

WHAT IS A “VALID” BREATH? – METHODOLOGICAL ISSUES

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Introduction: There is generally a lack of agreement about what constitutes a valid breath. A clear definition is particularly important to developers of computer based algorithms which estimate clinically important measures such as a respiratory rate, tidal volume and end-tidal gas measurements that are considered critical in the management of patients in clinical environments ranging from pre-hospital to the OR and ICU.

Discussion: The output of computer based algorithms is dependent upon the proper detection and clear definition of respiratory events such as the start of breath (SOB), end of breath (EOB), and the transition between inspiratory and expiratory phases. These boundaries can be inferred in a number of ways – using a constituent component of the breath (e.g. CO₂) or through more indirect measurements such as chest wall movement, or acoustic measurements. The definitions of SOB, EOB and what constitutes sufficient volume to be considered a breath are dependent upon clinical environment, context and technology. The criteria for what constitutes a patient effort or breath vary widely between the pre-hospital and hospital environments. Also what constitutes a useful gold standard needs further clarification. It is suggested that the criteria for breath detection and measurement should be optimized for the environment of use, clinical expectations and therapeutic procedure (e.g. procedural sedation, CPR, general anesthesia, and invasive and non-invasive ventilation). The relevant clinical and physiological questions asked in determining what is a breath also vary in a similar manner (e.g. is the breath “effective”, does it clear the deadspace, and does the breath represent a patient effort?). The issue is readily apparent with some algorithms where the reported breath rate can vary widely in presence of artifacts and small patient efforts. A recent study (1) using a large OR and ICU dataset found that the fraction of breaths for which the tidal volume was too small to clear the serial dead volume can be significant, and that algorithms which do not indicate the presence of very small breaths may fail to indicate hypoventilation.

Conclusion: The criteria for what constitutes a valid breath need to be clearly defined, context specific and clinically relevant. Algorithms need to better disclose their breath detection criteria and to be judged against relevant bench and clinical standards.

Reference:

1. Orr JA, Brewer LM, Jaffe MB. Evaluation of Adequacy of Tidal Volumes Using a Volumetric Capnography Reference Data Set. AARC 2010