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

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**Introduction:**

A method to reliably identify which patients have an elevated arterial partial pressure of CO2 (PaCO2) is required to rigorously study hypercapnic respiratory failure. Arterial blood gas (ABG) sampling is the reference standard, but it is painful, can cause complications, and is therefore not always obtained in usual care. Requiring ABG sampling may dissuade patients from participating in prospective studies, and may result in biased detection of hypercapnia in studies using passive detection. We sought to combine previously reported estimates of transcutaneous CO2 (TcCO2) sensor accuracy with the distribution of PaCO2 results to evaluate whether TcCO2 monitors might be accurate enough to identify hypercapnia among hospitalized adults.

**Methods:**

Inpatient encounters occurring Jan 1 to Dec 31, 2022 in which an ABG was drawn on the day of admission were requested from the TriNetX research network, which aggregates electronic health record data from 76 medical centers and roughly 115 million patients across the United States. We simulated a TcCO2 reading for each PaCO2 measurement using test agreement estimates from the meta-analysis by Conway et al. (Thorax, 2017) which estimated a mean bias of TcCO2 0.09 mmHg lower than PaCO2 and a population standard deviation (accounting for both within- and between-study variance) of 4.60 mmHg. Results were classified as true negatives (PaCO2 and TcCO2 < 45mmHg), false positives (PaCO2 < 45mmHg, TcCO2 ≥ 45mmHg), true positives (PaCO2 and TcCO2 ≥ 45mmHg), or false negatives (PaCO2 ≥ 45mmHg, TcCO2 < 45mmHg). Operating characteristics were subsequently calculated.

**Results:**

158,228 ABGs were included (57.8% critical care; 54.9% male; 35.3% ventilated; 65.4% non-Hispanic white, 14.4% black, 5.5% Hispanic; mean age 62.1 ± 16.4 years) showing a mean PaCO2 of 42.6 ±17.3mmHg. Hypercapnia was present in 47,995 (30.3%). Simulated TcCO2 measurements yielded the following operating characteristic estimates: sensitivity 84.2%, specificity 91.0%, negative predictive value 93.0%, and positive predictive value 80.4%.

**Conclusions:**

Our simulation suggests the accuracy of TcCO2 for binary classification of hypercapnia is likely to be high because many admitted patients have PaCO2 values sufficiently far from the threshold to make classification errors unlikely, given reported limits of agreement. Two limitations of this work are that patients receiving ABGs may have more extreme PaCO2 derangements than those without ABGs and disagreements between TcCO2-PaCO2 might be non-Gaussian. Nonetheless, TcCO2 may be a useful tool to more reliably capture the occurrence of hypercapnia among inpatients.

A graph of a normal distribution

Description automatically generated with medium confidence