

A. Buschiazzi¹, N. Patou Parvedy², T. Kerforne³, A. Mansour², J. Guihaire⁴, G. Dehery⁵, A. Parasido⁵, N. Nessler², E. Flecher¹

(1) Department of Thoracic and Cardiovascular Surgery, Pontchaillou, University Hospital of Rennes, Rennes, France. (2) Department of Anesthesia and Critical Care, Pontchaillou, University Hospital of Rennes, Rennes, France. (3) Department of Anesthesia and Critical Care, University Hospital of Poitiers, Poitiers, France. (4) Department of Cardiac Surgery, Marie Lannelongue Hospital, Le Plessis Robinson, France. (5) Department of Thoracic and Cardiovascular Surgery – Perfusion unit, Pontchaillou, University Hospital of Rennes, Rennes, France

Introduction

Heart transplantation is limited by donor scarcity, short cold storage times, and the risk of primary graft dysfunction (PGD)₁. **Normothermic ex vivo heart perfusion (NEVHP)** offers a way to **reduce ischemia-reperfusion injury**, **extend preservation**, and include **marginal or DCD donors**₂.

However, current graft evaluation mainly relies on lactate clearance, overlooking key biological responses. Artificial surfaces and non-physiological flow in NEVHP circuits can trigger inflammation and endothelial activation—both central to PGD. A pilot study at Rennes University Hospital using brain-dead porcine donors revealed significant inflammatory and endothelial responses during perfusion.

To investigate these mechanisms further and develop a more accessible research platform, we built a translational porcine NEVHP model using a pulsatile ECMO (MEDOS) system and a repurposed OCS™ Heart kit.

Material & Methods

Seven porcine hearts were retrieved following a beating-heart protocol. After 2 hours of cold storage, grafts were perfused for 4 hours using a **homemade NEVHP circuit** combining a **pulsatile MEDOS ECMO console** and a **repurposed OCS™ Heart kit**. The circuit was primed with autologous blood, heparin, and a nutrient solution (corticoids and vitamins). Perfusion followed clinical and OCS™ standards, maintaining **coronary flow at 650–850 mL/min**. **Lactate levels** were collected at baseline, 10 minutes post-connection, and every 30 minutes

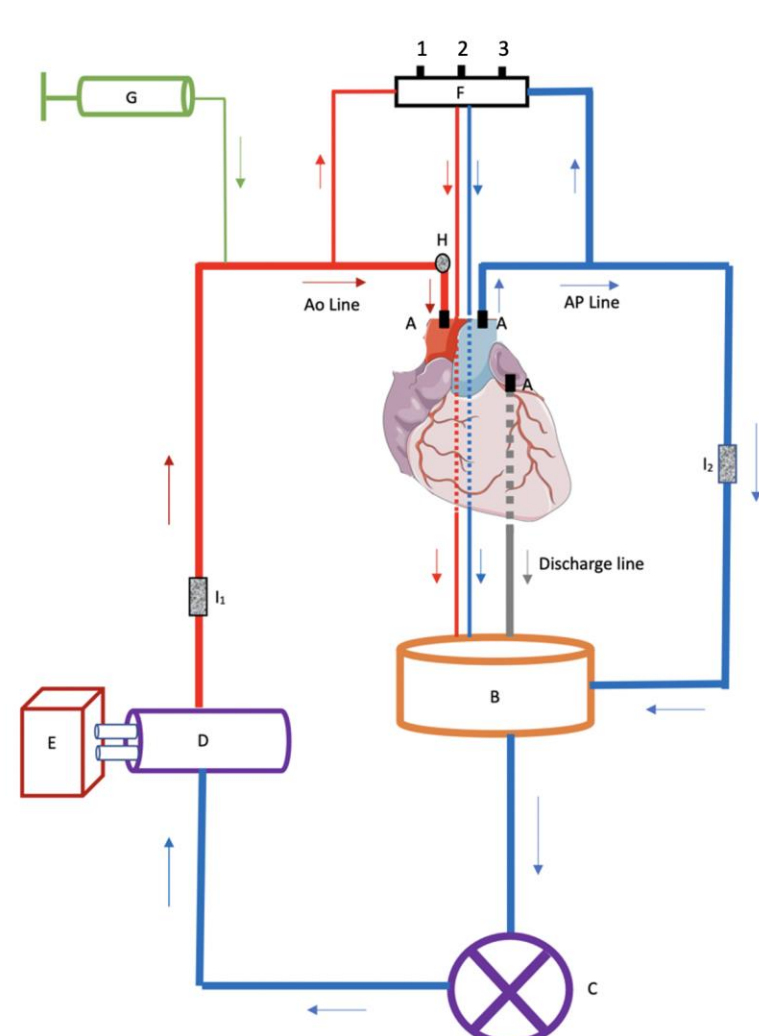


Figure 1. Diagram of the normothermic ex vivo heart perfusion circuit. (A) Secured cannula; (B) Blood reservoir; (C) Pump; (D) Membrane oxygenator; (E) Heat exchanger; (F) Sampling site (1) arterial sampling site (2) injection site (3) venous sampling site; (G) Perfusion pump; (H) Arterial pressure sensor; (I1) Aortic flow sensor; (I2) Coronary flow sensor.

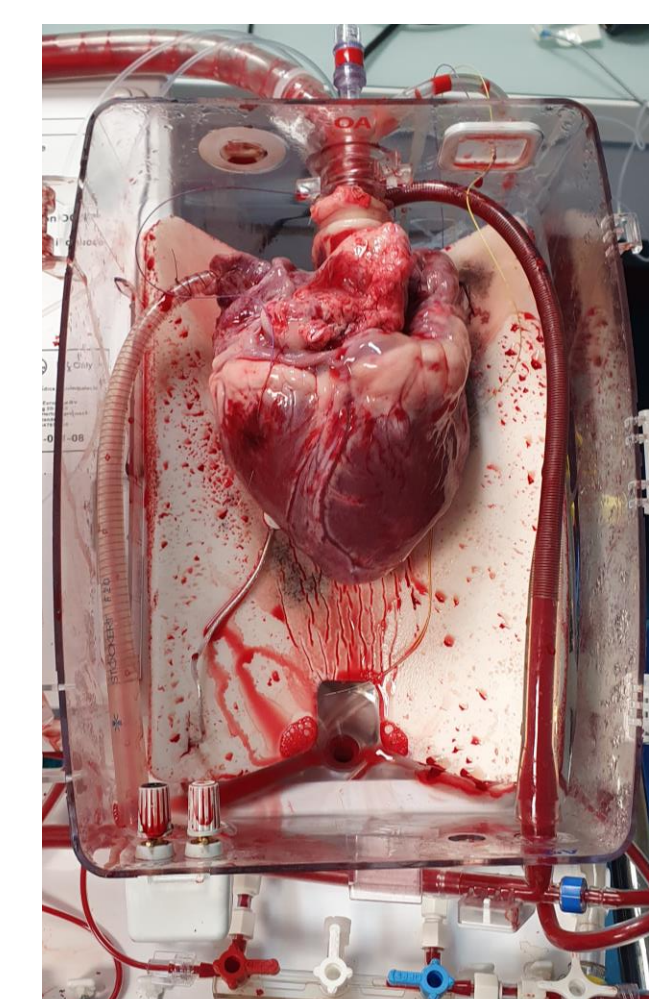


Figure 2 (left) et 3 (right). Homemade NEVHP set-up. Left - Homemade ex vivo heart perfusion circuit composed of a repurposed OCS™ console (right) and a pulsatile MEDOS ECMO pump/oxygenator (left). Right - OCS™ console with porcine heart

Results

All perfusions were hemodynamically stable, with consistent myocardial reanimation confirmed by a mean coronary flow of 710 ± 180 mL/min (Fig. 3). Arterial lactate levels (Fig. 4) significantly decreased from $4.45 [3.27–5.11]$ mmol/L at T₁₀ to $2.12 [1.59–3.35]$ mmol/L at 4 hours, indicating effective metabolic recovery.

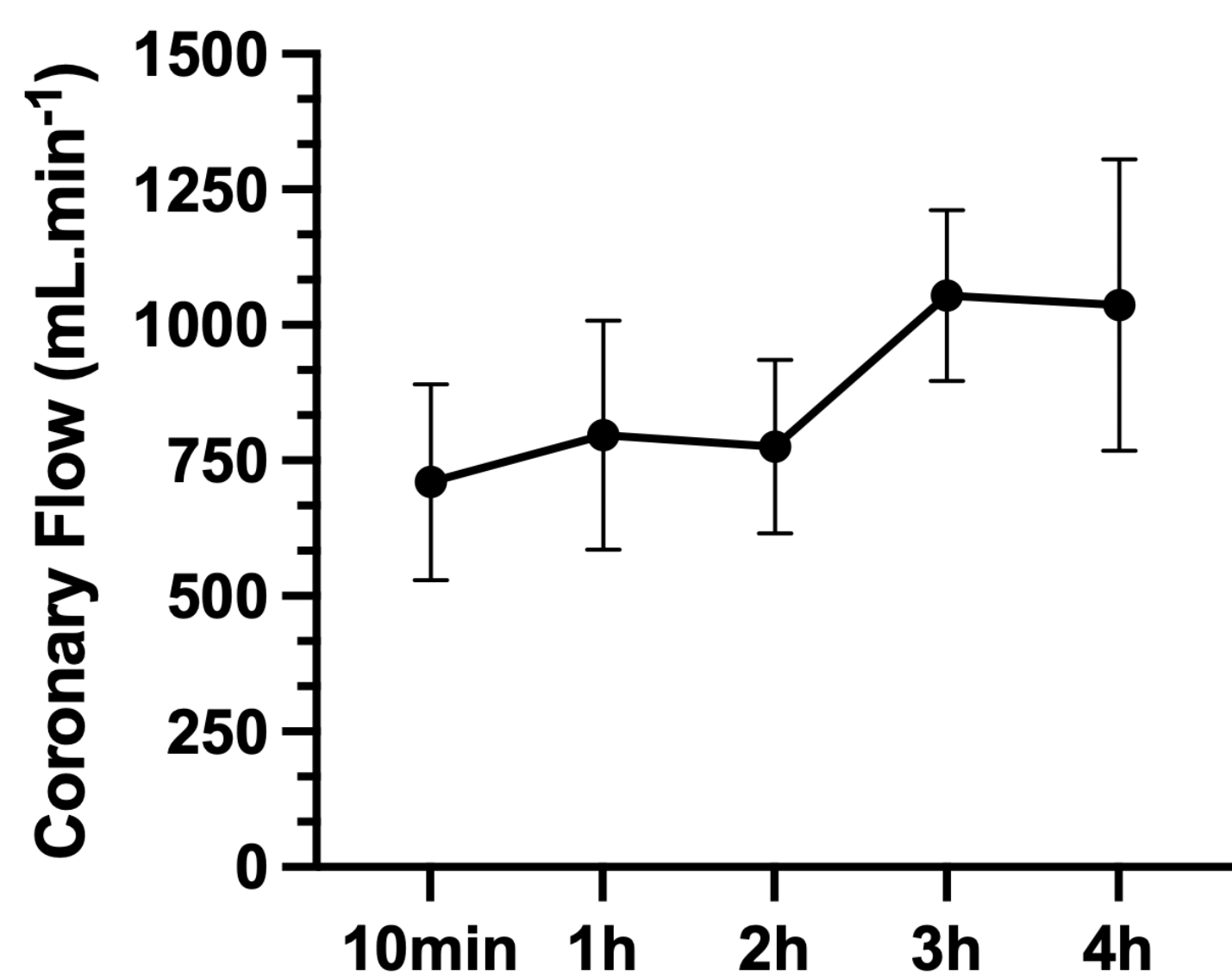


Figure 3. Coronary flow dynamics during NEVHP. Results are expressed in ml/min at T_{10mn} and every hour

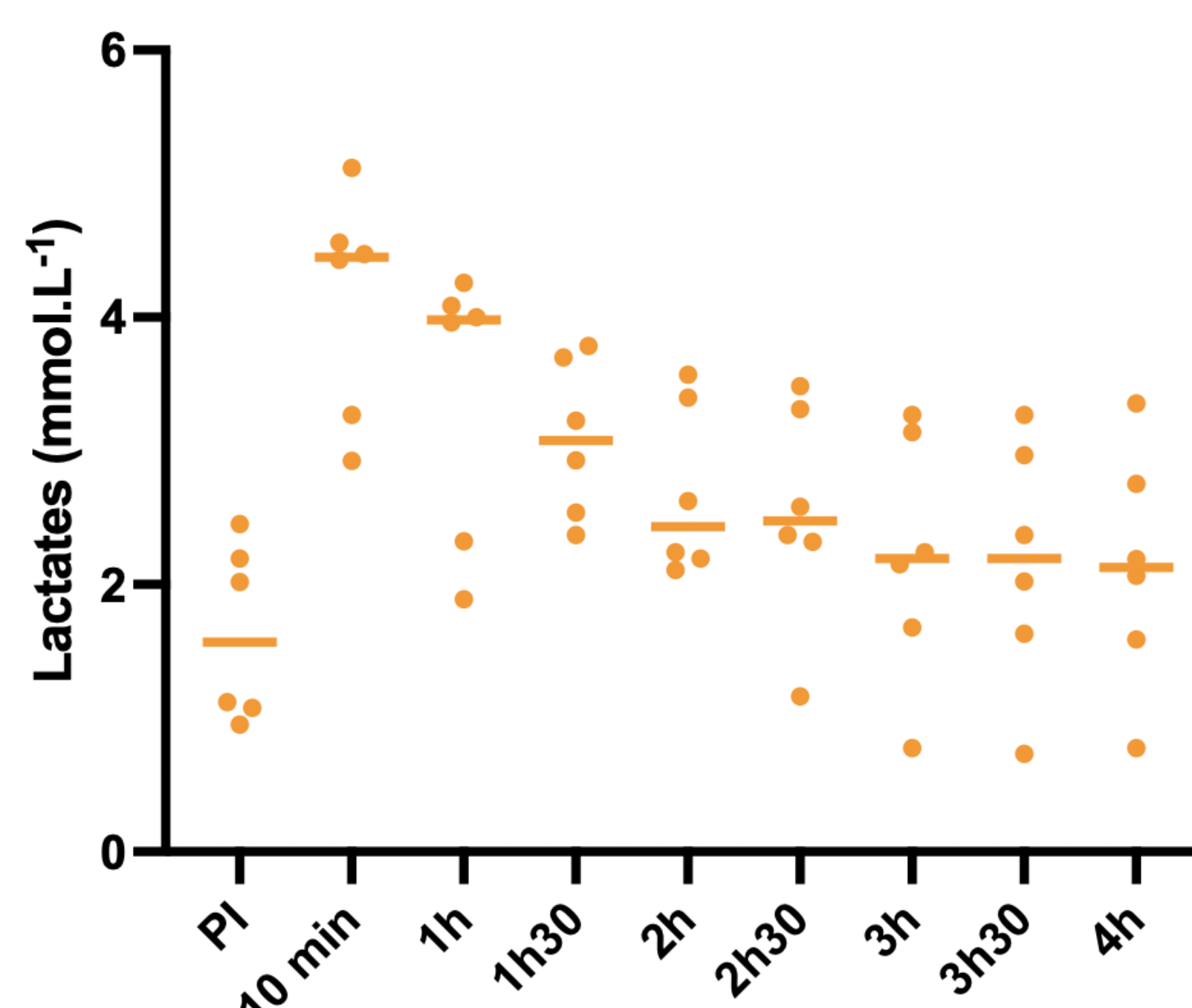


Figure 4. Trend in lactate concentration during NEVHP. Results are expressed in mmol/L at T_{10mn} and every 30min.

Conclusion

This low-cost, homemade ex vivo perfusion system combines a pulsatile MEDOS ECMO console with a repurposed OCS™ Heart kit to create a **clinically relevant** and **flexible platform** for porcine heart graft evaluation. Consistent coronary flow and a significant decrease in arterial lactate confirm **effective myocardial resuscitation**, validating the physiological robustness of this beating-heart model. The setup enables both functional and biological assessment under near-clinical conditions. Its affordability and reproducibility make it a valuable tool for translational research, perfusion strategy development, and surgical training—particularly in the context of marginal or DCD donor grafts.