

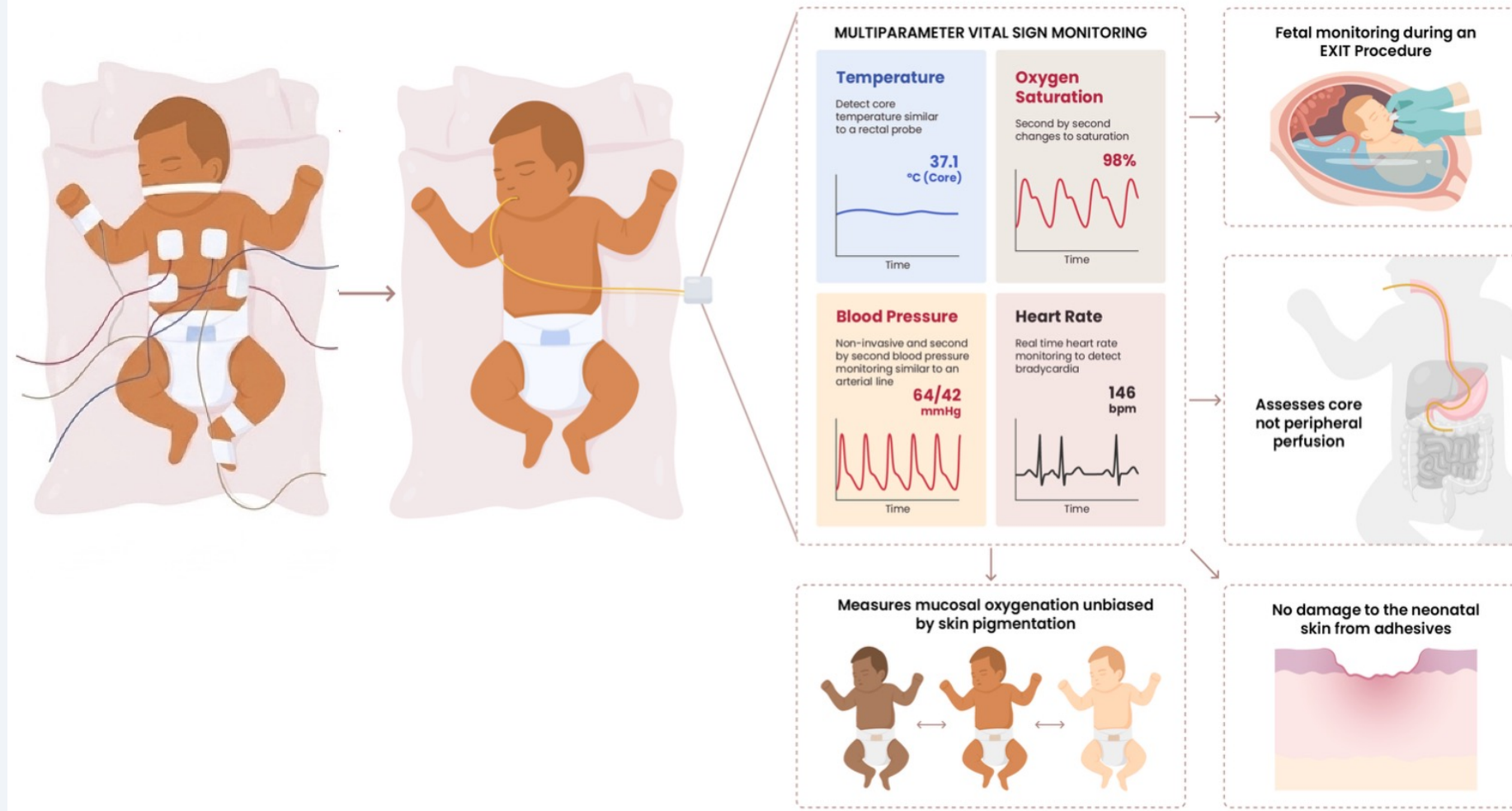
A Multiparameter Probe for Premature Infant Core Physiologic Monitoring (PreMo)

Liesman DR, Zhou J, Papastefan ST, Wang H, Chen C, Wales M, Dicks A, Ott KC, Redden CR, Li Y, Yu L, Xu Z, Wu M, Bai H, Premkumar A, Sammet S, Alhajjat AM, Rogers JA, Shaaban AF

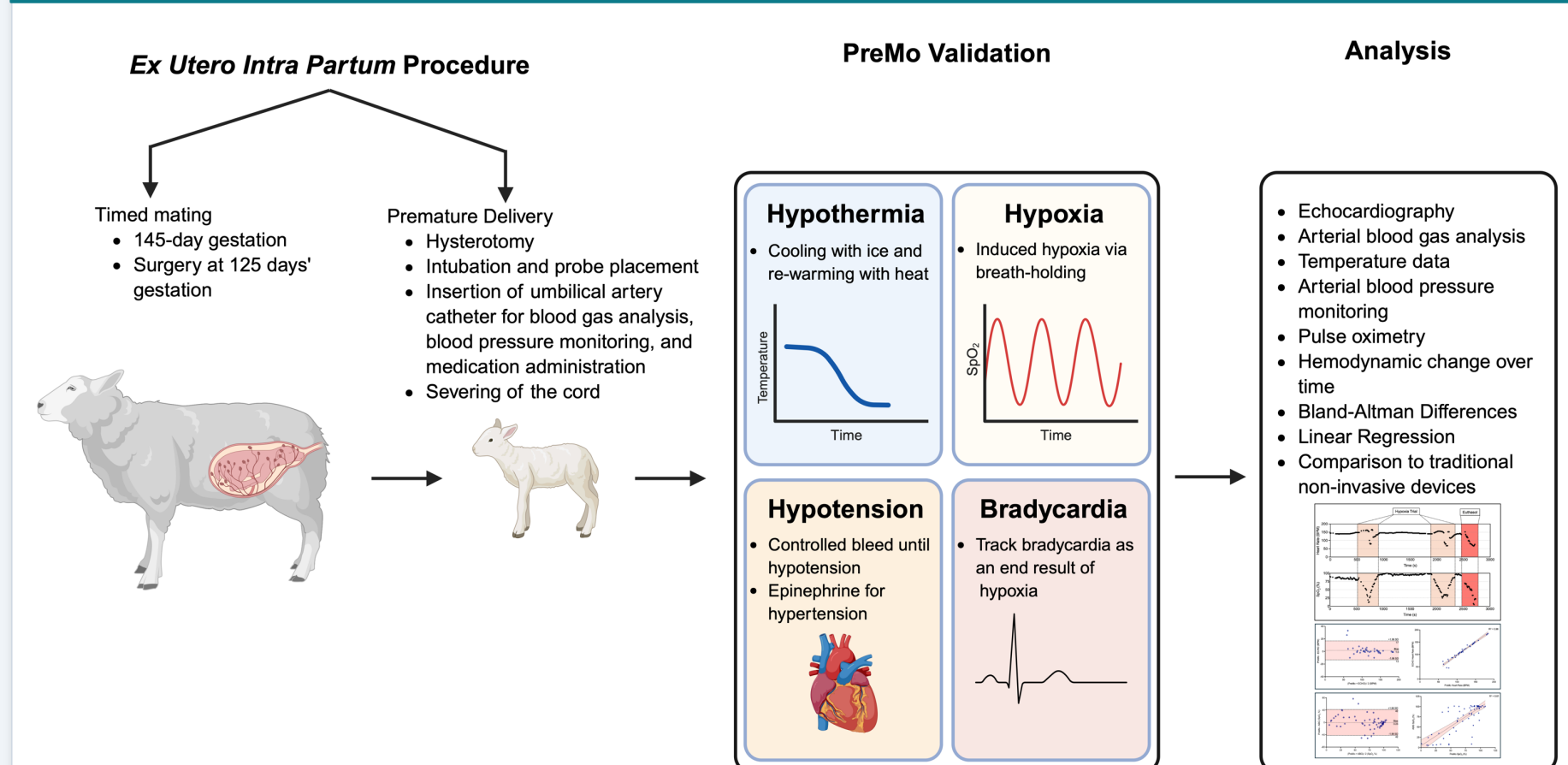
BACKGROUND

Conventional premature infant monitoring devices fail in hemodynamic extremis because they largely rely on peripheral perfusion. To bridge this gap, we designed a multiparameter monitoring probe that can be affixed to a nasogastric tube and inserted in the rectum or the esophagus. The probe, entitled PreMo, is fitted with an IR and red-light spectrometer and thermistor to provide continuous measurements of heart rate, oxygen saturation, blood pressure, and temperature. We sought to validate PreMo's ability to continuously track core physiology in a series of experiments on preterm lambs using gold standard comparisons.

THE PROBLEM AND PREMO'S POTENTIAL



METHODS



RESULTS

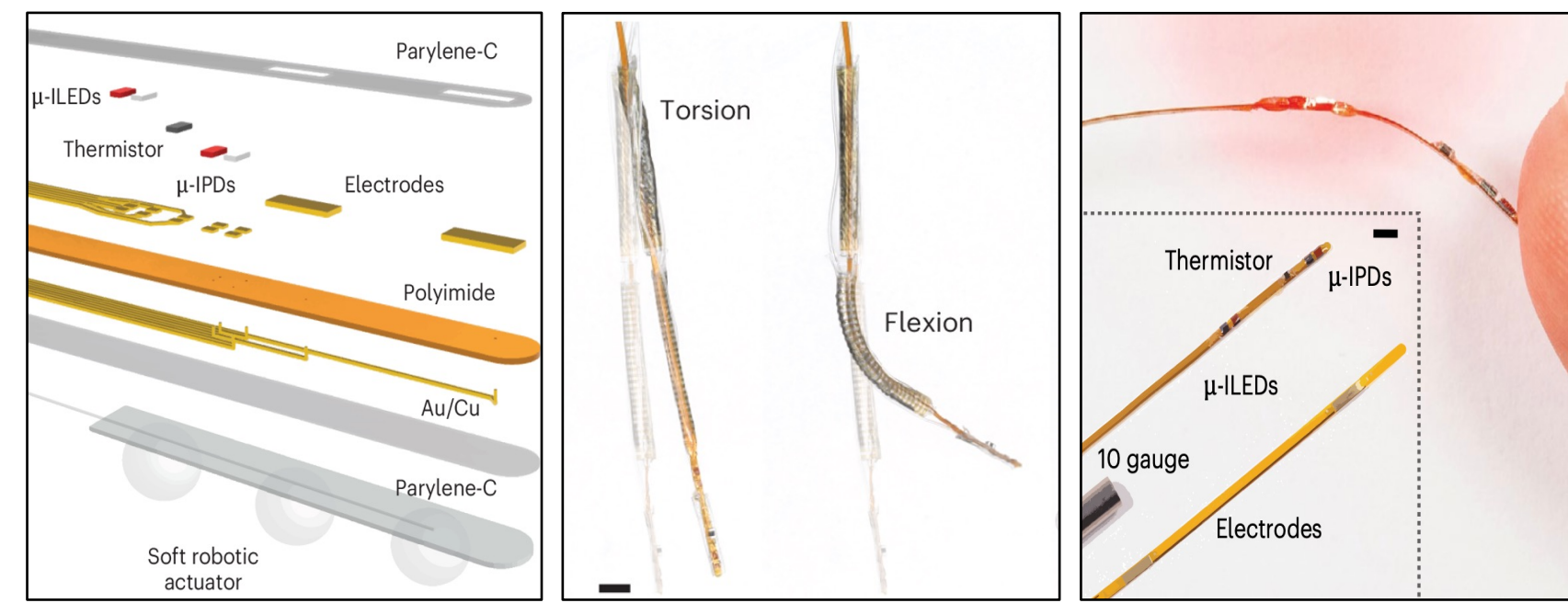


Figure 1. The construction of the PreMo probes with micro-electronics to allow for placement in the preterm infant esophagus and rectum. The probe is capable of torsion and flexion which are initiated by multimodal soft robotic actuators and can fit through a 10g needle and be affixed to a nasogastric tube for deployment.

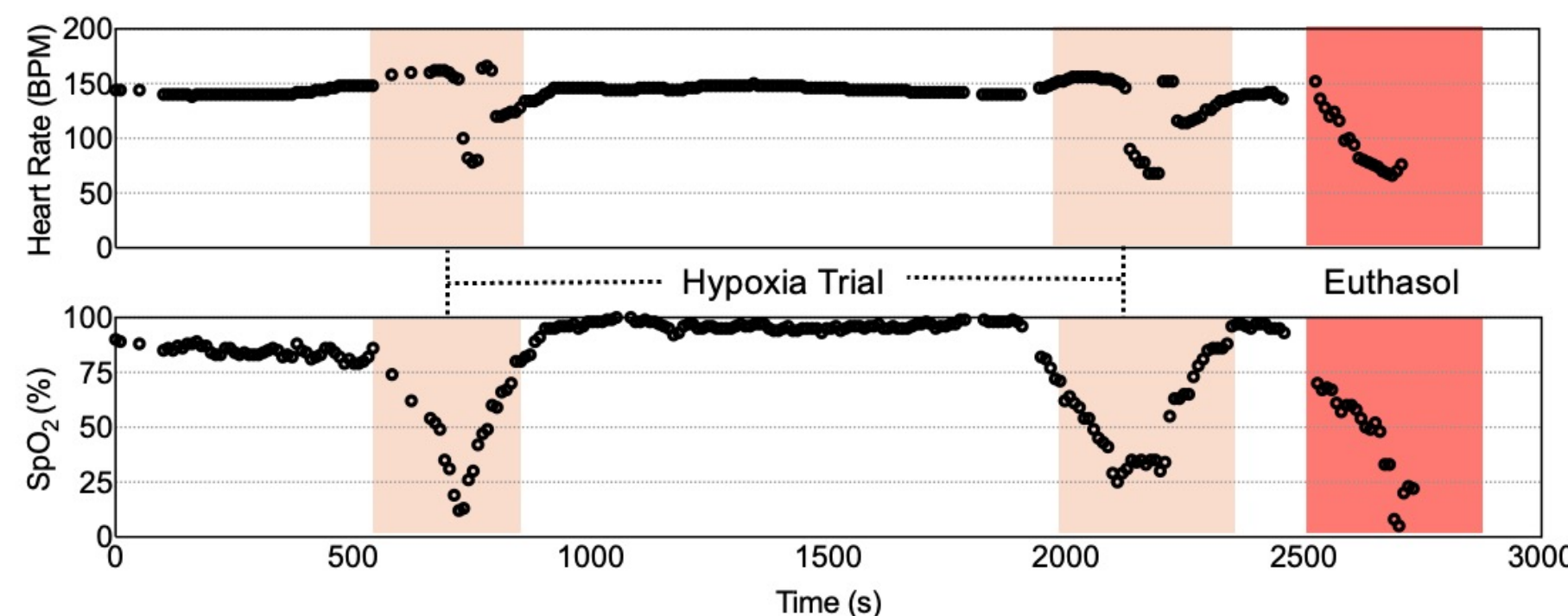


Figure 2. Continuous heart rate (top) and pulse oximetry (bottom) monitoring from one lamb shows severe hypoxia with bradycardia during hypoxia trials from ventilator cessation captured by PreMo. The Euthasol injection at the end of the experiment shows a loss of signal correlating with asystole.

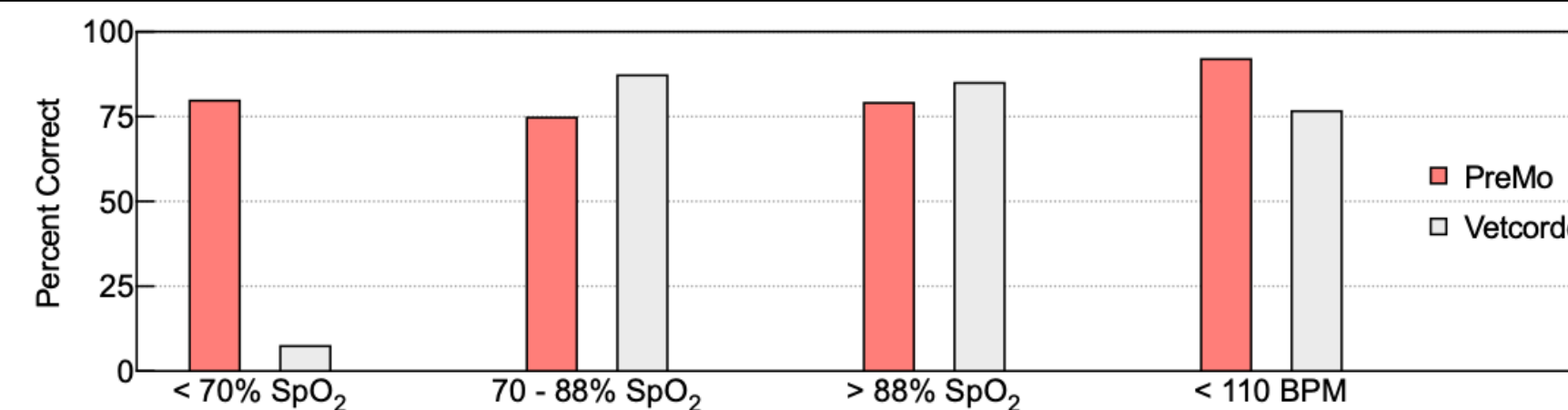


Figure 3. PreMo vs. Peripheral Pulse Oximeter (Vetcorder): PreMo correctly identified **80%** of events vs. **7.7%** of events during episodes of severe hypoxia in comparison to the standard peripheral pulse oximeter. There was no difference in the detection rate during moderate hypoxia (70-88% SpO₂), normoxia (> 88% SpO₂), and bradycardia.

DISCUSSION

PreMo provides accurate and continuous monitoring of heart rate, oxygen saturation, temperature, and blood pressure demonstrating agreement with gold standards and maintained signal fidelity during hemodynamic derangement. Ultimately, PreMo addresses a critical requirement in NICU care: continuous, real-time assessment of core rather than peripheral perfusion, offering the potential for a more sensitive indicator of early hemodynamic instability in vulnerable preterm infants.

RESULTS (cont.)

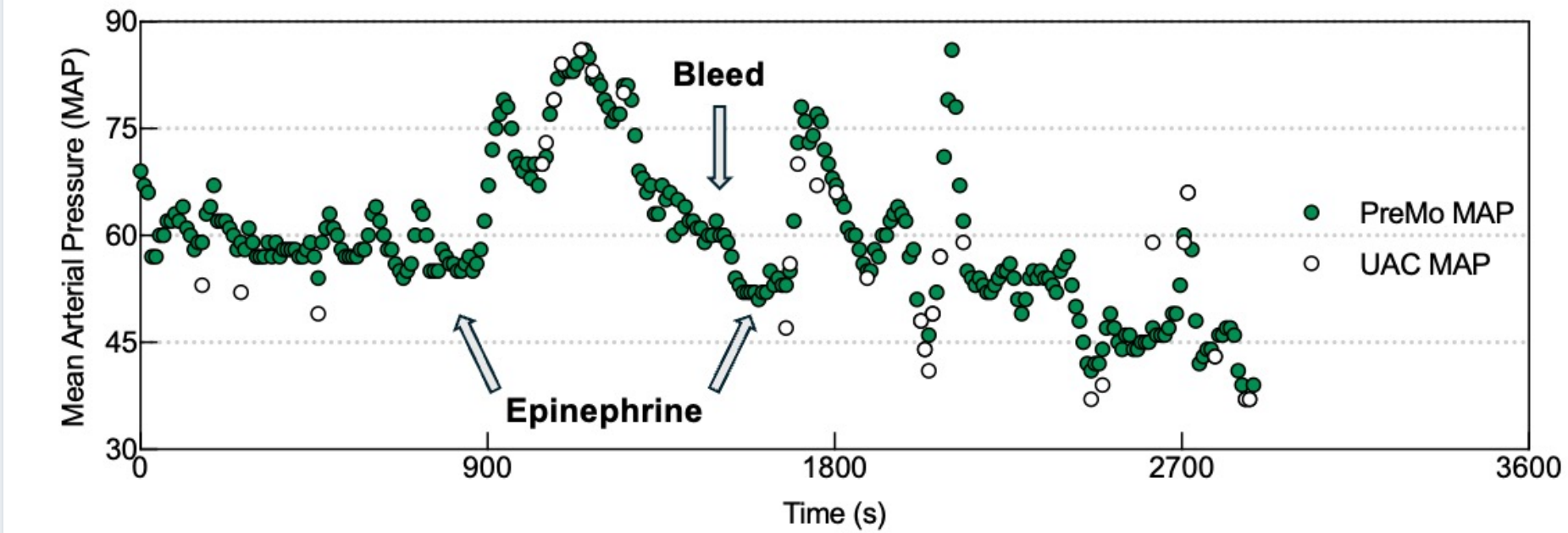


Figure 4. The blue dots represent PreMo-derived values, while the white dots reflect reference measurements from the umbilical artery catheter. Hypertension occurs rapidly following intra-arterial epinephrine administration, whereas a 20 cc/kg hemorrhage produced hypotension.

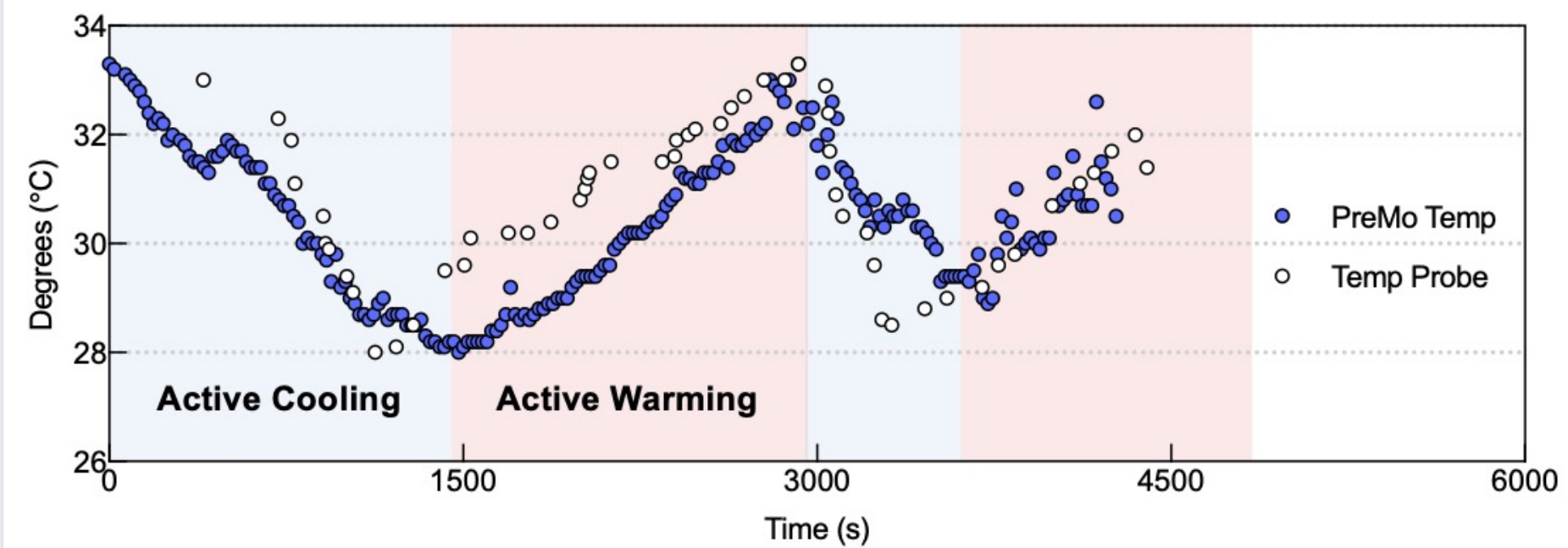


Figure 5. Continuous temperature monitoring in comparison to the gold standard esophageal temperature probe shows that PreMo slightly underestimates the core temperature. However, the depth of insertion was slightly different between PreMo and the temperature probe potentially explaining this discrepancy.

Vital Sign	Gold Standard	n	Mean Bias	95% LOA
Heart Rate	Echocardiography	70	-0.51 BPM	-11.8, 10.8 BPM
SpO ₂	Arterial Blood Gas	86	0.39%	-45.2, 41.1%
MAP	Umbilical Art. Line	65	0.71 mmHg	-7.9, 8.5 mmHg
Temperature	Esophageal Probe	68	-0.3°C	-2.0, 1.4°C

0.99
Lin's CCC
Heart Rate

0.96
Lin's CCC
Blood Pressure

0.75
Lin's CCC
Temperature

0.74
Lin's CCC
SpO₂