Between-centre differences for COVID-19 ICU mortality from early data in England

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The high numbers of COVID-19 patients developing severe respiratory failure has placed exceptional demands on ICU capacity around the world. Understanding the determinants of ICU mortality is important for surge planning and shared decision making. We used early data from the COVID-19 Hospitalisation in England Surveillance System (from the start of data collection 8th February -14th April 2020) to look for factors associated with ICU outcome in the hope that information from such timely analysis may be actionable before the outbreak peak. Immunosuppression, chronic renal disease and age were key determinants of ICU mortality in a proportional hazards mixed effects model. However variation in site-stratified random effects were even more appreciable, suggesting substantial between-centre variability in mortality. Notwithstanding possible ascertainment and lead-time effects, these early results motivate comparative effectiveness research to understand the origin of such differences and optimise surge ICU provision.

Introduction

Since the first cases emerged in November 2019 [1], the spread of SARS-CoV-2 infections has placed an unprecedented strain on healthcare resources globally. The intensive care unit (ICU) is a setting of particular concern as high numbers of patients developing severe respiratory complications from COVID-19 means that advanced outcome-critical resources may be rapidly exhausted. Indeed, in some areas, ICUs have been completely overwhelmed [2].

Understanding the determinants of ICU outcome is crucial both for surge planning and shared decision making with patients and relatives. Whilst a number of risk scores have been published [3] they do not specifically look at this population. Furthermore, ICU availability, admission policy and structure varies substantially across Europe [4] as do population demographics and government policy for surveillance and containment. As a result, it is likely that ICU outcomes could vary significantly from region to region which motivates an individualised approach to modelling. The UK, where cases are still rising, is of particular concern as recent reports suggest mortality may prove be particularly high. To this end, we sought to identify predictors of mortality in patients admitted to the ICU with COVID-19.

Data and analysis

We obtained de-identified COVID-19 Hospitalisation in England Surveillance System (CHESS) data from Public Health England (PHE) for the period from 8th February (data collection start) to 14th April 2020 (3,092 cases ICU cases– 609 deaths, 384 discharges from 94 NHS trusts across England).

We used a Cox proportional hazards mixed-effects model for mortality, with the NHS trust as the random effect. Predictors were normalised. The estimated coefficients associated with each predictor are shown in Figure 1.

Discussion and conclusions

Immunosuppression, chronic renal disease and age were key predictors of mortality. In comparison with these fixed effects, the magnitude of the between-centre variation (log hazard ratio varying between -2 to +2) is greater even the strongest fixed effects predictors. The cause of such between-centre variation is unclear and may have a variety of case-mix, severity or structural explanations. In particular, ICU demand varies both regionally and locally and we may hypothesize that high levels of strain or constraints on surge capacity could be actionable determinants, although we do not have data to examine this. Such considerations are important to understand as they may influence optimal configuration or transfer considerations locally.
**Authors’ contributions**

AE and MvdS conceived of and supervised the study. ZQ and AMA coded the statistical models. All authors contributed to the manuscript.

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