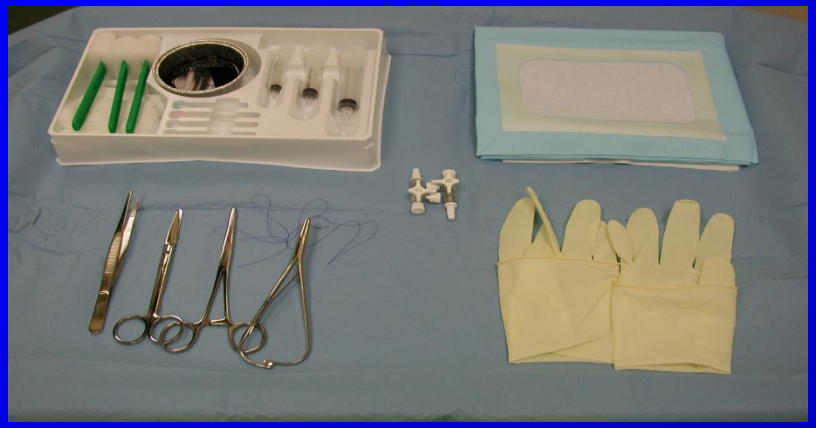


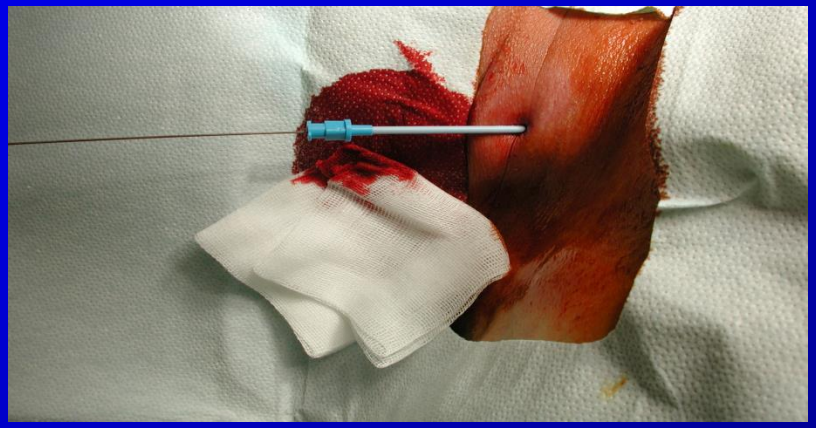


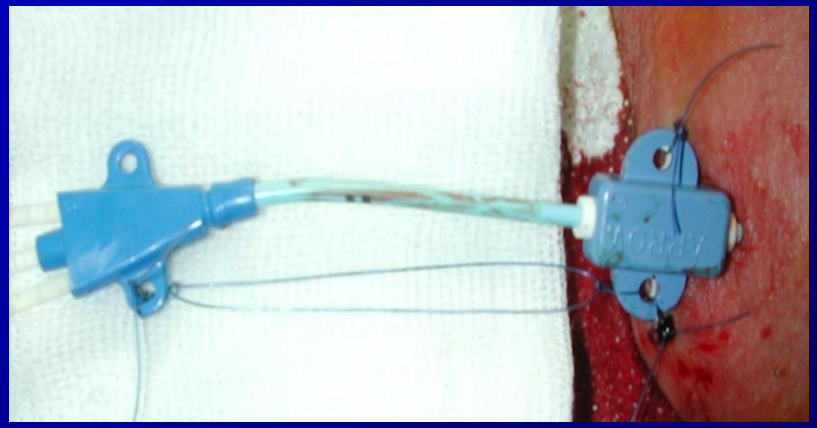
Subclavian vein supraclavicularly



Catheter insertion



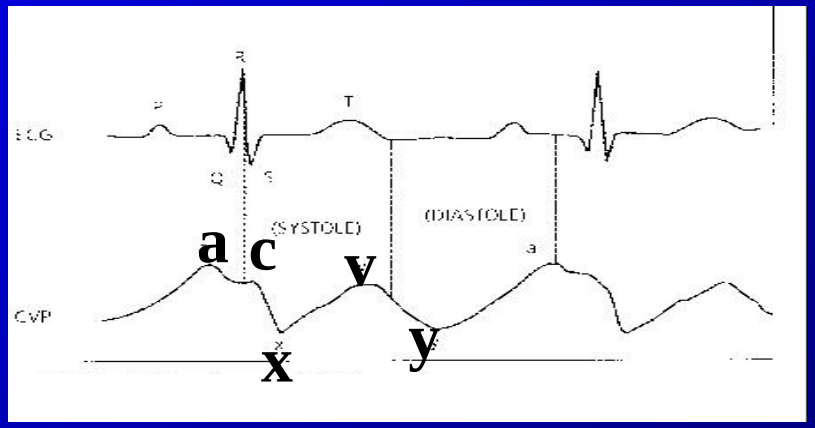


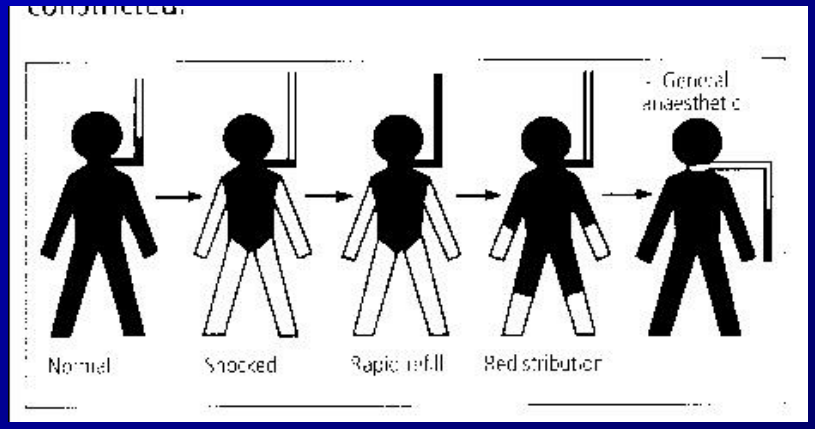


CVP measurement

- description:
  - a = atrial contraction
  - c = tricuspid valve bulging
  - x = atrial relaxation, opening RV
  - v = atrial filling, tricusp. valve. opening
  - y = early right ventricular filling
- normal values:

  0-9 mm Hg = 0-12 cm H_2O
- volume challenge





Blood pressure – direct measurement

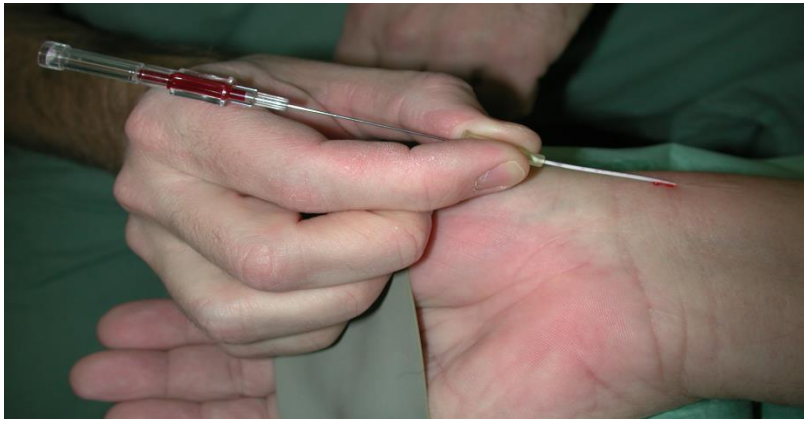
indication:

- Rapid changes of blood pressure
  e.g.. sepsis,bleeding, feochromocytoma
- vasoactive drugs administration
- big, aggressive surgeries
- diagnostics, repeated blood specimens

Site and cannulation methods

- upper extremity
  - radial, ulnar, brachial, axillary artery
- lower extremity
  - femoral, post. tibial. artery, a. dorsalis pedis
- direct puncture
- transfixation
- Seldinger´s technique

Cannulation



- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- management of anaesthesia
- **monitoring**
- preoperative and preanaesthetic evaluation

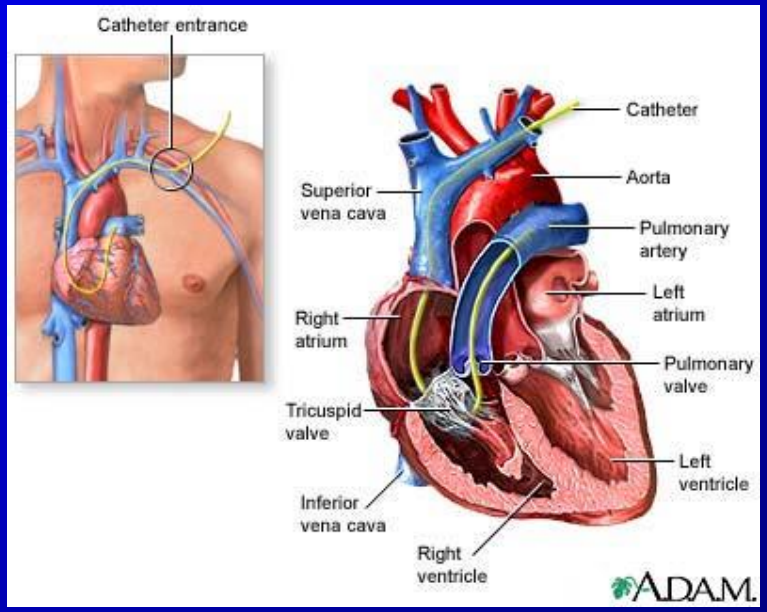
Observation and monitoring

Basic requirements – Harvard minimal principles for safety

1. continuous presence of the anaesthesiologist
2. BP and HR by 5 minutes
3. ECG continually
4. breathing and circulation by proper methods
5. FiO_2 in inhaled gases
6. breathing system disconnection
7. patients´s temperature
8. Hb saturation by oxygen and $ETCO_2$

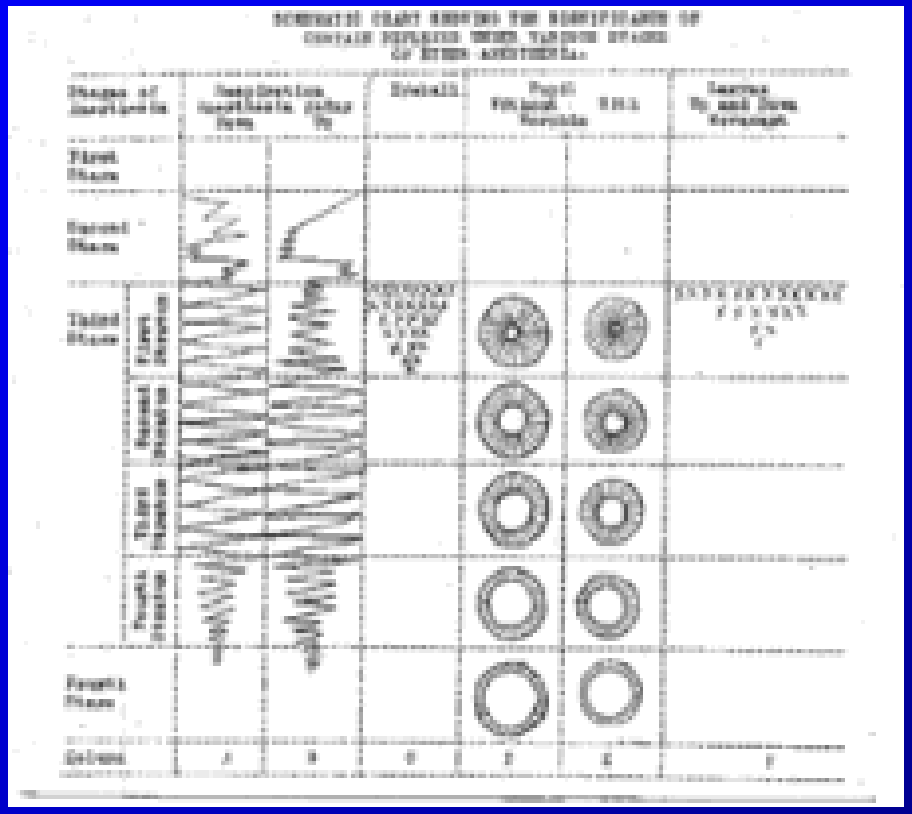
Advanced monitoring

- hemodynamics
- neuro-muscular relaxation
- depth of anaesthesia etc.



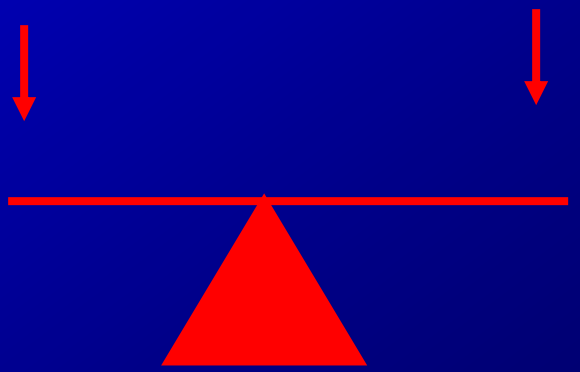
Depth of anaesthesia

Arthur Guedel



Depth

Stimulation



Problems of depth of anaesthesia monit.

- ether irritates airways
- opioids usage
- relaxants usage

tears - eyes for crying only

BIS – bispectral index

- to titrate hypnotics as needed
- decreases the risk of memories by 80 %[1]
- cummulative time with BIS < 45:
  RR of death by 24.4% higher per hour with BIS < 45[2]
- more frequent even outside op. theatres

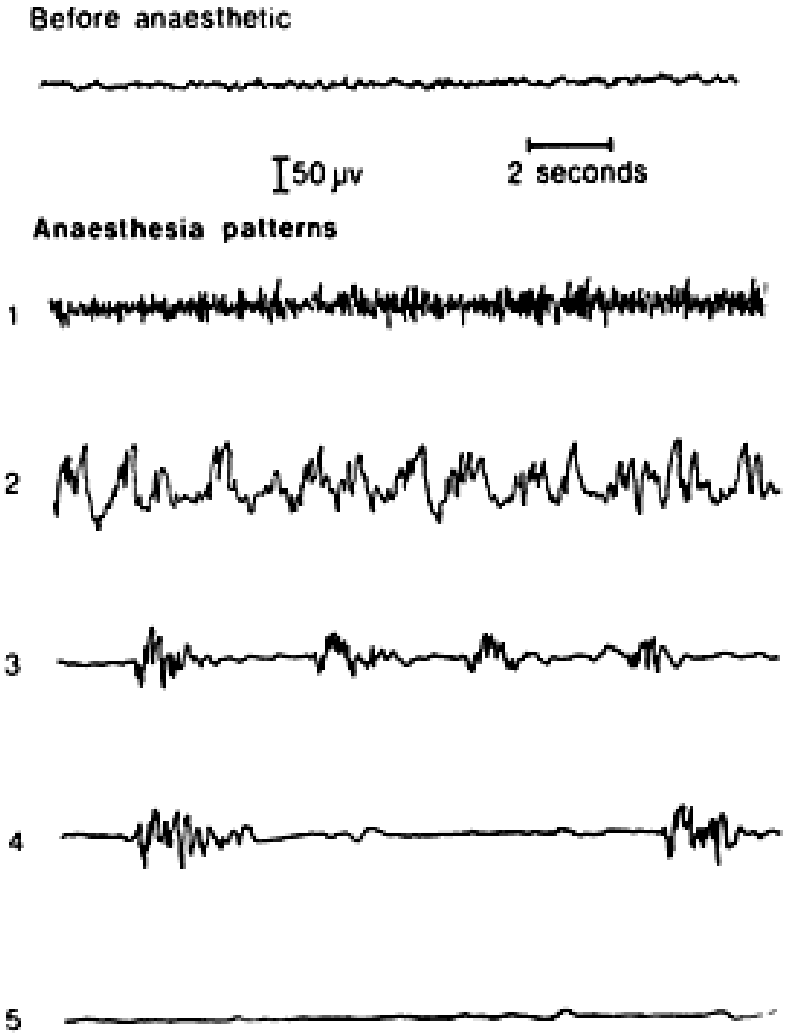
but

- not helpful for the effects of ketamine, dexmedetomidine, N_2O, xenone (NMDA antag.), opioids

1. Best Pract Res Clin Anaesthesiol. 2006;20(1):81-99
2. Anesth Analg 2005;100(1):4-10

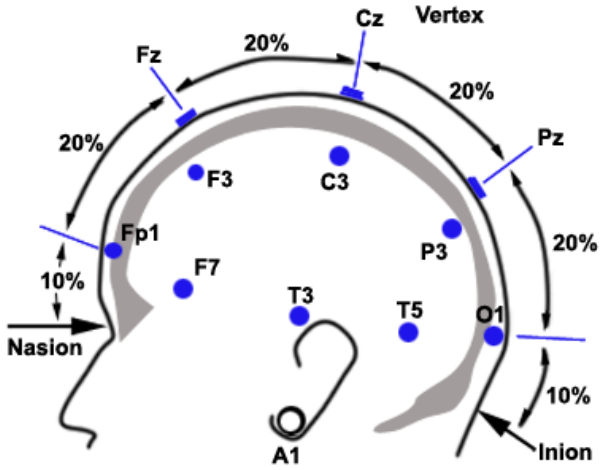
BIS – Bispectral index

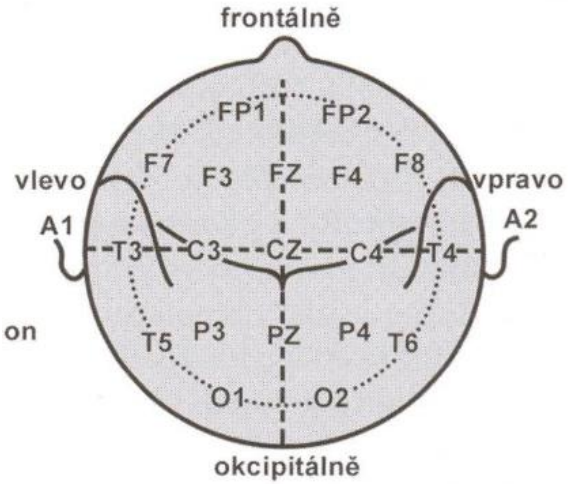
EEG changes in anaesthesia

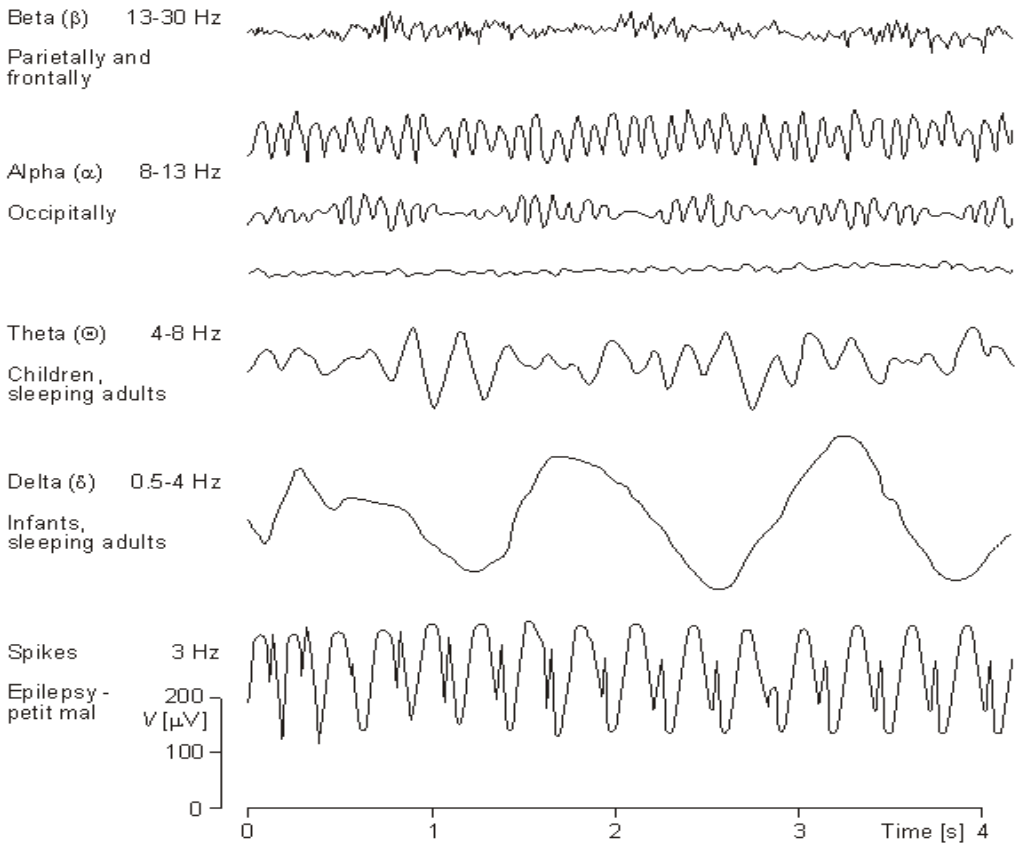


EEG

system 10/20, 19 + 2 electrodes

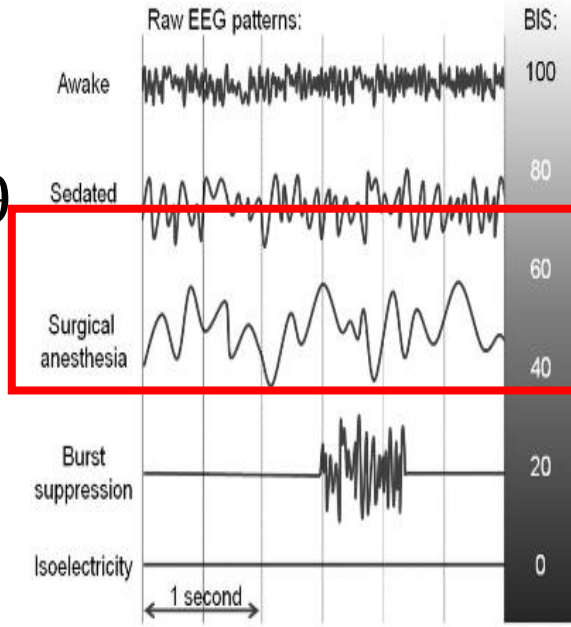






BIS – Bispectral index

- Aspect Medical Systems (AMS) 1994
- EEG + EMG
- Algoritmus not published
  burst supression r., beta r., synchronie Fast/Slow **result: 0-100**
- FDA approved for „depth of an.“,
  i.e. hypnotic component of anaesth 1996
- AMS bought by Covidien company 2009
- Other systems:
  - Narcotrend, E-Entropy (GE) etc.



BIS (processed EEG) indications

- to decrease the risk of awareness due to insufficient anaesthesia
- to shorten the time till awakening and to decrease anaesthetic consumption
- to gain indirectly information about brain perfusion
- other indications:
  - sedation intensity in ICU
  - brain hypoperfusion detection (CEA, SAH)
  - prognostication in brain trauma, during and after CPR

Depth af anaesthesia?

- too deep anaesthesia (BIS < 45) for too long time increases the risk of death within 2 years
- optimal BIS 40-60, really?

Monk TG: Anesthetic Depth Is a Predictor of Mortality: It's Time to Take the Next Step. Anesthesiology 2010 May;112(5):1070-2.

Depth of anaesthesia

- „depth of anaesthesia“ is a probability of different reactions to different stimuli

- patient is not a submarine!

Shafer SL, Stanski DR: Defining depth of anesthesia. Handb Exp Pharmacol 2008; 182:409 –23

Depth of anaesthesia:

are these systems shut:

1. **memory systems?**
2. **consciousness and perception?**
3. **reaction to pain („arousal“)?**
4. **vegetative reactions?**
5. **somatic reactions?**
6. **postoperative hyperalgesia?**
7. **immune and inflammatory reactions?**

Sleigh JW: Depth of Anesthesia. Perhaps the patient is not a submarine. Anesthesiology 2011;115(6):1-2

Does depth of anesthesia monitoring improve postoperative outcomes?

12/2011

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e-mail: TerriMonk@duke.edu

Current Opinion in Anesthesiology 2011, 24:665–669

Purpose of review

Devices using the electroencephalogram to estimate anesthetic depth have been available since 1996. Despite the use of these monitors for over a decade, there is little agreement among clinicians about the need for or value of depth of anesthesia monitoring. Since the majority of the studies evaluating the impact of depth of anesthesia monitoring on postoperative outcomes have utilized the bispectral index (BIS Covidian), this manuscript will focus on studies with this device. This review will evaluate the evidence that BIS monitoring can improve long-term outcomes.

Recent findings

BIS-guided anesthesia can reduce the incidence of awareness with recall in high-risk patients, but a recent study found that anesthetic management directed by an end-tidal anesthetic-agent concentration protocol is equally effective, and probably less expensive. Deep anesthesia (BIS < 45) during the intraoperative period is associated with increased postoperative mortality, but this relationship may be an epiphenomenon rather than causal.

Summary

There is growing concern that anesthetic management and even specific anesthetic agents may worsen outcomes in high-risk patients. There is, however, no conclusive evidence that depth of anesthesia monitors can improve outcomes and no evidenced-based reasons for anesthesia providers to change their current practice.

Regional anaesthesia

There is no safe anaesthesia,
there is only an anaesthesiologist,
who can make the anaesthesia safe.

Sir Robert McIntosh

Each anaesthesia is an intoxication
of the patient
by the anaesthesiologist.

- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks

„Regional anaesthesia is an art based on science.“

Mathieu Gielen

1996

„Regional anesthesia is simply an exercise in applied anatomy.“

Allon P. Winnie

- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks

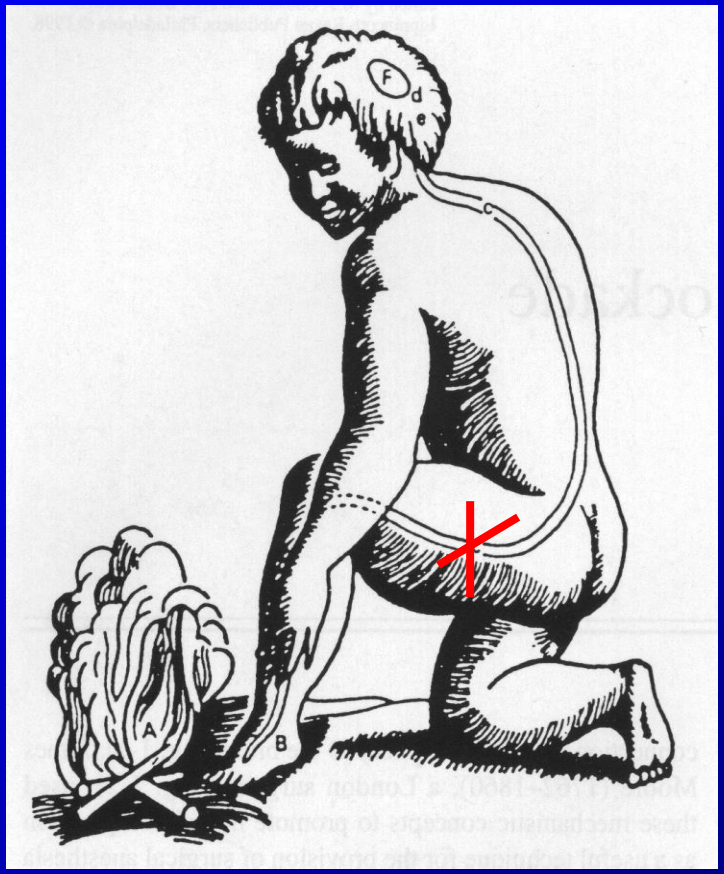
anaesthesia = loss of perception of pain, touch or temperature due to the action of physical or chemical agents.

– general anaesthesia is due to pharmacological modulation of the function of brain centers associated with alertness and pain

– regional anaesthesia is due to loss of conduction between periphery and brain centers

Encyclopedia Diderot (http://www.diderot.cz)

History of conduction anaesthesia



1886 - James Leonard Corning

History of conduction anaesthesia

- Pressure:
  - **nerve compression**

    Paré 1564
- Cold:
  - mixture of snow and ice

    Severino 1646
- Drugs:
  - cocain

    Koller 1884

Ambrois Paré

History of conduction anaesthesia

- Pressure:
  - **nerve compression**
    Moore 1784
- Cold:
  - mixture of snow and ice
    Severino 1646
- Drugs:
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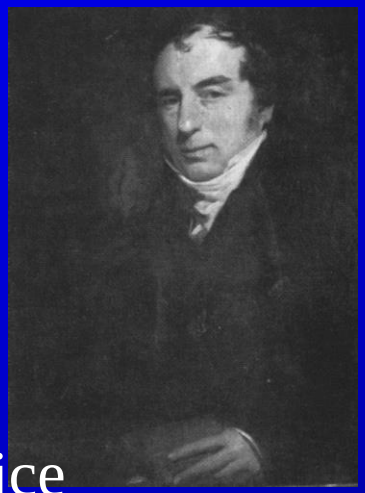
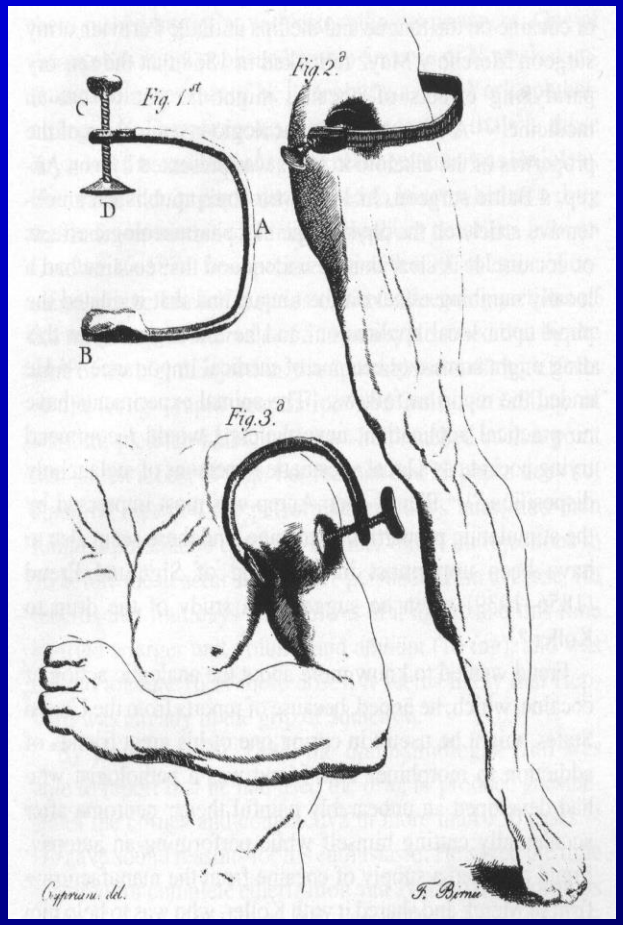


James Moore
(1762 - 1860)



History of conduction anaesthesia

- Pressure:
  - nerve compression
    Paré 1564
    Moore 1784
- Cold:
  - mixture of snow and ice
    Severino 1646
- Drugs:
  - cocain
    Koller 1884

Carl Koller (1857 - 1944)

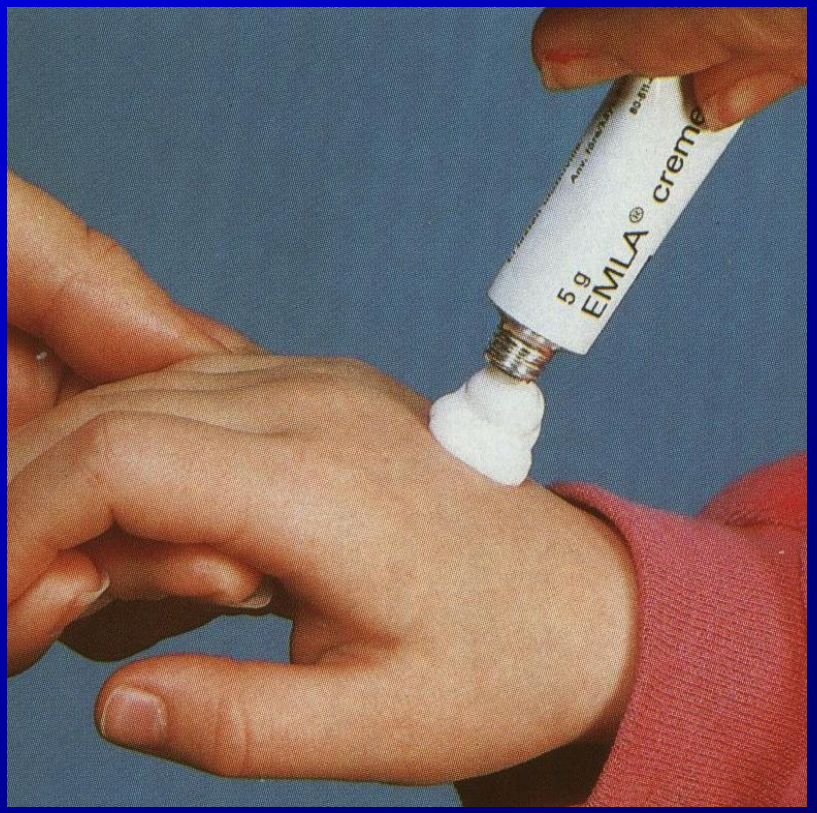
- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks

Regional anaesthesia - classification

- central (neuraxial) blocks
  - spinal
  - epidural
    - caudal
- peripheral nerve blocks
- intrapleural (interpleural) analgesia
- IVRA a IARA
- local anaesthesia
  - topical
  - infiltration

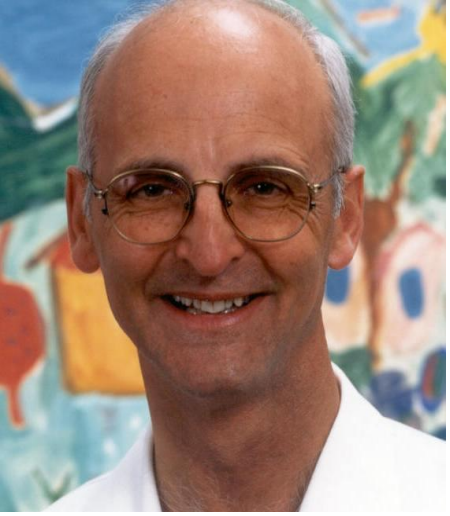
Topical anaesthesia

- eye, ear, nose
- mucous membranes
- skin



Intravenous Regional Anaesthesia

- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks



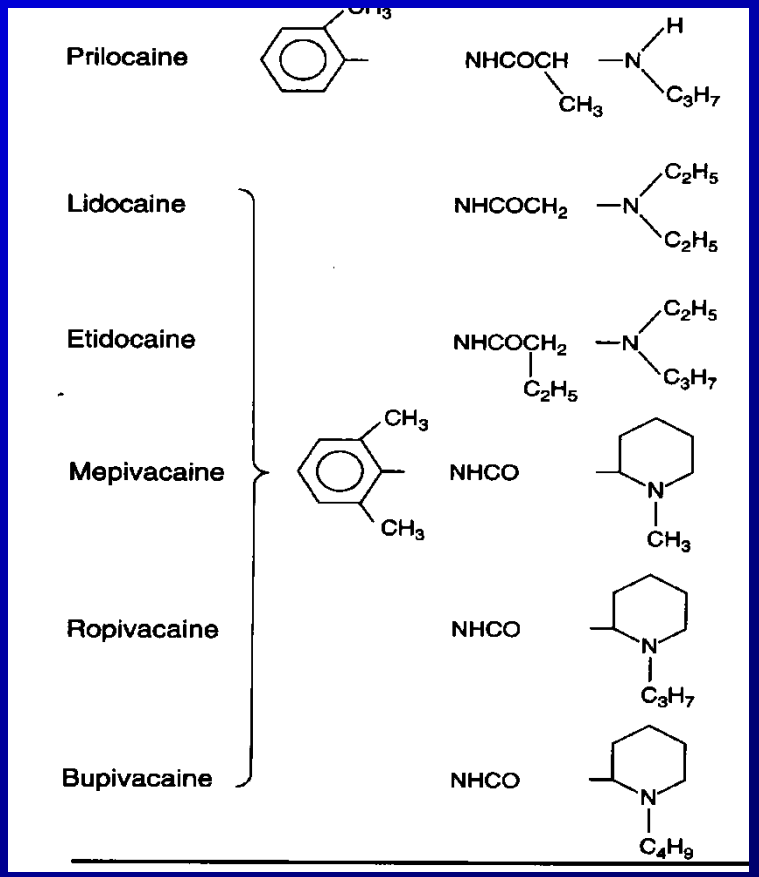
Martin Jöhr

Local anaesthetics -

wonder drugs or dangerous toxins?

Local anaesthetics - structure

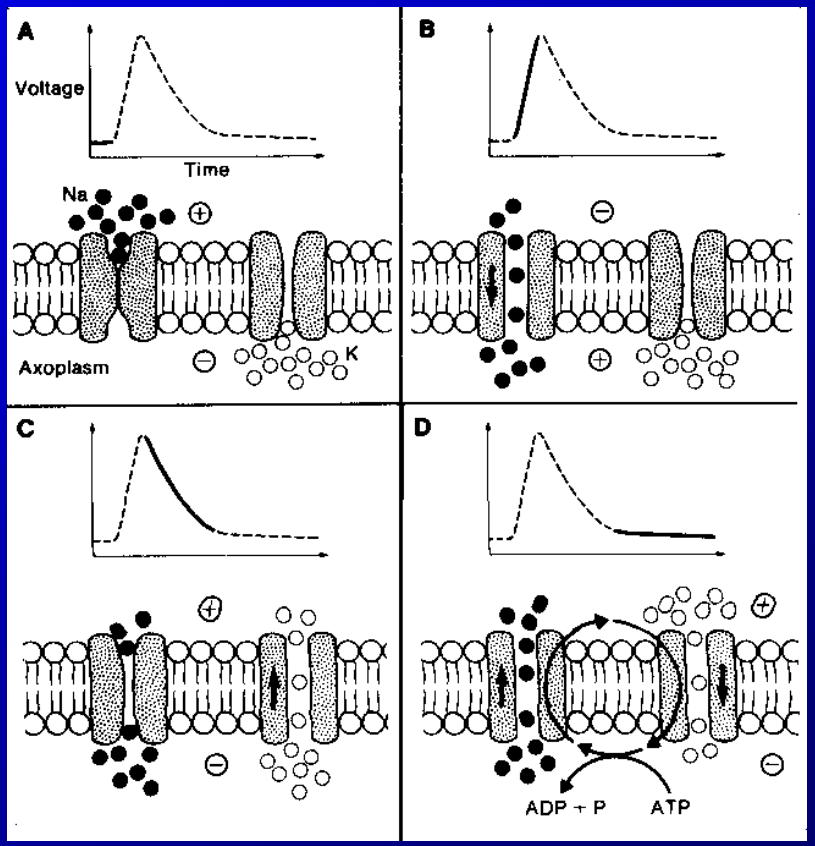
- **lipophilic** – aromatic ring
  - benzoic acid derivative
  - anilin derivative
- connecting chain
  - ester CO-O-C
  - amide CO-NH
- **hydrophilic**
  - aliphatic amine
  - aromatic ring



amides

Action potential

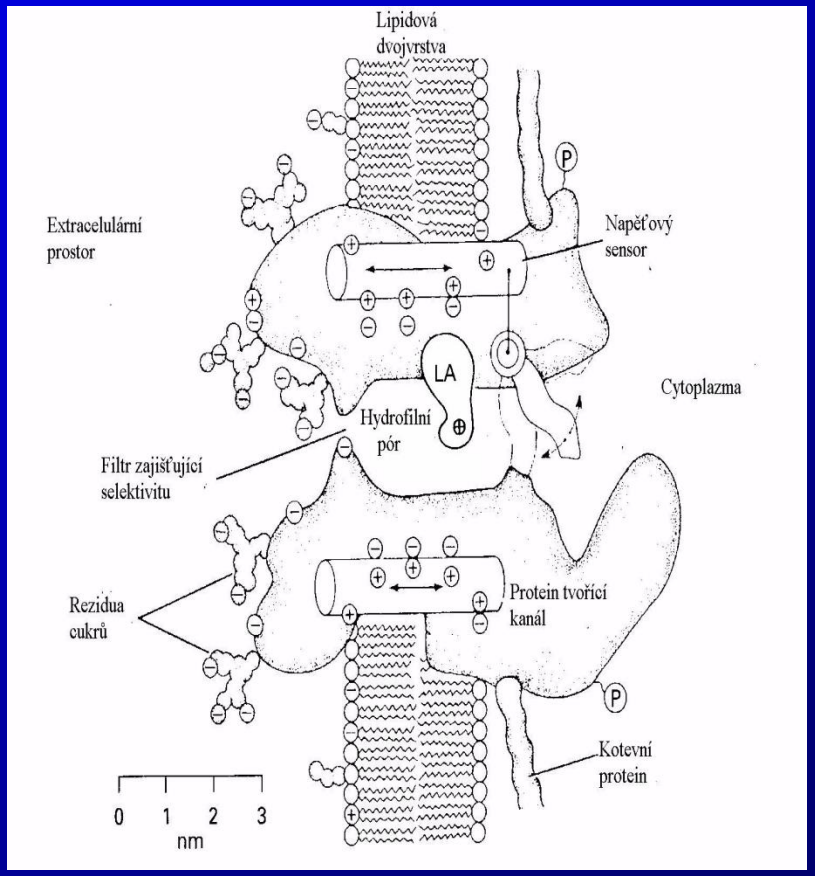
- Na^+ channels
- K^+ channels
- Na^+/K^+ ATPase



Local anaesthetics
- mechanism of action

Na^+ channel block

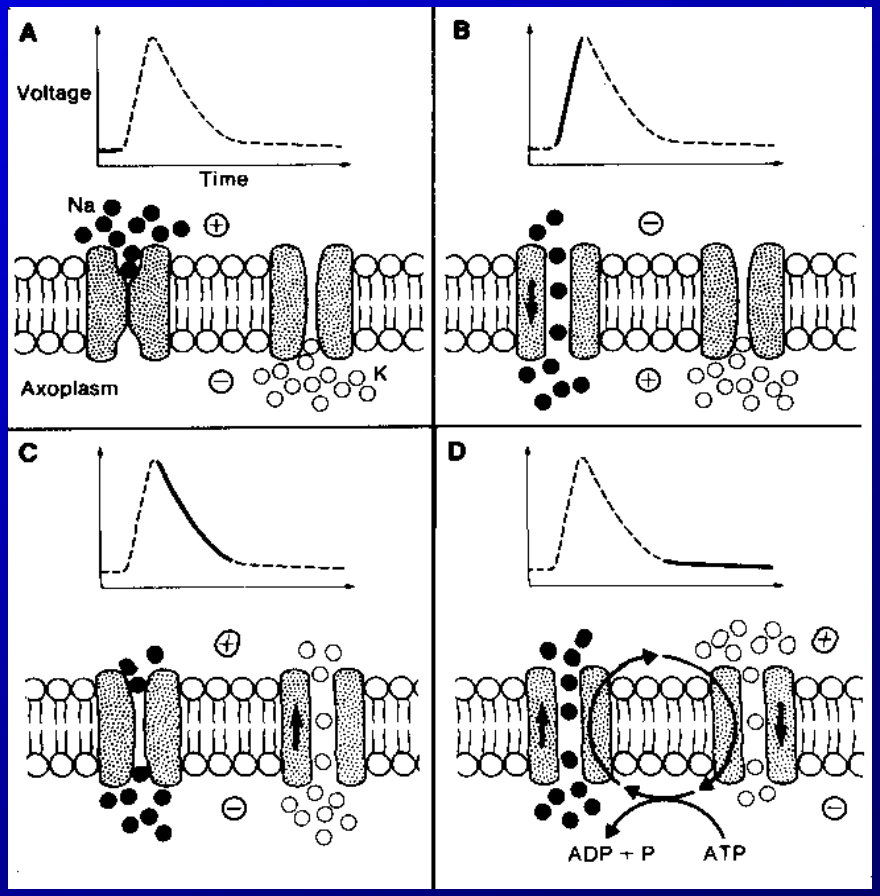
- myelinized fibers
  2 000 - 3 000 chan./μm^2
- non-myelinized fibers
  35 - 530 channels/μm^2
- to induce the block -
  > 80% channels affected



Local anaesthetics
- mechanism of action

- Na^+ channel block

- K^+ channel block
- Ca^{++} channel block
- mitochondria
- enzymes



Local anaesthetics
- mechanism of action

- K^+ channel block
  - „delayed rectifier“ - repolarization
  - „flicker“ - resting potential
  - „rapidly inactivating“ - „firing“
  - ATP-sensitive - vazodilatation
- Ca^{++} channels block
  - decreased neurotransmitter release
  - block of MAP (ERK) kinase $\Rightarrow \downarrow$ synthesis of proteins in the nucleus (eg. c-fos)

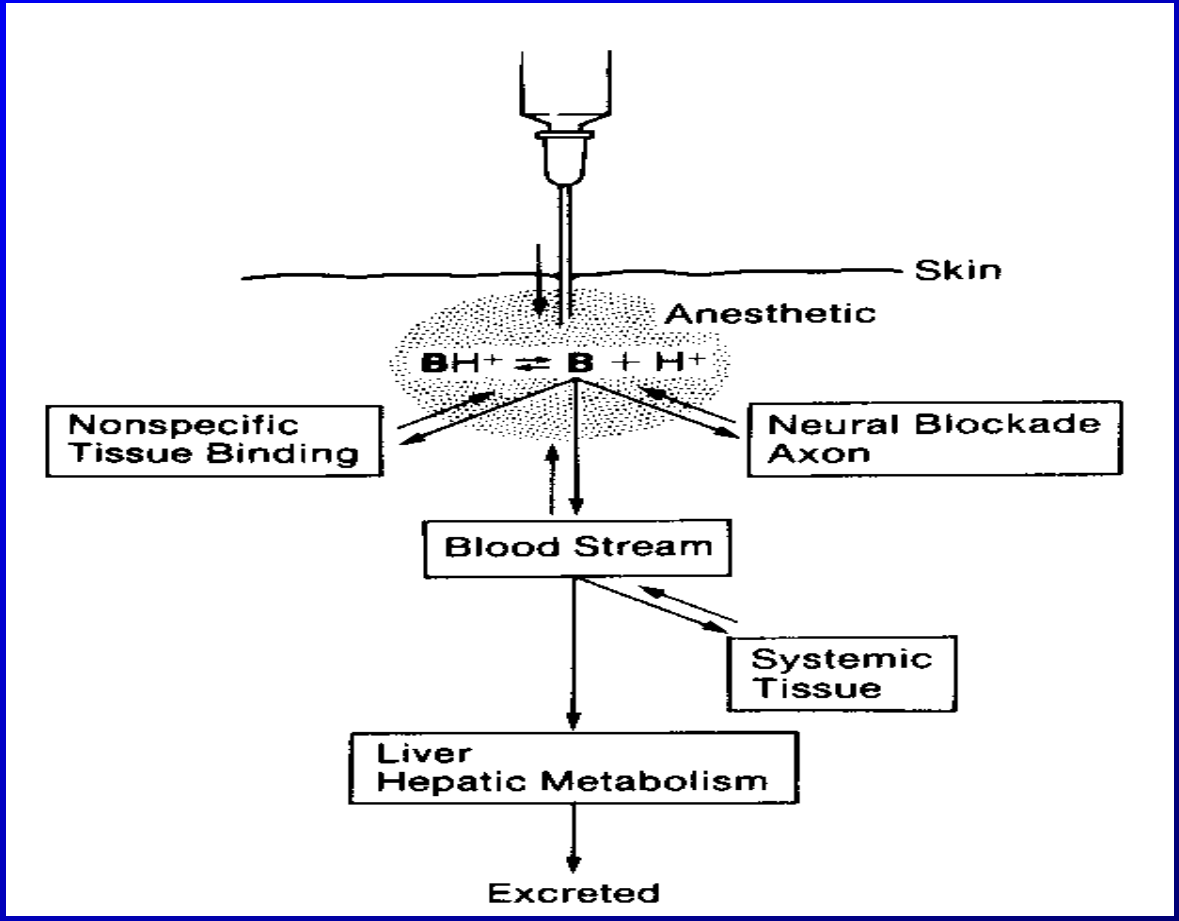
Local anaesthetics - mechanism of action

- receptor block
  - acetylcholin – muscarinic and nicotinic
  - β-adrenergic
  - NK-1 (substance P)
- enzyme block
  - adenylatcyclase, guanylatcyclase
  - fosfolipase A_2, fosfolipase C
  - Na^+/K^+ATPase, Ca^{++}/Mg^{++}ATPase

Local anaesthetics
- mechanism of action

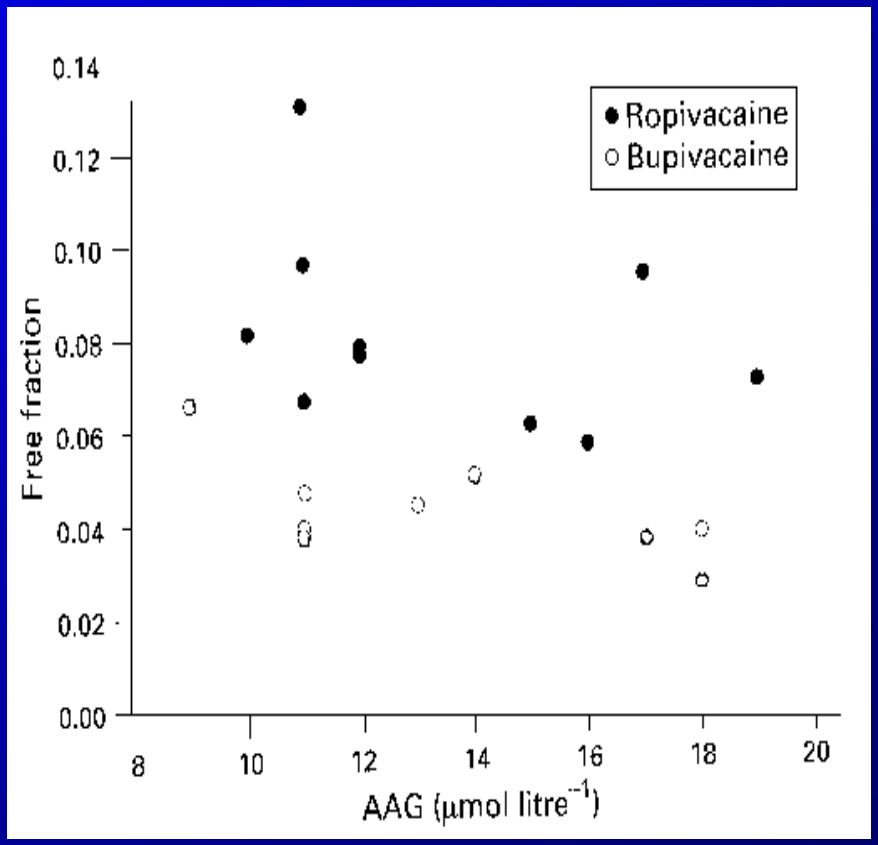
Complex

Local anaesthetics
- pharmacokinetics



Local anaesthetics - pharmacokinetics

- linear
- absorption
- distribution
  - binding to AAG (acute phase reactant)
  - 3-compartment model
- metabolism
- elimination



Systemic toxicity – 2 mechanisms

- accidental i.v. administration (correct dose into incorrect place)

  „Accidental i.v. administration of LA can occur to everybody, event to an expert, everywhere and every time.“

- dose too high (incorrect dose into correct place)

  „Safer LAs enable to use higher concentration and/or volume, thus more perfect and longer lasting block will be produced.“

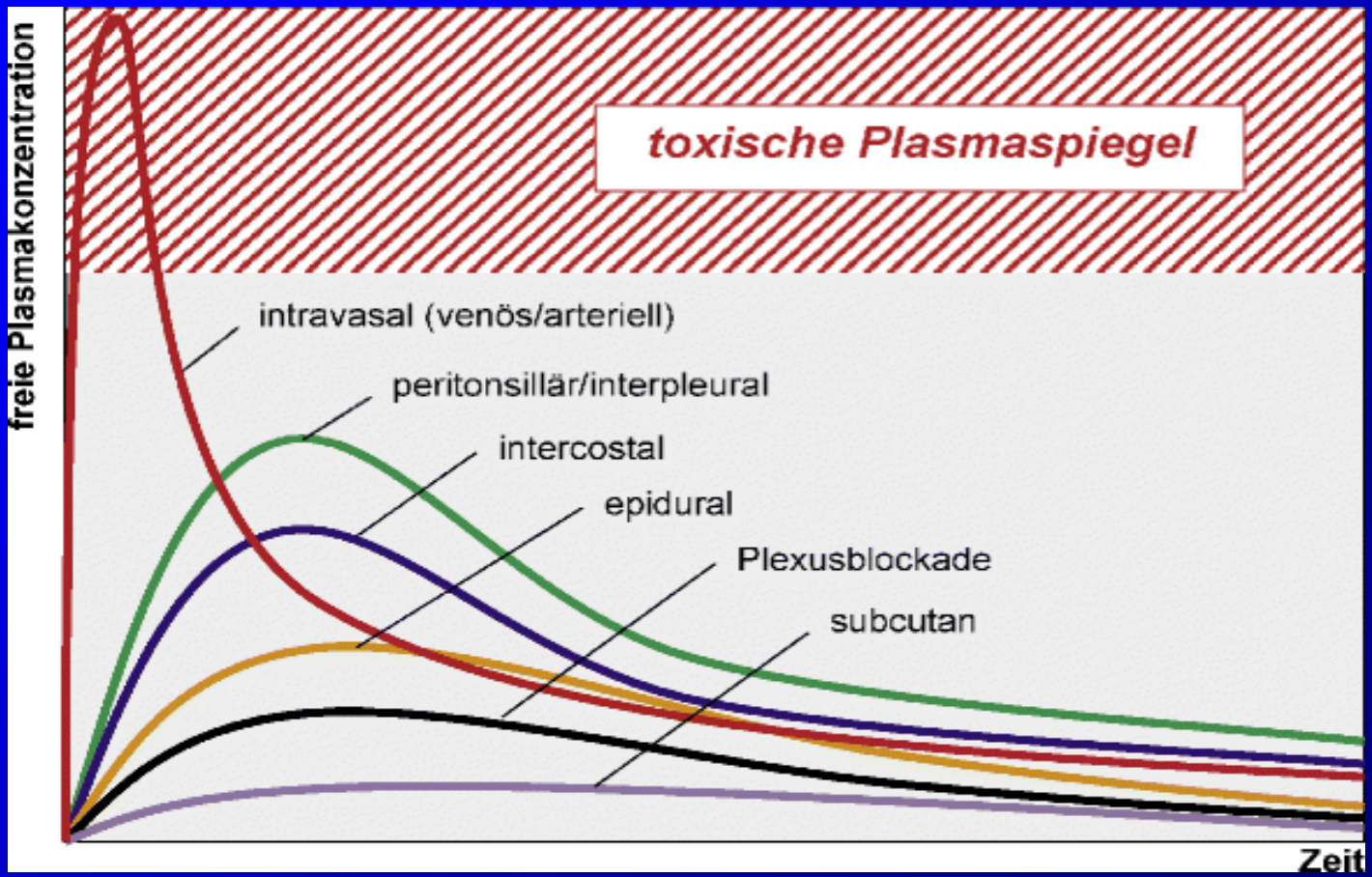
Local anaesthetics –adverse reactions

not uncommon

classification:

- reactions not caused by LAs
  - collaps, stress reaction, hyperventilation, panic reaction etc.
- allergy
- toxicity
  - due to vasoconstriction additive
  - due to LAs (incorrect place or overdosage)

Time course of toxic reactions



W. Zink, B. M. Graf : Toxikologie der Lokalanaesthetika: Pathomechanismen – - Klinik – Therapie. Der Anaesthesist 2003: 52: 1102 - 1123

Allergy to local anaesthetics

- incidence among anaesthesiological drugs

  1240 patients after anaphylaxis during 4 years

  – muscle relaxants 80%
  – hypnotics and benzodiazepins 9.2%
  – opioids 2.6%
  – LAs 0.25% (3 cases only)

  Laxenaire et. Al.: Anaesthetics responsible for anaphylactic shock. A French multicentre study. Ann Fr Anesth Reanim 1990; 9: 501-506

- incidence among adverse reaction to LAs

  true alergies account for less than 1%

  Giovannitti et al.: Assessment of allergy to local anesthetics

  JAMA 1979

Allergy to local anaesthetics

Mechanism:

- allergy of the I. type – IgE mediated
- allergy of the III. type - immunocomplex (pt. with decreased complement activity, RA)
- allergy of the IV. type – cells mediated, delayed allergy

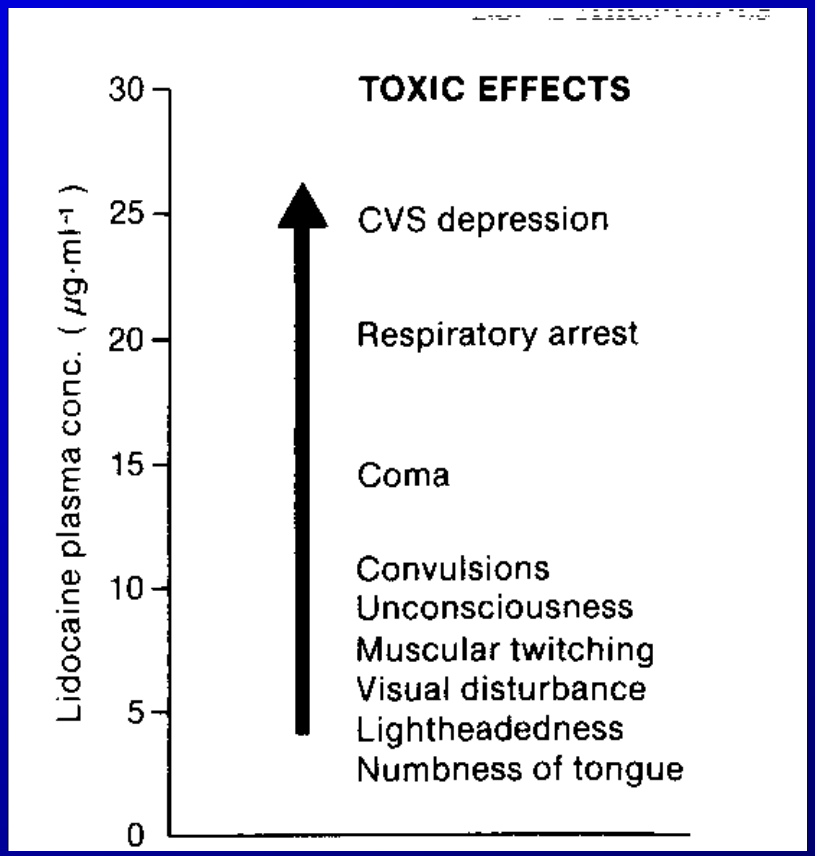
Allergy to local anaesthetics

- history and informed consent
- skin prick testing
  - 1% LA, additives (1% ester PABA, 5% Na metabisulfite), latex
  - pozitive histamine controll
- intradermal tests
  - 1% LA diluted by NaCl 1:10-1:100, 0.02-0.03 ml
- s.c. titration tests = challenge testing
  - 0,5 ml FR - 0,1 ml 1% LA
  - 0,1 ml 1% LA diluted 1:100 - 0,2 ml 1% LA
  - 0,1 ml 1% LA diluted 1:10 - 0,5 ml 1% LA
  - - 1,0 ml 1% LA

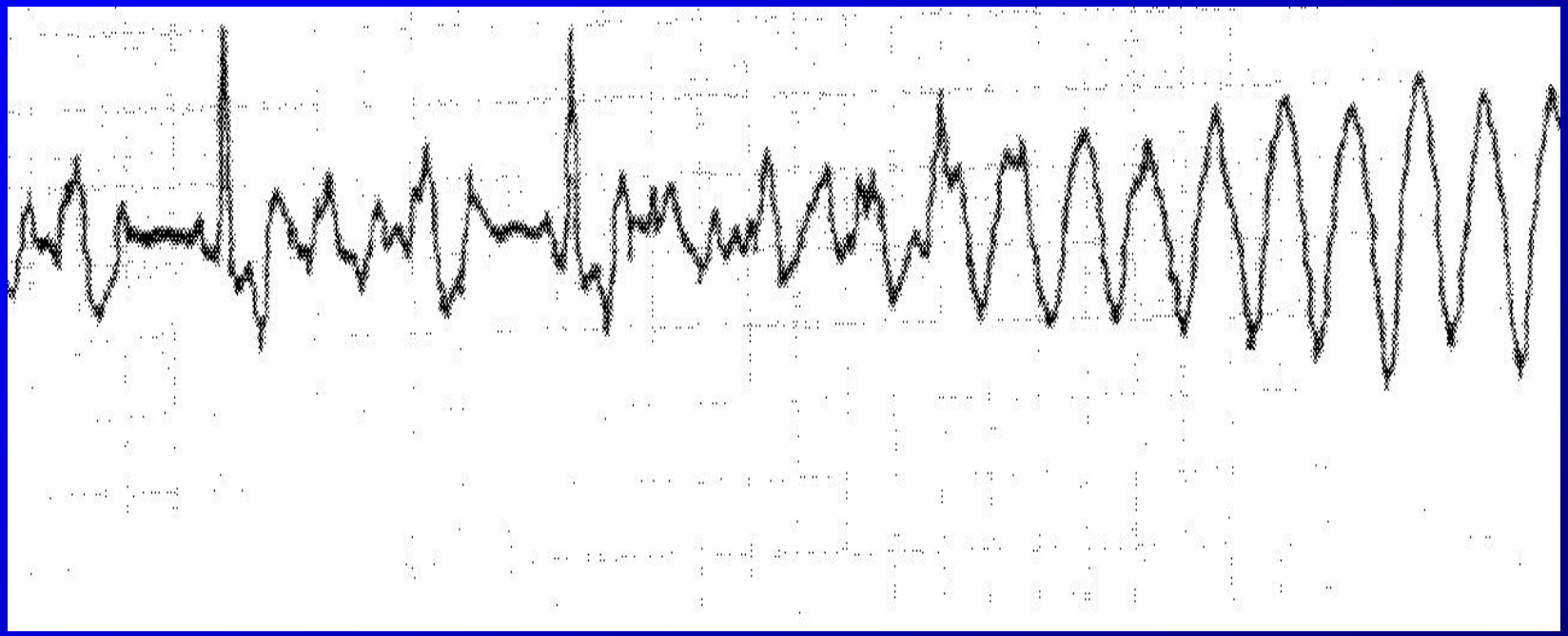
Neurotoxicity

Mechanismus

selective depression of inhibitory pathways a/or centers in CNS enabling subsequent CNS excitation



Local anaesthetics
- cardiotoxicity

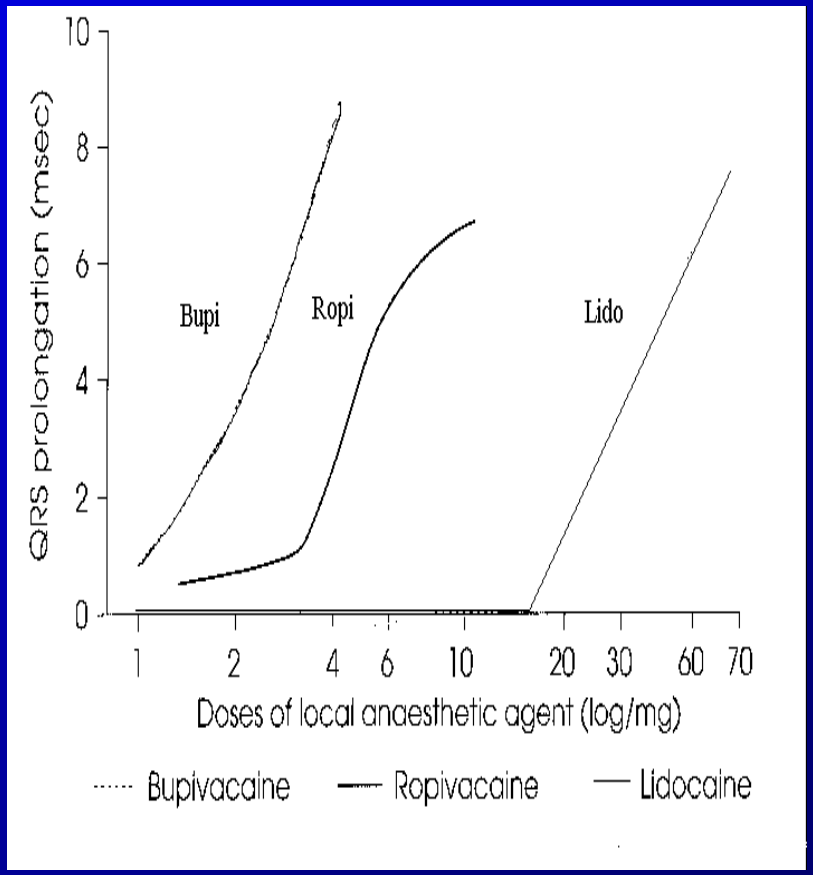


Local anaesthetics - cardiotoxicity

- effect on myocardium
  - conduction disturbances (Clarkson 1985)
  - negative inotropy (Lynch 1986)
  - coronary vasoconstriction (Leone 1989)
- sympathetic nerves block (Hotvedt 1983)
- effect on CNS (Thomas 1986)

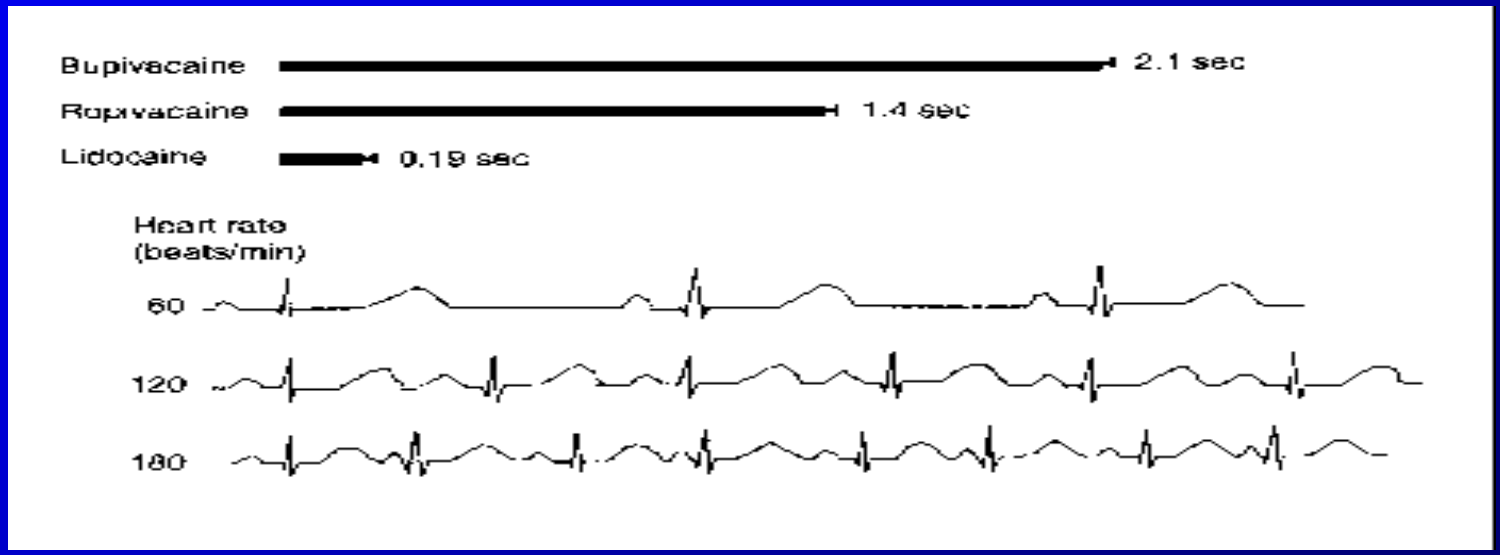
Local anaesthetics - cardiotoxicity

- conduction disturbances
  - QRS widening
  - electrophyziolog. toxicity: 15 : 6.7 : 1
- contractility disturbance
  - dP/dT
  - cardiodepressive effect: 4 : 3 : 1

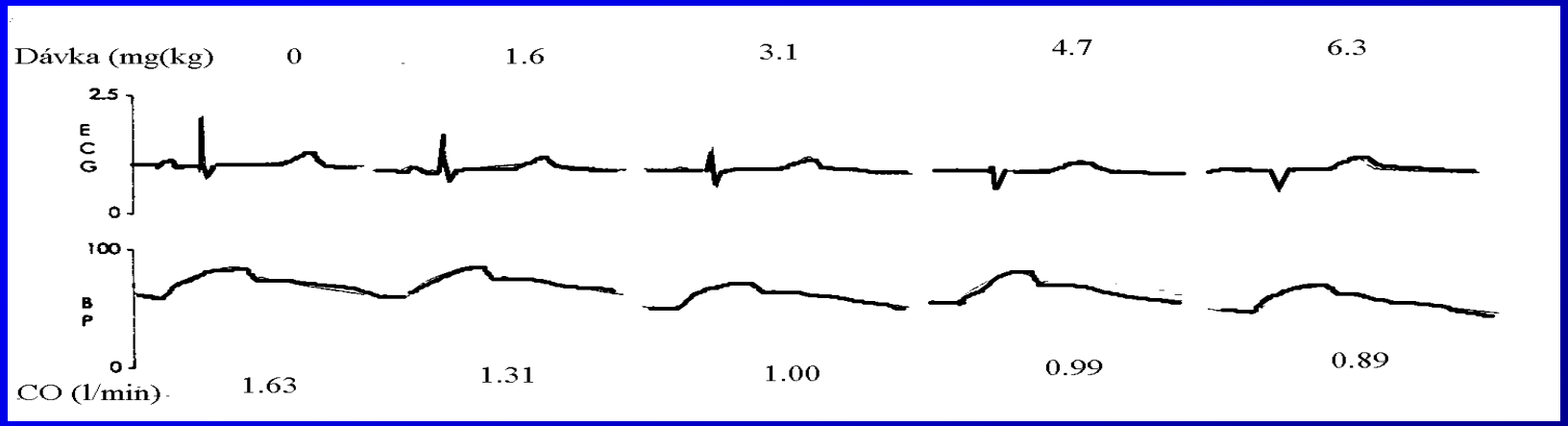


Local anaesthetics - cardiotoxicity

myocardial sodium channel block



Local anaesthetics cardiotoxicity - diagnosis



- BP and HR not very different
- CO decreases by 40 %, SVR increases
- R amplitude decreases, QRS is widening

Nyström, E.U.M. et al.: Blood Pressure Is Maintained Despite Profound Myocardial Depression During Acute Bupivacaine Overdose in Pigs

Anesth Analg 1999; 88: 1143-48

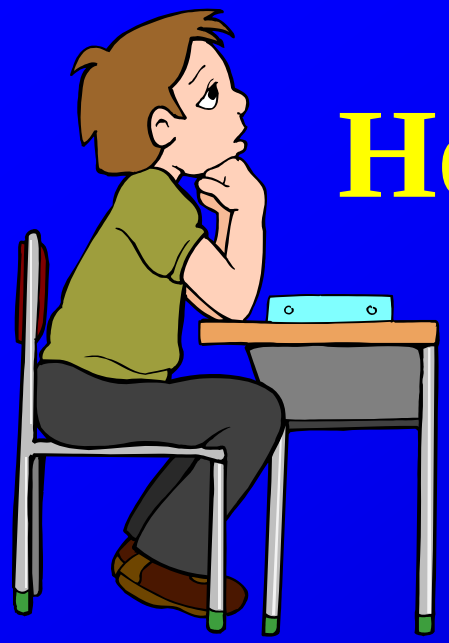
Local anaesthetics cardiotoxicity - treatment

- according to symptoms and guidelines
- oxygen, ventilation
- convulsions → anticonvulsive agents
- i.v. fluids, atropine, ephedrine, epinephrine
- **intralipid**

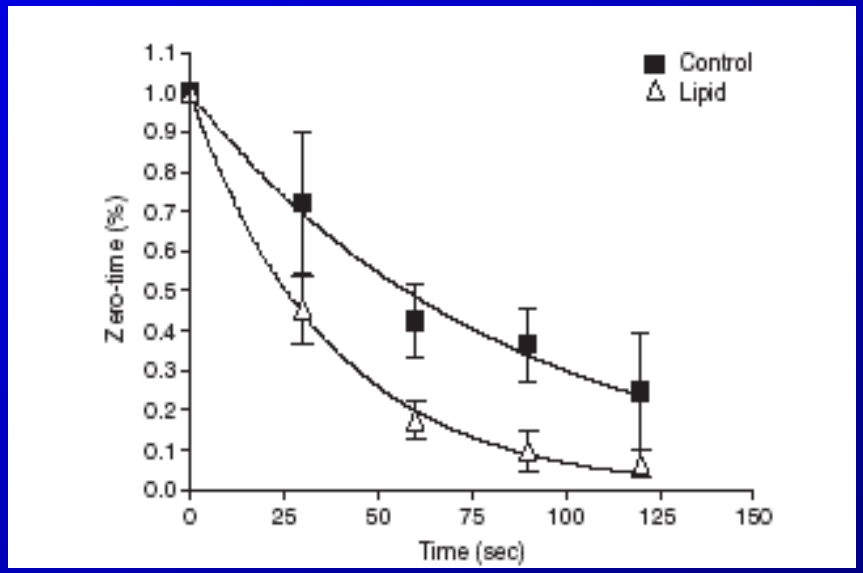
LipidRescue™

- significant signs of toxicity
  not responsive on standard treatment
- bolus 20% intralipid 1 ml/kg during 1 minute
- to be repeated by 3-5 minutes till max. dose 3 ml/kg
- to continuje with infusion 0.25 ml/kg/min till recovery of the circulation
- dose > 8 ml/kg unnecessary

Weinberg, G.: Reply to Drs. Goor, Groban, and Butterworth—lipid rescue: caveats and recommendations for the “Silver Bullet”
Reg Anesth Pain Med **2004**: 29: 74



How is it functioning?



- „lipid sink“
  Weinberg G: Toxicol Rev 2006;25(3):139-145
- CACT inhibition reversal
  Stehr SN et al: Reg Anesth Pain Med 2005;30:5
- direct pozitive inotropic effect
  Stehr SN et al.: Anesth Analg 2007;104:186-192

Can propofol substitute intralipid?

- adjusted in 10% emulsion, i.e. ½ dilution
- different emulsions of different producers
- necessary dose of 20% lipidu 1 ml/kg = 2 ml/kg 10 %, i.e. propofol dose 20 mg/kg = 1,5 g!
- propofol effects:
  - cardiodepressant
  - vasodilatation
  - mitochondrial inhibitos

PROPOFOL CONTRAINDICATED!

Reg Anesth Pain Med. 2010 Mar-Apr;35(2):188-93.

Treatment of local anesthetic systemic toxicity (LAST).

Weinberg GL.

University of Illinois College of Medicine, Jesse Brown VA Medical Center, Chicago, IL 60612, USA. guyw@uic.edu

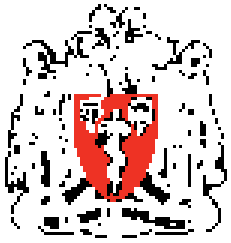
- prevention
- set the diagnosis of toxicity!
- have a plan and equipment
- ABCD of resuscitation
  - patent airways
  - breathing = oxygenation + ventilation
  - high-quality CPR
- suppress convulsions
- consider the possibility of cardiopulmonary bypass
- lipid emulsion
- adrenaline in low doses only, do not use vasopressin

Guidelines

- lipid emulsion + Weinberg´s protocol should be immediately available when LA are administered in high doses

- patients should be always treated using lipid emulsion

Picard J.: Lipid emulsion to treat overdose of local anaesthetic: the gift of the glob. Anaesthesia 2006;61(2):107-109



THE ASSOCIATION OF ANAESTHETISTS

of Great Britain & Ireland

Guidelines for the Management of Severe Local Anaesthetic Toxicity

Management of cardiac arrest associated with LA injection:

- Start cardiopulmonary resuscitation (CPR) using standard protocols
- Manage arrhythmias using the same protocols, recognising that they may be very refractory to treatment
- Prolonged resuscitation may be necessary; it may be appropriate to consider other options:
  - **Consider the use of cardiopulmonary bypass if available**
  - **Consider treatment with lipid emulsion**

Treatment of cardiac arrest with lipid emulsion: (approximate doses are given in red for a 70-kg patient)

- Give an intravenous bolus injection of Intralipid® 20% 1.5 ml.kg^{-1} over 1 min
  - Give a bolus of 100 ml
- Continue CPR
- Start an intravenous infusion of Intralipid® 20% at 0.25 ml.kg^{-1}.min^{-1}
  - Give at a rate of 400 ml over 20 min
- Repeat the bolus injection twice at 5 min intervals if an adequate circulation has not been restored
  - Give two further boluses of 100 ml at 5 min intervals
- After another 5 min, increase the rate to 0.5 ml.kg^{-1}.min^{-1} if an adequate circulation has not been restored
  - Give at a rate of 400 ml over 10 min
- Continue infusion until a stable and adequate circulation has been restored

http://www.lipidrescue.org

http://www.lipidregistry.org

- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks

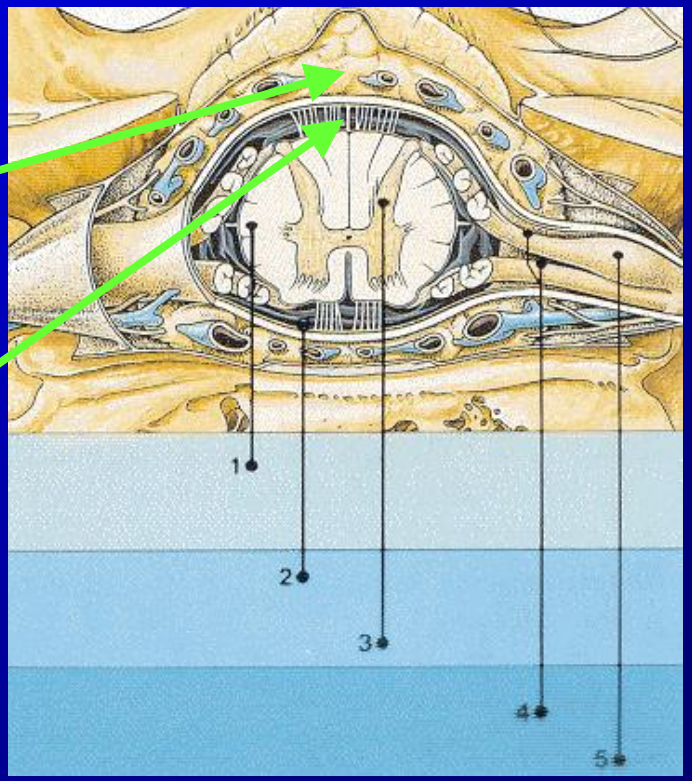
Central = neur(o)axial blocks

LA + other drugs

near the spinal cord

- epidural
  - caudal
- subarachnoid = spinal

- single-shot
- continual



Indications for central blocks

- absolute - none
- relative
  - surgery, especially below the navel
  - big surgery in abdominal and/or thoracic cavity
  - postoperative pain treatment
  - chronic pain treatment

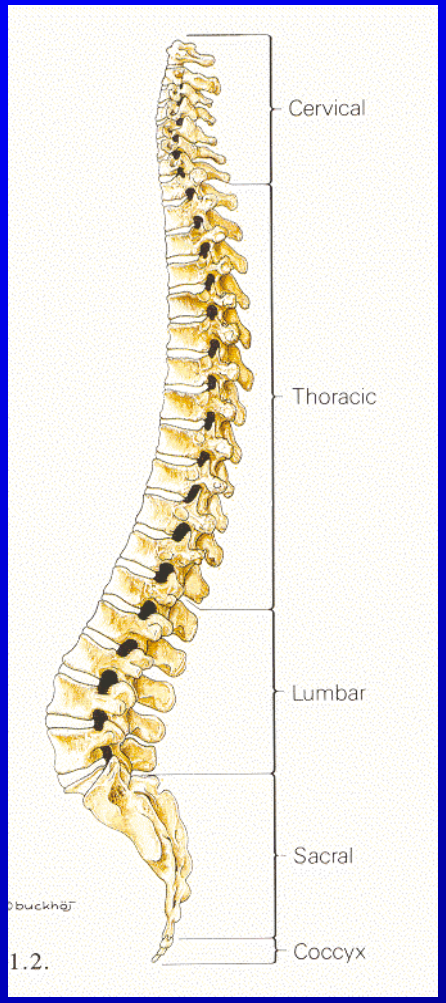
Spinal anatomy

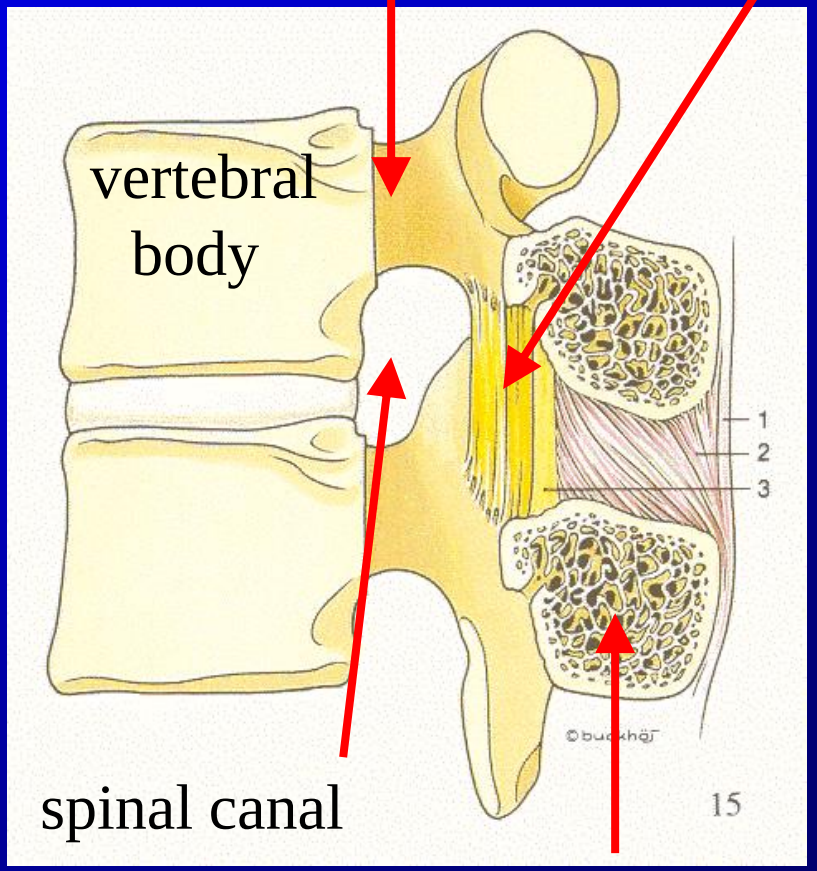
C1 - C7

Th1 - Th12

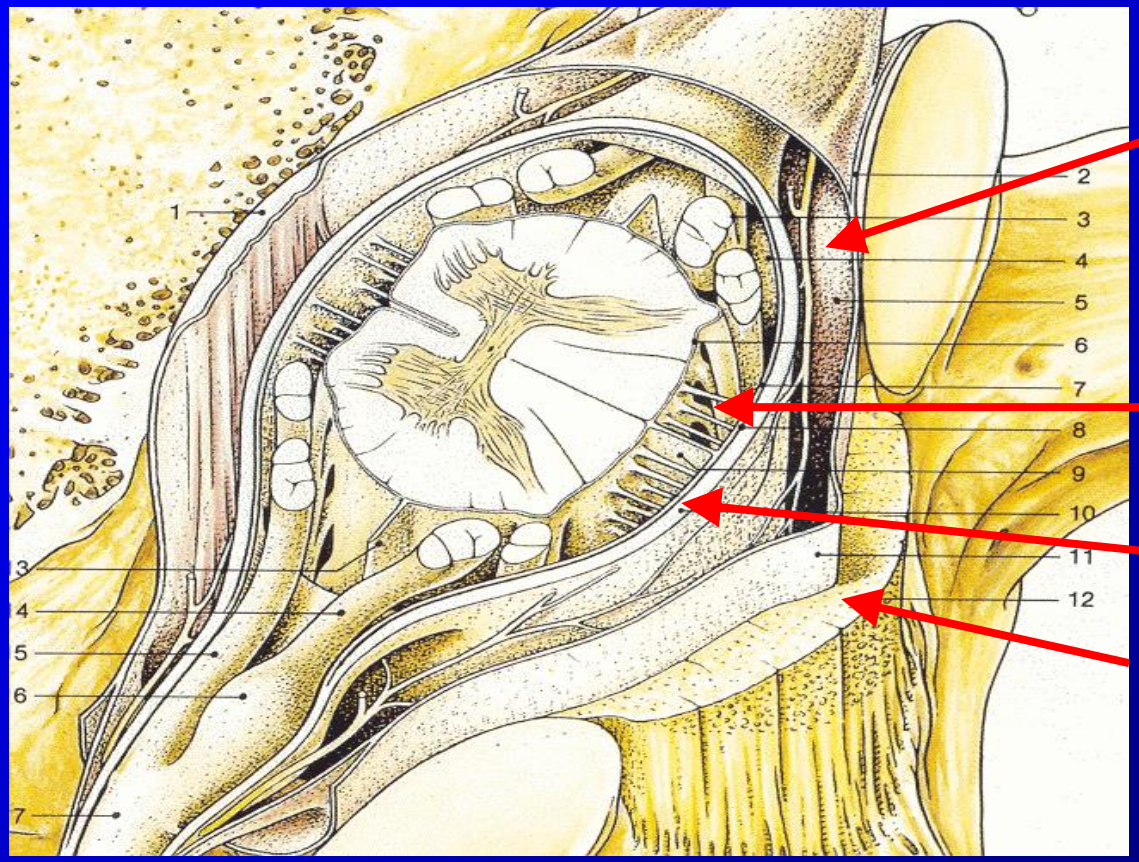
L1 - L5

S1 - S5





Spinal column and spinal cord



epidural space

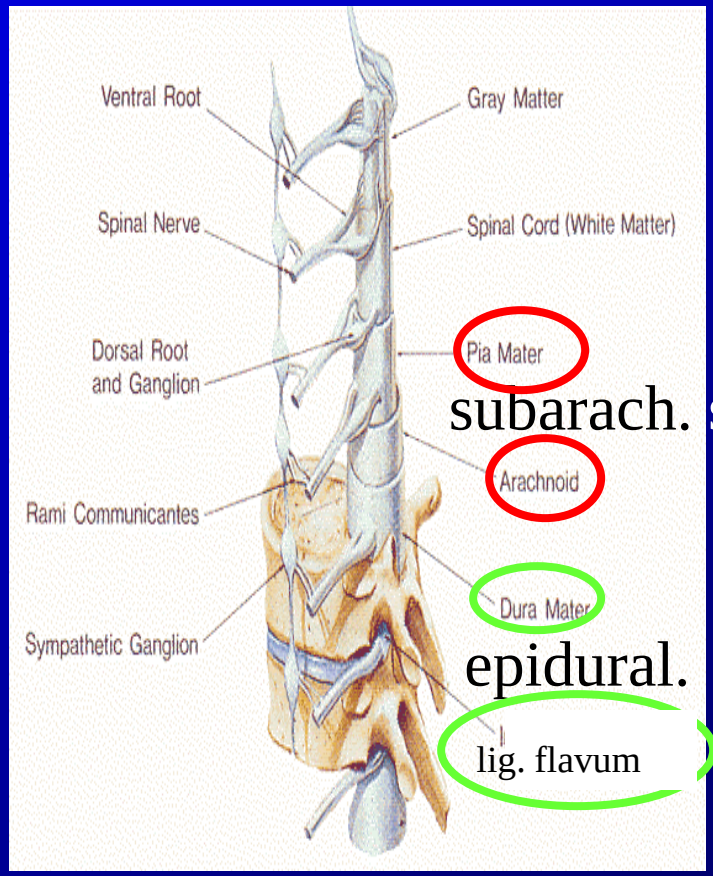
subarachnoid space

dura mater

lig. flavum

Spinal column and cord

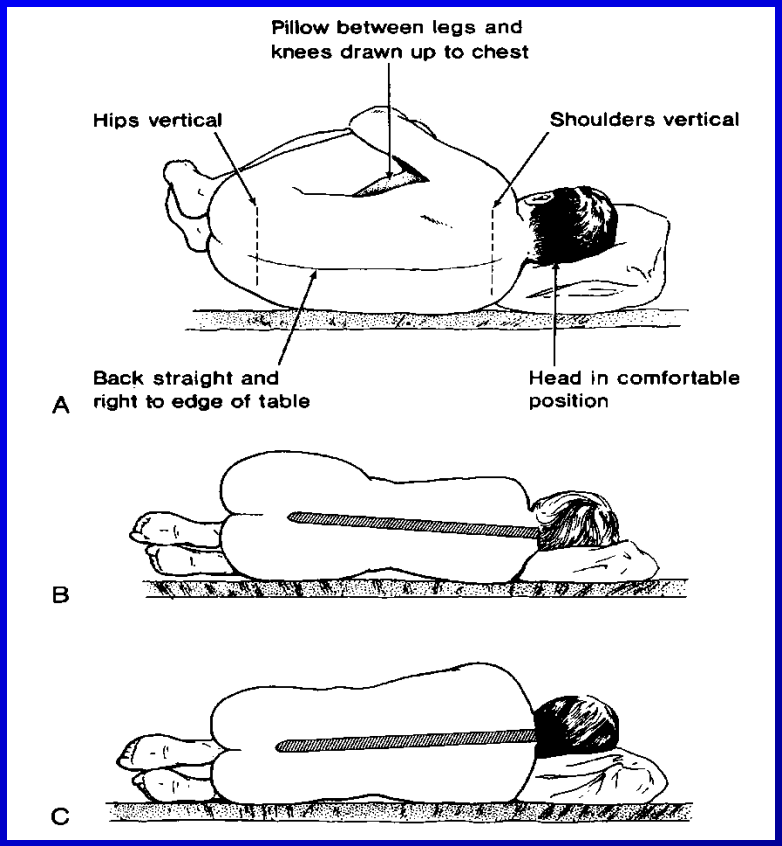
- epidural space
  - lig. flavum
  - dura mater
  - vessels, fat
- Subarachnoid space
  - pia arachnoidea
  - pia mater
  - cerebrospinal fluid

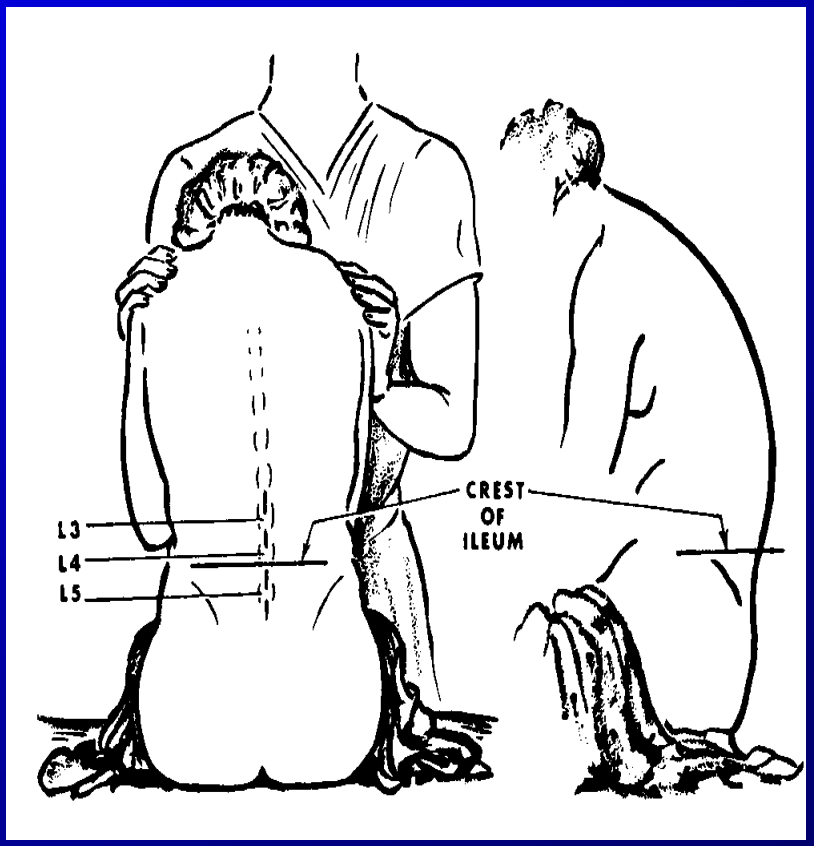


subarach. sp.

epidural. sp.

Patient´s position





Patient´s position

lying on side

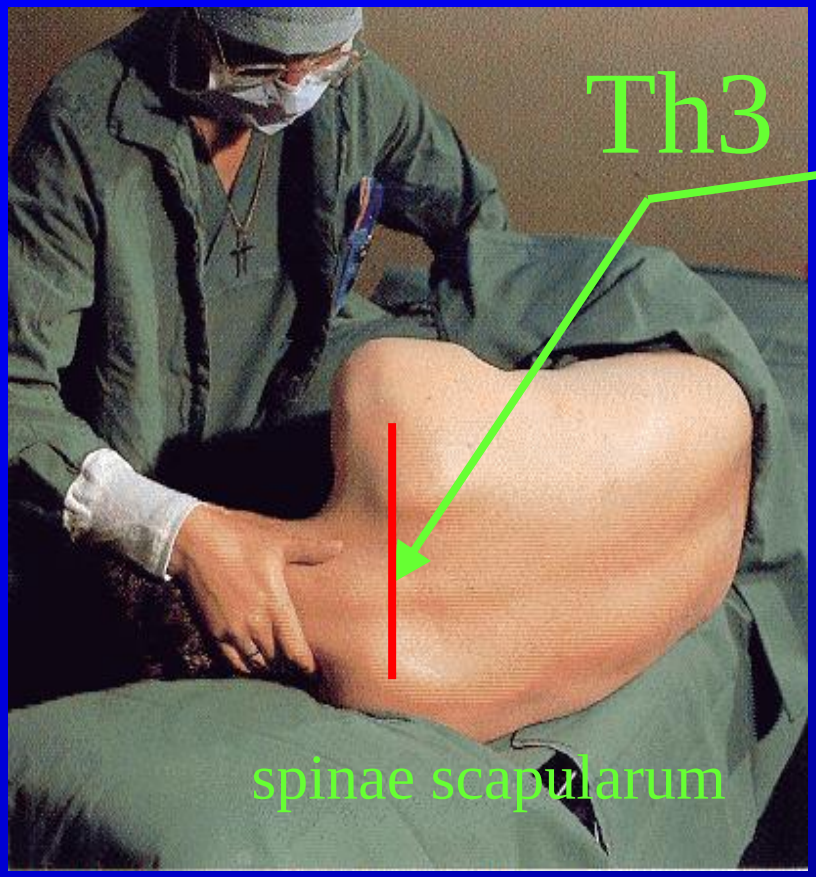
sitting

Orientation

lying on side

sitting

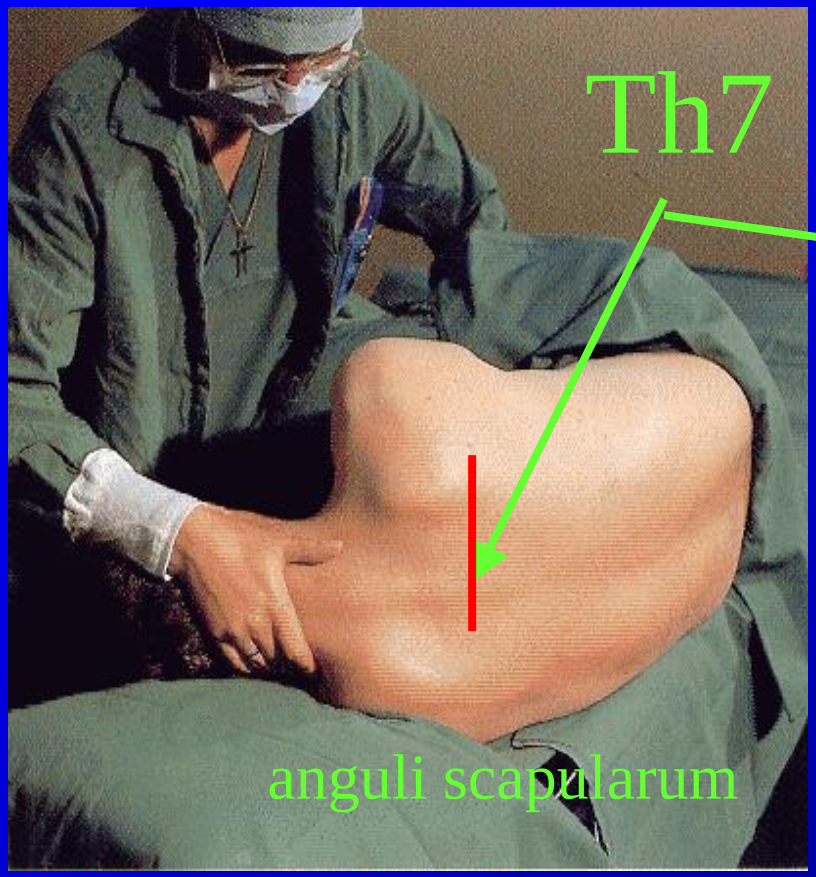
Orientation

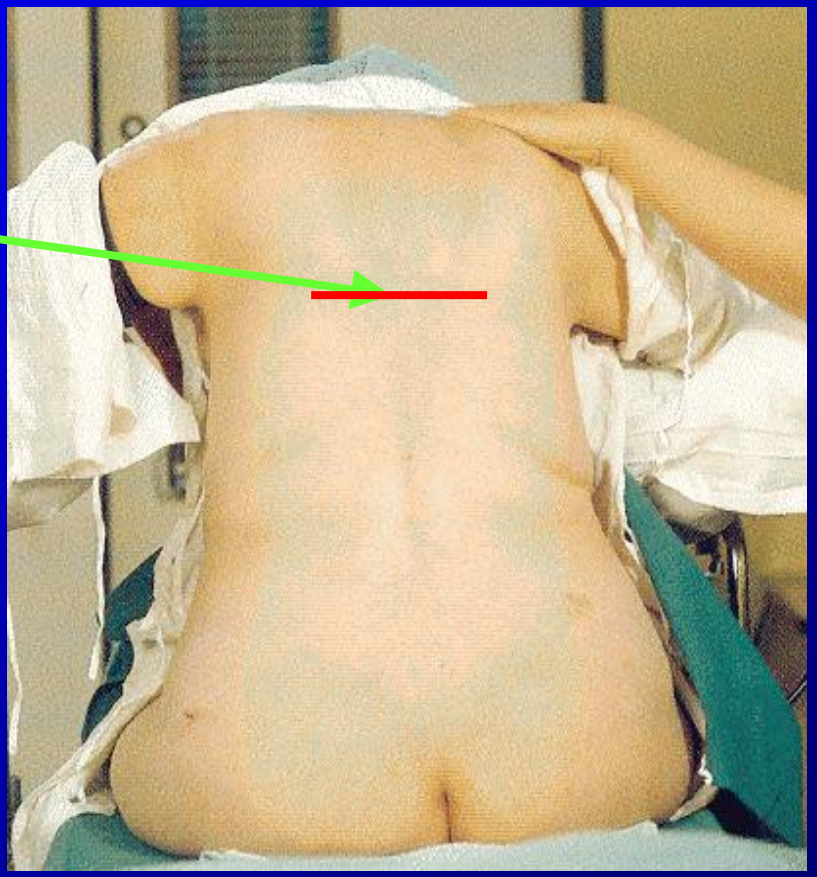


lying on side

sitting

Orientation



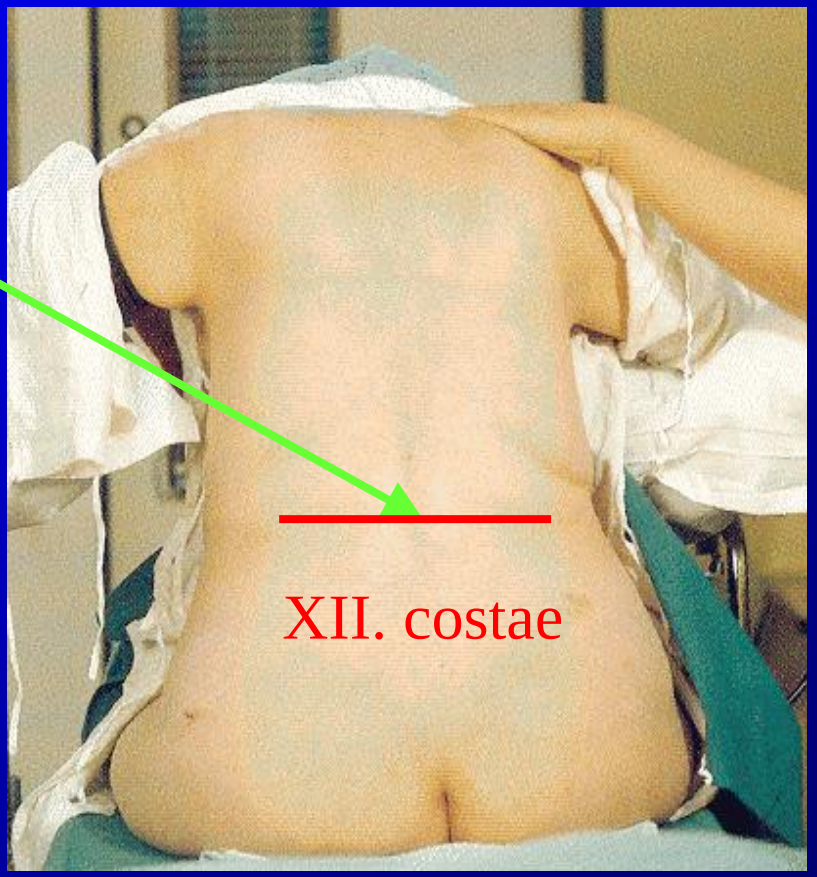


lying on side

sitting

Orientation

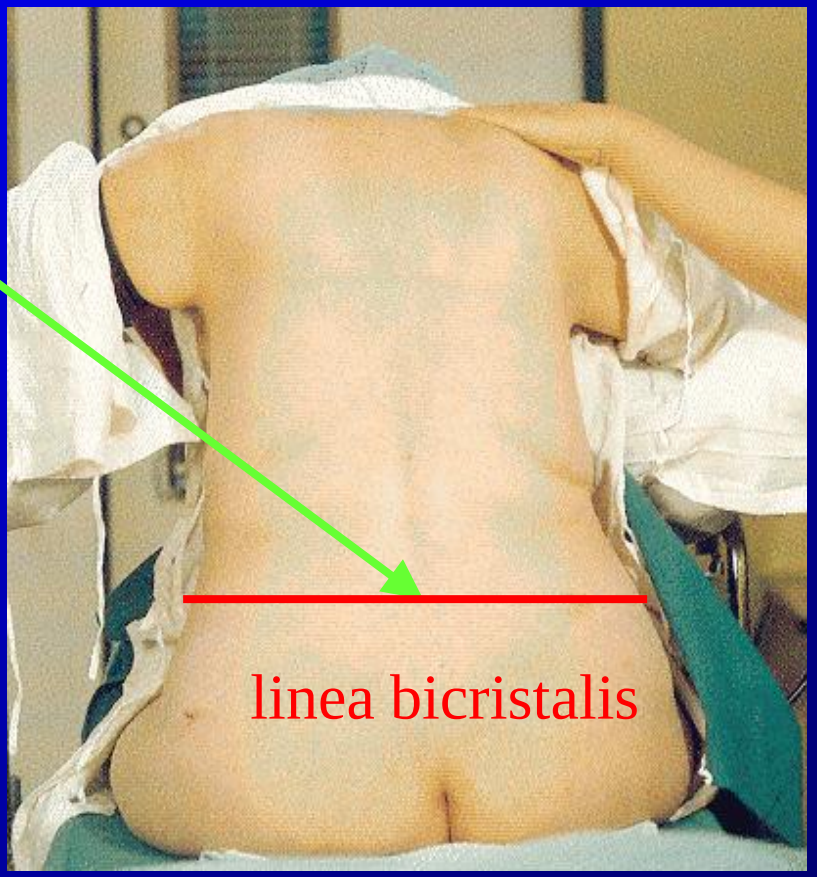
lying on side



sitting

Orientation

lying on side



sitting

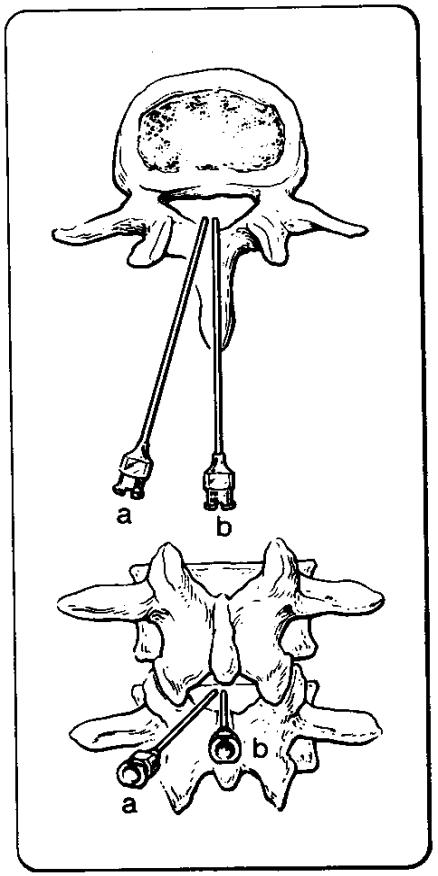
Orientation

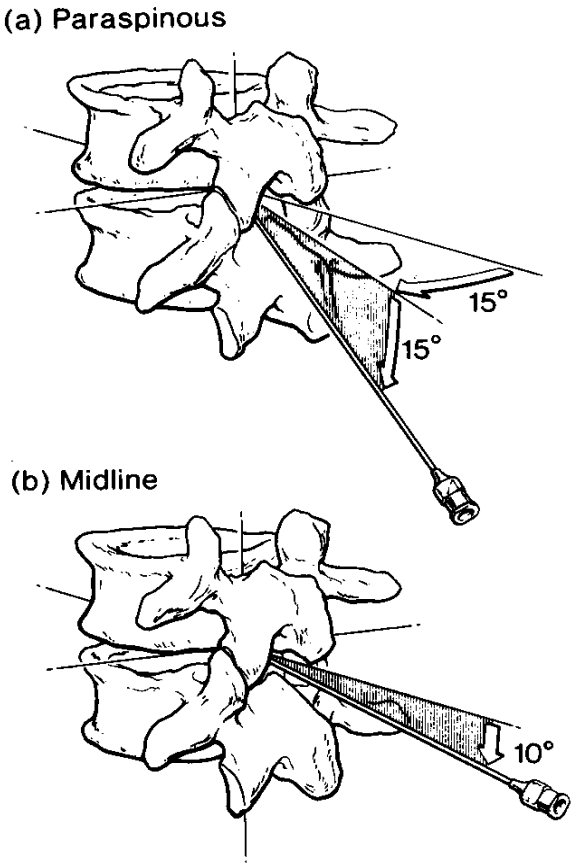
lying on side

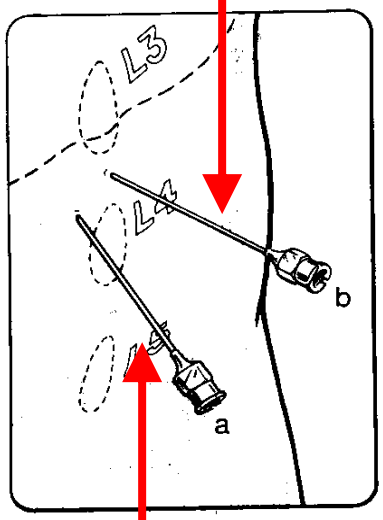
sitting

hiatus canalis sacralis

Approaches to spinal canal



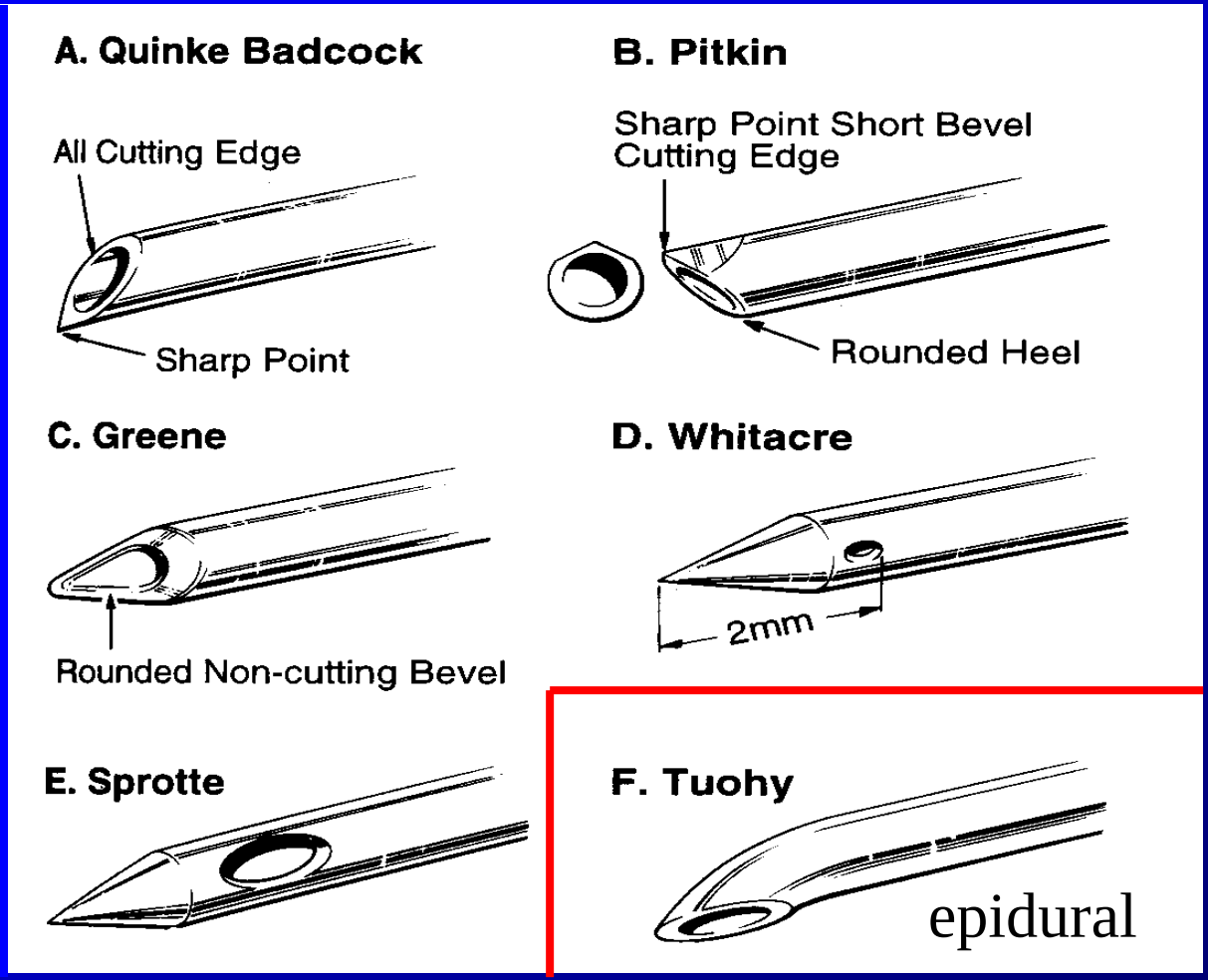




median

laminar

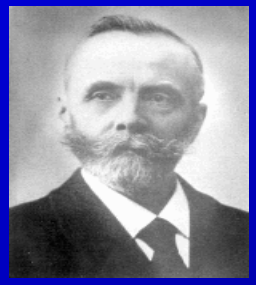
Needles for spinal/epidural anaesthesia



Spinal (subarachnoid) anaesthesia

LA and other drugs in CSF

- lumbar puncture
  - Heinrich Quincke (1841-1922)
- the first SA
  - August Bier (1861 - 1949)
- decline
  - Wooley and Roe case 1954
- today popular

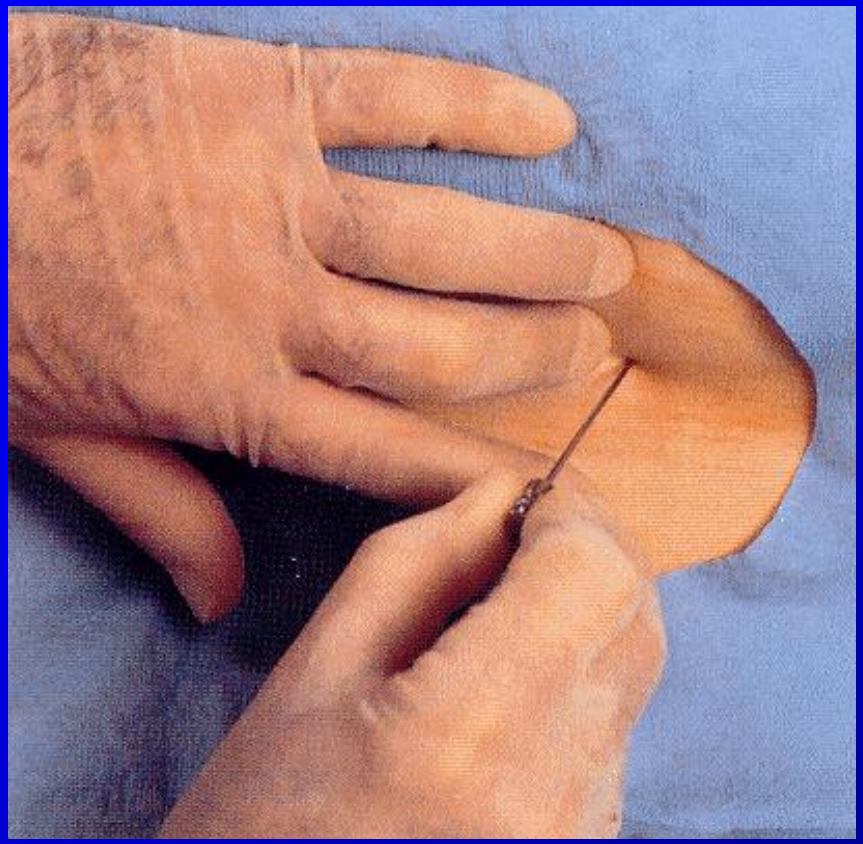


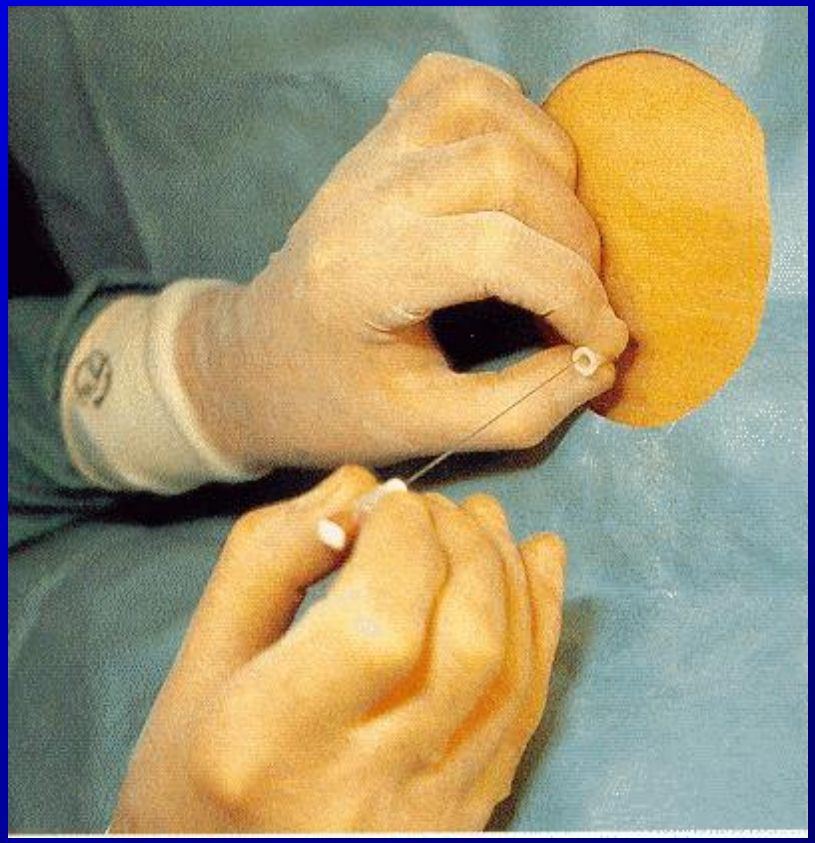
Quincke

Bier

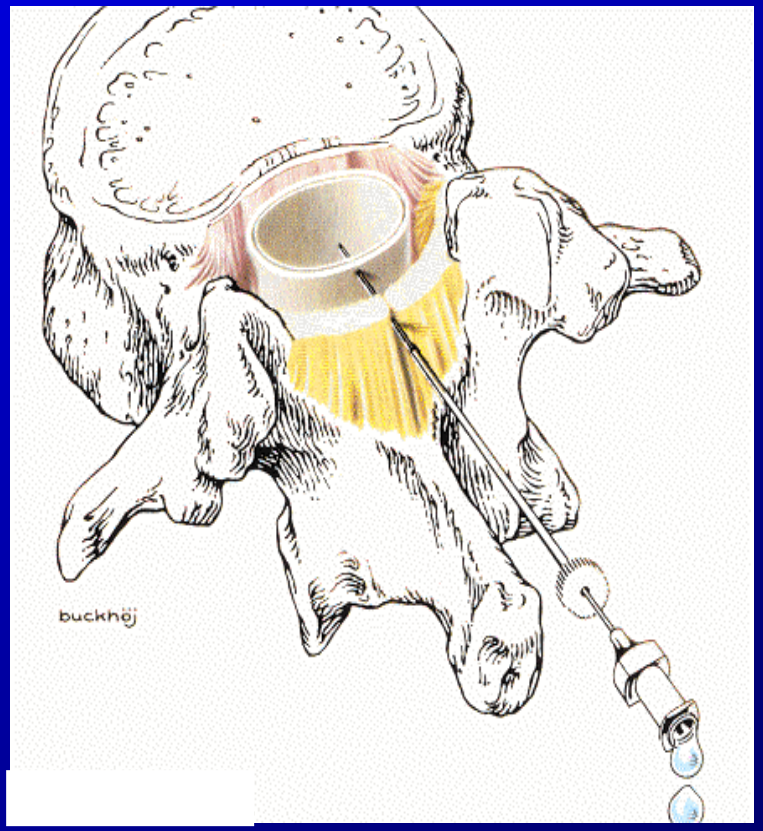
Bier performs SA round 1925

Spinal block





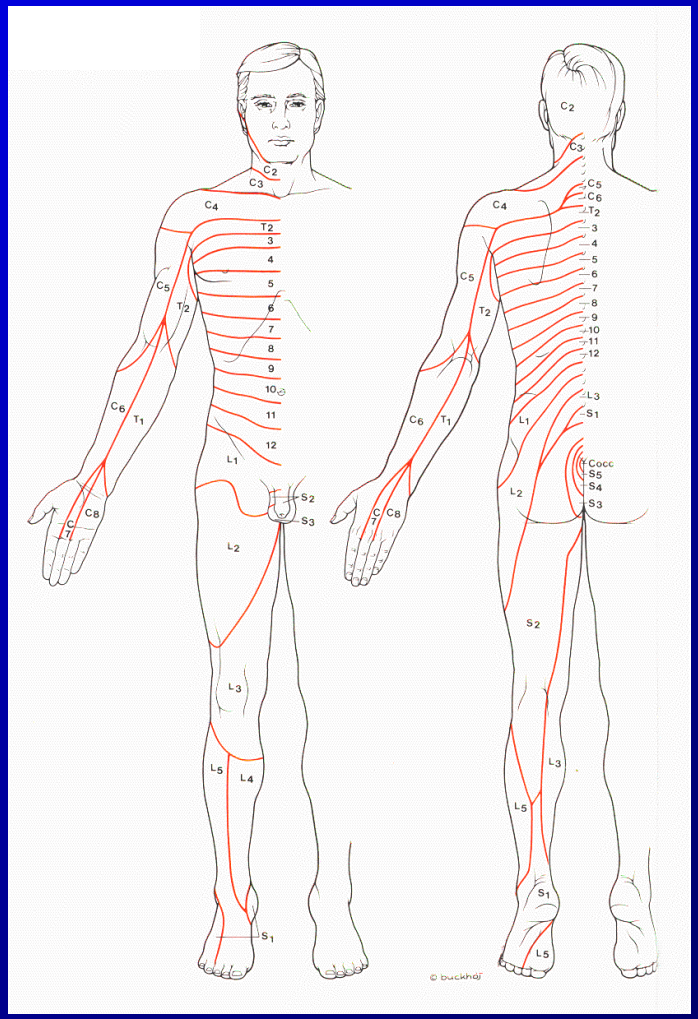
Spinal block



Block extent

influenced by 23 factors, especially:

- level of injection
- CSF volume
- LA
  - dose
  - volume
  - baricity
- patient position



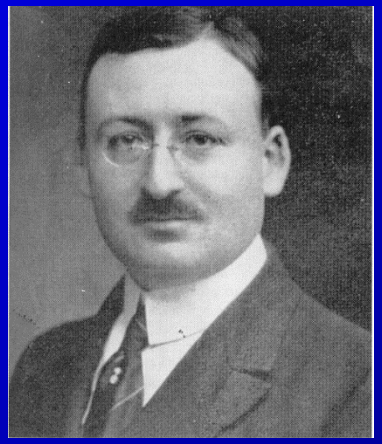
Spinal anaesthesia - - complications

- postdural puncture headache
- hypotension
- backache
- spinal canal bleeding

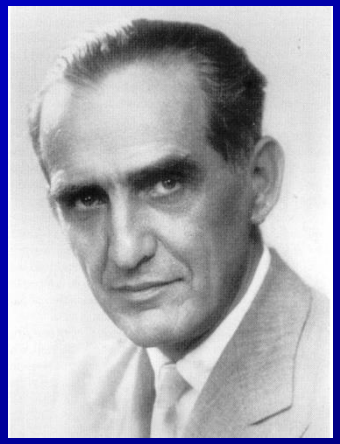
Epidural anaesthesia

LA and other drugs
into epidural space

- the first epidural anaesth.
  - 1921 Pagés
- decline
  - Wooley and Roe case 1954
- today
  - routine for big surgeries

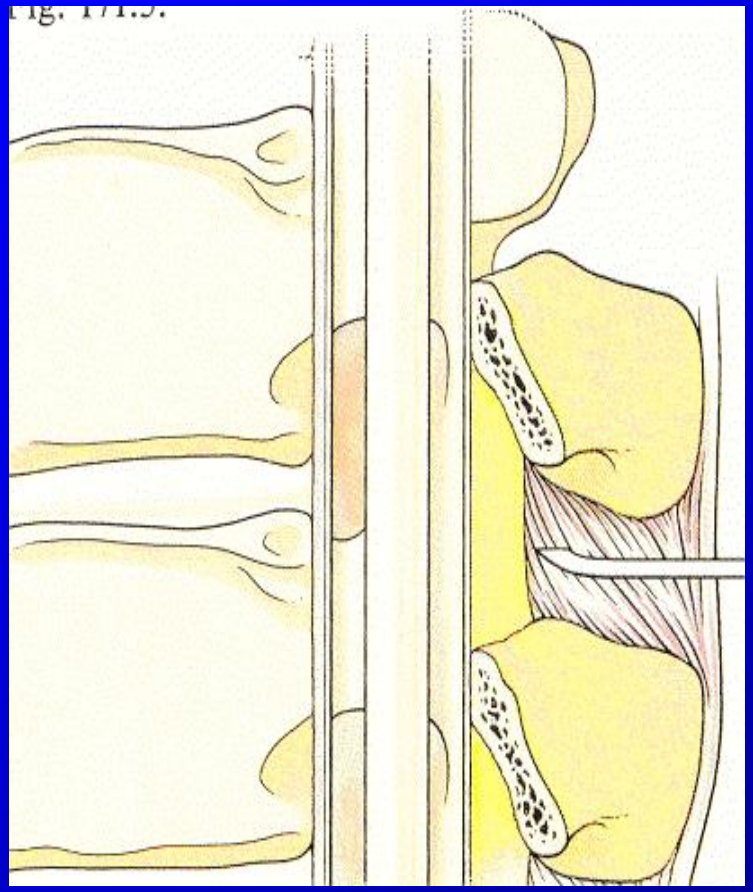


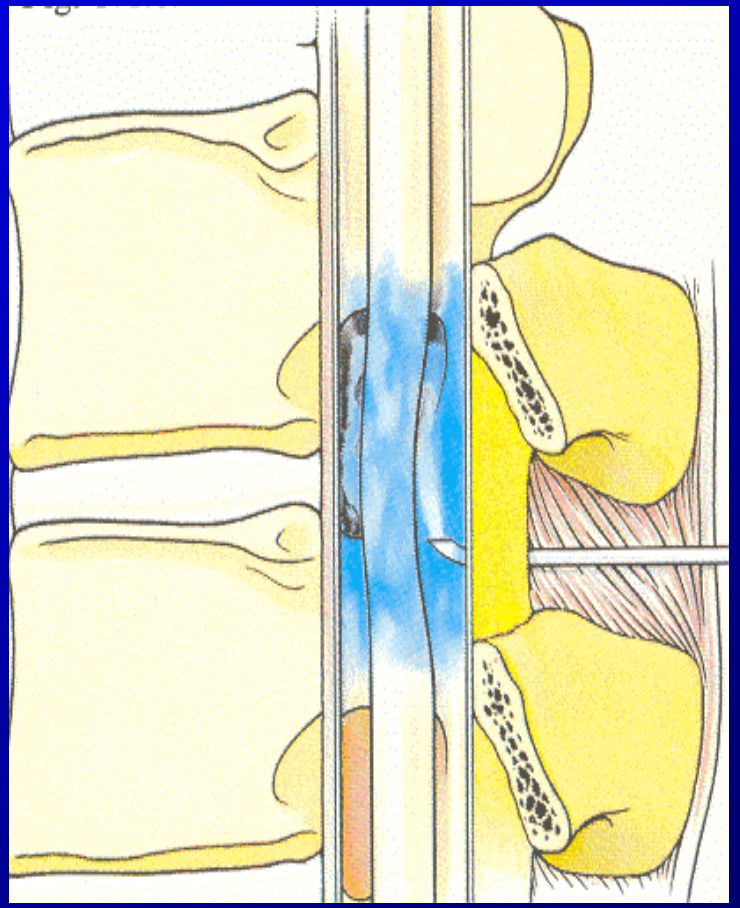
Pagés



Dogliotti

Epidural anaesthesia



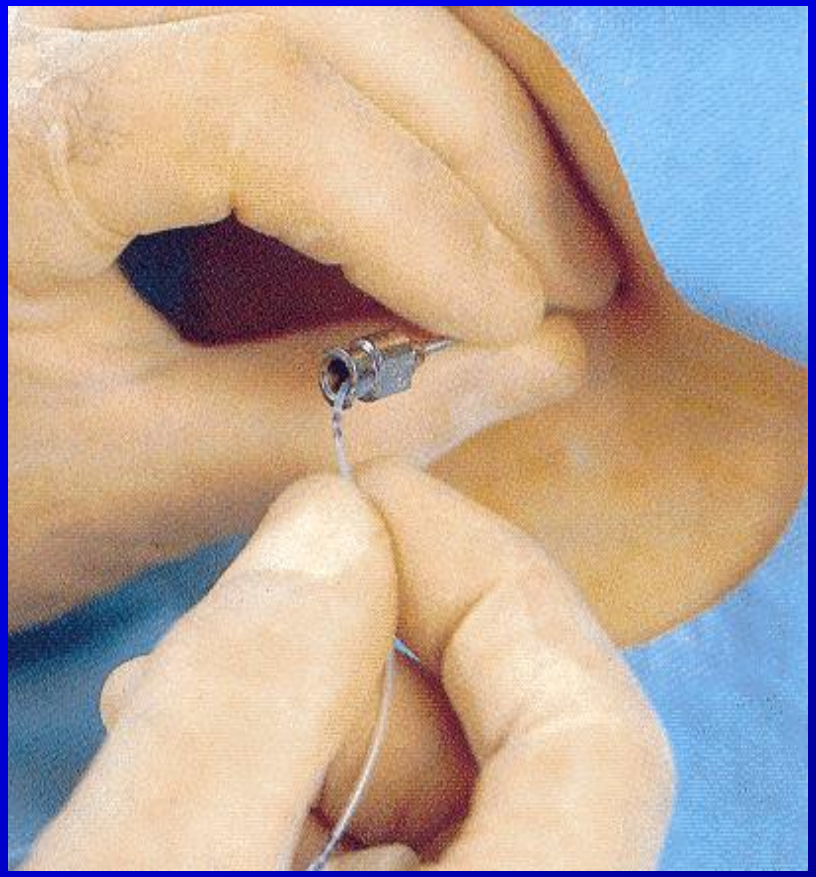


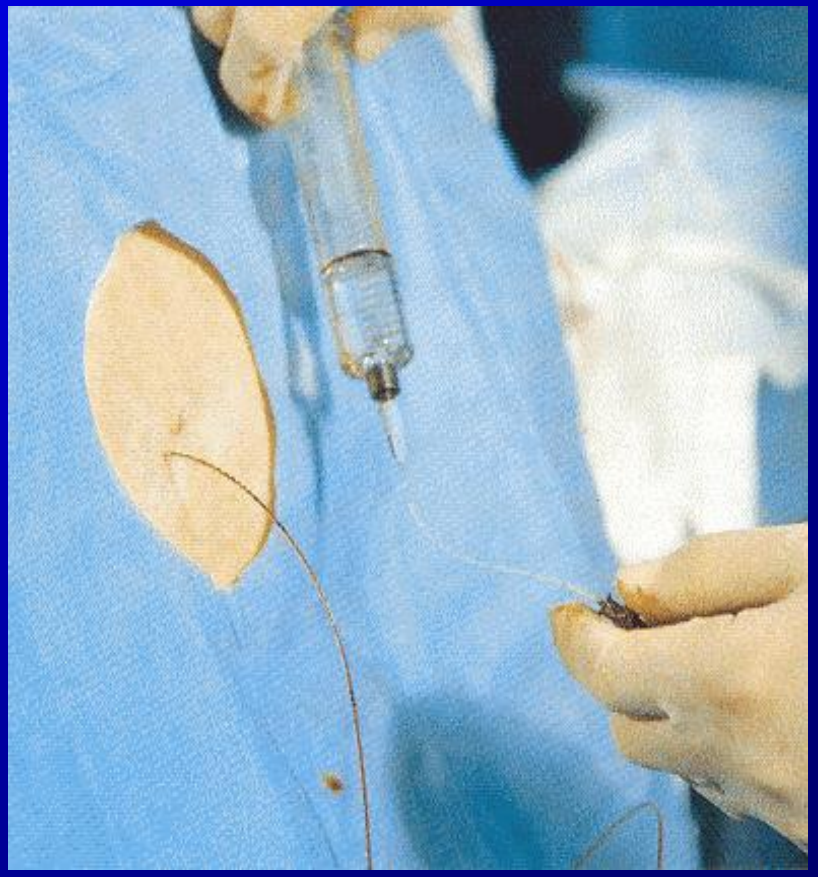
Epidural anaesthesia - detection

hanging drop

loss of resistance

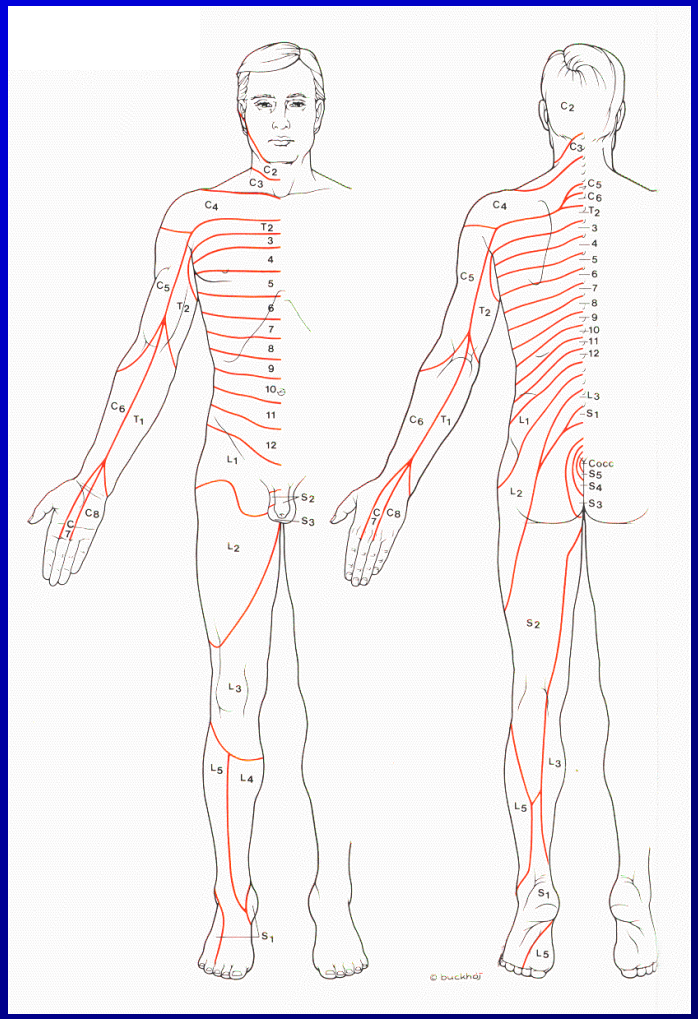
Continuous epidural anaesthesia



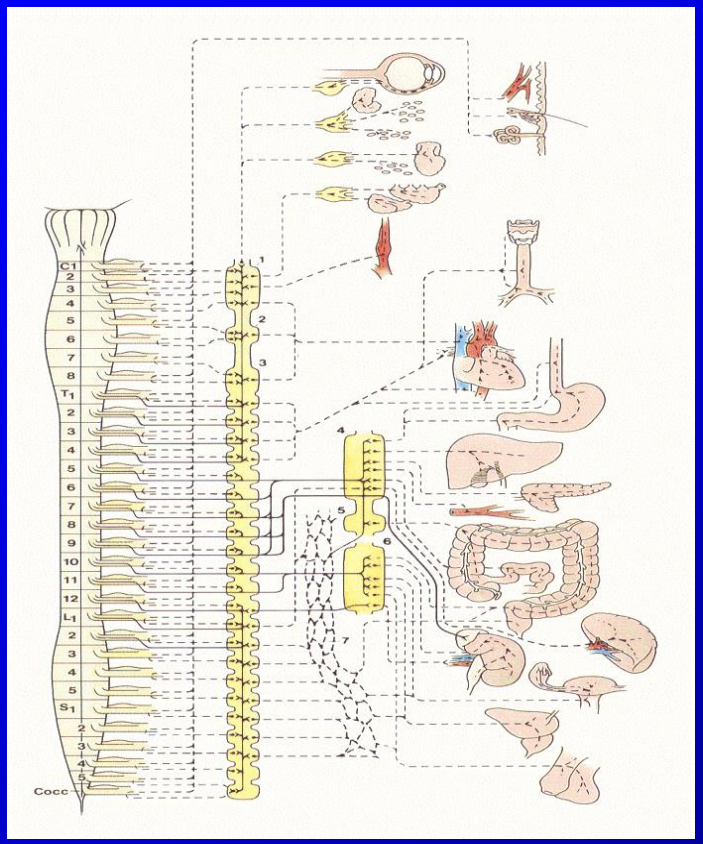


Block extent

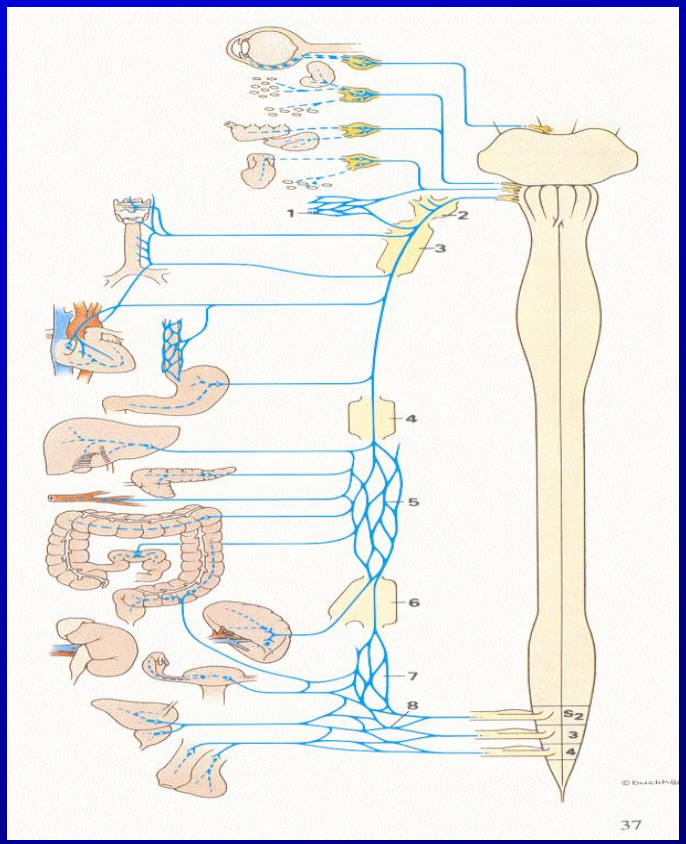
- level of injection
- age, height, weight
- LA
  - dose
  - volume



Vegetative innervation



Sympathetic n.s.



Parasympathetic n.s.

Differences between SA and EA

	Spinal	**Epidural**
Site of injection	CSF	Epidural space
Dose	≤ 20 mg	≤ 100 mg
Latency	≤ 10 minutes	15-20 minutes
Motor function	Plegia	Paresis
Sensitivity	Anaesthesia	Analgesia

Differences between SA and EA

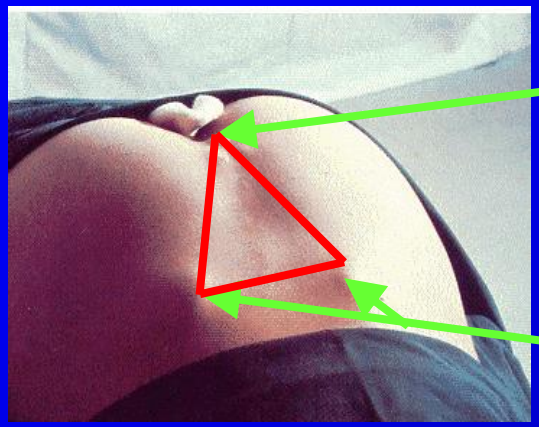
SA - advantages

- simple
- easy detection
- fast onset
- deep anaesthesia
- level control
- risk of toxicity ≈ 0

EPI -advantages

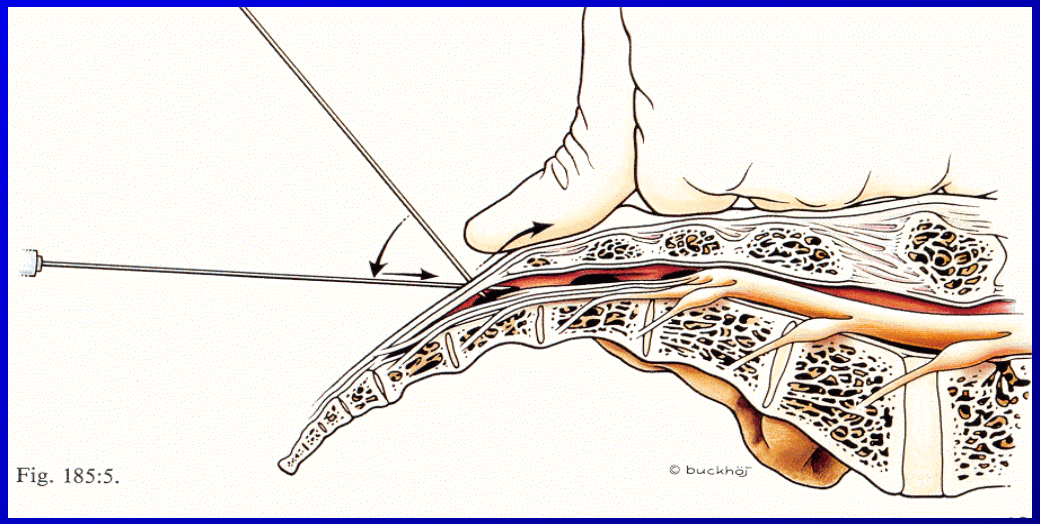
- w/o dural puncture
  - PDPH risk small
  - infection risk small
- less hypotension
- segmental analgesia
- sensory-motor separation

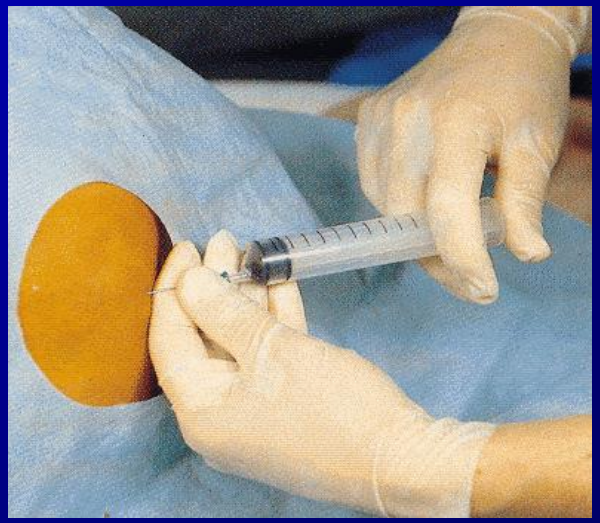
Caudal block



hiatus sacralis

spinae illiacae posteriores superiores





- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks
  - upper extremities

Brachial plexus blocks

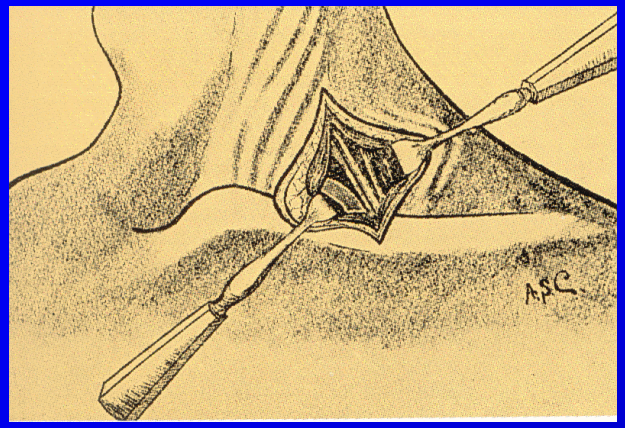
Rembrandt: Lecture on anatomy by dr. Nicolaes Tulp 1632

REGIONAL ANESTHESIA AND PAIN MEDICINE

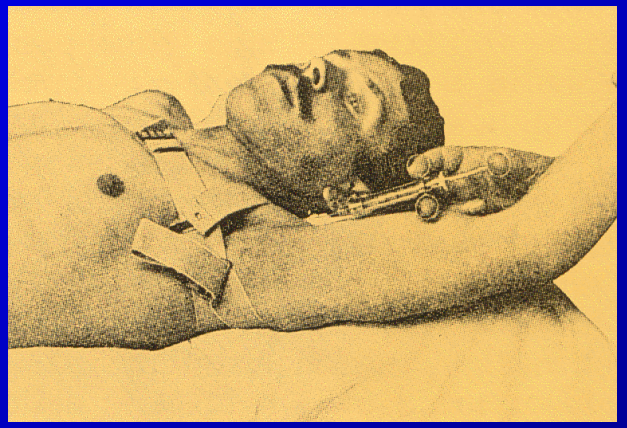
Peripheral Nerve Blocks -
- Regional Anesthesia for the New Millennium

Horlocker, TT: in Reg Anesth Pain Med 1998; 23(2): 237-240

History

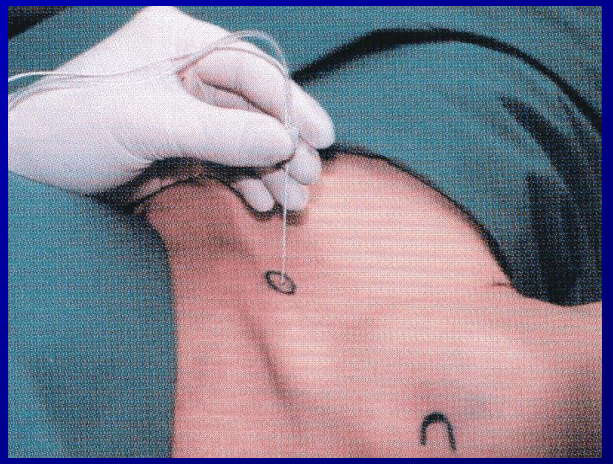


Halsted 1884



Hirschel 1911

Kulenkampff 1911



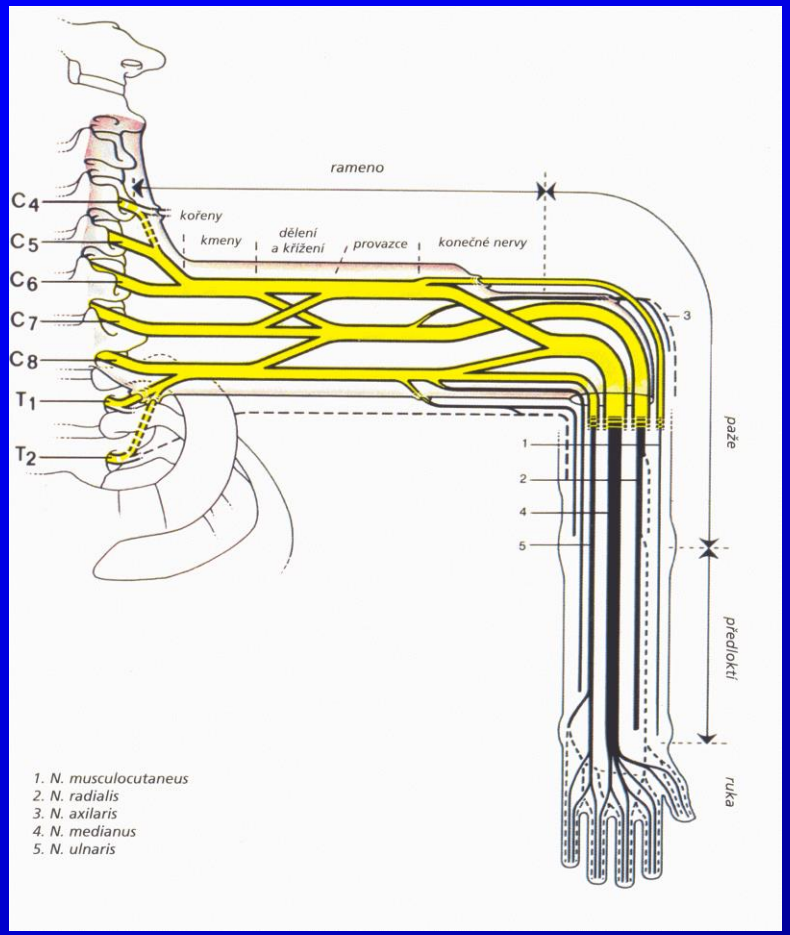
Kilka, Geiger, Mehrkens 1995

Peripheral nerve blocks - - indications

- Postooperative pain
- Sympathetic nerve block
- Mobilization for rehabilitation
- Intolerance of opioids, eg. PONV
- Frostbites, ischaemic damage
- Intraarterial injection
- High-risk patients
- Blood coagulation disturbances
- Difficult intubation

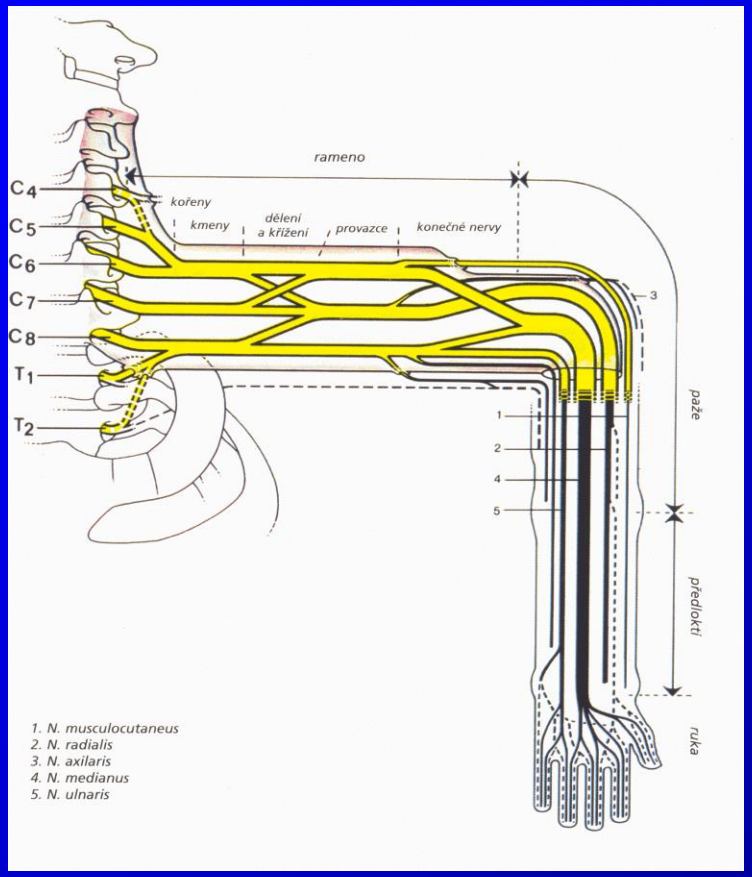
Graf, B.E., Martin E.: Periphere Nervenblockaden
Der Anaesthesist 2001:50:312-322

Brachial plexus



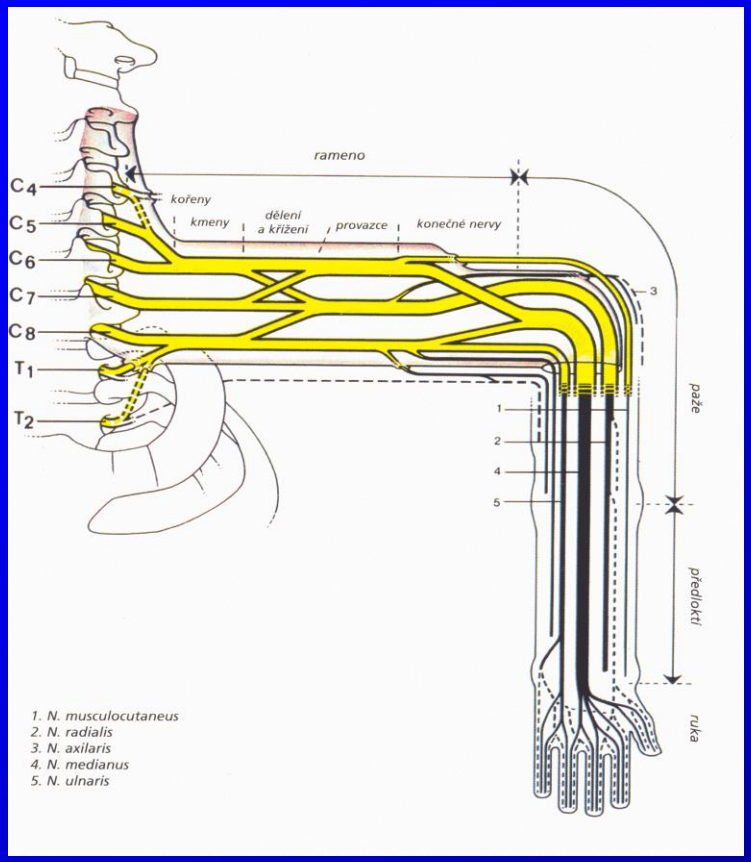
- roots C4 + **C5-Th1** + Th2
- trunks (trunci)
  - upper C5-C6
  - middle C7
  - lower C8-Th1
- division
  - front
  - back

Brachial plexus



- roots
- trunks
- division
- cords (fasciculi)
  - medial
  - lateral
  - back
- terminal nerves

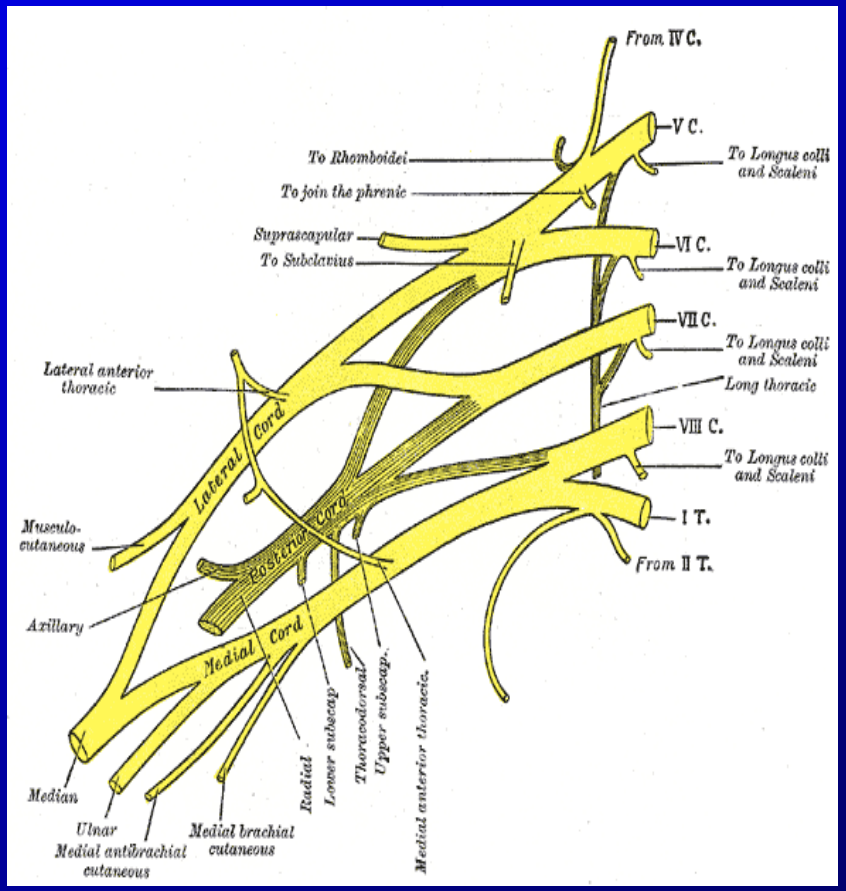
Brachial plexus



- cords (fasciculi)
  - lateral
    - musculocutaneous n.
    - lat. part of median n.
  - medial
    - med. part of median n.
    - ulnar n.
    - medial cutaneous brachial n..
    - medial cutaneous forearm n.
  - back
    - axillary n.
    - radial n.

Brachial plexus

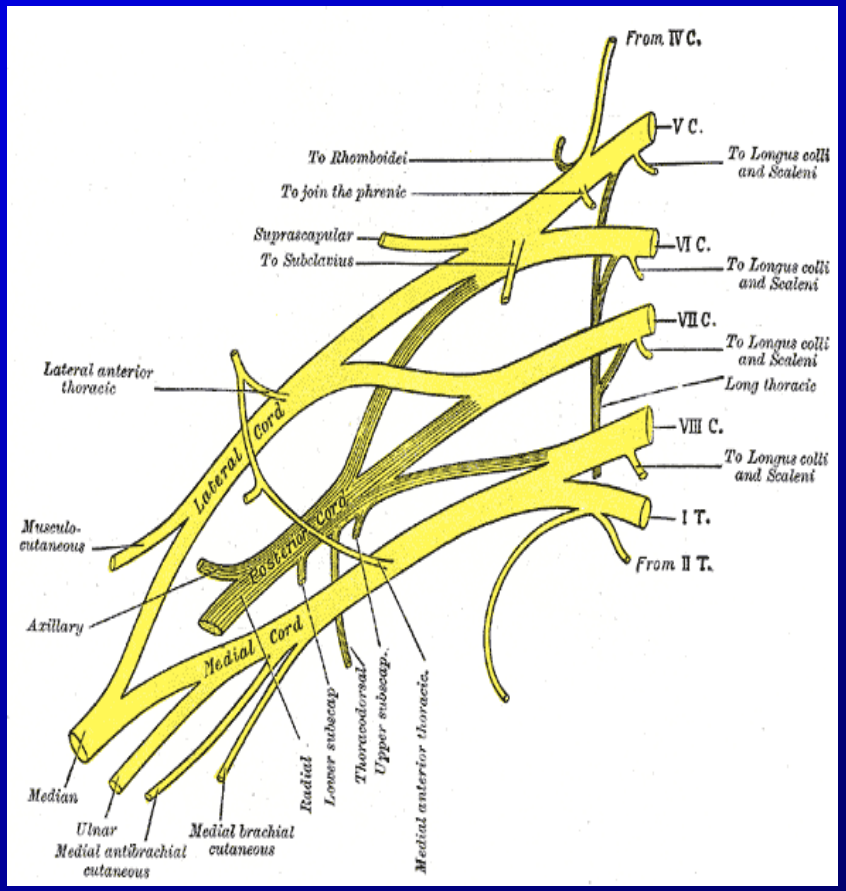
- supraclavicular part
  - dorsal scapular n.
  - long thoracic n.
  - subclavial n.
  - **suprascapular n.**
  - med. and lat. pectoral n.
  - subscapular n.
  - thoracodorsal n.
  - muscular branches
- **infraclavicular part**



Brachial plexus

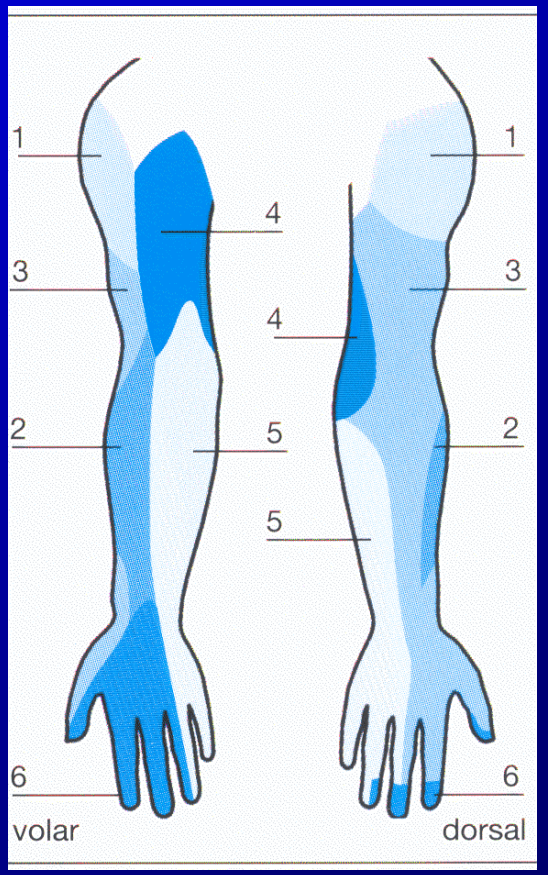
- supraclavicular part
- **infraclavicular part**
  - musculocutaneous n.
  - median n.
  - ulnar n.
  - radial n.
  - axillary n.

- sympathetic nerves to UE: Th1 - Th8



Brachial plexus

1. axillary n. C5-C6
2. musculocutaneous n. C5-7
   (lateral cutaneous forearm n.)
3. radial n. C5-Th1
4. medial cutaneous brachial n. C8-Th1
   medial cutaneous forearm n. C8-Th1
5. ulnar n. C8-Th1
6. median n. C6-Th1



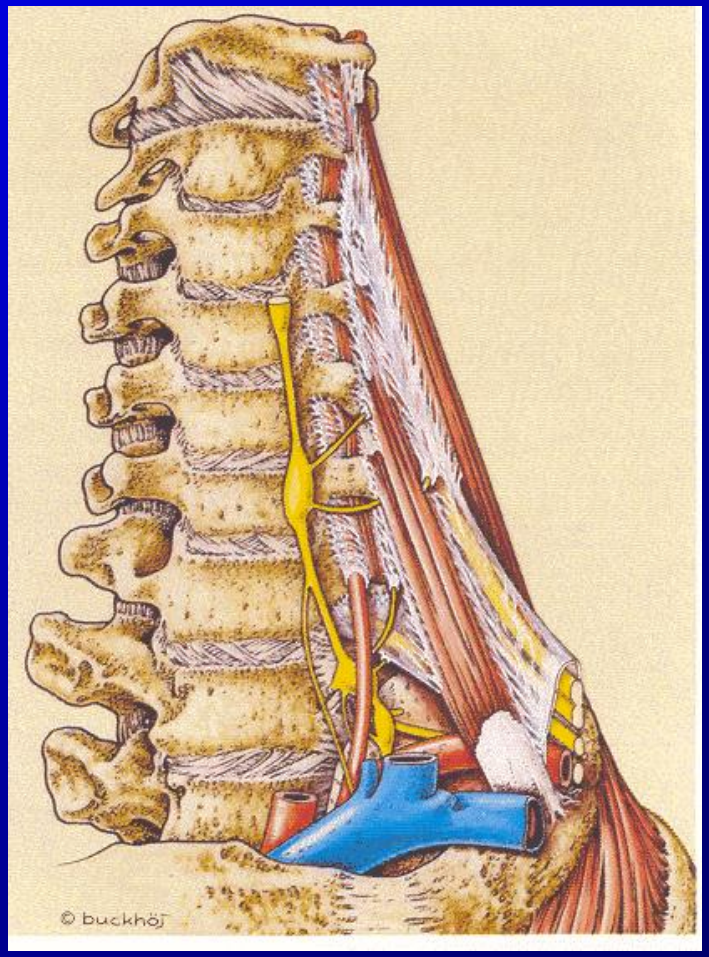
Brachial plexus

interfascial compartment

Allon P. Winnie 1964

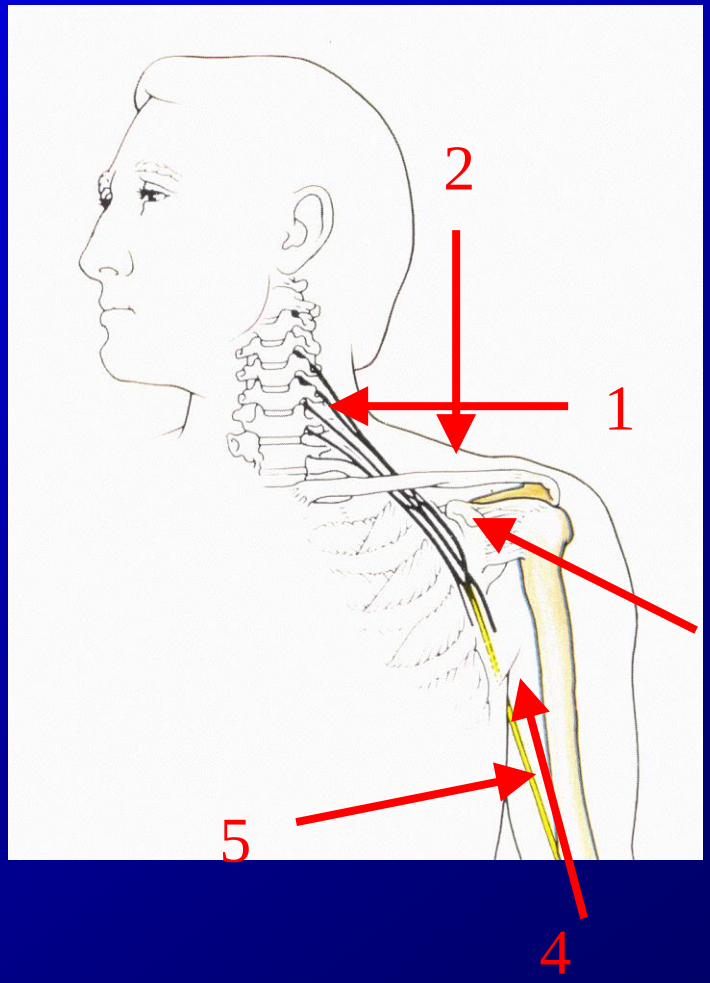
How to recognize correct needle position?

- mechanical paresthesias
- cold paresthesias
- loss of resistance
- **neurostimulation**



Brachial plexus blocks - - approaches

1. interscalene block
2. supraclavicular block
3. infraclavicular block
4. axillary block
5. midhumeral block

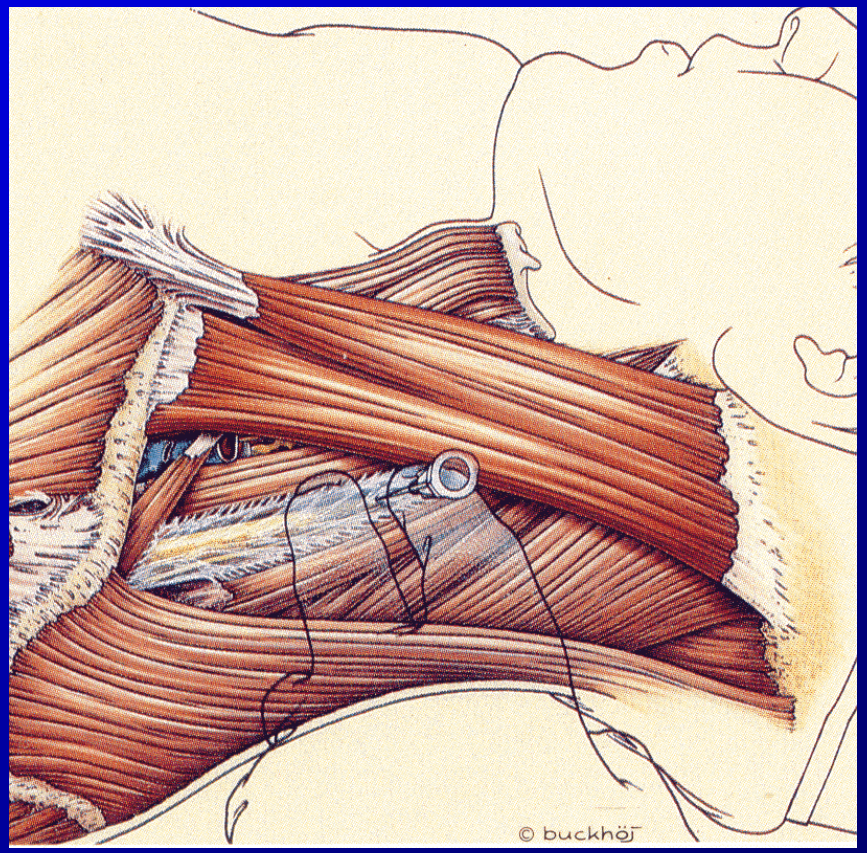


Interscalene block

- **indication:**
  - shoulder surgery
- **orientation:**
  - interscalene groove
  - cricoid cartilage - C6
  - external jugular v.
- **needle position :**
  - neurostimulator
- **dose:** 10-40 ml LA

Interscalene blok

- **problem:**
  - ulnar n.
- **complications:**
  - phrenic n. block
  - laryngeal recurrens n. block
  - central block
  - vertebral a. puncture

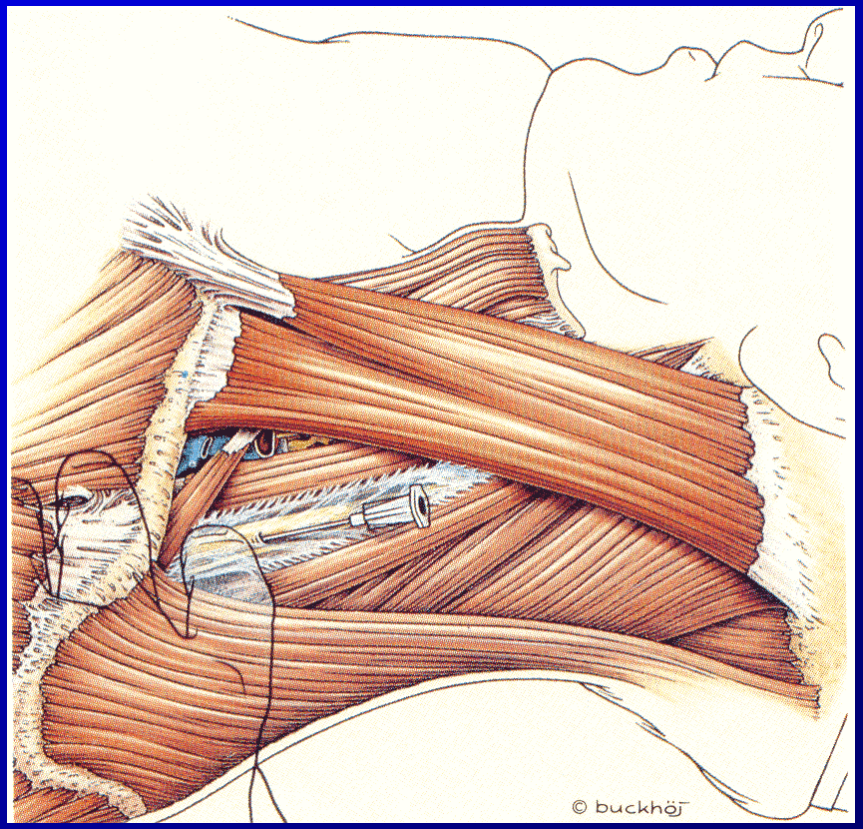


Supraclavicular block

- **indication:**
  - surgery below the clavicle
- **orientation:**
  - midpoint of the clavicle
  - subclavial a. pulsation
  - 1st rib
- **needle position:**
  - neurostimulator
- **dose:** 20-30 ml LA

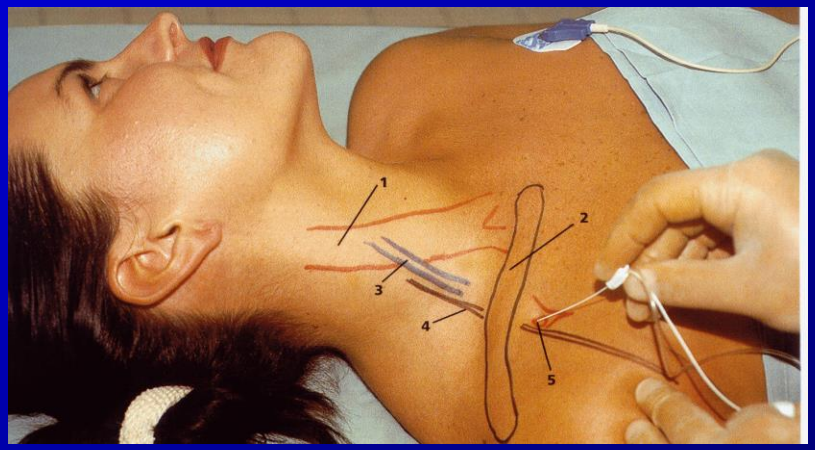
Supraclavicular block

- **problem:**
  - arterial puncture
- **complications:**
  - pneumothorax



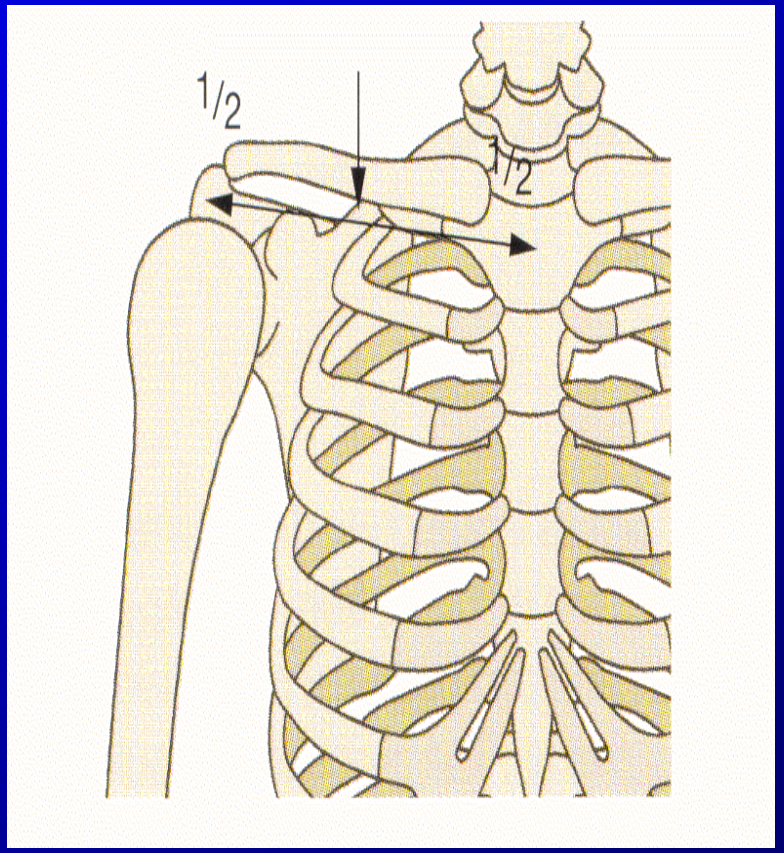
Infraclavicular block

- **indication:**
  - upper extremity surgery except for medial part of the arm
- **orientation:**
  - same as in subclavial vein puncture
- **needle position:**
  - neurostimulator
- **dose:** 30-40 ml LA



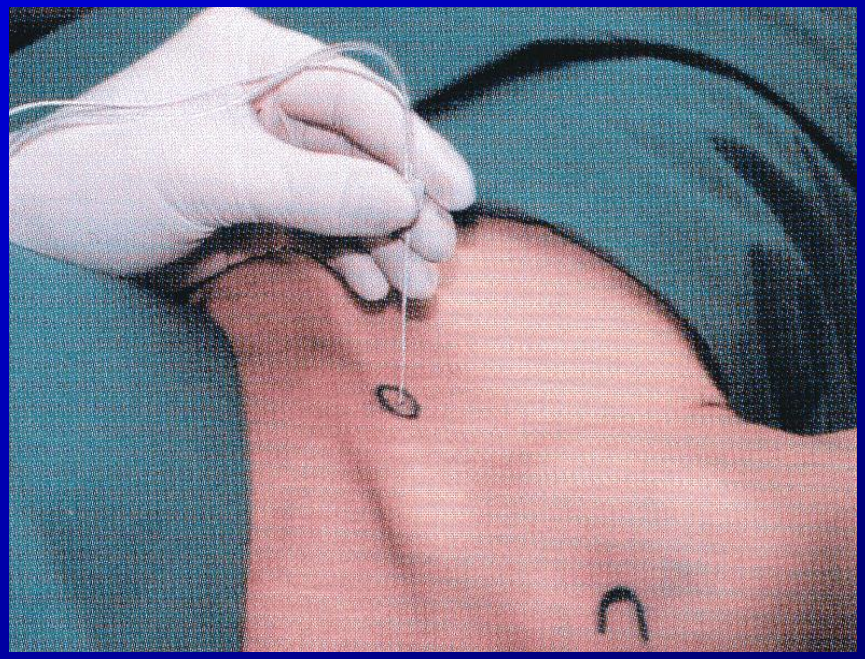
Vertical infraclavicular block

- **indication:**
  - surgery below midpoint of the arm
- **orientation:**
  - jugular groove
  - acromion
  - clavicle
- **needle position:**
  - neurostimulator
- **dose:** 40 ml LA



Vertical infraclavicular block

- **problem:**
  - vessel puncture
- **complications:**
  - pneumothorax (rarely)

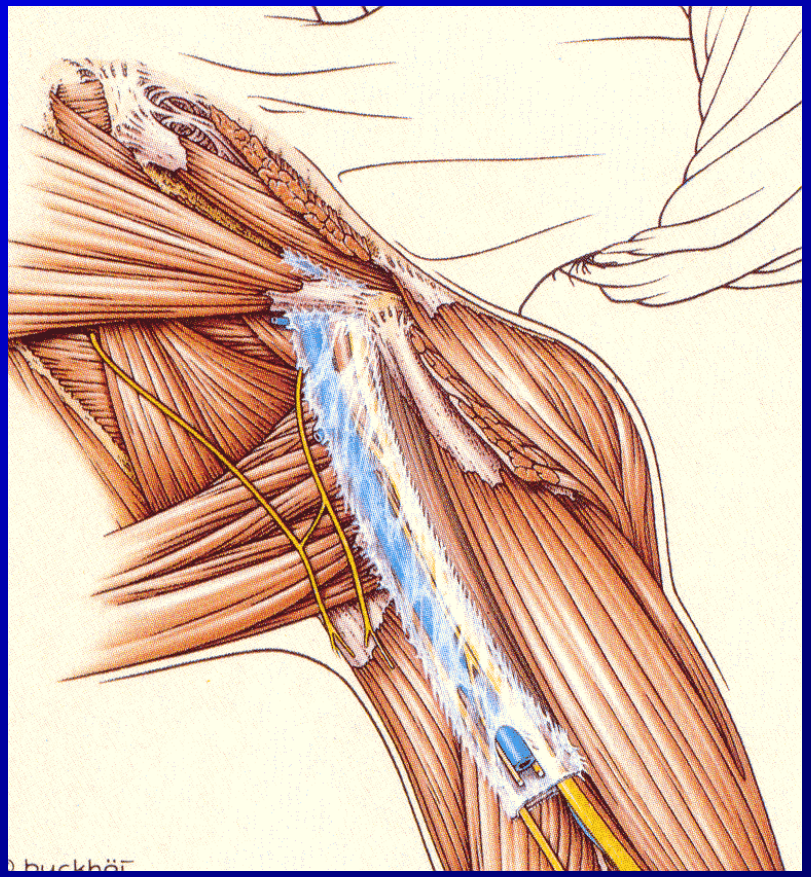


Axillary block

- **indication:**
  - surgery below the elbow
- **orientation:**
  - axillary a. pulsation
- **needle position:**
  - neurostimulator
  - loss of resistance
- **dose:** 40 ml LA

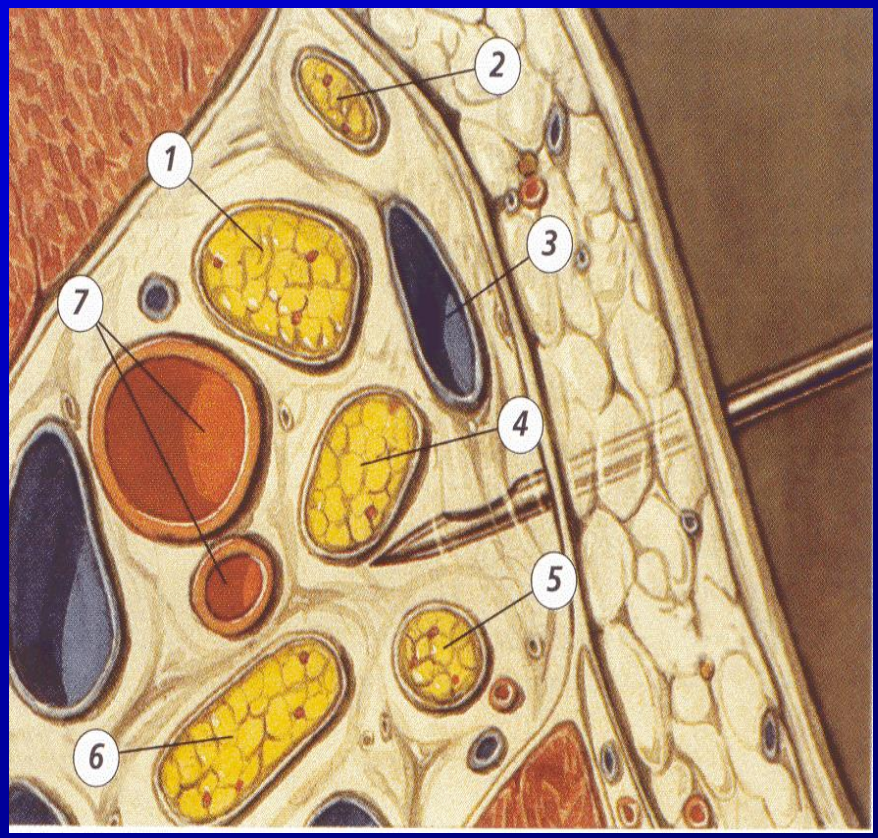
Axillary block

- **problem:**
  - radial n.
  - musculocutaneous n.
  - artery puncture?
- **complications:**
  - artery puncture



Midhumeral block

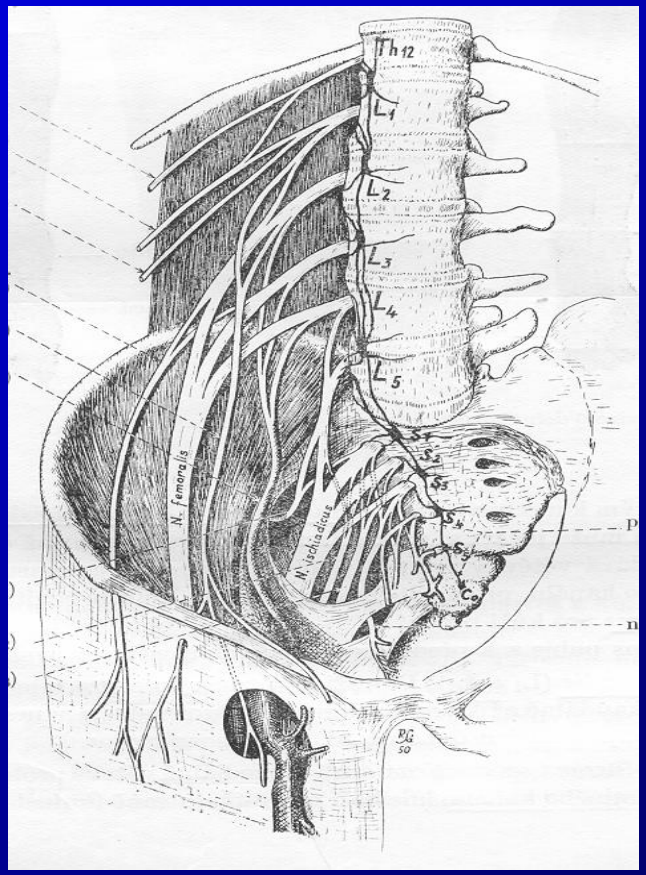
- **indication:**
  - surgery below the elbow
- **orientation:**
  - groove between biceps and triceps muscles in the midpoint of the arm
- **needle position:**
  - neurostimulator
- **dose:** 4 * 5-7 ml LA



- Definition of RA
- Classification of RA
- Local anaesthetics
- Central blocks
- Peripheral blocks
  - lower extremities

Lumbosacral plexus

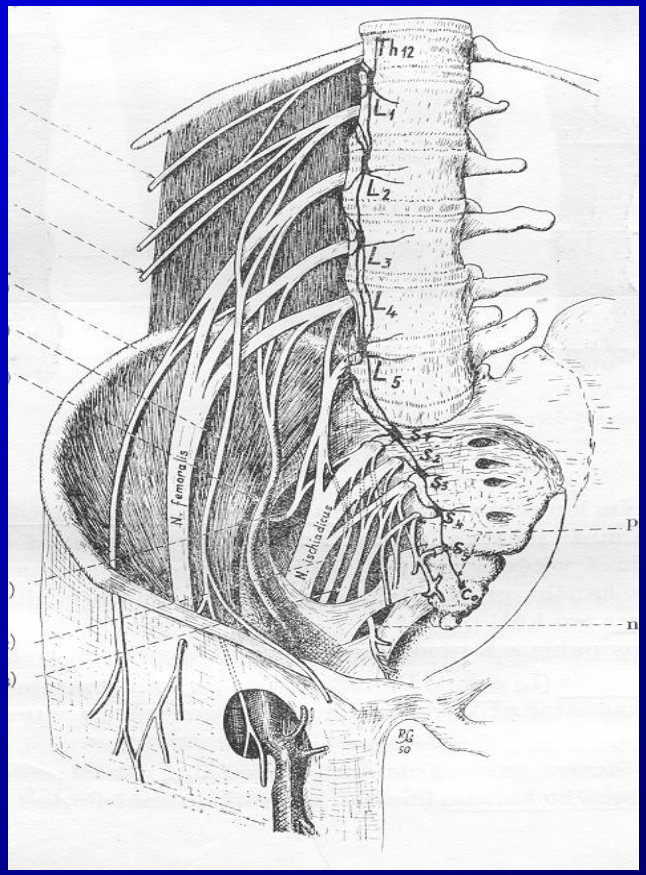
- **lumbal plexus**
  (Th12 - L4)
- **sacral plexus**
  (L4, L5, S1 - S5, Co)



H. Gray: Anatomy of the human body
http://www.bartleby.com/107/

Lumbosacral plexus

- **lumbal plexus (Th12 - L4)**
  - iliohypogastric n. (Th12, L1)
  - ilioinguinal n. (L1)
  - genitofemoral n. (L1,L2)
  - cutaneous femoral lat. n. (L2, L3)
  - **femoral n. (L2 - L4)**
  - obturator n. (L2 - L4)
- **sacral plexus**

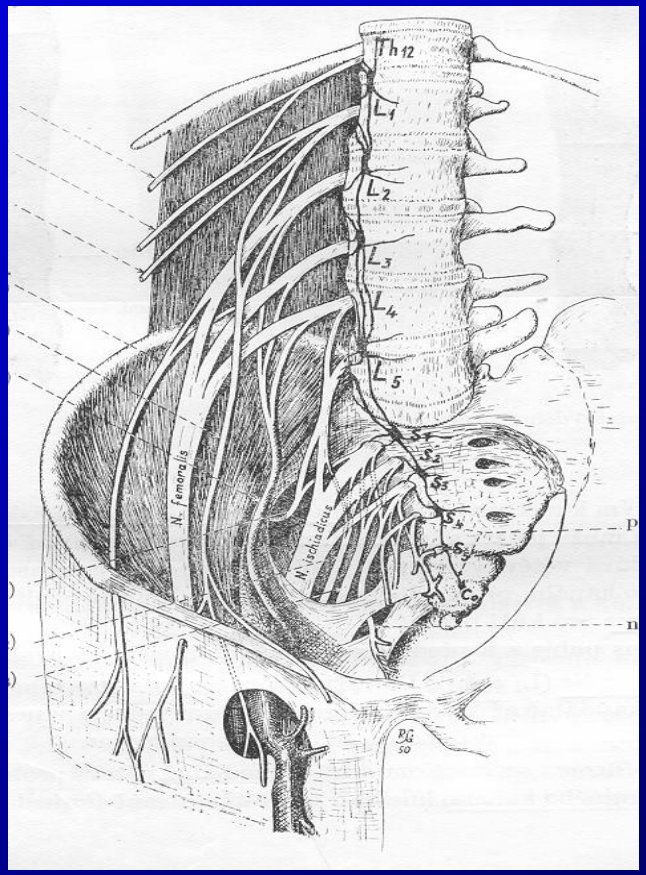


H. Gray: Anatomy of the human body
http://www.bartleby.com/107/

Lumbosacral plexus

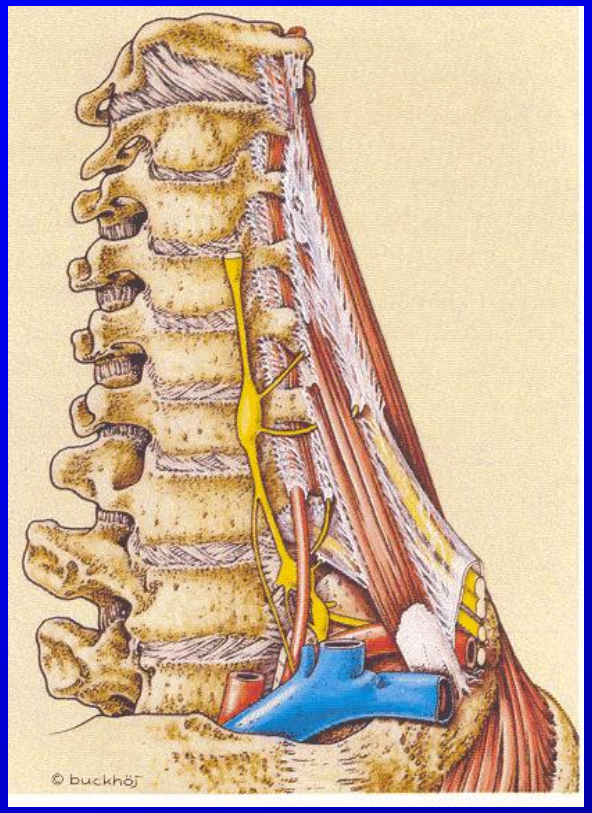
- **lumbal plexus**
- **sacral plexus**

  (L4, L5, S1 - S5, Co)
  - upper gluteal n. (L4, L5, S1)
  - lower gluteal n. (L5, S1, S2)
  - posterior cutaneous femoral n. (S1 - S3)
  - **sciatic n. (L4 - S3)**
  - pudendal n. (S3 - S4)
  - coccygeal n. (S5, Co)

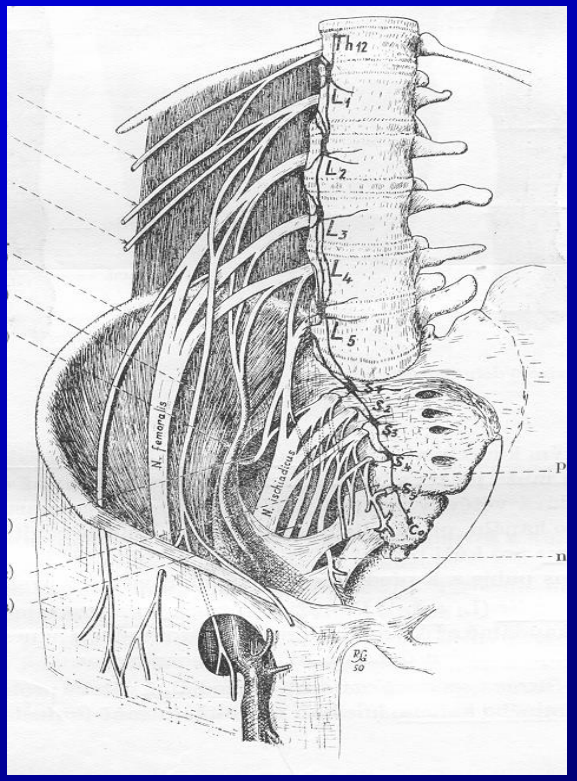


H. Gray: Anatomy of the human body
http://www.bartleby.com/107/

The difference between upper and lower extremities



brachial plexus

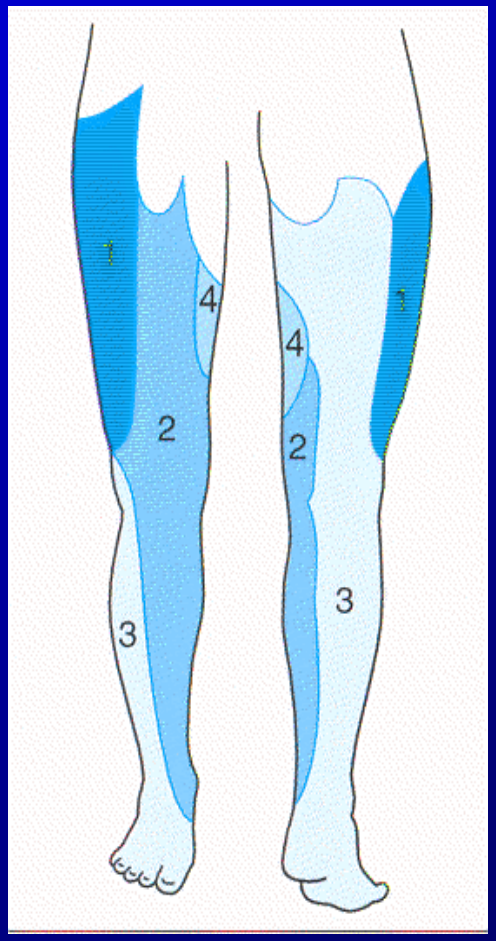


lumbosacral plexus

Lumbosacral plexus

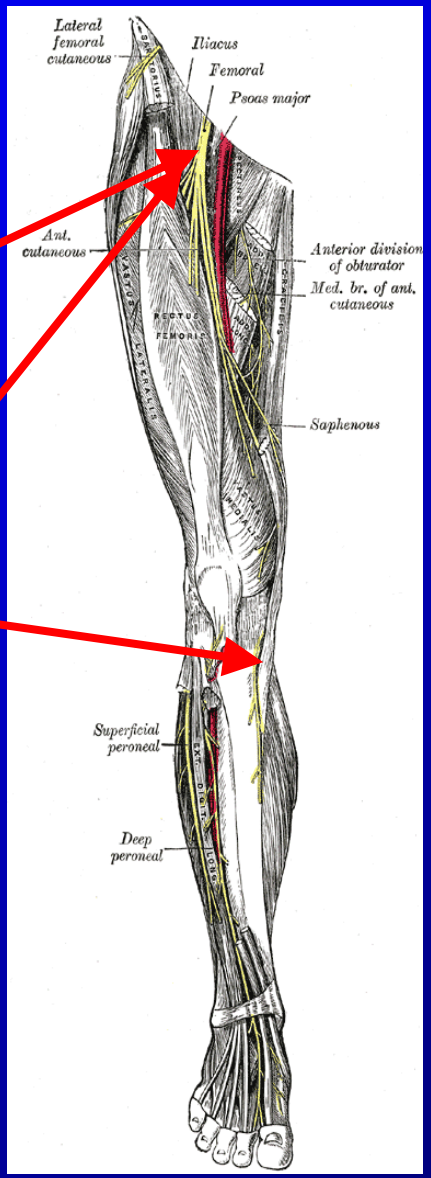
1 – cutaneous femoral lateral n.
2 – **femoral n.** → saphenus n.
3 – **sciatic n.** → tibial n.
→ peroneal n.
4 – obturator n.

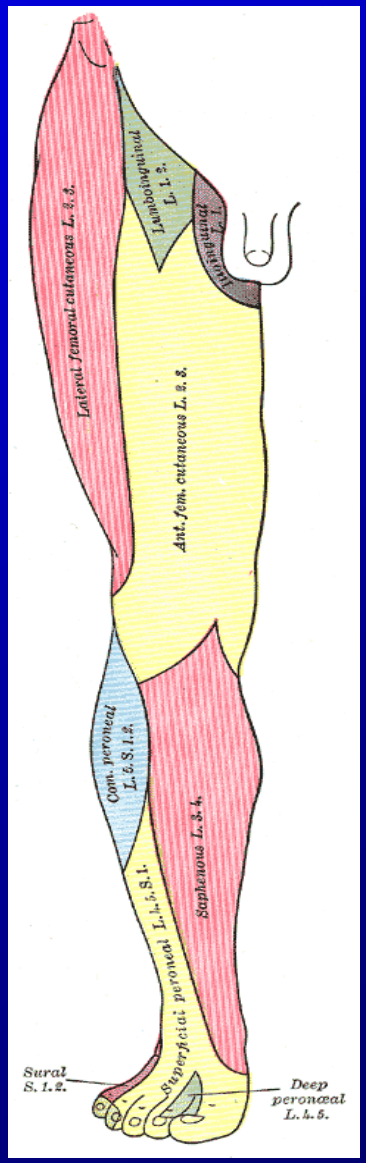
sciatic-femoral block



Femoral n. block
L2 - L4

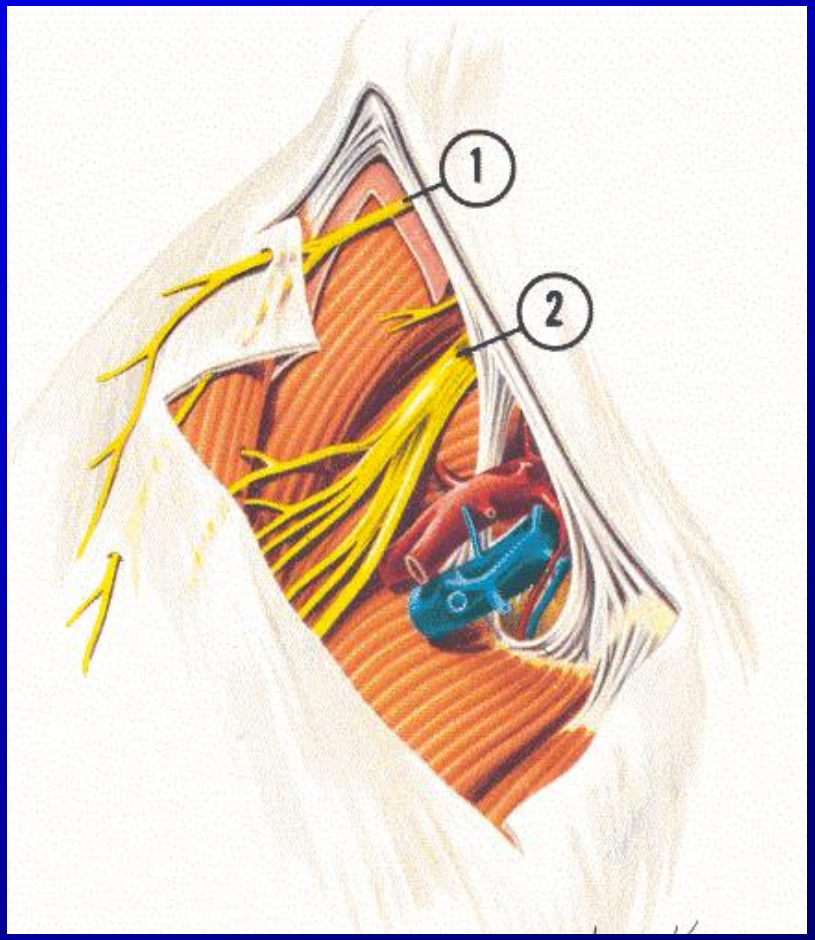
- 3-in-1 block
- femoral n. block
- saphenus n. block





Femoral nerve block

- **indication:**
  - surgery on the front of the thigh
  - arthroscopy
- **orientation:**
  - inguinal ligament
  - femoral a. pulsation
- **needle position:**
  - neurostimulator
  - loss of resistance

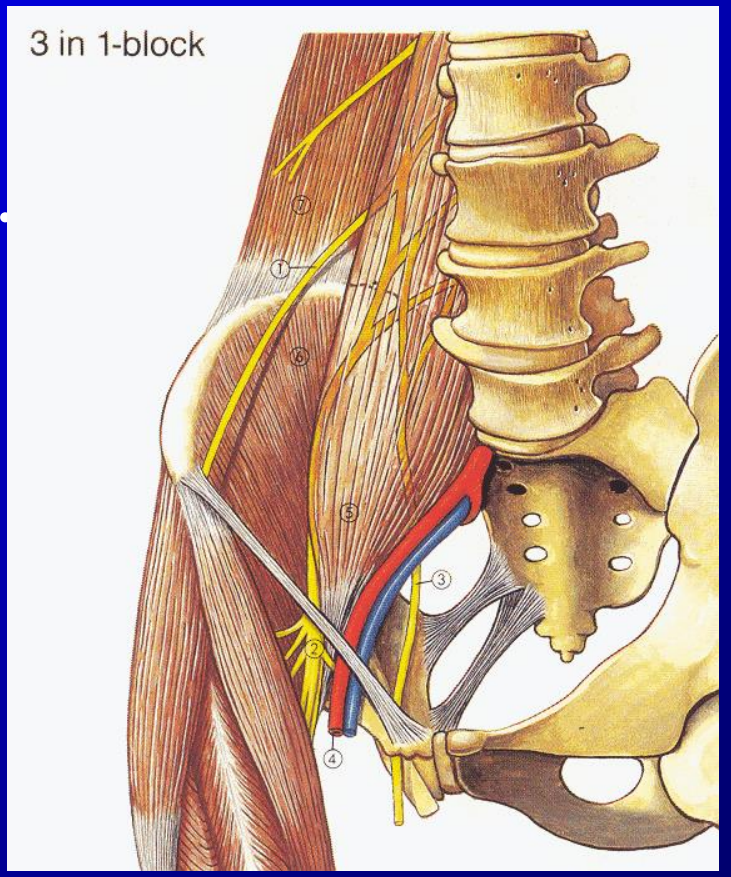


Femoral nerve block

- **dose:**
  - 10 - 15 - 30 ml LA
- **complications:**
  - femoral a. puncture

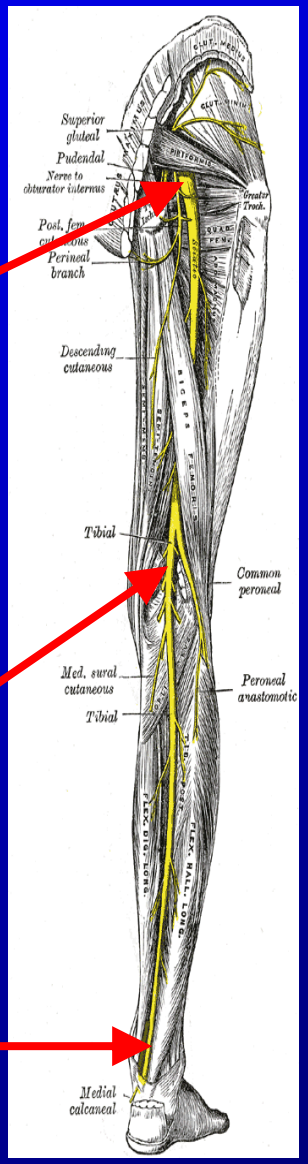
3-in-1 block

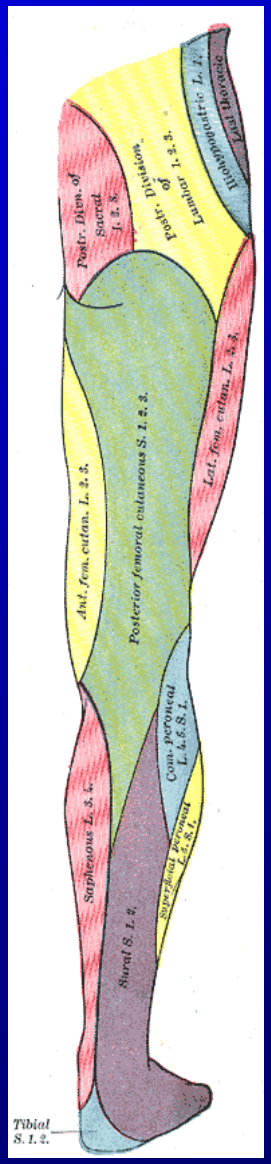
- femoral n.
- cutaneous femoral lat. n.
- obturator n.



Sciatic nerve
L4 - S3

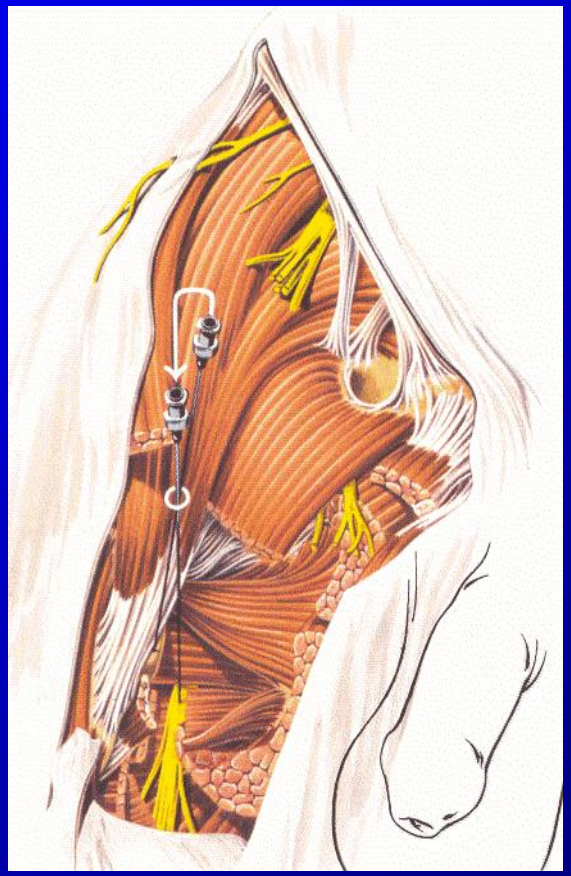
- Sciatic nerve block
  - frontal approach
  - back approach (Labat)
  - back approach (Raj)
- popliteal block
- foot block

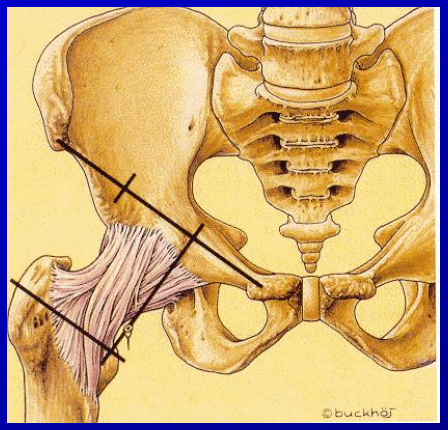


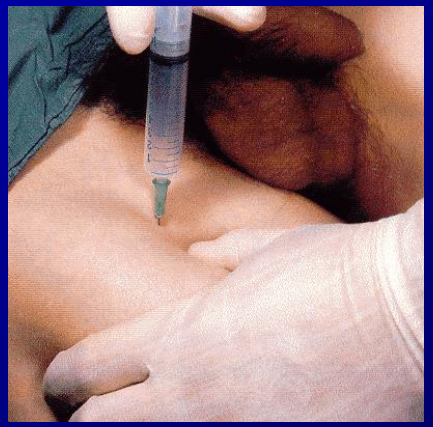


Sciatic nerve – frontal approach

- **indication:**
  - surgery in sciatic n. area
- **orientation:**
  - inguinal ligament
  - major trochanter
- **needle position:**
  - neurostimulator

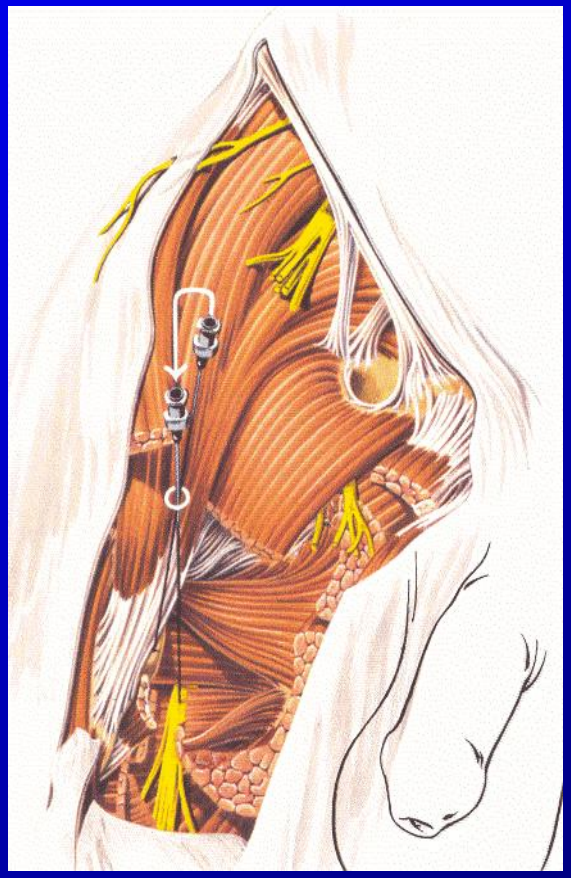


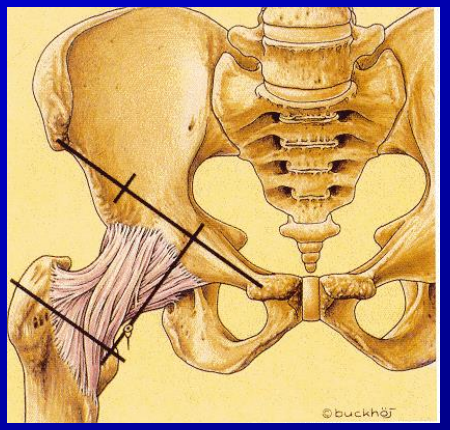


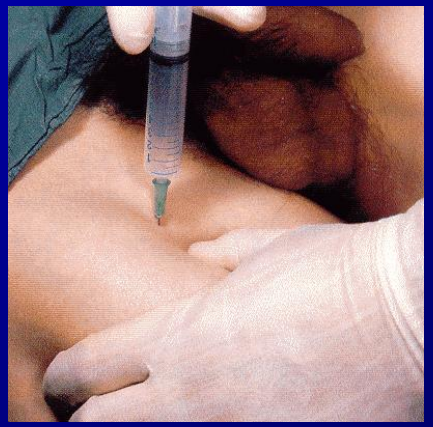


Sciatic nerve – frontal approach

- **dose:**
  - 20 ml LA
- **problem:**
  - depth
- **complications:**
  - toxicity
  - intraneural injection

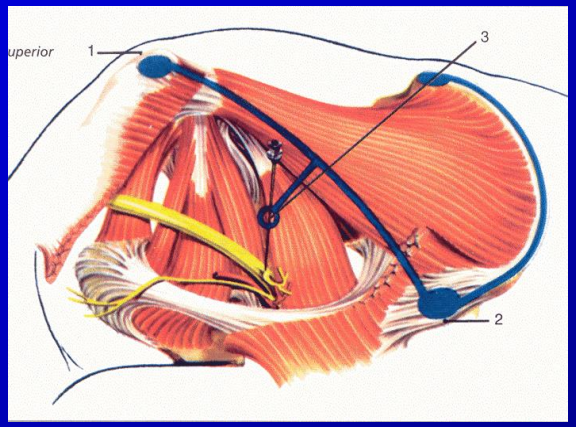


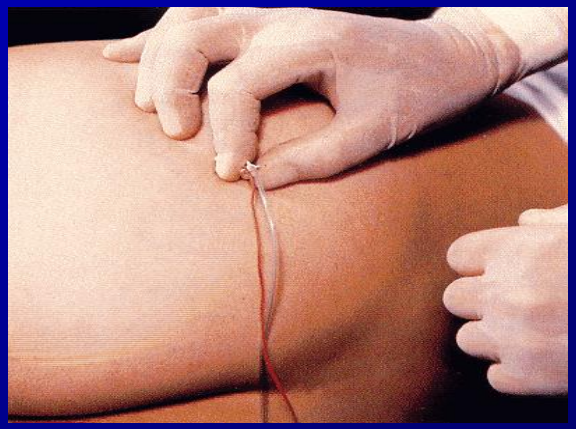




Sciatic nerve – posterior approach

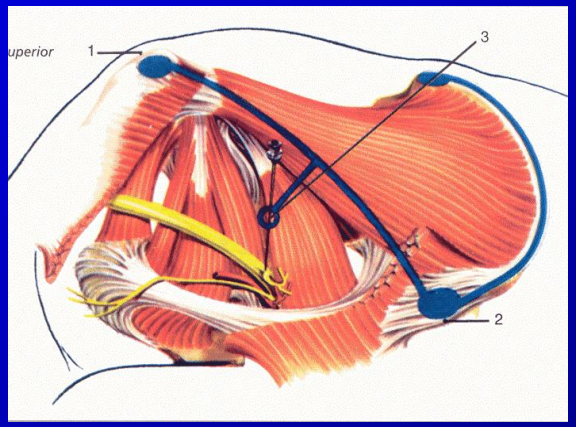
- **indication:**
  - surgery in sciatic nerve area
- **orientation:**
  - spina iliaca post. sup.
  - major trochanter
- **needle position:**
  - neurostimulator

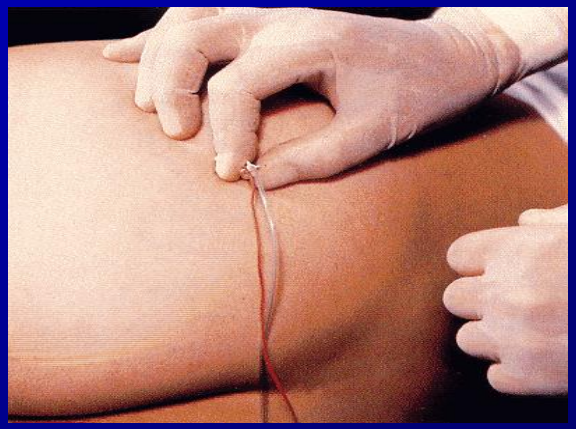




Sciatic nerve – posterior approach

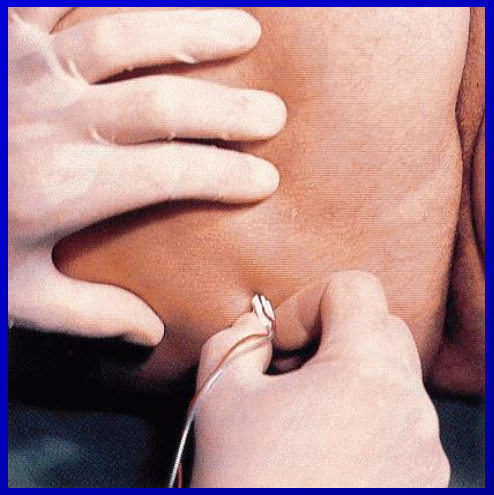
- **dose:**
  - 15 - 20 ml LA
- **problem:**
  - positioning
- **complications:**
  - toxicity
  - intraneural injection

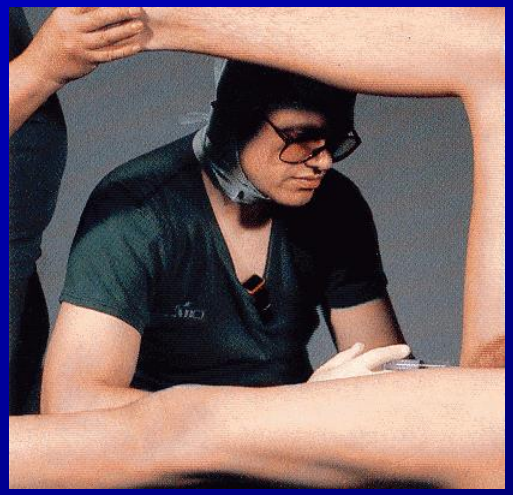




Sciatic nerve – appproach by Raj

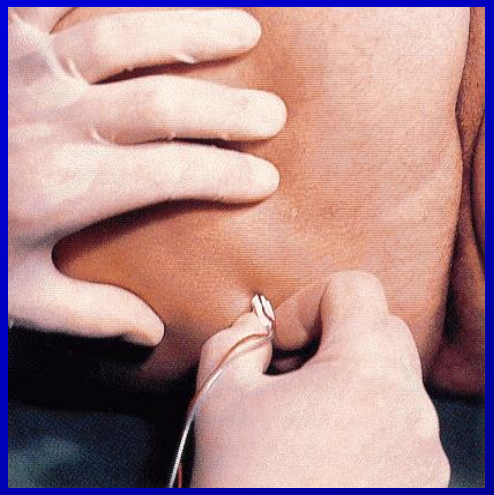
- **indication:**
  - surgery in sciatic n. area
- **orientation:**
  - major trochanter
  - tuber ischiadicum
- **needle position:**
  - neurostimulator

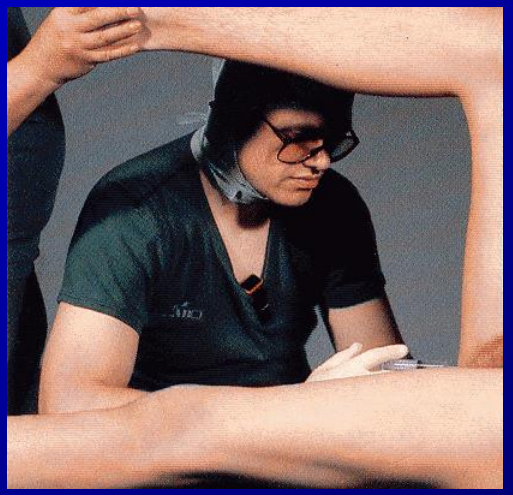




Sciatic nerve – approach by Raj

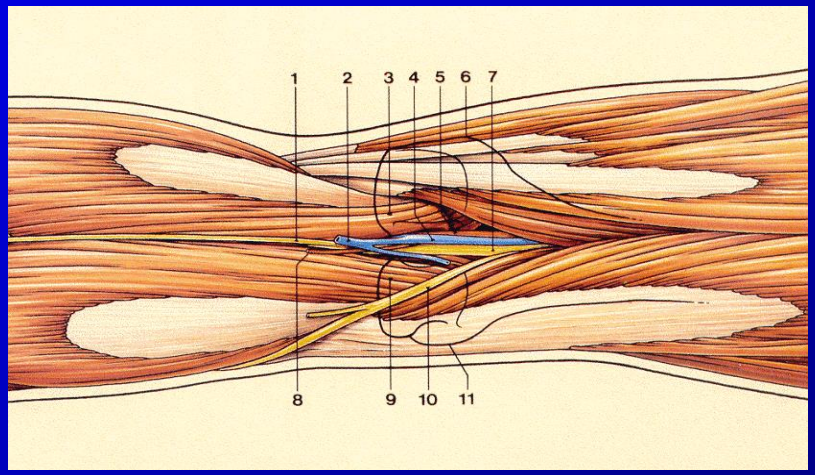
- **dose:**
  - 15 - 20 ml LA
- **problem:**
  - positioning
- **complications:**
  - toxicity
  - intraneural injection





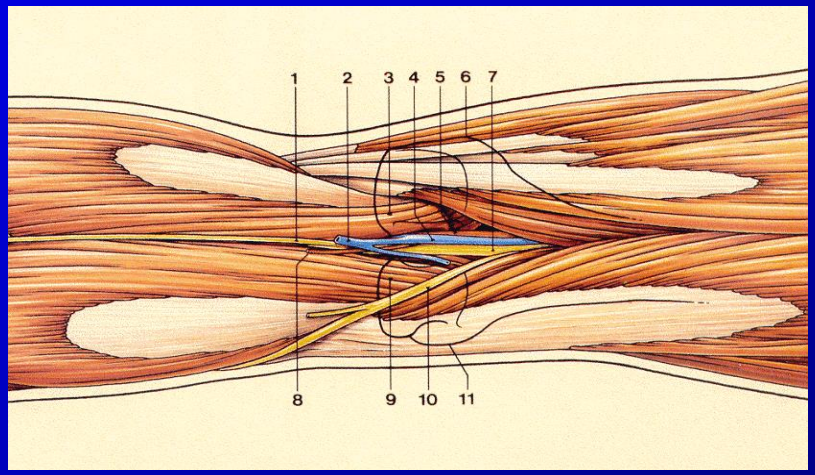
Popliteal block

- **indication:**
  - surgery in the area
- **orientation:**
  - popliteal crease
  - biceps femoris muscle
  - semitendinosus muscle
  - semimembranosus m.
- **needle position:**
  - neurostimulator



Popliteal block

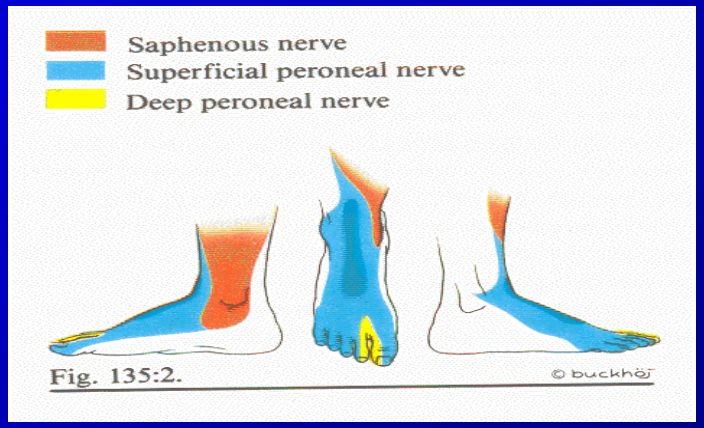
- **dose:**
  - 10 - 20 ml LA
- **problem:**
  - high sciatic nerve division
- **complications:**
  - toxicity
  - intraneural injection

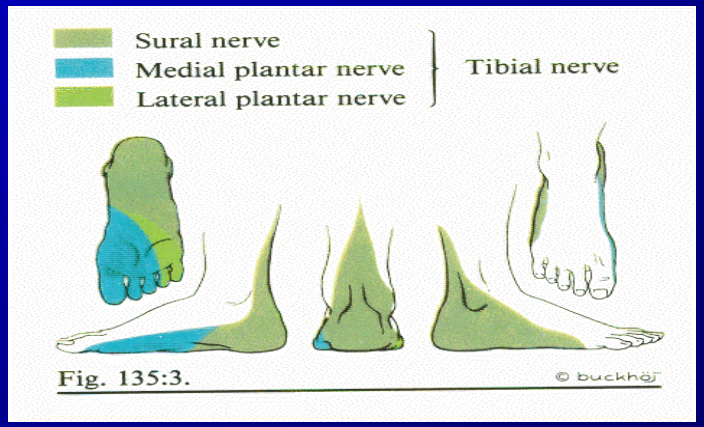


Foot block

nerves of the foot:

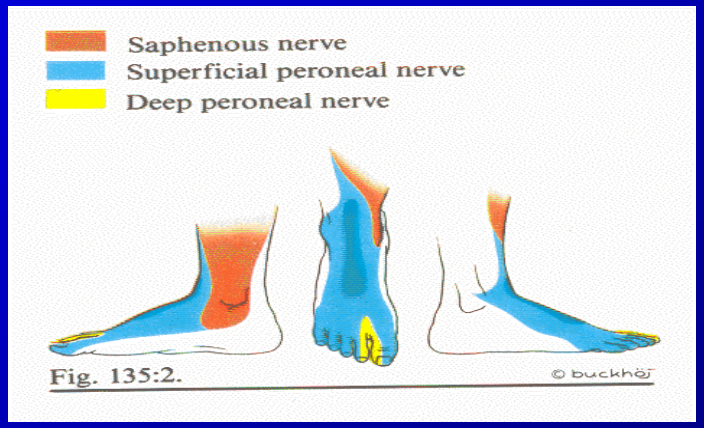
- saphenus n. (femoral n.)
- superficial peroneal n.
- deep peroneal n.
- sural n.
- tibial n.
  - medial plantar n.
  - lateral plantar n.

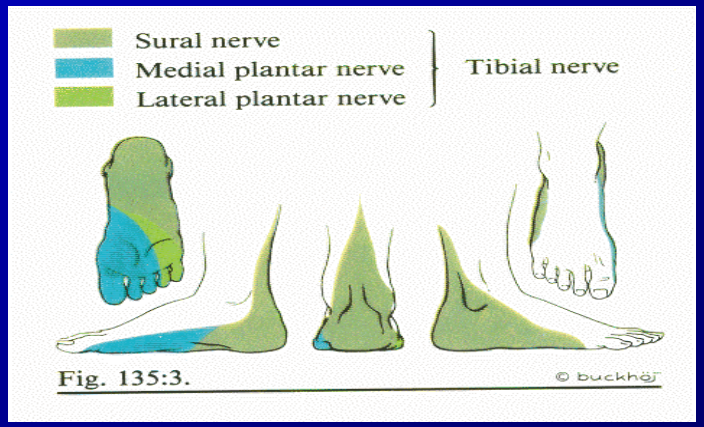




Foot block

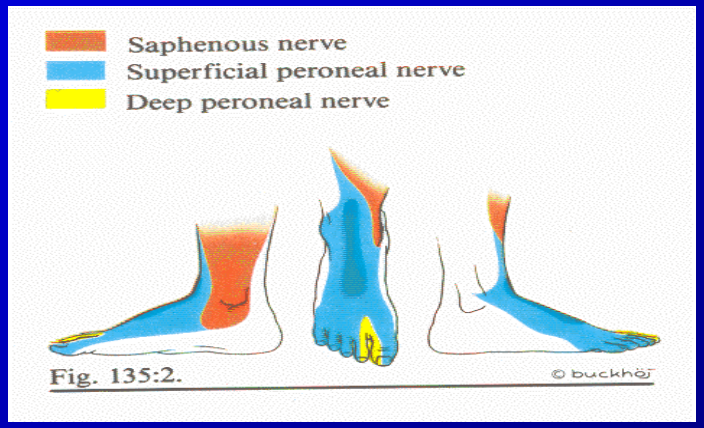
- **indication:**
  - foot surgery
- **orientation:**
  - dorsal a.
  - posterior tibial a.
  - ankles
- **needle position:**
  - arterial pulsation or infiltration

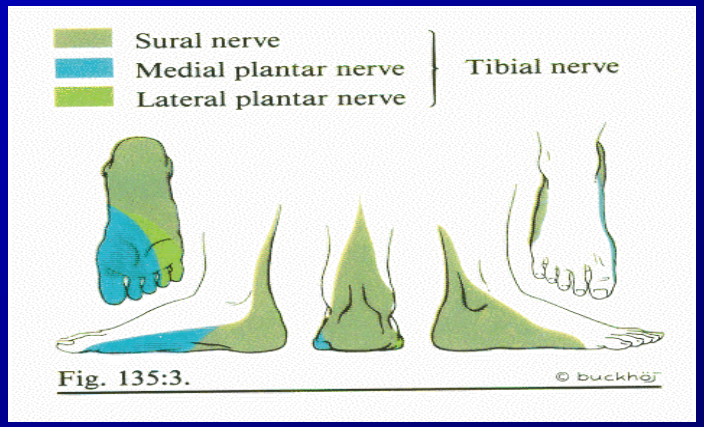




Foot block

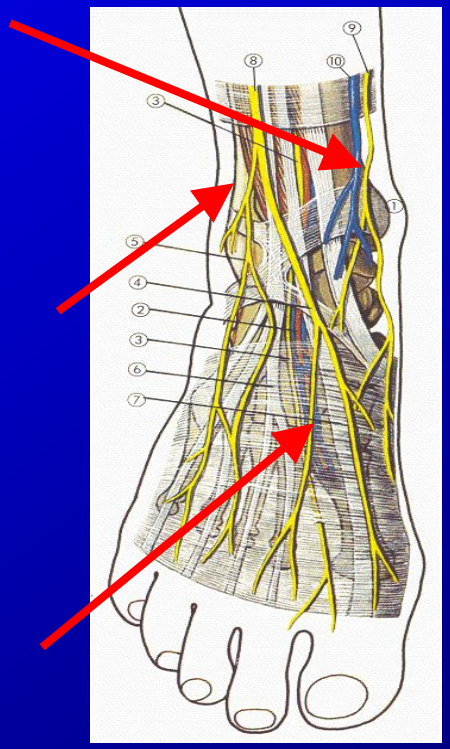
- **dose:**
  - approx. 20 ml LA
- **problem:**
  - more punctures
- **complications:**
  - intraneural injection
  - intraarterial injection

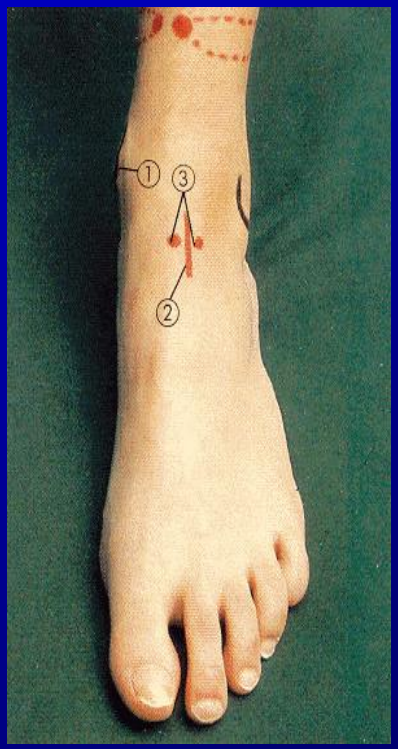




Foot block

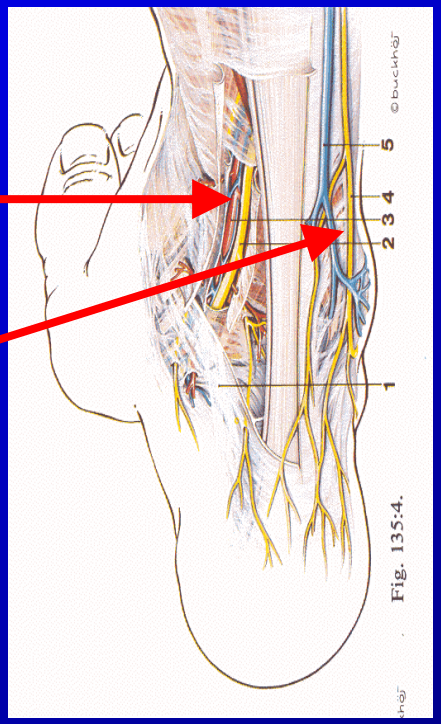
- **saphenus n.**
  - tibia – medial ankle
  - 5 ml LA
- **superficial peroneal n.**
  - tibia – lateral ankle
  - 5 ml LA
- **deep peroneal n.**
  - dorsal a.
  - 5 ml LA

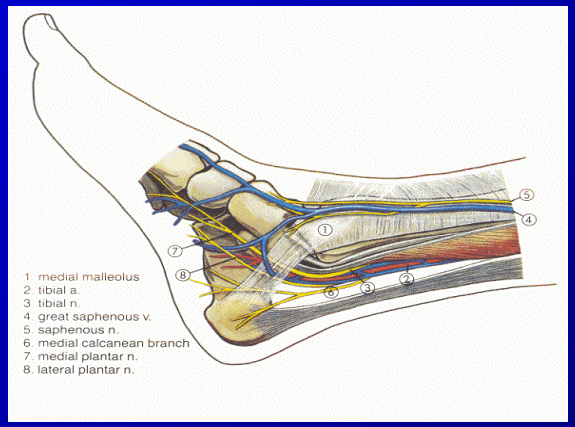


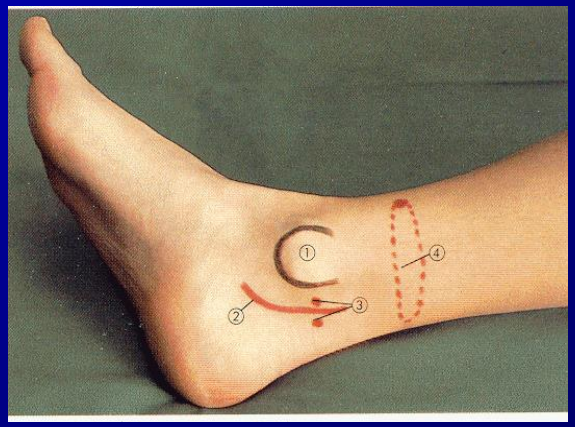


Foot block

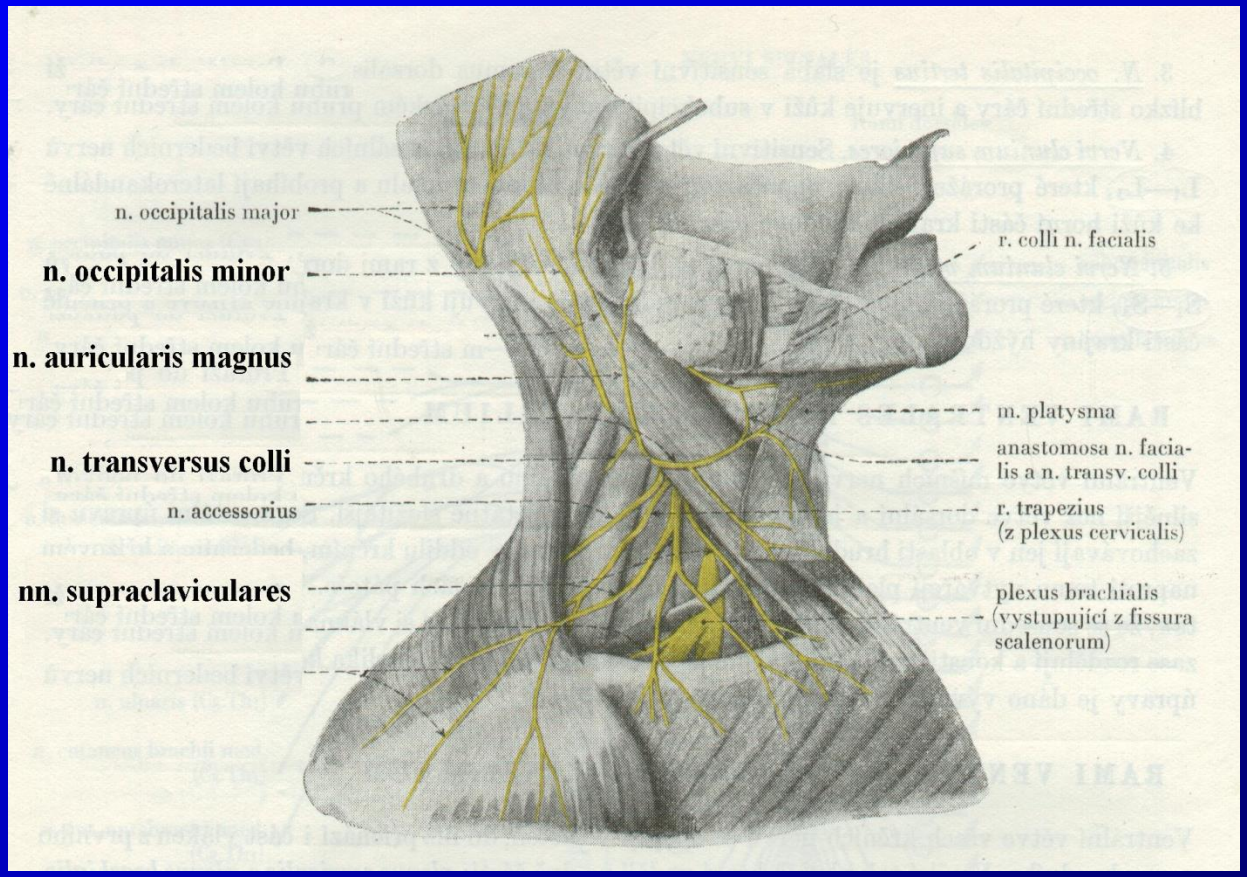
- **tibial n.**
  - posterior tibial a. (TiDiANeH)
  - 5 ml LA
- **sural n.**
  - lateral ankle
  - Achilles tendon
  - 5 ml LA







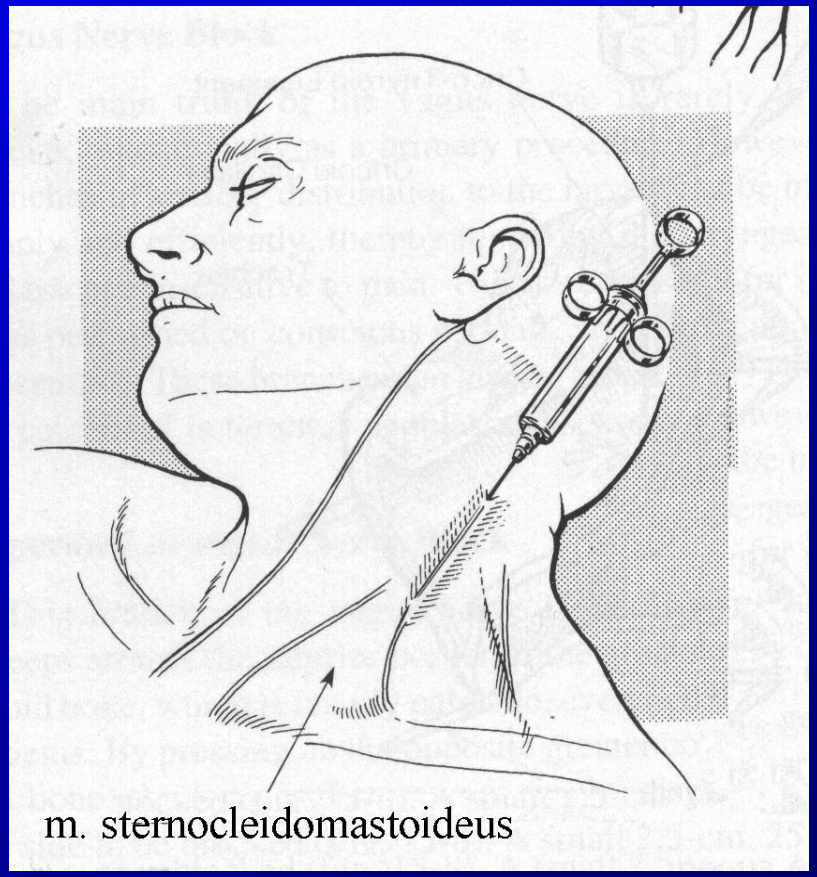
Cervical plexus block – superficial and intermediate



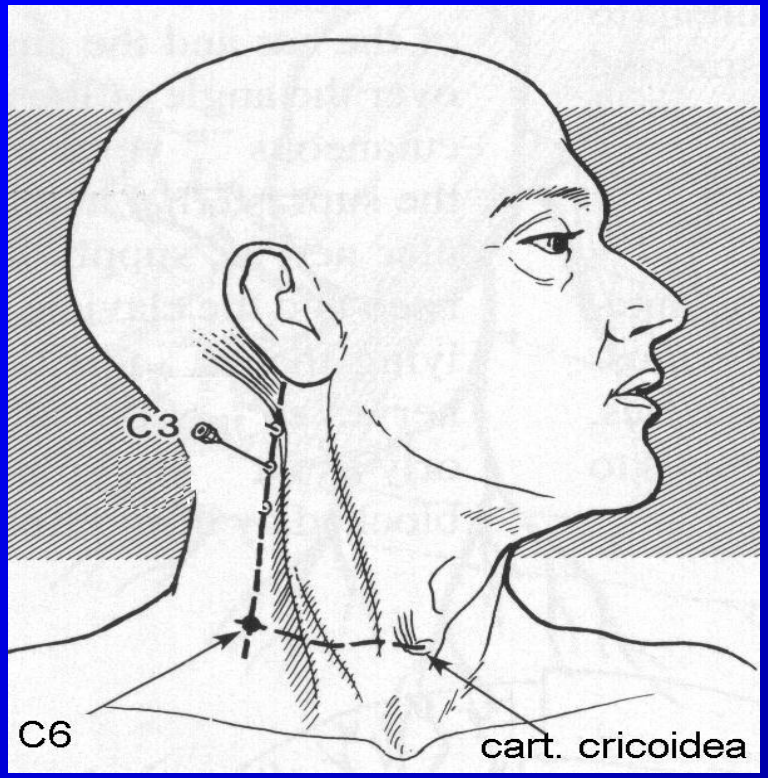
Cervical plexus block – superficial and intermediate

punctum nervosum
(in the middle of SCM m.)

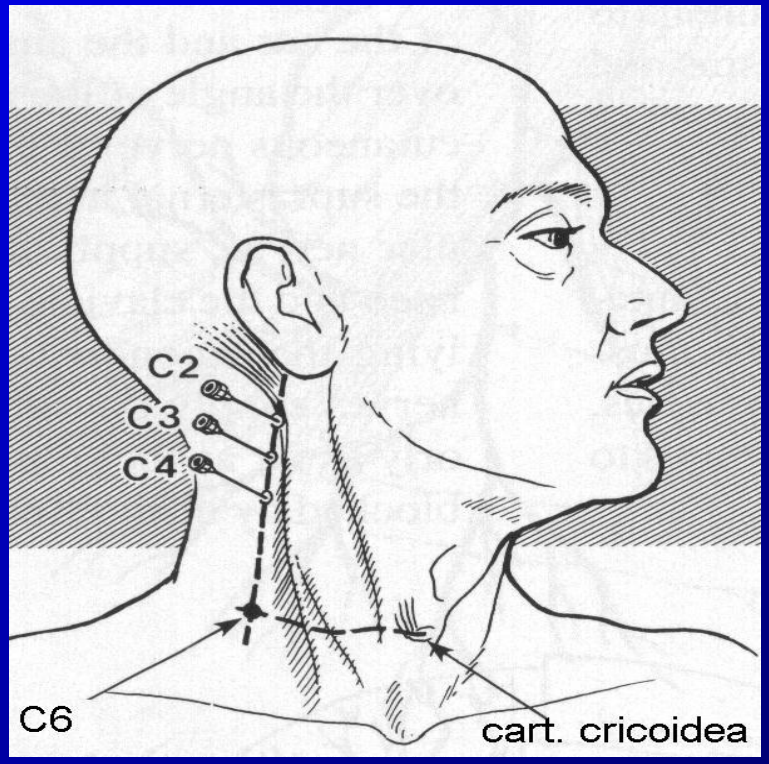
- 5 ml 0.375% bupi under the fascia
- along posterior border of SCM m.
- till 20 ml 0.375 % bupi



Cervical plexus block - deep



Technique of one needle

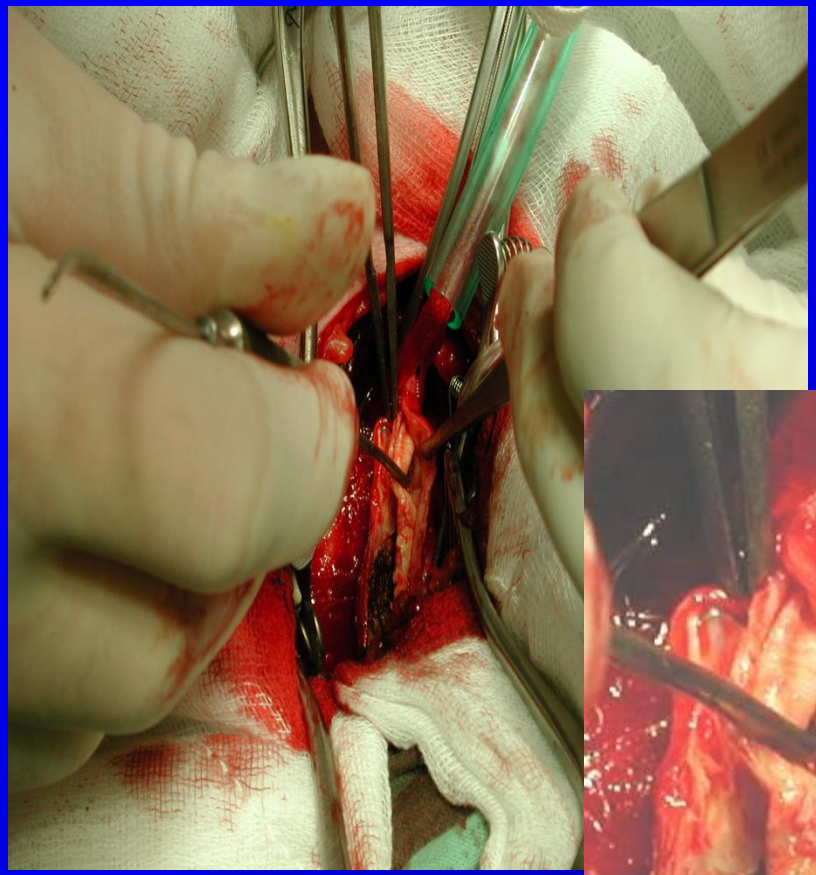


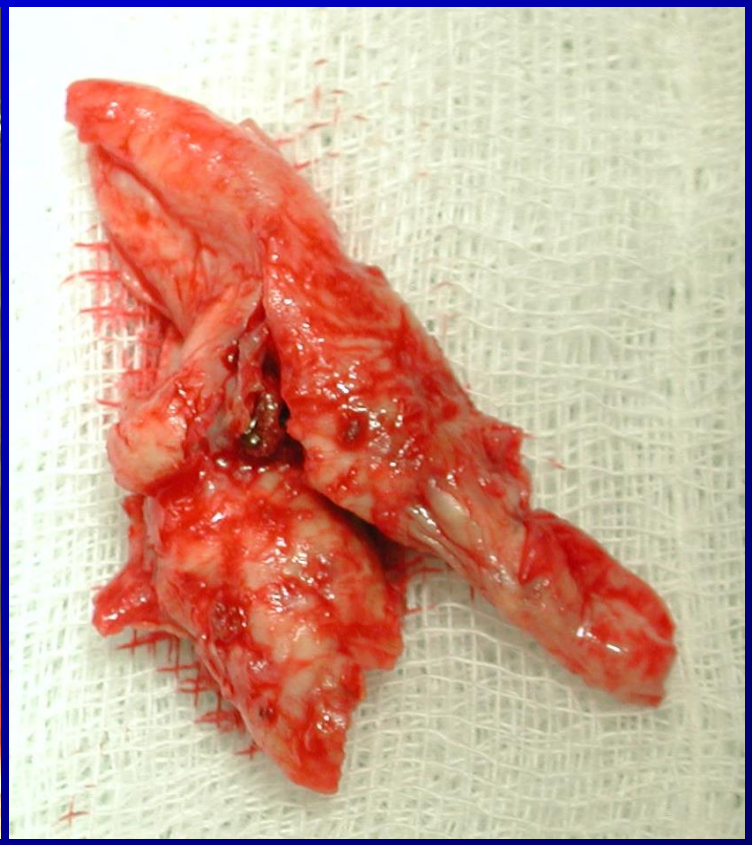
Technika of three needles

15 or 3 * 5 ml 0,375% bupivacaine

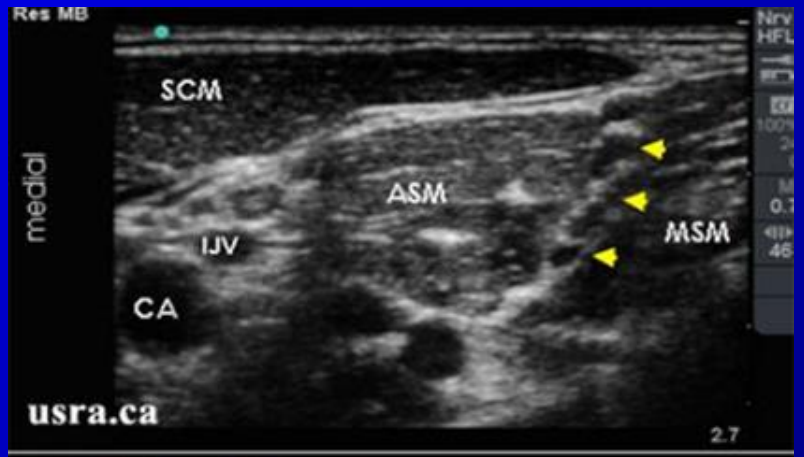
CEA

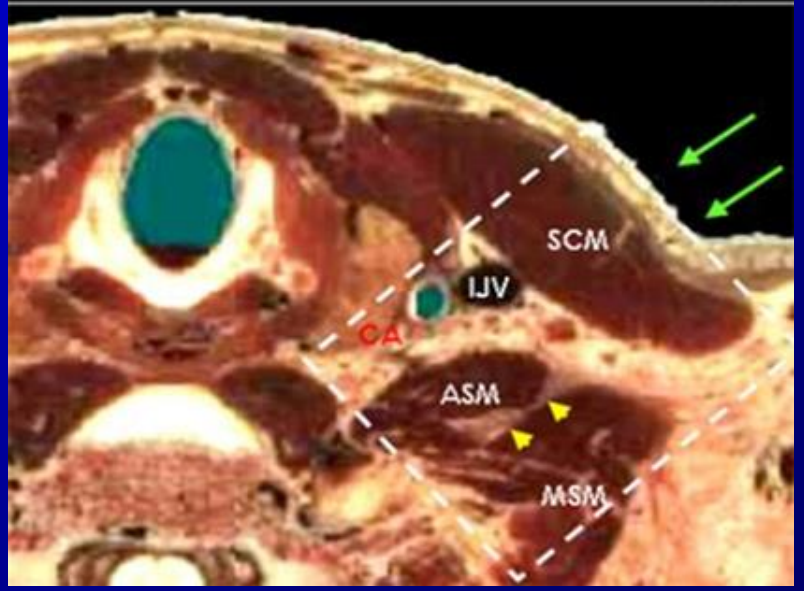
31/2002





Ultrasonographically guided regional blocks





What to tell the patient about the risks of RA?

- obligatory information
  - puncture pain, paresthesias, dyscomfort during surgery, hypotension, nausea, vomitting, pain during surgery, conversion to GA, PDPH, backache, urinary retention
- optional information
  - LA toxicity, alergy, transient neurological symptoms
- question only
  - cardiac arrest, spinal cord compression, permanent neurological damage etc.

Gligorijevic, S.: What to tell the patient about the risks of RA? What don´t we tell them?

Highlights in Regional Anaesthesia and Pain Therapy IV, 1995

Minimal clinical experience

- 50 epidural blocks for surgery incl. caesarean sections
- 50 spinal blocks
- 40 peripheral nerve blocks
- 25 blocks for acute, chronic or tumorous pain

American Medical Association data published in:

Thompson, MD: The Labat Lecture 1997. From Pauchet to Today. The French Connection.

Reg Anesth Pain Med 1998; 23(2): 126-133

Management of anaesthesia in a blocked patient

- analgesia produced by a block
- patient:
  - conscious, can listen music etc.
  - sedated (propofol, opioids, benzodiazepins)
  - general anaesthesia
    - patient´s comfort during long surgery
    - artificial ventilation needed

„When there are problems
with any regional technique,
look for the cause
first on the proximal end of the needle.“

Alon P. Winnie

- definition
- what is it anaesthesia?
- techniques of anaesthesia
- choice of anaesthesia
- anaesthetic drugs
- anaesthesiological machine
- management of anaesthesia
- monitoring
- **preoperative and preanaesthetic evaluation**

Terminology

- Preoperative evaluation 1: surgeon
  - indication and extent of surgery
- Preoperative evaluation 2: GP, I, C, Ped
  - can the patient undergo planned surgery?
- Preanaesthetic evaluation: anaesthesiologist
  - can the patient undergo anaesthesia,
  - decide about the type of anaesthesia,
  - obtain informed consent

Preoperative evaluation
Emergency procedures

- history
  - **A** - allergy
  - **M** - medications
  - **P** - previous illnesses
  - **L** - last meal
  - **E** - event
- clinical evaluation
- available laboratory tests
  according the the type and urgency of surgery

Preoperative evaluation
Elective procedures

- history
- clinical evaluation
- laboratory and other tests according to patient/surgery
- indication to surgery, type and extent of surgery

⇓

- anaesthetic evaluation

⇓

- ability to undergo anaesthesia, risk evaluation, optimization, informed consent ⇒ premedication

Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery

The Task Force for Preoperative Cardiac Risk Assessment and Perioperative Cardiac Management in Non-cardiac Surgery of the European Society of Cardiology (ESC) and endorsed by the European Society of Anaesthesiology (ESA)

Authors/Task Force Members: Don Poldermans (Chairperson) (The Netherlands), Jeroen J. Bax (The Netherlands), Eric Boersma (The Netherlands), Stefan De Hert (The Netherlands), Erik Eeckhout (Switzerland), Gerry Fowkes (UK), Bulent Gorenek (Turkey), Michael G. Hennerici (Germany), Bernard Iung (France), Malte Kelm (Germany), Keld Per Kjeldsen (Denmark), Steen Dalby Kristensen (Denmark), Jose Lopez-Sendon (Spain), Paolo Pelosi (Italy), François Philippe (France), Luc Pierard (Belgium), Piotr Ponikowski (Poland), Jean-Paul Schmid (Switzerland), Olav F.M. Sellevold (Norway), Rosa Sicari (Italy), Greet Van den Berghe (Belgium) and Frank Vermassen (Belgium)

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EJA 2010;27(2):92-137

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Guidelines for pre-operative cardiac risk assessment and perioperative cardiac management in non-cardiac surgery

The Task Force for Preoperative Cardiac Risk Assessment and Perioperative Cardiac Management in Non-cardiac Surgery of the European Society of Cardiology (ESC) and endorsed by the European Society of Anaesthesiology (ESA)

EJA 2010;27(2):92-137

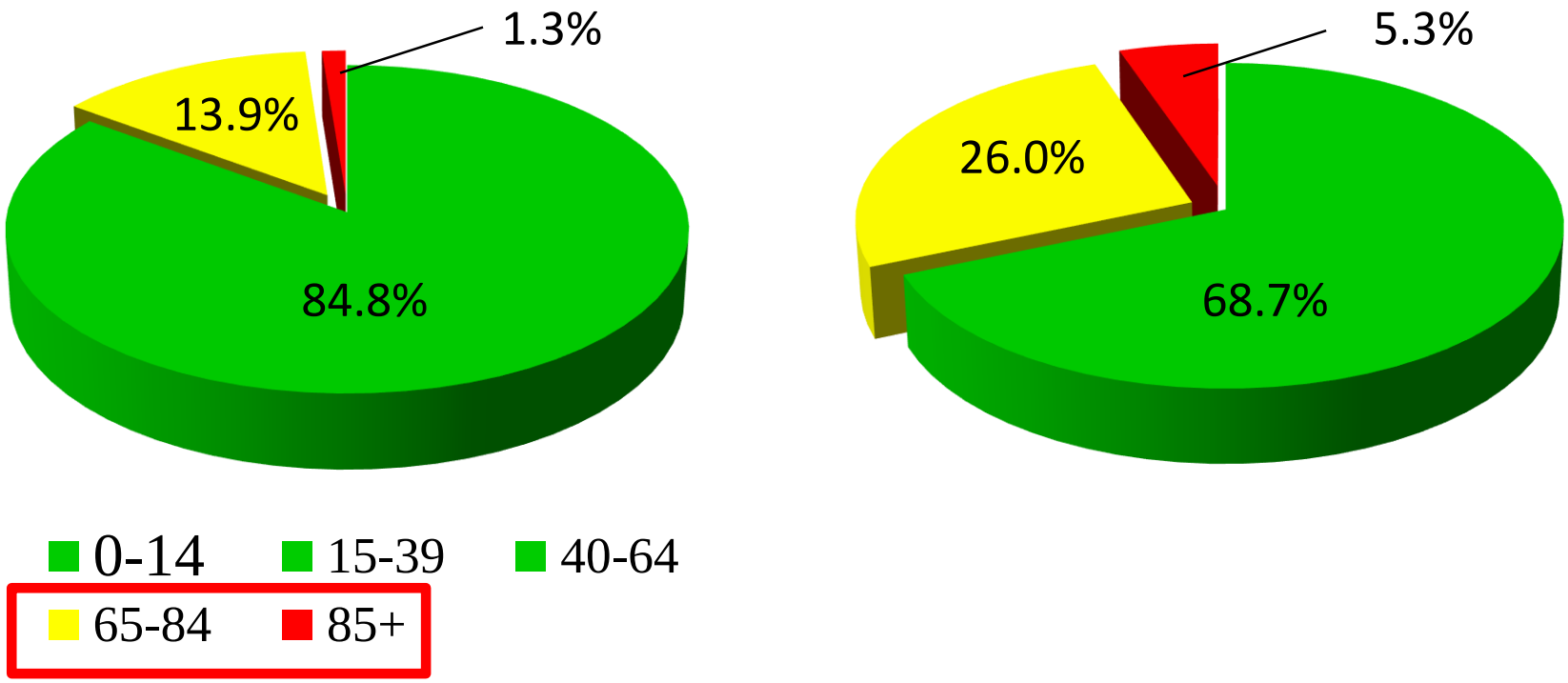
Table 11 Summary of pre-operative cardiac risk evaluation and pre-operative management

Step	Urgency	Cardiac condition	Type of surgery[a]	Functional capacity	Number of clinical risk factors[b]	LV echo	ECG	Stress testing[c]	β-Blockers[d]	ACE inhibitors[d,e]	Aspirin[d]	Statins[d]	Coronary revascularization[f]
1	Urgent surgery					III C	IIa C	III C	I C	I C	I C	I C	III C
2	Elective surgery	Unstable				I C	I C	III C					I C
3	Elective surgery	Stable	Low risk (<1%)		None	III B	III B	III C	II B	IIa C	IIb C	IIa B	III C
					≥1	III B	IIa B	III C	IIb B (titration) III A (no titration)	IIa C	IIb C	IIa B	III C
4				Excellent or good		III B	IIa B	III C	IIb (titration) III A (no titration)	IIa C	IIb C	IIa B	IIIC
5	Elective surgery		Intermediate risk (1–5%)	Moderate or poor	None	III B	IIb B	IIb C	IIa B (titration) II A (no titration)	I C	IIb C	IIa B	III B
					≥1	III B	I B	IIb C	IIa B(titration) III A (no titration)	I C	IIb C	IIa B	III B
6	Elective surgery		High risk (>5%)	Moderate or poor	≤2	IIa C	I B	IIb B	I B (titration) III A (no titration)	I C	IIb C	I B	IIb B
					≥3	IIa C	I B	I C	I B (titration) III A (no titration)	I C	IIb C	I B	IIb B

[a] Type of surgery (Table 4): risk of MI and cardiac death within 30 days after surgery. [b] Risk factors (Table 13): angina pectoris, MI, heart failure, stroke/transient ischaemic attack, renal dysfunction (creatinine >170 μmol/L or 2 mg/dL or a creatine clearance of <60 mL/min), diabetes mellitus. [c] Non-invasive testing not only for revascularization but also for patient counselling, change of perioperative management in relation to type of surgery, and anaesthesia technique. [d] Initiation of medical therapy, but in case of emergency surgery continuation of current medical therapy. Aspirin should be continued after stent replacement. [e] In the presence of LV dysfunction (ejection fraction <40%). [f] Class I recommendations for revascularization are consistent with the 2004 ACC/AHA guidelines: 1 = stable angina and significant left main disease; 2 = stable angina and three-vessel disease, especially when LV ejection fraction is <50%; 3 = stable angina and two-vessel disease with significant proximal left anterior descending coronary artery stenosis and either LV ejection fraction <50% or demonstrable ischaemia on non-invasive testing; 4 = high-risk unstable angina or non-STEMI; 5 = acute STEMI.

www.euroanaesthesia.org

Ageing continues!



http://www.czso.cz/csu/2003edicniplan.nsf/t/FF004F34A7/$File/4020rr02.xls

Ageing

successful

= to stay healthy

usual

= gaining illnesses

> 1/3 individuals > 65 years old ≥ 2 illnesses
> 2/3 individuals > 80 years old ≥ 2 illnesses
> 1/2 Americans > 65 years need ≥ 1 surgery

Frailty

reduced ability to maintain homeostasis in stress

Diagnosis:

- ✓ weight loss (> 4.5 kg in last year)
- ✓ exhaustion / fatigue (CES-D scale)
- ✓ weakness (↓ grip strength < 25 kp)
- ✓ walking speed slow (< 0.65 m/s = 2.5 km/h)
- ✓ physical activity low

Frailty present, if ≥ 3 items

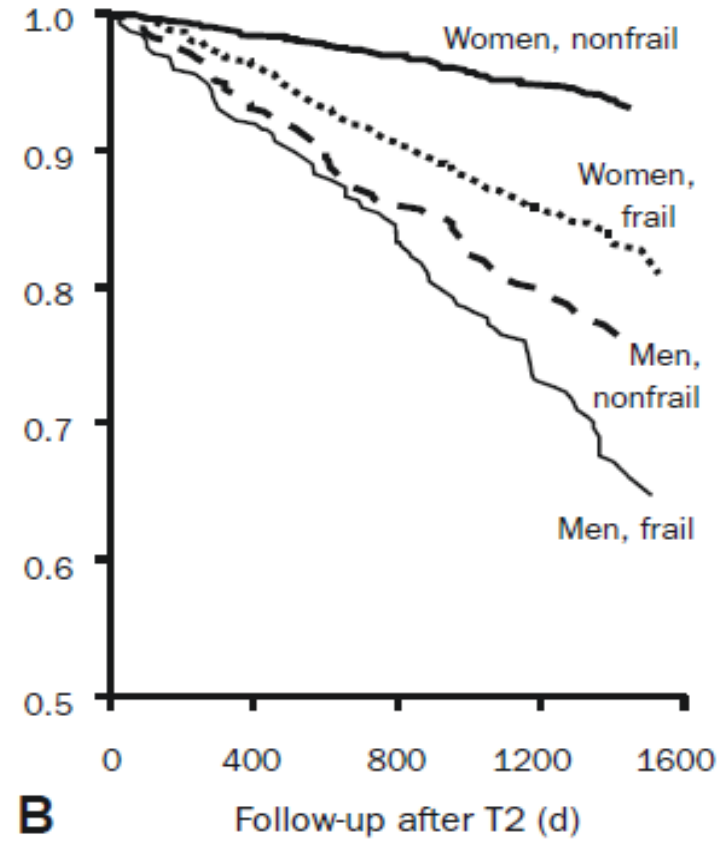
Prefrail, if 1 or 2

Frailty predicts death and unfavorable outcomes

- **Women's Health Initiative:**

  frail women die with 2x higher probability than non-frail[1]

- **Longitudinal Aging Study Amsterdam (LASA)[2]**
  - 5-year mortality in frail men ≈ 50%
  - older adults with a low educational level had higher odds of being frail than those with a high educational level (odds ratio 2.94; 95% CI, 1.84–4.71)[3]



LASA

Cardiac risk evaluation

- patient – Lee revised cardiac risk index
  - CHD (st.p. MI or angina pectoris)
  - heart failure
  - stroke, TIA
  - diabetes treated by insulin
  - renal dysfunction/hemodialysis
    (creatinine > 170 umol/l a/or GFR < 1 ml/s)
- surgery

Cardiac risk by type of surgery

Low (< 1 %)	Medium (1-5 %)	High (> 5 %)
Mastectomy	Abdomen	Aorta and big vessels
Teeth	CEA	Peripheral arteries
Endocrine surgery	Vessel angioplasty	
Eye surgery	Aortic stentgraft (EVAAR)	
Gynaecolog	Head and neck	
Plastic surgery	Hip, spine	
Small orthopedics	Lung, kidney, liver tx,	
Small urology	Big urology	

Boersma E et al.: Perioperative cardivascular mortality in noncardiac surgery: validation of the Lee cardiac risk index. Am. J Med 2005;118:1134-1141

Cardiac risk evaluation

- biomarkers (troponin, CRP, BNP a NT-proBNP)
- ECG
- rest echocardiography

  → for high-risk surgeries

  →in asymtpomatic pts not recommended
- ischemia evaluation (stress echo, scinti)

  →in high.-risk surgeries in pts. with ≥ 3 risk factors

CardioPulmonary Exercise Testing (CPET)

Integrated evaluation of:

- lungs
- cardiovascular systém
- blood
- neuropsychology
- muscles and joints

www.kardio-olomouc.cz/pic/kolo.jpg

Physical capacity

- stress evaluation or history
- max. VO_{2max} or MET

  1 MET (Metabolic Equivalent Task) = oxygen consumption of 40 years old man 70 kg at rest = 3,5 ml/kg/min
- physical capacity
  - Good - > 7 MET
  - Fair - 4 - 7 MET
  - Bad - < 4 MET

Physical capacity

MET	activity
1	• caring for self?
	• meal, dressing, toilet
	• walking at home
	• walking outside 3 - 5 km/hod
	• light housework (vacuum cleaning, dishes)
4	• stairs, walking uphill
	• walking flat, 6 km/hour
	• short distance running
	• heavy housework (moving furniture)
	• recreation sport
> 10	• strenuous sport

Physical capacity determines perioperative management

Is he/she able to climb 2 flights of stairs?

Physical capacity

MET	activity
1	• caring for self?
	• meal, dressing, toilet
	• walking at home → **frailty**
	• walking outside 3 - 5 km/hod
	• light housework (vacuum cleaning, dishes)
4	• stairs, walking uphill
	• walking flat, 6 km/hour
	• short distance running → **good capacity**
	• heavy housework (moving furniture)
	• recreation sport
> 10	• strenuous sport

The importance of physical capacity

risk stratification and prognosis

- heart failure
  VO_{2max} > 14 ml/kg/min associated with 1year survival 93 %
  Green P et al.: AM J Cardiol 2007 ;99:399-403
- operative period
  anaerobic threshold < 11 ml/kg/min → high risk of perioper. death in seniors undergoing big surgeries
  Older P et al.: Chest 1999;116:355-362

Physical status classification of American Society of Anesthesiologists

prof. Emory A. Rovenstine
1895-1960

Table 1. ASA Physical Status Classifications and Examples

ASA PS Classification	Definition	Examples
ASA I	A normal healthy patient	Healthy, nonsmoking, no or minimal alcohol use
ASA II	A patient with mild systemic disease	Mild diseases only without substantive functional limitations. Examples include (but not limited to): current smoker, social alcohol drinker, pregnancy, obesity (30 < BMI < 40), well-controlled DM/HTN, mild lung disease
ASA III	A patient with severe systemic disease	Substantive functional limitations; one or more moderate to severe diseases. Examples include (but not limited to): poorly controlled DM or HTN, COPD, morbid obesity (BMI ≥40), active hepatitis, alcohol dependence or abuse, implanted pacemaker, moderate reduction of ejection fraction, ESRD undergoing regularly scheduled dialysis, premature infant PCA <60 wk, history (>3 mo) of MI, CVA, TIA or CAD/stents
ASA IV	A patient with severe systemic disease that is a constant threat to life	Examples include (but not limited to): recent (<3 mo) MI, CVA, TIA or CAD/stents; ongoing cardiac ischemia or severe valve dysfunction; severe reduction of ejection fraction; sepsis; DIC; ARD; or ESRD not undergoing regularly scheduled dialysis
ASA V	A moribund patient who is not expected to survive without the operation	Examples include (but not limited to): ruptured abdominal/thoracic aneurysm, massive trauma, intracranial bleed with mass effect, ischemic bowel in the face of significant cardiac pathology or multiple organ/system dysfunction
ASA VI	A declared brain-dead patient whose organs are being removed for donor purposes	

ARD, acid reflux disease; **ASA,** American Society of Anesthesiologists; **BMI,** body mass index; **CAD,** coronary artery disease; **COPD,** chronic obstructive pulmonary disease; **CVA,** cerebral vascular accident; **DIC,** disseminated intravascular coagulation; **DM,** diabetes mellitus; **ESRD,** end-stage renal disease; **HTN,** hypertension; **MI,** myocardial infarction; **PCA,** postconceptual age; **PS,** physical status; **TIA,** transient ischemic attack

ASA classification

Group	Risk
• ASA 1:	0,06 %
• ASA 2:	0,47 %
• ASA 3:	4,39 %
• ASA 4:	23,48 %
• ASA 5:	50,77 %

Acute surgeries increase the risk 1,5-2,0x

Marx, G.: Computer analysis of postanesthetic deaths.
Anesth 1973;39:54

ASA classification

Table 2 Cardiac arrest incidence in 53 718 anaesthetics according to ASA physical status and surgical procedure. *Incidences followed by different letters are significantly different ($P<0.05$)

univ. nem. 1996-2005

	Anaesthetics		Cardiac arrests	
	n	(%)	*n*	Incidence* (per 10 000)
ASA physical status				
I	25 774	(47.98)	4	1.55[d]
II	18 349	(34.16)	11	5.99[d]
III	7428	(13.83)	40	53.85[c]
IV	1925	(3.58)	76	394.80[b]
V	242	(0.45)	55	2272.72[a]
Surgical procedures				
Elective	30 971	(57.65)	60	19.37[b]
Urgent	18 204	(33.89)	27	14.83[b]
Emergency	4543	(8.46)	99	218.30[a]

Br J Anaesth. 2006 May;96(5):569-75

Preoperative evaluation

- ASA 1, 2: general practitioner, or attending physician,
  valid 1 month
- ASA 3-5: internist, cardiologist, fresh

- Children: pediatrician
  valid: 2 weeks

Premedication

- aims:
  - to alleviate anxiety and fear
  - to facilitate induction
  - to lower the consumption of anaesthetics
  - to control pain, if necessary
- drugs:
  - benzodiazepins, opioids?, atropine?
- administration:
  - per os, i.m.?, i.v. in acute conditions

Preoperative pharmacotherapy

- to discuss 1 week before
- **to continue!**
  - beta-blockers, statins?
  - antiparkinsonic drugs (DOPA)
- **to discontinue!** (substitution , worsening of the disease?, sy from withdrawal?, restarting the therapy?)
  - irreversible MAO inhibitors
- **other drugs: by indication! and pharmacokinetics**

Stop Eating and Drinking Before Anesthesia or Sedation

Operation Time

Stop clear fluids **2 hours before** operation time

Stop solid foods **at midnight before** operation time

STOP

Stop breast milk **4 hours before** operation time

Stop bottle feeds/ tube feeds **6 hours before** operation time

Helfried Metzler

When to operate after PCI?

- 20% mortality, postpone surgery > 2-4 weeks

  G.L. Kaluza, J. Joseph, J.R. Lee et al.: **Catastrophic outcomes** of noncardiac surgery soon after coronary stenting.
  J Am Coll Cardiol 35 (**2000**), pp. 1288–1294.

- postpone at least for 6 weeks

  Wilson SH et al.: Clinical outcome of patients undergoing non-cardiac surgery in the two months following coronary stenting.
  J Am Coll Cardiol. **2003** Jul 16;42(2):234-40.

- with coated stents even longer

When to operate after PCI?

Helfried Metzler

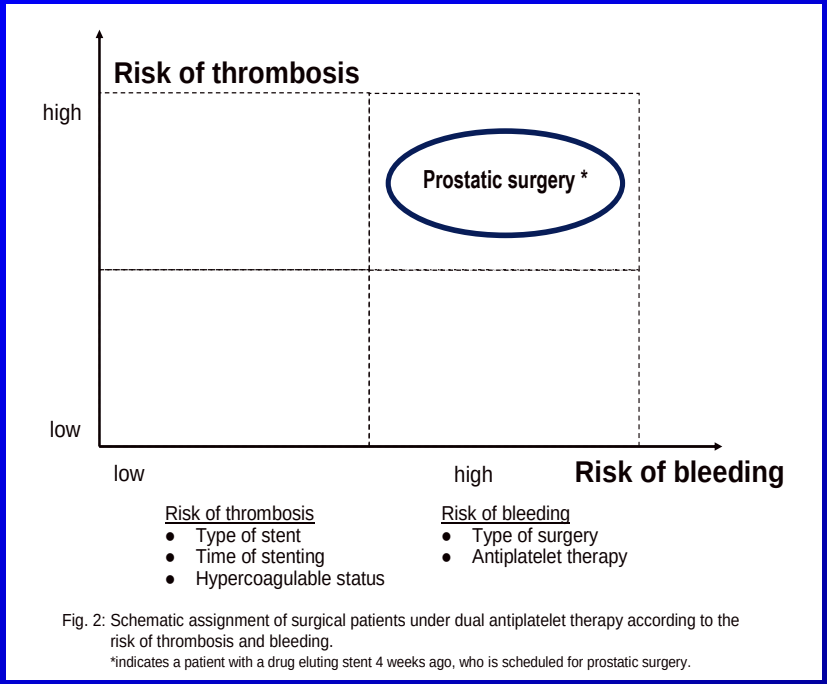


Fig. 2: Schematic assignment of surgical patients under dual antiplatelet therapy according to the risk of thrombosis and bleeding.
*indicates a patient with a drug eluting stent 4 weeks ago, who is scheduled for prostatic surgery.

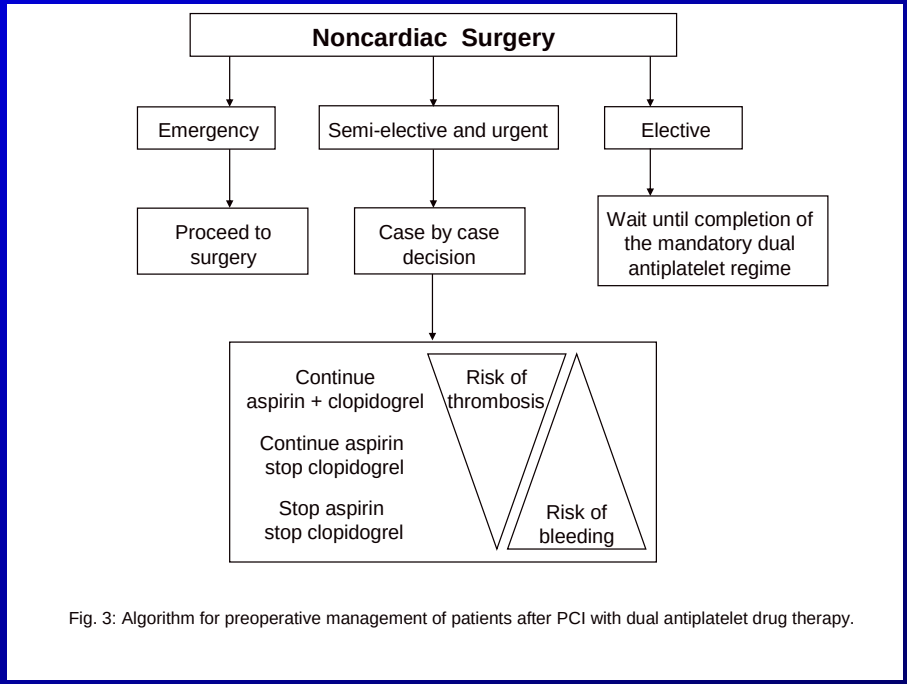


Fig. 3: Algorithm for preoperative management of patients after PCI with dual antiplatelet drug therapy.

H. Metzler in Book of Proceedings, 10th ICCVA, Praha, 2006