Any place for dead space?

The arterial to end-tidal CO_2 gradient, the diagnosis of pulmonary embolism and COVID-19.

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What is already known?

The difference between the end-tidal carbon dioxide ($ETCO_2$) and arterial carbon dioxide ($PaCO_2$) represents alveolar dead space.

This is commonly characterised as the alveolar dead space fraction (AVDSf) as shown in the equation – right. Pulmonary embolism (PE) increases dead space as shown in the diagram – below. It is therefore hypothesised that AVDSf may be a useful diagnostic tool for PE. Research in the Emergency Department has shown that AVDSf can help exclude PE when combined with other diagnostic tests.

Patients with COVID-19 are at high risk of concurrent PE but diagnosis in invasively ventilated patients is challenging due to limitations with routine assessment, infection control issues and clinical instability. No studies have assessed the potential role of AVDSf in this diagnostic process.

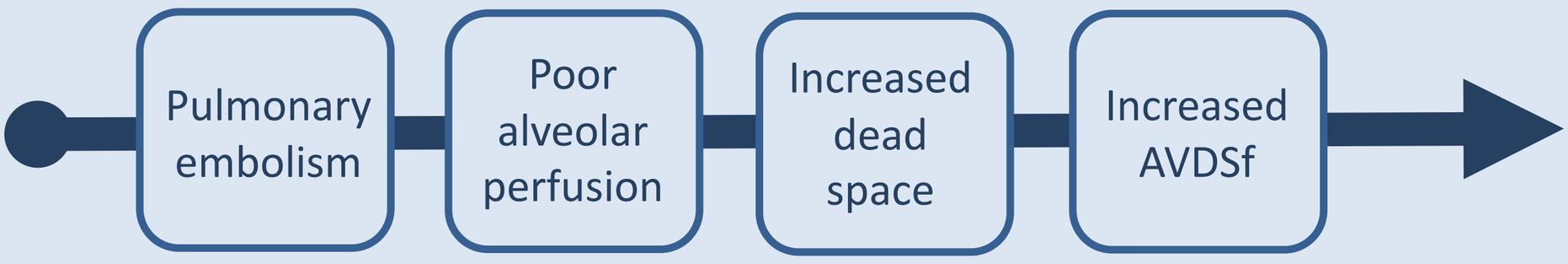
Alveolar Dead Space Fraction (AVDSf)

$$\frac{P_aCO_2 - P_{ET}CO_2}{P_aCO_2}$$

What did we do?

We undertook a retrospective, single-centre cohort study to investigate the diagnostic utility of AVDSf prior to Computed Tomography Pulmonary Angiogram (CTPA) in patients with severe COVID-19 and suspected PE.

All invasively ventilated patients with confirmed COVID-19 who underwent CTPA between March 2020 and April 2021 at a large NHS hospital were included.



Data collection

AVDSf values were derived from routine data taken at the closest available timepoint prior to the CTPA. Consultant radiologist reporting of the CTPA images was used as the reference standard for PE diagnosis.

Data overview

48 CTPAs were included in the final analysis.

Therapeutic-dose anticoagulation was given before CTPA in 45.8% (n=22) of cases.

The mean pre-CTPA PaO_2/FiO_2 (P/F ratio) was 134 mmHg (IQR 56.1).

The mean age of patient was 56 and the 28-day mortality was 70.4%.

What did we find?

n=48

PE on CTPA	No PE on CTPA
n=25	n=23
Mean AVDSf = 0.34	Mean AVDSf = 0.32

Difference in AVDSf between those with PE and those without was 0.02 and **was not significant** (*p*=0.255).

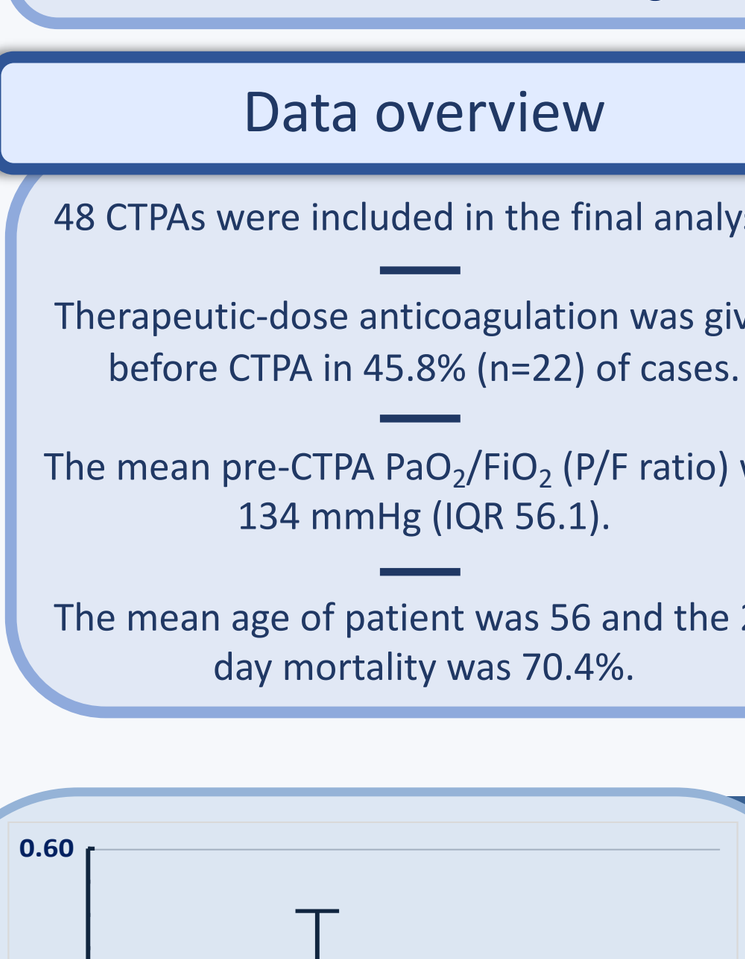
AVDSf as a diagnostic test

Determined cut off at 0.33:
Sensitivity = 0.56
Specificity = 0.48
Positive likelihood ratio = 1.07

AVDSf did not provide diagnostic utility at any cut-off. AUC = 0.561.

Of the 25 PEs found on CTPA:
8 were central/lobar.
11 were segmental.
6 were sub-segmental.

If sub-segmental PEs were excluded from PE positive group the mean AVDSf in PE positive group remained 0.35.



Box and whisker plot of pre-CTPA AVDSf in patients with PE (blue) and without PE (red).

Bottom line

Alveolar dead space fraction does not appear to add any diagnostic value when determining which patients with severe COVID-19 have a pulmonary embolism.

Strengths and limitations

This is the first study examining the use of AVDSf in COVID-19 patients. Identification of PE in patients with COVID-19 remains challenging and the information yielded from this study pragmatically addresses an area with limited existing research.

This study was single-centre and retrospective, with AVDSf only calculated at one time-point. We did not adjust for disease severity and all patients included in the study received mechanical ventilation, therefore our findings may not be generalisable to the overall COVID-19 population presenting to secondary care.

Where next?

Further research should consider examining the role of AVDSf in ambulatory COVID-19 patients presenting to secondary care. Research could also assess the potential value of monitoring changes in AVDSf over time as a diagnostic tool for PE.

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The authors of this study declare no conflicts of interest.