Invasive CO Measurement
Overview of mostly used methods
Thermodilution ▶ ICO (Intermittent CO)

Application:
- Pulmonary artery catheter
- Bolus application with cold water (10°C, 5-10 ml) into right atrium
- Recording of temperature in the pulmonary artery

Pro:
- Very accurate
- Uncritical indicator

Contra:
- Highly invasive
- Only spot values
- Averaging over 3 measurements
- Measurement user-dependent
**Thermodilution  ▶ CCO (Continuous CO)**

**Application:**
- Pulmonary artery catheter
- Heating filament positioned between RV and RA warming up the blood (max. 44°C)
- Recording of temperature in the pulmonary artery

**Pro:**
- Very accurate
- Uncritical indicator
- “continuous” CO (every 30-60s)
- Automatic measurement

**Contra:**
- Highly invasive
Arterial Pressure Wave Analysis  ➤ PICCO

Application:
- Arterial and venous entry
- Continuous measurement of arterial pressure curve
- Bolus application of cold water (8°C > 15 ml) into venous entry, recording of temperature in arterial entry for calibration

Pro:
- Accurate
- Uncritical indicator
- Less invasive
- Continuous CO

Contra:
- Addition of measurement error
- Recalibration necessary if the vascular resistance changes
- Accuracy of bolus application depending on user
Arterial Pressure Wave Analysis  LiDCO

Application:
• Arterial and venous entry
• Continuous measurement of arterial pressure curve
• Bolus application of isotonic lithium chloride into venous entry, recording of lithium concentration in arterial entry for calibration

Pro:
• Accurate
• Continuous CO
• Less invasive
• No indicator loss during measurement cycle

Contra:
• Addition of measurement error
• Indicator toxic when used in higher dose
• Recalibration necessary if the vascular resistance changes
Arterial Pressure Wave Analysis  FloTrac

Application:
- Arterial entry
- Continuous measurement of arterial pressure curve
- No calibration necessary

Pro:
- Easy to use
- Continuous CO
- Less invasive

Contra:
- Low accuracy
- Few studies
Trans Oesophageal Cardiac Output (TEE)

**Application:**
- Doppler probe in the oesophagus measures blood velocity profile in the descending aorta
- CO is calculated based on the blood velocity and the estimated vessel cross sectional area

**Pro:**
- Continuous CO
- Minimal invasive

**Contra:**
- Not adequate for long term measurement
- Skilled operator needed
- Patient must be sedated
- High variations in accuracy