FAST FACTS AND CONCEPTS #235
PROGNOSTIC MODELS IN CRITICALLY ILL ADULTS
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Background   Prognostication for ICU patients is challenging. Grieving families, trying to make informed decisions about their loved ones care, often ask *What are the chances he or she will get through this?* Several prognostic models have been developed to predict survival for groups of patients stratified by severity of illness. These are used in outcomes research to compare patient groups, assess and compare ICU performance and help guide resource allocation. Anecdotally, data from these models is sometimes used in discussing prognosis with family members of critically ill patients. This *Fast Fact* discusses common ICU prognostic models and their role in guiding patient care and communication.

Widely used ICU prognostic models   Common models for predicting mortality in medical-surgical ICU patients include the Acute Physiologic and Chronic Health Evaluation (APACHE) score, the Mortality Probability Model (MPM), the Simplified Acute Physiology Score (SAPS) and the Sequential Organ Failure Assessment (SOFA) score (1-4). The SOFA score can be calculated at the bedside based on laboratory and physiologic data; however, this model has not been widely used in either clinical or research practice by the critical care community to predict mortality. The APACHE, MPM, and SAPS models are more widely used and require computer software to calculate a score based on multiple variables including type of admission, the patient's underlying diseases, physiologic data, and – in the case of APACHE – laboratory data. The APACHE score is based on the worst values available during ICU Day 1 whereas MPM and SAPS scores are calculated based on data obtained within one hour of ICU admission. The models require re-validation over time as ICU interventions and outcomes change. The APACHE score is currently in its fourth version. MPM and SAPS are in their third versions. Although APACHE IV and MPM III require proprietary software to calculate a score, the SAPS3 score can be computed using a downloadable calculator (5). Individual institutions may use a model for all ICU admissions for purposes of quality monitoring, outcome reporting, or research, and so some clinicians may have these scores readily available to them.

Accuracy of the prognostic models   The discrimination and calibration ability of ICU prognostic models determine their predictive accuracy (6). Discrimination is the ability of a model to predict a mortality rate similar to the observed rate; calibration reflects a model's ability to predict an outcome at multiple levels (mortality rates). The most recent versions of APACHE, MPM, AND SOFA show both high discrimination and calibration. All three models report a score based on the above variables that correlates with a predicted in-hospital mortality rate. For example, a SAPS3 score of 73 correlates with a hospital mortality rate of 62%. The other two models work similarly.

Clinical use of ICU prognostic models   All of these models accurately predict *rates of in-hospital mortality in a population* of critically ill patients. This is different than predicting survival for an individual patient (7), let alone using them to guide individual treatment decisions. None of the models alone can, for instance, predict 100% mortality, a standard that some families and clinicians may require in order to limit life-sustaining treatments. Also, as these models focus solely on in-hospital mortality as the outcome measure, a patient's functional status, quality of life, and long-term prognosis are not predicted. These considerations can be equally as important as short-term survival for families and clinicians in determining appropriate treatment goals. Practically, then, the clinical use of the models is best limited to three uses:

1. *As a single 'data point' among many to guide patient-centered decision-making.* Clinicians can use outcome data from the tools, along with patient co-morbidity, long-term prognosis, baseline and anticipated functional status and quality of life, etc., to guide discussions (see *Fast Facts* 222-227). *Chances are your loved one is not going to survive this illness. She might, and currently we are doing everything we can to get her through this. However, even if she does, her emphysema is severe enough that we will not be able to improve her breathing or ability to take care of herself any more than before she became this ill, and it is very likely another event like this will happen again in the near future.*
2. As a screening tool to identify those ICU patients uniquely 'in need' of palliative care evaluation.
3. As a research tool to look at the impact of interventions on mortality, morbidity and quality of life.

References

1. Zimmerman JE, Kramer AA, McNair DS, Malila FM. Acute physiology and chronic health evaluation (APACHE) IV: hospital mortality assessment for today's critically ill patients. *Crit Care Med*. 2006; 34(5):1297-1310.

2. Higgins TL, Teres D, Copes WS, Nathanson BH, Stark M, Kramer AA. Assessing contemporary intensive care unit outcome: an updated mortality probability admission model (MPM$_0$-III). *Crit Care Med.* 2007; 35(3):827-835.

3. Moreno RP, Metnitz PG, Almeida E, et al. SAPS3—From evaluation for the patient to evaluation of the intensive care unit. Part 2: Development of a prognostic model for hospital mortality at ICU admission. *Intensive Care Med*. 2005; 31:1345-1355.

4. Ferreira FL, Bota DP, Bross A, Melot C, Vincent J. Serial evaluation of the SOFA score to predict outcome in critically ill patients. *JAMA*. 2001; 286(14):1754-1758.

5. SAPS3 Software. The SAPS3 Outcome Research Group. Available at: http://saps3.org/index2.html. Accessed April 21, 2010.

6. Teres D, Lemeshow S. Why severity models should be used with caution. *Crit Care Clin.* 1994; 10(1):93-110.

7. Rogers J, Fuller HD. Use of daily acute physiology and chronic health evaluation (APACHE) II scores to predict individual patient survival rate. *Crit Care Med*. 1994; 22(9):1402-1405.

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