**In Silico Estimation of the Performance of Transcutaneous CO2 Sensors for Detecting Hypercapnia in Newly Admitted Inpatients**

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**Introduction:**

Studies assessing the prevalence or clinical consequence of hypercapnia require reliable ascertainment of which patients have hypercapnia. Arterial blood gas (ABG) sampling is the reference standard test, but it is painful, can cause complications, and so is not universally obtained. We sought to combine previously reported estimates of transcutaneous CO2 (TcCO2) sensor accuracy with the distribution of arterial partial pressure of CO2 (PaCO2) results obtained across the United States to estimate whether TcCO2 monitors might be used to improve hypercapnia identification among inpatients.

**Methods:**

Inpatient encounters occurring Jan 1 to Dec 31, 2022, where an arterial blood gas was drawn on the day of admission were requested from the TriNetX research network (TriNetX, LLC. Cambridge, Massachusetts), which aggregates electronic health record data from 76 medical centers across the United States summarizing the care roughly 115 million patients. We simulated a TcCO2 reading for each PaCO2 measurement using test performance estimates from the 72 study- (2817 patients-) meta-analysis by Conway et al. (Thorax, 2017. Mean bias: TcCO2 0.0851 mmHg lower than PaCO2; pooled within-study standard deviation of the disagreement of 3.51 mmHg). Simulated readings were classified as true negatives (both PaCO2 and TcCO2 < 45 mmHg), false positive (PaCO2 < 45 mmHg but TcCO2 ≥ 45 mmHg), true positive (both PaCO2 and TcCO2 ≥ 45 mmHg), or a false negative (PaCO2 ≥ 45 mmHg but TcCO2 < 45 mmHg).

**Results:**

158,228 arterial blood gasses showed a mean PaCO2 of 42.6 (SD 17.3) mmHg. Hypercapnia was present in 47,995 (30.3%). Simulated paired TcCO2 measurements would identify 103,246 (65.3%) as a true negative, 6,977 (4.4%) as a false positive, 41,652 (26.32%) as a true positive, and 6,343 (4.0%) as a false negative (Figure 1). The estimated sensitivity is 86.8%, specificity is 93.6%, negative predictive value is 85.9%, and positive predictive value is 94.0%.

**Conclusions:**

Many newly admitted patients with hypercapnia have substantial PaCO2 elevation, so a binary determination of whether hypercapnia is present is unlikely to change if reported rates of concordance between TcCO2 and PaCO2 are accurate. However, one limitation is that patients who receive arterial blood gasses may have higher PaCO2 elevations than patients who are currently missed. This would lead to a decreased accuracy of TcCO2 among all patients with hypercapnia as compared with the subset who receive ABGs. Additionally, the true distribution of disagreement TcCO2-PaCO2 may not be Gaussian and the uncertainty of TcCO2-PaCO2 agreement was not explicitly modeled.

