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

The 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.

METRIC VALIDATION

The 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 the Vium Digital Vivarium™ 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 Metric 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

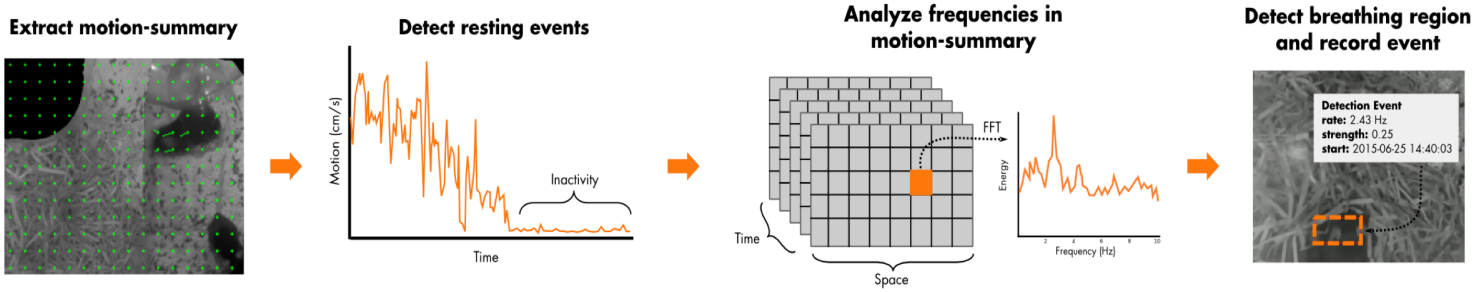

Figure 1: Breathing rate is generated from HD video using computer vision algorithms.

RESULTS

Our breathing metric was compared to breathing rate measured by the plethysmograph (Fig. 2, R2 = 0.981; RMS error = 3.7%). In this validation, we demonstrated that the 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 the Vium breathing metric accurately measures breathing rate. The Vium Digital Vivarium 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.

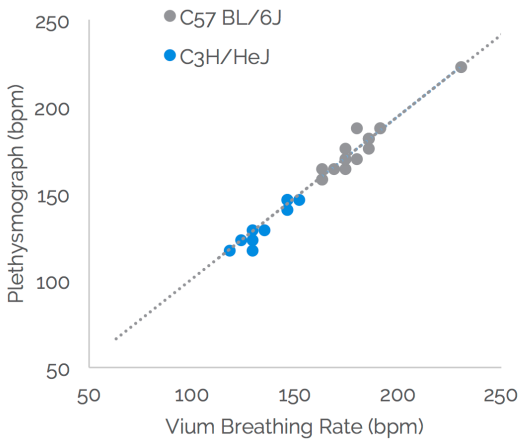

Figure 2: Breathing rate generated from the algorithm is highly correlated to breathing rate measured using the conventional plethysmograph.

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