

Pilot evaluation of the NIRSense Argus wearable tissue and pulse oximetry sensor in anesthetized dogs during hyperoxia, normoxia, and hypoxia

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CSU Veterinary
Health System

VECCTTR
VETERINARY EMERGENCY AND CRITICAL CARE,
TRAUMA, AND TRANSLATIONAL RESEARCH

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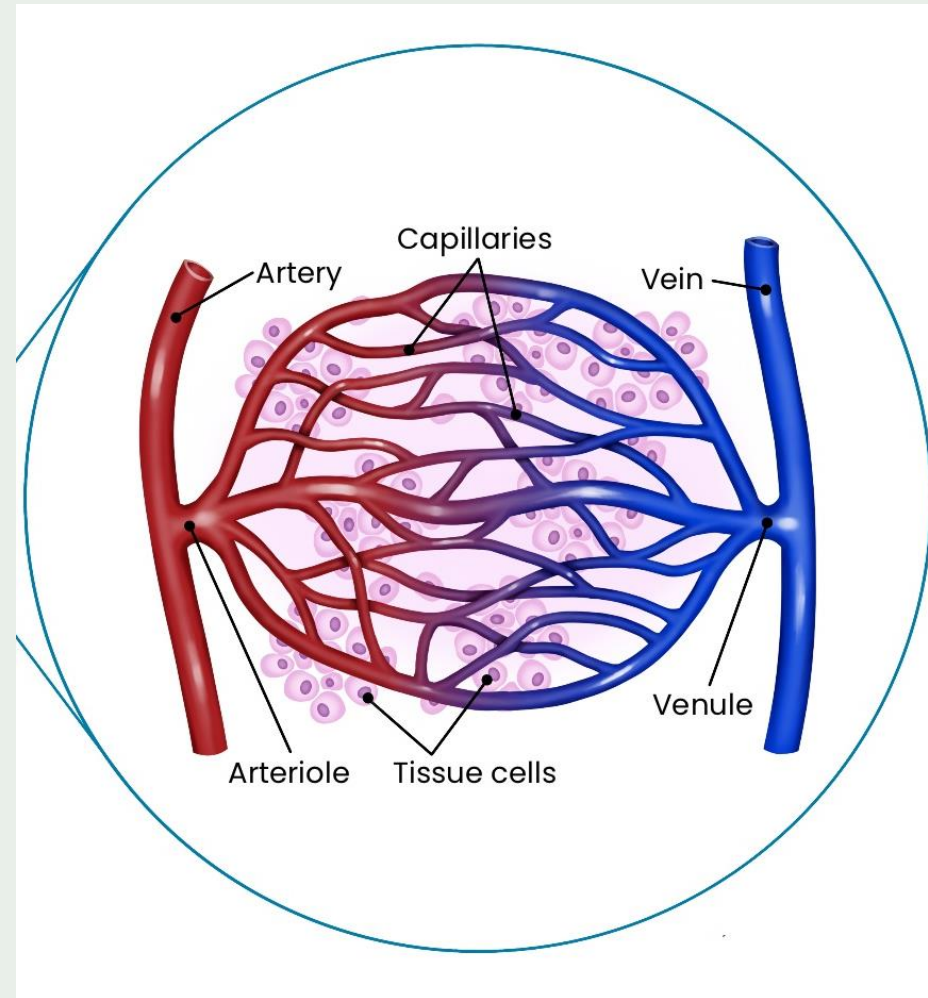




**How do you improve the ease,
granularity, mobility and
efficacy of monitoring?**

**Can it be wireless?
Can it get us new data?**

Tissue perfusion (St02)

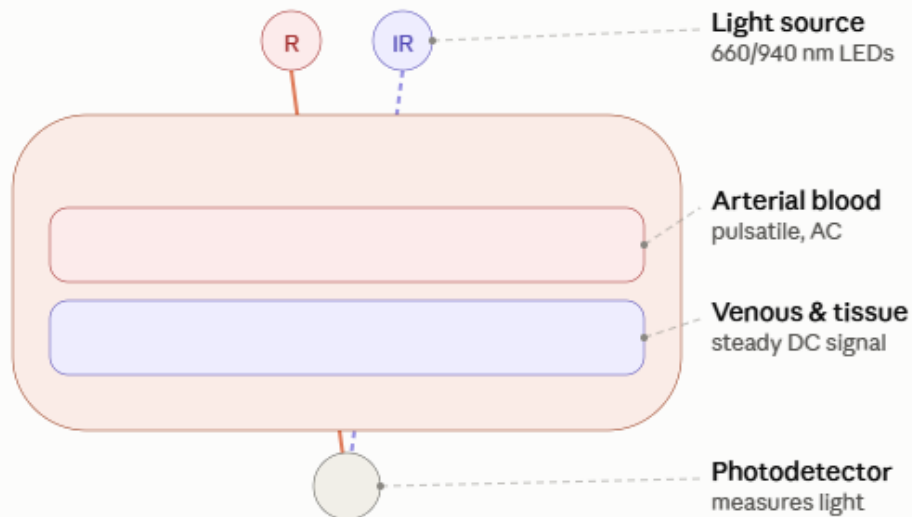


SpO2 and StO2



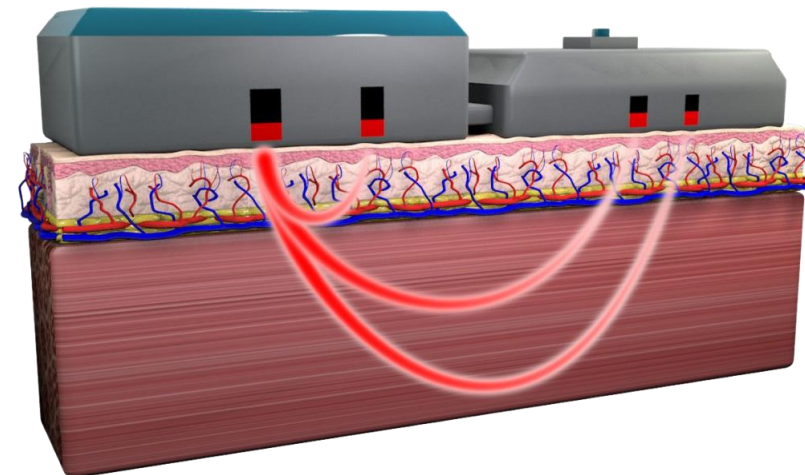
Pulse oximetry (SpO2)

- Measured with photoplethysmography (PPG)
- Reflects: Arterial oxygen saturation
- Needs a pulsatile artery
- Normal range: 95-100%
- Traditionally measured with SpO2 probe on tongue, ear, finger/toe



Tissue oximetry (StO2)

- Measured with near-infrared spectroscopy (NIRS)
- Reflects: Local tissue perfusion
- Needs to be able to penetrate to capillary bed
- Normal range: 60-80%
- Not traditionally measured in clinical medicine



NIRS Technology in Veterinary Medicine

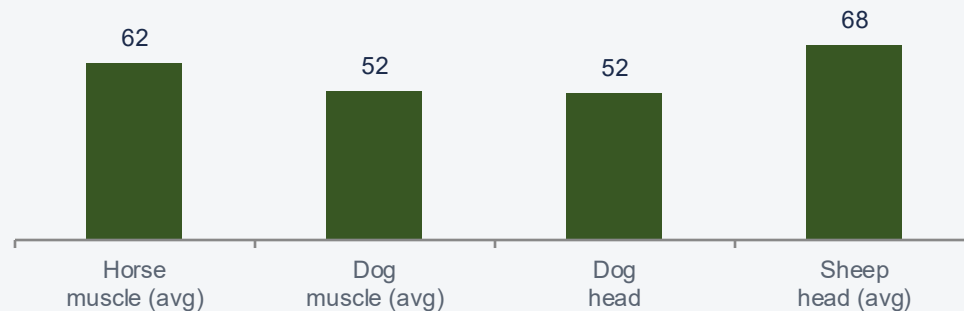


Non-invasive: Time-Domain NIRS

Frabasile et al., 2023 – Front. Vet. Sci.

Model: Horses (n=6), dogs (n=4), sheep (n=19) — muscle & head sites, awake, unshaven where possible

Mean StO₂ by tissue & species



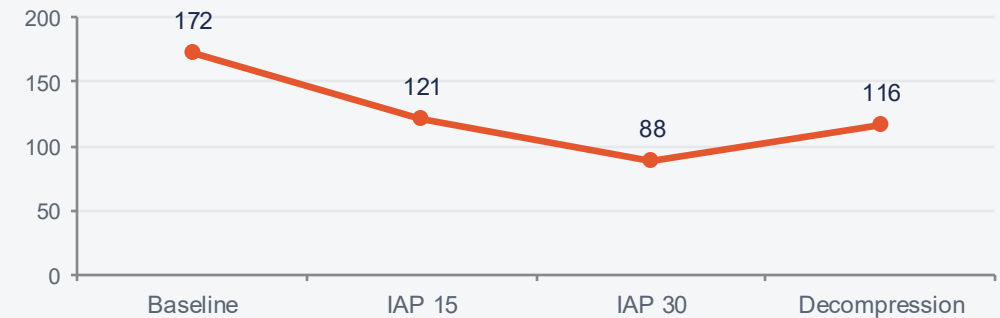
Invasive: Intraparenchymal Clark-type Oximetry

Nalbanti et al., 2026 – Front. Surg.

Model: Anesthetized dogs (n=8) under graded intra-abdominal pressure (IAP 0→15→30→decompression)

Method: Probe placed 3 mm under renal capsule measures partial tissue oxygen tension (ptiO₂) continuously — not NIRS, and not a saturation percentage

Renal cortical ptiO₂ vs. intra-abdominal pressure



NIRS Tissue Oximetry: Product Landscape

Clinical Cerebral & Somatic Oximetry

INVOS 5100C / 7100 *Medtronic*

Longest-established system (since 1993); dual-depth sensor subtracts scalp signal; pediatric-cleared.

ForeSight Elite *Edwards Lifesciences*

Acquired from CAS Medical; integrates with the HemoSphere hemodynamic monitoring platform.

EQUANOX 7600 / 8004 *Nonin Medical*

4-wavelength, dual-emitter sensor design intended to reduce surface variability artifacts.

O3 Regional Oximetry *Masimo*

Regional rSO₂ module built into Masimo's broader multi-parameter monitoring platform.

NIRO-200NX *Hamamatsu Photonics*

Spatially-resolved CW system reporting absolute tissue oxygenation index (TOI).

Portable Muscle Oximetry

Moxy Monitor *Fortiori Design*

Widely used 0–100% SmO₂ wearable; popular with endurance athletes and coaches.

PortaMon / Oxymon *Artinis Medical Systems*

Multi-channel, Bluetooth wearable; regarded as a research “gold standard” comparator.

NIRSense *NIRSense*

Wearable combining NIRS with PPG in one sensor; reports StO₂ for muscle and other vascularized tissue.

Humon Hex *Dynometrics (Humon)*

Consumer muscle-O₂ sensor; company ceased operations in 2020 — no longer sold.

BSX Insight *BSX Athletics*

Early consumer entrant; discontinued in 2017 as the company exited the category.

Research-Grade & Multichannel Systems

NIRSBOX *PIONIRS Srl*

Compact time-domain (TD) NIRS unit; used in veterinary studies (e.g., dog, horse, sheep tissue oximetry).

NIRScout / NIRSport2 *NIRx Medical Technologies*

Multichannel fNIRS imaging arrays for whole-head cortical mapping.

Oxiplex TS / Imagent *ISS Inc.*

Frequency-domain systems providing absolute $\mu a/\mu s'$ and hemoglobin values; research-only.

Brite / OctaMon *Artinis Medical Systems*

Wireless fNIRS arrays for cortical hemodynamics research outside the lab.

NIRSense Argus Device



Objective: Study objective: to evaluate the performance of the NIRSense Argus in dogs, during hyperoxia, normoxia, and hypoxia

Partnership



CSU VECCTTR Lab

Study design

Data collection

Data analysis

Abstract/manuscript
preparation

NIRSense, Inc.

Provided devices

No financial support

No influence on results,
discussion

Materials and Methods



6 healthy, purpose-bred dogs

3 female, 3 male



Anesthetized using standard protocol

Left dorsal pedal, right femoral, right jugular vein cannulated
Standard monitoring (EKG, EtCO₂, SpO₂)



Two NIRSense Argus sensors attached

Forelimb and medial hind limb – continuous NIRS and PPG data



3 oxygenation states (hyperoxia, normoxia, and hypoxia)

1ml blood drawn from each anatomical site for co-oximetry analysis



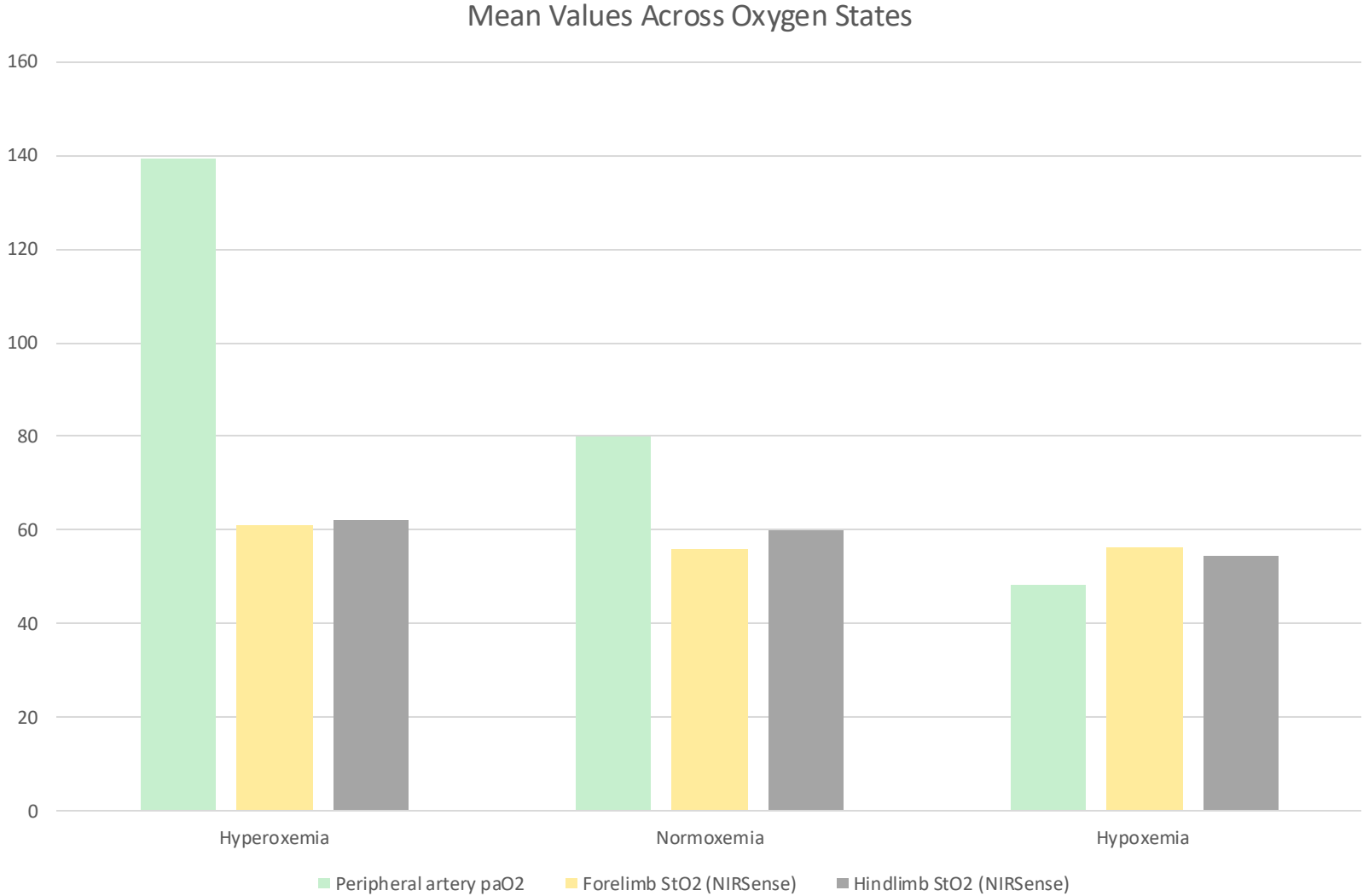
Placement of the NIRSense Devices



Results

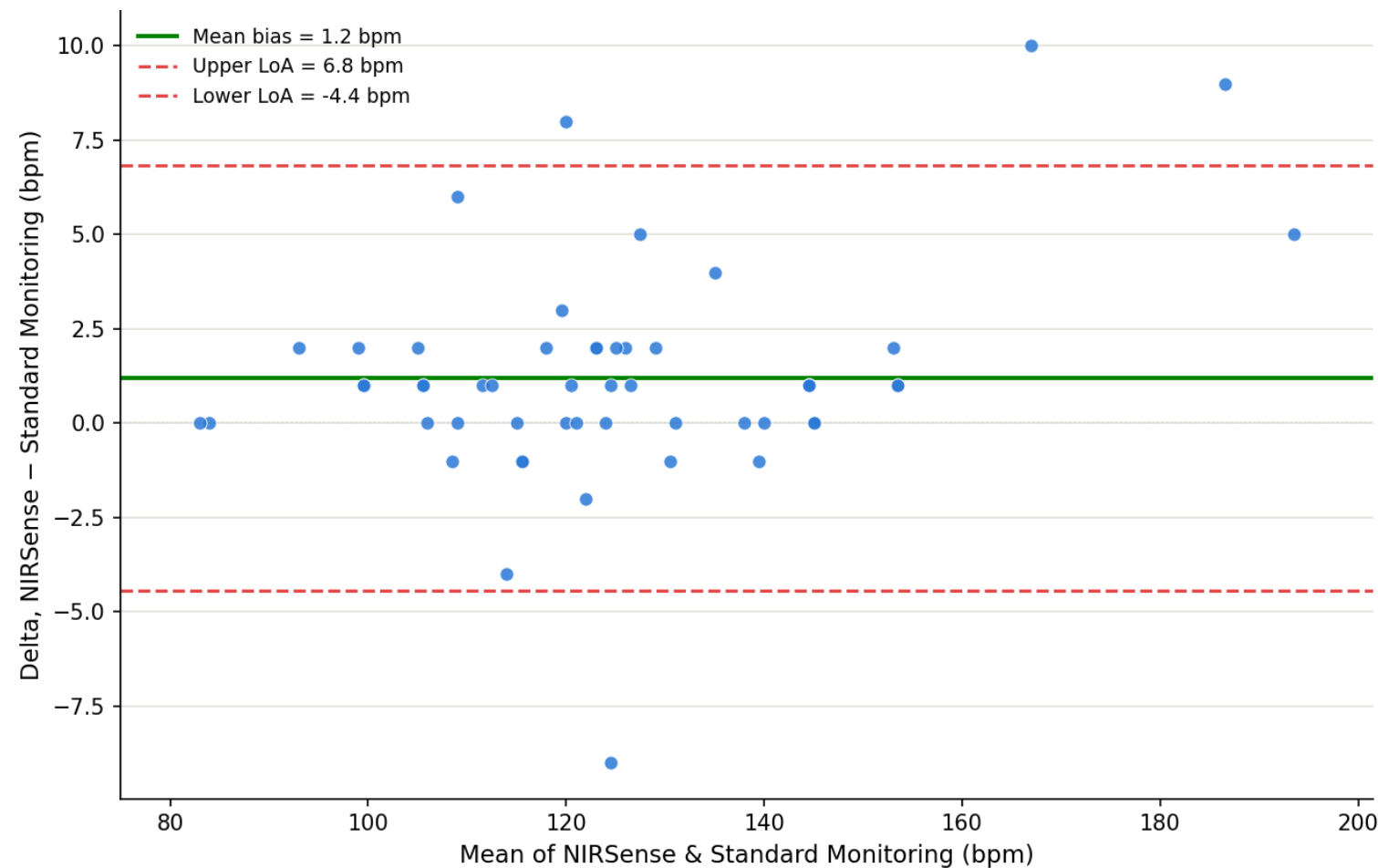
Condition	Mean PaO2 (mmHg)	SpO2 - Forelimb (%)	SpO2 - Hindlimb (%)	StO2 - Forelimb (%)	StO2 - Hindlimb (%)
Hyperoxia	139	100	98	61	62
Normoxia	80	99	96	56	63
Hypoxia	48	87	86	57	59

Results

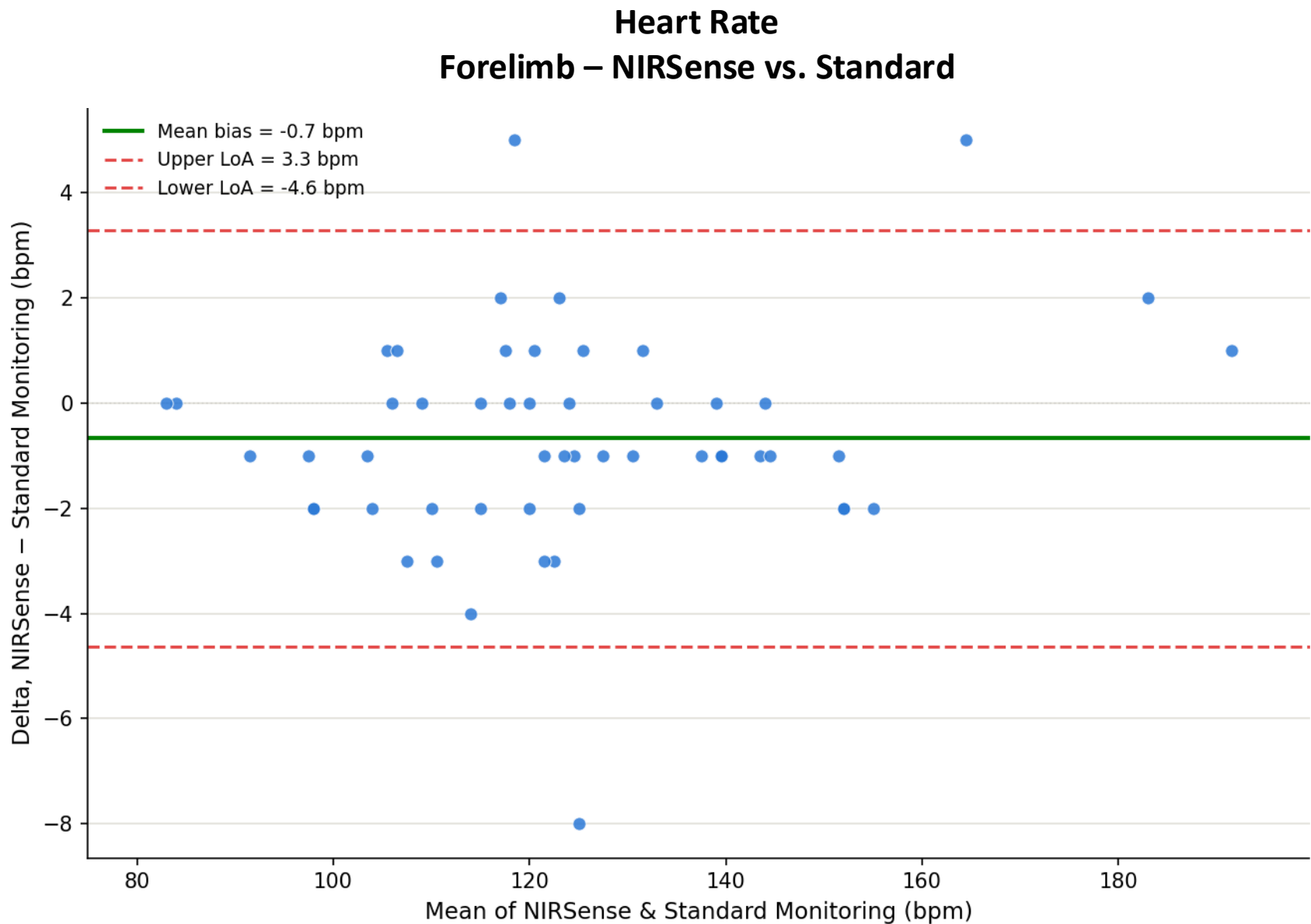


Results

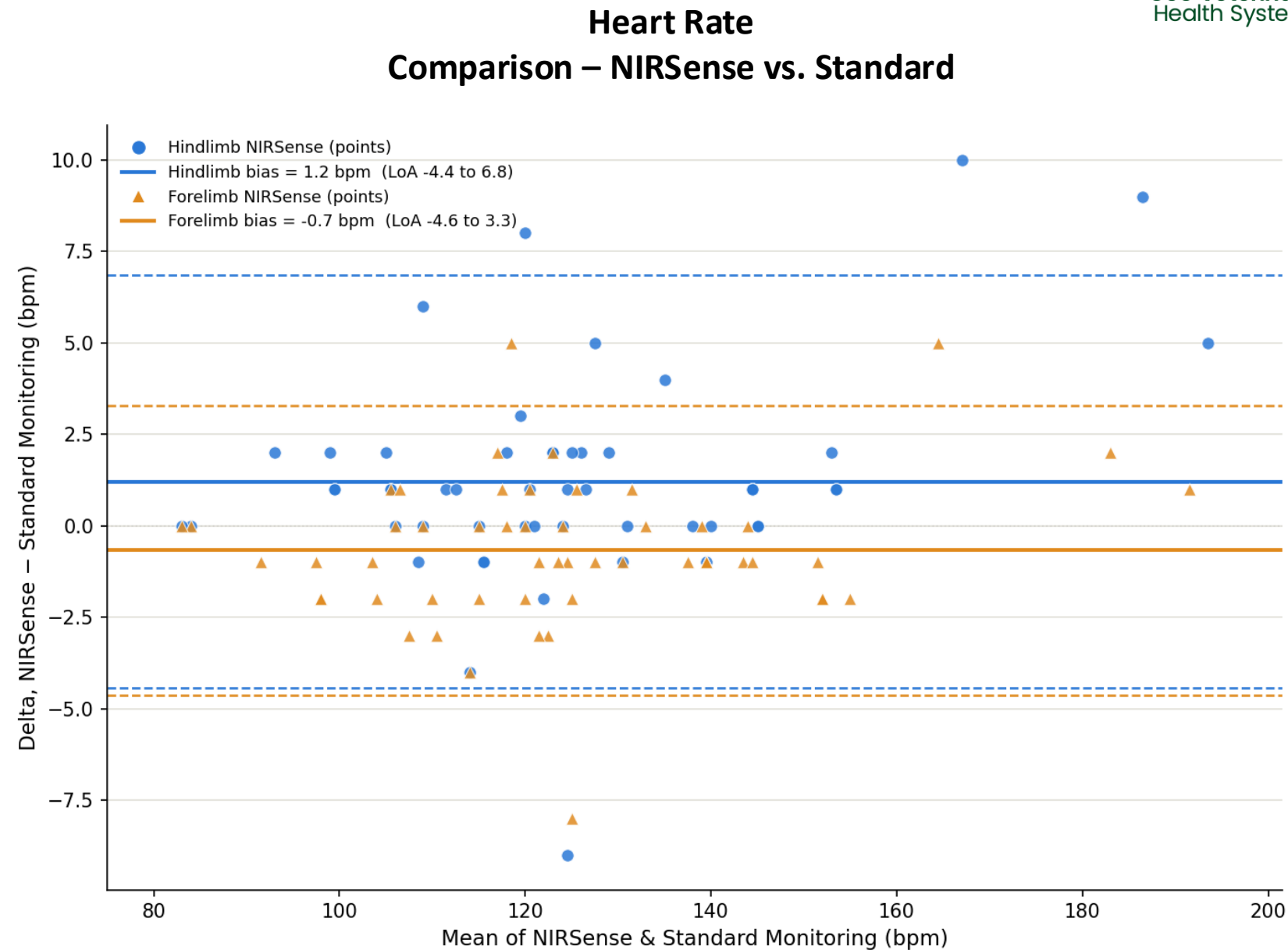
Heart Rate
Hindlimb – NIRSense vs. Standard



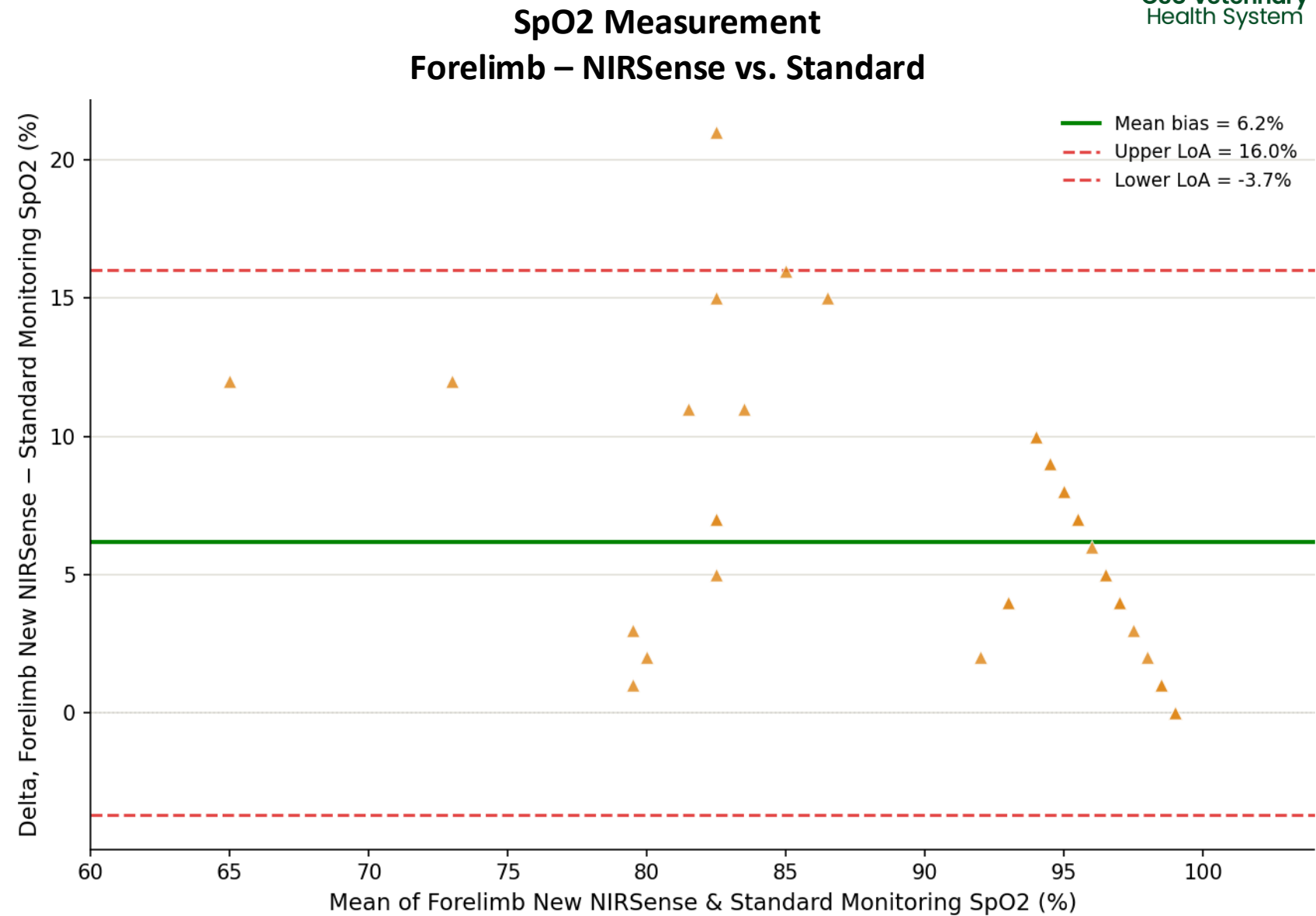
Results



Results

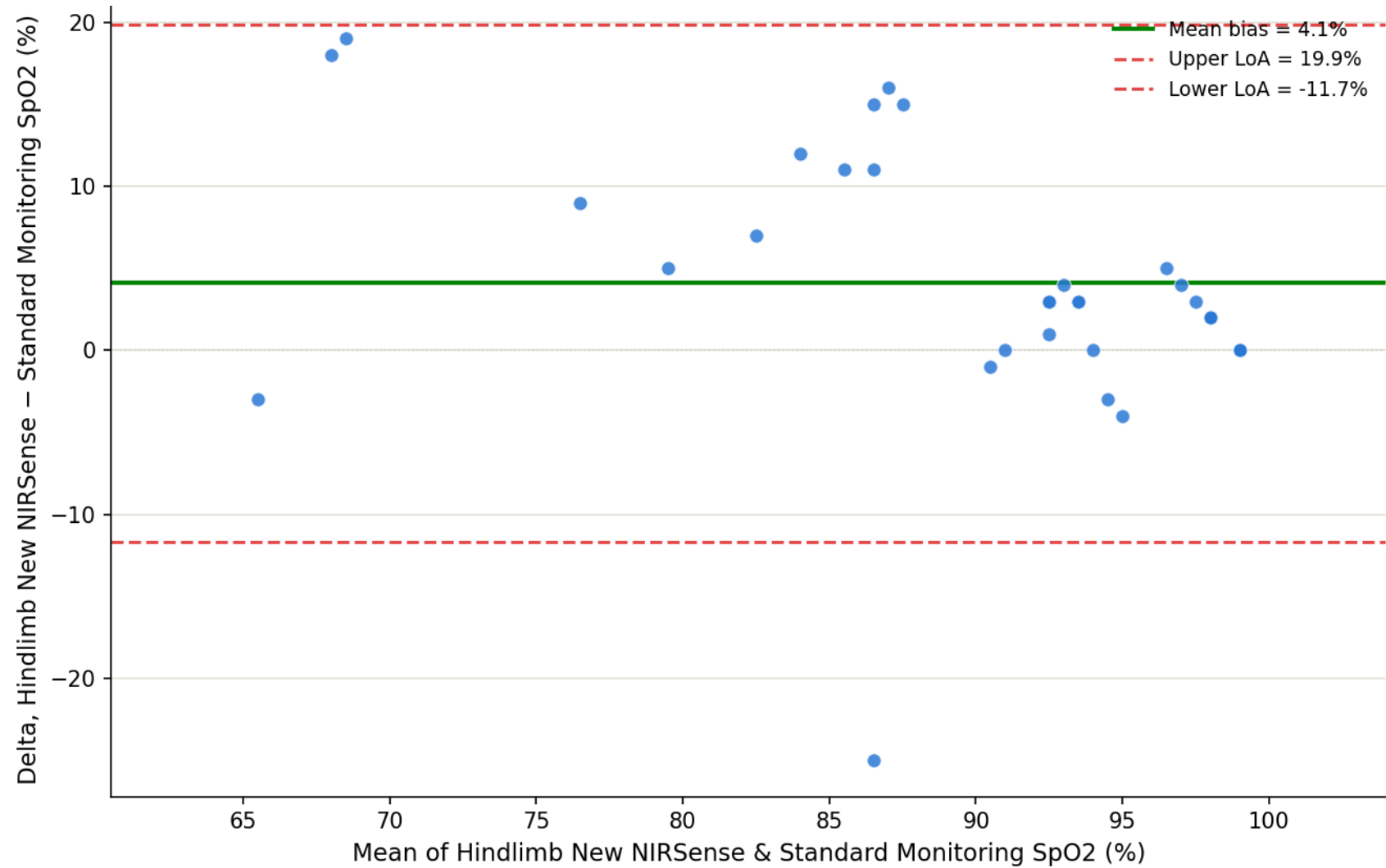


Results



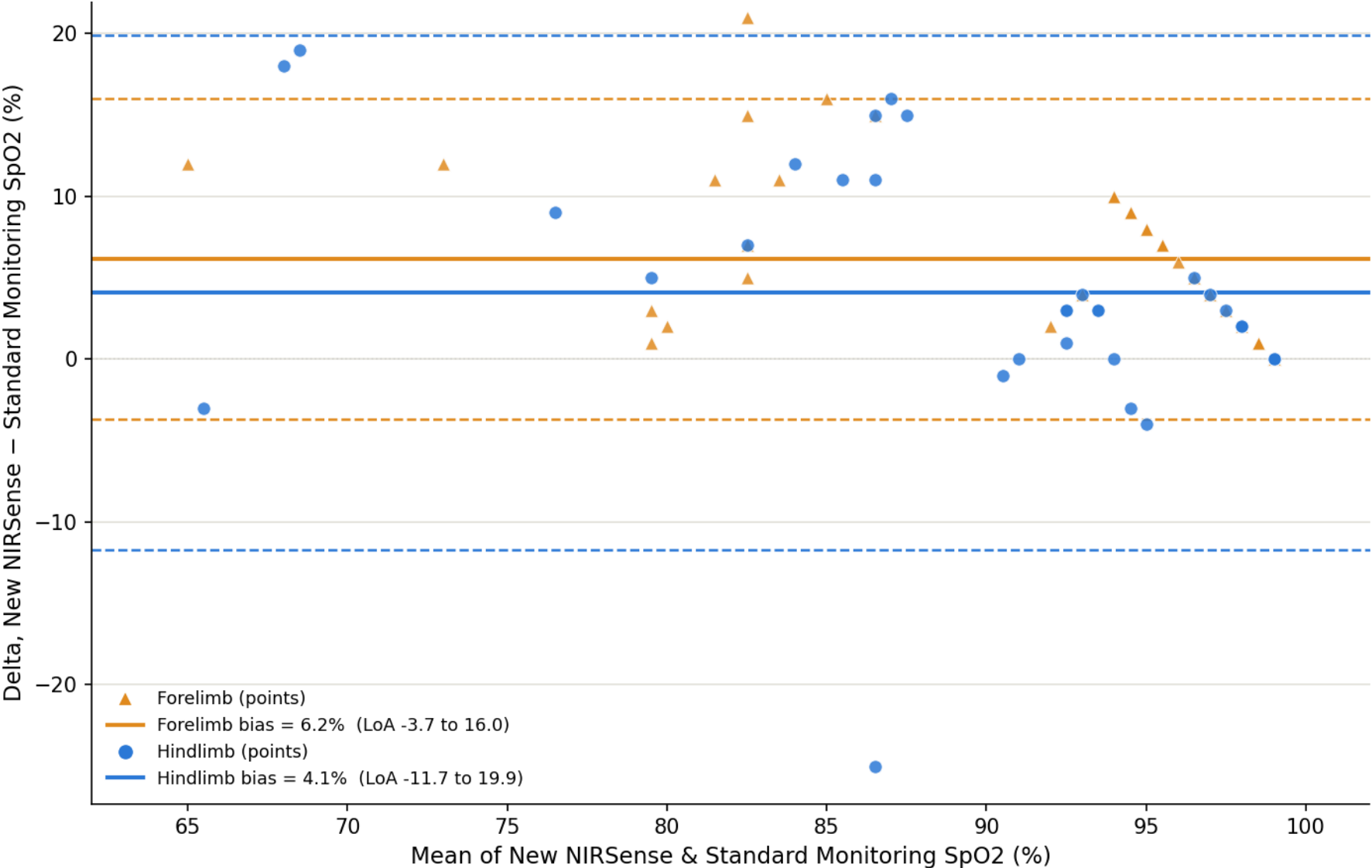
Results

SpO2 Measurement Hindlimb – NIRSense vs. Standard



Results

SpO2 Measurement NIRSense vs. Standard



Discussion

StO2

- Reliable readings across all oxygen states
- Sustained perfusion despite hypoxemia
- Difficult to correlate with HR and SpO2
- Consistent with other measurement of StO2

SpO2

- Limits of agreement are wide (NIRSense higher than standard monitoring)
- Individual dogs or oxygen states drove delta
- Limited data at lower levels of saturation
- Not calibrated for dogs (human algorithm)
- Discrepancy with PaO2

Discussion

Heart rate

- Mean bias low (+1.2 bpm)
- More disagreement at higher heart rate

Usability

- Generally easy to fit, even to small dog
- Requires Elasticon tape +/- cling wrap
- Ability to get consistent readings improved across the studies
- Expand to other devices

Future Studies

**Calibration
with other
monitoring**

**Hemorrhagic
shock**

**Other
species**

Conclusion

- Tissue perfusion does not always trend with other vital parameters
- NIRS technology reliable for StO₂ monitoring and wireless HR monitoring
- Calibration for dogs may improve other parameters
- Future opportunities for StO₂ monitoring
- One Health partnerships can improve the health of animals and people



Thank You

Questions?

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