

Impedance Cardiography (ICG)

Application of ICG in Intensive Care and Emergency

Aim of haemodynamic monitoring in ICU and ED

► Detection and therapy of insufficient organ perfusion

Answers to common cardiovascular questions:

- Hydration or Dehydration therapy?
- Which catecholamine should be used?
- Indication of further medication (vasopressin, vasodillators)?

Parameters required for sufficient haemodynamic monitoring:

- Haemodynamics
 - SV – Stroke Volume
 - CO – Cardiac Output
 - CI – Cardiac Index
- Afterload
 - SVRI – Systemic Vascular Resistance Index
 - MAP – Mean Arterial Pressure
- Contractility
 - ACI – Acceleration Index

Fluid Management

Preload Responsiveness

Question:

Will SV increase after application of additional fluid?

Current situation:

- Available parameters like CVP (central venous pressure) and PWP (pulmonary wedge pressure) are a poor predictor of preload responsiveness
- Parameters have to be measured invasively and are not available in every situation

Solution with Niccomo:

- Measurement of SVV (stroke volume variation) in ventilated patients as a highly sensitive indicator of preload responsiveness
- Standardized passive leg raising (PLR) test for patients who are spontaneously breathing

Fluid Management

Stroke Volume Variation (SVV)

Respiration affects:

- Heart Rate
- Blood Pressure
- Stroke Volume (SV)

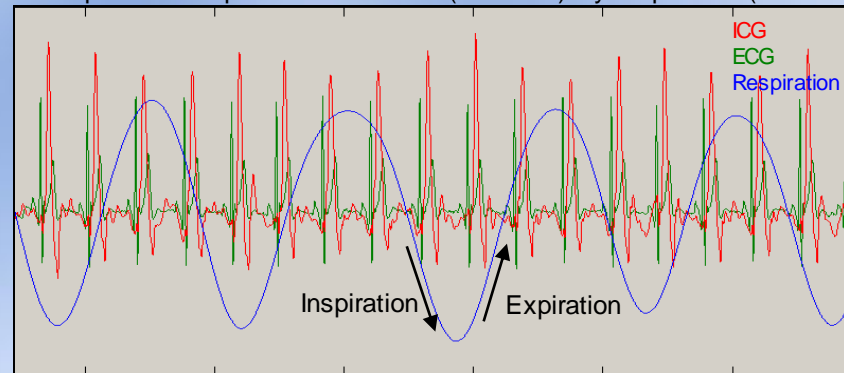


SVV describes the variation of SV during expiration to inspiration and is a predictor of preload responsiveness

Restrictions:

- Only possible in ventilated patients with tidal volumes of $\geq 8\text{cc/kg}$
- Arrhythmias adversely reduce accuracy of SVV

Example: ICG amplitude modulation (red wave) by respiration (blue wave):



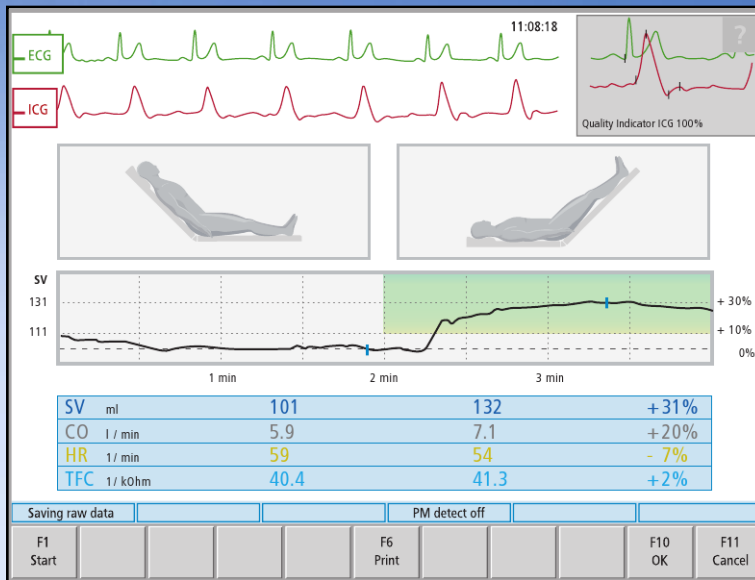
SVV over 15 %



Fluid responsive

Fluid Management

Passive Leg Raising Test (PLR)



- Preload change caused by PLR
- Record of SV change during PLR
- Standardized test procedure with software support
- Clear reproducible results due to beat-by-beat measurement

SV change over 15 %



Fluid responsive

Cardiogenic Shock ▶ cardiac cause

Causes:

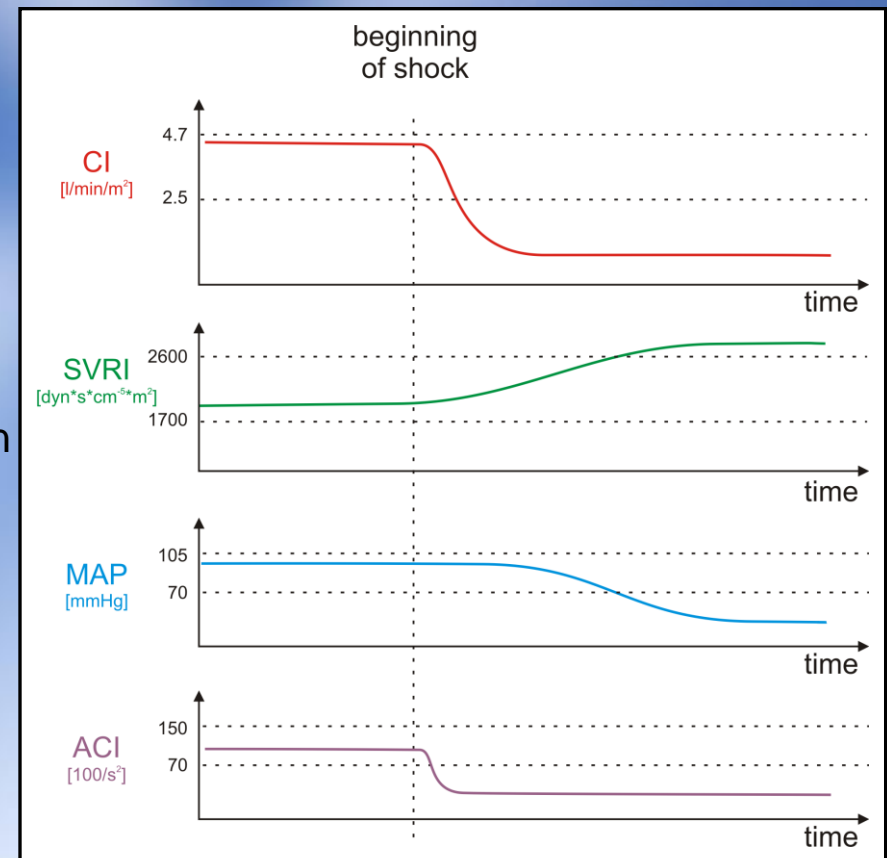
- Heart attack
- Heart insufficiency

Diagnosis:

- Decreased CI
- Increased SVRI due to vasoconstriction
- Decreased blood pressure
- Decreased contractility

Therapy:

- Nitroglycerin
- Catecholamine



Cardiogenic Shock ▶ non-cardiac cause

Causes:

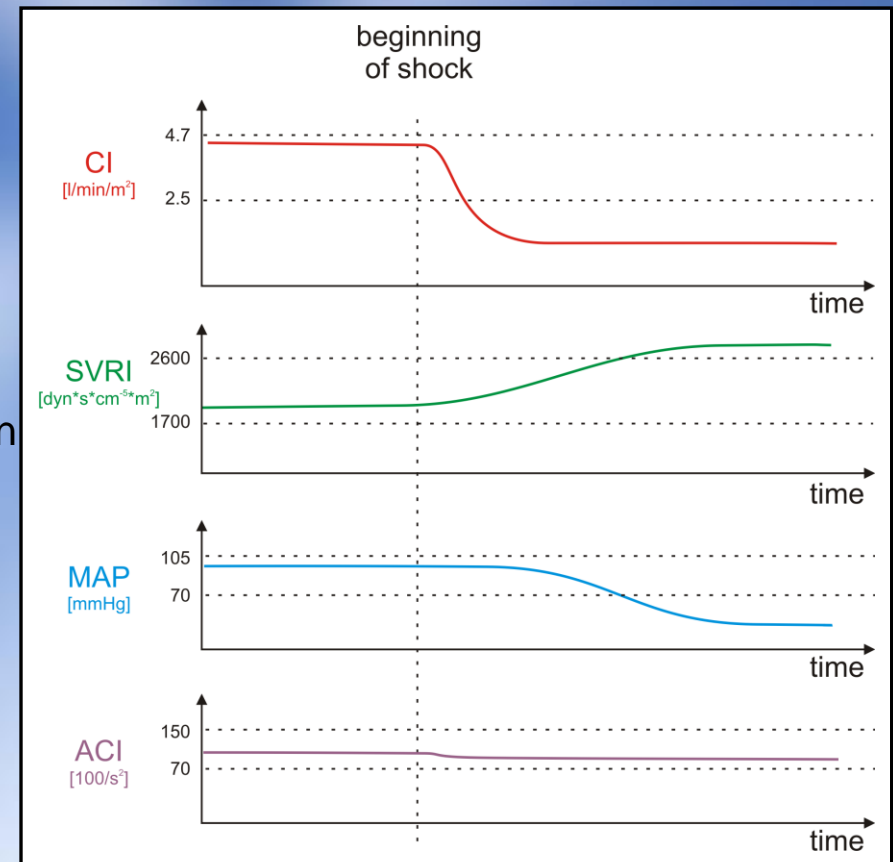
- Pulmonary embolism
- Pneumothorax

Diagnosis:

- Decreased CI
- Increased SVRI due to vasoconstriction
- Decreased blood pressure
- Normal contractility

Therapy:

- Anticoagulation
- Chest tube



Septic Shock

Causes:

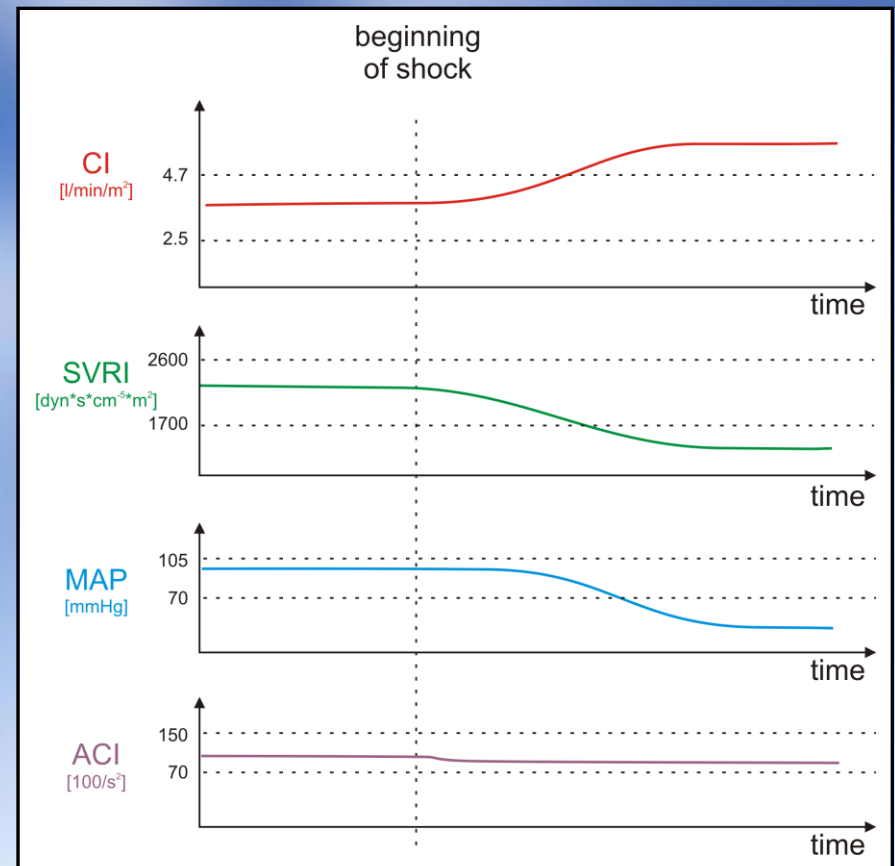
- Systemic infection

Diagnosis:

- Increased CI
- Decreased SVRI
- Decreased blood pressure
- Normal contractility

Therapy:

- Antibiotics



Hypovolemic Shock

Causes:

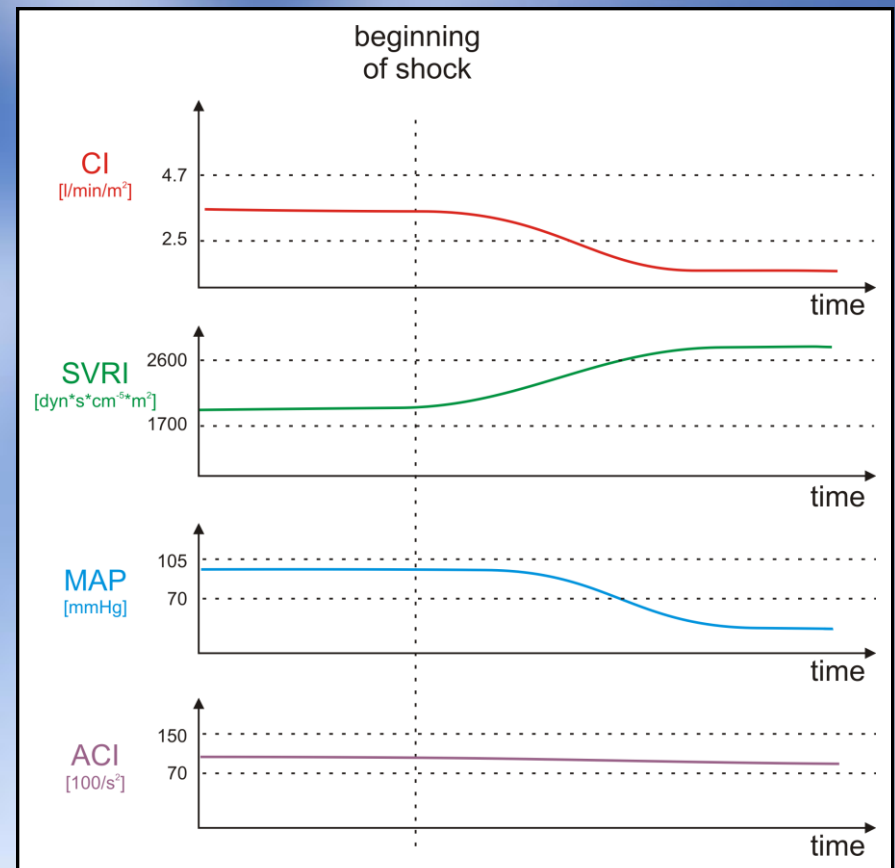
- Internal bleeding
- Traumatic bleeding

Diagnosis:

- Decreased CI
- Increased SVRI
- Decreased blood pressure
- Normal contractility

Therapy:

- Infusions
- Blood transfusions



Pulmonary Oedema

Question

Congestive Heart Failure or Volume Overload?



ICG diagnosis:

- Increased TFC
- Decreased ACI



Congestive Heart Failure



Therapy:

- Catecholamine
- Positive inotropic agents



ICG diagnosis:

- Increased TFC
- Normal ACI
- SWV < 10% during passive leg rising test



Volume Overload



Therapy:

- Diuretics

Dyspnea – Case study

Patient: 81 year old female
History: Hypertension, left ventricular hypertrophy, mitral regurgitation, atrial fibrillation, normal ejection fraction, chronic obstructive pulmonary disease.
Current therapy: Digoxin 0.125 mg qd, ACE inhibitor (Enalapril 5 mg bid).

Visit	Symptoms/ Exam	CI	SI	SVRI	TFC
#1	Rales, rhonchi, shortness of breath HR 76, BP 160/100	2.8	36	3400	23.2

ICG Interpretation: Normal CI, SVRI, and TFC do not indicate decompensated HF or pulmonary edema. Likely cause of symptoms is pulmonary disease.

Decision: Initiate antibiotics, bronchodilator.

Conclusion

Benefit of Impedance Cardiography in ICU and ED:

- Quick, easy haemodynamic assessment in addition to standard parameters
- Fast evaluation of preload responsiveness
- Early detection of changes in the haemodynamic status
- Optimization of medications
- Ideal for long term patient monitoring
- No additional physiological stress for the patient