LUNDS UNIVERSITET

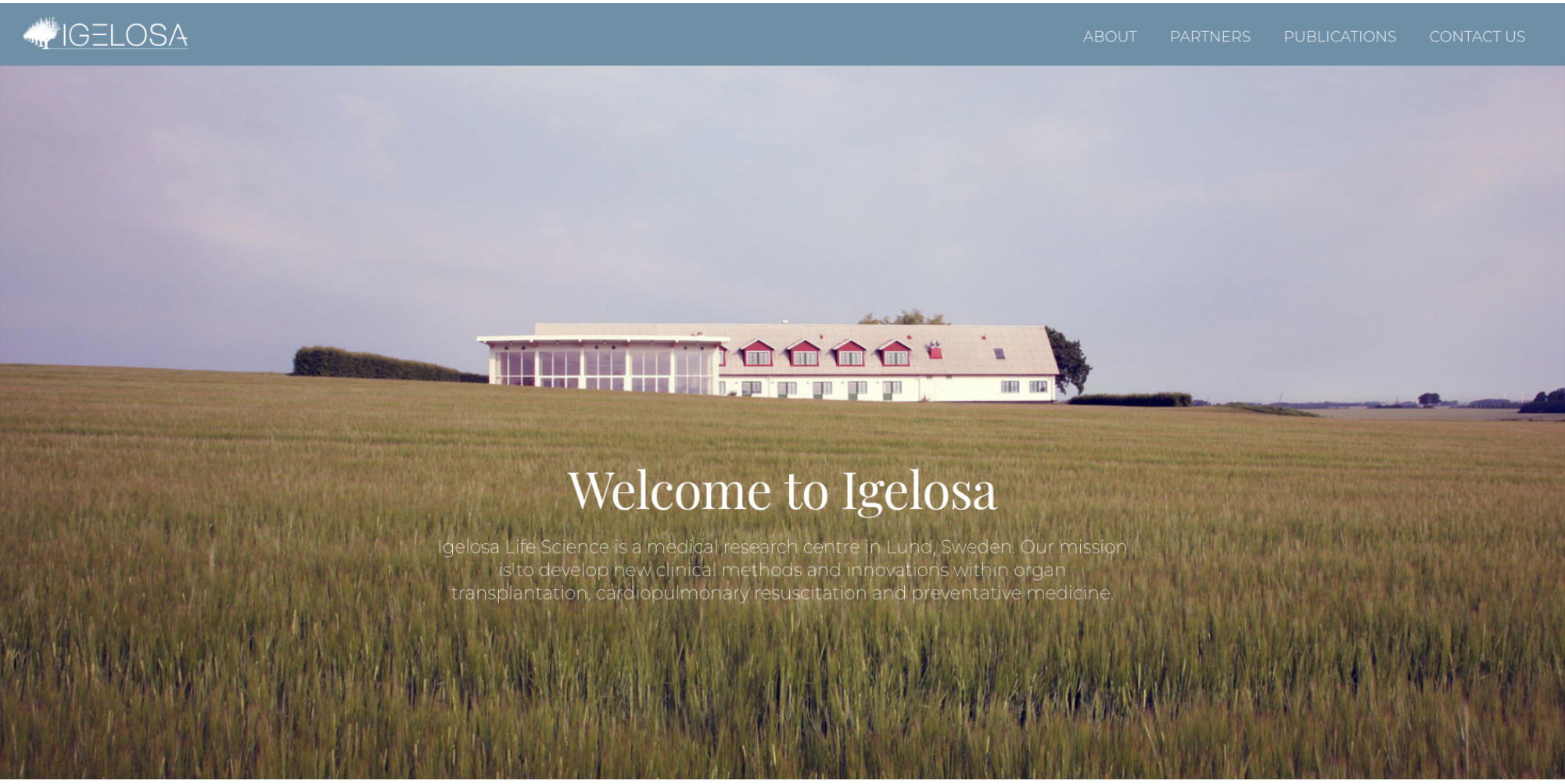
Prevention of stone heart

through hemodynamic control

Ylva Wahlquist

Contents

Igelösa


IGELOSA
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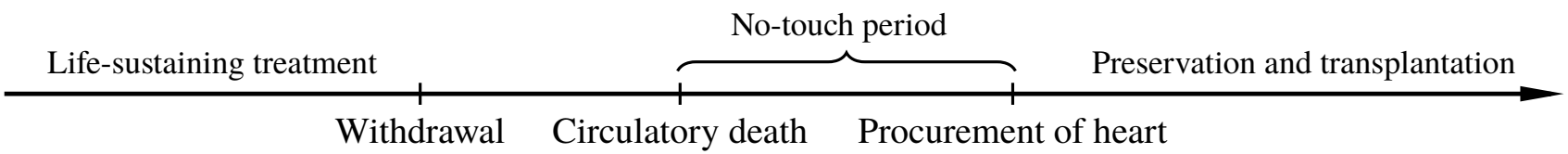
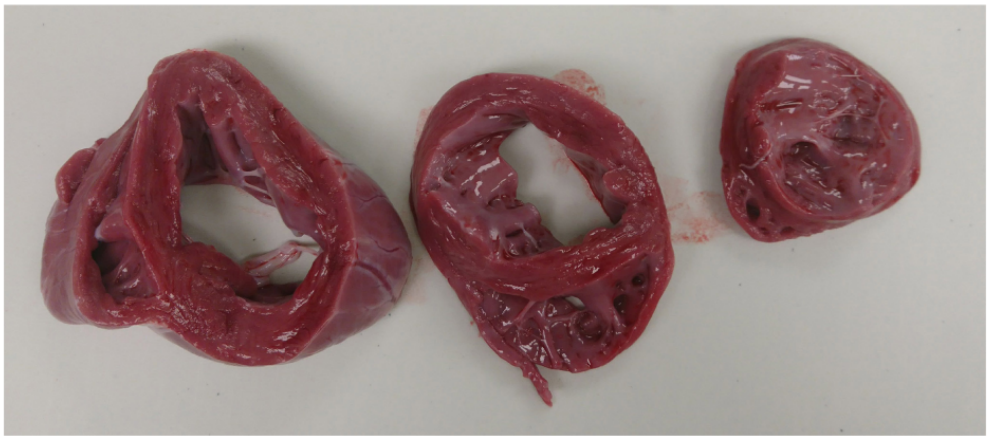
Welcome to Igelosa
Igelosa Life Science is a medical research centre in Lund, Sweden. Our mission is to develop new clinical methods and innovations within organ transplantation, cardiopulmonary resuscitation and preventative medicine.

DCD - donation after circulatory death

- Today, hearts are donated in Sweden only when a patient can be determined brain-death (DBD)
- To increase the number of available hearts, include patients with irreversible brain damage (DCD)
- DCD is allowed in several countries with a no-touch period that varies between 2 min (USA), 5 min (UK) and 20 min (Italy)



Stone heart



(a) Heart in the absence of ischemic myocardial contracture.

(b) Heart with manifested ischemic myocardial contracture.

Project objective

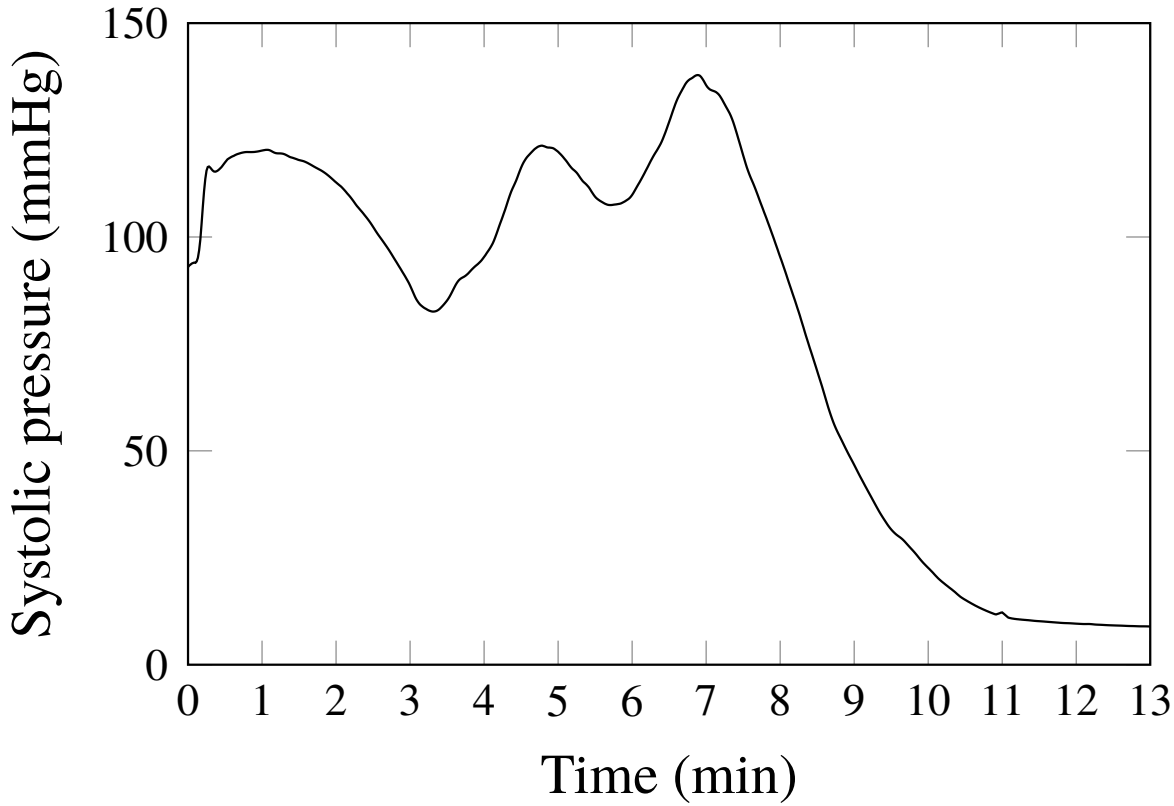
Prevent stone heart for at least 30 min (no-touch) through hemodynamic normalization

How? Limit cardiac work after withdrawal of life support

Example: stone heart case

Idea:

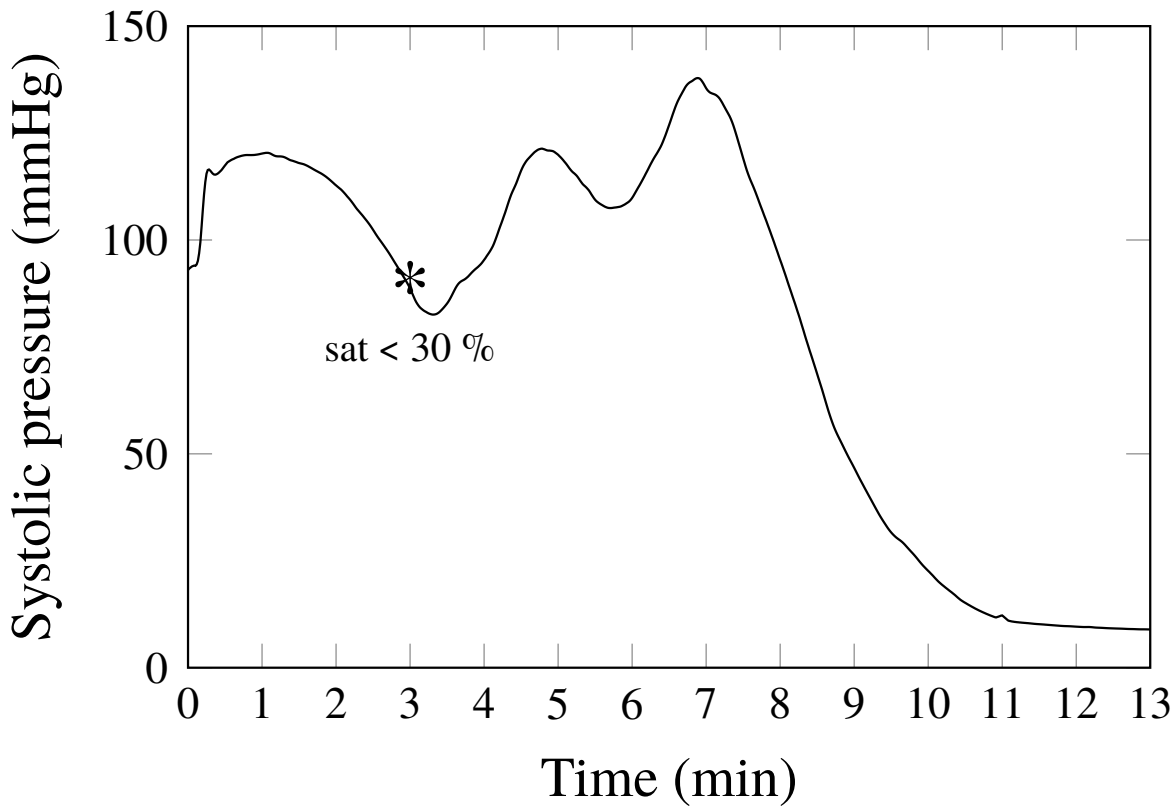
High pressure and high heart rate with no oxygen may be harmful



Example: stone heart case

Idea:

High pressure and high heart rate with no oxygen may be harmful



Setup

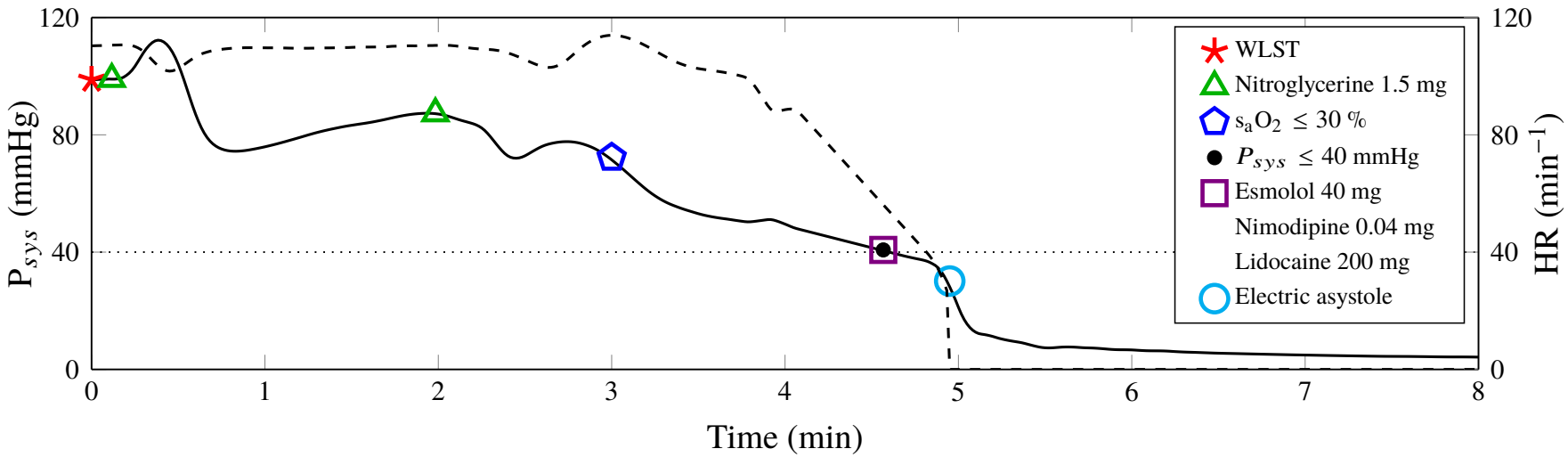
- Blood pressure sensors
- Computer-controlled infusion pumps
- ECG
- Computer running controller and gui
- Blood gas measurements

Hemodynamic control

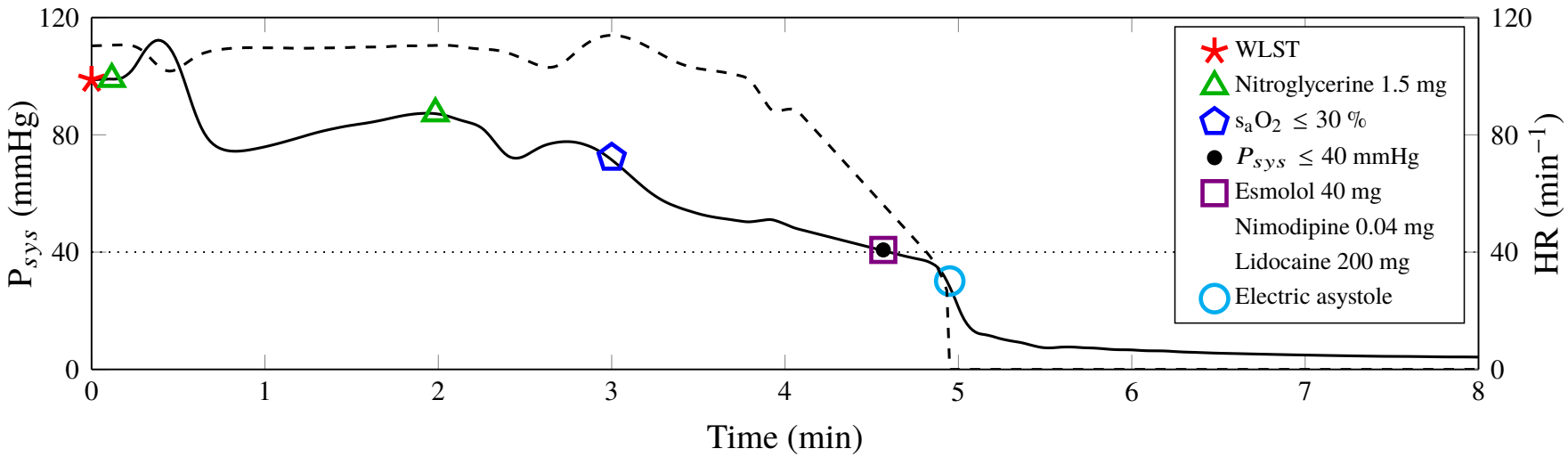
- Blood pressure control in closed-loop
- Control signals: drug infusions
- Nitroglycerine to lower pressure
- In case of overdosing, increase pressure with noradrenaline

Problem: Nitroglycerine resulted in tolerance and tachycardia, ventricular fibrillation
Solution: Add more drugs (slower response)

Example: fully automated case

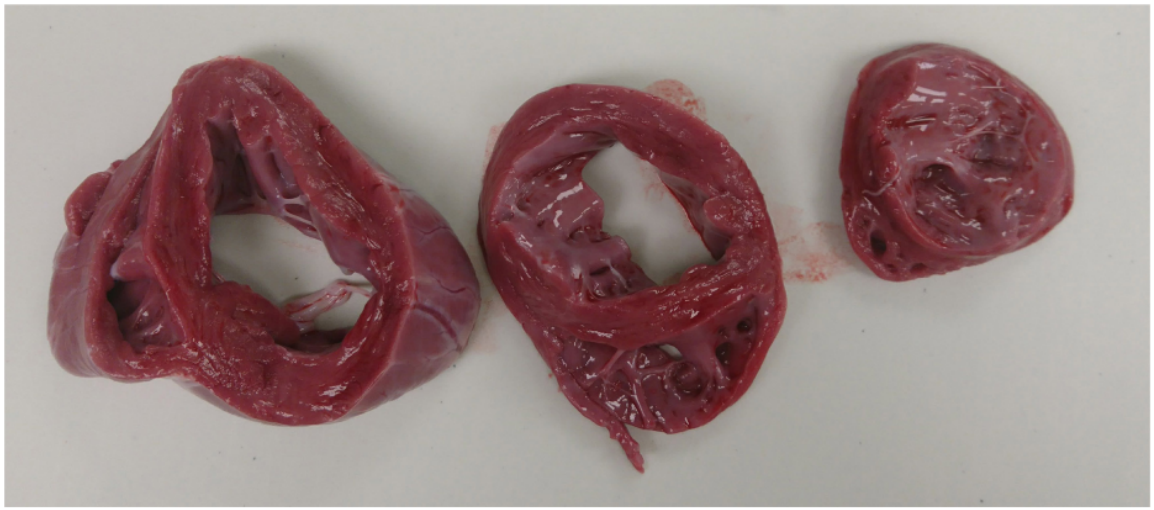


Example: fully automated case



The heart was very soft 1 h after circulatory death

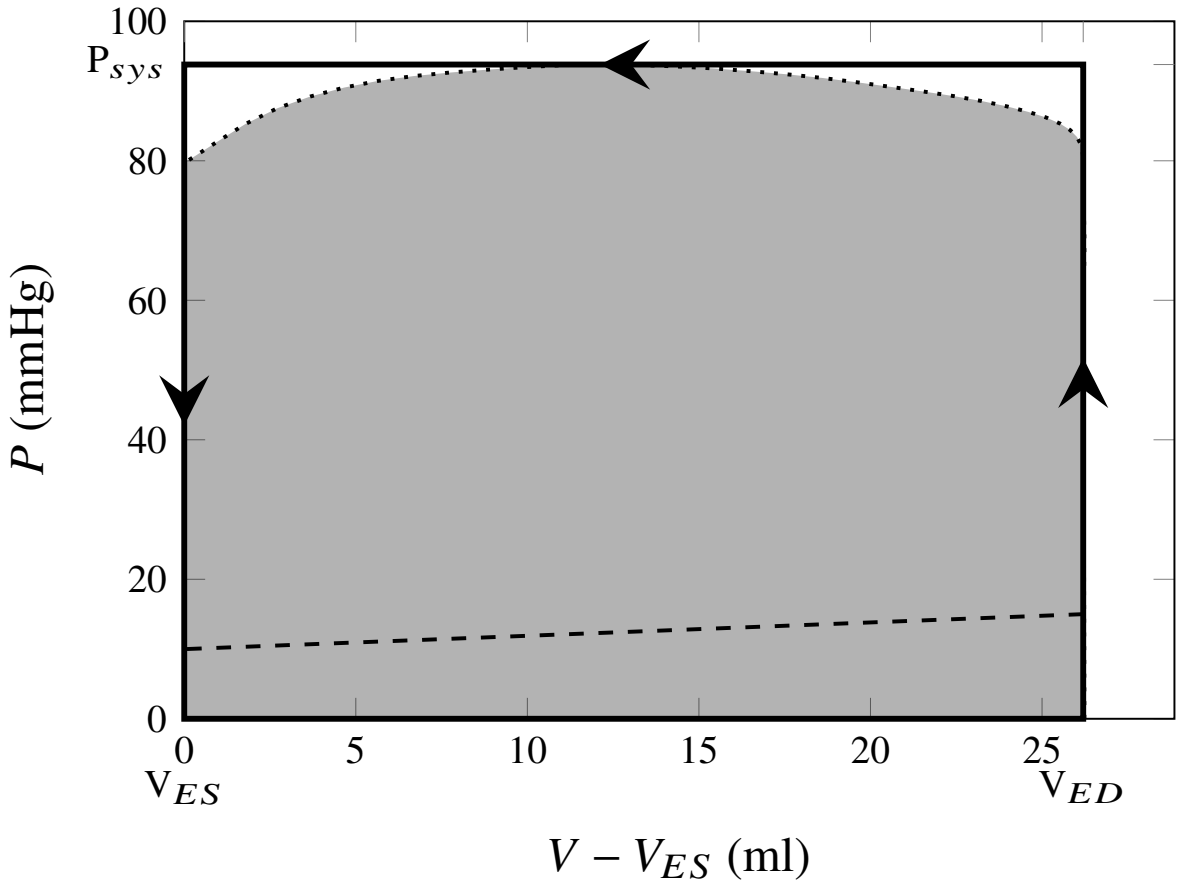
Results



(a) Heart in the absence of ischemic myocardial contracture.

(b) Heart with manifested ischemic myocardial contracture.

Estimation of cardiac work



$$W(V_1, V_2) = -\int_{V_1}^{V_2} P(V)\, dV$$

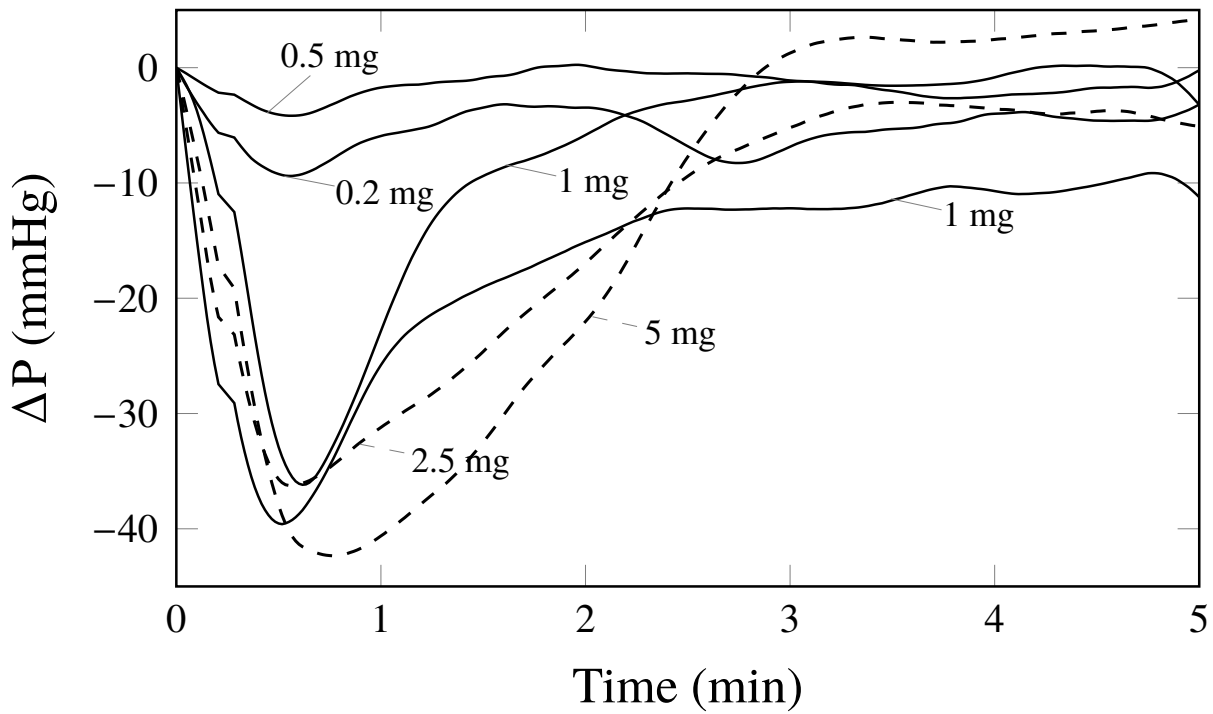
$$\hat{W}_c = P_{sys}\, SV$$

Ongoing and future work

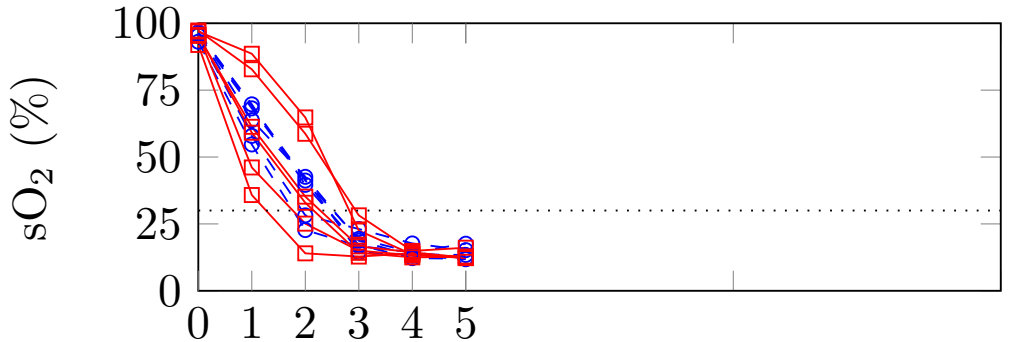
- ATP measurements
- Rewrite software in golang for further integration with Igelösa's software
- Try other drugs for more effective pressure control
- Controlled DCD $\longrightarrow$ preservation $\longrightarrow$ evaluation $\longrightarrow$ preservation $\longrightarrow$ transplantation
- Identifiability of PKPD models

Identifiability of PKPD models

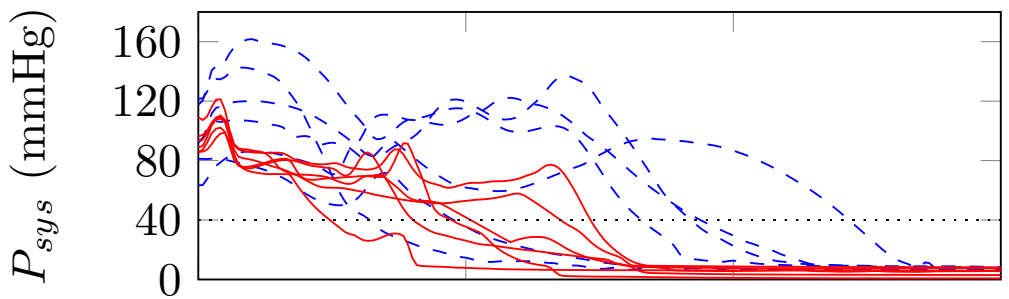
Impulse responses to nitroglycerine



Results



(a) Arterial oxygen saturation.



(b) Systolic aortic pressure.