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VALIDATION OF TRANSCUTANEOUS CARBON DIOXIDE DURING PULSATILE ADULT CARDIOPULMONARY BYPASS

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Purpose

Measurements of transcutaneous carbon dioxide ($tcCO_2$) have been used in multiple venues, such as during procedures utilizing jet ventilation, the ICU and neo-natal ICU. These measurements are evaluated at the tissue level and provide actionable information regarding the production of CO_2. Several locations for the $tcCO_2$ sensor have been previously validated. However, $tcCO_2$ measurements have not been validated under the conditions of cardiopulmonary bypass (CPB). The purpose of this study was to 1) validate the use of $tcCO_2$ during CPB and 2) identify a location for the sensor that would optimize estimation of $PaCO_2$ when compared to the gold standard of blood gas analysis.

Methods

$tcCO_2$ measurements (N = 141) were collected every 30 minutes during 46 pulsatile CPB procedures and compared to arterial and venous blood gas values, cerebral regional saturations, SVRI, VCO2i, and other parameters . Three sensor locations were examined: forehead, ear lobe, and submandibular area. The agreement / differences between the $tcCO_2$ and the $PaCO_2$ were compared by sensor location. Multiple linear correlation was used to model the $tcCO_2$-$PaCO_2$ difference as a function of the other collected parameters.

The table shows that the $tcCO_2$ values agreed best with the $PaCO_2$ in the submandibular position.

$tcCO_2$ - $PaCO_2$ Difference Versus TC Sensor Location

TC Sensor Location	N	Mean	Stdev	Median	IQR	p Value
1 Forehead	71	2.9	8.1	1.4	12.5	2 = 0.001
						3 = 0.470
2 Ear Lobe	28	-2.9	2.6	-3.1	3.0	1 = 0.001
						3 = 0.047
3 Submandibular	42	1.5	7.8	-0.3	5.6	1 = 0.470
						2= 0.047

Comment: Stdev = standard deviation, IQR = interquartile range, p Value is compared to other location groups.

The small median difference and acceptable IQR support the validity of the $tcCO_2$ measurement. The linear regression model for predicting the agreement between $tcCO_2$ and $PaCO_2$ included the cerebral regional saturation and the PVO_2 ($r = 0.497$, $df = 140$, $p < 0.001$).

Conclusions

Our experience in utilizing $tcCO_2$ during CPB has demonstrated accuracy in estimating $PaCO_2$ when compared to the gold standard arterial blood gas analysis. The best agreement between the transcutaneous CO_2 values and arterial blood pCO_2 analysis was observed when the sensor was placed in the submandibular position.