Should The Non Invasive Co2 Monitoring Be Used As A Part Of The Daily Routine?

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Citation

Abstract
We compared practicality and trustworthiness of invasive arterial blood gas, noninvasive ventilator monitoring, transcutaneous monitoring and pulse oxymeter on the 20 patients whom we applied mechanical ventilation in ICU. The study included 100 synchronous measures including arterial blood gas, ventilator monitor measures, transcutaneous monitor measures and patient side monitor measures of patients. No statistically significant correlation is found between ETCO$_2$ and PtcCO$_2$ as well as ETCO$_2$ and blood gas PCO$_2$ measures. A positive and good level of statistically significant correlation is found between PtcCO$_2$ and blood gas PCO$_2$ measures ($p<0.01$). The PtcCO$_2$ values which were measured with transcutaneous SPO$_2$/PtcCO$_2$ monitor were fully correlated with blood gas CO$_2$ values, PtcCO$_2$ values are found to be superior to ETCO$_2$ values. When technical problems such as probe maintenance, sensor sensitivity and the need for frequent calibration are overcome, it is also considered that transcutaneous CO$_2$ monitoring will be an essential monitoring for ICU.

INTRODUCTION
In ICU, the continuous monitoring of CO$_2$ and pH of the patient who is under mechanical ventilation is as important as SPO$_2$ monitoring. Nowadays SPO$_2$ can be monitored by non invasive method in a safe and practical manner; however machines which can measure non invasive CO$_2$ are being tried and hence being further improved. Furthermore, same method and machine is under trial to measure pH. In our study, we compared practicality and trustworthiness of invasive arterial blood gas (PCO$_2$, SatO$_2$), noninvasive ventilator monitoring (ETCO$_2$, SPO$_2$, PR), transcutaneous monitoring (PtcCO$_2$, SPO$_2$, PR) and pulse oxymeter (SPO$_2$, PR) on the patients whom we applied mechanical ventilation in ICU.

METHODS
The study included 100 synchronous measures including arterial blood gas, ventilator monitor measures, transcutaneous monitor measures and patient side monitor measures of patients whom we applied mechanical ventilation in ICU due to various reasons. Arterial blood CO$_2$ pressure (PCO$_2$) and arterial blood O$_2$ saturation (SatO$_2$) in arterial blood gas are measured with Chiron/Diagnostic 865. End tidal CO$_2$ (ETCO$_2$), peripheral O$_2$ saturation [SPO2(V)], peripheral pulse [PR(V)] are measured with Drager Evita 4 (Lubeck, Germany) ventilator monitor. Transcutaneous CO$_2$ (PtcCO$_2$), peripheral O$_2$ saturation [SPO2(T)], peripheral pulse [PR(T)] are measured with Sen Tec Digital Monitor System (V-Sign). Peripheral O$_2$ saturation [SPO2(M)] and peripheral pulse [PR(M)] are measured with Drager Infinity Kappa (Germany) monitor saturation probe. All of these are measured and recorded synchronously and compared with each other.

Before starting the measures, the required calibration of transcutaneous monitor and ventilator is made. In all the measures, the probe of transcutaneous machine is fixed to the right ear lobe of the patient with the probe’s clip. Before the measures, it’s ensured that the ear lobe is clean. Difficulties such as the need for frequent calibration, re-fixation of the probe’s position, and the occurrence of unexplainable errors at unexpected times are encountered. During the evaluation of the findings of the study, the SPPS for Windows 10.0 software is used for statistical analysis. During the evaluation of the data from the study, Pearson correlation analysis is used to calculate the correlation of the quantitative data along with the descriptive statistical methods (average, standard deviation). Conclusions are evaluated within the 95% confidence interval and at $p<0.05$. 

1 of 5
RESULTS

A positive and very good level of statistically significant correlation is found between the values of arterial blood O$_2$ saturation (SatO$_2$), peripheral O$_2$ saturation with ventilator monitor [SPO$_2(V)$], peripheral O$_2$ saturation with Transcutaneous monitor [SPO$_2(T)$], peripheral O$_2$ saturation with patient side monitor saturation probe. (p<0.01) (Table 1)

Figure 1

Table 1: SPO(V), SPO(M), SPO(T) ve SatO corelations

No statistically significant correlation is found between ETCO$_2$ and PtcCO$_2$ as well as ETCO$_2$ and blood gas PCO$_2$ measures. (p>0.05), (Table 3).

Figure 3

Table 3: ETCO, PtcCO ve PCO corelations

A positive and very good level of statistically significant correlation is found between the measured values of ventilator monitor and peripheral pulse [PR(V)], transcutaneous monitor and peripheral pulse [PR(T)], patient side monitor probe and peripheral pulse [PR(M)] (p<0.01) (Table 2)

Figure 2

Table 2: PR(V), PR(M) ve PR(T) corelations

A positive and good level of statistically significant correlation is found between PtcCO$_2$ and blood gas PCO$_2$ measures. (p<0.01) (Graphic 1)

Figure 4

Graphic 1: PtcCO ile PCO corelation

DISCUSSION

For the patients who are under mechanical ventilation in ICU as well as for the ones who are under anesthesia, the O$_2$ and CO$_2$ monitoring are the “must be performed” ones. Although monitoring with the arterial blood gas is trustable, because of the fact that it’s invasive and does not allow continuous monitoring, it is unpractical to apply. In this case, the importance of continuous noninvasive monitoring is once again highlighted. In this subject, SPO$_2$ monitoring
with saturation probes and ETCO\textsubscript{2} monitoring with gas sample taken from the expiratory branch of the ventilator circuit are the methods that have been in use for a long time. It’s also a fact that ETCO\textsubscript{2} does not always move in parallel with the arterial CO\textsubscript{2}. Also our findings did not find any correlation between ETCO\textsubscript{2} and arterial CO\textsubscript{2}. Because of these reasons, search for non invasive CO\textsubscript{2} measure methods is continuing. In the recent years, due to ease of use, monitors tracking transcutaneous PtcCO\textsubscript{2} monitoring and SPO\textsubscript{2} through non invasive ear probe have started to be utilized (1,2,3).

McCormack et al. (4) investigated the clinical utility of transcutaneous carbon dioxide monitoring in the postoperative period, and quantified the effects of different perioperative analgesic regimens on postoperative respiratory function. They found that; the transcutaneous capnometer successfully recorded data for 98 % of the total time when it was applied to patients.

Casati A et al. (5) compared end tidal carbon dioxide (ETCO\textsubscript{2}) with transcutaneous CO\textsubscript{2} measurements during mechanical ventilation in elderly patients. They reported that; transcutaneous monitoring of CO\textsubscript{2} partial pressure gave a more accurate estimation of arterial CO\textsubscript{2} partial pressure than end tidal carbon dioxide (ETCO\textsubscript{2}) did.

Dullenkopf et al. (6) compared SPO\textsubscript{2} with ETCO\textsubscript{2} from patient side monitor and SPO\textsubscript{2} with PtcCO\textsubscript{2} from transcutaneous monitor ear probe with 111 blood gas sample taken from 60 children patients who had anesthesia. As a result, they found that transcutaneous measures were correlated with arterial blood gas and other monitor measures. They reported that transcutaneous measures can be used in anesthesia applications.

Griffin et al. (7) compared arterial blood gas PaCO\textsubscript{2} measures with ETCO\textsubscript{2} and PtcCO\textsubscript{2} measures in 30 morbid obese patients who had gastric bypass operation and found a better correlation between PtcCO\textsubscript{2} and PaCO\textsubscript{2} than ETCO\textsubscript{2}. As a result of our study, we found the same significant correlation between PtcCO\textsubscript{2} and PaCO\textsubscript{2}.

Oshibushi et al. (8) found a correlation between PtcCO\textsubscript{2} and ETCO\textsubscript{2} in 26 patients who had thorax surgery.

Nelson et al. (9) showed that they detected hypoventilation, which they could not detect prior by using only SPO\textsubscript{2} monitoring, by using transcutaneous SPO\textsubscript{2} / PtcCO\textsubscript{2} monitor in patients whom they applied sedation during ERCP.

Tatevossian et al. (10) utilized SPO\textsubscript{2} PtcCO\textsubscript{2} monitor during early resuscitation stage of trauma patients who had ARDS. They reported that high PtcCO\textsubscript{2} and low SPO\textsubscript{2} are important as early indicators of poor tissue perfusion in patients who died at that stage and that it can be used in daily routine.

Janssens et al. (11) found correlation between blood gas measures and monitor measures in a study in which they evaluated trustworthiness and ease of use of the transcutaneous SPO\textsubscript{2} / PtcCO\textsubscript{2} monitor. They reported that they did not have problems with the probe they fixed to the same ear for 8 hours and had no skin burns. We also did not have any skin burns during our study but we had unwanted difficulties such as no measuring or incorrect measuring. We overcame these difficulties with simple methods such as recalibration or changing the place of clip on the ear. These methods which seem simple were discouraging and time consuming.

As a conclusion of our study, as the PtcCO\textsubscript{2} values which were measured with transcutaneous SPO\textsubscript{2} / PtcCO\textsubscript{2} monitor were fully correlated with blood gas CO\textsubscript{2} values, PtcCO\textsubscript{2} values are found to be superior to ETCO\textsubscript{2} values.

Compared to blood gas monitoring, transcutaneous CO\textsubscript{2} monitoring is evaluated to be more comfortable for the patient and more practical for the doctor since it’s non invasive and allows continuous monitoring. However the difficulties that the machine brings to users such as probe maintenance, sensor sensitivity, need for frequent calibration and need for extensive maintenance requirements in long term usage can be underestimated. It’s a fact that once technical difficulties are overcome, this method will be an essential monitoring device for ICUs.

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**References**


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