T E Oh: Intensive Care Manual

Organization Aspects

Chapter 2: Predicting Outcome of Critical Illness

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With the technological expansion of the 1980s has come the increasing expense of caring for the critically ill. The concept of outcome prediction has, in part, emanated from society's need to rationalize limited financial resources, and to optimize the care of those patients who have a reasonable chance of meaningful recovery from critical illness. Within this broad concept, come the difficult ethical considerations of when to limit resources in particular, seemingly hopeless cases. Clearly, the problem extends beyond simple statistical analyses. Aspects of medical decision making, as well as illness severity scoring systems, are thus becoming increasingly important. This discussion will focus on adult Intensive Care patients only.

"Whole Patient" Considerations

When assessing possible outcome from critical illness, the following patient variables should be considered:

1. Age

In general, increasing age is associated with a reduced ability to recover from a critical illness. The reasons include increased propensity for the initial life-threatening illness, reduced physiological reserve, and the development of complications during treatment. The concept of "biological versus chronological" age has some merit, in that it attempts to quantify the overall health status of the individual through "age". The elderly patient has a higher incidence of cardiovascular and respiratory disease, which makes the likelihood of intercurrent myocardial infarction and respiratory failure higher. At the extremes of age, a non-specific state of immune deficiency exists either through poor nutrition, hormonal changes, or other mechanisms. These not only increase the likelihood of acquiring severe infection de novo, but also increases the incidence of developing nosocomial infection whilst in the ICU. All these factors will adversely affect outcome.

The elderly have an increased incidence of social isolation, often living alone with little home help. Their admission may be directly related to this. In addition, a longer period of convalescence may be necessary. As a result of critical illness, an elderly patient may have little or no chance of returning to independent existence. These issues are relevant to overall management plans.

2. Past Illnesses

The nature and severity of a pre-morbid medical condition will affect outcome. A detailed understanding of the patient's past illnesses is of major importance. Preexistant illnesses will reduce physiological reserve. For example, the emphysematous patient who is dyspnoeic on minimal exertion, is less likely to tolerate long-term assisted ventilation without barotrauma and infectious complications.

Patients with cancer and haematological malignancy require special consideration. The prognosis of many cancers thought to be incurable 5 years ago, are not excellent, with good long-term survival. However, complications from intensive chemotherapy (such as infections from neutropenia and bleeding from thrombocytopenia) may affect outcome. Whilst the outcome for critically ill cancer patients is worse than that for a comparable group without cancer, it is important to ascertain the nature and extent of the underlying disease, and the likelihood for long-term survival from that disease alone. Consultation with a clinical oncologist/haematologist is helpful.

3. Current Illness

The severity and extent of the current illness has, obviously, a major impact on outcome. Many diseases can be accurately staged, and prognostic information obtained from this assessment. Scoring systems are applicable in many cases (see below). For example, a severe head injury who presents in coma and with a low Glasgow Coma Score will, in general, do less well than one who presents with minimal neurological abnormality. An understanding of the pathophysiology is important to both management and outcome. When the current illness is considered, morbidity associated with treatment, must also be borne in mind.

4. Response to Treatment

Depending on the illness, the likelihood of recovery may be reasonably assessed after a defined period of time. For instance, the outlook for adult patients in persistant coma 4 days following cardiac arrest/hypoxic encephalopathy, is uniformly bleak. However, time frames like this correspond to specific clinical entities. The above bleak outlook, for example, cannot be applied with accuracy to all head-injured young adults 4 days after injury. Recovery and response to treatment vary according to the patient, the disease and the resources available. With adequate understanding of each case, it is reasonable to set a time, at which absence of clinical improvement would indicate a reassessment of further aggressive treatment. It is well recognized that prolonged Intensive Care is associated with increasing mortality/morbidity, as a function of the severity of illness.

5. Social Circumstances

Consideration of the patient's social situation will often give insight into the nature of the medical problem. For example, treatment and long-term outlook will be limited by the incompetence of the chronic alcoholic to care for himself following hospital discharge, and who is not a candidate for social support services. A similar situation involves the chronic, multi-medication dependent, but non-compliant patient.

It is important to consider the patient's family when making decisions regarding Intensive Care. (See Chapter 1, Organization of Intensive Care Units.) The nature and prognosis of the illness should be clarified. Time may be required to allow close relatives to form realistic expectations and goals, and repeated discussions are often necessary.

6. Future "Quality of Life"

The most difficult area in outcome prediction is the estimation of the quality of life, should the patient survive. High probabilities of permanent, severe physical or mental incapacitation, and subsequent intolerable distress, may influence continuation of "all out" aggressive therapy. Unfortunately, it is extremely difficult to discern the extent of disability the patient may wish to tolerate. Care must be taken to avoid using one's own perceptions without consideration for the patient's and family's viewpoint.

Resources

In today's society, health care resources are finite. Decisions are necessary regarding the admission of patients unlikely to do well into over-burdened ICUs. Clear admission and discharge policies are necessary. (See Chapter 1, Organization of Intensive Care Units.) Prognostic stratification, based on numerous criteria can help guide admission or treatment decisions.

Illness Severity Scoring Systems

Several scoring systems have emerged over recent years, in an attempt to statistically quantify the relationship between disease severity and outcome. Scoring systems are in common practice in many areas of medicine. Most forms of malignant disease are staged according to extent of tumour, and clinical staging correlates with survival and the response to treatment. The major scoring systems are discussed below.

Acute Physiology and Chronic Health Evaluation II (APACHE II)

The APACHE II severity of disease classification was devised by Knaus in an attempt to stratify prognostic groups of critically ill patients, as well as determine the success of different forms of treatment. The original APACHE score was based on 34 physiological parameters (the Acute Physiology Score (APS)), and a subjective assessment of the severity of chronic, intercurrent disease, but was found to be too cumbersome for routine clinical use. APACHE II was developed as a simplified, clinically useful classification, using 12 easily measured variables (APS) and an evaluation of pre-morbid health. Although debate has occurred on the timing of assessment, it is recommended that the worst score over the first 24 hours following ICU admission be used. The 12 parameters comprising the APS are:

1. Temperature (°C)
2. Mean arterial pressure (mmHg)
3. Heart rate (beats/min)
4. Alveolar-arterial oxygen gradient (A-aDO_2) if fractional inspired oxygen (FIO_2) is 0.5 or greater or PaO_2 if FIO_2 is less than 0.5.
6. Arterial pH
7. Serum sodium (mmol/L)
8. Serum potassium (mmol/L)
9. Serum creatinine (mg/100 mL)
10. Haematocrit (%)
12. Glasgow coma score (GCS).

Depending on the degree of derangement, a weighted score is assigned to each parameter (APS). Unlike the original APACHE, all parameters should be entered, except perhaps arterial pH and creatinine in routine postoperative monitoring cases, where it is assumed that these will be normal. Care must also be exercised in correctly recording GCS of 15, when neurological problems are unlikely to exist. The GCS is a subjective assessment, unlike the other criteria, and is therefore subject to potential bias.

Points are also assigned for increasing age, emergency postoperative or nonoperative admission, and if a history of severe organ system insufficiency exists. Within the physiological parameters defined above, double weighting is assigned to derangements of serum creatinine in the setting of acute renal failure in the critically ill. The maximum possible score is 71, although nearly all patients have scores much lower than this. Increasing scores correlate with higher hospital mortality, at each 5 point increment, across a wide range of diseases. It should be recognized, however, that the APACHE score reflects the severity of physiological derangement within a single diagnostic category, at a single point in time. Differing disease states have intrinsically differing outcomes, most notably diabetic ketoacidosis, where a profound physiologic derangement on admission is not predictive of subsequent mortality. Similarly, a high initial APACHE II score in postoperative coronary artery bypass patients need not result in a high mortality. In contrast, similar scores in patients with septic shock are associated with a much higher fatal outcome. However, within both these groups, an increasingly high score reflects a poorer outcome. Problems also arise when the patient's disease is difficult to categorize. For example, should a dilutional coagulopathy in the setting of hypovolemic shock due to poly-trauma be classified as haematologic, cardiac or traumatic? The inability to account for the development of multi-system failure after subsequent admission remains another problem.

It is recommended that disease-specific mortality predictions be based on at least 50 patients in each diagnostic category, and at least 20 patients should be in the least-frequent outcome category. This will minimize potential chance results. Those patients who can only be classified by specific (multi-) organ system dysfunction (as opposed to specific diagnosis) may be more difficult to compare.

It is argued that expected death rates based on the APACHE II score may be compared to actual death rates as a means of judging therapeutic efficacy. The score may also be used to assess the effects of different treatment modalities. Although these concepts are tenable, care must be used in the application of raw scores across different hospitals and health care systems, each with varying practices and biases. Further studies are required to assess these important considerations.

Whilst the score was not designed originally to influence patient management decisions, it may provide the clinician with more information to guide future decisions, particularly with respect to the probability of hospital death. An APACHE II trend analysis may be more appropriate, utilizing sequential APACHE scores at fixed intervals (eg, daily), and noting the rate of change relative to the last score. It should not, however, replace balanced medical assessments, based not only on the APACHE II score, but also on the less-tangible concepts described earlier. There is sufficient APACHE II score overlap in survivors versus non-survivors in many diseases, to be cautious in its widespread application as a predictor of mortality.

Sickness Scoring

Several variants of the APACHE II score have been developed in an attempt to enhance its prognostic ability. One such system is Bion's "sickness score" (SS). Using a APACHE II "template", the following modifications are made:

1. Units are converted to SI units.

2. Haemoglobin concentration is used rather than Haematocrit.

3. Oxygenation is assessed using a ratio of the FIO_2 and PaO_2.

4. The "chronic disease" category is redefined to include conditions associated with loss of independent self-care.

5. Clinical judgment is used in the application of the Glasgow Coma Score.

6. Haemodynamic instability is assessed to reflect overall abnormalities rather than transient, perhaps drug-induced, changes.

7. Daily scores are charted, to assess response to treatment.

Using these guidelines, periodic neurological and cardiovascular abnormalities due to sedative drugs could be "buffered" in the overall scoring analysis. It was also postulated, as the ICU is a place where acute physiological disturbances could be remedied, that the response to treatment was important as a prognostic indicator.

Increasing SS was associated with higher mortality, as was a sequential rise over time, indicating a lack of response to treatment. The admission SS correctly identified 80.6% of survivors and 70.4% of non-survivors. Trend analysis enhanced the predictive accuracy. However, decisions t continue or withdraw Intensive Care should be based on clinical judgement, with an appreciation of the changing SS as another marker of disease severity.

Simplified Acute Physiology Score (SAPS)

Le Gall reduced the former 34-variable APACHE score to 14 easily definable parameters, similar to the current APACHE II score. Minor variations to account for ventilated patients were made. The conclusions were similar to results obtained from the APACHE II and SS studies. With increasing SAPS, mortality increased progressively, although disease-related mortality/SAPS correlation has, to date, not been published.

Mortality Prediction Models (MPMs)

Lemeshow devised MPMs based on multivariate statistical analysis of a large cohort of adult general Intensive Care patients. The predictive ability of these models to assess mortality risk is similar to the scoring systems cited above. Serial assessments may be more accurate in predicting future mortality. The system may be more elegant, in that admission diagnosis is not required. A series of true/false questions are answered, and these are weighted according to their individual contribution to mortality. The predictive ability of sequential MPMs is approximately 74-80%, which still leaves enough inaccuracy to limit its usefulness as a tool for making decisions affecting outcome without resort to clinical judgement and experience.

Therapeutic Intervention Scoring System (TISS)

TISS was developed in 1974, and updated in 1983 in response to changing technology and new procedures. By assigning a score to those procedures performed on patients in the ICU, an indicator of the severity of illness, and perhaps prognosis, could be inferred. In addition, the establishment of the appropriate nurse/patient ratio and staff/bed utilization could be established.

It was suggested that a competent ICU nurse could handle 40-50 TISS points/day. The number of therapeutic interventions on a given patient would, by necessity, be dependent on the type of care given, and the implied need for such procedures such as invasive monitoring and assisted ventilation. An unacceptably high TISS in the setting of continued active treatment would suggest that discharge from the ICU was inappropriate.

Whilst TISS has been shown to be valuable from a unit administration standpoint, its inability to predict death in an individual mitigates its use as a serious prognostic indicator. TISS points are physician-dependent. As medical practices are different at each institution, so are the potential therapeutic interventions performed.

Other Scoring Systems

Whilst multivariable scoring is helpful in the critically ill, a unisystem disease severity score may, by itself, be of major prognostic importance, even in the setting of multisystem disease. Common scoring systems include the injury severity score (ISS) (see Management of Severe and Multiple Trauma), Glasgow coma score (GCS), trauma score and the abbreviated burn index. For instance, a head-injured patient with a poor GCS will have a poor outcome, independent of the development of a small myocardial infarct. Other concurrent medical problems will usually increase the likelihood of a poor outcome, if they are functionally important or have an unfavourable prognosis by themselves. This requires an understanding of the individual importance of particular disease states and the need for specialist Intensive Care physicians with a broad background in a number of medical specialties.

Comparison Between Different Scoring Systems

To date, very little work has been done to compare the above systems. Analysis of 1997 patients using the Acute Physiology Score (APACHE without the chronic health evaluation), SAPS, and MPMs, showed little difference between any system in predictive ability over a wide range of scores. All systems showed that increasing severity of physiological derangement was associated with increased mortality. The MPM was, however, based only on a single assessment on admission, and not on serial assessment. It remains to be seen whether sequential MPM analysis is superior.