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

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Citation

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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 ETCO₂ and PtcCO₂ as well as ETCO₂ and blood gas PCO₂ measures. A positive and good level of statistically significant correlation is found between PtcCO₂ and blood gas PCO₂ measures (p<0.01). The PtcCO₂ values which were measured with transcutaneous SPO₂/PtcCO₂ monitor were fully correlated with blood gas CO₂ values, PtcCO₂ values are found to be superior to ETCO₂ values. When technical problems such as probe maintenance, sensor sensitivity and the need for frequent calibration are overcome, it is also considered that transcutaneous CO₂ 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 $p<0.05$.

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 [SPO2(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

		$SPO_2(V)$	$SPO_2(M)$	$SPO_2(T)$	$SatO_2$
$SPO_2(V)$	r		0,839	0,898	0,922
	p		0,001**	0,001**	0,001**
	n		100	100	100
$SPO_2(M)$	r	0,839		0,808	0,846
	p	0,001**		0,001**	0,001**
	n	100		100	100
$SPO_2(T)$	r	0,898	0,808		0,820
	p	0,001**	0,001**		0,001**
	n	100	100		100
$SatO_2$	r	0,922	0,846	0,820	
	p	0,001**	0,001**	0,001**	
	n	100	100	100	

** p<0,01

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

		PR(V)	PR(M)	PR(T)
PR(V)	r		0,993	0,988
	p		0,001**	0,001**
	n		100	100
PR (M)	r	0,993		0,989
	p	0,001**		0,001**
	n	100		100
PR (T)	r	0,988	0,989	
	p	0,001**	0,001**	
	n	100	100	

** p<0,01

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

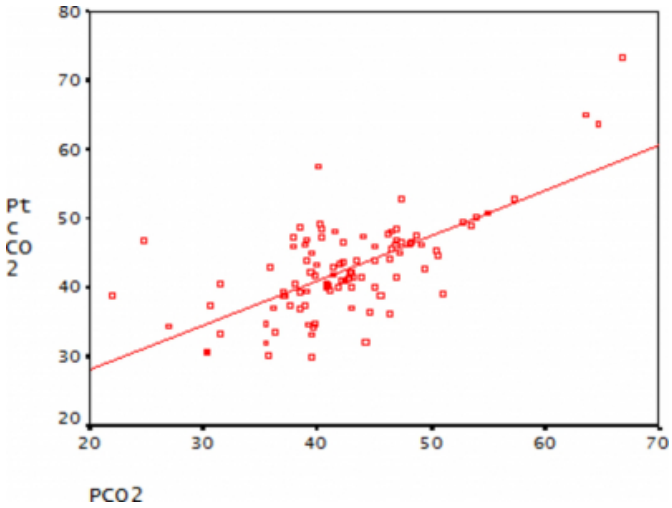
		$ETCO_2$	$PtcCO_2$	PCO_2
$ETCO_2$	r		0,279	0,115
	p		0,122	0,539
	n		100	100
$PtcCO_2$	r	0,279		0,677
	p	0,122		0,001**
	n	100		100
PCO_2	r	0,115	0,677	
	p	0,539	0,001**	
	n	100	100	

** p<0,01

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 $ETCO_2$ 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 $ETCO_2$ does not always move in parallel with the arterial CO_2. Also our findings did not find any correlation between $ETCO_2$ and arterial CO_2. Because of these reasons, search for non invasive CO_2 measure methods is continuing. In the recent years, due to ease of use, monitors tracking transcutaneous $PtcCO_2$ monitoring and SPO_2 through non invasive ear probe have started to be utilized ([1],[2],[3]).

McCormack et al. ([2]) 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. ([3]) compared end tidal carbon dioxide ($ETCO_2$) with transcutaneous CO_2 measurements during mechanical ventilation in elderly patients. They reported that; transcutaneous monitoring of CO_2 partial pressure gave a more accurate estimation of arterial CO_2 partial pressure than end tidal carbon dioxide ($ETCO_2$) did.

Dullenkopf et al. ([4]) compared SPO_2 with $ETCO_2$ from patient side monitor and SPO_2 with $PtcCO_2$ 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. ([5]) compared arterial blood gas $PaCO_2$ measures with $ETCO_2$ and $PtcCO_2$ measures in 30 morbid obese patients who had gastric bypass operation and found a better correlation between $PtcCO_2$ and $PaCO_2$ than $ETCO_2$. As a result of our study, we found the same significant correlation between $PtcCO_2$ and $PaCO_2$.

Oshibushi et al. ([6]) found a correlation between $PtcCO_2$ and $ETCO_2$ in 26 patients who had thorax surgery.

Nelson et al. ([7]) showed that they detected hypoventilation, which they could not detect prior by using only SPO_2 monitoring, by using transcutaneous SPO_2 / $PtcCO_2$ monitor in patients whom they applied sedation during ERCP.

Tatevossian et al. ([8]) utilized SPO_2 $PtcCO_2$ monitor during early resuscitation stage of trauma patients who had ARDS. They reported that high $PtcCO_2$ and low SPO_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. ([9]) 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_2 / $PtcCO_2$ 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 $PtcCO_2$ 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.

Compared to blood gas monitoring, transcutaneous CO_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 overcame, this method will be an essential monitoring device for ICUs.

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