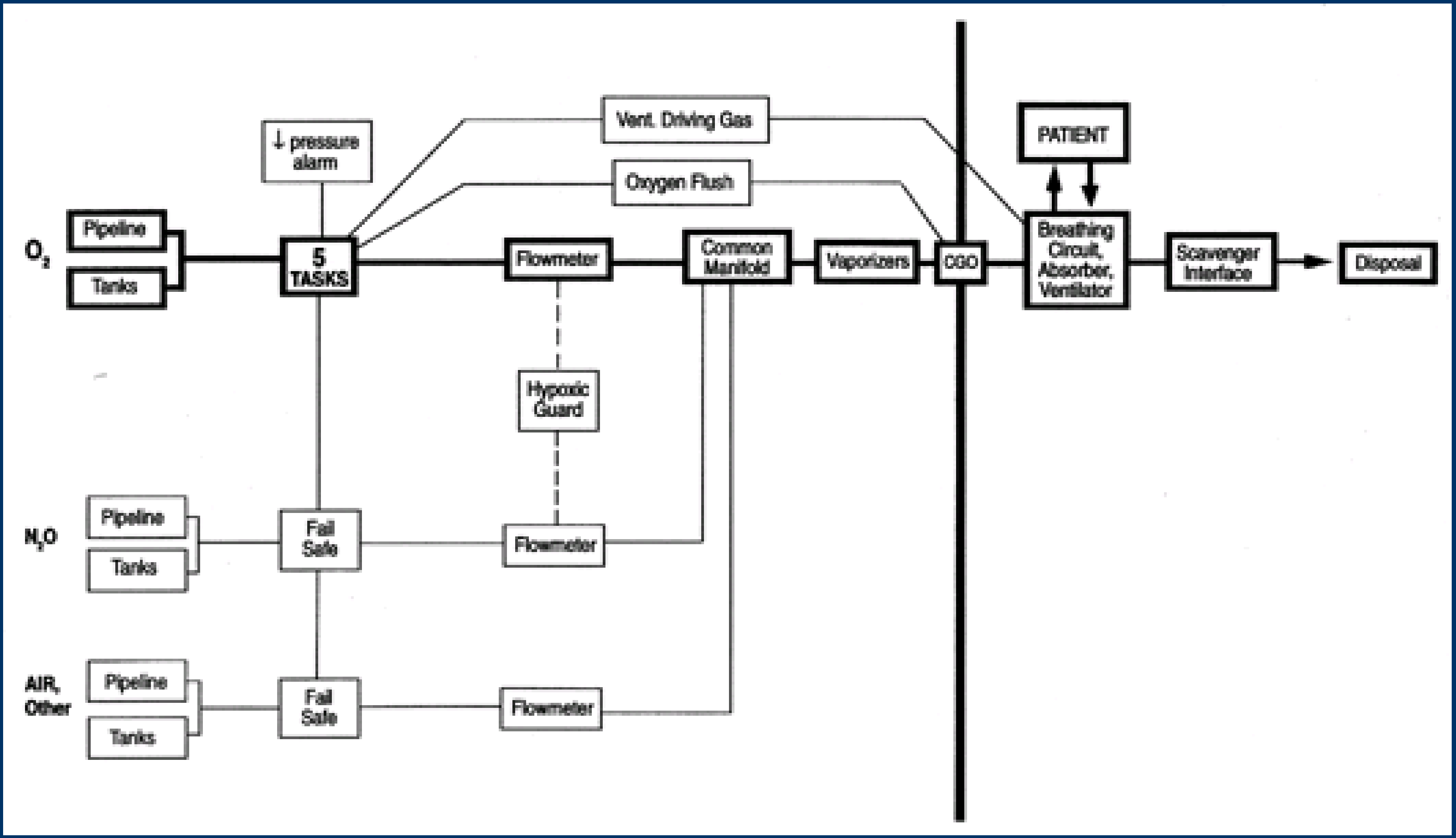
Anesteziologický přístroj, monitorace

L.Dadák
ARK FNUSA & LF MU

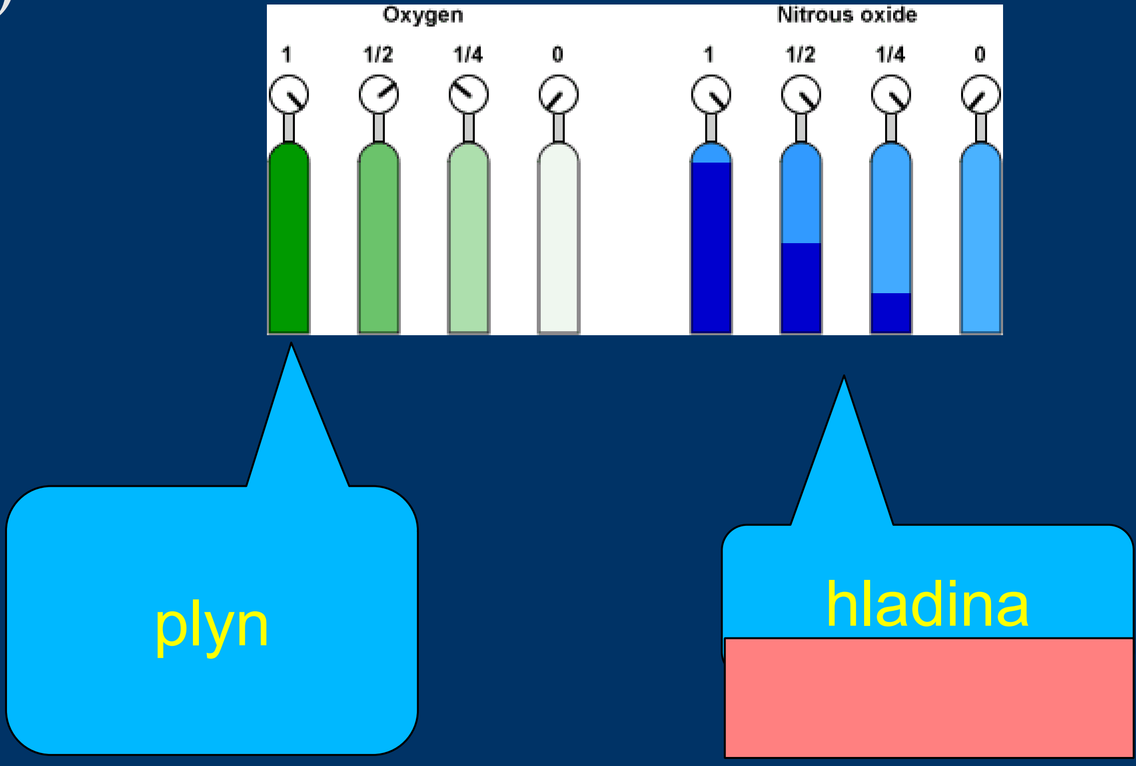


Vent. Driving Gas
↓ pressure alarm
Oxygen Flush
PATIENT
O_2
Pipeline
Tanks
5 TASKS
Flowmeter
Common Manifold
Vaporizers
CGO
Breathing Circuit, Absorber, Ventilator
Scavenger Interface
Disposal
Hypoxic Guard
N_2O
Pipeline
Tanks
Fail Safe
Flowmeter
AIR, Other
Pipeline
Tanks
Fail Safe
Flowmeter

Plyny – značení ISO

O_2 - bílý

- frakční destilace stlačeného = kapalného vzuchu.
- (N_2 vře dříve než O_2)



N20 - modrý

- tlak 5 MPa

Vzduch bílo/černý

CO_2 - šedý

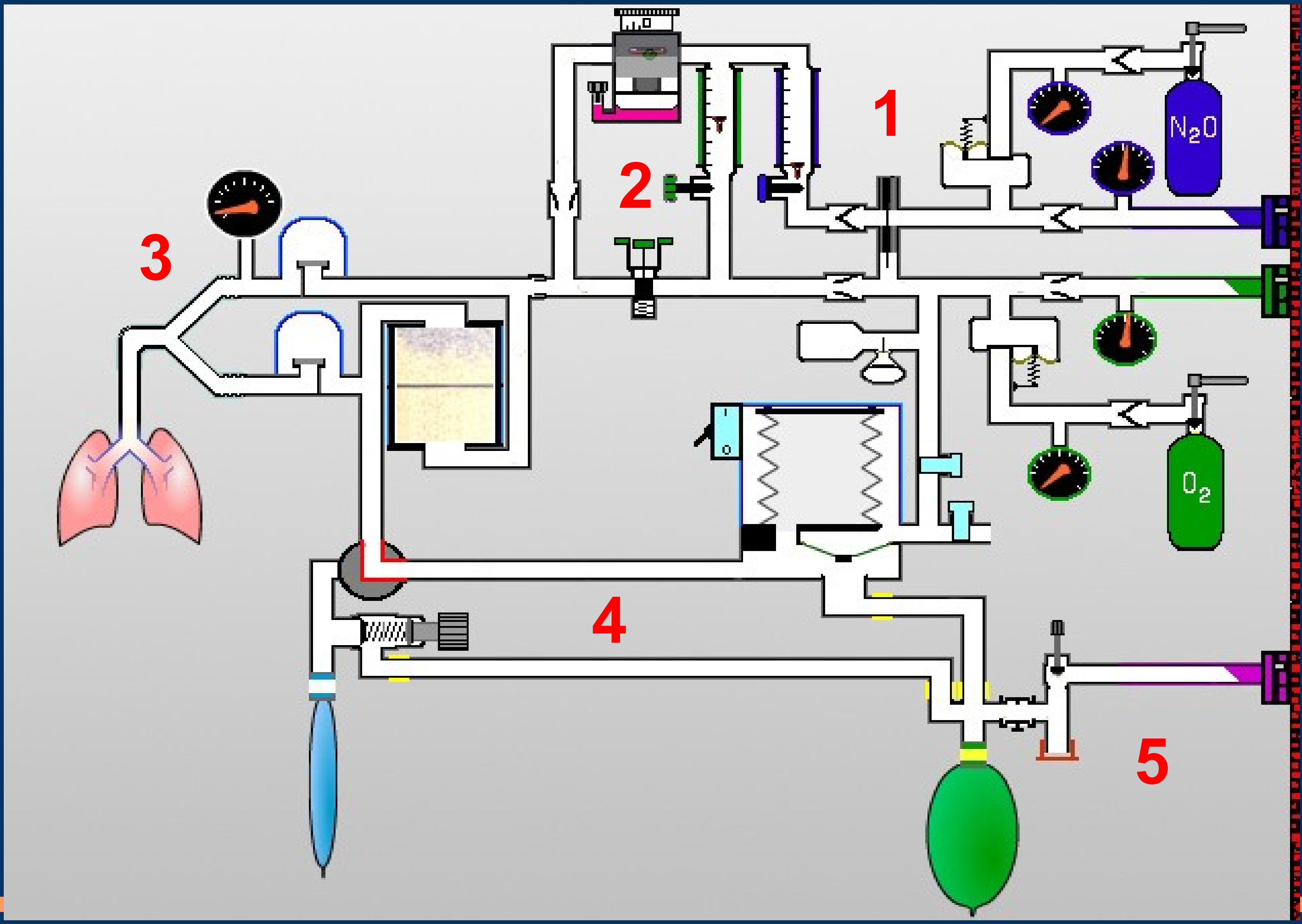
Anesteziologický přístroj

umožňuje ventilovat definovanou směsí plynů

části:

1. High pressure system
2. Low pressure system - směs plynů, inhalační anestetikum
3. Breathing circuit - vdech, výdech část
4. Ventilation systems (manual and mechanical)
5. Scavenging system - odtah anest.plynů

Části anest. přístroje

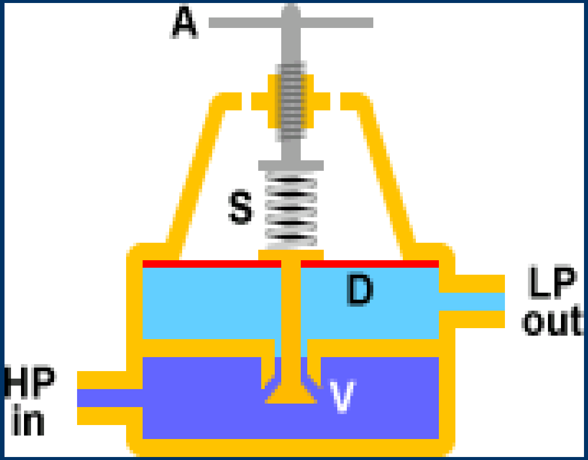


Vysokotlaká část

Zdroj stačeného plynu

- tlakové láhve
- centrální rozvod plynů
- bezpečnostní chlopeň
- redukční ventil

pO2 > pN2O

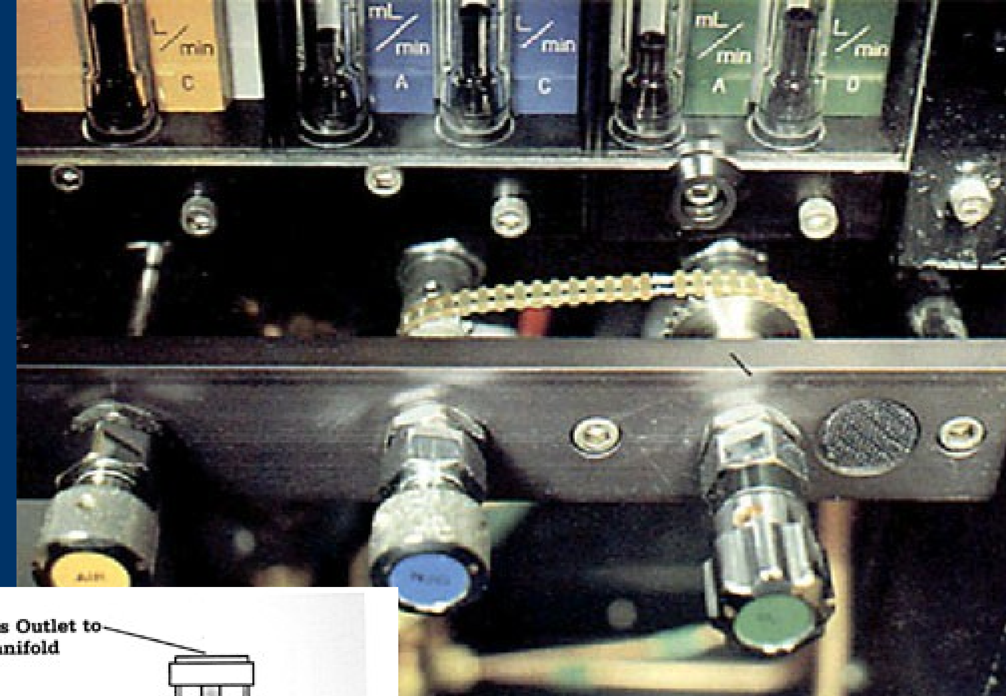


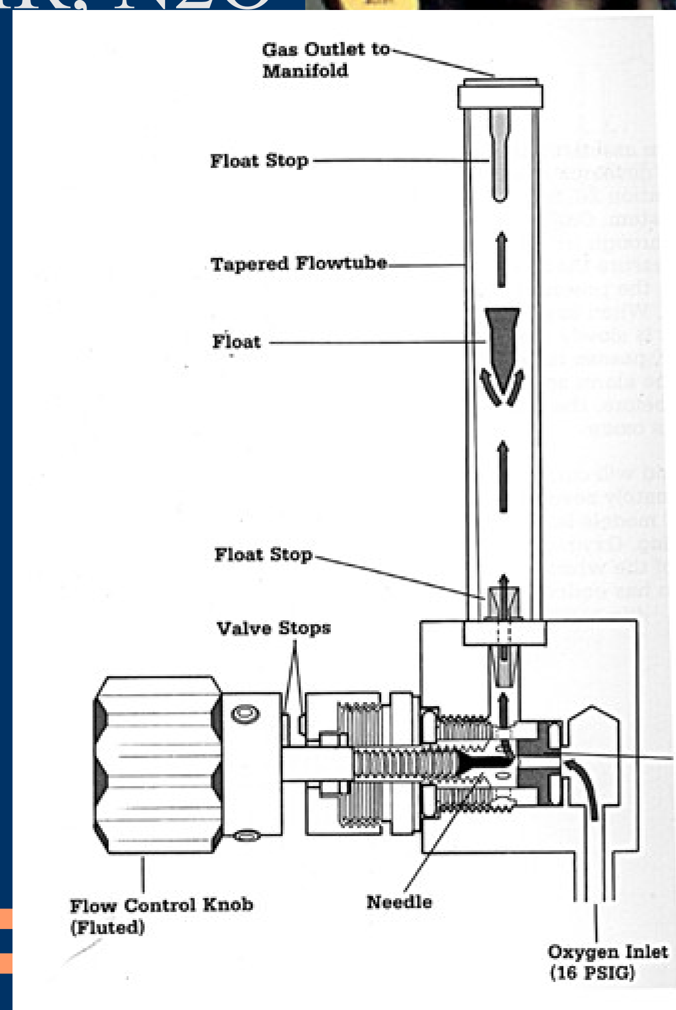
- manometr

Nízkotlaká část

- průtokoměry = flowmetr O2, AIR, N2O
- odpařovač
- bypass

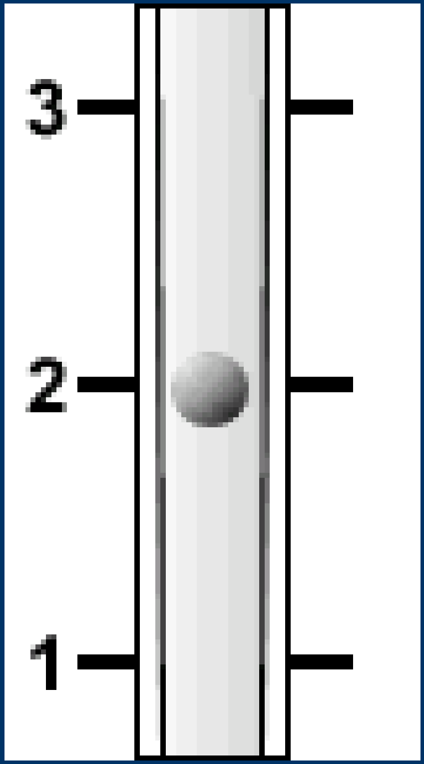
řízení průtoku
a koncentrace



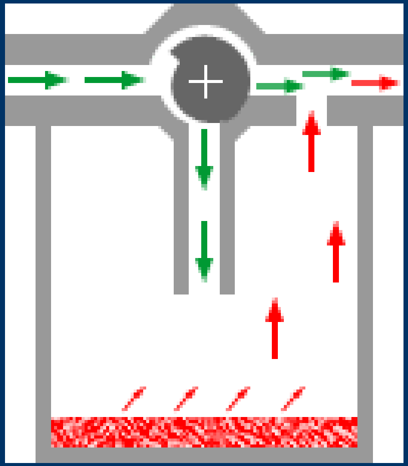


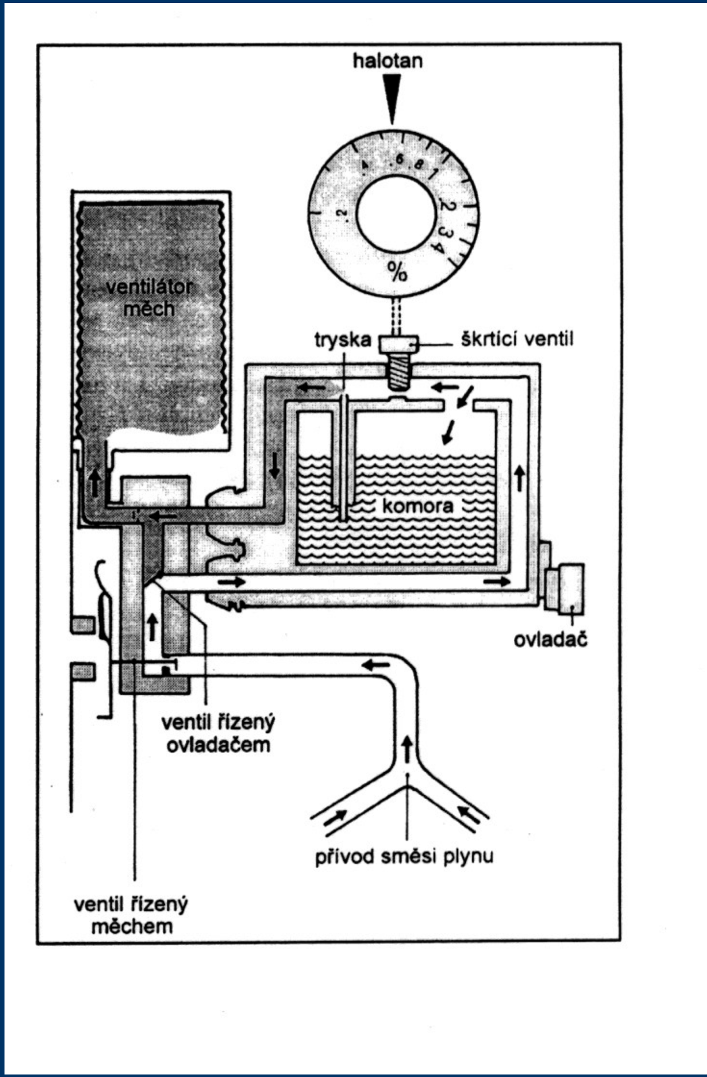
Průtoky anest. plynu

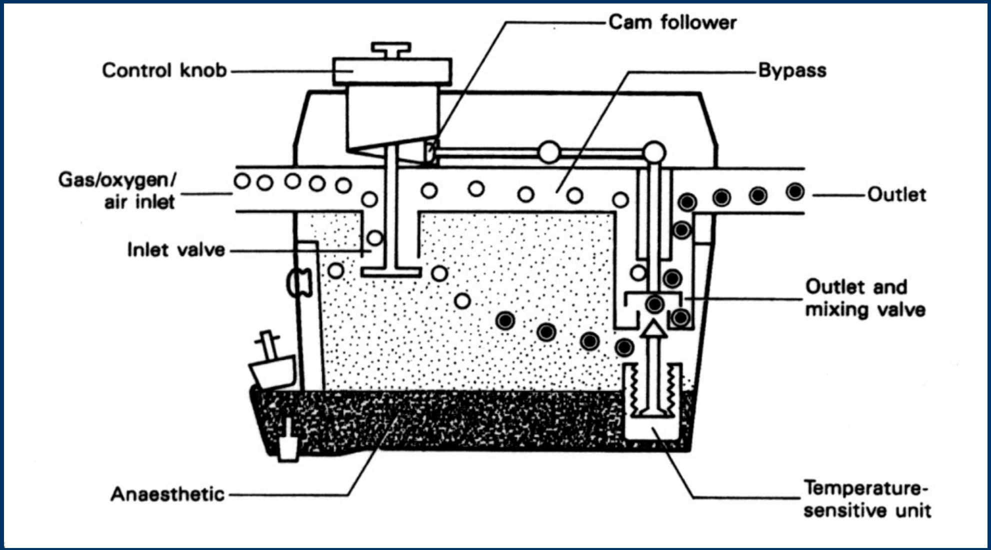
- dříve : 2..4
- low flow pod 1 l/min
- minimal flow pod 0,5l/min
- uzavřený systém



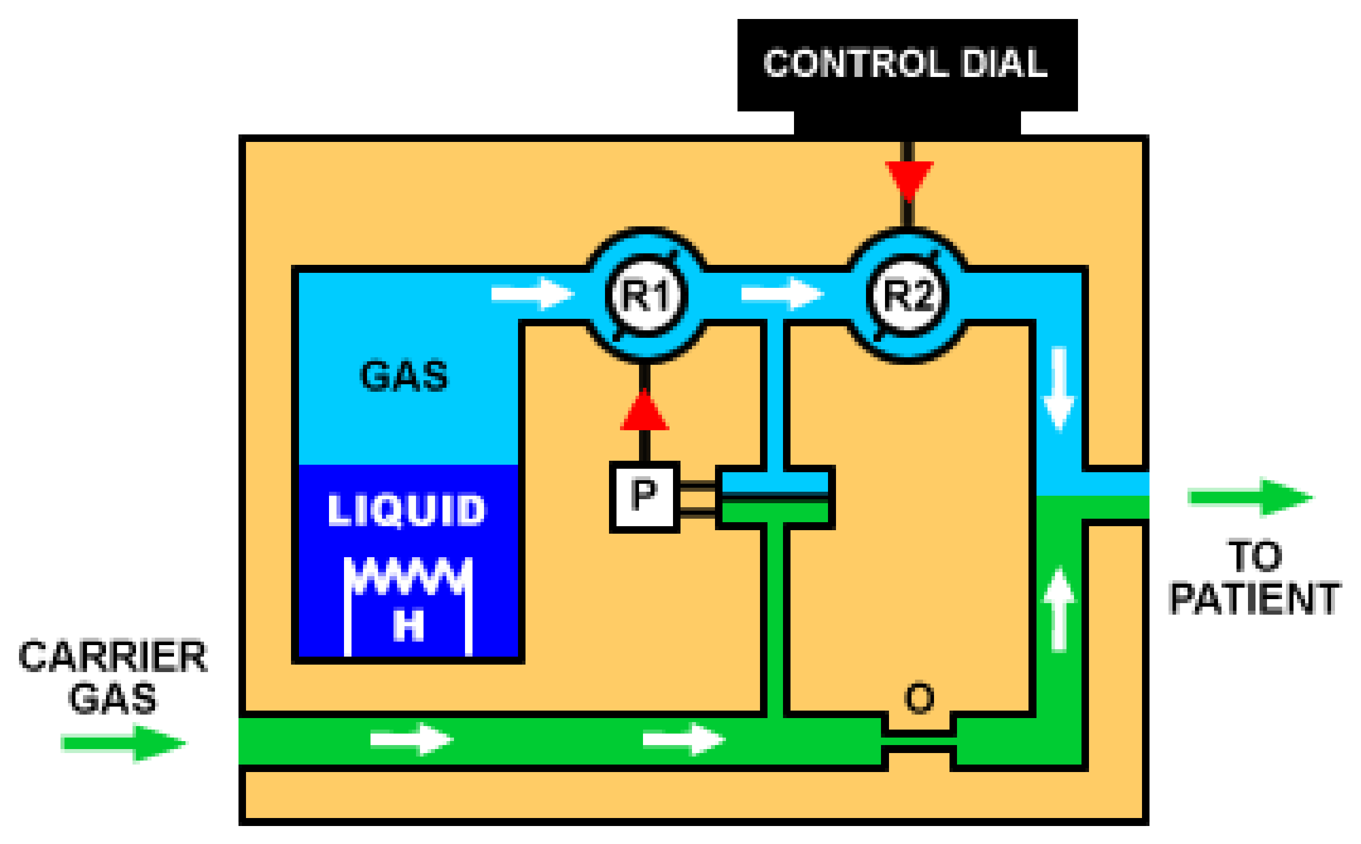
Odpařovače




halotan
.2
.4
.6
.8
1
2
3
4
%
ventilátor
měch
tryska
škrtící ventil
komora
ovladač
ventil řízený
ovladačem
přívod směsi plynu
ventil řízený
měchem

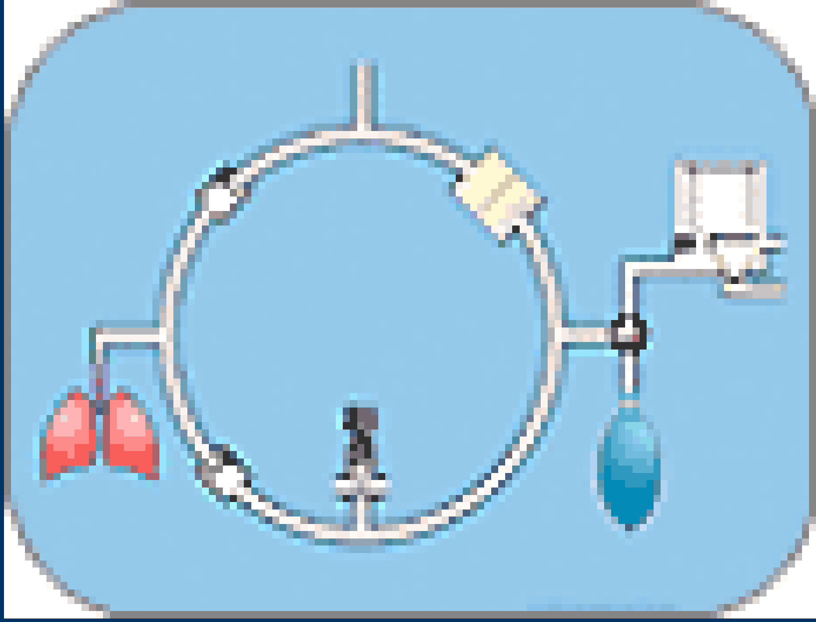

Cam follower
Control knob
Bypass
Gas/oxygen/
air inlet
Outlet
Inlet valve
Outlet and
mixing valve
Anaesthetic
Temperature-
sensitive unit

Všechno je jinak … Desfluran



Dýchací okruh

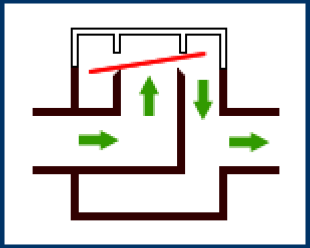
- chlopeň vdechová
- manometr
- Y spojka
- chlopeň výdechová
- volumetr
- pohlcovač CO_2
- hadice
- přepadový ventil

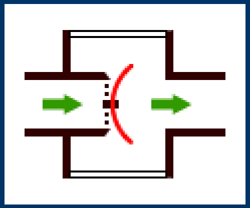


umožní znovu vdechovat plyn zbavený CO_2 – low flow

chlopeň vdechová

1 směr





manometr

Y spojka, filtr, prodlužovací hadice

chlopeň výdechová

volumetr

pohlcovač CO2

Neutralizační reakce:

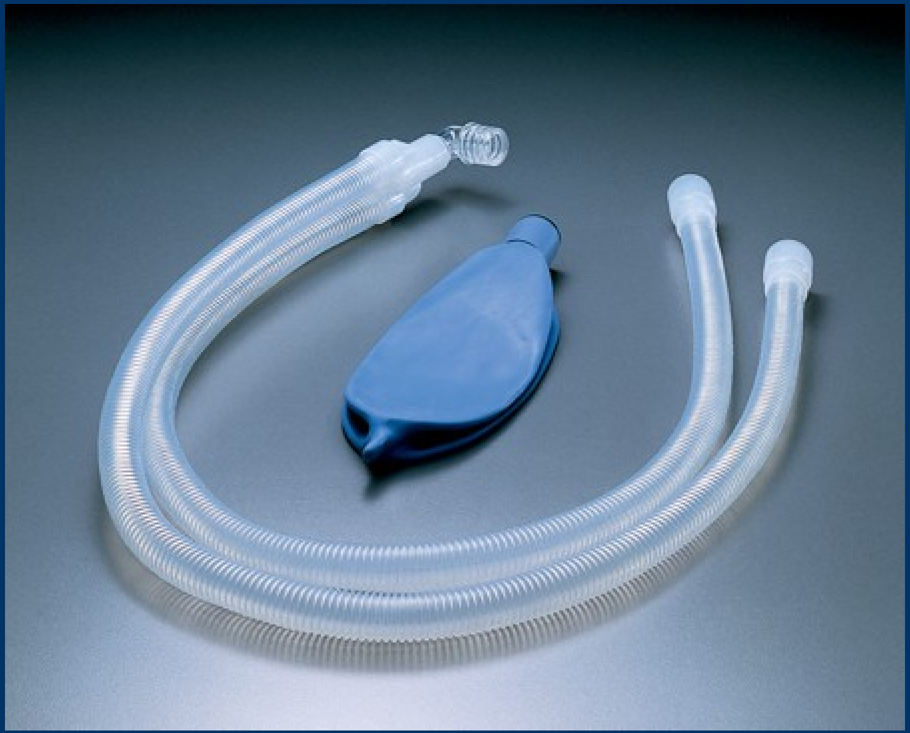
$CO_2 + H_2O \rightarrow H_2CO_3$

$H_2CO_3 + 2\ NaOH \rightarrow Na_2CO_3 + 2\ H_2O$ + tep

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

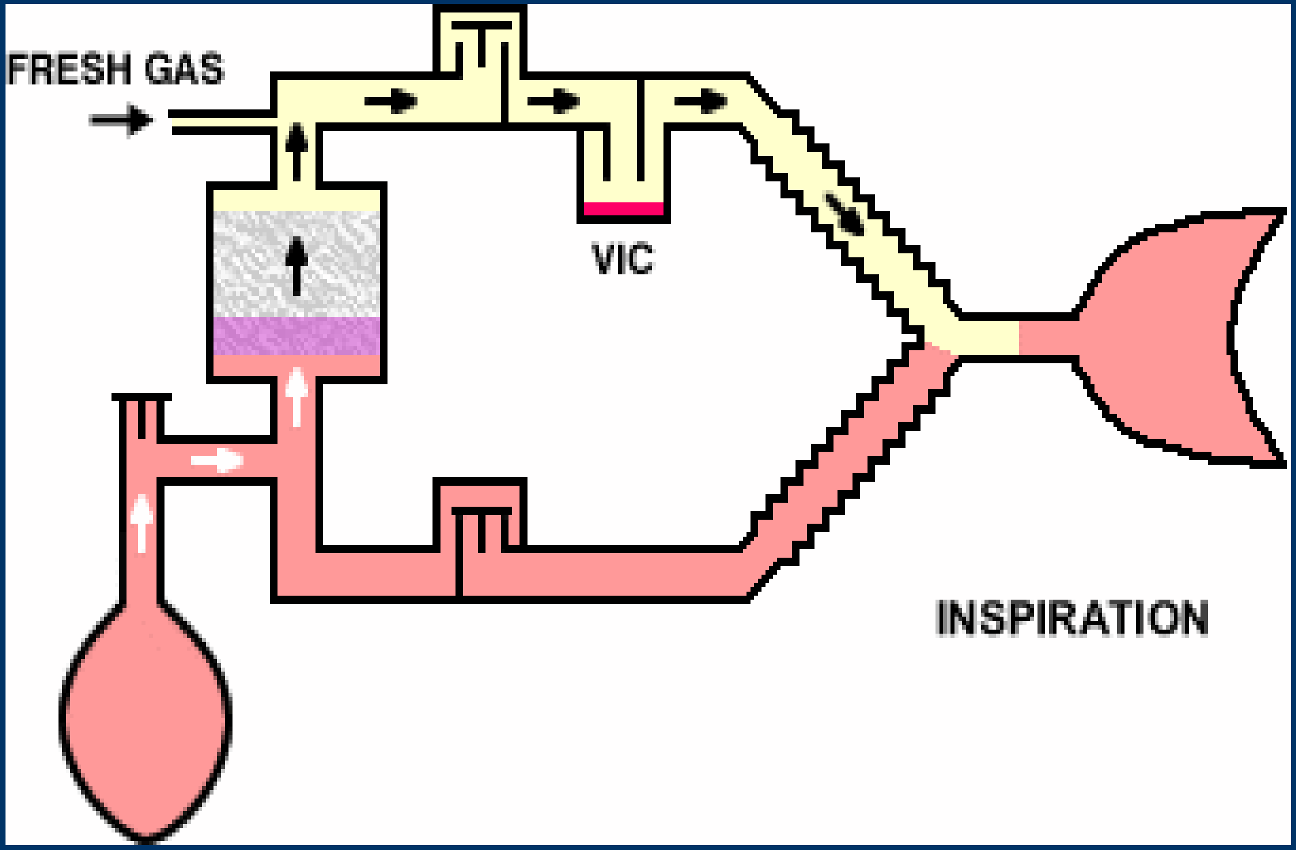
kapacita: (teoreticky26l) reálně15-20l CO2/100 g

hadice



přepadový ventil

Dýchací okruh

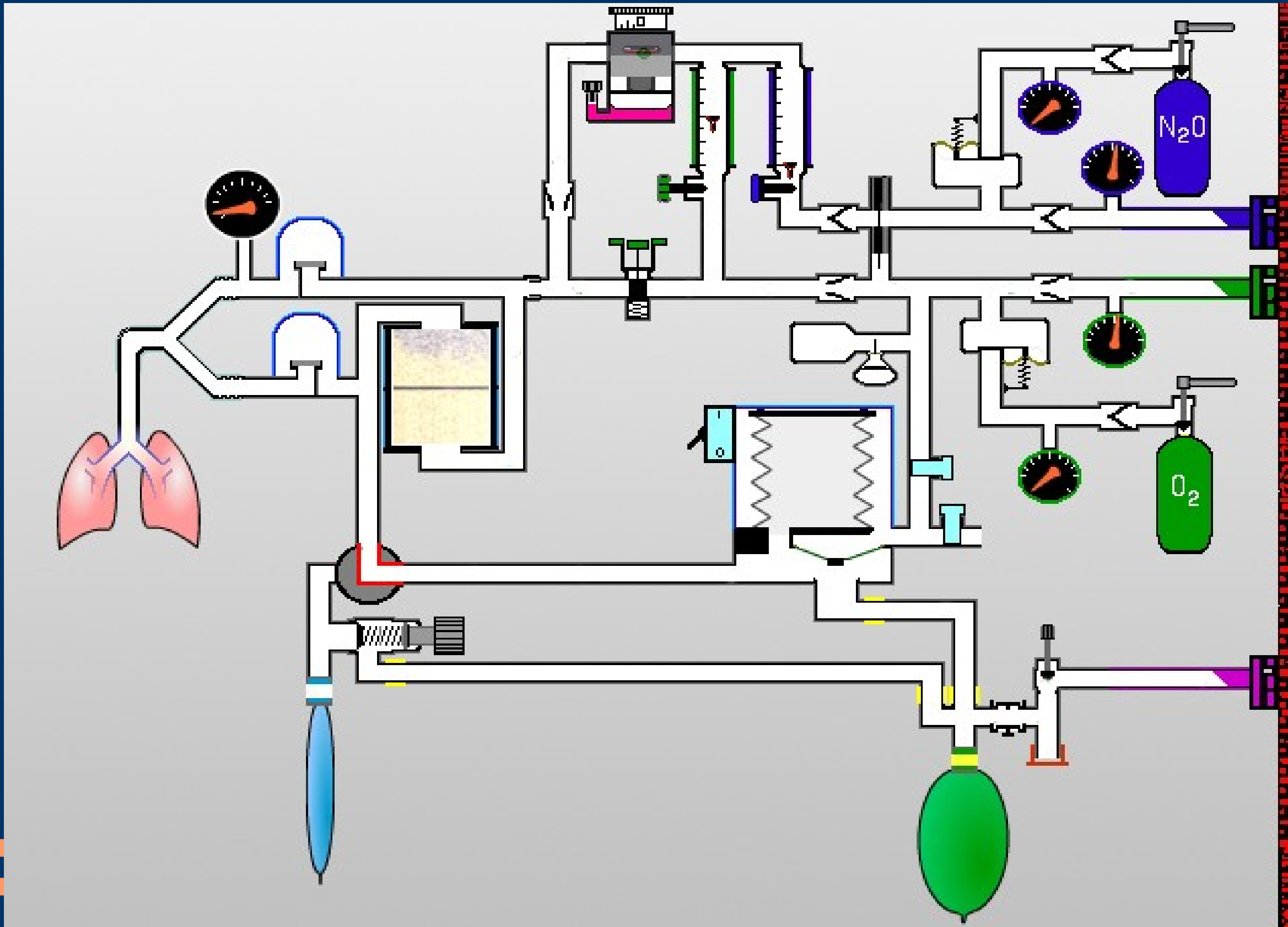


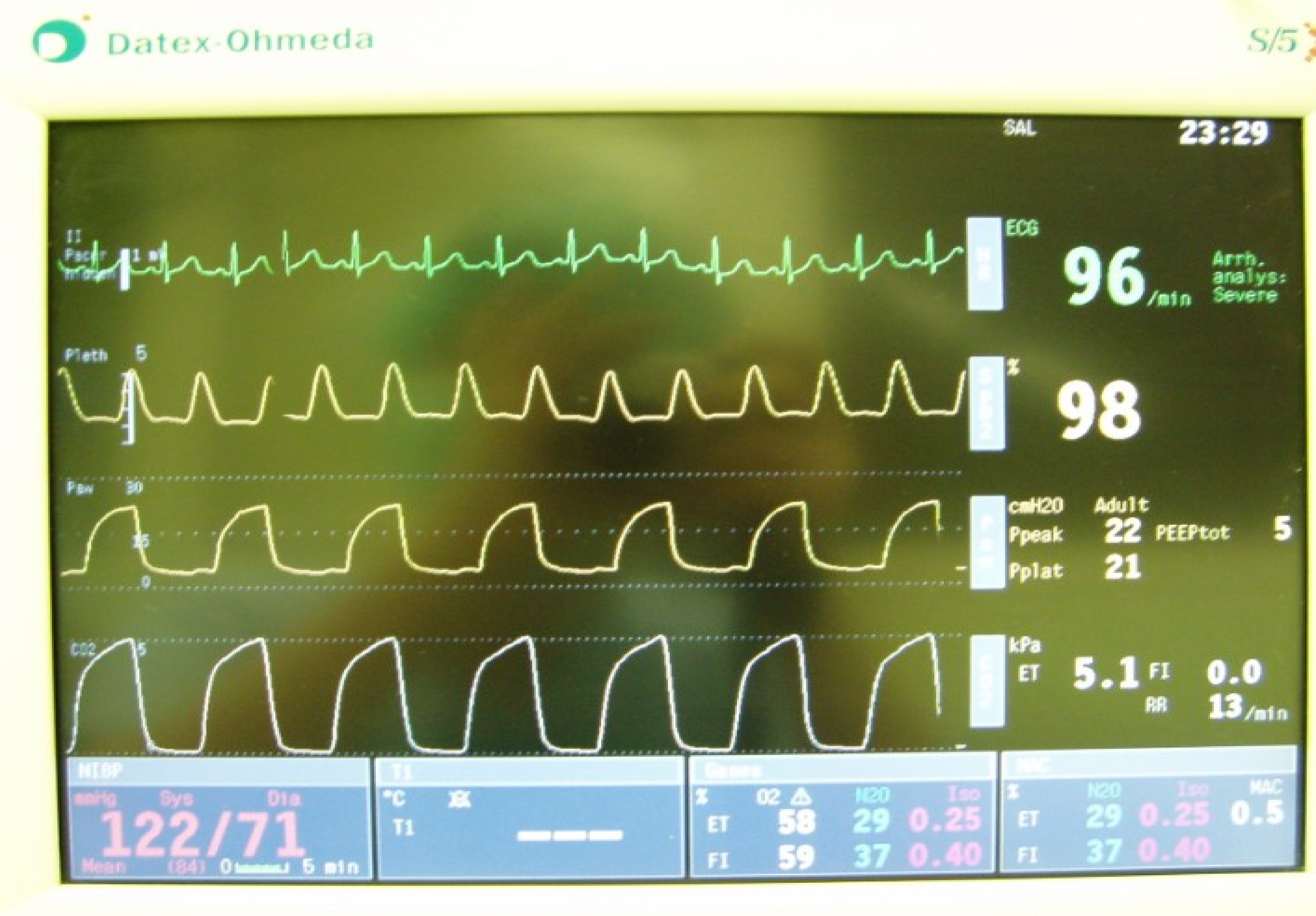
Ventilační část

- ventilátor
  (objemově řízená ventilace, (PCV)
  Vt 6 ml/kg, f dle CO_2, PEEP 5
- manuálně - vak

Odtah anest. plynů

- přebytečné plyny mimo sál




Datex-Ohmeda
S/5
SAL
23:29
II
ECG
96 /min
Arrh. analys: Severe
Pleth 5
%
98
Paw 30
cmH2O Adult
Ppeak 22 PEEPtot 5
Pplat 21
CO2 5
kPa
ET 5.1 FI 0.0
RR 13/min
NIBP
mmHg Sys Dia
122/71
Mean (84) 0 5 min
T1
°C
T1
Gases
% O2 N2O Iso
ET 58 29 0.25
FI 59 37 0.40
MAC
% N2O Iso MAC
ET 29 0.25 0.5
FI 37 0.40

Monitorace pacienta

monere, "to warn"

systematicky kontrolovat

..použitím smyslů a elektronických zařízení opakovaně nebo kontinuálně měřit proměnné anestezovaného pacienta.

Smysly klamou, ...

… ale bez smyslů to nejde

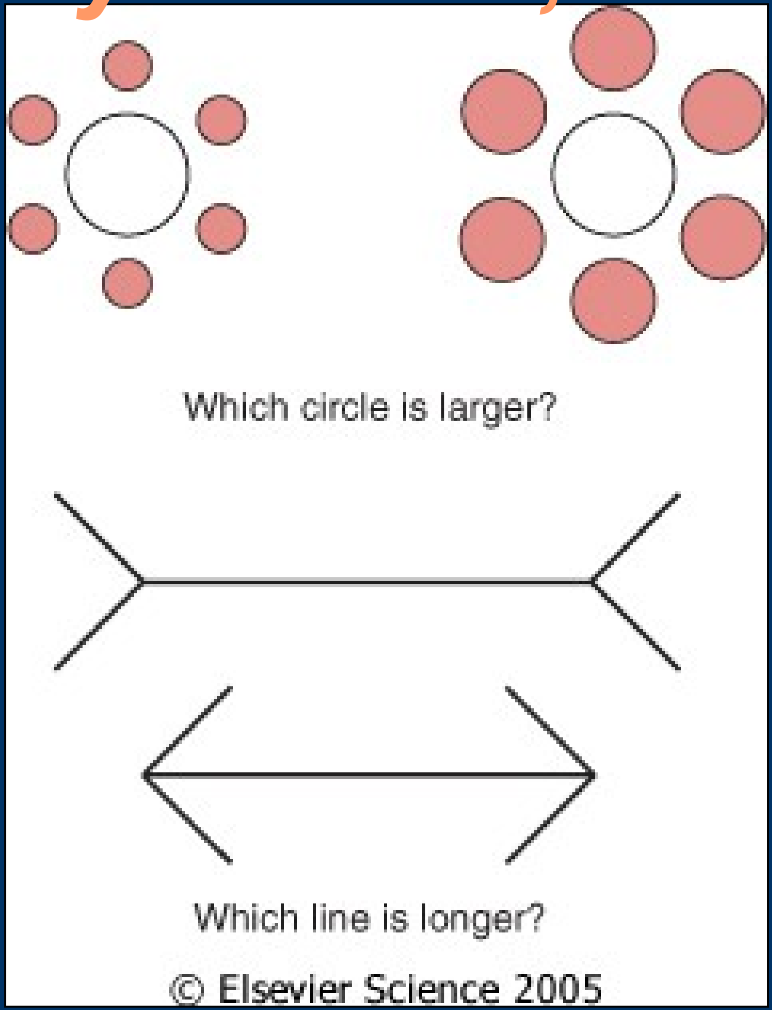


Figure 30-1 Optical illusions. We perceive the circles to be different sizes because we infer the size by relative dimensions. The closeness of the smaller circles makes the inner circle appear smaller, and vice versa. The lines appear to be different sizes because we use straight-line perspective to estimate size and distance. This illusion reportedly does not work in cultures where straight lines are not used. Therefore, our internal perceptions lead us to err in estimating size and length. In the same way, the internal programming of our monitors can lead us to misinterpret results.

Monitorace

1) trvalá přítomnost anesteziologa/sestry

Sledovat + hodnotit kontinuálně

- Airway + Breathing
  - průchodné d.cesty
  - kvalita dýchání, slyšitelné fenomeny, poslech
- Circulation
  - kvalita a frekvence pulsu, prokrvení, barva sliznic
- hloubka anestezie ~ vědomí
  - zornice, pocení, pohyb kk.

Cíl: předejít problému

>>>> Alarm <<<<

< ?? co s ním ??>

- všimnout si
- interpretovat = vyhodnotit
- reagovat = něco změnit
  - vypnout alarm?
  - upravit hranice alarmu?

Fonendoskop

\+ při anestezii okamžitě dostupný.

- ventilační problém (bronchospasmus, laryngospasmus při LM)

\- SpO2, EtCO2 a EKG detekují problém snadněji než kontinuální poslech.

Monitorace oběhu fonendoskopem – jen není-li dostupná elektronická monitorace.

EKG

- srdeční frekvence
- rytmus
- extrasystoly
- ST změny
  - ischemie

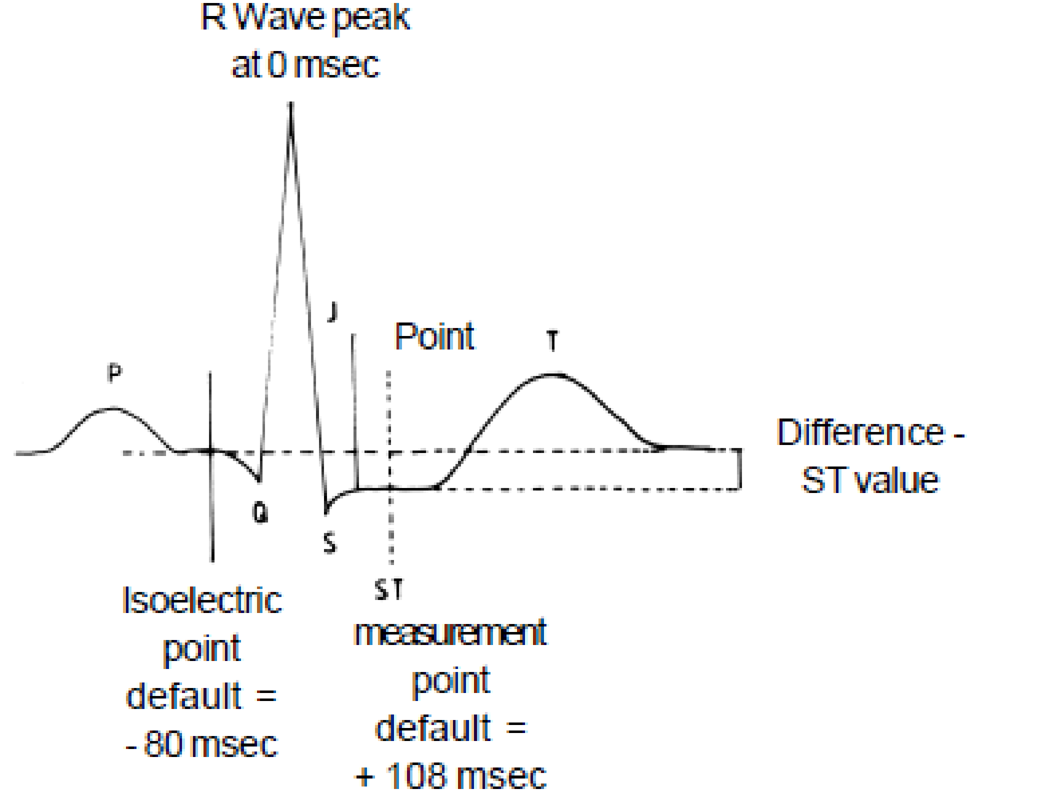
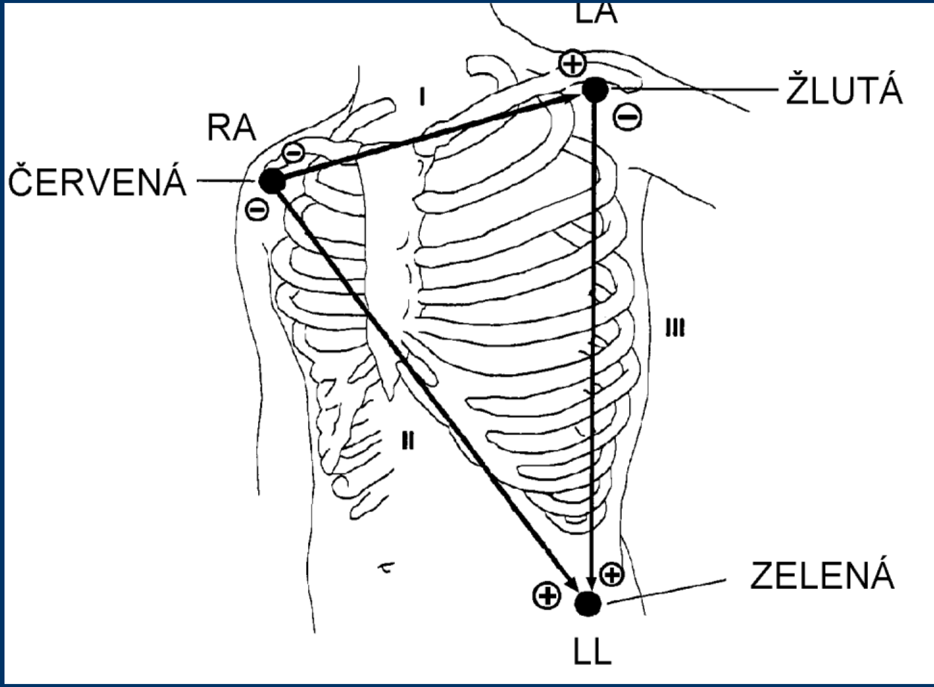
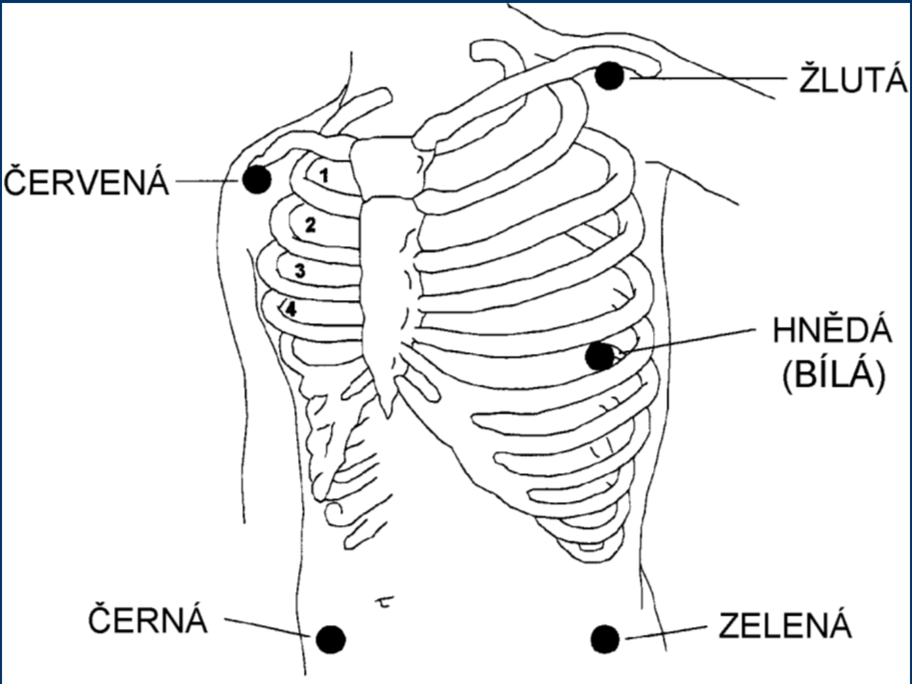


Fig - 4 : Adjustable reference points for automated ST segment analysis

Polohy elektrod





sinusový rytmus

Obr. 2a: Sinusová tachykardie

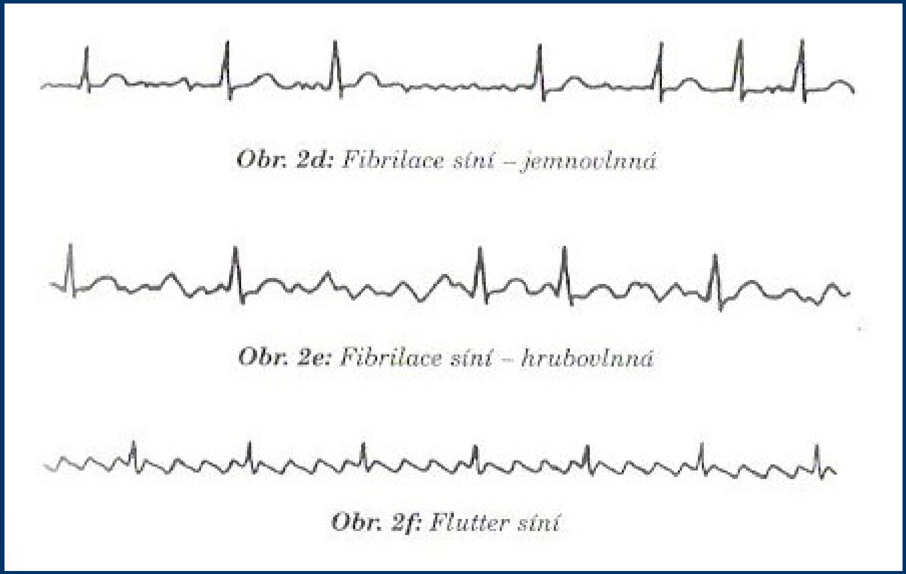
Obr. 2b: Sinusová bradykardie

SVT: (není P, QRS štíhlé, pravidelná)

Obr. 2c: Supraventrikulární tachykardie

fisi

nepravidelná akce, QRS štíhlé

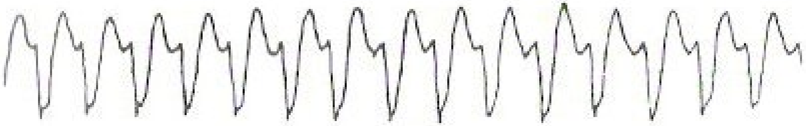


Obr. 2d: Fibrilace síní – jemnovlnná

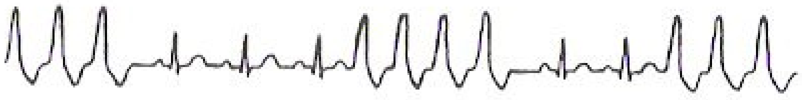
Obr. 2e: Fibrilace síní – hrubovlnná

Obr. 2f: Flutter síní

komorový rytmus



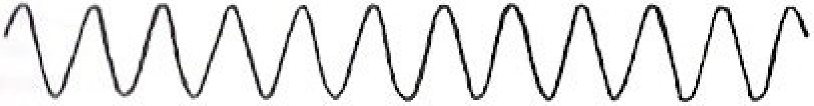
Obr. 2g: Komorová tachykardie



Obr. 2h: Repetitivní komorová tachykardie

Obr. 2j: Preterminální stahy

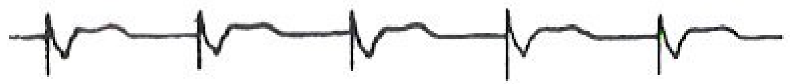
Obr. 2k: Terminální stahy



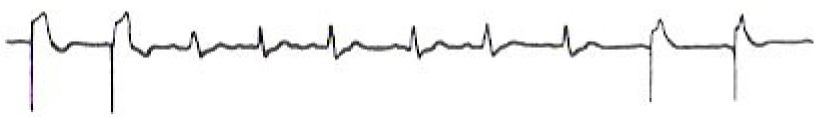
Obr. 2l: Flutter komor, příp. rychlá komorová paroxyzmální tachykardie

elektrostimulace

spike, komplex



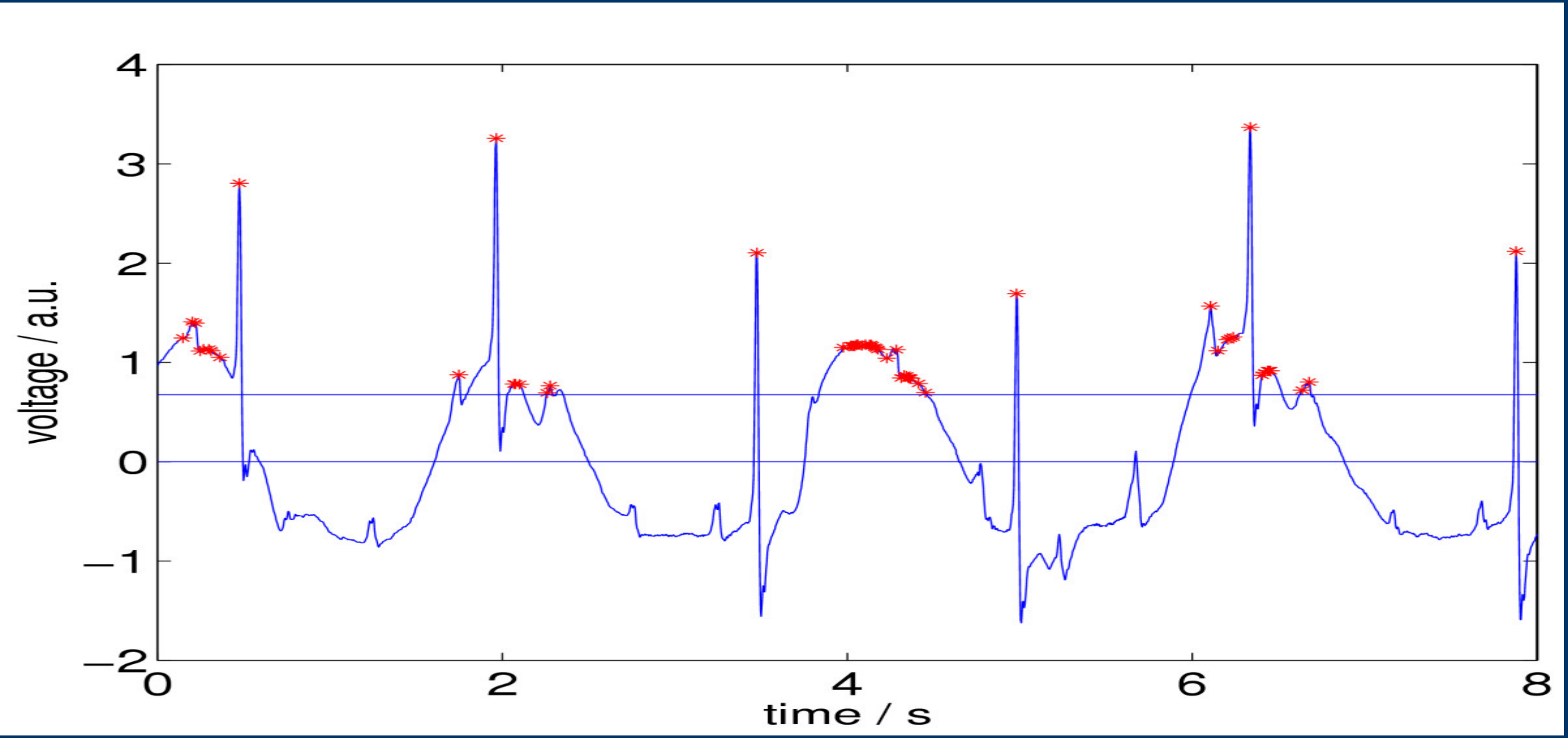
Obr. 2m: *Elektrostimulace „fixed rate“*



Obr. 2n: *Elektrostimulace „on demand“*

EKG … tepová frekvence

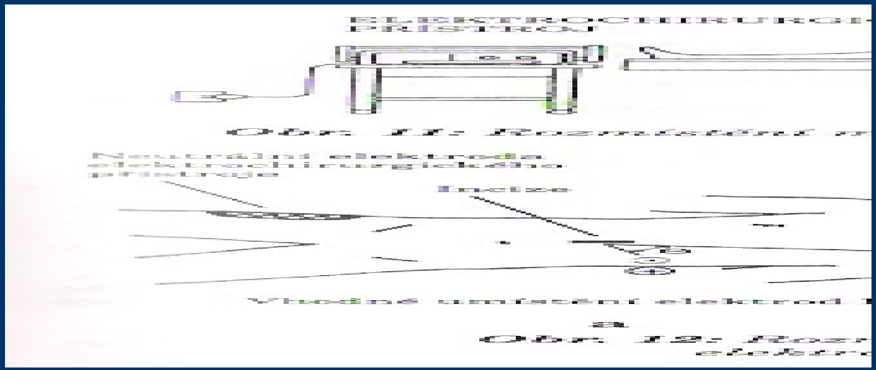
- 45/min nebo 150/min nebo ??

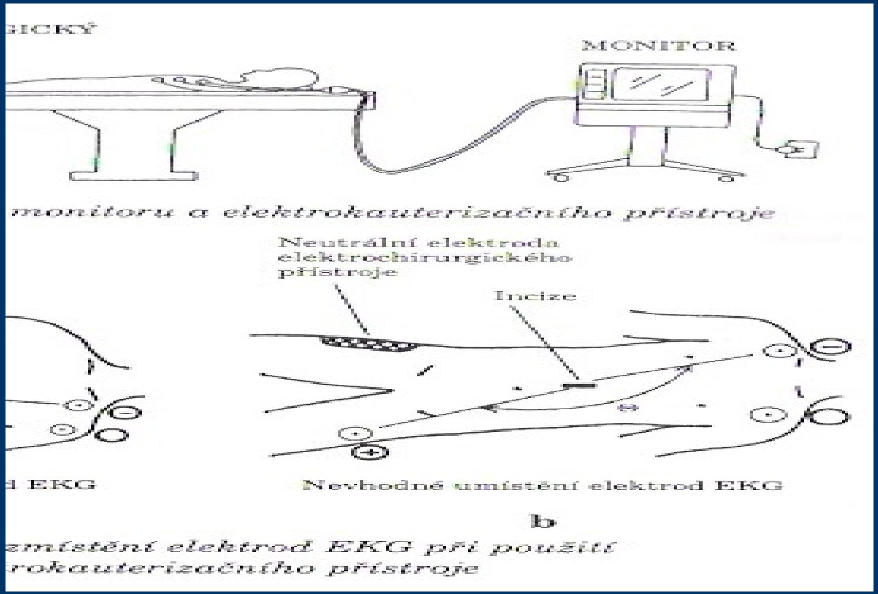


Amann et al. BioMedical Engineering OnLine 2005 4:60 doi:10.1186/1475-925X-4-60

EKG – komplikace monitorace

- elektrické rušení jinými přístroji (pálení)
- přívodná šňůra kříží EKG kabel
- kabel jako anténa (smyčka)
- defibrilační výboj (norma povoluje 10s)





Princip měření NIBP

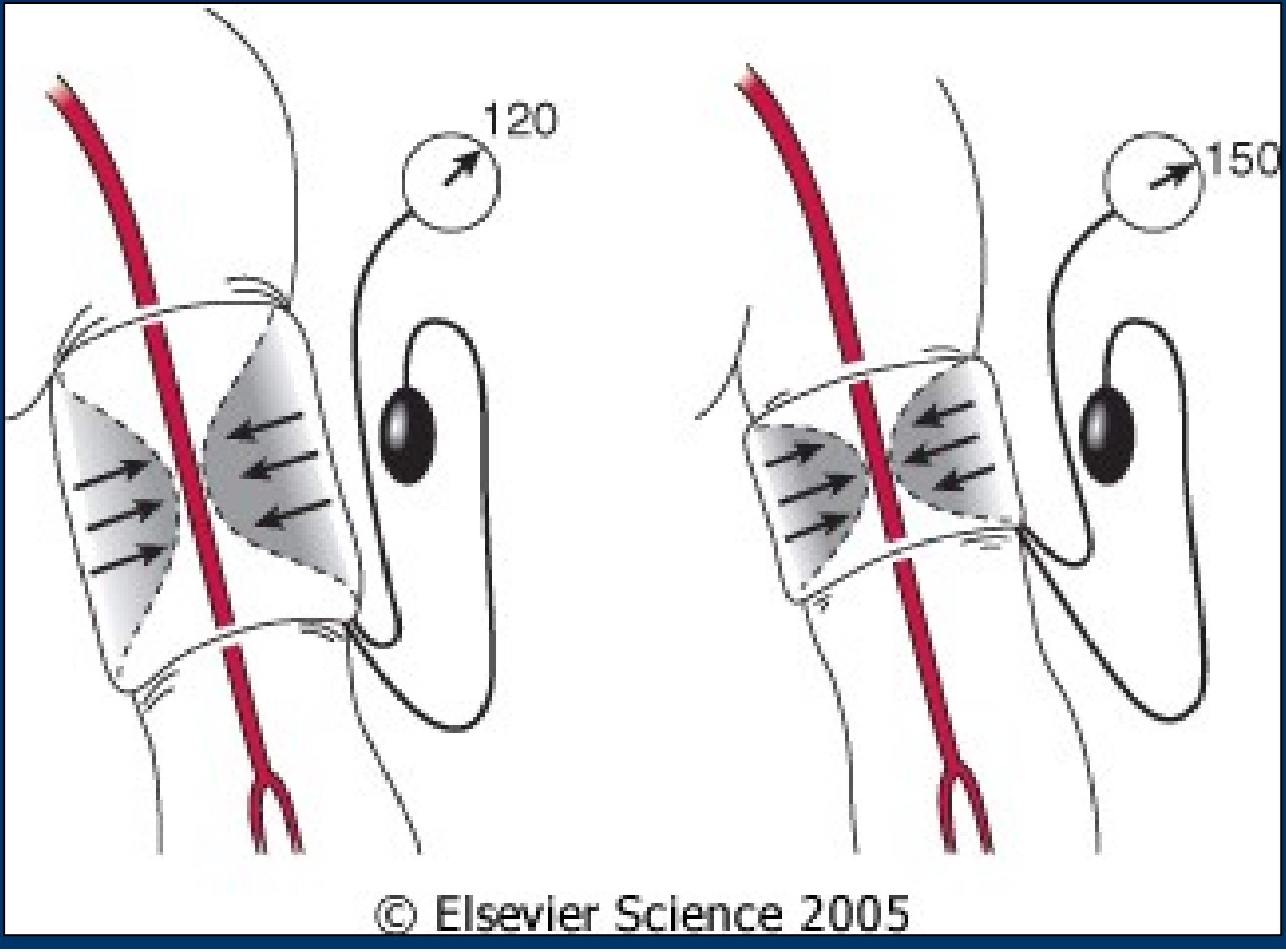


Figure 32-2 Effect of cuff size on manual blood pressure measurement. An inappropriately small blood pressure cuff yields erroneously high values for blood pressure because the pressure within the cuff is incompletely transmitted to the underlying artery.

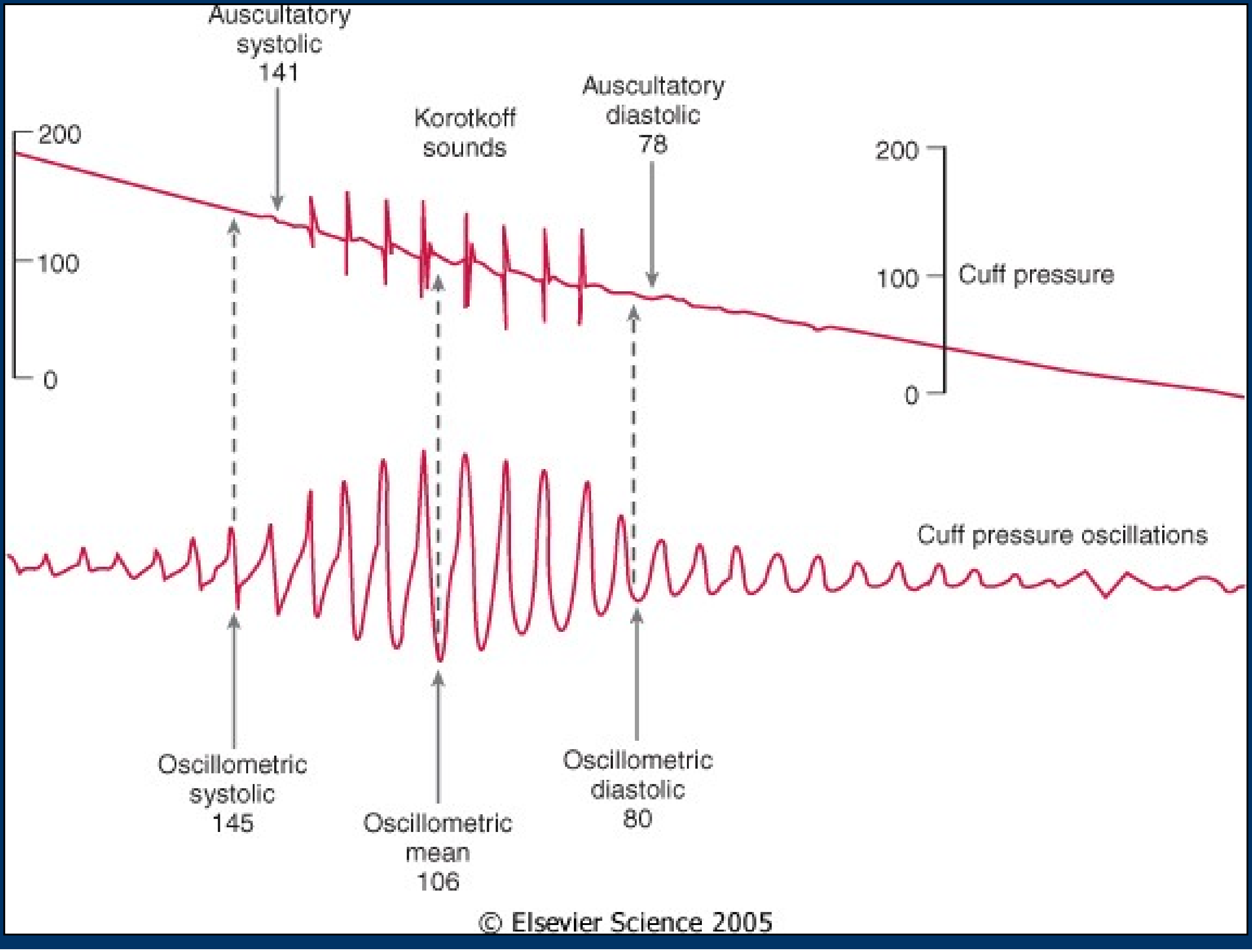


Figure 32-3 Comparison of blood pressure measurements by Korotkoff sounds and oscillometry. Oscillometric systolic blood pressure is recorded at the point where cuff pressure oscillations begin to increase, mean pressure corresponds to the point of maximal oscillations, and diastolic pressure is measured when the oscillations become attenuated. Note the correspondence between these measurements and the Korotkoff sounds that determine auscultatory systolic and diastolic pressure. (Redrawn from Geddes LA: Cardiovascular Devices and Their Applications. New York John Wiley, 1984, Fig 34-2. Reprinted by permission of John Wiley & Sons, Inc.)

NIBP

komplikace :

- bolest
- Petechie
- Otok končetiny
- Venous stasis, thrombophlebitis
- Peripheral neuropathy
- Compartment syndrome

- Nesnadné měření
- třes, pohyb. aktivita
- bradykardie < 40/min
- obezita
- šok - vazokonstr.

IBP, kanylace arterie

- kontinuálně, real-time
- očekávám ovlivnění oběhu farmaky / mechanicky
- opakované odběry krve
- selhání NIBP
- přídatná informace z pulzové křivky
    - Pulse Pressure Variation

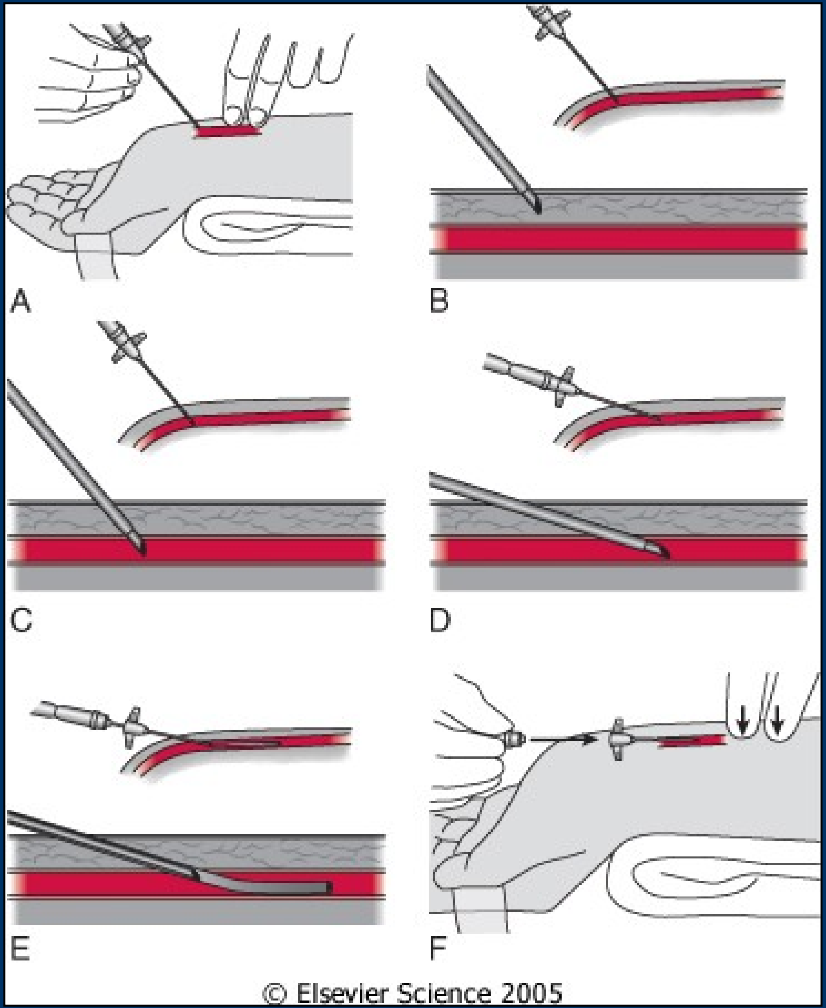
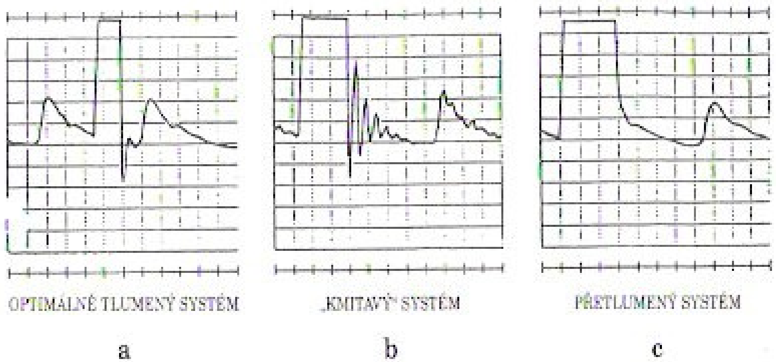


Figure 32-4 Percutaneous radial artery cannulation. A, The wrist is positioned and the artery identified by palpation. B, The catheter-over-needle assembly is introduced through the skin and advanced toward the artery. C, Entry of the needle tip into the artery is identified by the flash of arterial blood in the needle hub reservoir. D, The needle-catheter assembly is advanced at a lower angle to ensure entry of the catheter tip into the vessel. E, If blood flow continues into the needle reservoir, the catheter is advanced gently over the needle into the artery. F, The catheter is attached to pressure monitoring tubing while maintaining proximal occlusive pressure on the artery.

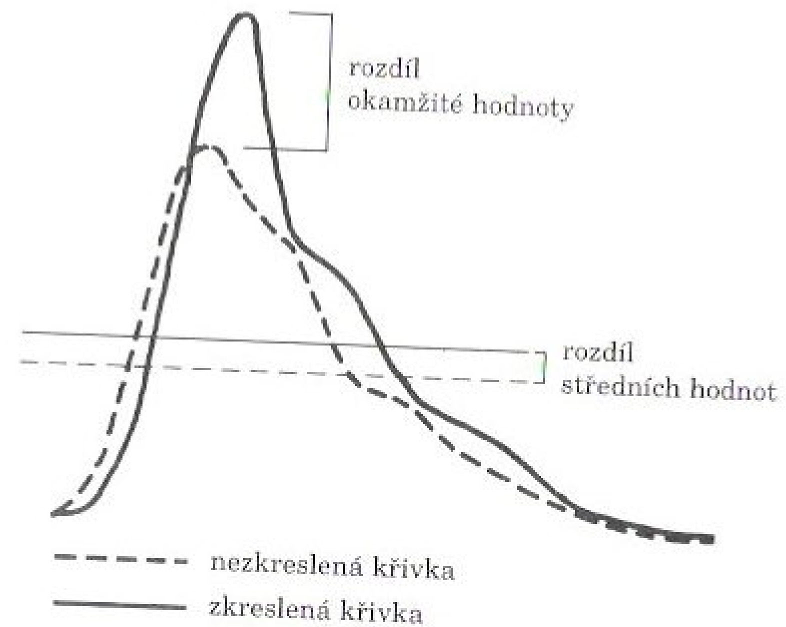
Měření invazivního tlaku

a. radialis / a. femoralis / a. brachialis
arterie – hadička – komůrka – přetlaková manžeta
s infuzí (trvalý proplach kanyly ml/h)

- kapalina je neztlačitelná X vzduch
- sraženina / zalomení zvyšuje odpor



Obr. 15: Zkreslení tlakové křivky přenosem



Obr. 17: Vliv přenosového zkreslení tlakové křivky na střední hodnotu tlaku

!!Alarm!! Low BP

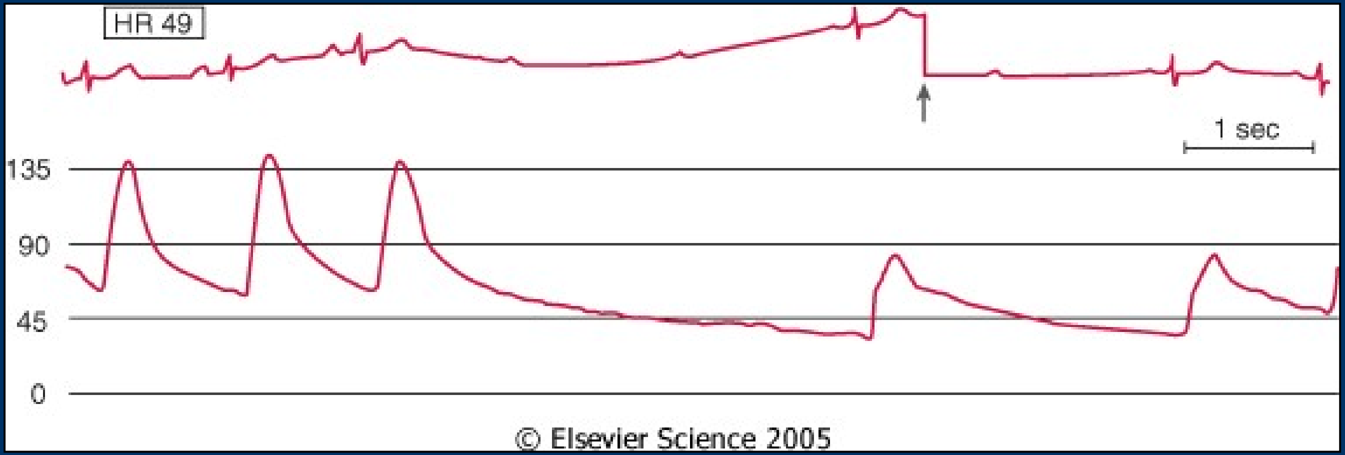
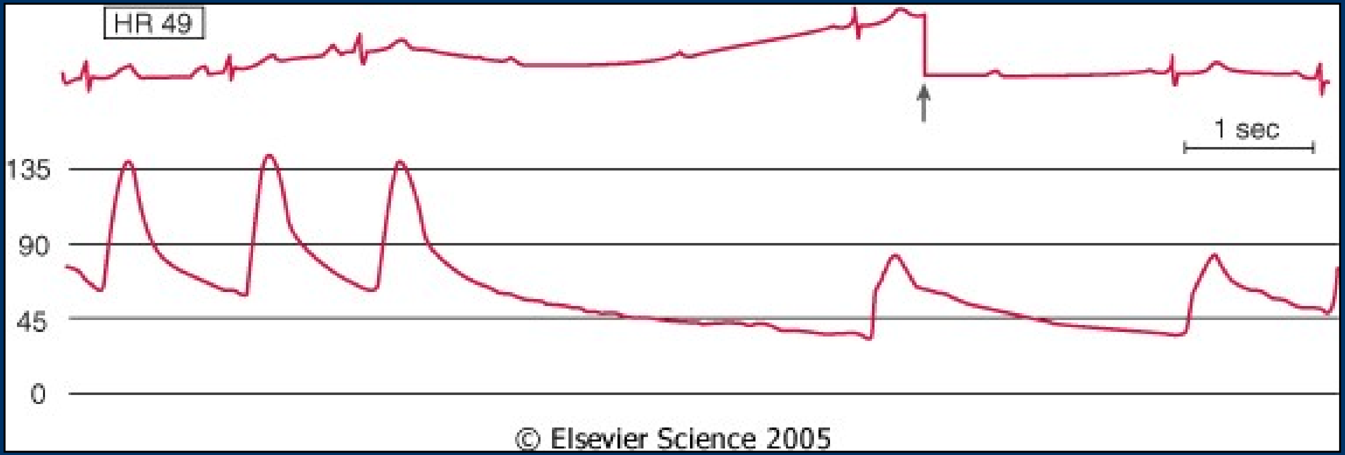


Figure 32-1 Digital heart rate (HR) displays may fail to warn of dangerous bradyarrhythmias. Direct observation of the electrocardiogram (ECG) and the arterial blood pressure traces reveals complete heart block and a 4-second period of asystole, whereas the digital display reports an HR of 49 beats/min. Note that the ECG filter (arrow) corrects the baseline drift so that the trace remains on the recording screen. (From Mark JB: Atlas of Cardiovascular Monitoring. New York, Churchill Livingstone, 1998, Fig. 13-2.)

srdeční akce: 49/minutu, EKG: AV blokáda III



O2 v těle

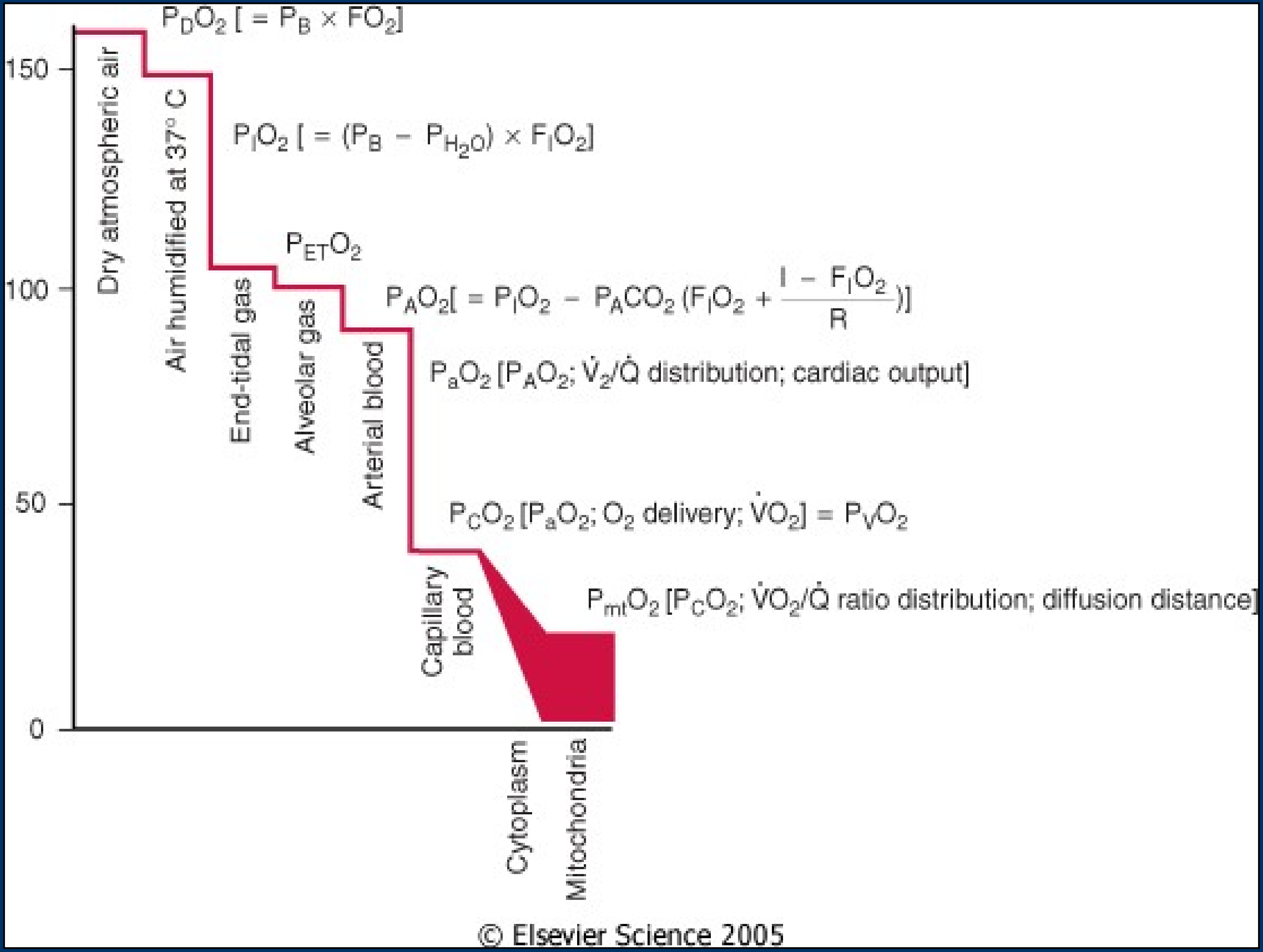


Figure 36-1 Oxygen transport cascade. A schematic view of the steps in oxygen transport from the atmosphere to the site of utilization in the mitochondrion is shown here. Approximate Po2 values are shown for each step in the cascade, and factors determining those partial pressures are shown within the square brackets. There is a distribution of tissue Po2 values depending on local capillary blood flow, tissue oxygen consumption, and diffusion distances. Mitochondrial Po2 values are depicted as a range because reported levels vary widely. (Adapted from Nunn JF: Nunn's Applied Respiratory Physiology, 4th ed. Boston, Butterworth-Heinemann, 1993.)

Oxygenace tkání

- monitorace O2 ve vdechovaném plynu
- SpO2 =saturace
- Arteriální krevní plyny = „Astrup“ - analýza krve
  - nízký srdeční výdej při dobré oxygenační fci plic

Saturace, SpO2 , „pulzák“

systémová arteriální saturace hemoglobinu kyslíkem určená pomocí pletyzmografické pulzní oxymetrie

místa měření:

- prst
- ušní lalůček
- nosní křídlo
- ret

1000/s měření červenou, infrač. a „pozadí“ - světlo na sále

- Odlišit pulzující = arteriální
- nepulzující = ... absorbci světla

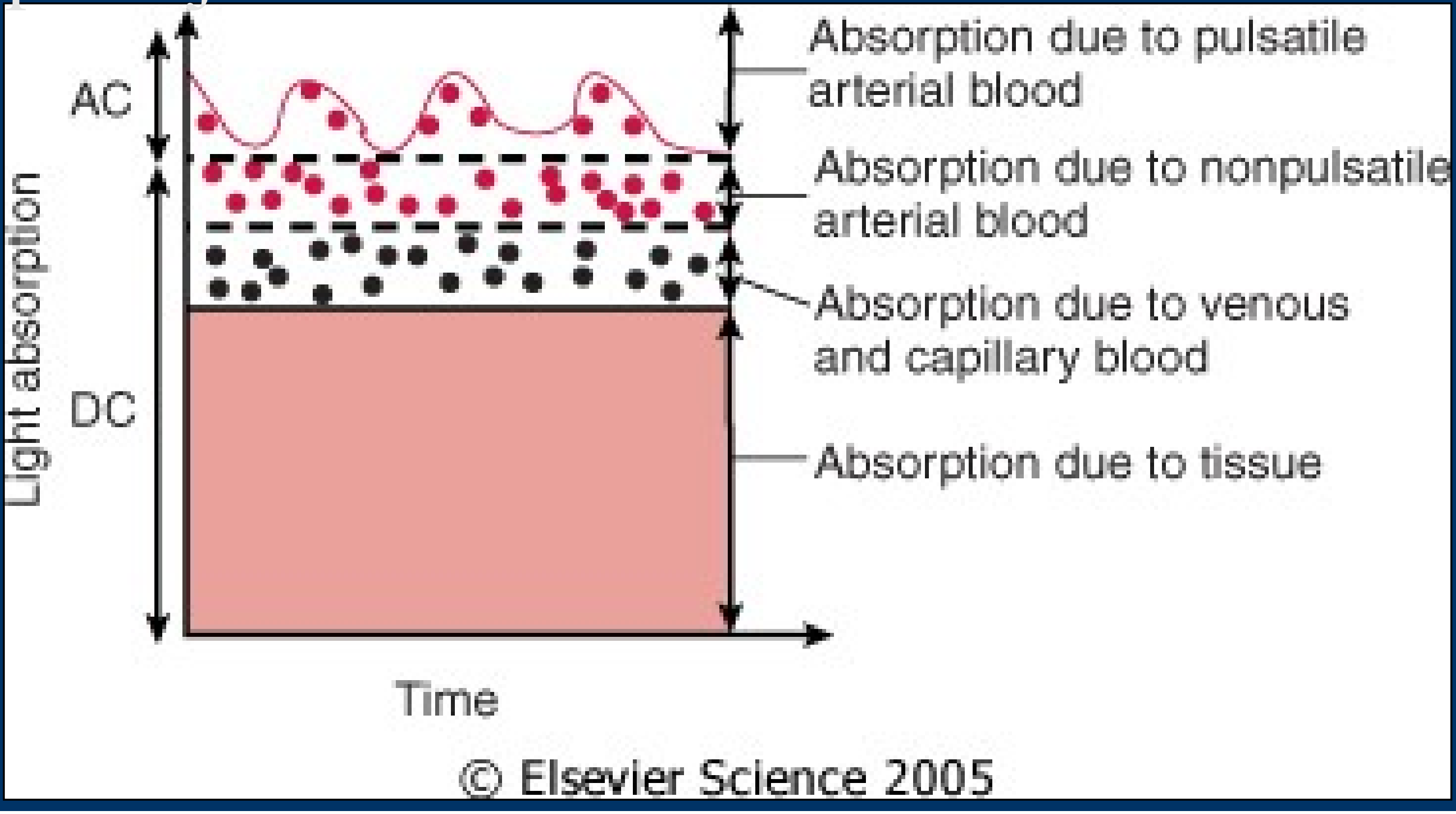


Figure 36-10 Principle of pulse oximetry. Light passing through tissue containing blood is absorbed by tissue and by arterial, capillary, and venous blood. Usually, only the arterial blood is pulsatile. Light absorption may therefore be split into a pulsatile component (AC) and a constant or nonpulsatile component (DC). Hemoglobin O2 saturation may be obtained by application of Equation 19 in the text. (Data from Tremper KK, Barker SJ: Pulse oximetry. Anesthesiology 70:98, 1989.)

2 vlnové délky, 2absorbce pro Hb a HbO2

$$S = \frac{AC_{660} / DC_{660}}{AC_{940} / DC_{940}}$$ odpovídá % HBO/(HB+HBO)

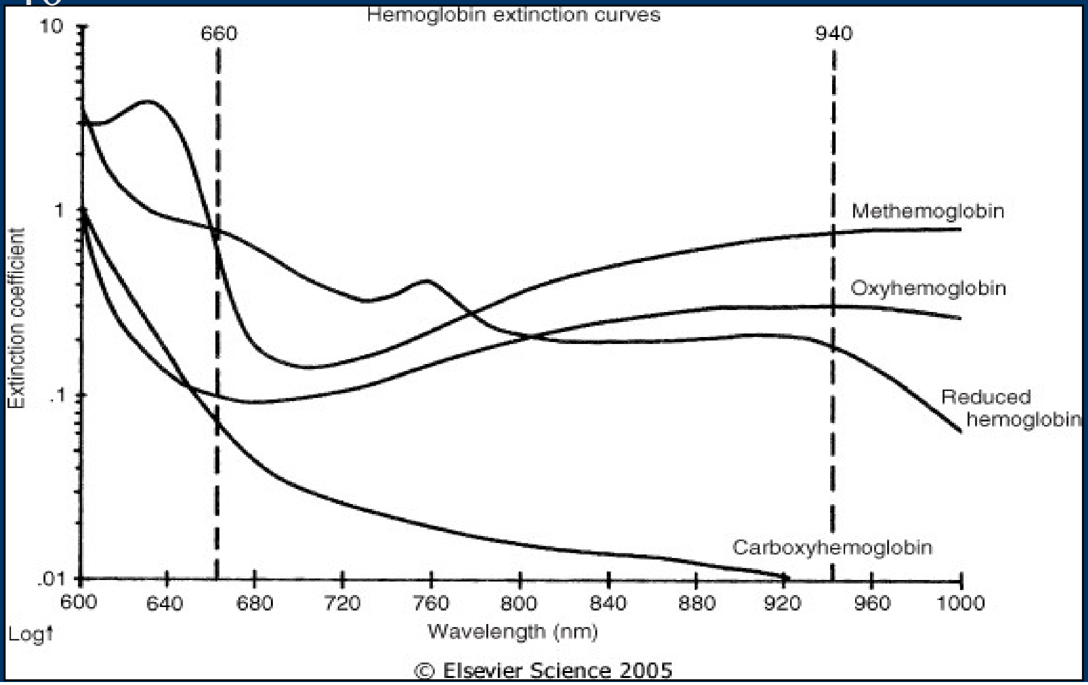
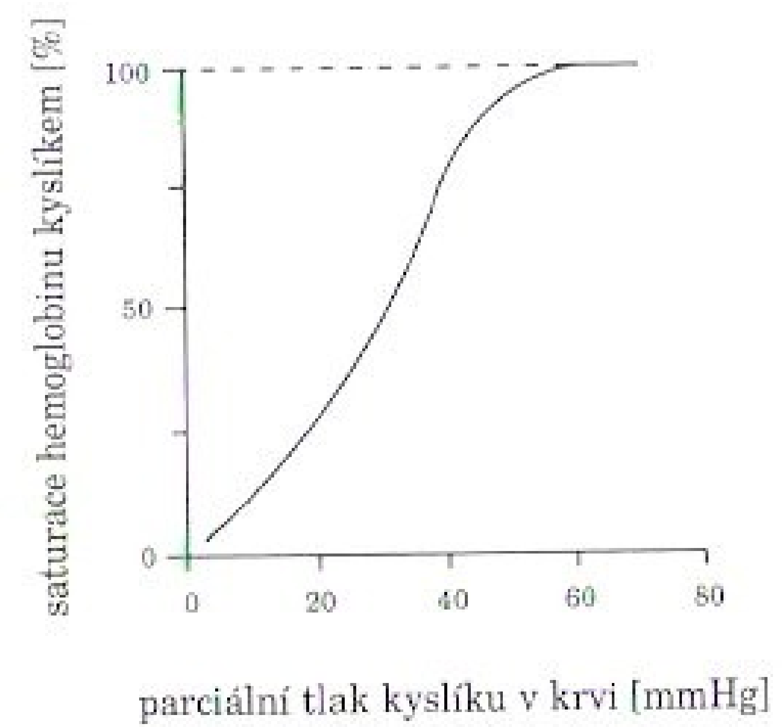


Figure 30-34 Hemoglobin extinction curves. Pulse oximetry uses the wavelengths of 660 and 940 nm because they are available in solid-state emitters (not all wavelengths are able to be emitted from diodes). Unfortunately, HbCO and HbO2 absorb equally at 660 nm. Therefore, HbCO and HbO2 both read as Sao2 to a conventional pulse oximeter. In addition, Hbmet and reduced Hb share absorption at 660 nm and interfere with correct Sao2 measurement. (Courtesy of Susan Manson, Biox/Ohmeda, Boulder, Colorado, 1986.)

SpO2 – HbO2 - O2 ve tkáni

- od SpO2 90% níže klesá hodnota rychleji
- PaO2 klesá konstantně

nepřesnost 5%
nehraje pro život roli
!! pokles !!



Obr. 46: *Disociační křivka hemoglobinu*

Vliv chladu na SpO2 – posun v čase

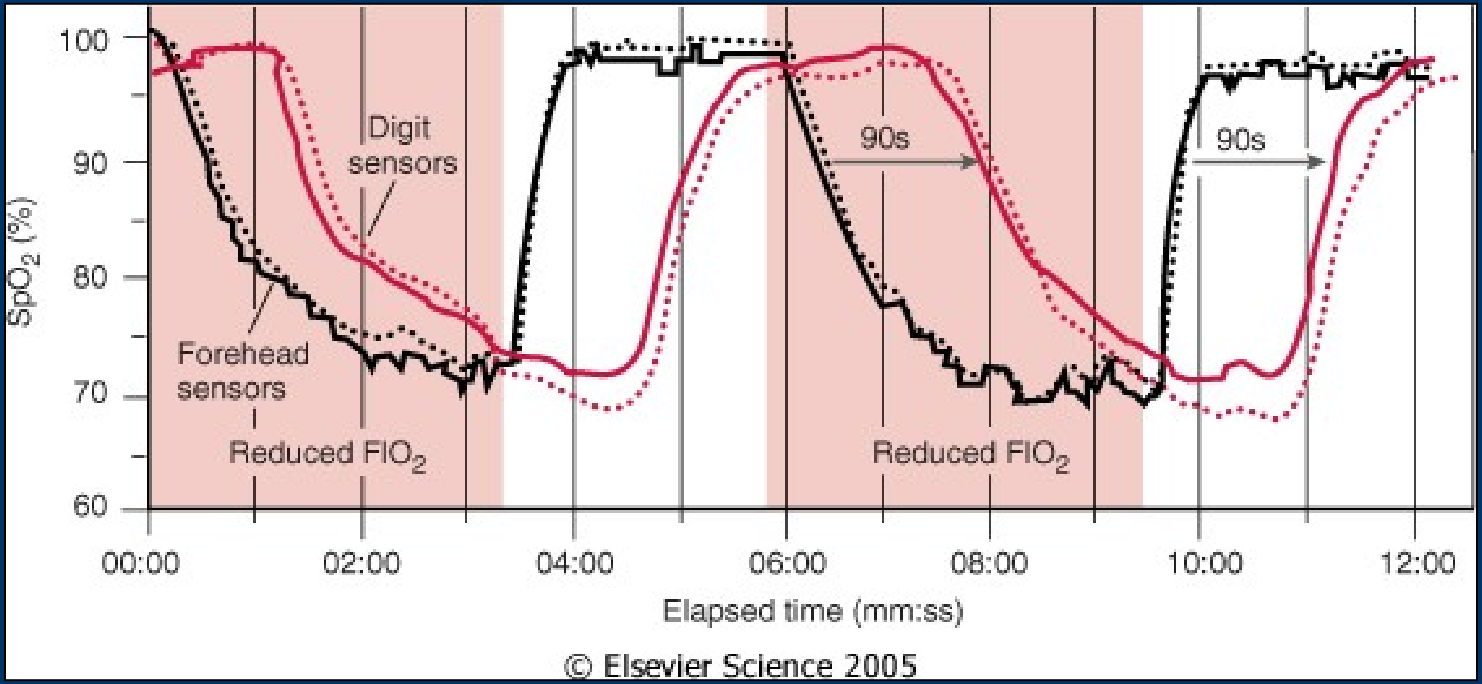
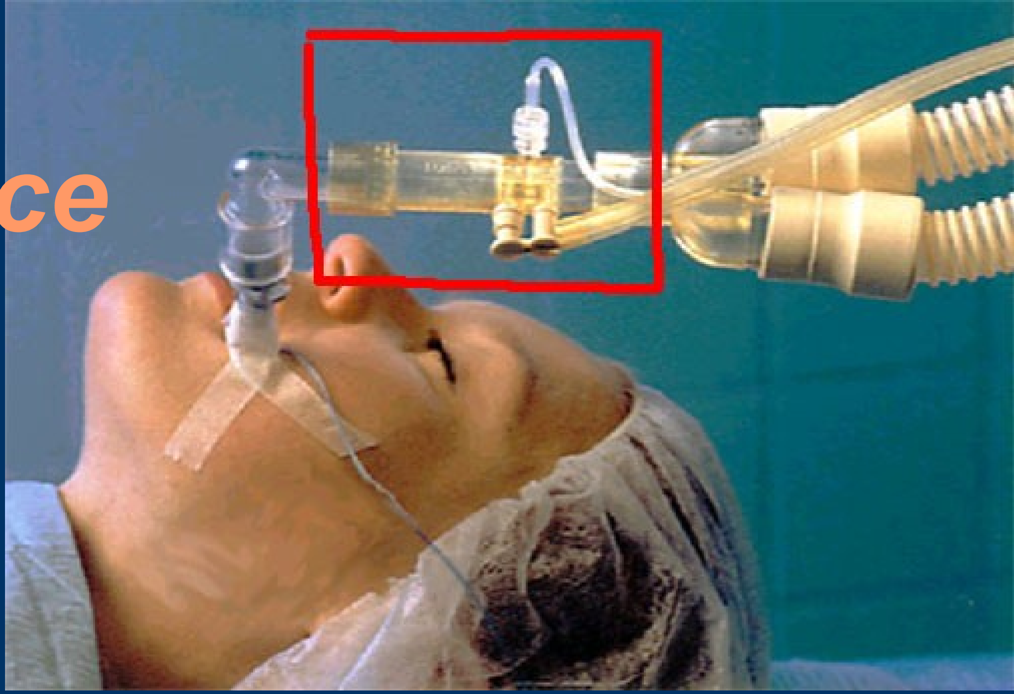


Figure 36-11 Effect of pulse oximeter probe replacement on delay from onset of hypoxemia to a drop in the measured Spo2. During cold-induced peripheral vasoconstriction in normal volunteers, the onset of hypoxemia was detected more quickly using an oximeter probe on the forehead compared with the finger. Other studies have shown a similar advantage for pulse oximeter probes placed on the ear. (From Bebout DE, Mannheimer PD, Wun C-C: Site-dependent differences in the time to detect changes in saturation during low perfusion. Crit Care Med 29:A115, 2002.)

Monitorace ventilace



- P,V, flow;
- PV křivka
- Analýza plynů
  - O_2,
  - $EtCO_2$ – kapnometrie, kapnograf
  - N_2O, [%] volatilní anestetika

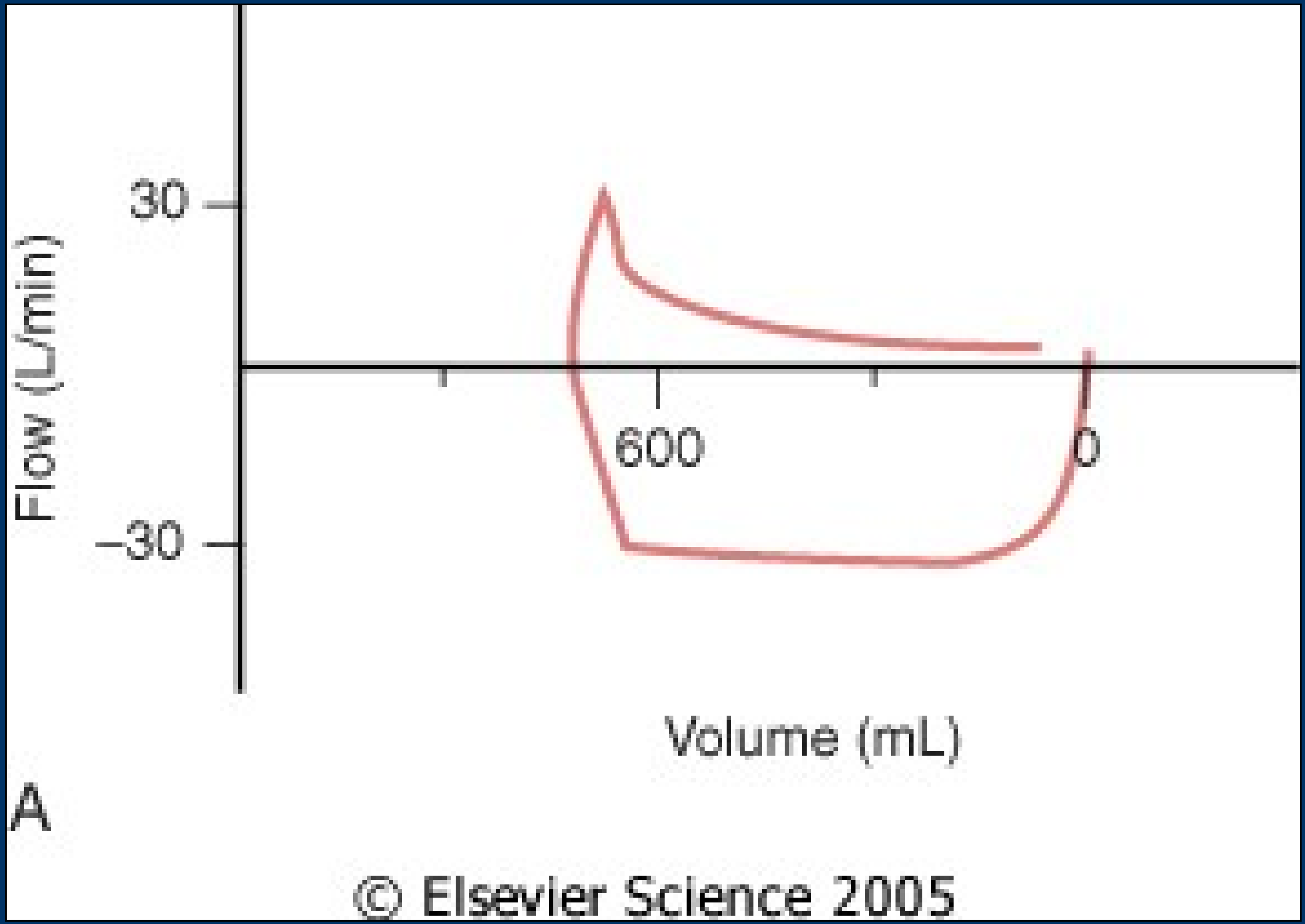
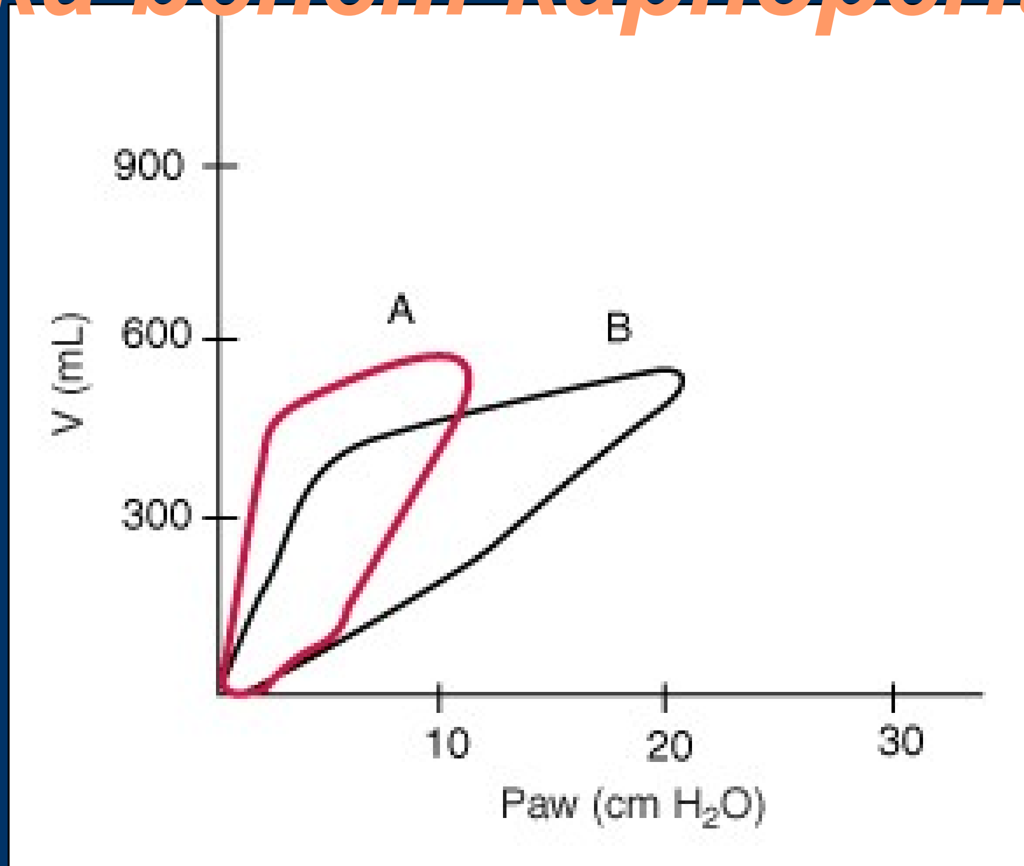


Figure 36-24 Flow (ordinate) versus volume (abscissa). A, Closed-chest positive-pressure ventilation under general anesthesia in a patient with severe airways obstruction and hyperinflation before surgery to reduce lung volume. The flow-volume curve shows inspiratory (negative) and expiratory (positive) flow on the ordinate, plotted clockwise from zero volume on the abscissa. Expiratory flow started with a sharp upward peak and then fell immediately to a low flow rate with convexity toward the volume axis, suggesting expiratory flow limitation. expiratory flow rate was so low that inflation of the next positive-pressure breath was initiated before expiratory flow reached zero. Because expiratory flow continued up to this point, there must have been intrinsic positive end-expiratory pressure (PEEPi). B, A similar closed-check flow-volume curve after lung resection shows that the characteristic pattern of expiratory flow limitation has disappeared and that expiratory flow rate fell to zero before inflation started for the next breath (i.e., no suggestion of PEEPi). (Adapted from Dueck R: Assessment and monitoring of flow limitation and other parameters from flow/volume loops. J Clin Monit Comput 16:425, 2000.)

PV křivka během kapnoperitonea

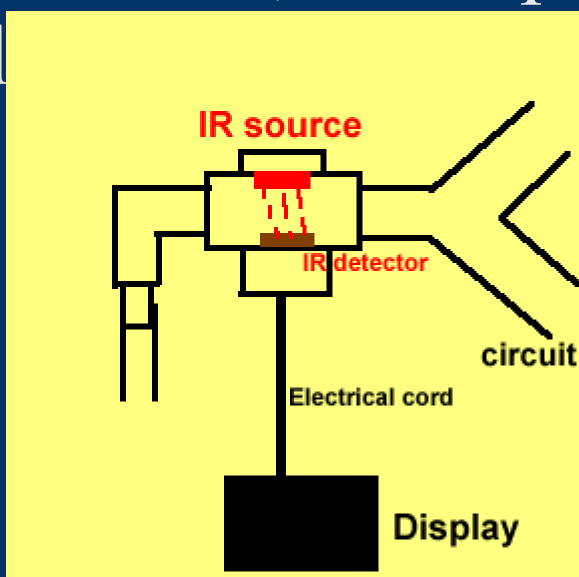


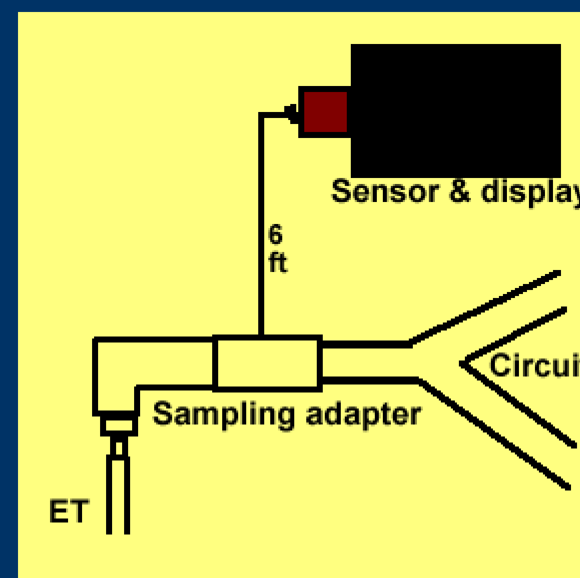
	TV	Ppeak	Pplat	C	$P_{ET}CO_2$
A	522	12	9	56	31
B	525	21	19	27	39

Figure 57-1 Change in total respiratory compliance during pneumoperitoneum for laparoscopic cholecystectomy. The intra-abdominal pressure was 14 mm Hg, and the head-up tilt was 10 degrees. The airway pressure (Paw) versus volume (V) curves and data were obtained from the screen of a Datex Ultima monitoring device. Curves are generated for before insufflation (A) and 30 minutes after insufflation (B). Values are given for tidal volume (TV, in mL); peak airway pressure (Ppeak, in cm H2O); plateau airway pressure (Pplat, in cm H2O); total respiratory compliance (C, in mL/cm H2O); and end-tidal carbon dioxide tension (PetCO2, in mm Hg).

Monitorace dýchané směsi

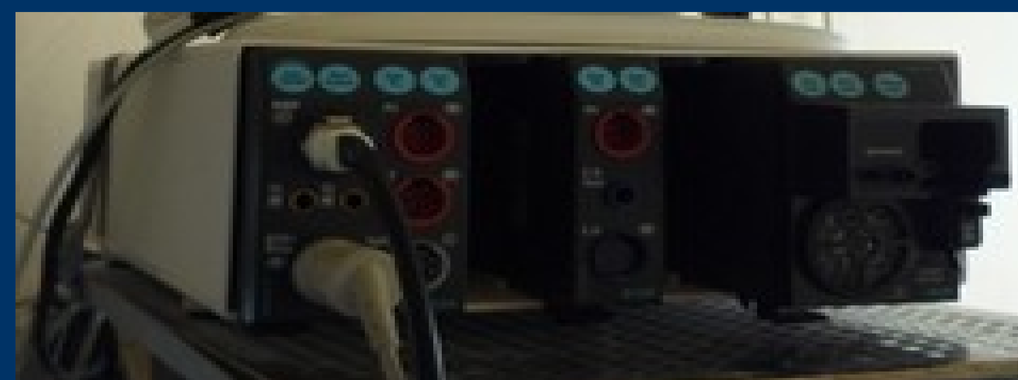
Main-stream Side-
stream
jen CO_2, méně přesné zpoždění
l





Monitorace dýchané směsi

Main-stream Side-
stream



O2 je paramagnetický (side stream monitor)

Minimální fiO2: 21%
bezpečné 30%
běžně : do 60%
hypoxie, 100%
preoxygenace 100%

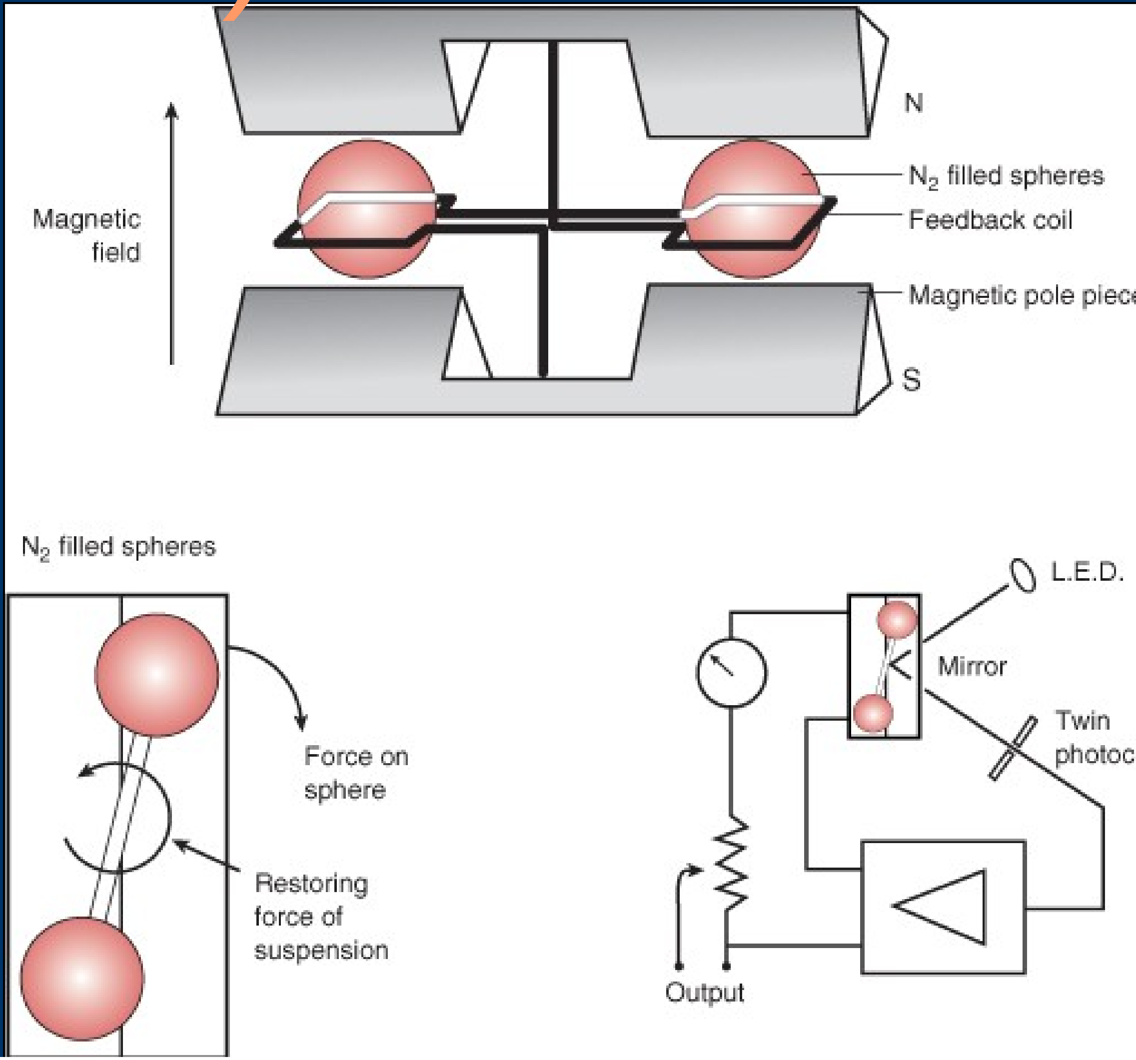
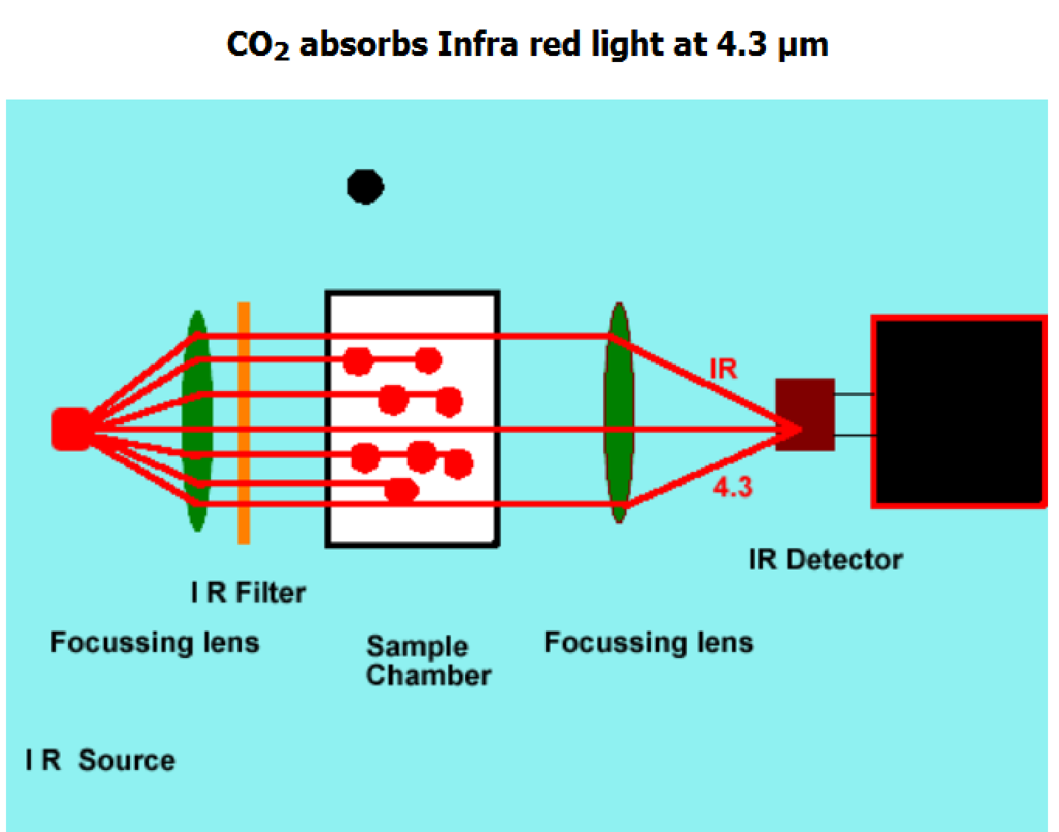


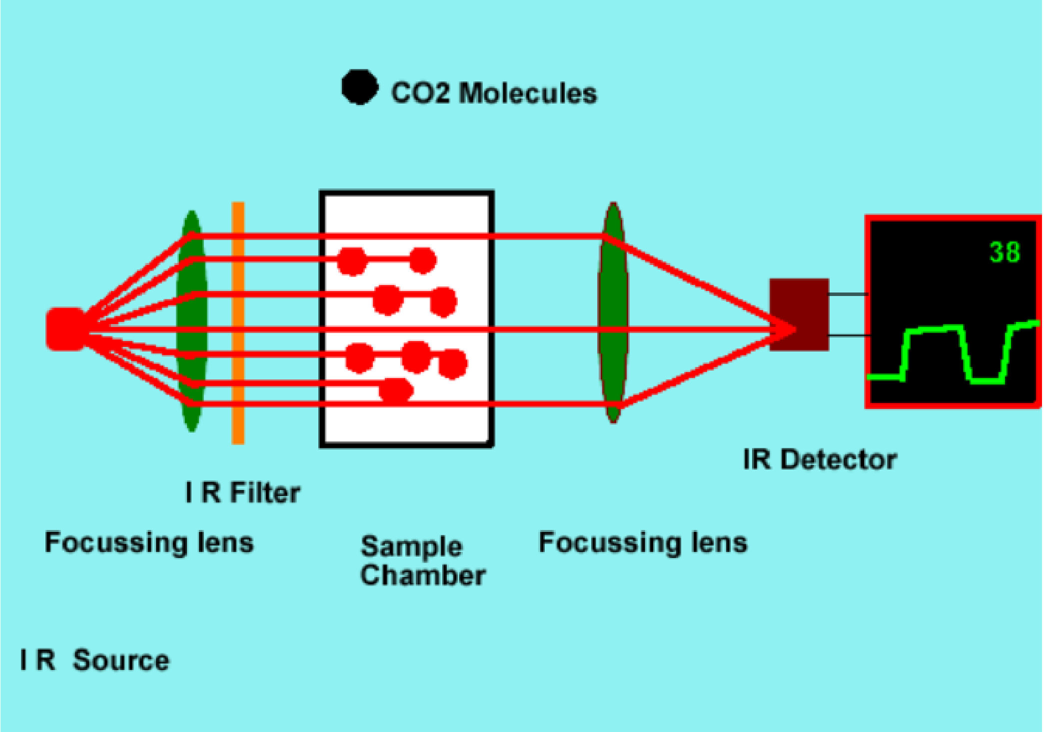
Figure 36-13 Paramagnetic oxygen analyzer. Two sealed spheres filled with nitrogen are suspended in a magnetic field. Nitrogen (N2) is slightly diamagnetic, and the resting position of the beam is such that the spheres are displaced away from the strongest portion of the field. If the surrounding gas contains oxygen, the spheres are pushed further out of the field by the relatively paramagnetic oxygen. The magnitude of the torque is related to the paramagnetism of the gas mixture and is proportional to the partial pressure of oxygen (Po2). Movement of the dumbbell is detected by photocells, and a feedback current is applied to the coil encircling the spheres, returning the dumbbell to the zero position. The restoring current and output voltage are proportional to the Po2. (Courtesy of Servomex Co., Norwood, MA.)

Kapnometr, kapnograf



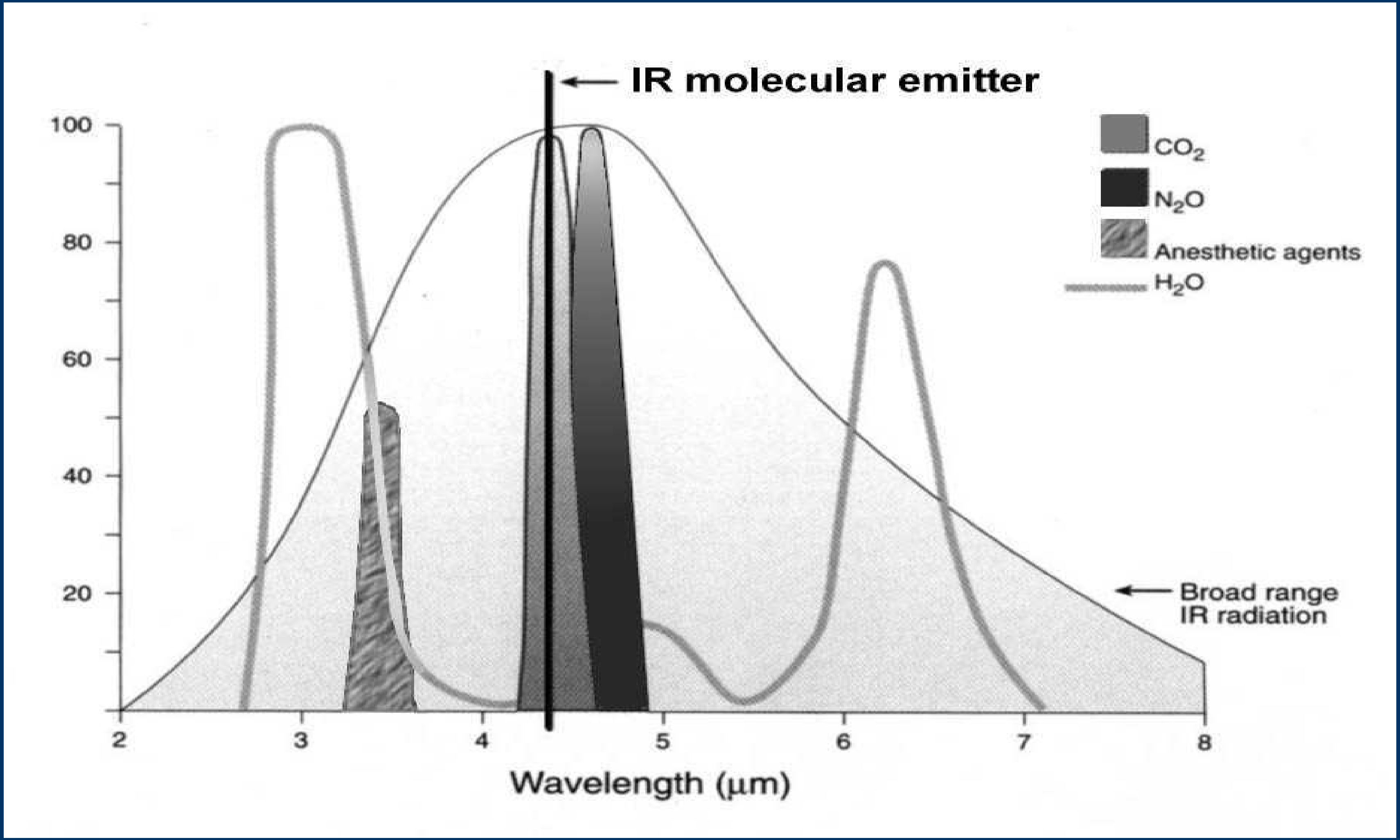
- Infra-red Spectrography – pohlcení záření

http://www.capnography.com/Physics/Physicsphysical.htm



CO_2 absorbs Infra red light at 4.3 µm

CO2 emituje IR záření



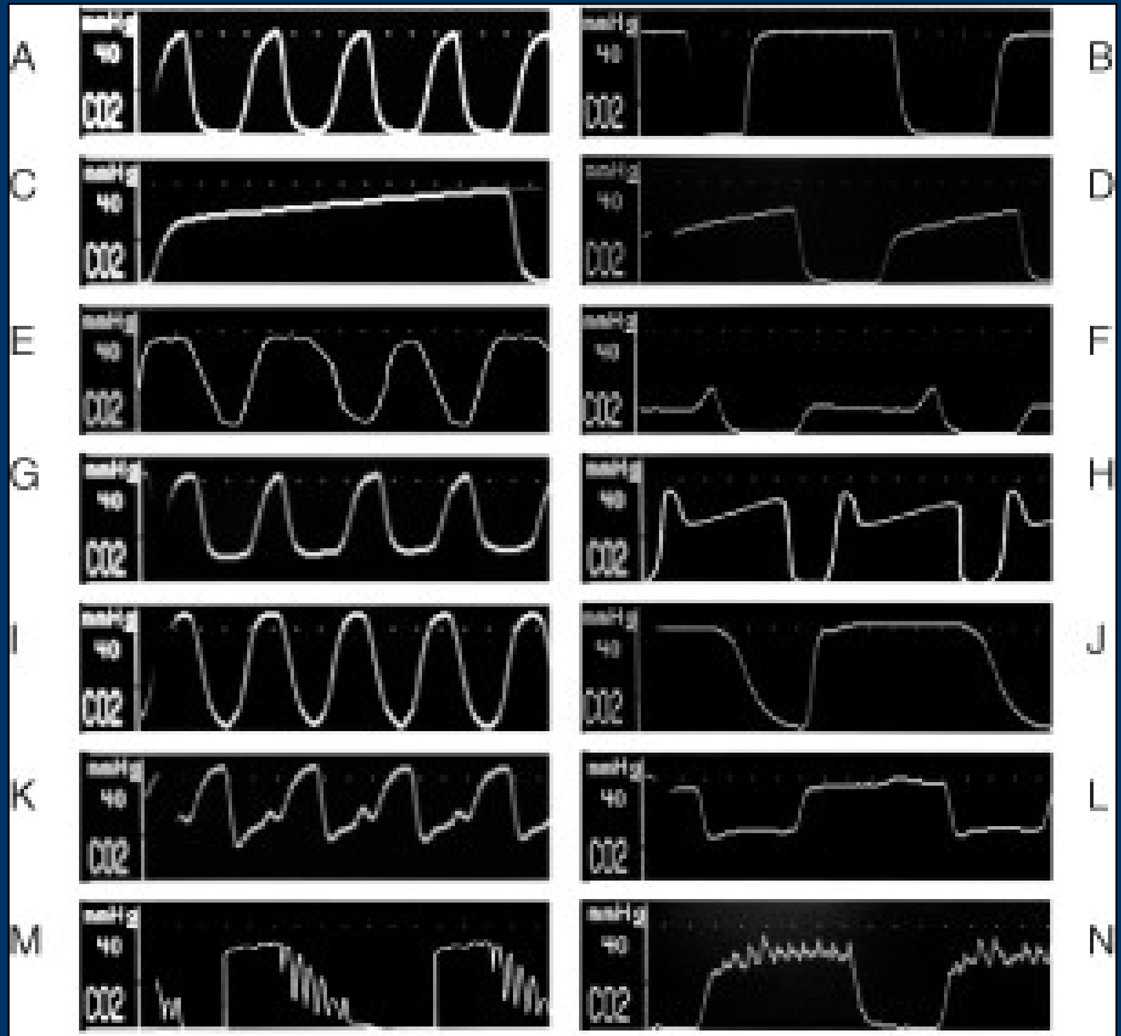
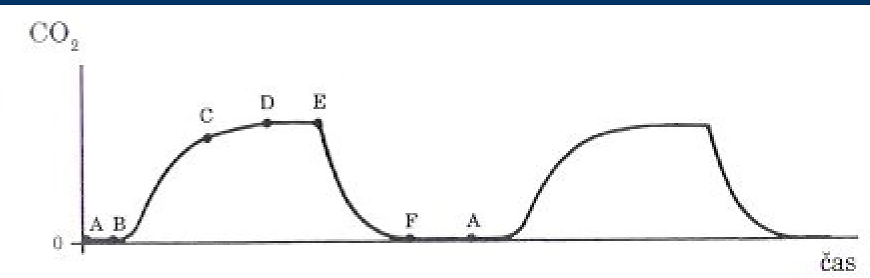


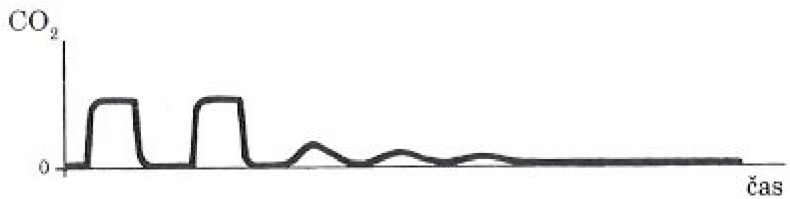
Figure 36-18 Examples of capnograph waves. A, Normal spontaneous breathing. B, Normal mechanical ventilation. C, Prolonged exhalation during spontaneous breathing. As CO2 diffuses from the mixed venous blood into the alveoli, its concentration progressively rises (see Fig. 36-19). D, Increased slope of phase III in a mechanically ventilated patient with emphysema. E, Added dead space during spontaneous ventilation. F, Dual plateau (i.e. tails-up pattern) caused by a leak in the sample line.325 The alveolar plateau is artifactually low because of dilution of exhaled gas with air leaking inward. During each mechanical breath, the leak is reduced because of higher pressure within the airway and tubing, explaining the rise in the CO2 concentration at the end of the alveolar plateau. This pattern is not seen during spontaneous ventilation because the required increase in airway pressure is absent. G, Exhausted CO2 absorbent produces an inhaled CO2 concentration greater than zero. H, Double peak for a patient with a single lung transplant. The first peak represents CO2 from the transplanted (normal) lung. CO2 exhalation from the remaining (obstructed) lung is delayed, producing the second peak. I, Inspiratory valve stuck open during spontaneous breathing. Some backflow into the inspired limb of the circuit causes a rise in the level of inspired CO2. J, Inspiratory valve stuck open during mechanical ventilation. The "slurred" downslope during inspiration represents a small amount of inspired CO2 in the inspired limb of the circuit. K and L, Expiratory valve stuck open during spontaneous breathing or mechanical ventilation. Inhalation of exhaled gas causes an increase in inspired CO2. M, Cardiogenic oscillations, when seen, usually occur with sidestream capnographs for spontaneously breathing patients at the end of each exhalation. Cardiac action causes to-and-fro movement of the interface between exhaled and fresh gas. The CO2 concentration in gas entering the sampling line therefore alternates between high and low values. N, Electrical noise resulting from a malfunctioning component. The seemingly random nature of the signal perturbations (about three per second) implies a nonbiologic cause.

Normální dýchání spont.
řízené



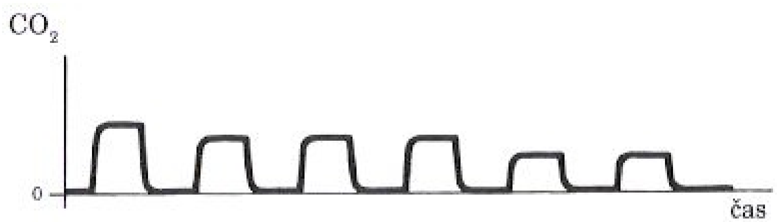
***Obr. 50:** Kapnografická křivka*

A: začátek exspirační fáze
A – B: clearance anatomického mrtvého prostoru
B – C: směs plynu z mrtvého prostoru a alveolů
C – D: počátek alveolární koncentrace
D – E: peak end-tidal CO_2, alveolární koncentrace (rovné plateau)
E: začátek inspirační fáze
E – F: clearance mrtvého prostoru
F – A: inspirovaný plyn neobsahující CO_2



Obr. 51a

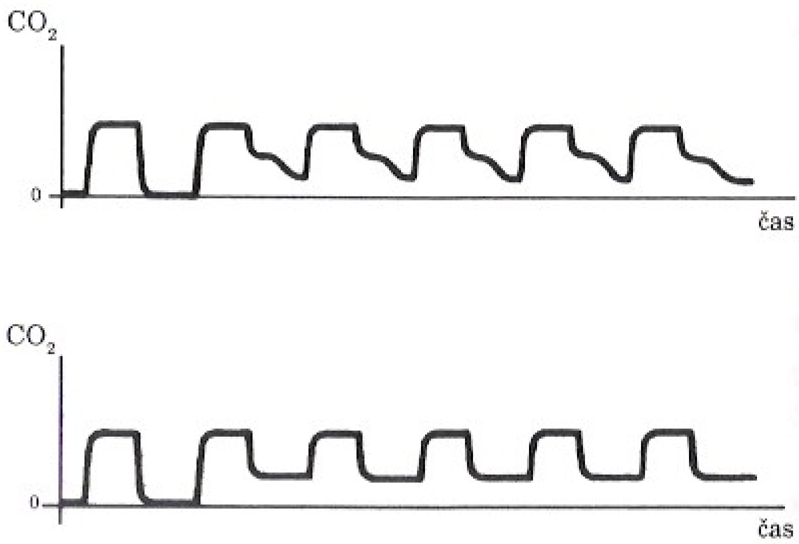
- zaklemovaná tracheální rourka
- závada na kapnografu



Obr. 51b

- částečná obstrukce ventilačního systému nebo únik v systému
- hyperventilace
- pokles metabolismu
- pokles tělesné teploty
- pokles plicní perfuze

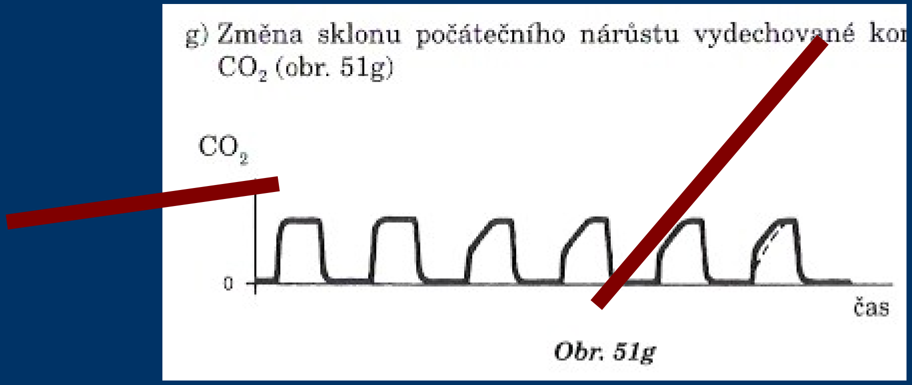
c) Rychlý exponenciální pokles vydechované koncentrace CO_2 (obr. 51c)

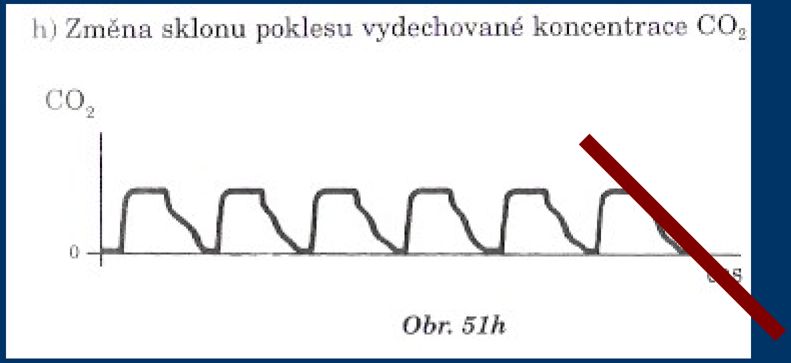


Obr. 51f

- saturovaný CO_2 absorbér
- kondenzace vody v analyzátoru
- chyba kalibrace
- zpětné vdechování objemu mrtvého prostoru
- vadná exspirační chlopeň

obstrukce d.c.





expirium

inspirium

edition

zdravé plíce, alveoly vyprázdněny současně

Různá ventilace alveolů
nejprve vyprázdněny dobře ventilované
pak špatně ventilované

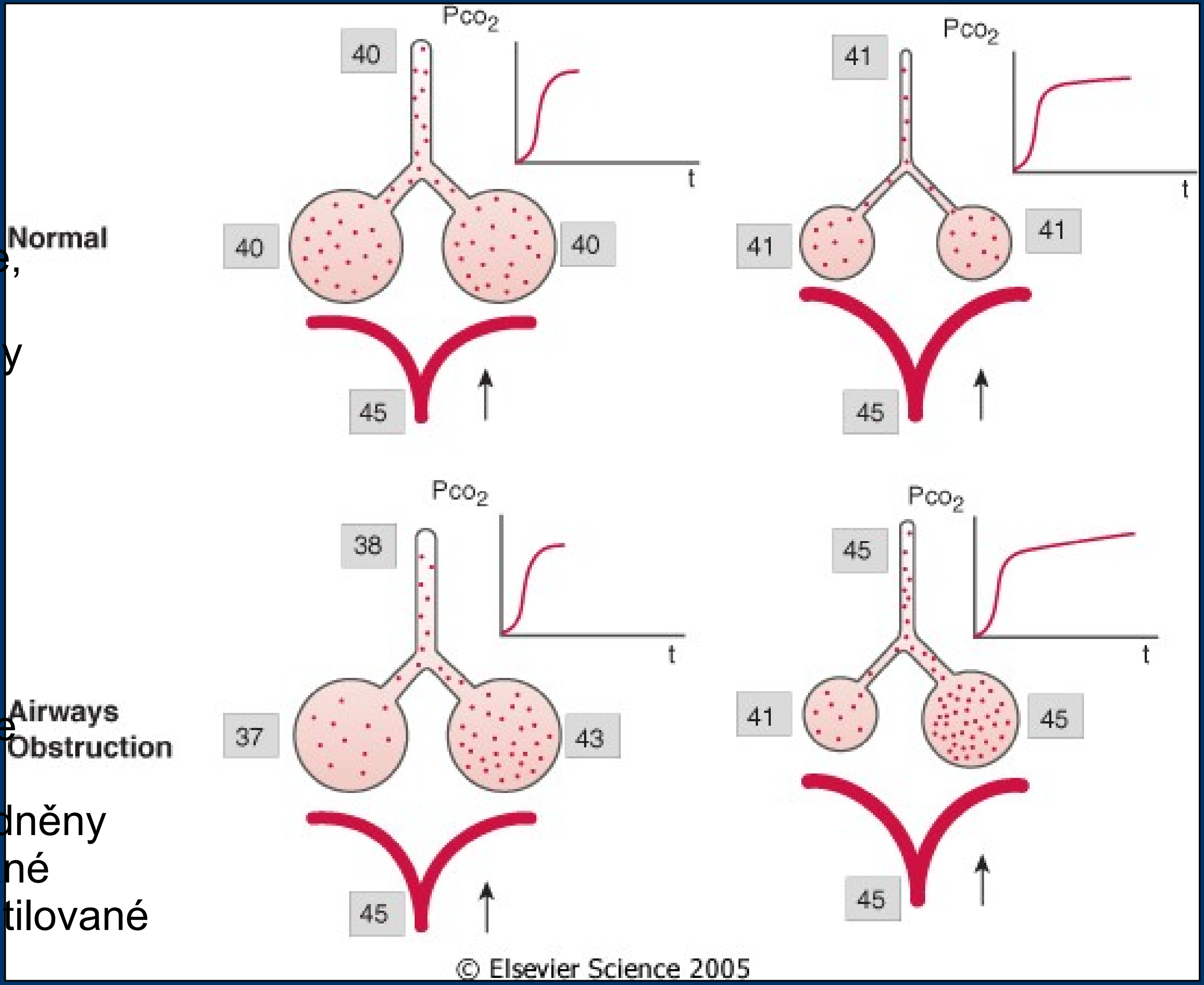


Figure 36-19 Mechanisms of airways obstruction producing an upsloping phase III capnogram. In a normal, healthy person (upper panel), there is a narrow range of [Vdot]a/[Qdot] ratios with values close to 1. Gas exchange units therefore have similar Pco2 and tend to empty synchronously, and the expired Pco2 remains relatively constant. During the course of exhalation, the alveolar Pco2 slowly rises as CO2 continuously diffuses from the blood. This causes a slight increase in Pco2 toward the end of expiration, and this increase can be pronounced if the exhalation is prolonged (see Fig. 36-18C). In a patient with diffuse airways obstruction (lower panel), the airway pathology is heterogeneous, with gas exchange units having a wide range of [Vdot]a/[Qdot] ratios. Well-ventilated gas exchange units, with gas containing a lower Pco2, empty first; poorly ventilated units, with a higher Pco2, empty last. In addition to the continuous rise in Pco2 mentioned previously, there is a progressive increase caused by asynchronous exhalation.

edition

CO2 při kapnoperitoneu

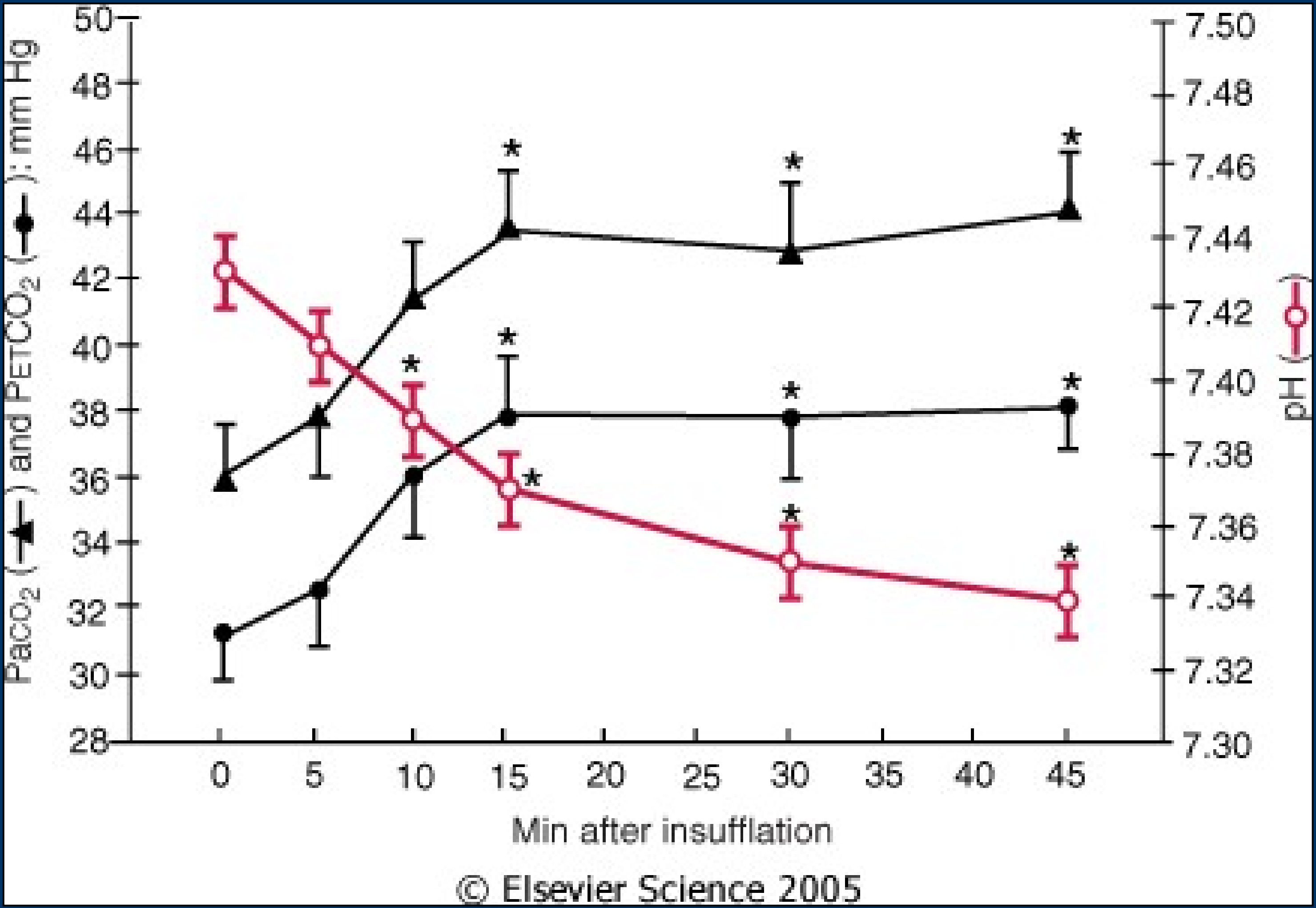


Figure 57-2 Ventilatory changes (pH, Paco2, and PetCO2) during CO2 pneumoperitoneum for laparoscopic cholecystectomy. For 13 American Society of Anesthesiologists (ASA) class I and II patients, minute ventilation was kept constant at 100 mL/kg/min with a respiratory rate of 12 per minute during the study. Intra-abdominal pressure was 14 mm Hg. Data are given as the mean ± SEM.*, P .05 compared with time 0.

edition

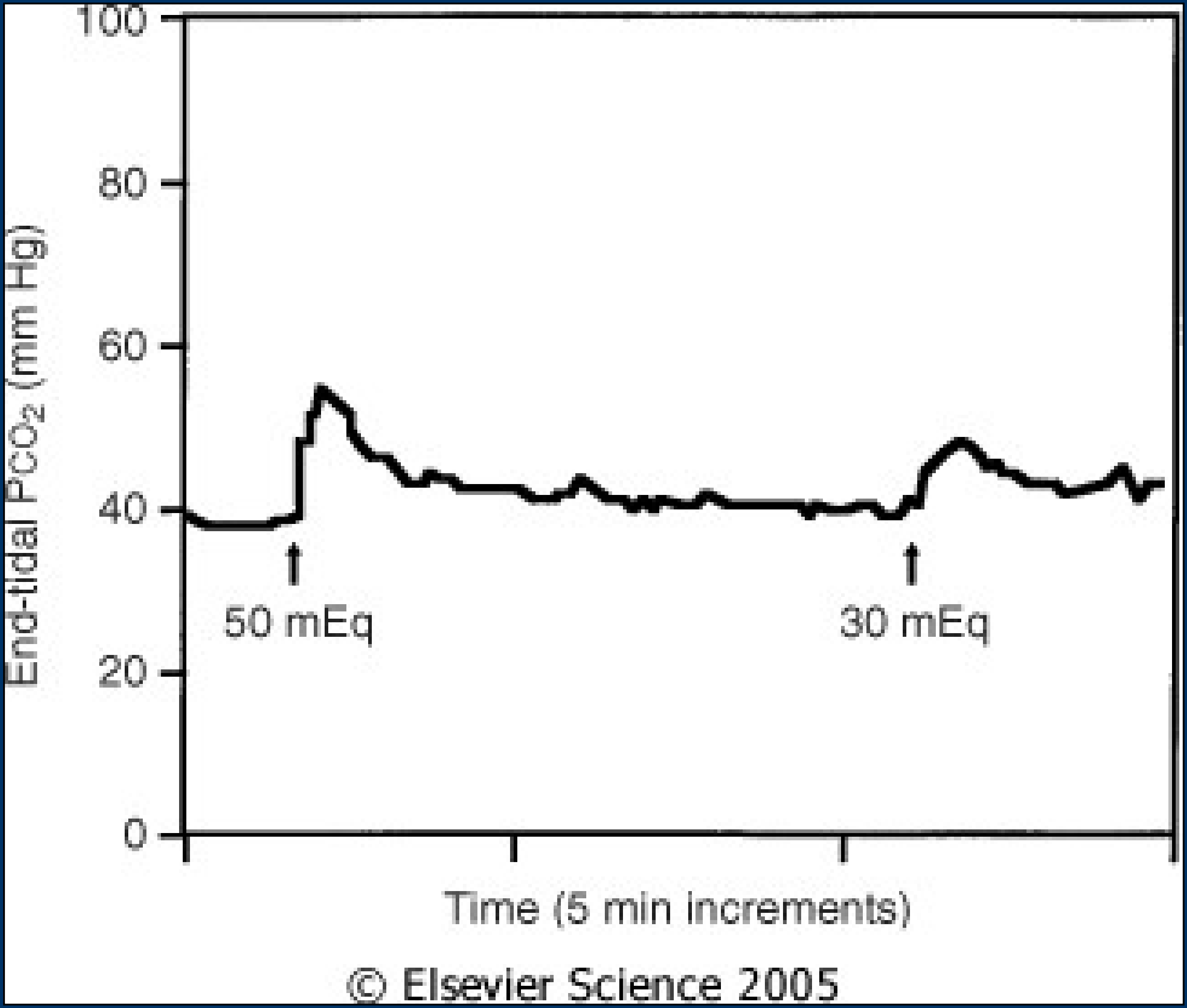


Figure 36-20 The effect of $NaHCO_3^-$ administration on end-tidal Pco2. A continuous tracing of end-tidal Pco2 is shown as a function of time. Intravenous administration of 50 mEq followed by 30 mEq of $NaHCO_3$ results in an abrupt increase in expired CO_2 because of neutralization of bicarbonate by hydrogen ions.

Kapnograf

Náhlý pokles na 0:

- zaklemovaná, zalomená trach.rourka
- porucha kapnografu

Postupný pokles:

- částečná obstrukce
- hyperventilace
- pokles metabolismu
- pokles perfuze plic

Nulové $etCO_2$

- intubace do jícnu

Monitorace tělesné teploty

- u výkonů delších 60 minut
- aktivní ohřívání – podložkou, prouděním teplého vzduchu

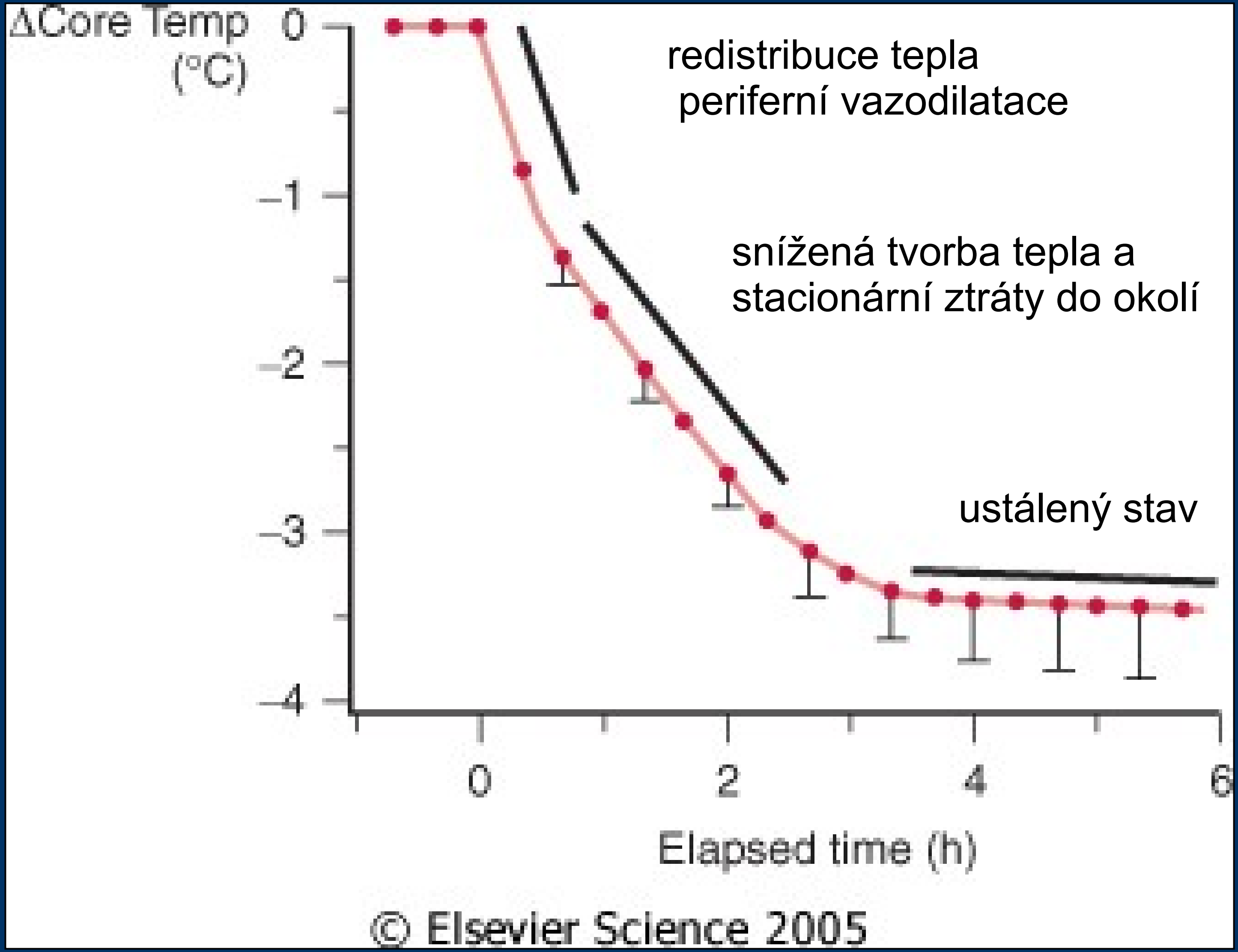
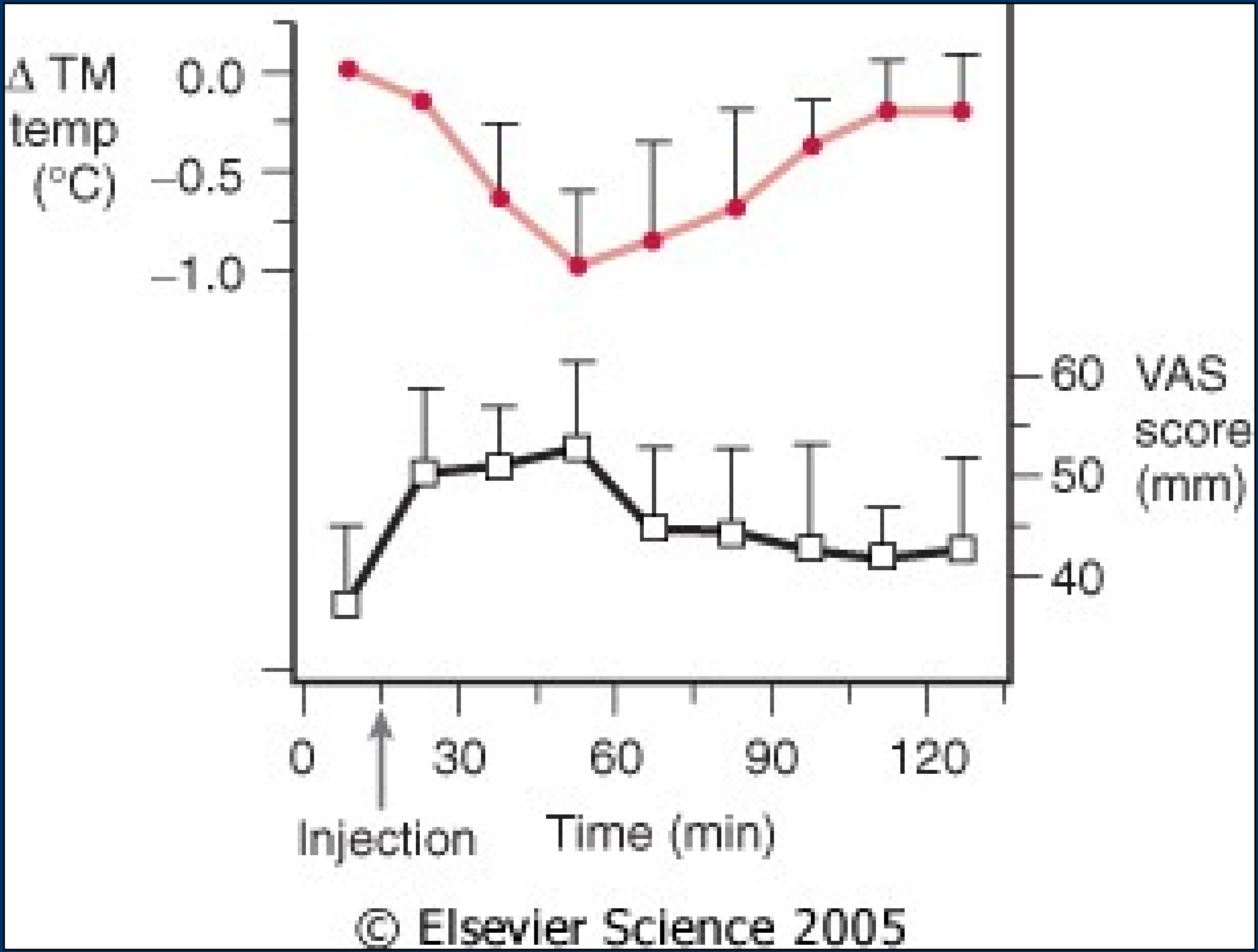


Figure 40-7 Hypothermia during general anesthesia develops with a characteristic pattern. An initial rapid decrease in core temperature results from a core-to-peripheral redistribution of body heat. This redistribution is followed by a slow, linear reduction in core temperature that results simply from heat loss exceeding heat production. Finally, core temperature stabilizes and subsequently remains virtually unchanged. This plateau phase may be a passive thermal steady state or might result when sufficient hypothermia triggers thermoregulatory vasoconstriction. Results are presented as means ± SD.



15 minutes po EPI anestezii pokles teploty jádra, vzestup pocitu tepelné pohody (visual analog scale -VAS). Interestingly, however, maximal thermal comfort coincided with the minimum core temperature. Tympanálně měřená teplota. (Redrawn with modification from Sessler DI, Ponte J: Shivering during epidural anesthesia. Anesthesiology 72:816-821, 1990.)

Monitorace nervosvalové blokády

- single-twitch
- train-of-four (TOF)
- tetanic, post-tetanic count (PTC)
- double-burst stimulation (DBS)

Single-twitch

- 1Hz .. 0,1Hz, kontinuálně

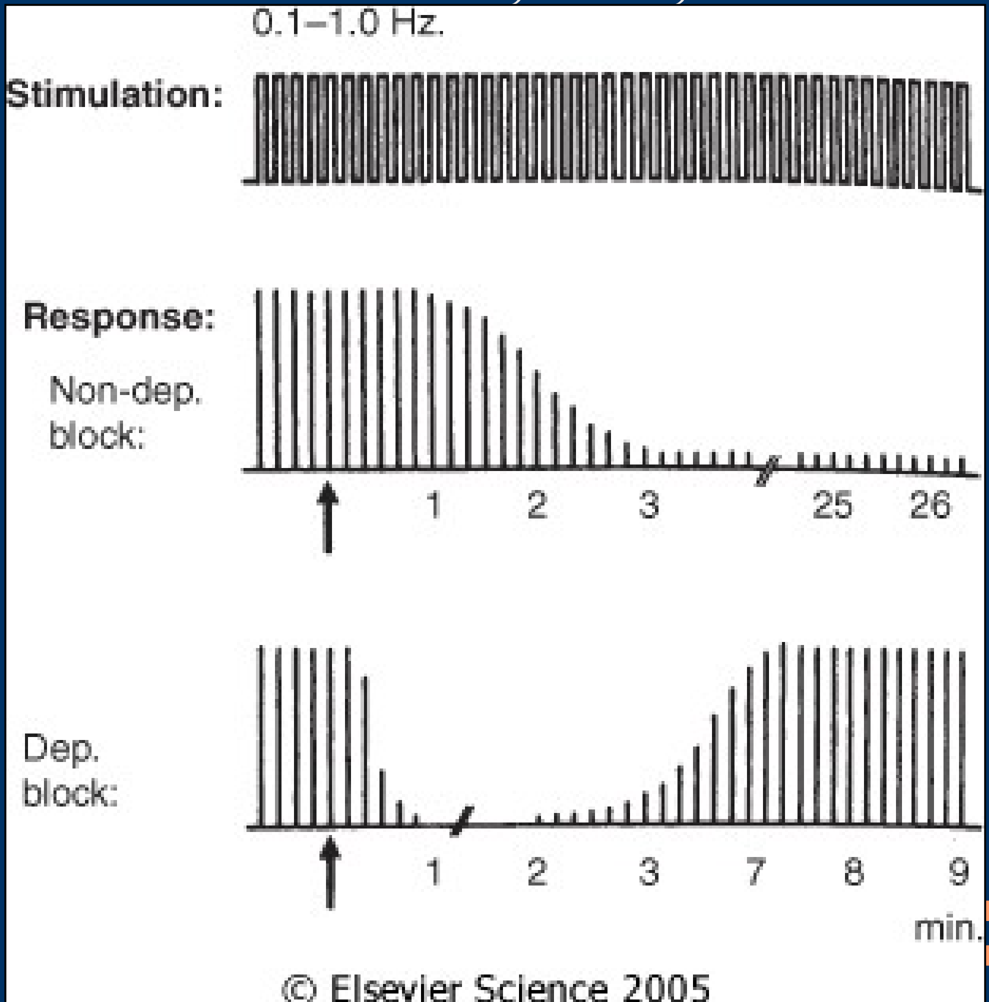


Figure 39-1 Pattern of electrical stimulation and evoked muscle responses to single-twitch nerve stimulation (at frequencies of 0.1 to 1.0 Hz) after injection of nondepolarizing (Non-dep) and depolarizing (Dep) neuromuscular blocking drugs (arrows). Note that except for the difference in time factors, no differences in the strength of the evoked responses exist between the two types of block.

TOF

- 4 stimuly á 0,5s (2Hz)

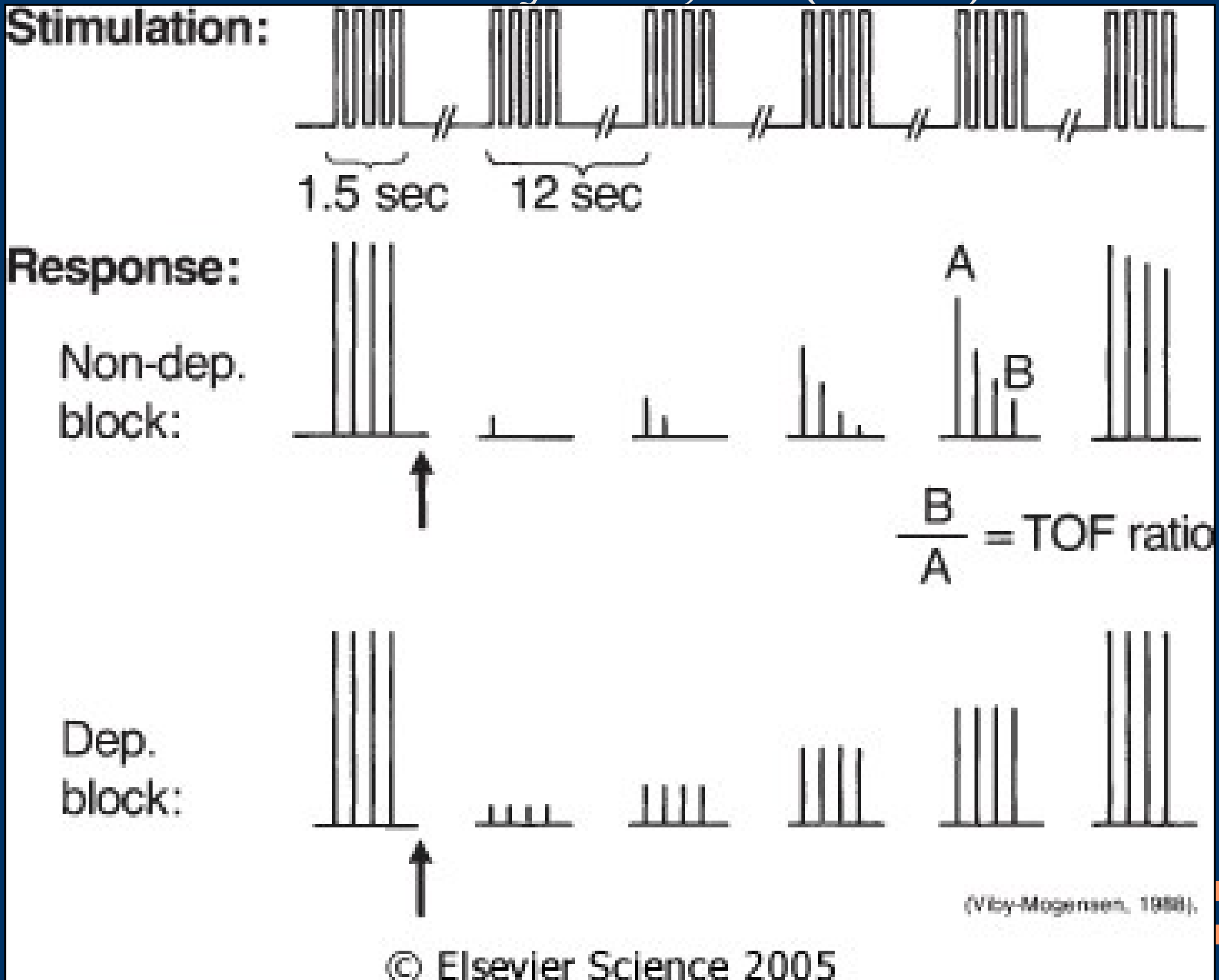
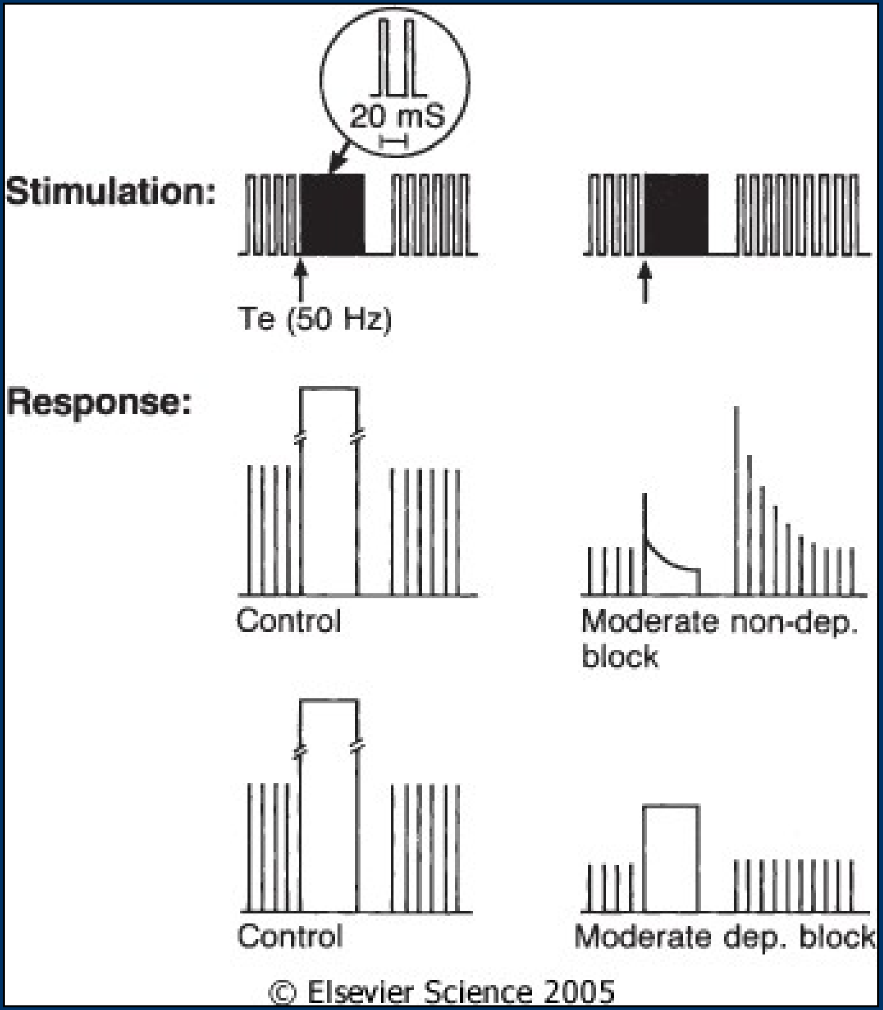


Figure 39-2 Pattern of electrical stimulation and evoked muscle responses to TOF nerve stimulation before and after injection of nondepolarizing (Non-dep) and depolarizing (Dep) neuromuscular blocking drugs (arrows).

Tetanická stimulace

- bolestivá; 50Hz na 5s



Posttetanická facilitace

Figure 39-3 Pattern of stimulation and evoked muscle responses to tetanic (50-Hz) nerve stimulation for 5 seconds (Te) and post-tetanic stimulation (1.0-Hz) twitch. Stimulation was applied before injection of neuromuscular blocking drugs and during moderate nondepolarizing and depolarizing blocks. Note fade in the response to tetanic stimulation, plus post-tetanic facilitation of transmission during nondepolarizing blockade. During depolarizing blockade, the tetanic response is well sustained and no post-tetanic facilitation of transmission occurs.

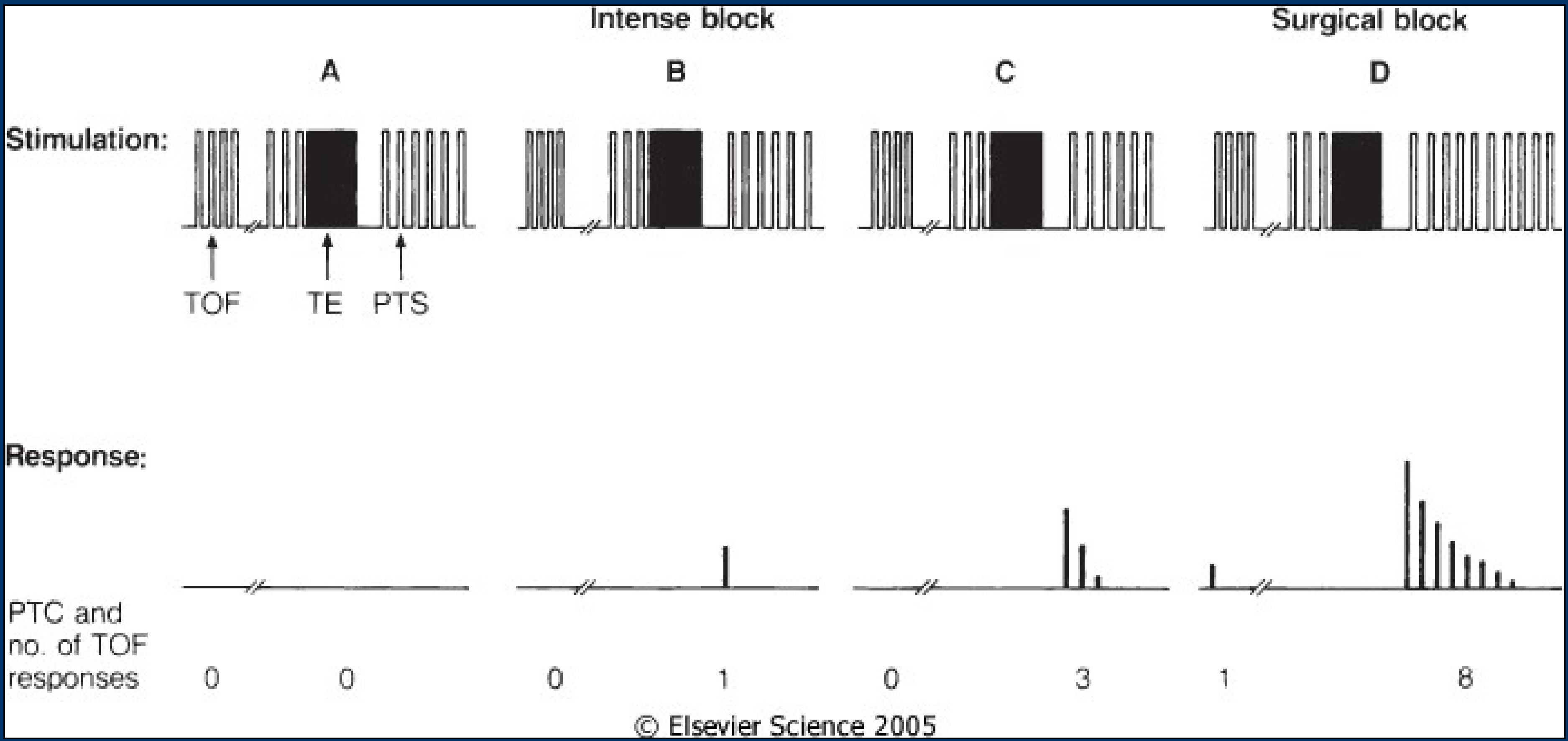


Figure 39-4 Pattern of electrical stimulation and evoked muscle responses to TOF nerve stimulation, 50-Hz tetanic nerve stimulation for 5 seconds (TE), and 1.0-Hz post-tetanic twitch stimulation (PTS) during four different levels of nondepolarizing neuromuscular blockade. During very intense blockade of the peripheral muscles (A), no response to any of the forms of stimulation occurs. During less pronounced blockade (B and C), there is still no response to stimulation, but post-tetanic facilitation of transmission is present. During surgical block (D), the first response to TOF appears and post-tetanic facilitation increases further. The post-tetanic count (see text) is 1 during intense block (B), 3 during less intense block (C), and 8 during surgical block (D).

Double-burst stimulation

- 2 krátké sekvence 50-Hz tetanické stimulace, odděleny pauzou 750 ms
- nerelaxovaný sval – 2 stejně silné kontrakce
- částečné relaxovaný sval – 2. je slabší

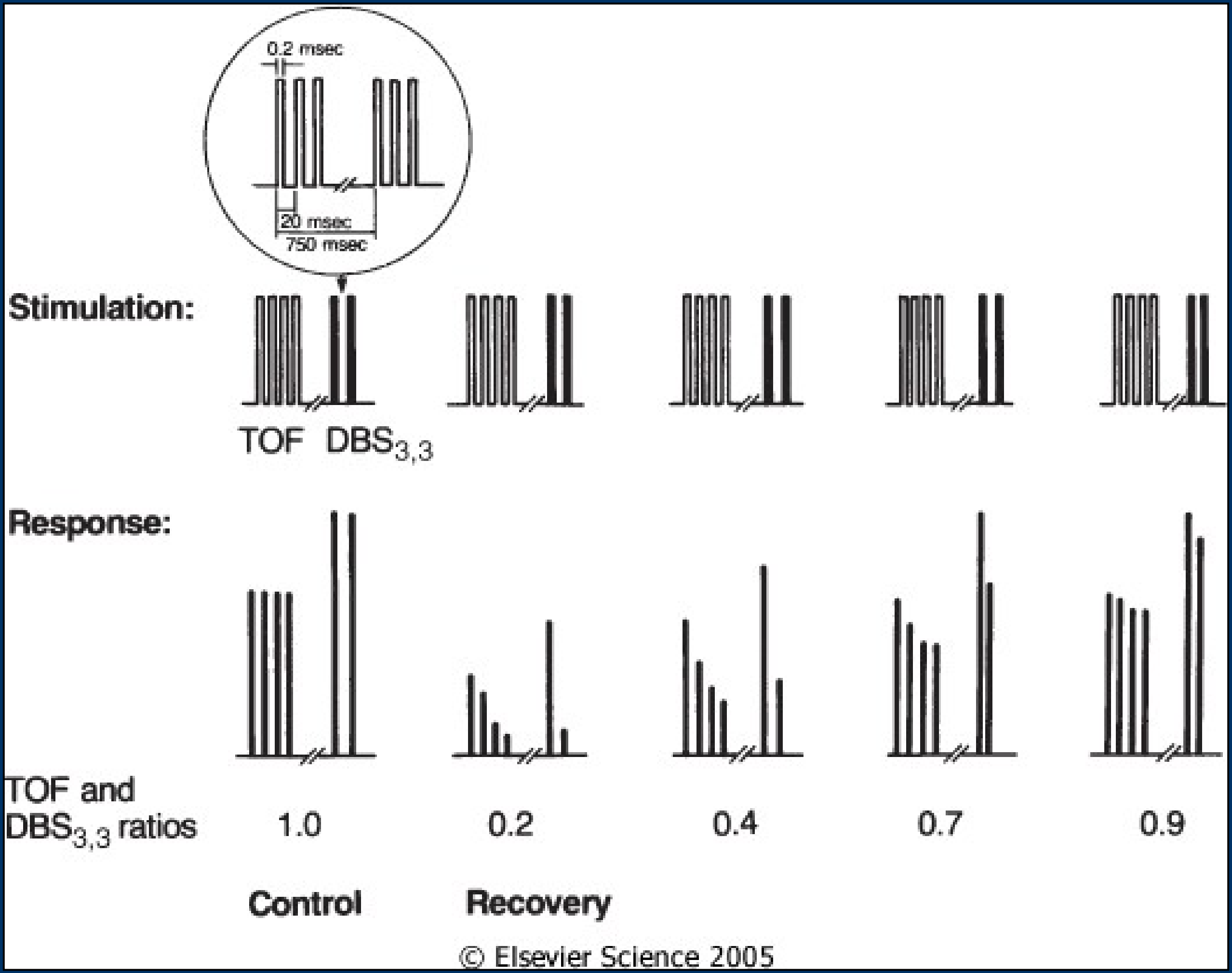


Figure 39-7 Pattern of electrical stimulation and evoked muscle responses to TOF nerve stimulation and double-burst nerve stimulation (i.e., three impulses in each of two tetanic bursts, DBS3,3) before injection of muscle relaxants (control) and during recovery from nondepolarizing neuromuscular blockade. TOF ratio is the amplitude of the fourth response to TOF divided by the amplitude of the first response. DBS3,3 ratio is the amplitude of the second response to DBS3,3 divided by the amplitude of the first response. (See text for further explanation.)

Sledované parametry anest. přístroje

- hmotnost palice
- tloušťka a počet polštářů

Sledované parametry anest. přístroje

- tlaky v Centrálním rozvodu / tlak. lahvích
- funkce ventilátoru (vlnovec se vrací až nahoru)

Bdělost při CA

- Bdělost je pooperační vzpomínka na události během celkové anestezie
- 0,1 – 0,2% operované populace (1:800)
  - mimotělní oběh
  - císařský řez
  - trauma

reportují:

- pocit svalové relaxace, nemožnost pohybu
- konverzace
- strach, bolest, bezmoc

Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial

*P S Myles, K Leslie, J McNeil, A Forbes, M T V Chan, for the B-Aware trial group**

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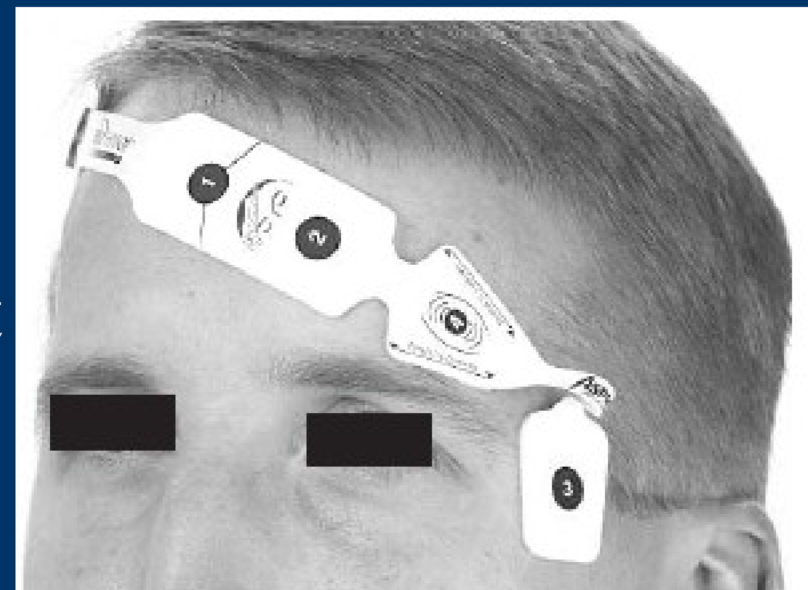
Whipple's procedure	Heard the anaesthetist say "the pressure is really low", and the surgeon respond "can you do something about it?". Recalls movement and pain within the abdomen. Tried to move, but was unable to (1=ND, 2=Y, 3=Y)
Laparotomy, ruptured hepatoma	Remembers going "half asleep", then hearing shouting ("...do things faster... because things are crashing..."). Felt anxious, dizzy, and breathless, and could not move. Some abdominal pain (1=ND, 2=Y, 3=D)
Anterior resection	Heard noises during surgery; tried to move but was unable (1=Y, 2=Y, 3=Y)

Until 30 days after enrolment, the number of patients who reported awareness under anaesthesia was significantly smaller in the BIS group than in the routine care group (2 [0·17%] *vs* 11 [0·91%]; OR 0·18; 95% adjusted CI 0·02–0·84; p=0·022); the absolute reduction in the risk of awareness was 0·74%. The number needed to treat (NNT) was 138 (95% CI 77–641). The benefit of

Monitorace hloubky bezvědomí

- EEG – matematika → BIS .. číslo charakterizující bdělost 100 .. 0



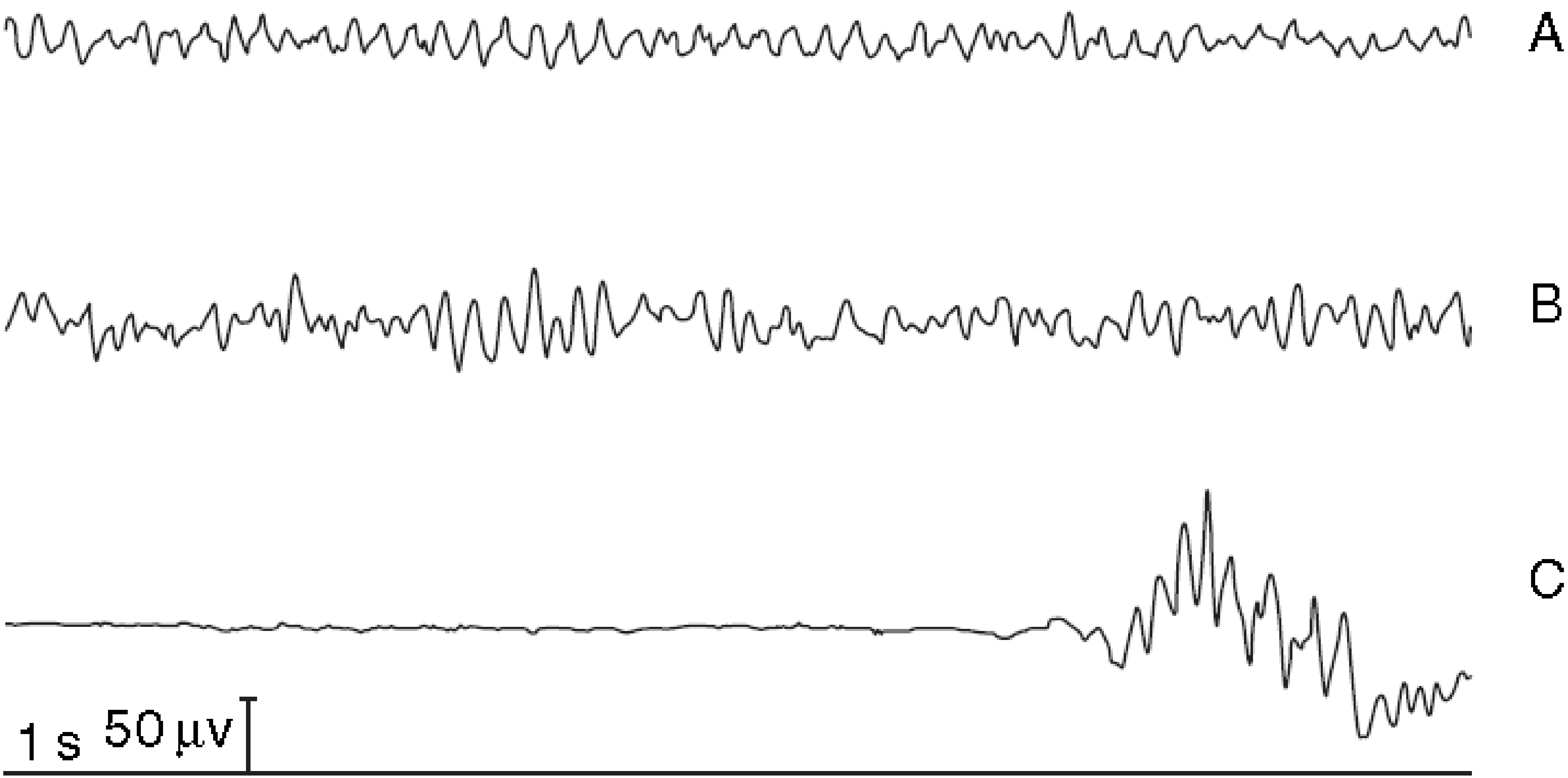


Fig 5 Raw EEG waves. A, awake state; B, β-activation; C, burst suppression.

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BJA

Depth of anaesthesia monitoring: what's available, what's validated and what's next?

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Příště .... farmakologie