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# COMPARISON OF OXYGENATION SATURATION INDEX WITH OXYGENATION INDEX AND SOFA SCORE IN PREDICTING OUTCOME OF PATIENTS WITH ACUTE RESPIRATORY DISTRESS SYNDROME

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## ABSTRACT

***Background:*** Acute Respiratory Distress Syndrome (ARDS) is a severe form of hypoxemic respiratory failure with high morbidity and mortality worldwide. The Oxygenation Index (OI), calculated from arterial blood gas (ABG) data, is a well-established marker of disease severity in mechanically ventilated ARDS patients. However, its reliance on invasive arterial sampling limits utility in resource-constrained settings. The Oxygen Saturation Index (OSI), a non-invasive surrogate derived from peripheral oxygen saturation ($SpO_2$), $FiO_2$, and mean airway pressure, offers continuous bedside monitoring without arterial access. This study aimed to compare OSI with OI and the Sequential Organ Failure Assessment (SOFA) score in predicting clinical outcomes in ARDS patients admitted to a tertiary care ICU. ***Methods:*** A hospital-based observational cross-sectional study was conducted over 18 months among 70 adult ARDS patients admitted to the ICU of Dr. D.Y. Patil Medical College, Kolhapur. Patients fulfilling the Berlin definition of ARDS were enrolled using a non-probability sampling technique. OSI, OI, and SOFA scores were serially calculated on Day 1 and Day 4 of ICU admission. Clinical outcomes including mortality and total ICU stay were recorded. Pearson correlation analysis assessed associations among study parameters. ***Results:*** Among 70 patients, 55 (78.6%) expired and 15 (21.4%) survived. Expired patients demonstrated significantly higher OSI, OI, and SOFA scores on both Day 1 and Day 4 ($p<0.001$). Day 4 OSI was 8.00±3.07 in expired patients versus 2.69±1.19 in survivors. OSI exhibited an extremely strong positive correlation with OI on Day 1 ($r=0.990$) and Day 4 ($r=0.988$), and a significant positive correlation with SOFA score on Day 1 ($r=0.571$) and Day 4 ($r=0.621$), all $p<0.001$. ***Conclusion:*** OSI is a reliable, non-invasive surrogate for OI and demonstrates significant prognostic value in ARDS. Serial OSI assessment, particularly by Day 4, may serve as a practical bedside tool for risk stratification and outcome prediction, with performance comparable to OI and complementary to SOFA score.

**KEYWORDS:** Acute Respiratory Distress Syndrome; Oxygen Saturation Index; Oxygenation Index; SOFA Score; Mortality Prediction; Intensive Care Unit; Hypoxemic Respiratory Failure.

## INTRODUCTION

Acute respiratory distress syndrome (ARDS) is a severe form of non-cardiogenic hypoxemic respiratory failure defined by the Berlin criteria: acute onset within one week of a known insult, bilateral opacities on chest imaging unexplained by cardiac failure, and impaired oxygenation staged by $PaO_2/FiO_2$ thresholds under minimum PEEP. Despite advances in lung-protective ventilation, hospital mortality ranges from one-third in mild to nearly half in severe ARDS, highlighting the need for reliable, practical severity indices. The Oxygenation Index ($OI = FiO_2 \times \text{mean airway pressure} \times 100 / PaO_2$) is a well-established severity marker but requires invasive arterial blood gas (ABG) sampling, limiting its use in resource-constrained settings.

The Oxygen Saturation Index ($OSI = FiO_2 \times \text{mean airway pressure} \times 100 / SpO_2$) substitutes non-invasive pulse oximetry for $PaO_2$, enabling continuous bedside monitoring without arterial access, reducing cost, and allowing denser longitudinal data collection. Since ARDS outcomes are also shaped by systemic organ failure, comparison with the Sequential Organ Failure Assessment (SOFA) score provides complementary prognostic information. This study therefore aimed to compare OSI with OI and SOFA score in predicting clinical outcomes among ARDS patients admitted to a tertiary care ICU.

## MATERIALS AND METHODS

An observational, cross-sectional, hospital-based study was conducted at the Intensive Care Unit (ICU) of Dr. D.Y. Patil Medical College, Hospital and Research Institute, Kolhapur, Maharashtra, India. The study was carried out over an 18-month period following approval from the Institutional Research Committee (IRC) and the Institutional Ethics Committee (IEC). Informed consent was obtained from all participants or their legally authorized representatives. A non-probability sampling technique was employed, and all patients meeting the eligibility criteria during the study period were enrolled consecutively.

**Study Population:** Adult patients aged ≥18 years admitted to the ICU with a diagnosis of ARDS as per the Berlin definition were enrolled. The Berlin definition requires: (i) acute onset of respiratory distress within one week of a known or new clinical insult; (ii) bilateral opacities on chest radiograph or CT not fully explained by effusions, lobar collapse, or nodules; (iii) respiratory failure not fully explained by cardiac failure or fluid overload; and (iv) $PaO_2/FiO_2$ ratio <300 mmHg with a minimum of 5 $cmH_2O$ PEEP on mechanical ventilation.

**Exclusion Criteria:** The following patients were excluded: those with cardiogenic pulmonary edema or primary cardiac failure; patients receiving extracorporeal membrane oxygenation (ECMO) that could directly alter oxygenation indices; pregnant women due to physiological alterations in oxygen dynamics; patients with end-stage organ failure such as chronic renal failure on dialysis or decompensated cirrhosis; and patients who were discharged or died within 24 hours of ICU admission, as insufficient data precluded reliable index calculation.

**Data Collection and Index Calculation:** Baseline demographics (age, sex), comorbidities (diabetes mellitus, hypertension, chronic renal failure, liver disease, coronary artery disease, malignancy, chronic obstructive airway disease), and clinical parameters were recorded at ICU admission. OSI ($FiO_2 \times MAP \times 100 / SpO_2$), OI ($FiO_2 \times MAP \times 100 / PaO_2$), and SOFA scores were calculated on Day 1 and Day 4 of ICU admission. $SpO_2$ was recorded by pulse oximetry; $PaO_2$ from simultaneous ABG; mean airway pressure (MAP) and $FiO_2$ from the mechanical ventilator display. Clinical outcomes including ICU mortality and total ICU stay duration were documented.

**Statistical Analysis:** Continuous variables were expressed as mean ± standard deviation (SD) and compared using independent samples t-test. Categorical variables were expressed as frequencies and percentages and compared using chi-square test. Pearson correlation coefficients were computed to assess associations between OSI, OI, and SOFA score on Day 1 and Day 4. A p-value <0.05 was considered statistically significant. Statistical analyses were performed using standard software.

## RESULTS

### Baseline Characteristics

The study enrolled 70 adult ARDS patients, of whom 55 (78.6%) expired and 15 (21.4%) survived during ICU admission. The mean age of the overall cohort was 65.53 ± 10.03 years. Age was comparable between survivors (65.47 ± 9.41 years) and expired patients (65.55 ± 10.27 years), with no statistically significant difference (p=0.979). Males constituted 71.4% of the study population; the gender distribution was non-significant between groups (p=0.641). The mean number of comorbidities was also comparable between groups (survivors: 1.33 ± 0.82 vs. expired: 1.60 ± 1.00; p=0.310), indicating that baseline demographic and comorbidity burden did not drive the observed outcome differences.

**Table 1: Baseline Characteristics of Study Population (N=70)**

| Parameter | Total (N=70) | Survived (n=15) | Expired (n=55) | p-value | Significance |
|---|---|---|---|---|---|
| Age (years) – Mean ± SD | 65.53 ± 10.03 | 65.47 ± 9.41 | 65.55 ± 10.27 | 0.979 | NS |
| Gender: Male – n (%) | 50 (71.4%) | 10 (66.7%) | 40 (72.7%) | 0.641 | NS |
| Gender: Female – n (%) | 20 (28.6%) | 5 (33.3%) | 15 (27.3%) | 0.641 | NS |
| Comorbidities – Mean ± SD | 1.54 ± 0.96 | 1.33 ± 0.82 | 1.60 ± 1.00 | 0.310 | NS |

### Distribution of Comorbidities

Diabetes mellitus was the most prevalent comorbidity, present in 49 patients (70.0%), followed by hypertension in 32 patients (45.7%). Chronic renal failure was observed in 3 patients (4.3%) and liver disease in 2 patients (2.9%). Coronary artery disease, malignancy, and chronic obstructive airway disease were not reported in this cohort.

**Table 2: Distribution of Comorbidities (N=70)**

| Comorbidity | Number (n) | Percentage (%) |
|---|---|---|
| Diabetes Mellitus | 49 | 70.0 |

| | | |
|---|---|---|
| Hypertension | 32 | 45.7 |
| Chronic Renal Failure | 3 | 4.3 |
| Liver Disease | 2 | 2.9 |
| CAD / Malignancy / COAD | 0 | 0.0 |

**Oxygenation Parameters by Mortality Outcome**

$SpO_2$ on Day 4 was significantly higher among survivors compared with expired patients (96.60 ± 2.69% vs. 88.09 ± 7.25%; $p<0.001$), while Day 1 $SpO_2$ difference was not statistically significant ($p=0.062$). Mean airway pressure (MAP) was significantly lower in survivors on both Day 1 and Day 4 ($p<0.001$). $PaO_2$ was significantly higher among survivors on both Day 1 and Day 4 ($p<0.001$), reflecting markedly better gas exchange in the surviving group.

**Table 3: Oxygenation Parameters by Mortality Outcome (Mean ± SD)**

| Parameter | Survived (n=15) Mean ± SD | Expired (n=55) Mean ± SD | p-value | Significance |
|---|---|---|---|---|
| $SpO_2$ Day 1 (%) | 95.00 ± 4.60 | 88.25 ± 13.37 | 0.062 | NS |
| $SpO_2$ Day 4 (%) | 96.60 ± 2.69 | 88.09 ± 7.25 | <0.001 | *** |
| MAP Day 1 ($cmH_2O$) | 6.00 ± 0.65 | 7.40 ± 0.98 | <0.001 | *** |
| MAP Day 4 ($cmH_2O$) | 5.80 ± 0.86 | 7.76 ± 1.36 | <0.001 | *** |
| $PaO_2$ Day 1 (mmHg) | 83.07 ± 10.26 | 65.18 ± 14.99 | <0.001 | *** |
| $PaO_2$ Day 4 (mmHg) | 88.33 ± 14.97 | 62.62 ± 20.27 | <0.001 | *** |

**OSI and OI by Mortality Outcome**

Expired patients had significantly higher OSI and OI values on both Day 1 and Day 4 (all $p<0.001$). OSI Day 1 was 6.98 ± 2.76 in expired patients versus 3.17 ± 1.44 in survivors. By Day 4, OSI widened further: 8.00 ± 3.07 in expired vs. 2.69 ± 1.19 in survivors, reflecting diverging trajectories. OI showed a similar pattern: OI Day 1 was 10.73 ± 5.25 (expired) vs. 3.66 ± 1.69 (survivors), and OI Day 4 was 12.90 ± 6.64 vs. 2.96 ± 1.02. The worsening trajectory in expired patients reflects progressive ventilatory failure despite ongoing support.

**Table 4: OSI and OI by Mortality Outcome (Mean ± SD)**

| Index | Time Point | Overall (N=70) | Survived (n=15) | Expired (n=55) | p-value | Significance |
|---|---|---|---|---|---|---|
| OSI | Day 1 | 6.17 ± 2.93 | 3.17 ± 1.44 | 6.98 ± 2.76 | <0.001 | *** |
| OSI | Day 4 | 6.85 ± 3.58 | 2.69 ± 1.19 | 8.00 ± 3.07 | <0.001 | *** |
| OI | Day 1 | 9.22 ± 5.48 | 3.66 ± 1.69 | 10.73 ± 5.25 | <0.001 | *** |
| OI | Day 4 | 10.77 ± 6.98 | 2.96 ± 1.02 | 12.90 ± 6.64 | <0.001 | *** |

**SOFA Score and Clinical Outcomes**

SOFA scores were significantly higher among expired patients on both assessment days. SOFA Day 1 was 8.85 ± 2.53 in expired patients versus 6.60 ± 1.35 in survivors ($p=0.001$). SOFA Day 4 was 9.42 ± 2.63 in expired versus 5.93 ± 1.22 in survivors ($p<0.001$). The overall ICU mortality was 78.6%. Survivors had a significantly longer ICU stay compared with expired patients (10.67 ± 1.80 days vs. 8.42 ± 1.63 days; $p<0.001$), reflecting the longer period of recovery and monitoring needed in those who eventually improved.

**Table 5: SOFA Score and Clinical Outcomes by Mortality Group**

| SOFA / Outcome | Overall (N=70) | Survived (n=15) | Expired (n=55) | p-value | Significance |
|---|---|---|---|---|---|
| SOFA Score Day 1 | 8.37 ± 2.50 | 6.60 ± 1.35 | 8.85 ± 2.53 | 0.001 | ** |
| SOFA Score Day 4 | 8.67 ± 2.72 | 5.93 ± 1.22 | 9.42 ± 2.63 | <0.001 | *** |
| ICU Stay (days) | 8.90 ± 1.83 | 10.67 ± 1.80 | 8.42 ± 1.63 | <0.001 | *** |

**Correlation Analysis**

OSI demonstrated an extremely strong positive correlation with OI on Day 1 ($r=0.990$, $p<0.001$) and Day 4 ($r=0.988$, $p<0.001$), confirming near-identical behaviour of the two indices in tracking oxygenation impairment. OSI also showed significant positive correlations with SOFA score on Day 1 ($r=0.571$, $p<0.001$) and Day 4 ($r=0.621$, $p<0.001$), indicating that worsening respiratory oxygenation reflects broader systemic severity. Similarly, OI correlated significantly with SOFA score on Day 1 ($r=0.548$) and Day 4 ($r=0.602$), both $p<0.001$. The strengthening correlations between oxygenation indices and SOFA from Day 1 to Day 4 suggest that persistent oxygenation failure becomes increasingly intertwined with multi-organ dysfunction over the ICU course.

**Table 6: Pearson Correlation Coefficients between OSI, OI, and SOFA Score**

| Variables Compared | Time Point | Pearson r | p-value | Significance |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| OSI vs OI | Day 1 | 0.990 | <0.001 | *** |
| OSI vs OI | Day 4 | 0.988 | <0.001 | *** |
| OSI vs SOFA | Day 1 | 0.571 | <0.001 | *** |
| OSI vs SOFA | Day 4 | 0.621 | <0.001 | *** |
| OI vs SOFA | Day 1 | 0.548 | <0.001 | *** |
| OI vs SOFA | Day 4 | 0.602 | <0.001 | *** |

**DISCUSSION**

The present study examined the prognostic performance of OSI, OI, and SOFA score in 70 mechanically ventilated ARDS patients, with an overall ICU mortality of 78.6%. The high mortality observed is consistent with the known severity of ARDS in tertiary care ICUs and reflects the predominantly severe phenotype of the enrolled cohort. Notably, baseline demographic and comorbidity characteristics were comparable between survivors and non-survivors, isolating oxygenation and organ failure indices as the primary discriminators of outcome.

OSI was significantly higher among expired patients on both Day 1 and Day 4, confirming its strong prognostic value. The divergence in OSI trajectories between survivors and non-survivors was particularly evident by Day 4, with survivors showing improvement (from 3.17 to 2.69) and non-survivors demonstrating continued deterioration (from 6.98 to 8.00). This serial behaviour aligns with the clinical concept that treatment response by Day 4 is a critical inflection point in ARDS management. The present findings support OSI as a non-invasive, continuously obtainable bedside tool that can effectively track disease trajectory and signal early treatment failure.

OI showed parallel findings, with highly significant differences between groups on both days and a trajectory of worsening among non-survivors despite ventilatory support. The near-perfect correlation between OSI and OI ($r \geq 0.988$ on both days) is the most striking finding of this study, demonstrating that OSI and OI convey virtually identical prognostic information. This validates OSI as a reliable non-invasive substitute for OI, particularly in settings where arterial cannulation is limited by resource constraints, patient anatomy, or coagulopathy. Several prior studies in both adult and neonatal populations have reported similar strong correlations, lending external validity to the present findings.

SOFA scores were significantly higher among non-survivors and continued to rise from Day 1 to Day 4, while survivors showed a decline consistent with resolving multi-organ dysfunction. The significant positive correlations between both OSI and OI with SOFA, strengthening over time, highlight the interrelationship between pulmonary oxygenation failure and systemic organ dysfunction in ARDS. These findings suggest that neither a respiratory-specific index alone nor a systemic score alone provides a complete prognostic picture; rather, combined serial assessment of OSI and SOFA offers complementary and additive information for outcome prediction.

The ICU stay finding survivors staying significantly longer (10.67 vs. 8.42 days) should not be interpreted as a paradox. In a cohort with 78.6% mortality, a shorter stay among non-survivors simply reflects early death from refractory respiratory failure or multi-organ dysfunction, not faster recovery. Survivors required prolonged ventilatory support, gradual weaning, and close monitoring before discharge. This underscores that ICU stay duration in ARDS must be interpreted in the context of outcome, not as an independent marker of clinical improvement.

The strengths of the present study include a well-defined study population adhering to Berlin criteria, serial assessment at clinically meaningful time points (Day 1 and Day 4), and simultaneous comparison of three established prognostic indices. The main limitation is the single-centre design and relatively small sample size, which may limit generalizability. A prospective multicentre study with larger cohorts and formal ROC analysis would further delineate the optimal OSI threshold for clinical decision-making. Additionally, this study did not account for the effect of ventilatory settings changes between Day 1 and Day 4, which may influence OSI independently of disease severity.

**CONCLUSION**

The present study demonstrated that OSI, OI, and SOFA score are each significant predictors of mortality in patients with ARDS. Baseline characteristics including age, sex, and comorbidity burden did not differ significantly between survivors and non-survivors, confirming that the observed outcome differences were driven by disease severity rather than patient demographics.

Both OSI and OI were markedly and significantly elevated among non-survivors on Day 1 and remained persistently high through Day 4, while survivors demonstrated clear improvement across both indices. SOFA scores followed a parallel pattern, reflecting progressive systemic organ dysfunction in non-survivors and recovery in survivors. The extremely strong positive correlation between OSI and OI on both assessment days $r=0.990$ and $r=0.988$ respectively

confirms that OSI closely and reliably mirrors invasive oxygenation measurements. The significant and strengthening correlations between oxygenation indices and SOFA score over time further indicate that worsening respiratory failure is closely coupled with deteriorating organ function.

Serial OSI monitoring, particularly the trajectory from Day 1 to Day 4, provides clinically meaningful information for risk stratification and early identification of treatment non-responders. As a non-invasive, cost-effective, and continuously obtainable parameter requiring only pulse oximetry and ventilator data, OSI is highly accessible in both well-resourced and resource-limited ICU settings. Based on the present findings, OSI may confidently serve as a practical alternative or supplement to OI for monitoring ARDS severity, guiding clinical decisions, and predicting outcomes, and its integration into routine ICU protocols warrants strong consideration.

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