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CORRELATION OF OXYGEN SATURATION INDEX WITH OXYGENATION INDEX OF PATIENTS ADMITTED IN PICU REQUIRING MECHANICAL VENTILATION

Paediatric Medicine

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ABSTRACT

Background: Oxygenation index (OI) is an invasive measurement routinely used as a marker of severity of hypoxic respiratory failure (HRF). Oxygen saturation index (OSI) is a non-invasive measurement and has been used increasingly in PICU as a marker for HRF. It may be useful in identifying children with HRF, acute respiratory distress syndrome (ARDS) and acute lung injury (ALI). **Objective:** Correlation and risk stratification of oxygen saturation index with oxygenation index in mechanically ventilated patients admitted in PICU. **Methods:** Children aged 1month to 14 year admitted in PICU of our department, requiring ventilatory care during December 2021 to December 2022 and fitting into inclusion and exclusion criteria were included, relevant clinical and laboratory details were recorded in the preconstructed proforma. OI and OSI correlation and risk stratification of these patients were calculated and statistically analyzed. **Results:** In this study total 120 patients enrolled, of which 60% were male and 40% were female. Invasive ventilation required in 49.2% and non- invasive ventilation required in 50.8% patients. According to OI risk stratification, 50.8% of patients were normal, and 28.3% had mild, 16.7% had moderate and 4.2% had severe ARDS respectively. While according to OSI 50% of patients were normal and 25.8% had mild, 20% had moderate and 4.2% had severe ARDS. OSI and OI were significantly correlated with correlation coefficient r=0.74, (p=0.0001). **Conclusion:** OSI and OI are significantly correlated so noninvasive OSI can be used to assess severity of HRF, ARDS and ALI.

KEYWORDS

Oxygenation index, Oxygen saturation index, Acute respiratory distress syndrome, Acute lung injury, Hypoxic respiratory failure, Mechanical ventilation

INTRODUCTION:

Around 30% to 60% of all admitted patient in pediatric intensive care unit (PICU) require mechanical ventilation (1). Out of these patients up to 25% have Acute lung injury (ALI) and 5% to 10% have Acute respiratory distress syndrome (ARDS). With the implementation of lung protective ventilation strategies, overall morbidity and mortality have been improved significantly for both adult and children with ALI and ARDS (1).

ARDS was first identified in adults but is now being recognized in children as well (3). The American-European Consensus Conference (AECC) in 1994 defined an adult criterion which was used to characterize ALI and ARDS (4). In previous studies, a good correlation between PaO2 and SpO2 was identified (5,6). A further study has led to development of two indices, oxygenation index and oxygen saturation index to diagnose ARDS.

For monitoring of critically ill children with respiratory illness, various parameters are used. These parameters include, SaO2, ABG monitoring and arterial blood pressure monitoring. According to recent PARDS consensus guidelines (7), to determine oxygenation status, the emphasis has shifted toward the oxygenation index as compare to PF ratio, as studies have shown that the oxygenation index is effective at predicting mortality and outcome in ARDS (8). The oxygenation index, on the other hand, will require PaO2 to be calculated. Unless the child has an arterial line, the arterial blood gas test is difficult to perform in children because it requires multiple pricks. Any dependable non-invasive technique would be ideal for tracking the progression or deterioration of the lung disease. Because an invasive procedure is required to determine PaO2, a thorough search for an alternative method of monitoring children with ARDS has begun.

The OSI emerged as a result of the search for a suitable alternative for monitoring ARDS children. The oxygen saturation index is calculated using pulse oximetry (SpO2). In the NICU, OSI is a valid and reliable indicator for assessing the severity of lung damage and respiratory failure (9, 5). Hence, this study was planned to compare and analyse the relationship between oxygen saturation index and oxygenation index in critically ill children who require ventilatory care not only due to ARDS, but also due to a variety of non-ARDS conditions that necessitate ventilatory support in the paediatric population.

MATERIALS AND METHODS:

A Cross-sectional study was conducted over 1 year period in paediatric intensive care unit of Department of Paediatrics in M.G.M. Medical College, M.Y, Hospital, and CNBC Indore (Madhya Pradesh).Ethical clearance for the study was taken from the institutional ethical committee.

In this study all mechanically ventilated patients aged 1month to 14 year during December 2021 to December 2022 were included.

Patients with cyanotic heart disease and severe anemia were excluded. Also those refuse to participate and patients in which ABG and SpO2 cannot be recorded simultaneously (hypothermia, shock, hypo perfusion, methemoglobinemia etc) were excluded from study.

Study Process

All relevant demographic and clinical details were recorded in preconstructed proforma, also written informed consent/assent was taken from the parents/patients.

We collected PaO2, FiO2 and MAP measurements of PICU patients on ventilator with the help of ABG and ventilator settings. SpO2 is measured by pulse oximetry at the same time of ABG extraction.

Comparison of ABG and SpO2 values were collected and oxygenation index, oxygen saturation index were calculated and analyzed.

Formulas:

- OI (Oxygenation index) = MAP × FiO2 × 100 ÷ PaO2

According to PARDS definition for OI, categorized into mild ARDS - 4 to <8, moderate ARDS – 8 to <16, severe ARDS - >16 (10).

- OSI (oxygenation index) = MAP × FiO2 × 100 ÷ SpO2

According to PARDS definition for OSI, categorized into mild ARDS - 5 to <7.5, moderate ARDS – 7.5 to <12.3, severe ARDS - >12.3 (10).

Statistical Analysis

Data were entered into Microsoft excel spread sheet and analyzed using open sources software. Continuous data will be expressed in terms of mean and SD. Categorical data will be expressed in form of proportions and percentage. Appropriate test of significance like spearman correlation was applied wherever necessary and p value <0.05will be considered statistically significant.

RESULT:

In this study majority 60% patients were male and 40% were female. Most of patients were in 1 year- 5 year age group (48.8%), followed by 1month- <1 year (33.3%) and >5 year (18.3%).

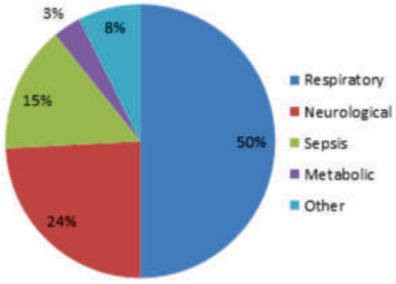

Figure-1 Distribution of patients according to diagnosis at the time of admission

Maximum number of patients admitted due to respiratory disease 50%, followed by neurological disease 24%.

Table-1 Distribution of study participants according to requirements of mechanical ventilation

Mechanical ventilation (N=120)	MODE Number (%)	Indication Number (%)
INVASIVE (N=59)	SIMV 55(45.8%)	Severe respiratory distress 68(56.7%)
	AC mode 4(3.3%)	Poor respiratory efforts 43(35.8%)
NON- INVASIVE (N=61)	NIPPV 56(46.7%)	GCS score<8 9(7.5%)
	BiPAP 5(4.2%)	

49.2% patients required invasive ventilation while 50.8% require non-invasive ventilation, In an invasive ventilation 45.8% required SIMV mode while only 3.3% required AC mode, among those requiring non-invasive, 46.7% required NIPPV mode while only 4.2% required Bipap and 56.7% patients, required mechanical ventilation due to severe respiratory distress,35.8% due to poor respiratory efforts and 7.5% for GCS score <8.

Table- 2 Risk stratification of patients according to OI and OSI

N=120	OI Number (%)	OSI Number (%)
Normal (OI<4, OSI<5)	61 (50.8%)	60 (50%)
Mild ARDS(OI 4 to <8, OSI 5 to <7.5)	34 (28.3%)	31 (25.8%)
Moderate ARDS(OI 8 to <16, OSI 7.5 to <12.3)	20 (16.7%)	24 (20%)
Severe ARDS(OI ≥16, OSI ≥12.3)	5 (4.2%)	5 (4.2%)

As per PARDS definition of ARDS for OI, 50.8% of patients were normal and 28.3%, 16.7% and 4.2% of patients were in the range of mild, moderate and severe ARDS respectively, according to OSI, 50% of patients were normal and 25.8%, 20% and 4.2% of patients were in the range of mild, moderate and severe ARDS.

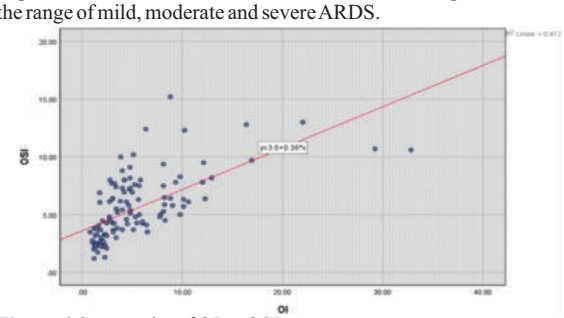

Figure-2 Scatter plot of OI vs OSI

Scatter plot between OI and OSI showed corresponding linear correlation. And spearman Rho correlation test was applied to find out the correlation between OI and OSI, As the OI increased, the OSI also increased and vice-a-versa. The correlation coefficient value is 0.741 and p value is <0.0001 (which is less than p= 0.05) which is statistically significant.

DISCUSSION:

ARDS and ALI are the major contributors to morbidity and mortality among children admitted to PICU, especially, in the developing countries (1). In children, the incidence of ARDS is estimated to be 2.2 to 12.8 per 100,000 patients annually (12).

This study aimed at correlation and risk stratification of oxygen saturation index with oxygenation index of ventilated patients admitted in PICU of MYH and CNBC hospital Indore, during the study period.

A total of 120 children were included in this study, out of those male children contributed to 60% and the remaining 40% were female children. It is same as studies by M. Alissamir et al. and Lohano et al., in which also preponderance of male gender, 64% male vs 36% female was there and in Lohano et al. 55.8% patients, were male. (13,12)

In current study, children belongs to different age groups are 1month to <1 year 33.3%, 1 year to 5 year 48.4% and > 5 year18.3%. The 1 year to 5 year age group seen to be predominant. A similar result was observed in study done by Ahmed et al., the majority of patients were in 1year to 6 year age group. (14)

In current study 56.7% patients, required mechanical ventilation due to severe respiratory distress,35.8% due to poor respiratory efforts and 7.5% for GCS score <8. Study done by Winny et al., had similar findings as this study, showed the indication for use of mechanical ventilation for severe respiratory distress in 40.5% patients, followed by poor respiratory efforts 16.7%.(15)

In the current study, 49.2% patients required invasive ventilation while 50.8% require non-invasive ventilation, In an invasive ventilation 45.8% required SIMV mode while only 3.3% required AC mode, among those requiring non-invasive, 46.7% required NIPPV mode while only 4.2% required Bipap. But in a similar study done by Lohano et al., 88% of the patients required invasive mechanical ventilation, while 11.7% required non-invasive mechanical ventilation. Similarly study done by Wong JJM et al., almost 95% required invasive mechanical ventilation. Results of these studies are not similar to current study, which might be due to different protocol followed at different centre. (12,16)

In this study according to OI risk stratification, 50.8% of patients were normal, and 28.3% had mild ARDS, 16.7% had moderate ARDS and 4.2% of patients had severe ARDS respectively. While according to OSI risk stratification, 50% of patients were normal and 25.8% had mild ARDS, 20% had moderate ARDS and 4.2% of patients had severe ARDS. The study done by Lohano et al., OI in 0.8% patients were normal and 41.7% had mild ARDS, 45% had moderate ARDS and 12.5% had severe ARDS, while OSI in 4.2% patients were normal and 25.8% had mild ARDS, 45% had moderate ARDS and 25% had severe ARDS. This difference is due to they included only respiratory disease cases. Another study by Ahmed et al., risk stratification done for OSI, in which 79% patients were normal and 21% patients had ARDS. (12,14)

In the present study, a strong correlation between OSI and OI (r=0.741, p=<0.0001) was found. In a similar study by M. Alisamir et al., the OSI and OI were significantly correlated (r=0.726, p=<0.001). In another similar study by Vadi S et al., OSI and OI were strong correlated(r=0.82). Similarly study done by M. Zadkarani et al., there was a significant association and correlation between OI and OSI (p<0.001). The difference in the correlation value might be due to the variations in sample size. (12, 17, 18)

This study also faced limitation as sample size was small, and all data were collected from only one centre and further multicentre research with larger sample size are required, to increase the accuracy.

Use of OSI has been increasing in pediatric and adult intensive care units as a marker for respiratory failure as well as lung injury [19, 20].

Oxygen saturation index can be calculated easily, without the need for invasive blood sampling, and may be useful in identifying children with hypoxic respiratory failure.

CONCLUSION:

In this study, there is a strong correlation between the OSI and OI has been observed. So, the OSI is a reliable non- invasive and readily available marker to assess severity of hypoxic respiratory failure, ARDS and acute lung injury, which minimize arterial blood sampling by pulse oximetry. Considering complications of arterial blood sampling such as anemia and bleeding in the critical care patients, pulse oximetry is a desirable replacement for arterial blood sampling.

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