

# Prognostication in urgent intensive care unit referrals: a cohort study

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## ABSTRACT

**Objectives** Prognostication is an essential ability to clinicians. Nevertheless, it has been shown to be quite variable in acutely ill patients, potentially leading to inappropriate care. We aimed to assess the accuracy of physician's prediction of hospital mortality in acutely deteriorating patients referred for urgent intensive care unit (ICU) admission.

**Methods** Prospective cohort of acutely ill patients referred for urgent ICU admission in an academic, tertiary hospital. Physicians' prognosis assessments were recorded at ICU referral.

Prognosis was assessed as survival without severe disabilities, survival with severe disabilities or no survival. Prognosis was further dichotomised in good prognosis (survival without severe disabilities) or poor prognosis (survival with severe disabilities or no survival) for prediction of hospital mortality.

**Results** There were 2374 analysed referrals, with 2103 (88.6%) patients with complete data on mortality and physicians' prognosis. There were 593 (34.4%), 215 (66.4%) and 51 (94.4%) deaths in the groups ascribed a prognosis of survival without disabilities, survival with severe disabilities or no survival, respectively ( $p < 0.001$ ). Sensitivity was 31%, specificity was 91% and the area under the receiver operating characteristic curve was 0.61 for prediction of mortality. After multivariable analysis, severity of illness, performance status and ICU admission were associated with an increased likelihood of incorrect classification, while worse predicted prognosis was associated with a lower chance of incorrect classification.

**Conclusions** Physician's prediction was associated with hospital mortality, but overall accuracy was poor, mainly due to low sensitivity to detect risk of poor prognosis.

## INTRODUCTION

Prediction of outcomes is an essential part of clinicians' role. For acutely ill patients, estimated probabilities of hospital

mortality may provide important information for clinical decision-making,<sup>1</sup> such as informing prognosis to patients and relatives, discussions of goal-of-care and decisions about resource allocation.<sup>1,2</sup>

Acute deterioration events may be used as indicators to trigger palliative care assessment.<sup>3</sup> However, there is little research on the ability of physicians to predict which patients would benefit from intensive care.<sup>4</sup> There is great variability in those predictions<sup>4</sup> and non-clinical features may affect judgement,<sup>5</sup> which has raised concern about biases, self-fulfilling prophecies<sup>4,6-9</sup> and potentially inappropriate care.<sup>10</sup>

The aim of this study was to assess the accuracy of physician's prediction of prognosis within a cohort of acutely deteriorating patients referred for urgent intensive care unit (ICU) admission. The effect of physicians' expertise and the effect of actual ICU admission on the predictive ability were also assessed.

## METHODS

### Setting

Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo is an academic, tertiary healthcare complex located in São Paulo, Brazil, totalling 1000 hospital beds,<sup>11</sup> with 110 ICU beds, divided in 10 ICUs. There is a multidisciplinary palliative care team acting in the hospital.

### Study design

This was a prospective cohort of patients referred for urgent ICU admission from 1 May 2014 to 20 May 2015. Physicians requesting an ICU bed were asked to record the most probable prognosis if the patient were to be admitted to the ICU. This prognosis assessment was recorded at ICU referral and was not available to the triaging ICU physician, so should not have had any influence on the ICU

admission decision. Prognosis was assessed as a three-stage variable: hospital survival without severe disabilities (defined as severe cognitive impairment), hospital survival with severe disabilities or no survival. This variable was further dichotomised in good prognosis (survival without severe disabilities) or poor prognosis (survival with severe disabilities or no survival). Other variables were also collected, such as those necessary for the calculation of the Mortality Probability Model II (MPMII0) score, used to predict hospital mortality at ICU admission.<sup>12</sup>

Only the first urgent ICU referral was evaluated in patients with multiple ICU referrals. Patients younger than 16 years or referred for elective surgery were excluded from the analysis. Assessment of prognosis for each patient was registered once and by only one physician (either a medical resident, medical fellow or attending physician).

The primary outcome was hospital mortality.

### Statistical analysis

Categorical variables were evaluated with  $\chi^2$  statistics. Continuous variables were evaluated by analysis of variance test. Test characteristics (ie, sensitivity and specificity) were assessed after dichotomisation of the physicians' prognosis variable. Patients with a prediction of poor prognosis who ultimately died were regarded as true-positives, while patients with a prediction of good prognosis who ultimately survived were regarded as true-negatives. Conversely, patients with a prediction of poor prognosis who ultimately survived were regarded as false-positives and patients with a prediction of good prognosis who ultimately died were regarded as false-negatives. Discrimination was assessed through the analysis of the area under the receiving operator characteristic (AUROC) curve.

Multiple logistic regression analysis was performed to identify variables independently associated with incorrect classification (ie, false-positives or false-negatives). The final model was developed through backwards stepwise with Wald's statistics ( $p < 0.1$ ). Variables related to the outcome of interest, such as physician expertise and ICU admission, were forced into the final model.

Patients with missing data were excluded from analysis. A two-tailed  $p$  value of less than 0.05 was considered as statistically significant. Statistical analyses were performed with SPSS V.21.0.

### RESULTS

In the study period, there were 3115 urgent ICU referrals. After exclusion of 612 repeated referrals, 27 patients younger than 16 years and 102 elective surgical patients, 2374 (76.2%) patients were analysed. Characteristics of those patients, as well as missing data, are depicted on online supplementary table 1.

After excluding missing data for mortality and physician prognosis, there were 2103 (88.6%) patients in the main analyses.

### Physician's predictive ability

Physician's subjective prognosis was associated with hospital mortality (table 1). Physician's predictive ability remained similar after stratification by expertise and ICU admission (table 1 and online supplementary figure 1).

The AUROC for physician's prognosis was 0.61 (95% CI 0.59 to 0.64). There was no significant difference in the AUROC for physicians' prognosis after stratification for expertise or ICU admission (online supplementary table 2).

Subjective prognosis was dichotomised into good prognosis and poor prognosis for calculation of test's characteristics. Specificity was calculated as 91% (95% CI 89.3 to 92.5) and sensitivity was 31% (95% CI 27.9 to 34.2), with a total correct classification of 66.5% (1398 episodes). Positive likelihood ratio was 3.44 (95% CI 2.81 to 4.21) and negative likelihood ratio was 0.76 (95% CI 0.72 to 0.80).

### Predictors of incorrect classification

There were 705/2103 (33.5%) episodes of incorrect classification, 593/705 (84%) related to patients ascribed a good prognosis and ultimately died (false-negatives) and 112/705 (16%) related to patients ascribed a poor prognosis who ultimately survived (false-positives).

After multivariate analysis, physician's expertise was not associated with incorrect classification (online supplementary table 3). More severely ill patients, as measured by MPMII0 score, and patients with lower performance status were more likely to be incorrectly classified. However, worse prognosis assessments (survival with disabilities or no survival) were associated with a lower chance of incorrect classification. On the other hand, ICU admission was associated with an increased likelihood of incorrect classification.

### DISCUSSION

This study has found that, in a large cohort of acutely decompensating patients, physicians' prediction of prognosis was associated with hospital mortality, however with poor overall discrimination. Moreover, there were no differences on prognosis assessments depending on physician's level of expertise. Nevertheless, severity of illness, performance status and ICU admission were associated with an increased likelihood of incorrect classification, while worse predicted prognosis was associated with a lower chance of incorrect classification.

In this study, physician's prognosis demonstrated low accuracy,<sup>13</sup> with an AUROC of 0.61, but with a high specificity of 91%, which suggest that the low sensitivity for detecting mortality risk of 31% was the main

**Table 1** Association of physicians' predicted prognosis with mortality, overall (A) and stratified by expertise of referring physician (B) and by ICU admission (C)

	Survivors N (%)	Deceased N (%)	P values
<b>A. Overall</b>			
Survival without disabilities	1132 (65.6)	593 (34.4)	<0.001
Survival with severe disabilities	109 (33.6)	215 (66.4)	
No survival	3 (5.6)	51 (94.4)	
<b>B. Expertise of referring physician</b>			
Medical resident			
Survival without disabilities	754 (65.6)	395 (34.4)	<0.001
Survival with severe disabilities	64 (29.8)	151 (70.2)	
No survival	2 (6.5)	29 (93.5)	
Medical fellow			
Survival without disabilities	299 (66.9)	148 (33.1)	<0.001
Survival with severe disabilities	36 (41.4)	51 (58.6)	
No survival	1 (16.7)	5 (83.3)	
Attending physician			
Survival without disabilities	64 (57.1)	48 (42.9)	<0.001
Survival with severe disabilities	6 (31.6)	13 (68.4)	
No survival	0 (0)	14 (100)	
<b>C. ICU admission</b>			
Refused ICU			
Survival without disabilities	431 (66.3)	219 (33.7)	<0.001
Survival with severe disabilities	53 (29.4)	127 (70.6)	
No survival	2 (4.4)	43 (95.6)	
Admitted to the ICU			
Survival without disabilities	615 (65.3)	327 (34.7)	<0.001
Survival with severe disabilities	48 (39.3)	74 (60.7)	
No survival	1 (11.1)	8 (88.9)	

ICU, intensive care unit.

driver for the low overall accuracy. Moreover, 84% of all incorrect classifications were due to false-negatives, that is, patients ascribed a good prognosis who ultimately died. These results suggest that physicians were overly optimistic, which is further supported by the fact that physician's predictions of worse prognoses had a good chance of being correct and were independently associated with a lower chance of incorrect classification, meaning that physicians would err more when predicting good prognosis than a worse prognosis. Those findings agree with the literature, which has shown that clinicians' predictive ability may be excessively optimistic.<sup>14</sup>

The accuracy of physicians' predictions in this study was lower than that of MPMII0 score and lower than what has been demonstrated in studies evaluating the prediction ability of ICU physicians.<sup>2</sup> Nevertheless, our reported accuracy is similar to what has been found for physician's first impression in the emergency department.<sup>15</sup> It is possible that intensive care physicians may have greater expertise to predict prognosis in critically ill patients<sup>16</sup> or that the assessment of the patient in the ICU, after initial treatment and investigations, may be done with additional information that would improve physicians' predictive ability.<sup>7</sup>

Physician's expertise, as assessed in this study, was not associated with predictive ability. Although it seems intuitive that higher expertise would lead to higher accuracy, clinicians' prognostication is highly variable<sup>4</sup> and the literature is not consensual in this subject, with varying results being reported.<sup>6,7</sup>

Physicians' prognoses have been implicated to end-of-life care decisions<sup>17</sup> and, ultimately, ICU mortality,<sup>18</sup> so concern has been raised about the possibility that decisions made on the basis of uncertain predictions could become self-fulfilling prophecies.<sup>9</sup> A self-fulfilling prophecy is defined as "a false definition of the situation evoking a new behavior which makes the original false conception come 'true'".<sup>8</sup> Nevertheless, in this study, there was little evidence of self-fulfilling prophecies. After stratification for ICU admission, there was no difference on predictive ability among the different prognostic groups. Moreover, even though ICU admission was associated with incorrect classification on multivariate analysis, this difference was driven by a higher chance of false-negatives, that is, patients ascribed a good prognosis and ultimately died. This finding supports an overly optimistic behaviour by the physicians, rather than the occurrence of self-fulfilling prophecies.

This study, although representing a diverse case-mix and 10 different ICUs with different ICU policies, was a single-centre study, which limits its generalisability. Moreover, only one physician assessed each patient and in only one moment, so it was not possible to evaluate inter-rater and intra-rater reliability, even though it has already been shown to be highly variable.<sup>4</sup> In addition, it is not possible to completely exclude contamination among the different physician expertise groups, as more junior physicians may have discussed the patient's prognosis with more senior physicians. Also, as most observational studies, we had some missing data, but it represented a small proportion of most variables and we have handled it as proposed by others.<sup>19</sup>

## CONCLUSION

Overall accuracy of physicians' prediction of mortality was poor in this cohort of acutely ill patients referred for ICU admission. This low accuracy was driven by a failure to recognise patients with poor prognosis, especially in patients who were admitted to the ICU. There was no effect of physician's expertise on predictive ability.

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## REFERENCES

- Lemeshow S, Klar J, Teres D. Outcome prediction for individual intensive care patients: useful, misused, or abused? *Intensive Care Med* 1995;21:770–6.
- Sinuff T, Adhikari NK, Cook DJ, *et al.* Mortality predictions in the intensive care unit: comparing physicians with scoring systems. *Crit Care Med* 2006;34:878–85.
- Jones D, Moran J, Winters B, *et al.* The rapid response system and end-of-life care. *Curr Opin Crit Care* 2013;19:616–23.
- Cook DJ, Guyatt GH, Jaeschke R, *et al.* Determinants in Canadian health care workers of the decision to withdraw life support from the critically ill. Canadian Critical Care Trials Group. *JAMA* 1995;273:703–8.
- Finley Caulfield A, Gabler L, Lansberg MG, *et al.* Outcome prediction in mechanically ventilated neurologic patients by junior neurointensivists. *Neurology* 2010;74:1096–101.
- Gusmão Vicente F, Polito Lomar F, Mélot C, *et al.* Can the experienced ICU physician predict ICU length of stay and outcome better than less experienced colleagues? *Intensive Care Med* 2004;30:655–9.
- Barrera R, Nygard S, Sogoloff H, *et al.* Accuracy of predictions of survival at admission to the intensive care unit. *J Crit Care* 2001;16:32–5.
- Wilkinson D. The self-fulfilling prophecy in intensive care. *Theor Med Bioeth* 2009;30:401–10.
- Søreide E, Baardsen R, Probabilities BR. Probabilities, predictors, and self-fulfilling prophecies. *Crit Care Med* 2013;41:1158–60.
- Schneiderman LJ, Gilmer T, Teetzel HD, *et al.* Effect of ethics consultations on nonbeneficial life-sustaining treatments in the intensive care setting: a randomized controlled trial. *JAMA* 2003;290:1166–72.
- Carvalho CRR, Bonfá ESDdeO, Rodrigues AJ. Hospital das Clínicas of University of São Paulo Medical School. *Revista de Medicina* 2016;95:37.
- Lemeshow S, Teres D, Klar J, *et al.* Mortality Probability Models (MPM II) based on an international cohort of intensive care unit patients. *JAMA* 1993;270:2478–86.
- Carter JV, Pan J, Rai SN, *et al.* ROC-ing along: evaluation and interpretation of receiver operating characteristic curves. *Surgery* 2016;159:1638–45.
- Glare P, Virik K, Jones M, *et al.* A systematic review of physicians' survival predictions in terminally ill cancer patients. *BMJ* 2003;327:195–8.
- Beglinger B, Rohacek M, Ackermann S, *et al.* Physician's first clinical impression of emergency department patients with nonspecific complaints is associated with morbidity and mortality. *Medicine* 2015;94:e374.
- Copeland-Fields L, Griffin T, Jenkins T, *et al.* Comparison of outcome predictions made by physicians, by nurses, and by using the Mortality Prediction Model. *Am J Crit Care* 2001;10:313–9.
- Cook D, Rocker G, Level of Care Study Investigators and the Canadian Critical Care Trials Group. Withdrawal of mechanical ventilation in anticipation of death in the intensive care unit. *N Engl J Med* 2003;349:1123–32.
- Rocker G, Level of Care Study Investigators Canadian Critical Care Trials Group. Clinician predictions of intensive care unit mortality. *Crit Care Med* 2004;32:1149–54.
- Vesin A, Azoulay E, Ruckly S, *et al.* Reporting and handling missing values in clinical studies in intensive care units. *Intensive Care Med* 2013;39:1396–404.