

# Predictors of poor outcome in patients admitted to Intensive Care following failed high-flow nasal oxygen therapy

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## Introduction

High-flow nasal oxygen (HFNO) therapy is an effective and widely used oxygen delivery method in adults with respiratory failure<sup>1</sup>. However, prolonged HFNO therapy in deteriorating patients who are suitable for escalation delays intubation, which results in increased mortality, reduced extubation success and longer ICU admissions<sup>2</sup>.

This study aims to identify patient characteristics, including but not limited to the ROX index, that are predictive of poor outcome in adults who fail HFNO therapy and are admitted to ICU for mechanical ventilation.

## ROX Index

The ROX index was first described by Roca et al in 2016. It was developed as a tool to predict the need for mechanical ventilation in patients with acute hypoxaemic respiratory failure receiving HFNO. The index is calculated as  $([SpO_2 / FiO_2] / \text{respiratory rate})^3$ . The lower the result, the more likely the patient is to fail treatment on HFNO and require intubation.

## Methods

This retrospective observational cohort study included all patients admitted to the intensive care unit (ICU) from the medical high dependency unit (HDU) at the Queen Elizabeth University Hospital (QEUH) in Glasgow following a failed trial of HFNO between 1<sup>st</sup> January 2016 and 1<sup>st</sup> January 2019.

Demographic and clinical data were collected from the electronic record and the ROX index was calculated for all patients one hour after initiation of HFNO and immediately prior to transfer to ICU. ROX scores were split into quartiles and the delta change over the two measurements was calculated.

Chi square tests were used to assess whether variables were predictive of ICU mortality. These variables included age, gender, presence of cardiovascular failure in HDU, presence of central nervous system failure in HDU and delta change between the two ROX scores. Correction was applied for multiple comparisons.

## Results

Of 106 patients, 66 were male (62%). Age ranged from 16 to 87 years with a median age of 59, and median HDU stay prior to ICU transfer was 0.79 days.

In HDU, 19% of patients received cardiovascular support and 40% were confused. Patients received a median of 12 hours of HFNO therapy prior to ICU transfer (range 1-166).

Once admitted to ICU, 86% received invasive ventilation; 77% required vasopressor support and 19% required renal replacement therapy. These figures are in keeping with the entire QEUH ICU cohort, according to the 2020 SICSAG Report.

Median ICU length of stay was 6.3 days and 35% of patients died in ICU. A further 8% died prior to discharge, making hospital mortality in this cohort 43%. Both ICU and hospital mortality are markedly higher in this cohort than the whole QEUH ICU cohort.

There was no statistically significant relationship between ICU outcome and any of the following: hours of HFNO therapy received in HDU ( $p=0.800$ ); initial ROX index ( $p=0.363$ ); ROX index prior to ICU transfer ( $p=0.376$ ); or delta change between the two ROX scores ( $p=0.361$ ).

Only age was statistically significantly related to ICU and hospital outcome. In a regression analysis, only age and quartile of ROX index prior to ICU transfer were related to ICU outcome, with  $p$  values of 0.009 and 0.03 respectively. When included in a model and subjected to ROC curve analysis, this gave a value of 0.696.

## Discussion

This study found that quartile of ROX index immediately prior to ICU transfer was associated with ICU outcome in a regression analysis. This supports the use of the ROX index to assess severity of respiratory failure and demonstrates that the index can be used as an independent predictor of ICU mortality in this cohort.

We have not demonstrated any characteristics other than age to be predictive of poor outcome in patients admitted to ICU following a period of HFNO therapy. This highlights the challenge in decision-making regarding timing of intubation of patients with respiratory failure.

## Strengths and Limitations

Strengths of this study include the relatively long study period of three years and inclusion of all patients requiring escalation to ICU following a period of HFNO therapy, regardless of aetiology of respiratory failure.

The main limitations are the retrospective nature of data collection, relatively small patient cohort and data collection from a single site only.

## Conclusion

This study adds to the wealth of literature that supports use of the ROX index as a measure of severity of respiratory failure and demonstrates that ROX index immediately prior to intubation is associated with ICU mortality. Unfortunately the study has not identified any patient characteristics other than age that can be used to predict which patients receiving HFNO are likely to have poor outcomes.

Multicentre prospective randomised controlled trials assessing timing of intubation in patients receiving HFNO therapy would provide further evidence to improve decision-making in this cohort.



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## References

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3. Roca et al. Predicting success of high-flow nasal cannula in pneumonia patients with hypoxemic respiratory failure: The utility of the ROX index. *Journal of Critical Care*. 2016.