The Association Between Arterial-End-Tidal Carbon Dioxide Difference and Outcomes After Out-of-Hospital Cardiac Arrest

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Introduction: End-tidal carbon dioxide ($E\text{\textsubscript{T}}\text{CO}_2$) is frequently used in cardiac arrest care to assess the adequacy of chest compressions and tracheal tube placement, as well as a surrogate marker for cardiac output. However, multiple studies have also investigated the usefulness of $E\text{\textsubscript{T}}\text{CO}_2$ as an indicator of resuscitation from cardiac arrest, as $E\text{\textsubscript{T}}\text{CO}_2$ values have been shown to correlate with cardiac output, myocardial perfusion pressure, and return of spontaneous circulation. Its prognostic value may be affected by arterial carbon dioxide ($P\text{\textsubscript{a}}\text{CO}_2$) tension. We sought to determine if the difference between $P\text{\textsubscript{a}}\text{CO}_2$ and $E\text{\textsubscript{T}}\text{CO}_2$ is associated with hospital mortality and neurologic outcome following OHCA.

Methods: This was a retrospective cohort study of adult patients (≥18 years) who achieved sustained return of spontaneous circulation (ROSC) following treatment for OHCA by Seattle Fire Department (SFD) between January 1, 2017 and December 31, 2019. The primary exposure was the $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ difference on hospital arrival, achieved by using the first available $P\text{\textsubscript{a}}\text{CO}_2$ recorded in the electronic health record and the last $E\text{\textsubscript{T}}\text{CO}_2$ value captured by SFD. The primary outcome of the study was survival to hospital discharge. The secondary outcome was favorable neurologic status at discharge, as measured by the Cerebral Performance Category (CPC) score. We used receiver operating characteristic (ROC) curves to determine discrimination threshold and multivariate logistic regression to examine the association between the $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ difference and outcome.

Results: Of 701 OHCA patients transported to the hospitals, 263 had sustained ROSC and qualifying $E\text{\textsubscript{T}}\text{CO}_2$ and $P\text{\textsubscript{a}}\text{CO}_2$ values. Of these, 116 (44%) survived to hospital discharge. Patients had similar baseline characteristics, including initial cardiac rhythm, regardless of survival. The median $E\text{\textsubscript{T}}\text{CO}_2$ was 37 (IQR 10) mmHg among survivors and 39 (IQR 17) mmHg among non-survivors as measured by the last EMS value prior to ED arrival. The median $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ was 10 mmHg (IQR 11) and 15 mmHg (IQR 21) ($p<0.05$) for survivors and non-survivors. After adjusting for covariates, a higher $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ difference on hospital arrival was associated with higher hospital mortality (OR 0.97, 95% CI: 0.95-0.99). Area under the receiver operator characteristic curve (AUC-ROC) for $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ difference was 0.64 (95% CI 0.57-0.70) compared with 0.56 (95% CI 0.49-0.63) for $E\text{\textsubscript{T}}\text{CO}_2$ alone. In a multivariable model, lower $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ difference was associated with favorable neurologic status upon discharge (OR 0.97, 95% CI: 0.95-0.99) with an AUC of 0.60 (95% CI 0.53-0.67, Table 3) for favorable neurologic status at discharge compared with AUC 0.51 (95% CI 0.44-0.58, Table 3) for $E\text{\textsubscript{T}}\text{CO}_2$ alone.

Conclusion: $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ is associated with survival to hospital discharge and neurologic status on discharge in OHCA patients and can be used as a prognostic tool in post-arrest care. Future studies should examine the role of $P\text{\textsubscript{a}}\text{CO}_2-E\text{\textsubscript{T}}\text{CO}_2$ as a possible monitoring tool and marker of recovery in post-arrest care.