

The Truth about Laboratory Animal Monitoring

Not all pulse oximeters & heart rate monitors are equal

As biomedical research continues to progress, small animal subjects such as mice, rats, gerbils, hamsters, guinea pigs and other rodents are increasingly used as surgical models. To improve the outcome of surgeries, new devices have been developed using advanced technology and engineering to monitor the animal’s physiological status during surgery. Instruments designed for small animals that combine measurement of oxygen saturation level (SpO2), heart rate, blood pressure, respiratory rate, or end-tidal CO2, and core body temperature deliver important information for improving the outcomes of surgery and the quality of the research.

About Pulse Oximetry

A critical monitoring technique used in human surgery is pulse oximetry, a method for monitoring the level of oxygen carried in a patient’s blood. Oxygen saturation has been referred to as the fifth vital sign, joining heart rate, respiration rate, temperature, and blood pressure as a critical physiological measurement. The technique has been used for monitoring patients in recovery rooms, intensive care units, and neonatal wards. The theory of pulse oximetry remains the same, whether working with humans or rodents. Pulse oximetry is well documented and requires no further validation.

The biggest challenge researchers face is finding monitoring equipment that has:

- hardware sensitive enough to capture the high frequency arterial pulsations of rodents
- sensors that fit the unique anatomy of rodents without interfering with surgical procedures
- small footprint on the lab bench
- multi-functional capability

Hardware

Rodent pulse oximeters have sensitive arterial waveform acquisition hardware designed to accurately capture small, high frequency arterial pulsation seen in rodents. For example, the arterial pulsation (perfusion or perfusion index) of a mouse is at least an order of magnitude weaker than the arterial pulsation seen in humans, while the frequency is an order of magnitude higher.

Therefore a significantly more sensitive monitor is required. The heart rate of a human, rat, and mouse all differ to a degree where a researcher may not be able to use a human pulse oximeter on a rat, nor a rat pulse oximeter on a mouse.

	Human	Rat	Mouse
Heart Rate	60 – 80	330 – 480	310 – 840

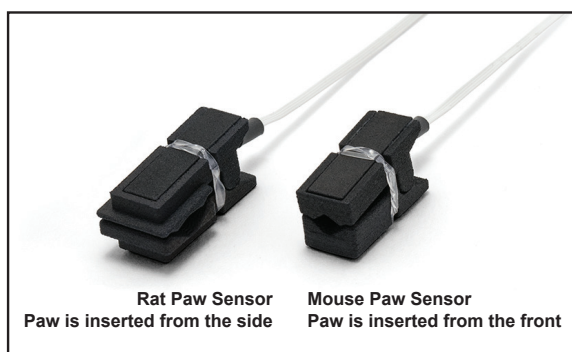
Although the pulse oximeter hardware designed by STARR Life Sciences, Inc. is capable of measuring the high frequency arterial pulsation, it falls short in several other areas that are key to successful vital sign monitoring in rodents.

Sensors

For humans and large animals, pulse oximetry sensors are typically placed on the ear, finger or large exposed surface area. For rodents, the sensors are applied to the throat, thigh, tail or paw. A variety of sensors are available from both STARR Life Sciences and Kent Scientific:

	STARR Life Sciences	Kent Scientific	Technical Note
Design	Spring-loaded	Non-impinging ✓	Does not impede blood flow to the appendage
Tension Adjuster	No	Yes ✓	User has the ability to adjust the tension based on research needs
Resistant to Ambient Light	No (requires blanket)	Yes ✓	Covering the sensor site is impractical in most surgical procedures
Light Weight Cables	No	Yes ✓	Designed not to push or pull at sensor site
Durability	No (limited to 100 hrs.)	Yes (up to 50,000 hrs.) ✓	STARR Life Sciences, Inc. sensors are programmed to stop after only 100 hours

Throat clip sensors are not practical for small animals; the risk of accidentally impeding airflow to the animal is too great. Thigh sensors are bulky and require the researcher to remove fur prior to application. The most practical sensor for rodents is an adjustable paw sensor designed to fit the anatomy of a rat or mouse paw. Kent Scientific's rat sensor and mouse sensor were designed to accommodate the physical characteristic of each animal's paw.



Paw sensor applied to animal

Small Footprint

For many researchers there is limited space to work with in the lab. Often competing for space on the lab bench is a surgical table, stereotaxic frame, microscope, or imaging system. The last thing a researcher has space for is another piece of equipment. For this reason, Kent Scientific designed a modular system that includes a built-in screen, eliminating the need for a separate laptop to view or save data.

	STARR Life Sciences	Kent Scientific
Built-in screen	No (requires laptop)	Yes ✓
Internal memory	No	Yes ✓
Battery option	No	Yes ✓
Integrated warming and temperature control	No	Yes ✓

In addition to providing advanced capabilities within a self-contained monitoring system, Kent Scientific offers pulse oximetry and heart rate monitoring as part of the PhysioSuite system.

Multi-functional Capability

Integrating some of the basic requirements your animal requires while anesthetized into one system further reduces the overall footprint and provides vital information on the animal's health. Maintaining the animal's body temperature is extremely important. The ratio of body surface area to body mass is greater in rodents than in larger species, therefore thermal support is critical during surgery and recovery of rodents. Anesthetic drugs lower metabolism which can cause hypothermia. Urinary excretion during this time prolongs the effects of hypothermia. The rodent's body heat dissipates from the tail and paws resulting in a significant decrease in core and surface temperatures.

The PhysioSuite® is essentially a box that a researcher equips with the modules their research requires. Each module is a separate component that provides a specific function: pulse oximetry, warming, ventilation, and CO2 monitoring.

One of the modules included with the purchase of pulse oximetry and heart rate monitoring is the RightTemp® module. The RightTemp module allows the researcher to warm, monitor, and maintain the animal's body temperature.

	STARR Life Sciences	Kent Scientific	Notes
Warming capability	No	Yes ✓ (far infrared warming pads)	FREE with PhysioSuite pulse oximetry system
Temperature monitoring	Yes, 1 probe included	Yes, 2 probes included ✓	Mouse and Rat probe included with PhysioSuite
Self-regulate animal body temperature	No	Yes ✓	Set animal temperature and system will regulate automatically

In addition to animal warming, the PhysioSuite has the capability of incorporating additional modules that are commonly used while animals are under anesthesia. When compared to modules offered by STARR Life Sciences, Inc., the PhysioSuite with pulse oximetry and heart rate monitoring system provides greater flexibility to support researchers' needs now and well into the future.

	STARR Life Sciences	Kent Scientific	Notes
Automatic ventilation	No	Yes ✓	Animals weighing up to 1,250g
End-tidal CO2 monitoring	No	Yes ✓	Side-stream sampling

Conclusion

Laboratory animal surgeries must adhere to society's concerns for maximizing animal health and safety. Research facilities adhering to ethical guidelines and concerns expect laboratories to maintain safe surgical procedures for staff and subjects, while conserving time and resources. A compact vital signs monitoring system designed to manage the physiological conditions of small animals under anesthesia can address these challenges.

Better research results occur when investigators can control experimental variables.

The objective of achieving reproducible results while conserving research resources is important for scientific, humane and economic reasons. Noninvasive pulse oximetry, along with other physiological monitoring, helps achieve these objectives.

Electronic monitoring instruments can never replace human clinical observation. However, some devices are capable of outperforming humans by maintaining continuous observation of the animal, and by measuring parameters that humans are unable to detect and quantify reliably. Uninterrupted monitoring provides scientists with the capability to track trends and to alert the researcher when physiological parameters are out of bounds. This is far more valuable than intermittent, visual observations.

About Kent Scientific Corporation

We are committed to provide you with innovative physiological products to assist in your research and help you bring drugs to market faster and more efficiently. We support your research needs with a well-trained group of dedicated employees providing knowledgeable technical support and extensive, multi-media product training. For additional information, visit www.kentscientific.com. For questions or technical support, contact Kent Scientific toll-free in the US at 1-888-572-8887 or 860-626-1172.



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