

# Correlation of Pao<sub>2</sub>/Fio<sub>2</sub> Ratio with Spo<sub>2</sub>/Fio<sub>2</sub> Ratio in Children on Mechanical Ventilation

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## ABSTRACT

**Background:** Mechanical ventilation is frequently used in pediatric patients to ensure adequate gas exchange, improve respiratory distress, and to resolve pulmonary or other disorders. Monitoring of various parameters which are invasive, while patient is on mechanical ventilation it is fundamental to observe the progress of patient's condition. We conducted this study to observe if PaO<sub>2</sub>/Fio<sub>2</sub> and the ratio of SPO<sub>2</sub> /Fio<sub>2</sub> can be used interchangeably, we can have option for lesser invasive parameter.

**Aim:** To determine the correlation of PaO<sub>2</sub>/Fio<sub>2</sub> with SPO<sub>2</sub> /Fio<sub>2</sub> ratio in children on mechanical ventilation.

**Methods:** A Cross-sectional study, Non-probability and purposive sampling. The study conducted at The Children's hospital and the Institute of Child Health, Lahore from 04-10-2017 to 03-06-2018.

Informed consent was obtained. Arterial blood gas sampling for calculation of PaO<sub>2</sub>/Fio<sub>2</sub> ratio and simultaneous recording of SPO<sub>2</sub> for measurement of SPO<sub>2</sub>/Fio<sub>2</sub> ratio was done. The data collected was analysed on S.P.S.S (Statistical Package for Social Sciences) version 22.

**Results:** In this study 30 patients on mechanical ventilation were enrolled with mean age of 58.55±5 months. There was male predominance. (M: F ratio 2:1). This study showed a strong positive correlation of the PaO<sub>2</sub>/Fio<sub>2</sub> with SPO<sub>2</sub>/Fio<sub>2</sub> that is r=0.603.

**Conclusion:** According to our study noninvasive SpO<sub>2</sub>/Fio<sub>2</sub> ratio (Pfr) can reliably be used in place of PaO<sub>2</sub>/Fio<sub>2</sub> ratio (SFr) in children on mechanical ventilation as a strong correlation was observed between them. The advantage is invasive arterial sampling can be replaced by non-invasive pulse oximetry for oxygen saturation.

**Key words:** Mechanical Ventilation, Pediatric ICU, SPO<sub>2</sub>/Fio<sub>2</sub>, PaO<sub>2</sub>/Fio<sub>2</sub>

## INTRODUCTION

According to an estimate 30-64% of pediatric ICU patients need mechanical ventilation.<sup>1</sup> The ones on mechanical ventilation are traditionally monitored by various measures of oxygenation to observe the progress. Many monitoring indices can be used like arterial to alveolar oxygen difference, but mostly Pfr ( PaO<sub>2</sub>/ Fio<sub>2</sub> ratio) has been used routinely because it is simple.<sup>2</sup> When patient is in intensive care frequent oxygenation measurements are required which is done by invasive method of arterial prick as in many patients, an arterial line is not routinely placed.<sup>3</sup> In addition arterial sampling is now being increasingly discouraged in ICUs due to cost, complications like anemia & hematoma at needle site.

Many less invasive ways to monitor patients on positive pressure ventilation have been proposed by several authors which include SFr (SPO<sub>2</sub>/Fio<sub>2</sub> ratio), SPO<sub>2</sub>/PaCO<sub>2</sub> and SPO<sub>2</sub> by saturation monitor.<sup>2</sup> Some other studies identified strong relation between Pfr, SFr and oxygen index indicating that these indices can be replaced interchangeably at bedside in sick patients on mechanical ventilation.<sup>1-4</sup> Adult studies have demonstrated that use of pulse oximetry has shown 40-60% reduction in arterial blood gas measurements with no adverse effects on patient outcome.<sup>1</sup> A non invasive marker for PaO<sub>2</sub>/Fio<sub>2</sub> ratio can be very helpful alternate for decreasing arterial measurements. Similarly some studies in children have also proved this correlation in context of detecting acute lung injury and respiratory distress syndrome.<sup>5-7</sup> Hardly any studies have been done in Pakistan. This study is done to determine the correlation between PaO<sub>2</sub>/Fio<sub>2</sub> and SPO<sub>2</sub>/Fio<sub>2</sub> ratio, so that the burden and cost of invasive markers can be reduced.

The objective of the study was to determine the correlation between PaO<sub>2</sub>/Fio<sub>2</sub> and SPO<sub>2</sub>/Fio<sub>2</sub> ratio in children on Mechanical ventilation.

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## MATERIAL AND METHODS

It was a cross-sectional study done at the Pediatric ICU, The Children's Hospital, Lahore from 04-10-2017 to 03-06-2018. All patients in PICU on mechanical ventilator with a stay of at least 48 hours were enrolled. While patients with chronic disease (Pulmonary obstructive or restrictive), on mechanical ventilation for less than 48 hours and those with unstable clinical condition 3 hours before and 3 hours after the time of measurement were not included.

**Data Collection:** A total number of 30 patients on mechanical ventilation after fulfilling the study criteria were included. Approval was taken from Ethical committee. Parents were informed about the procedure and consent obtained. All the children were subjected to detailed history and physical examination and demographic data recorded. Arterial blood gas sampling for calculation of Pfr and measurement of SFr was done simultaneously (within 5 minutes). Data was collected on predesigned proforma.

**Data analysis** was done by S.P.S.S Version 22. Quantitative data like age, SPO<sub>2</sub>/Fio<sub>2</sub>, PaO<sub>2</sub>/Fio<sub>2</sub> shown as mean ± SD (standard deviation), while qualitative data was presented as frequency and percentage (%). Pearson correlation was applied to find correlation between SPO<sub>2</sub>/Fio<sub>2</sub> and PaO<sub>2</sub>/Fio<sub>2</sub>. A P-value of less than 0.05 was considered statistically significant.

Data stratification was done for gender, age, type and duration of ventilation. Post stratification Pearson correlation was calculated. Sample size of 30 patients was taken and calculated by taking α error 0.05 and anticipated correlation "r" value between SPO<sub>2</sub>/Fio<sub>2</sub> and PaO<sub>2</sub>/Fio<sub>2</sub> of +0.7594.

## RESULTS

In this present study total 30 children were enrolled. Mean age was 58.55±5 months with minimum and maximum values of 2 & 168 months respectively. There were 20(66.67%) male and 10 (33.33%) female patients with a ratio 2:1(Figure1). In our study Pressure control mode of ventilation was found in 2(6.7%) patients, Pressure support ventilation was found in 9(30%) patients and

SIMV ventilation was noted in 19(63.3%) patients as shown in Table1. The mean value of SPO<sub>2</sub> in the patients was 96.60±2.86 with minimum and maximum values of 89 & 100 respectively. The mean value of FiO<sub>2</sub> of the patients was 36.23±15.45 with minimum and maximum values of 21 & 100 respectively. The results showed that the mean of PaO<sub>2</sub> of the patients was 108.96±36.96 with minimum and maximum values of 66.4 & 203 respectively. There is strong positive correlation between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub> i.e. r=0.603(Figure2). There is strong positive correlation found between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub> stratified by age i.e. r=0.615 & 0.761 respectively. Similarly a strong positive relation was there between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub> ratio when stratified by gender i.e. r=0.622 & 0.736 respectively. There is strong positive correlation found between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub> in pressure control mode and pressure support mode of ventilation and weak correlation was found in SIMV mode of ventilation i.e. r=1.000, 0.531 & 0.383 respectively as shown in Table2.

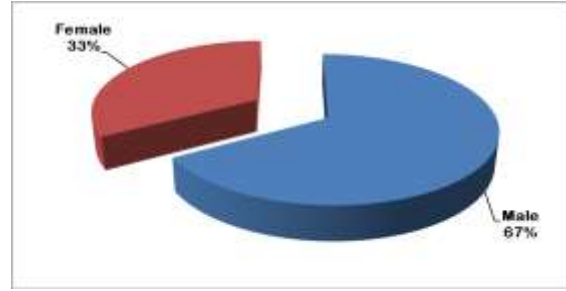


Fig 1: Frequency distribution of gender

Table 1: Frequency distribution of mode of ventilation

Mode of Ventilation	Frequency	Percent
Pressure control mode	2	6.7
Pressure support	9	30.0
SIMV	19	63.3
Total	30	100.0

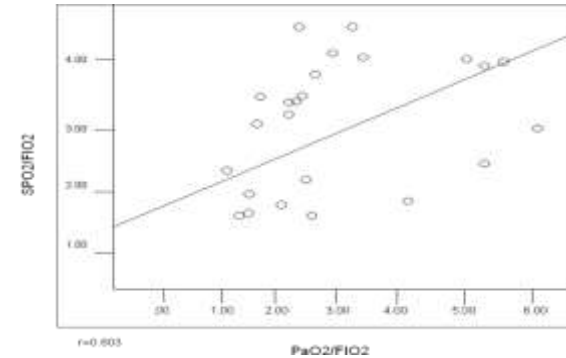


Fig. 2: Correlation between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub>

Table 2: Correlation between the PaO<sub>2</sub>/FiO<sub>2</sub> stratified by Mode of ventilation

Mode of Ventilation	Ratio	Correlation	SPO <sub>2</sub> /FiO <sub>2</sub>	PaO <sub>2</sub> /FiO <sub>2</sub>
Pressure control mode	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	1	1.000
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)		
Pressure support	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	1.000	1
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)		
SIMV	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	1	0.531
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)		0.141
SIMV	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	0.531	1
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)	0.141	
SIMV	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	1	0.383
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)		0.106
SIMV	SPO <sub>2</sub> ratio FiO <sub>2</sub>	Pearson correlation	0.531	1
	PaO <sub>2</sub> ratio FiO <sub>2</sub>	Sig.(2-tailed)	0.106	

**DISCUSSION**

In critically ill patients, mechanical ventilation is an important component of management and routine arterial blood gas analysis is being done for monitoring these patients. According to an estimation about 30 to 60% of children in Pediatric ICUs are on mechanical ventilation about 25% of these may develop acute lung injury (ALI) and 5 to10% may have acute respiratory distress syndrome. They are major contributors to rise in mortality at PICUs.<sup>8,9</sup> In most Pediatric ICUs, pulse oximeter is available for continuous monitoring of oxygenation or the patients. The frequent of arterial blood gas sampling has been reduced by routine use of pulse oximetry. This means pulse oximetry can cut short the costs of arterial sampling.

The diagnostic criteria used by AECC-American European consensus conference-1994 for acute lung injury (ALI) and early diagnosis of acute respiratory distress is PaO<sub>2</sub>/FiO<sub>2</sub> (PF ratio) ≤300 for ALI and for ARDS ≤200. But the criteria needs sample of arterial blood.<sup>10, 11</sup> In our study a strong positive correlation is seen between the PaO<sub>2</sub>/FiO<sub>2</sub> and SPO<sub>2</sub>/FiO<sub>2</sub>, r=0.603. The mean value of PaO<sub>2</sub> of the patients was 108.96±36.96 and the mean value of FiO<sub>2</sub> of the patients was 36.23±15.45. A study by NematBilan et al<sup>12</sup> presented that the SF ratio (SPO<sub>2</sub>/FiO<sub>2</sub>) is a suitable marker which is noninvasive and safe in children. Similarly Carlos Lobete et al<sup>5</sup> have shown that saturation of oxygen by pulse oximetry/FiO<sub>2</sub> ratio is a reliable marker for patients with acute respiratory failure. Some authors have suggested, other

ways to monitor oxygenation in ventilated patients like Oxygenation Index (which is defined as FiO<sub>2</sub>), Ventilatory ratio (VR) and the Mean Airway Pressure / PaO<sub>2</sub>.<sup>13</sup> Another study done in adults showed that SF= SpO<sub>2</sub>/FiO<sub>2</sub> (the pulse oximetry saturation ratio) is a good substitute for PF ratio at SpO<sub>2</sub> less than 97%. Although in retrospective studies done in pediatric age group, the SF ratios to PF ratios for ARDS (200) and ALI (300) were low when compared to the adult study.<sup>1,14</sup> Similarly some studies in children have also proved this correlation.<sup>3, 5-7</sup> As a whole SF ratio had very good<sup>15</sup> discrimination power for PF values of 200 ( under receiver operating characteristic curve 0.90) and 300 ( under receiver operating characteristic curve 0.82) Some other studies identified correlation between SFr, PFr and oxygen index suggesting that these markers may be reliably interchanged for measuring oxygenation at bedside in critically sick patients on positive pressure ventilation.<sup>14</sup> A study done by DewiShandi Laila et al<sup>16</sup> has shown that S/F ratio and P/F ratio had a low correlation (r=0.2; P=0.18).

Although a small sample size is the main limitation in our study, in future a similar study can be carried out on larger scale in order to get desired implementation results.

**CONCLUSION**

According to our study noninvasive SpO<sub>2</sub>/FiO<sub>2</sub> ratio (PFr) can reliably be used in place of PaO<sub>2</sub>/FiO<sub>2</sub> ratio(SFr) in children on mechanical ventilation as a strong correlation was observed

between them. The advantage is invasive arterial sampling can be replaced by non-invasive pulse oximetry for oxygen saturation.

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