Breathing Rate

Breathing Rate Changes Monitored Non-Invasively 24/7

INTRODUCTION

Measuring changes in Breathing Rate can lead to the early detection of disease (1) and is key in evaluating the safety profile of novel therapeutics (2), (3). A range of conditions including exercise, stress, lung disorders, cardiovascular disease, metabolic acidosis, drug overdose, and central nervous system abnormalities can all manifest in detectable alterations in Breathing Rate (1), (3-5).

VIUM BREATHING RATE

Vium Breathing Rate (breaths per minute) is derived from continuous video streams of animals in Vium Smart Housing. Computer vision algorithms search for regions of time when animals are stationary, and identify periodic motion that falls within a frequency band containing known rodent breathing rates (6). The peak root mean square (RMS) power is compared to a threshold to determine whether the periodic motion is significant.

BIOMARKER VALIDATION

Vium Breathing Rate was compared to breathing rate measured by conventional whole-body plethysmography of awake mice with known differences in baseline breathing rate (3).

METHODS

Six-week old male C57BL/6J and C3H/HeJ mice were acclimated to Vium Smart Housing for a total of one week prior to commencing the study. Animals were singly housed three days prior to study start. Unrestrained animals were placed in a whole-body plethysmograph (EMKA technologies), and breathing rate was simultaneously collected via plethysmograph and the Vium Breathing Rate algorithm.

Preclinical Researchers Use This Biomarker to:

- **Compare baseline and post-therapeutic intervention breathing rates**
- **Evaluate drug efficacy in models that use breathing rate as a readout**
- **Obtain an early indication of off-target effects and/or potential safety signals**
- **Track breathing rate over time to assess disease progression and acute conditions**

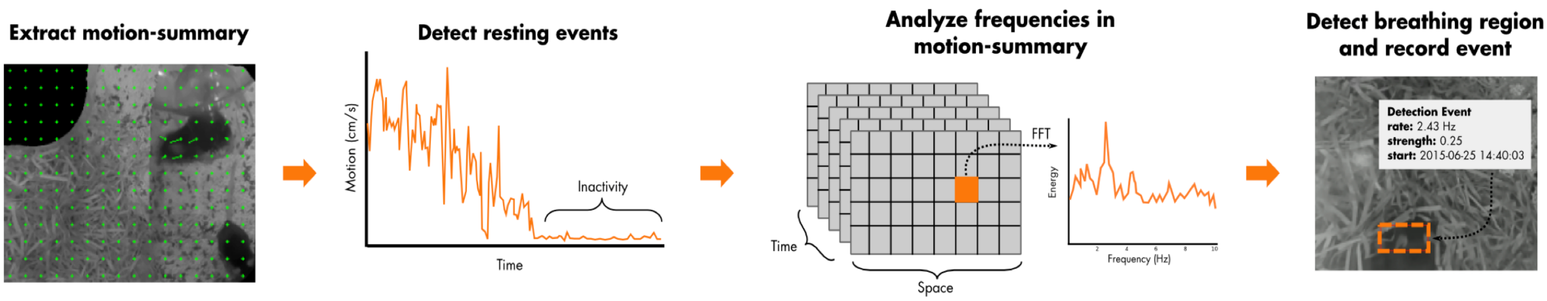

Figure 1: Breathing rate is generated from HD video using computer vision algorithms.

RESULTS

Our Breathing Rate Biomarker was compared to breathing rate measured by the plethysmograph (Fig. 2, R2 = 0.981; RMS error = 3.7%). In this validation, we demonstrated that Vium Breathing Rate has a 95% confidence interval of -2.9% to +8% of the breathing rate observed by plethysmograph. Consistent with the literature6 we observed that C3H/HeJ mice had a significantly lower breathing rate (136.3 +/- 3.2) than C57BL/6J animals (180.7 +/- 3.7) [ANOVA: F(1,27) = 65.99; p < 0.0001].

DISCUSSION

We have successfully demonstrated that Vium Breathing Rate accurately measures breathing rate. The Vium Digital Vivarium Platform provides an unprecedented opportunity to obtain continuous real, in cage, breathing rate data, over the course of a study, without the need for human intervention. Removing the human intervention eliminates the introduction of variables associated with stress and anxiety, known to affect animal physiology. This results in more reliable and reproducible data from which scientists can glean valuable information on drug safety and efficacy and provides data not often assessed due to the laborious and notoriously unreliable conventional methods of collection.

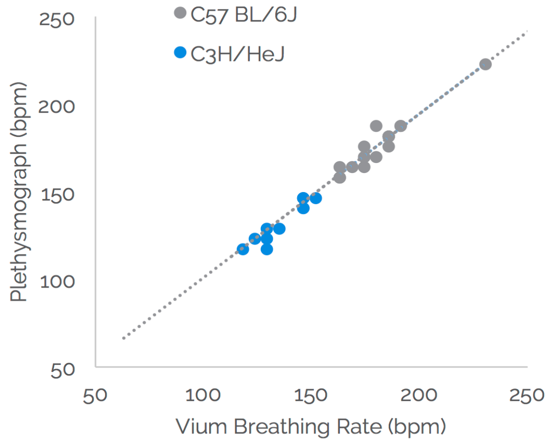

Figure 2: Breathing rate generated from the algorithm is highly correlated to breathing rate measured using the conventional plethysmograph.

REFERENCES

1. Braun SR. Respiratory Rate and Pattern. In: Walker HK, Hall WD, Hurst JW, editors. Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition. Boston: Butterworths; 1990. Chapter 43.

2. Pugsley MK, Authier S, Curtis MJ. Principles of safety pharmacology. Br J Pharmacol. 2008 Aug;154(7):1382-99.

3. Murphy DJ. Assessment of respiratory function in safety pharmacology. Fundam Clin Pharmacol. 2002 Jun;16(3):183-96.

4. Dick TE, Hsieh YH, Dhingra RR, Baekey DM, Galán RF, Wehrwein E, Morris KF. Cardiorespiratory coupling: common rhythms in cardiac, sympathetic, and respiratory activities. Prog Brain Res. 2014;209:191-205

5. Jerath R, Barnes VA, Crawford MW. Mind-body response and neurophysiological changes during stress and meditation: central role of homeostasis. J Biol Regul Homeost Agents. 2014 OctDec;28(4):545-54.

6. Groeben H, Meier S, Tankersley CG, Mitzner W, Brown RH. Heritable differences in respiratory drive and breathing pattern in mice during anaesthesia and emergence. Br J Anaesth. 2003 Oct;91(4):541