Review Article

Mortality In Critically Ill Patients – A Short Review

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Abstract

Intensive care units are an integral part of any hospital which deals with critically ill patients who are at extremes of physiological dysfunction. Mortality in critically ill patients vary from 18% up to 40% in various studies across the world due to varied clinical practice, ICU design and individual patient factors. Mortality prediction models such as APACHE score and SOFA score and other scoring tools are used commonly in ICU to prognostic patients and to predict mortality but none of the tools have been shown to be superior among various studies conducted. Demographic factors such level of sophistication of ICU, financial status can adversely affect the prognosis of patients and they are especially important in developing countries such as India. Individual clinical characteristics such as patient's pre-morbid status and co-morbidities, presence of sepsis with shock, acute respiratory distress syndrome have significant effects on the prognosis of critically ill patients. Sepsis is one of the most common disease condition in an ICU setting, although there are limitations to surviving sepsis guidelines, the recommendations are still widely followed in many hospitals. Our understanding of mechanical ventilation has improved tremendously in the past few years with immense data from evidence based studies which has contributed to the decline in ICU mortality and overall hospital mortality.

Keywords : ICU mortality, APACHE score, Sepsis, ARDS

Introduction

Intensive care units are specialized treatment units which provides highly specialized medical care for life threatening organ failures which may develop in acute and chronic diseases at any point during the course of the disease. ICUs provide specially designed monitoring with highly skilled personnel for patients at extremes of physiological deterioration. The concept of critical care unit was introduced in the early 19th century by Dr. Walter E Dandy when the exceptional idea of intensive care beds was introduced in Johns Hopkins Hospital in Baltimore.[1]

The notion of intensive care units in India has developed rapidly in the past few decades. Numerous studies have evaluated factors which may predict positive and negative outcomes in critically ill patients but due to the varied nature of critical care units which are markedly different in design, resources, management and care delivery there is no consensus regarding the optimal ICU care. In this review article we will look at some of the factors which contribute to the prognosis of patients who are admitted in an intensive care setting.

Mortality Prediction Models in ICU

Mortality prediction models have been developed to assess objectively and quantitatively the level of organ dysfunction and predict mortality in ICU patients. Clinicians and researchers have always known how important performance of ICU is to overall hospital mortality.

Most widely used Mortality predictions models are:-

APACHE II – Acute Physiology, Age, Chronic Health Evaluation score The APACHE score was introduced in 1981 by Knaus et.al and an updated version, APACHE II score in 1985, which is the most widely used prediction model for critically ill patients.[2,3] Although APACHE III and IV models have also been in use for a few years now, APACHE II still remains the most widely used when compared to the older and newer models.

Mortality prediction models may not change the clinical management of patients but they are still used in prognosticating patients and may help family members make informed decision about the aggressiveness of care. They are also useful to compare baseline status of patients in clinical trials and studies conducted in an ICU setting, evaluate the success of new or differing forms of therapies.

The APACHE II score uses 12 physiologic measurements, age and previous health status and the score is calculated within first 24 hours of admission to ICU using the initial values or the worst measurement in the first day of admission.[4] The scores range from 0 to 71 and higher scores correspond to increased risk of death and severe disease.

APACHE II Score	Nonoperative	Postoperative
0-4	4%	1%
5-9	8%	3%
10-14	15%	7%
15-19	25%	12%
20-24	40%	30%
25-29	55%	35%
30-34	73%	73%
>34	85%	88%

Table 1 : APACHE scores with corresponding in-hospital mortality rates (adapted from Knaus et.al. 1985)

SAPS III – Simplified Acute Physiology Score

The SAPS III is an extensive tool which uses 29 parameters to predict mortality in hospitalized patients. Although developed to assess mortality it can also be used to compare mortality across different time and different hospitals.

SOFA – Sequential Organ Failure Assessment score

SOFA score is one of most commonly used scoring tools used in the ICU settings. The scoring is done at admission and then re-calculated on subsequent days. The mortality rate is nearly 50% with increasing SOFA score and less than 27% when the scores remain unchanged.[5]

The components of the score is divided into six categories, one for each major organ system (respiratory, cardiovascular, hepatic, coagulation, renal and neurological).

SOFA Score	Mortality if initial score	Mortality if highest score
0-1	0.0%	0.0%
2-3	6.4%	1.5%
4-5	20.2%	6.7%
6-7	21.5%	18.2%
8-9	33.3%	26.3%
10-11	50.0%	45.8%
12-14	95.2%	80.0%
>14	95.2%	89.7%

Table 2 : SOFA score and Mortality scores

The table above shows the risk of mortality associated with increasing SOFA scores calculated on admission (initial scores) as well as mortality associated with highest SOFA scores during ICU stay.[6]

Demographic and Clinical characteristics of ICU patients

Patients who are admitted to intensive care units have significantly severe disease when compared to patients who are admitted to the ward. Hence, when predicting mortality for a patient, the patient's clinical characteristics and level of sophistication of the ICU plays a very important role.

In a study which was done across 124 ICUs in India, patients who were admitted to ICUs which were well equipped (well equipped ICUs were defined as ICU or hospitals which had Dialysis, CT scan, microbiology, biochemistry and hematology laboratories, echocardiography and cardiac catheterization lab) had a lower mortality when compared to ill-equipped ICUs. (21% vs 28 %; p<0.001). The study also showed that nearly 30% of the ICUs in India were not adequately equipped to handle critically ill patients.[4]

Patients who were admitted to Medical ICU also had higher mortality when compared surgical ICU(medical vs surgical : 20% vs 9%;p < 0.001), with higher mortality among patients who underwent emergency surgical procedures when compared to elective ones.[2]

Another entity which contributed to patient mortality was patient's financial source. In India, patients still do not have sufficient insurance coverage or government aid to cover medical expenses. The study showed that 80% of the intensive care patient were self-paying and they had a higher mortality (self paying vs others: 19% vs 16 %).[4] Although it will be difficult to draw conclusions from the above result, the study shows the poor coverage of medical insurance in such a vast country and the need to improve government aid and health insurance to remove economic and financial burden from families and individuals.

Intensive care unit patients are often in severe physiological dysfunction with one or more organ failures. Numerous studies have shown patient's clinical characteristics have a profound effect on the outcome of the patient. Pre-existing illnesses worsen the chances of survival. In a study done in India, presence of co-morbidities(namely Chronic obstructive pulmonary disease, hematological or solid organ malignancies, chronic renal failure, liver failure or immunosuppressive treatment) significantly worsened the mortality in ICU patients. Mortality worsened with increasing number of co-morbidities which can be seen in the table below. Mortality nearly doubles with increasing number of co-morbidities when compared to patients with no co-morbidities.[4]

Number of co-morbidities	All patients	Survivors	Non-survivors	Mortality (%)
0	2536	2147	389	15%
1	1182	923	259	28%
2	268	206	62	23%
3	47	29	18	38%

Table 3 : Mortality associated with Number of co-morbidities

Leading causes of mortality in an intensive care setting are sepsis, cardiovascular failure and respiratory failure. Recognition and prompt initiation of supportive management in the form of administering antibiotics, inotropic support and mechanical ventilation has been shown to reduce morbidity and mortality in all forms of critically ill patients.[7]

ICU patients can develop sepsis which they may have acquired from the community or from the hospital/ICU itself. Severe sepsis or septic shock (defined by Surviving Sepsis Campaign (SSC)) during ICU stay has increased mortality irrespective of other parameters. (OR : 1.699; CI :1.3 – 2.1).[4] Hence prompt recognition of sepsis at the earliest along with resuscitation of the patient according to protocols laid done by Surviving sepsis campaign bear utmost importance.[8] (Sepsis bundles of SSC will be discussed in the following section – Interventions in ICU).

Apart from sepsis and septic shock, patients who have developed acute respiratory distress syndrome (ARDS), as defined by the Berlin criteria (PaO2/FiO2 < 300), have nearly twice the risk of mortality when compared to others who do not have ARDS. (OR : 2.2 ; CI : 1.7 – 2.9).[2] Patients diagnosed to have ARDS require ventilator support, either as non-invasive ventilation or invasive mechanical ventilation and mechanical ventilation was independent predictor of mortality with the most probability for death (OR : 2.8; CI 2.3 – 3.4).[4]

Interventions in Intensive Care Units

Interventions performed in the ICU for critically ill patients can be to treat a disease,used as substitute for physiological function or can be to tackle a failing organ system in a patient with multi-organ dysfunction.

Infections are one of the most difficult entities encountered in an intensive care setting and they can vary from patients presenting with features of sepsis or SIRS to patients with profound septic shock.[9] Surviving sepsis campaign bundles were initially proposed to achieve targets in patients who presented with features of septic shock within 6 hours (resuscitation) of presentation and within 24 hours (management) of presentation.[10,11]

However, the recent update in the SSC has strong recommendation for specific targets to be achieved within 1 hour of identification of septic shock (Although not all the targets may be achieved within 1 hour but they should be initiated).

The SSC recommends early recognition of septic shock and initiation of empiric broad spectrum antibiotics within first 1 hour of presentation, following the reports from a study done by Rivers et al.[10] Every hour of delay increases the mortality by 7.6%. SSC also recommends at least 2 sets of blood culture before starting antibiotics and a target mean arterial blood pressure above 65 mmHg with fluid resuscitation or with use of vasopressors.

Recent trials, such as Protocolized Care for Early Septic Shock (ProCESS)[13] trial in the United States, the Australian Resuscitation in Sepsis Evaluation (ARISE)[14] trial and the Protocolised Management of Sepsis (ProMISe)[15] trial in England debunked the earlier recommendations of the SSC and did not show any significant change in mortality or need for organ support in any of the patients although most expert physicians will agree that in management of patients with septic shock SSC guidelines play a vital role.

Surviving Sepsis bundles Resuscitation bundle - 1 hour bundle	Target patients
Measure lactate	All patients
Re-measure Lactate	If initial lactate was elevated (>2 mmol/ L)
Blood culture before antibiotics	All patients
Broad spectrum antibiotics within 3 hours for ED admissions and 1 hour for others	All patients
Fluids - 30ml/kg of crystalloids	Hypotension or Lactate > 4 mmol / L
Mean arterial pressure > 65 mmHg	Septic shock or lactate >= 4mmol/L

Table 4 : Surviving Sepsis Guidelines

Mechanical ventilation is one of the defining intervention in an intensive care setting and remains the cornerstone for patients with acute respiratory distress syndrome. Several studies have showed improvement in mortality in ICU patients with increasing evidence based practice of medicine in the critical care setting, with a decrease in crude mortality in 2010 when compared to 1998 (28% vs 31%; OR 0.87 ; CI - 0.8 – 0.94).[16] One of the pioneering trial, The ARDSnet trial, which proposed lower tidal volume (4-6ml/kg) when compared to traditional tidal volume (6-8ml/kg) showed a reduction in mortality from 40% to 31% ($p < 0.007$).[17] Non-invasive ventilation has also increased over the past few decades which has led to lesser complications associated with invasive ventilation such as ventilator associated pneumonia and ventilator associated lung injury.

Some of other interventions which has improved mortality in critically ill patients are administering

corticosteroids in septic shock patients, intravenous proton pump inhibitors to prevent ventilator associated pneumonia which have changed the outlook of patients who undergo critical care treatment.

Conclusion

Although the concept of critical care has been a new field of venture in the medical fraternity, evidence based practice has seen tremendous improvements in critically ill patient care over past few decades. Mortality prediction models such as APACHE and SOFA score helps in prognosticating patients in ICU and to follow patient's improvement to medical therapy. Studies done across our Indian subcontinent helps us to realize the need for better equipped critical care units and the need for better funding and financial support for patients and families. Surviving sepsis guidelines have drawn criticism for invasive monitoring such as Central venous pressure and Central venous oxygen saturation monitoring but expert physicians will not deny the need for early recognition of sepsis, prompt administration of antibiotics and maintaining target end points when resuscitating critically ill patients. Mortality in ICU has seen a decreasing trend along with decrease in hospital mortality due to better understanding of the mechanics of invasive and non-invasive ventilation and implementation of strategies to prevent complications in intensive care patients.

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