Development of a new automated Kidney Perfusion System for Organ Conditioning and Function Monitoring

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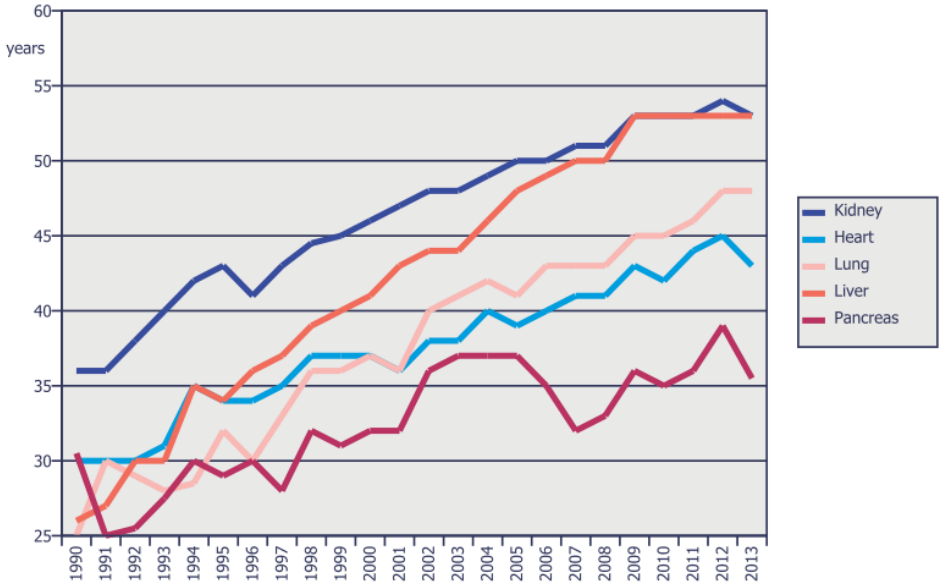
Motivation – Problem & Background

- Eurotransplant Region, 2014
  - Patients on kidney transplant waiting list : 10.689
  - Deceased donor kidneys transplanted : 3.119

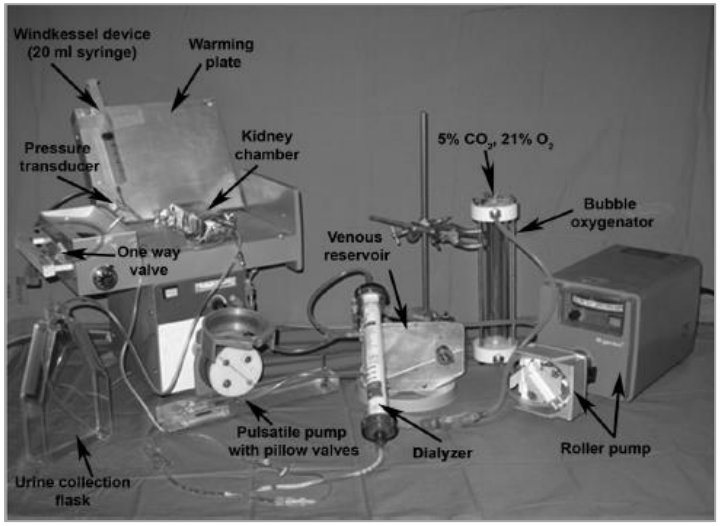
- Actual Trend:
  - Marginal kidney grafts
  - Older donors
  - Extended criteria donors



- Intensification
  - Reperfusion injury after static cold storage (SCS)

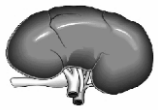
Motivation – Possible Solution

- Static cold storage is not enough
- Need for
  - Organ Reconditioning
  - Test for Graft Function
- Possible Solution:
  - Warm machine perfusion of kidneys
- No commercial system available
- Use of individual complex ECLS-Settings
- No standardized, easy to use System or Setup



Perfusion System - Demands

Storage shell & canulation



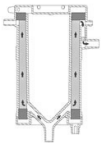
Perfusate

Perfusate

Physiological supply of the organ for the improvement and maintainance of organs functionality

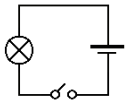
Heating

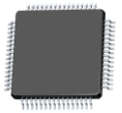
Oxygenation



Sensor technology

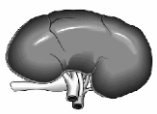
Monitoring of the grafts function and automation of the ex-vivo Perfusion





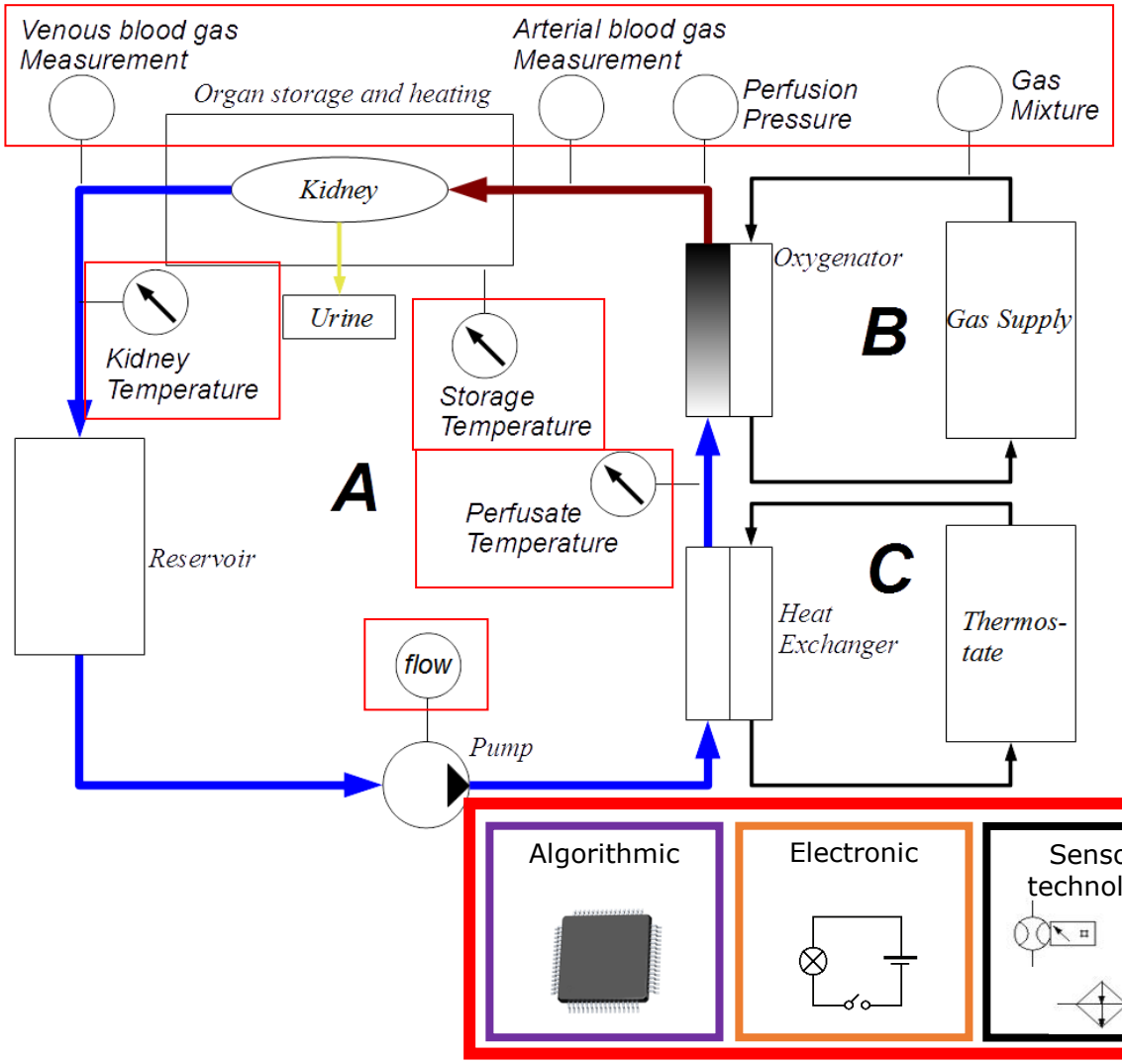
Perfusion System – Modular Topology

Storage shell & canulation

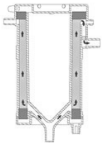


Perfusate

Perfusate circulation

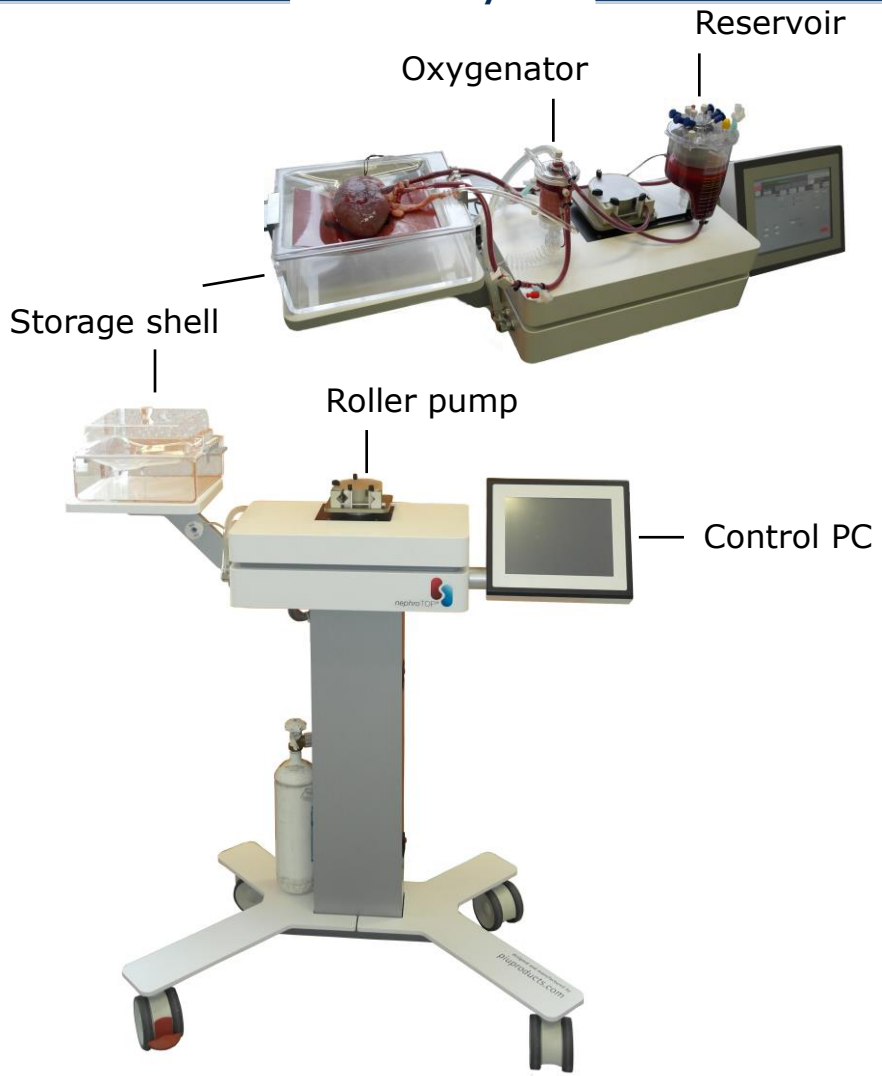


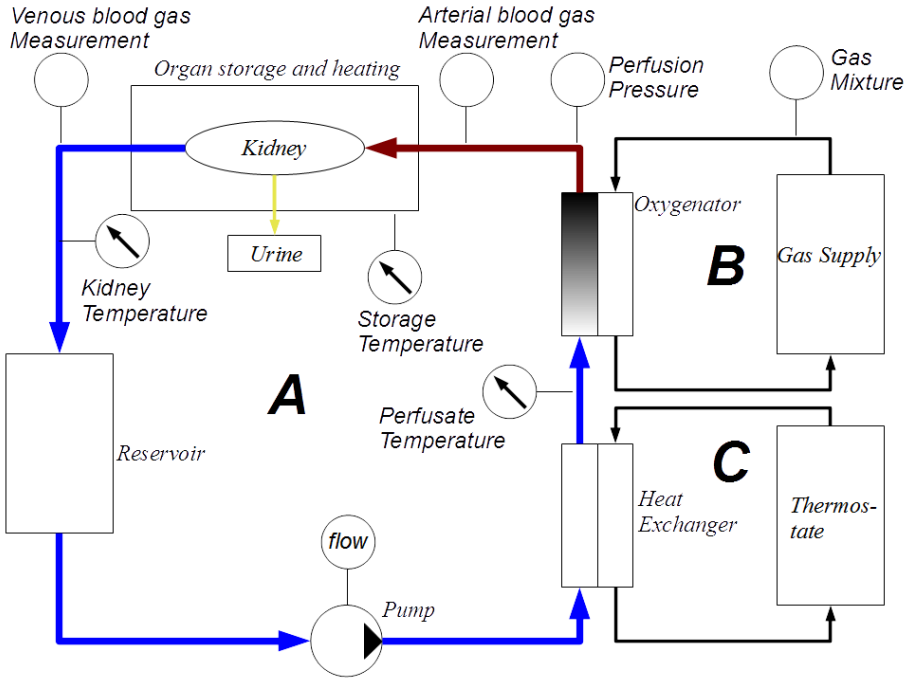
Oxygenation



Heating

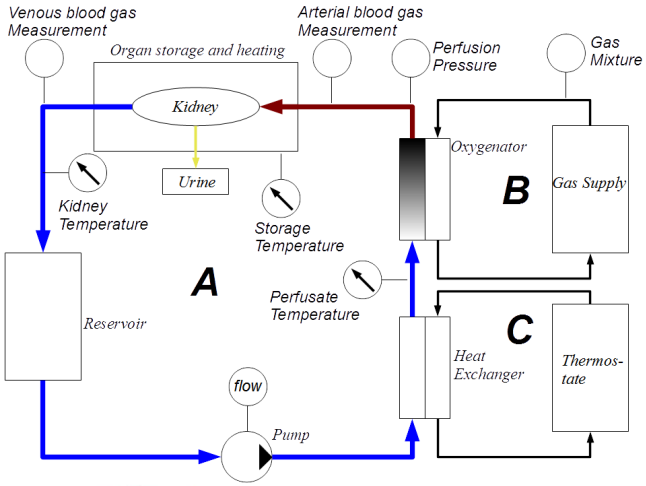
Perfusion System - Prototype





Perfusion System – Automation of Modules

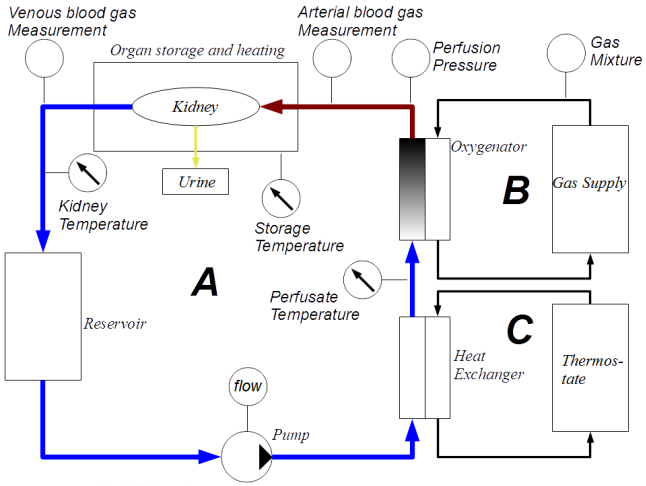
- Automation of subprocesses
  - Focus on safety & robustness
  - Easier to use
  - Faster to learn
  - Better results
- Cascaded control of temperatures
  - Kidney temperature
  - Range: ambient temp. – 38°C
- Roller Pump is flow source
  - Range: 20 – 500 ml/min



Perfusion System – Automation of Modules

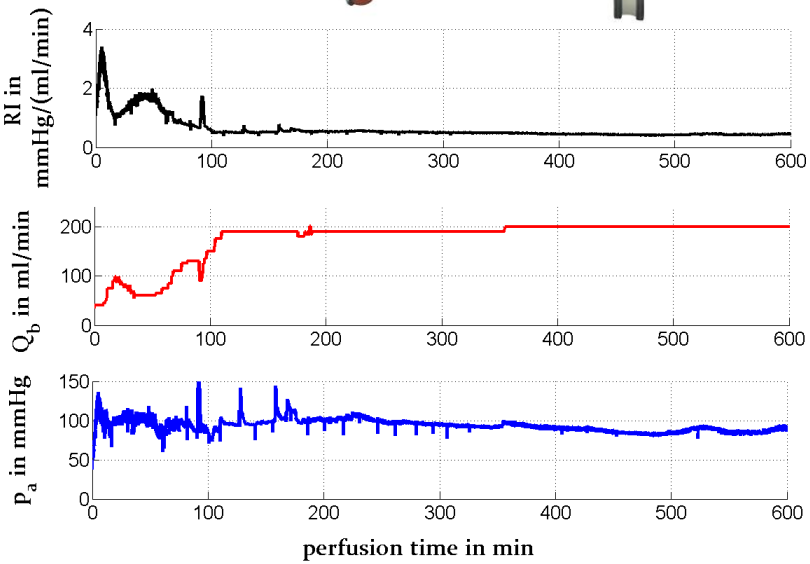
- Control of arterial perfusion pressure
  - Changing kidney resistances
    - ➢ Automatic adaption of flow
  - Respecting vascular compliance
  - Range: 0 – 180 mmHg

- Control of arterial oxygen and carbon dioxide partial pressures
  - Combination with Terumo - CDI500 for active control
  - Passive gas supply with gas mixer possible (without CDI)
  - Ranges:
    - ➢ O2: 40 – 500 mmHg
    - ➢ CO2: 20 – 500 mmHg



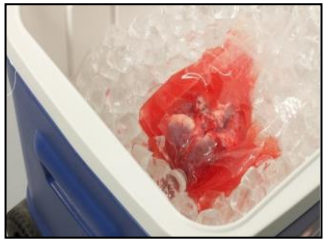
Perfusion System – Process Monitoring

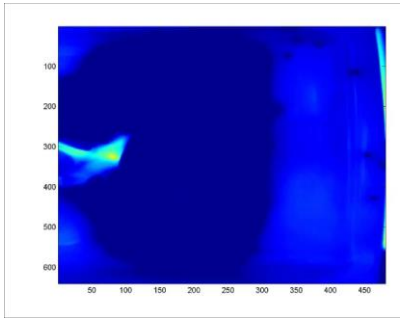
- Central monitoring and data logging
- Hemodynamic parameters
  - Perfusion pressure
  - Flow
  - Resistance
- Temperatures
  - Kidney, perfusate, heater
- Blood gas analysis
  - O_2- & CO_2-partial pressures
  - pH
  - Hematocrit



Methods – Experimental Procedure

Organ retrieval → Initial flush → Storage on ice → Vessel cannulation → **NMP**



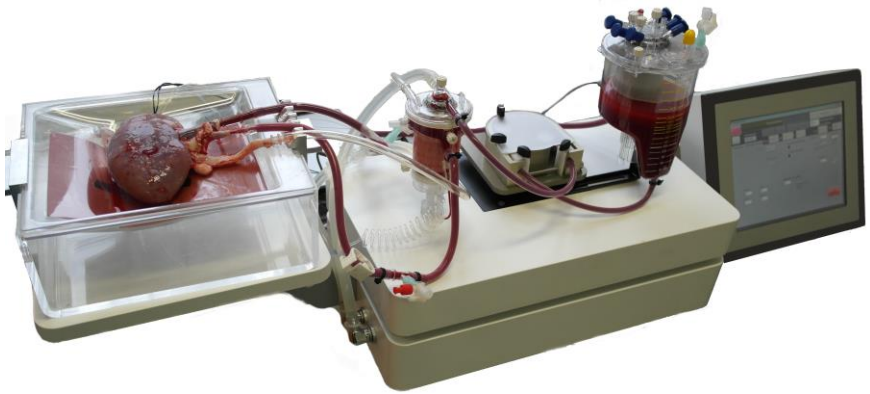


Results – Achievements and Future Work

- Successful system validation
- Use during 22 kidney perfusion experiments
- Further Aims:
  - Kidney evaluation based on
    - Hemodynamic parameters
    - Autoregulatory behaviour
    - Optical parameters
    - Spectrometric measurements
    - Biomarkers
  - Design of organ storage
    - Avoid loss of perfusate
    - Guarantee adequate perfusion

Summary

- Design of a standard system for warm machine perfusion of isolated kidneys
- Automation of the process
- Central process monitoring
- Base for further establishment of organ perfusion!



Thank you!

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