medis
MEDIZINISCHE MESSTECHNIK GmbH

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:

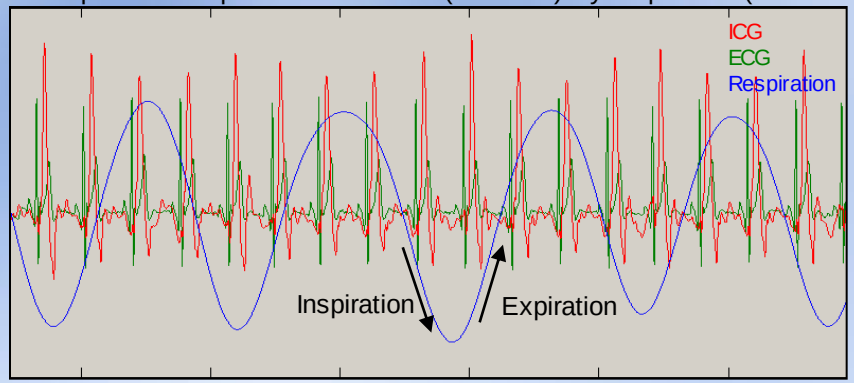
- Heart Rate
- Blood Pressure
- Stroke Volume (SV)

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 ≥ 8cc/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

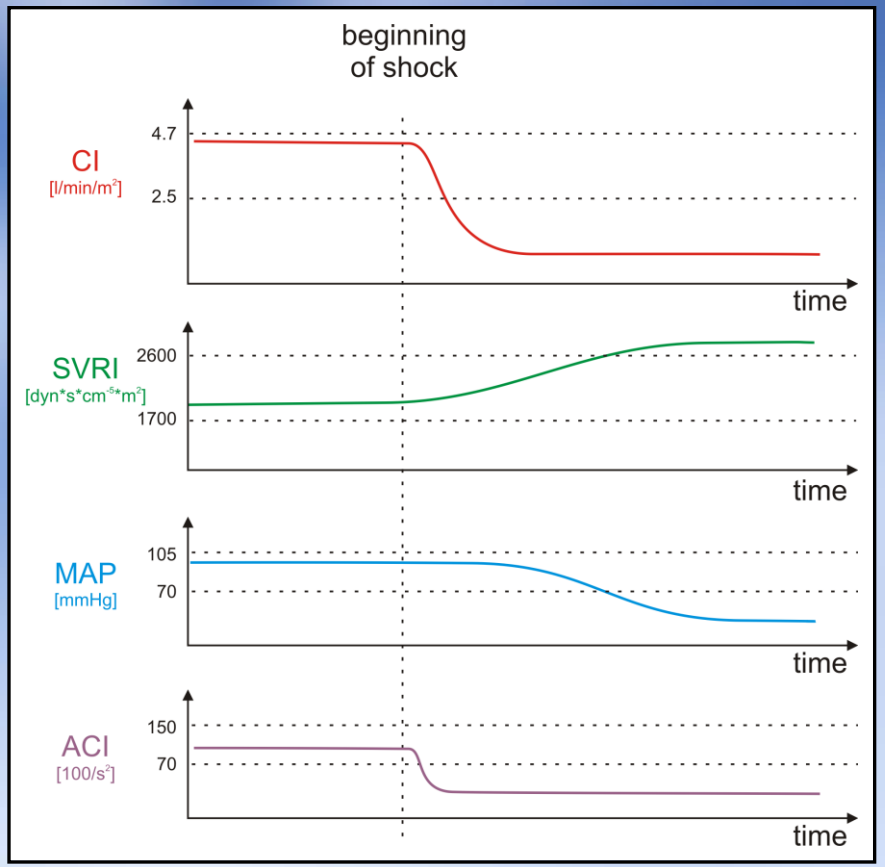
SV change over 15 % → **Fluid responsive**

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



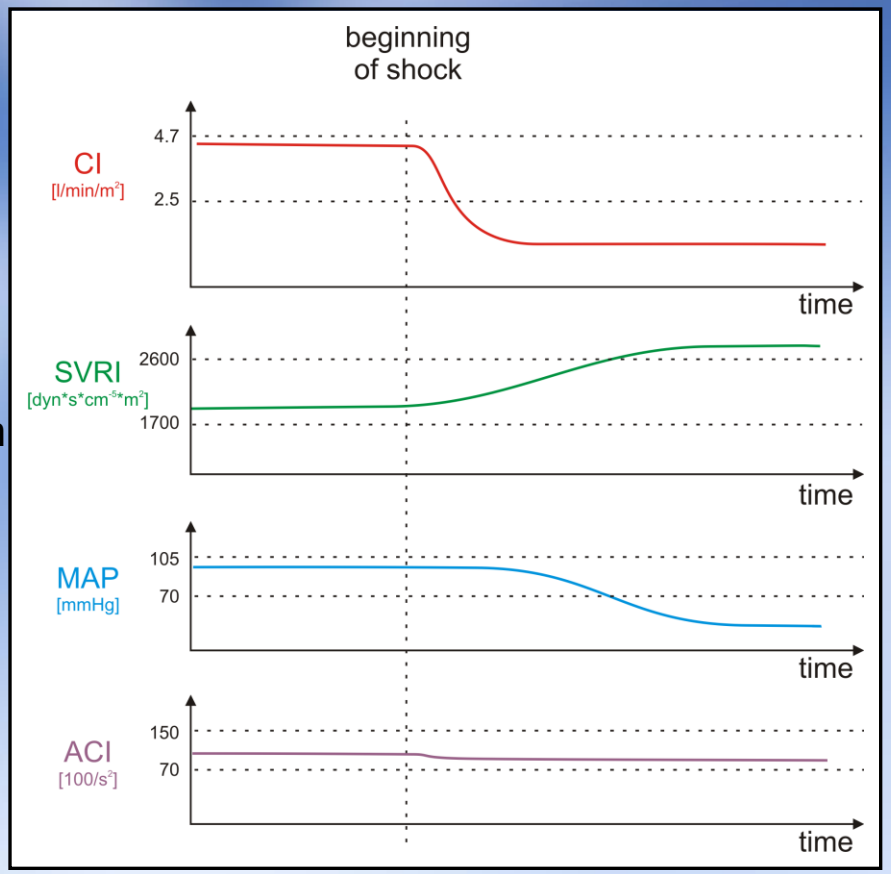
Ramirez, et al. Journal of the American College of Cardiology, 2004;43

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

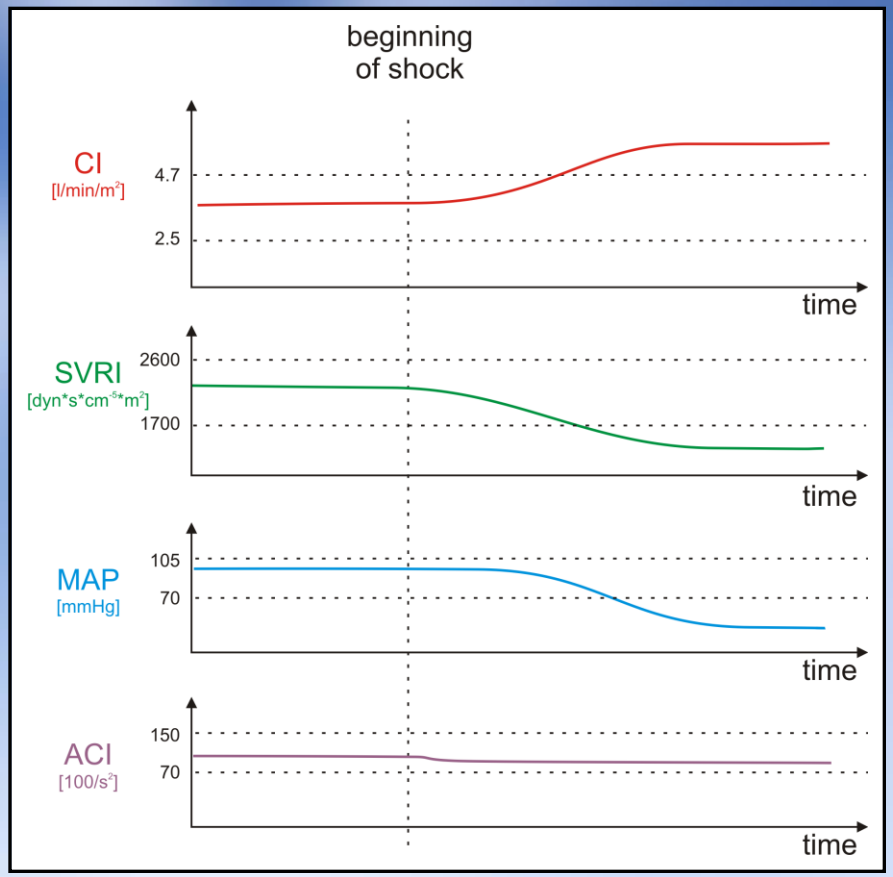


Septic Shock

Causes:
- Systemic infection

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

Therapy:
- Antibiotics



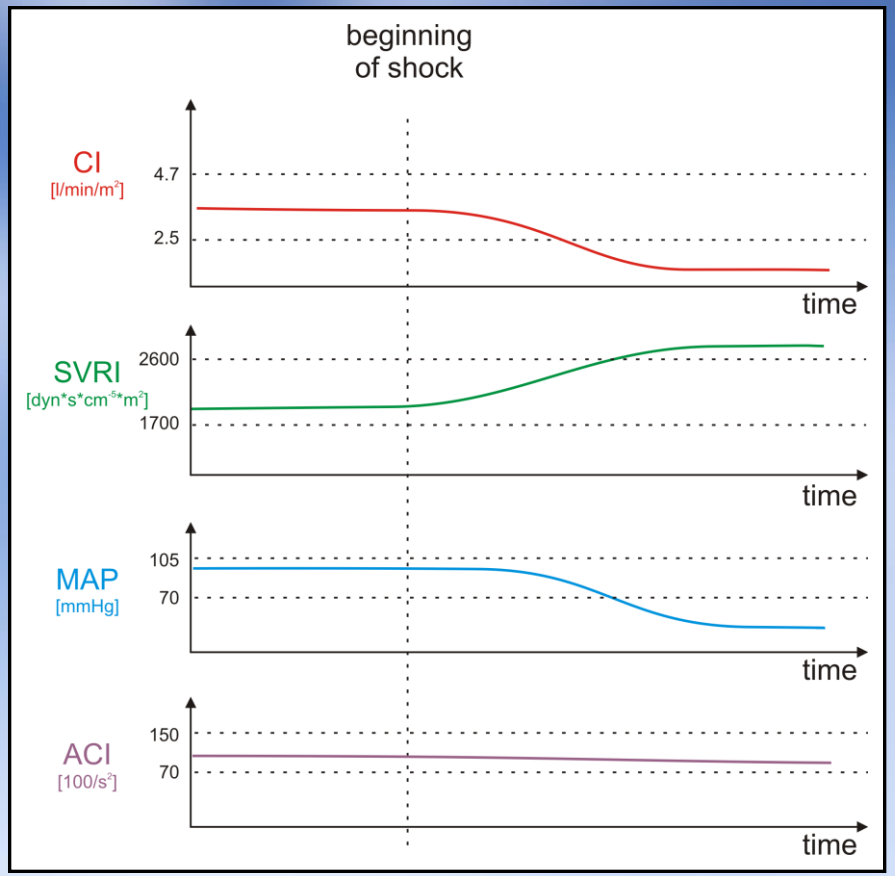
Summers R, et al. EJEM. 1999;6:1-7.

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
- SVV < 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.

From John Strobeck, M.D., The Heart Lung Center, Hawthorne, NJ

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