Institute of Surgical Research

„B" Module – Basic Medical Skills
Monitoring Skills in Medicine

B1-2 Practicals – Perioperative volume therapy

B3-4 Practicals – Cardiovascular monitoring

B5-6 Practicals – Complex monitoring

- respiratory system,
- microcirculation,
- gastrointestinal system,
- excretion – urinary tract monitoring

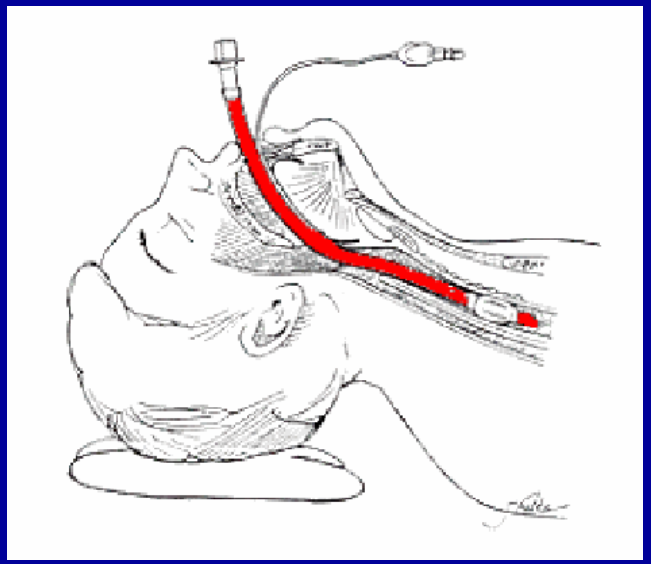
Respiratory System Monitoring

1. Observations: respiratory movements; type, depth and frequency of breathing; skin colour (cyanosis).

2. Methods for monitoring the respiratory system:
    - Securing open airways – intubation
    - Mechanical ventilation
    - Monitoring of respiratory gases

Endotracheal intubation

Definition: introducing a tube through the mouth or nose to secure open airways.



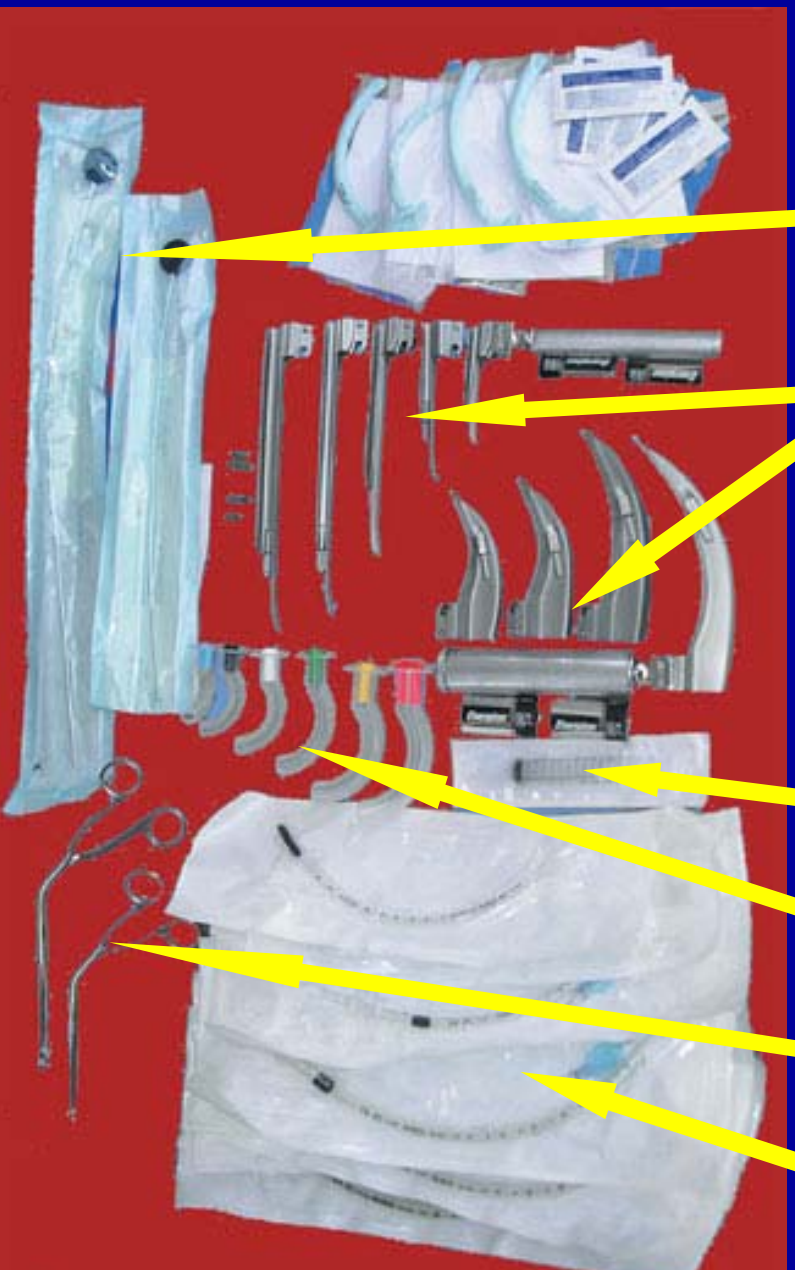
Advantages of endotracheal intubation

- decreased anatomical dead space, increased efficiency of alveolar ventilation
- possibility for positive pressure ventilation; air/anesthetic gas mixture could enter only the lungs
- aspiration (vomiting, regurgitation) can be avoided
- enables easy suctioning of the mucus
- atelectasis (micro or macro) can be eliminated/avoided
- easy patient positioning
- giving drugs can be easy intratracheally.

Technique of endotracheal intubation

1. Preparing the equipments
2. Patient positioning
3. General or local anesthesia
4. Oxygenization
5. Head positioning, the pharyx-larynx axis
6. Muscle relaxation
7. Intubation with laryngoscope
8. Depth of intubation
9. Controlling
10. Fixation

1. Preparing the equipments



Ruben-ballon with valve and mask, tube adaptors, adhesive tape

suction catheter, suction pump

laryngoscope

laryngeal mask

syringe

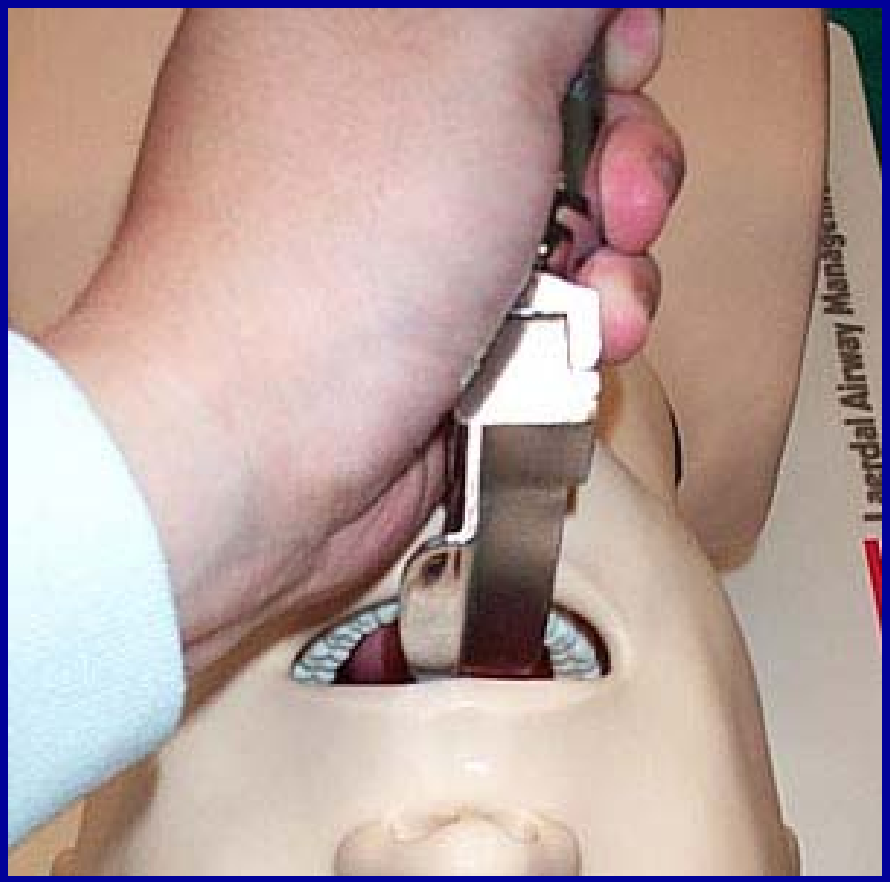
Guedel-tube

Magill-forceps

endotracheal tubes

2. Patient positioning

The most preferred position: the patient is laid in supine position, the head is toward the person performing the procedure.



3. General or local anesthesia

General anesthesia or local anesthesia and sedation should be induced.

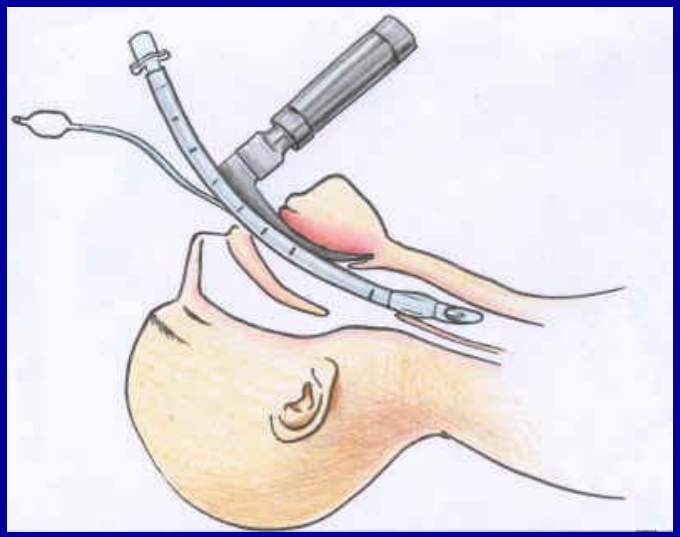
4. Oxygenization

Deliver oxygen with a face mask (for 3 min at least).

5. Head positioning I.

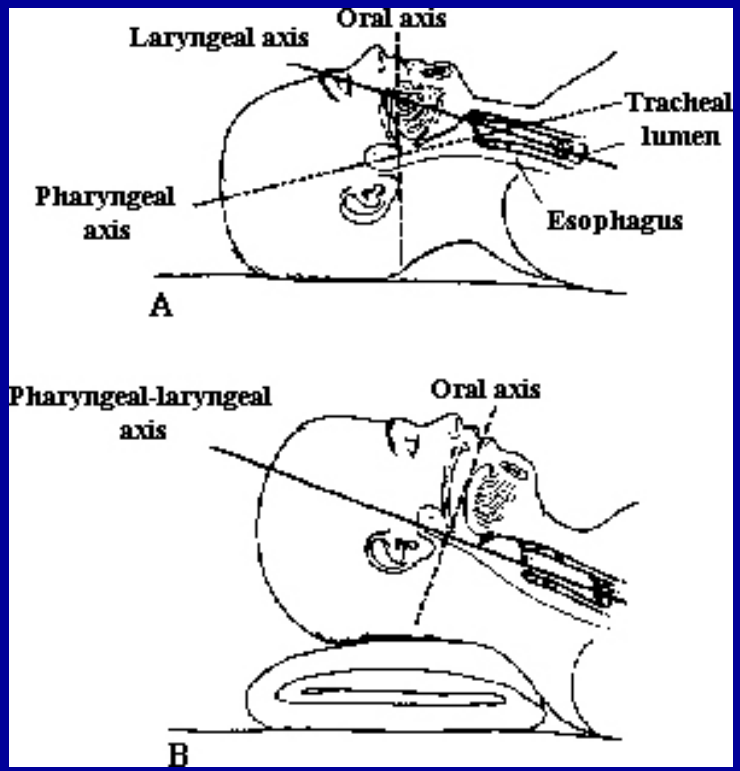
Possibilities for the alignment of the oral and pharyngeal axis:

1. Classical Jackson position: the patient is laid in supine position without pillow, the head should be tilted backward at the atlanto-occipital joint, so the cervical spine is retroflected.



5. Head positioning II.

2. Modified Jackson position (short-necked, obese patient, torticollis): a 10-15 cm pillow is placed under the nape, and the head is tilted so that the mouth can be opened (sniffing position).



6. Relaxation

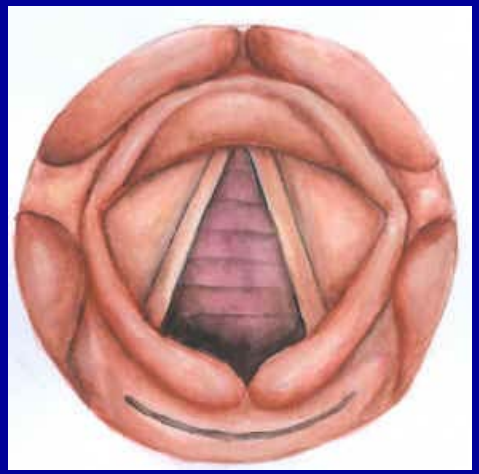
Paralyze the patient using muscle relaxation after oxygenation and anesthesia, and wait for the effect.

7. Intubation with laryngoscope I.

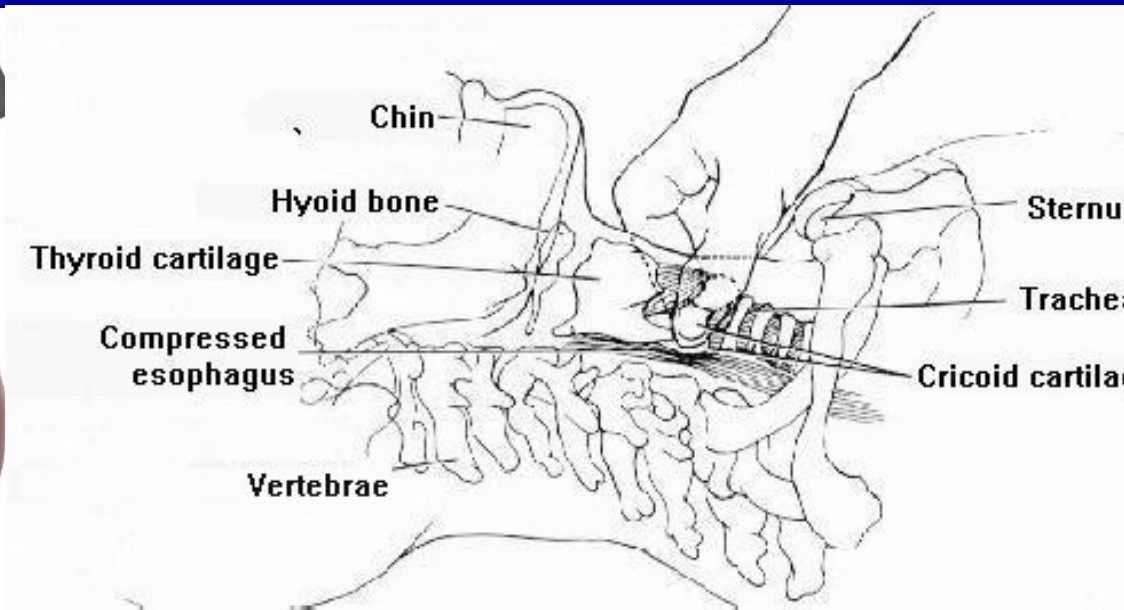
1. Grasp the laryngoscope by the left hand and insert the curved blade into the mouth along with the median line of the tongue. If necessary push the tongue to the left side with the „Z” blade.
2. The end of the blade should be between the base of tongue and the epiglottis, in the plica glossoepiglottica. By lifting the base of tongue the epiglottis will be elevated...

7. Intubation with laryngoscope II.

3. … and the triangular glottis with its peak will be visible upward.



4. If the epiglottis and the trachea cannot be seen, the assistant may press down the base of thyroid and cricoid cartilage (*Sellick-maneuver*).



8. Depth of intubation

The distal end of tube has to be positioned in the trachea **1 to 3 cm above the bifurcation**. Depth of intubation can be read on the tube.

Blowing the cuff: inhibits the inspirated air to escape and trickling of saliva, blood, or gastric content into the lung; allows suctioning.

The balloon has an automatic valve which shuts down after removal of inflating syringe.

Avoid overinflation!

9. Controlling

1. **Auscultation** at both axillary lines. If the tube is too deep, it may get into the right bronchus and ventilation is weak or can not be heard on the left side.
2. Knock the wall of the upper thorax and **listen** at the end of the tube – the outflow of air can be heard.
3. **Insufflation** through the tube induces a symmetrical moving of the chest.
4. Using **capnography**, the CO_2 waveform indicates the right position of the tube ($EtCO_2$ is zero, if the tube is in the oesophagus).

10. Fixation

A bite protector (**Guedel-tube** or a wet roller bandage) in the mouth can be used to avoid biting of the tube.

The tube and the bite protector are **fixed** with a strip of adhesive tape.

Monitoring of respiratory gases

Non-invasive

Capnometry

Measurement of end-tidal CO_2
– Infrared absorption photometry

Pulseoximetry

Measurement of O_2 saturation in arterial blood
Difference in red and infrared light absorption between oxy- and deoxyhemoglobin

Invasive: blood gas analysis

Measurement of arterial pCO_2

Measurement of arterial pO_2 and oxygen saturation

- highly accurate
- intermittent

Capnography vs Capnometry

Capnography

capnograph

Measurement and display of both $EtCO_2$ value and CO_2 waveform - capnogram

Capnometry

capnometer

Measurement and display of $EtCO_2$ valu
(no waveform)

Capnograph / Pulse-oximeter

OxiMax N-85

Sensors

Measured parameters:

$EtCO_2$	end-tidal CO_2
RR	respiratory rate
$FiCO_2$	inspirated CO_2
SaO_2	O_2 saturation
P	heart rate

continuously monitored.

Invasive monitoring of respiratory gases
Blood gas analysis

Goals: to determine

- the patient's blood gas values (O_2 uptake and CO_2 elimination in the lung, blood pH)
- the function of lungs and kidneys, and their role in acid-base balance
- respiratory diseases.

AVL Compact 2
(AVL Medical Instruments)

Steps:

- taking blood sample (inhibitor of blood coagulation, air bubbles!),
- measurement using blood gas analyzer,
- data interpretation, treatment of the patient.

Blood gas analysis – Taking blood sample

Improper tools, or incorrect sample manipulation → **inaccuracy !**

Before **taking blood sample**, draw/discard about 4-times of cannula volume with a 5 ml syringe.

- Fill the conus of a 2 ml syringe with heparine (50-100 µl/ml blood).
- Take blood sample (max. 1 ml) into the syringe.
- Remove air bubbles from the syringe.
- Close the syringe with a cap.
- Flush the cannula with saline.

Directly before the measurement, remove some drops from the sample.

Blood gas and acid-base parameters

Measured parameters:

pO_2, pCO_2, pH

Calculated parameters:

BE, HCO_3^-, $cHCO_3^-$, SaO_2, ctO_2

Metabolites:

cLactate, cGlucose

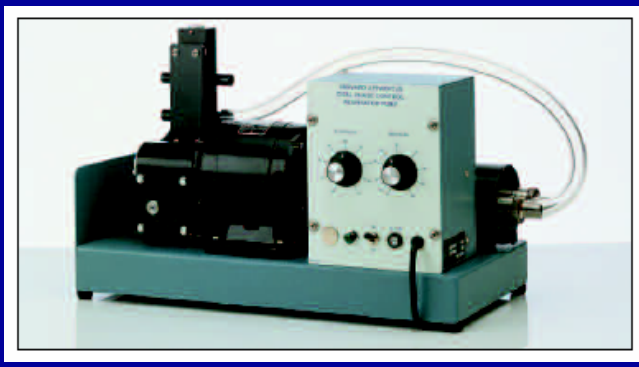
Electrolytes:

cK^+, cNa^+, cCl^-, cCa^{2+}

Mechanical ventilation

Indications of mechanical ventilation:

- insufficient breathing or in absence of spontaneous breathing,
- in severe hypoxemia or hypercapnia/in respiratory failure,
- increased work of breathing,
- stabilization of chest wall.



Respirator

Goals of mechanical ventilation:

- to increase oxygenation,
- to prevent/to eliminate atelectasis,
- to ensure optimal ventilation,
- to improve ventilation/perfusion ratio,
- to decrease work of breathing.

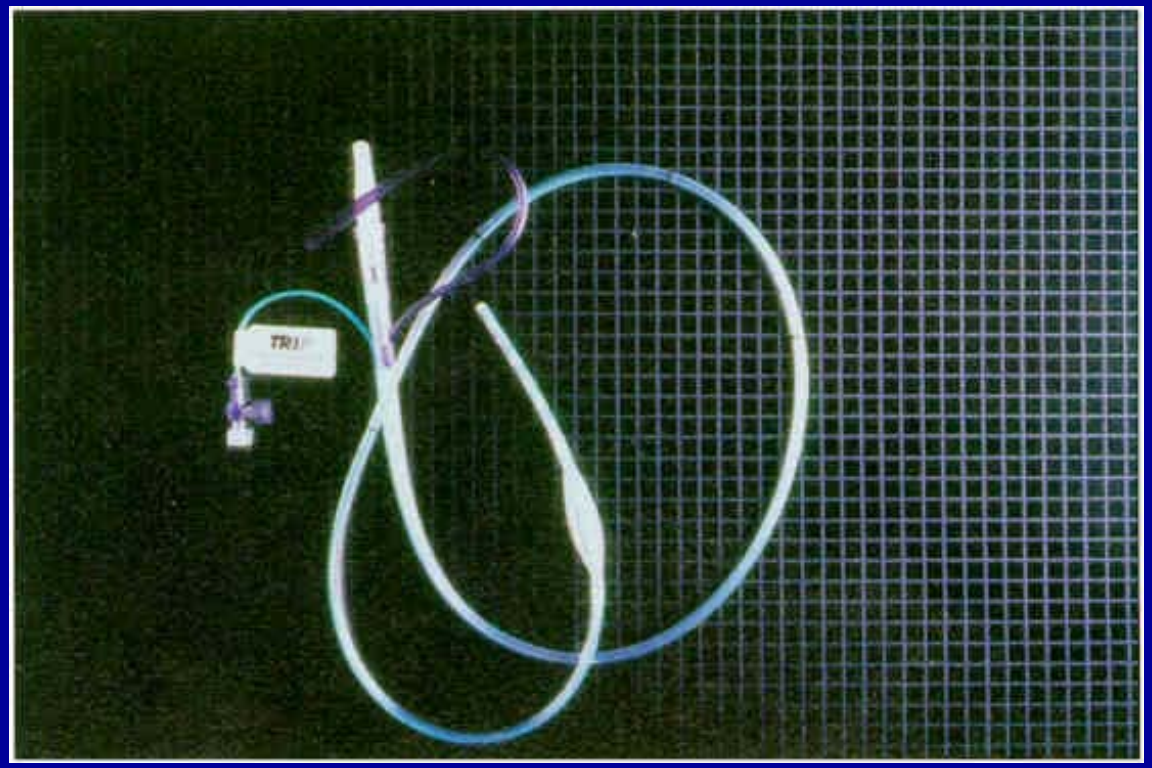
The most widely used technique of mechanical ventilation

with positive pressure: during inspiration air is forced into the lungs with higher pressure than that in the alveoli,

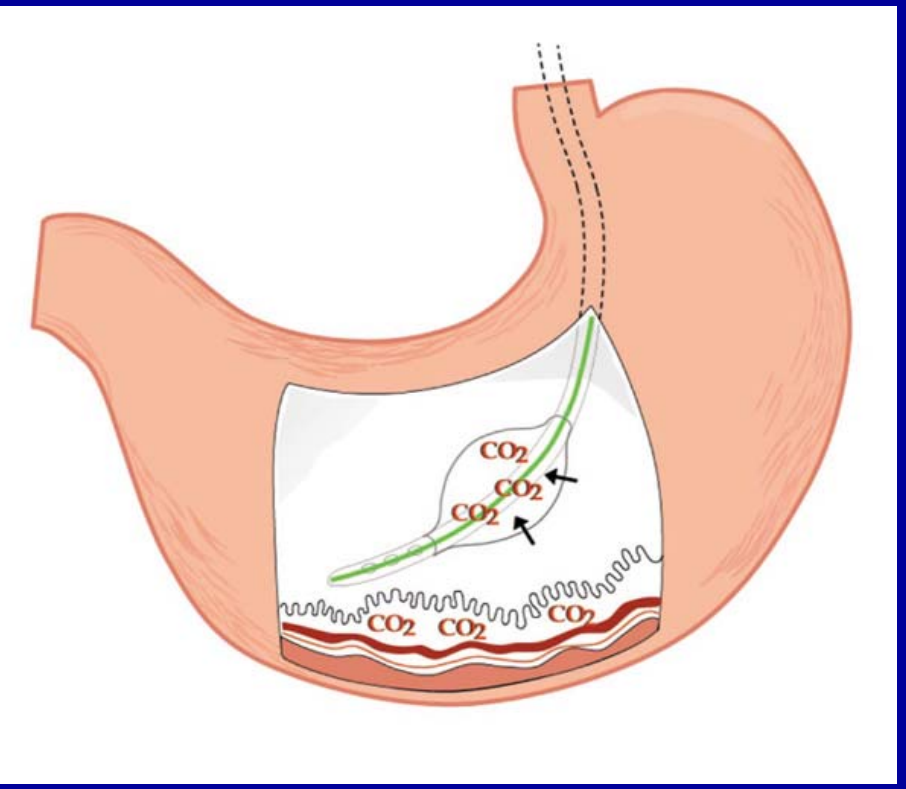
with volume-controlled respirator: inspiration with preset tidal volume and ventilator rate or with preset minute ventilation, with inspiration/expiration ratio (pressurized valve to prevent extremely high pressure overload).

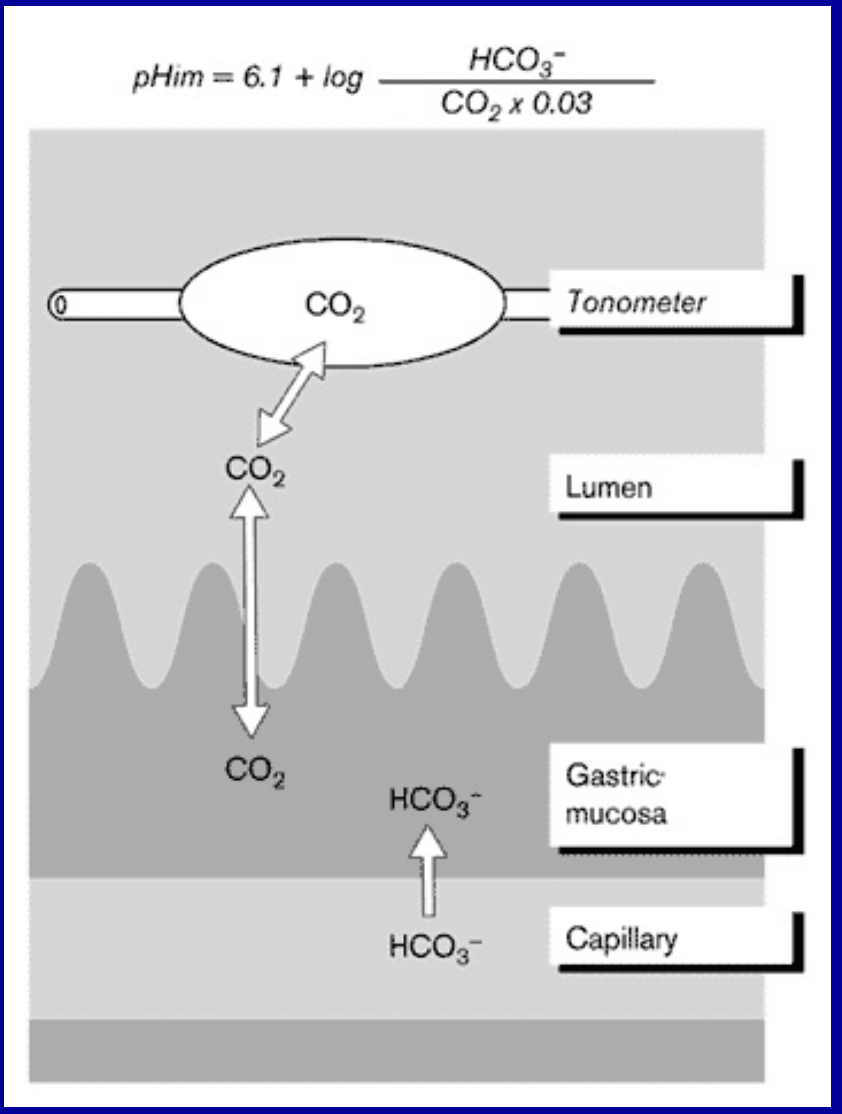
Gastrointestinal tract monitoring

Gastric tonometry



Indirect tonometry: the basics





Determination of intramucosal pH (pHi)

pCO_2 HCO_3^-

Tonomitor sample: measurement of mucosal pCO_2

Arterial blood sample: HCO_3^- is determined by pCO_2 and pH

$$pHi = pK_D + lg \frac{[\quad]}{0{,}03 \quad x}$$

CO_2-gap

CO_2-gap = $pgCO_2$ - $pACO_2$

$pgCO_2$ = local (measured by tonomitor) tissue pCO_2

$pACO_2$ = arterial pCO_2

Catheters of gastrotonometry

Sigmoid Tonomitor (with balloon)

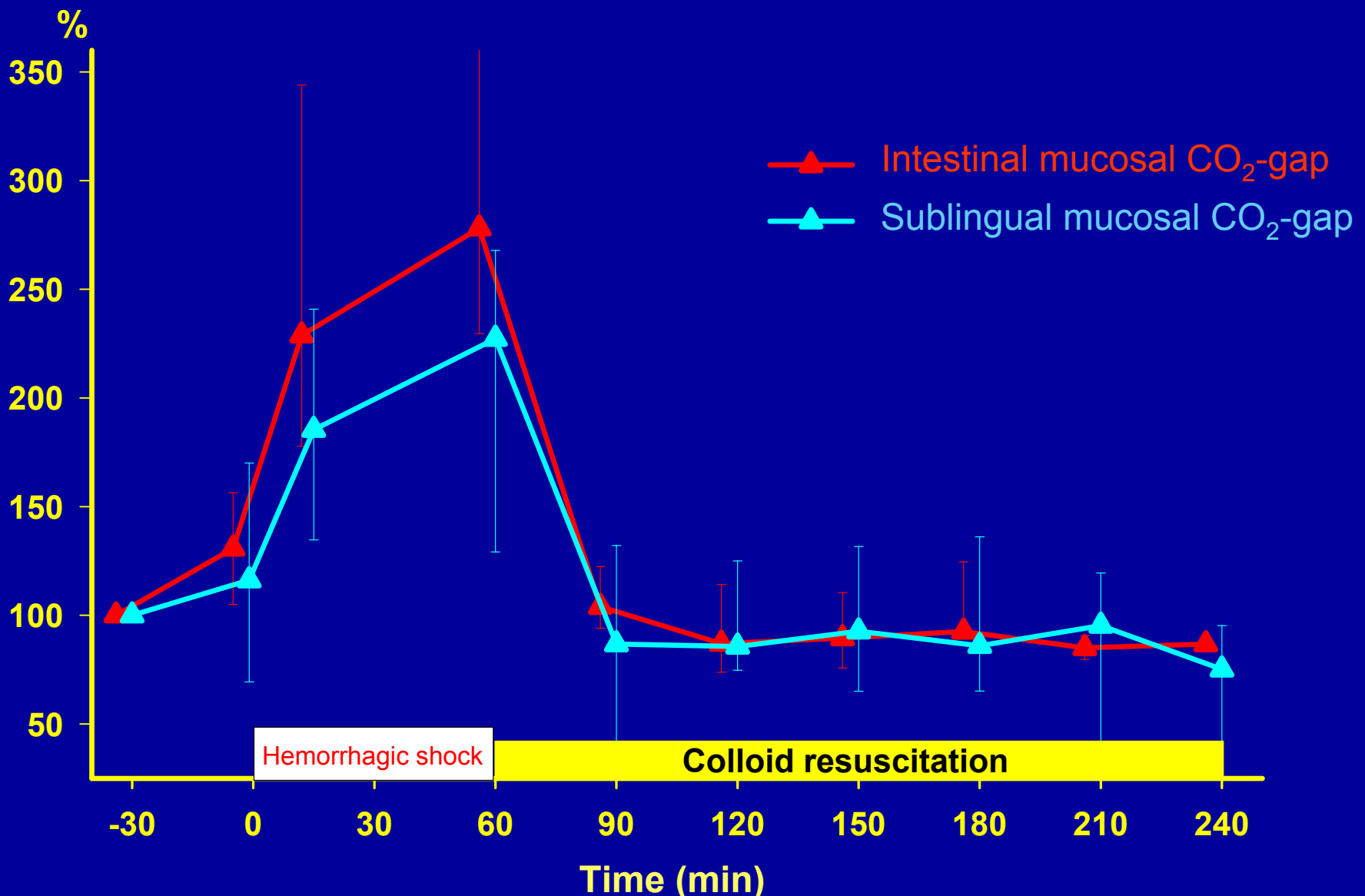
Equilibration time: min. 30 min
„Static" device

Capillary Tonomitor

by Boda et al. 2006

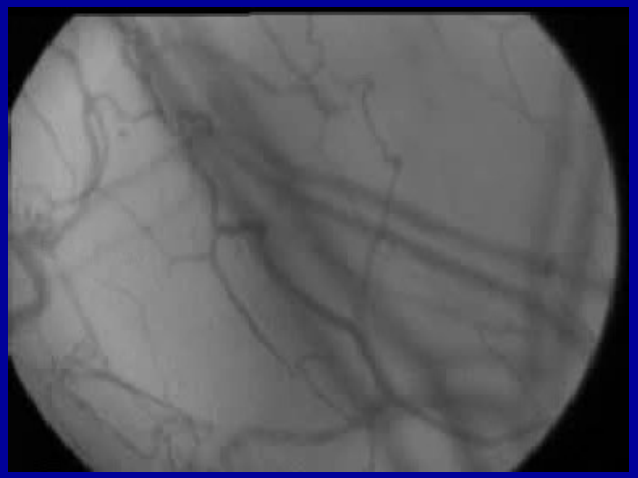
Equilibration time: 5-6 min
„Dynamic" device

Intestinal and sublingual mucosal CO_2-gap in hemorrhagic shock



Monitoring of the microcirculation

Microcirculation of sublingual mucosa using intravital videomicroscopy or orthogonal polarization spectral (OPS) imaging.



Natural contrast agent: Hgb in the capillaries;
Visibility: approx. 1 mm depth;

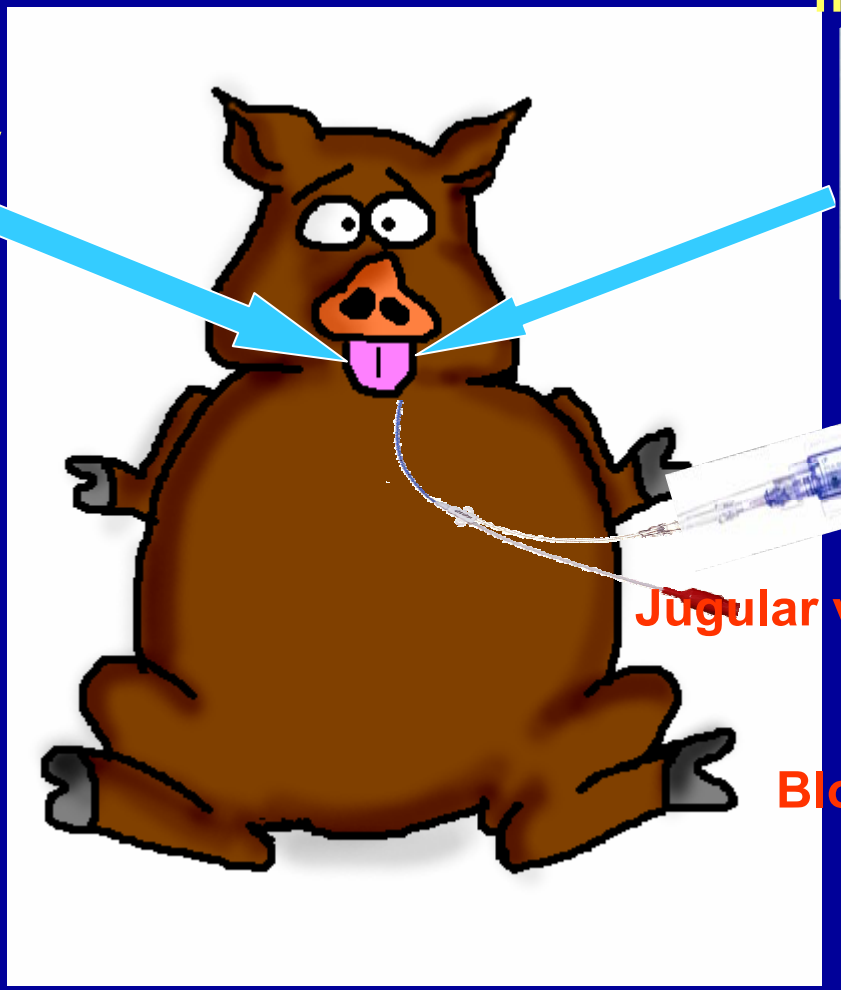
Measured parameters:

Red blood cell velocity
Capillary perfusion ratio (perfused/nonperfused capillaries ratio)

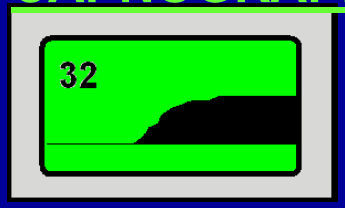
Mechanical ventilation

OPS imaging of microcirculation

Sublingual capillary tonomitor



CAPNOGRAPH



pCO_2-gap determination

Jugular vein and carotid arte
cannulation
Blood sample
Blood gas analysis

All you want to know about

Catheterization

(but never dare to ask)

Urinary system monitoring

Catheterization of the bladder

Definition: artificial emptying of the urinary bladder.

Aims: **therapeutic** (urine retention, incontinence, preoperative preparation)
diagnostic (monitoring fluid status, urologic/microbiologic tests)

Principles of catheterization

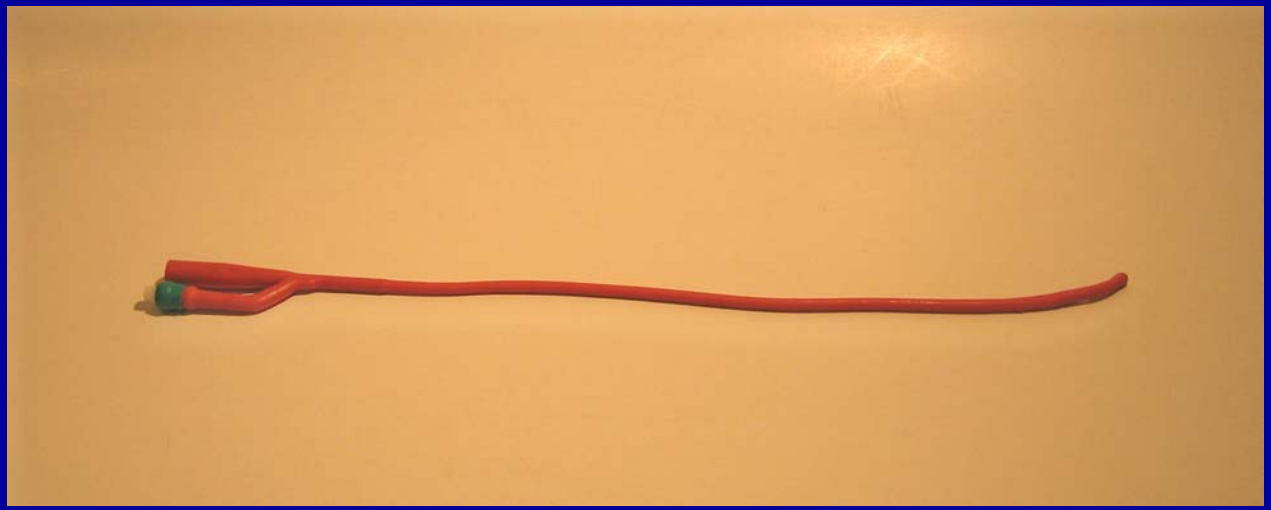
- catheterize only if it is necessary
- avoid catheterization in case of urethral injuries
- catheterize in accordance with the rules of asepsis!

Catheters

Material: synthetic, latex or silicone.

Size: external diameter is given in Charriére (1 Ch) or 1 French (1 F) (=0.33 mm)

The most widely used: 14-22 Ch Foley-catheter (with balloon, easy fixation).



Tools for catheterization

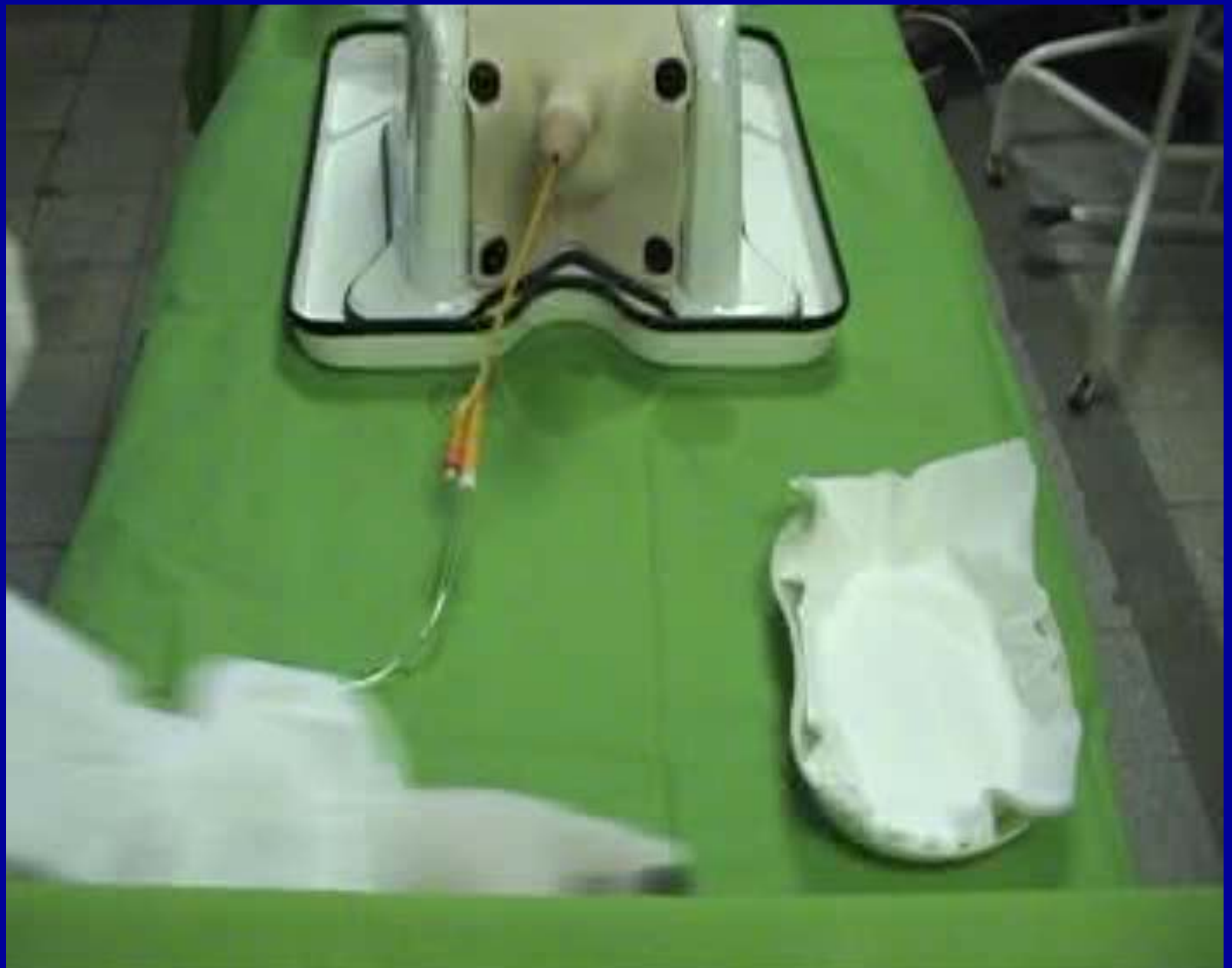
- catheter in appropriate size
- urine container sack and tube
- sponges for cleaning of genital area
- disinfectant
- saline (in syringe) to fill the balloon
- sterile lubricant (Instillagel)
- sterile gloves

Male catheterization

- Lift the penis (about 60 degrees) with left hand and retract the foreskin
- Clean the urethral meatus with disinfectant 3 times
- Inject some Instillagel to the urethra
- Insert the catheter into the urethra with sterile forceps
- Fill the balloon with 10 ml saline
- Pull back the catheter until the balloon allows
- Connect the urine container sack to the catheter.

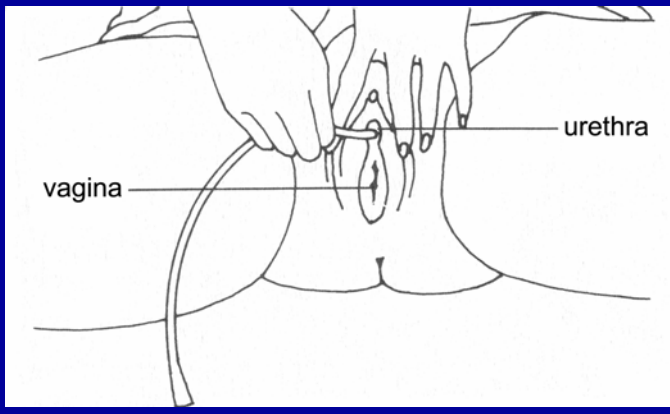
Male catheterization

Removing the catheter in males



Female catheterization

- Spread the labia gently with left hand
- Clean the introitus with disinfectant 3 times
- Grasp the catheter with sterile forceps at some cm-s from the end
- Put Instillagel onto the first some cm-s of the catheter
- Insert the catheter gently into the urethra
- Connect the urine container sack to the catheter
- Fill the catheter with 10 ml saline
- Pull the catheter back.



Female catheterization

Removing catheter in females

The execution of the practical

Endotracheal intubation *in vivo* (ext. operating room)

Capnography → $EtCO_2$ end-tidal CO_2

Pulse oximetry → SaO_2 O_2 saturation

Sublingual gastrotonometry

max. 6 students
Endotracheal intubation - model (int. op. room)

max. 4 students
Scrub preparation (ext. op. room)
***Cannulation of jugular vein and carotid artery*;**
Surgical team: surgeon, 2 assistants, 1 scrub nurse;

max. 6 students
Bladder catheterization - model (int. op. room)

male **femal**

Taking blood samples → Blood gas analysis
Mechanical ventilation - settings
Sublingual microcirculation - OPS technique

Have a good practice!