

# Monitoring of Conscious, Unrestrained Animals with MouseOx® Plus

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## Product Description

The MouseOx® Plus is a multi-parameter pulse oximeter that can monitor the cardio-pulmonary health of small animals (heart rates 90 to 900 bpm) continuously, in real-time, using a single clip attached to an animal.

### *Parameters:*

- Arterial Oxygen Saturation ( $S_pO_2$ )
- Heart Rate
- Breath Rate
- Activity Parameter

### *Animals:*

- Mice
- Rats
- Any animal with heart rate > 100 bpm (non-specific calibration)

### *Types of Conscious Unrestrained Monitoring:*

- Influenza, Pneumonia, RSV & Other Acute Respiratory Disorders
- Lung Injury
- Lung Cancer, COPD, Sleep Apnea & Other Chronic Respiratory Disorders
- Shock Models
- Stroke & Brain Injury
- Hypertension, Hypotension & Other Cardiovascular Disorders
- Hypoxia & Inhalation Studies
- Vital Signs Monitoring During Imaging
- Vital Signs Monitoring During Surgery & Experiments Requiring Anesthesia
- Pharmacology & Toxicology

## Why Use MouseOx® Plus?

### *Benefits of Pulse Oximetry:*

- Single parameter that is a comprehensive monitor of both cardiac and pulmonary health (adequacy of ventilation, lung perfusion and gas exchange)
- Pulse-ox is a continuous monitoring modality – no intermittent samples
- One of the most accessible and widely used human clinical parameters
  - Emergency assessment and transport
  - Pre-op and post-op monitoring
  - Conscious sedation monitoring
  - Since 1998, the utilization of pulse oximetry has been mandated throughout hospital and homecare patient guidelines
- Completely non-invasive - no adhesives, no needle sticks, no catheters, no IVs, no surgery
- Measures the oxygen level in ARTERIAL blood only

- Prior to the widespread use of pulse oximetry, studies in anesthesia journals estimated 2,000 to 10,000 deaths per year due to undetected hypoxemia (lack of oxygen in the blood).
- Oxygen level is clinically more important in arteries than elsewhere, but before pulse oximetry, it was difficult to measure
  - Deep location of arteries
  - Arteries under high pressure (can cause bleeding)
  - Difficult to seal arteries when retracting the catheter
  - Samples are only intermittent
- Pulse oximetry is now recommended as a monitoring technique for anesthetized animals by the NIH (just added in 8<sup>th</sup> edition):
  - “For anesthesia delivery, the use of precision vaporizers and monitoring equipment, e.g., *pulse oximeter for determining arterial blood oxygen saturation levels, increases the safety and choices of anesthetic agents for use in rodents and other small species.*” NIH Guide for Care and Use of Laboratory Animals, 8<sup>th</sup> ed., Pg 122 Paragraph 5, 2011.
  - “Careful monitoring and timely attention to problems increase the likelihood of a successful surgical outcome (Kuhlman et al. 2008). *Monitoring includes routine evaluation and recording of anesthetic depth and physiologic functions and conditions, such as body temperature, cardiac and respiratory rates and pattern (Flegal et al. 2009), and blood pressure (Kuhlman et al. 2008)...*” NIH Guide for Care and Use of Laboratory Animals, 8<sup>th</sup> ed., Pg 119 Paragraph 1, 2011.
  - Guide for the Care and Use of Laboratory Animals, 8<sup>th</sup> Edition, 2011 can be viewed at the following website: <http://oacu.od.nih.gov/regs/guide/2011.pdf>.
- Monitoring arterial oxygen saturation is very useful for identification of:
  - overall status of cardio-pulmonary health
    - adequacy of ventilation
    - pulmonary gas exchange
    - adequacy of pulmonary perfusion
  - general homeostasis

#### ***Benefits of MouseOx® Plus over Clinical Pulse Oximeters:***

- 4 of 5 Vital Signs from 1 monitor – clinical pulse oximeters only provide S<sub>p</sub>O<sub>2</sub> and Heart Rate  
In addition to S<sub>p</sub>O<sub>2</sub>:
  - Heart Rate
  - Breath Rate
  - Activity/Motion Flag
- Unlike clinical pulse oximeters:
  - MouseOx® Plus is calibrated *in situ* for saturation from 100% to below 30% (clinical pulse ox devices cannot be calibrated directly at low saturation levels [ $< 85\%$ ])
  - MouseOx® Plus has a fast response to physiologic changes ( $< 5$  seconds)
  - In addition to visual and audible parameter alarms, MouseOx® Plus has patent-pending anesthesia alarms that can help monitor the depth of anesthesia
  - MouseOx® Plus has parameter averaging functionality, rendering “eye-balling” values a thing of the past
  - MouseOx® Plus tells the user when parameter values are not to be trusted
- Multiplexer™ option allows monitoring of up to 16 animals from one MouseOx® Plus device
- Pulse oximeter data can be stored to files

- Highly configurable product – purchase only what you need
  - Base Unit and Monitoring Software
  - Recording Software
  - Body Temperature Module
  - Switchbox for Monitoring up to 16 Animals with 1 MouseOx® Plus (Multiplexer™)
  - MRI Sensor
  - Conscious Subject Monitoring Software
  - Conscious Measurements Enclosure
  - Real-time, Raw Cardiac Pleth Signal
  - Analog Deployment of All Parameters (STARR-Link™)
- Parameters can be disseminated as analog voltages for recording into central data collection systems (e.g., Dataq, Spike II, PowerLab, etc.)
- Conscious Measurements Enclosure
  - Make measurements on **unstressed** animals
  - Monitor 24 hours or longer without direct contact with the animal
  - Measurement from a single collar clip – no anesthesia, no surgery
  - Animals are unrestrained and can be left unattended
  - Food and water available *ad libitum*
  - 2 Sizes - for mice and rats
  - Low-torque slip-ring to allow animal to spin without winding wires
  - Counterbalanced load – subject feels no weight from wires

***Benefits of MouseOx® Plus Multi-Animal, Conscious, Unrestrained Measurement System:***

- Connect up to 16 animals at a time to one MouseOx® Plus device using the Multiplexer™
- Measure MouseOx® Plus parameters on conscious, unrestrained animals using the Conscious Measurements Enclosure (CME)
- Make measurements on completely unstressed animals
- One-time sunk cost – purchase all equipment needed, except sensors, one time
  - One-time purchase of MouseOx® Plus, Multiplexer™ and CMEs
  - Only non-reusable part is the sensor, which has 100 hour use per sensor
  - Your second, or even twenty-second, round of studies costs less than \$1,500 (for 16 animals)
- Easy and inexpensive to use
  - No surgery and no surgical protocols
  - No anesthesia required
  - Animals can be left unattended
  - No implanted batteries to recharge or replace
  - Switch animals out any time
  - Make measurements on the SAME animal many different times

***Ease of Use:***

- All parameters (except temperature) from a single clip-on sensor
- Small footprint device – processor is your computer connected with regular USB cable
- Multiple sensor clip sizes – from neonatal mice to large adult rats

- Conscious Measurements Enclosure – set clip and leave animal alone for hours while collecting data – no surgery required

#### *Many Others Are Using MouseOx® Plus*

- Over 100 references to MouseOx® in scientific literature
- See [www.starrlifesciences.com](http://www.starrlifesciences.com) → Resources → MouseOx Publications

### **Understanding the Limitations of MouseOx® Plus in Conscious Unrestrained Applications**

The MouseOx® Plus can measure vital signs in small animals that are conscious and unrestrained. However, there are some limitations to its use in this particular realm. It must be understood that oxygen saturation **cannot** be measured while the animal is moving. The theory behind pulse oximetry that allows calculations of oxygen saturation to be obtained from absorption of light measurements requires that the tissue residing between the sensor pads not change. When the animal moves, or even flexes muscles under the skin without obvious surface movement of the sensor pads, this assumption is violated, rendering the measurement of oxygen saturation undoable. **Thus, an animal that is conscious and unrestrained, must also be still while the saturation measurement is being made.**

### **Principles of Pulse Oximetry**

Several types of pulse oximeters were developed in the mid 1900's, but the modern version used throughout hospitals today was invented in 1972. In 1980, modern pulse oximetry was first commercialized, making it readily available - it quickly grew in popularity. Because of its ease-of-use, low cost and non-invasive nature, pulse oximetry is mandated in nearly all hospital and homecare patient care guidelines. In the hospital, this includes first responders to post-operative and critical care monitoring.

Pulse oximetry is a technique for monitoring the level of oxygen carried to the tissues on hemoglobin molecules in red blood cells. Since 97% of oxygen is carried on hemoglobin, pulse oximetry provides a very robust assessment of arterial oxygenation. This is fortunate, because the alternative for monitoring arterial oxygen, an indwelling arterial catheter, is highly undesirable.

In pulse oximetry, the saturation is measured directly (not through a table or other function) with the use of 2 different wavelengths of light. One is red, which you can see, and the other is infrared, which you cannot. The absorption of light by hemoglobin changes based on the degree of oxygen bound to the hemoglobin. Most people are familiar with the fact that de-oxygenated blood appears much darker than fresh blood. These variations can be tied back to the level of hemoglobin saturation through calibration that can be performed by the manufacturer, obviating the need for the user to do so.

Moreover, the word "pulse" in pulse oximetry refers to the fact that the light absorption received by a pulse ox sensor oscillates with the cardiac pulsation. Because blood pulsation is completely damped by the time blood enters the capillary bed, the pulsating signal can only arise from the arterial system, and therefore measurements are made only on arterial blood and not on tissues, capillary blood or venous blood.