The Australian and New Zealand Risk of Death (ANZROD) model: getting mortality prediction right for intensive care units

David Pilcher, Eldho Paul, Michael Bailey and Sue Huckson

The Australian and New Zealand Risk of Death (ANZROD) mortality prediction model has recently been published.[1] Over the coming months, you may see more publications regarding its application before this model is incorporated into routine reporting of intensive care unit statistics.

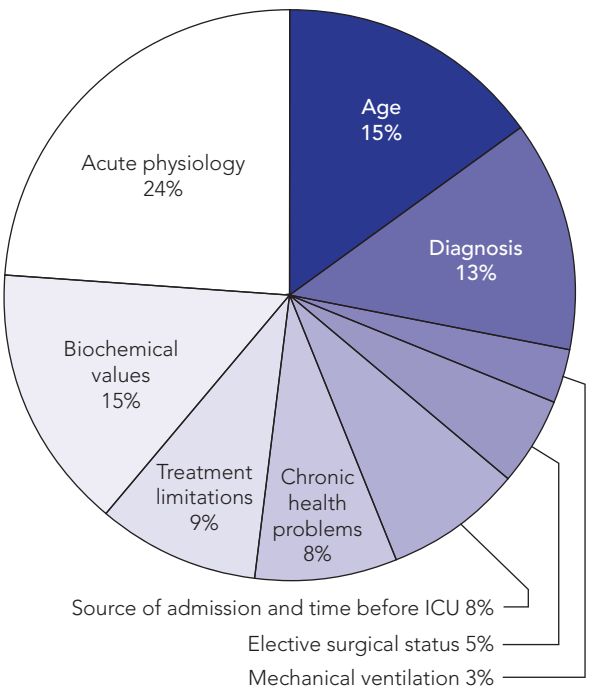
Why develop a new prediction model for use in Australia and New Zealand?

We have an international gold standard with the Acute Physiology and Chronic Health Evaluation (APACHE) III-j model. The variables for APACHE III-j are already collected by almost every ICU in Australia and New Zealand, and it has been used for benchmarking ICU performance for over a decade.[2] However, although APACHE III-j accurately predicted the number of deaths in our ICUs in 2002, this is no longer the case.

Mortality outcomes have progressively dropped below APACHE III-j estimations, but this has not been constant for all diagnoses.[3] Risk-adjusted mortality rates for elective surgery have halved over the past 10 years, but medical and emergency surgical deaths have dropped by only 20%. For diagnoses such as cardiac valve surgery, APACHE III-j now predicts three times as many deaths as actually occur. The predicted mortality for diagnoses such as chronic obstructive pulmonary disease (COPD) and cardiac arrest is more accurate, but is still overestimated by about 10%. This variation can have significant implications for performance monitoring. Imagine two hospitals: if you look at their standardised mortality ratios (the ratio of observed deaths to predicted deaths), the cardiothoracic ICU that does many valve operations will appear "better" than the general ICU that admits many patients with COPD and cardiac arrest, even though both ICUs may be performing at exactly the average for Australia and New Zealand.

Thus, the time had come for a new mortality prediction model for Australia and New Zealand.

Figure 1. Relative contributions to predicted risk of mortality in the Australian and New Zealand Risk of Death (ANZROD) model*



ICU = intensive care unit. * Proportions determined by mean *z* score from logistic regression equations.

How was ANZROD developed?

In 2011, we began developing ANZROD by starting with a few principles:

- Accurate prediction for all diagnoses
- Use only variables that are already collected — no requirement for additional data collection
- Applicability to every adult patient — unlike APACHE, which excludes certain patient groups, ANZROD excludes only those admitted for palliative care or organ donation.

Based on data from 450000 ICU admissions submitted to the Australian and New Zealand Intensive Care Society (ANZICS) Adult Patient Database between 2004 and 2009, ANZROD was developed by combining APACHE III-j score components, admission source and diagnosis, lead time, ventilation status and treatment limitations into eight separate equations, one for each major diagnostic group.

ANZROD was then recalibrated on over 100 000 admissions from 2012 to further "tweak" the predictions to represent modern intensive care outcomes.

Is ANZROD better than APACHE?

ANZROD predicts mortality very well, with better calibration and discrimination than APACHE, for almost all patient groups, including cardiothoracic and trauma patients (for details, see http://www.ncbi.nlm.nih.gov/pubmed/24074958).[1] The use of eight separate equations allows more appropriate weighting of individual components for each diagnostic group. For example, a Glasgow Coma Scale (GCS) score of three recorded for a patient with a head injury has much more prognostic significance than a similar GCS score recorded for a patient admitted after elective cardiac surgery, where it is likely to represent an erroneous value due to sedation. The greater weighting of the GCS score in the equation for trauma patients thus provides more robust mortality prediction.

We have now spent many hours with Michael and Eldho lamenting David's dodgy knowledge of statistics, and David spinning yarns and anecdotes about ICU patients under the guise of providing clinical input. From a personal perspective, it has allowed us to learn the relative contributions of age, diagnosis and chronic health problems to the prediction of mortality for ICU patients. It is not surprising that the acute physiological disturbance of the patient is the most important factor, accounting for about a quarter of a patient's risk of death (Figure 1), while chronic health factors account for less than one-tenth (about the same as the presence of a treatment limitation at ICU admission).

What's in a name?

We considered other names but, by the time we came to submit the model for publication, it had simply become ANZROD. We believe the name suits it well. It is not a "score" as such but a "prediction of mortality", the value of which represents a person's actual chance of dying after admission to an ICU in Australia or New Zealand. The name may sound a little "daggy" (and only we really know what that word means!) but it is ours, it is accurate and, regardless of its name, it will work for all your adult patients.

What will ANZROD mean to you and when is it coming?

At present, ANZROD is being assessed "in the background" by the ANZICS Centre for Outcome and Resource Evaluation. In time, an online calculator will also be made available. ANZROD will facilitate better benchmarking of ICU performance and better risk adjustment for researchers. Look out for more publications describing its use and application in Australian and New Zealand ICUs over the next few months. ANZROD is expected to be added to routine reporting practice in ICUs in Australia and New Zealand in mid 2014.

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