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CO_2 oscillation during Cardiopulmonary Resuscitation: the role of respiratory system compliance.

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Dear Editor,

we read with interest the manuscript by Dr. Grieco and colleagues entitled "Intrathoracic airway closure impacts CO_2 signal and delivered ventilation during cardiopulmonary resuscitation" (1).

The authors conducted a very elegant clinical investigation corroborated by focused experiments in the Thiel cadaver model, describing a peculiar oscillatory capnographic pattern during cardiopulmonary resuscitation (CPR). From the results, it has been speculated that a low oscillating CO_2 during chest compressions is due to the presence of airway collapse, which obstructs the airflow. However, as mentioned by the authors in the discussion, individual differences in the compliance of the respiratory system (Cpl,rs, including the lungs and of the chest wall) could have a great preminence in explaining this finding. For a given pressure applied to the sternum during a chest compression, the gas volume displacement will be directly proportional to the compliance of the respiratory system. Therefore, patients with a lower Airway Opening Index (AOI) may have had lower Cpl,rs. This would also explain the correlation between alveolar ventilation and AOI, because greater ventilation was likely in patients with higher compliance. Interestingly, a greater AOI was observed in patients with a shockable rhythm, who are likely to have a shorter duration of cardiac arrest compared to those with non-shockable rhythms and thus a lesser deterioration in Cpl,rs (2)

We wonder about the correlation between Cpl,rs measured during regular tidal ventilation and AOI.

While small airway closure might affect the measurement of compliance, this is unlikely during regular tidal ventilation. We accept that a formal 'static' measurement of Cpl cannot be obtained during chest compression, but a good estimate would be possible from the delivered Vt, given that a constant inspiratory pressure was applied. Indeed, a reliable value for Cpl,rs can be obtained in the Thiel cadavers.

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Respiratory system compliance could also explain the beneficial effects of Positive End Expiratory Pressure (PEEP). Ventilation due to chest compression occurs between Functional Residual Capacity and residual volume (3). At this level of lung volume, the Pressure-Volume (PV) curve of normal subjects is less compliant than it is above FRC (4). The application of PEEP would increase the end-expiratory lung volume and cause the chest compressions to "ventilate" the respiratory system in a more compliant part of the PV curve, leading to greater tidal volume and greater alveolar ventilation.

Finally, the "circulatory" component of CPR, i.e. forward blood flow generated by chest compression, impacts $EtCO_2$ and might potentially affect the subsequent AOI calculation. Indeed, ventilation and hemodynamics are deeply interconnected in the pathophysiology of CPR, as cardiac output is the major determinant of CO_2 transport to the lungs. Since cardiac output may vary during CPR in relationship to chest compression quality and/or patient's condition, e.g. development of stoned heart for prolonged resuscitation and Cpl,rs modification, the evolving AOI may change over time.

In conclusion while we believe that the work by Grieco et al., does not completely tease out the relative contributions of compliance *vs*. airway closure in the generation of CO_2 oscillation, their findings have tremendous clinical relevance, particularly for the potential benefits of PEEP during CPR and highlight the importance of more studies on the topic.

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