WHAT IS "DEAD SPACE"? - METHODOLOGICAL ISSUES

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Introduction: Dead space measurement provides insight into the distribution of ventilation and matching of ventilation and perfusion.[1] The term "Wasted Ventilation" or respiratory dead space (VD) is considered to be that volume of each breath that is inhaled but does not participate in gas exchange. As well as the volume of the airway in which there is no significant exchange of oxygen and carbon dioxide.[2] However, in clinical settings and in the literature the term is used inconsistently and may describe all or any combination of the following; total, physiologic, anatomic, alveolar, and apparatus V_D.

Discussion: A partial explanation for the confusion in terminology is that the volume of VD that is measured is dependent upon a number of factors including the "type" of VD, the method of measurement, and patient particulars (e.g. intubated? spontaneously or mechanically assisted, body position).[3]

Apparatus dead space (VDapp) or equipment dead space (or mechanical or instrumental) refers to the dead space introduced in a breathing circuit used for mechanical ventilation or in some cases added volume used in the measurement of VDapp. It may be expressed as a dynamic or effective dead space (e.g. masks) to distinguish itself from geometric or physical dead space (measured volumetrically or estimated dimensionally).

Anatomic' dead space methods do not quite measure the same volume as the morphological definition. The 1 ml per lb. rule of thumb has been shown to poorly correlate body weight with measured "anatomic" dead space (r2= -0002)[4] Instead a functional definition needs to be adapted based upon the method used to estimate the anatomic dead space, often referred to as airway dead space. Methods for estimating airway dead space include equal area method, linear extrapolation of expired CO2 volume, and polynomial curve fits which have greater numerical and algorithmic complexity.

Physiologic dead space (VDphys), the sum of apparatus, anatomic and alveolar dead space, has been shown as a dead space fraction to be clinically useful including as a predictor of outcome in ALI/ARDS. While alveolar CO2 is used in the mass balance derivation of VDphys, the Enghoff modification which assumes the near equality of the PCO2 in alveolar gas and arterial blood is often applied. However, a number of approaches have used other surrogates for PACO2 including end-tidal CO2 and extrapolated values from the volumetric capnogram.

Conclusion: Values for dead space used clinically and reported in the literature need to clearly define what dead space volume is being measured and how it measured to avoid confusion and problems with interpretation of values. Improved clarity through the development of standardized terminology is suggested.

References

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