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PROGNOSTIC VALUE OF VENTILATORY RATIO IN PREDICTING ICU MORTALITY AMONG MECHANICALLY VENTILATED INTERSTITIAL LUNG DISEASE PATIENTS: A RETROSPECTIVE ANALYSIS

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ABSTRACT

Background: Interstitial lung disease (ILD) patients requiring invasive mechanical ventilation often face poor prognosis1. The ventilatory ratio (VR), a simple bedside index reflecting ventilatory efficiency and dead space ventilation, may serve as a prognostic tool. **Objective:** To assess the association between VR and ICU mortality in ILD patients. **Methods:** A retrospective study was conducted on mechanically ventilated ILD patients in ICU over 1 year. Demographics, clinical data, and VR were analyzed in relation to ICU outcomes. **Results:** Among 120 ILD patients, ICU mortality was 72%. Non-survivors had significantly higher VR (2.2 vs. 1.5, $p < 0.001$). A VR >1.9 predicted mortality with 85% sensitivity and 70% specificity. **Conclusion:** Elevated VR is significantly associated with ICU mortality in ILD patients and may serve as a reliable prognostic indicator.

KEYWORDS

Ventilatory Ratio, Prognostic Marker, Interstitial Lung Disease, Dead Space Ventilation, PAO2/FIO2 RATIO

INTRODUCTION

Interstitial lung disease (ILD) refers to a group of chronic lung disorders that result in fibrosis and impaired gas exchange[2]. Patients with advanced ILD may require ICU care and mechanical ventilation, often with poor outcomes. Identifying early prognostic indicators is critical for clinical decision-making[3].

The ventilatory ratio (VR) is a dimensionless index calculated from minute ventilation and $PaCO_2$, representing ventilation efficiency and dead space fraction. Its utility has been explored in ARDS, but limited data exist on its role in ILD[4]. This study investigates the association between VR and ICU mortality in ILD patients on mechanical ventilation

Aims And Objectives

Primary Aim:
To evaluate the association between ventilatory ratio and ICU mortality in ILD patients requiring mechanical ventilation.

Secondary Objectives:
To compare VR trends between survivors and non-survivors.
To identify a VR threshold predictive of ICU mortality

Methodology

Study Design: Retrospective observational study

Inclusion Criteria:
Adults (>18 years) with confirmed ILD
Required invasive mechanical ventilation

Exclusion Criteria:
Incomplete medical records
ICU stay <24 hours
Neuromuscular disease affecting respiration

Data Collection:
Clinical and ventilatory data were extracted from medical records. VR was calculated as

$$VR = \frac{\text{Minute Ventilation} \times PaCO_2}{\text{Predicted Body Weight} \times 100 \times 37.5}$$

Statistical Analysis:
SPSS version 30 used. Continuous variables: t-test or Mann-Whitney U; categorical: chi-square test. ROC analysis performed to find optimal VR cut-off.

RESULTS

Population: 120 ILD patients; mean age 64 ± 10 years; 58% male
ICU Mortality: 72%

A total of 120 patients diagnosed with ILD and requiring invasive mechanical ventilation were included in the study. The mean age was 64.3 ± 10.2 years, with 58.3% (n = 70) being male and 41.7% (n = 50) female.

The overall ICU mortality rate was 72.5% (n = 87), while 27.5% (n = 33) survived and were discharged from the ICU.

Comparison Between Survivors And Non-survivor

PARAMETERS	SURVIVORS (n=33)	Non survivors (n=87)	p-value
AGE(YEARS)	61.2 ± 9.4	65.5 ±10.5	0.021*
VR on DAY1	1.52 ± 0.31	2.21 ± 0.43	<0.001**
VR ON DAY3	1.63 ± 0.29	2.34 ± 0.45	<0.001**
PaO2/FiO2 ratio on day 1	186 ± 44	142 ± 39	<0.001**
LENGTH OF ICU STAY(DAYS)	9.6 ± 3.4	6.7 ± 2 .9	0.004*
DURATION OF MECHANICAL VENTILATION	7.2 ± 2.5	5.8 ± 3.1	0.032*

(*Independent sample t-test used; $p < 0.05$ considered significant.)

A positive correlation was observed between rising VR and mortality ($r = 0.63$, $p < 0.001$).

Patients with a VR > 1.9 on Day 1 had significantly higher ICU mortality (AUC = 0.82, 95% CI: 0.73–0.90; $p < 0.001$).

Sensitivity and specificity for VR >1.9 in predicting ICU mortality were 85% and 70%, respectively.

Multivariate logistic regression identified VR on Day 1 (OR: 3.15, 95% CI: 1.87–5.29, $p < 0.001$) and PaO_2/FiO_2 ratio <150 (OR: 2.61, 95% CI: 1.42–4.79, $p = 0.002$) as independent predictors of mortality.

DISCUSSION

In this retrospective analysis, we investigated the prognostic relevance of the ventilatory ratio (VR) in mechanically ventilated patients with interstitial lung disease (ILD) admitted to the intensive care unit (ICU). Our findings demonstrate that an elevated VR, particularly on Day 1 and Day 3 of mechanical ventilation, is significantly associated with increased ICU mortality.

Non-survivors exhibited consistently higher VR values compared to survivors, reinforcing the hypothesis that impaired ventilatory efficiency is a key determinant of adverse outcomes. These results are concordant with prior studies in acute respiratory distress syndrome (ARDS) and COVID-19 cohorts, where elevated VR has been linked to increased dead space ventilation and poor prognosis (Sinha et al., 2019; Madahar & Beitler, 2021)[5]. In our cohort, a VR threshold of >1.9 was identified as a potential predictor of mortality, yielding a sensitivity of 85% and specificity of 70%, suggesting its clinical utility as a bedside risk stratification tool.

Additionally, PaO_2/FiO_2 ratios were significantly lower among non-survivors, indicating more severe oxygenation impairment. The shorter ICU stay and reduced duration of mechanical ventilation in non-survivors likely reflect early deterioration rather than successful

weaning. These findings are consistent with prior literature, which describes high mortality rates in ventilated ILD patients and emphasizes the importance of early prognostic indicators to guide management decisions (Song et al., 2011; Wu et al., 2019)[6].

VR offers a non-invasive, rapidly obtainable parameter based on routinely measured ventilatory and arterial blood gas values. Its integration into early ICU assessment protocols may support decision-making regarding escalation of care and advanced directives, particularly in patients with limited pulmonary reserve[7].

However, this study has notable limitations. The retrospective design and single-center setting may limit generalizability[8,9]. Heterogeneity in ILD subtypes, pre-existing comorbidities, and ventilator strategies could act as potential confounders. Additionally, dynamic changes in VR beyond Day 3 were not explored, and the sample size, while moderate, limits subgroup analyses.

Prospective multicenter studies are warranted to validate our findings and assess the additive prognostic value of VR when combined with other indices, such as driving pressure, static compliance, and biomarkers of lung injury[10].

CONCLUSION

Ventilatory ratio is a valuable and readily available marker associated with ICU mortality in ILD patients on mechanical ventilation. A VR >1.9 within the first 24 hours may serve as a prognostic indicator. Routine VR monitoring could enhance risk stratification and clinical management in ILD patients in the ICU. Prospective multicenter studies are needed for further validation

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Ethical Approval – The study was approved by the ethics committee

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