

ANZROD, COPE 4 and PIM 3: caveat emptor

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Recently, we have witnessed a growing interest in metrics for assessment of clinical performance,^{1,2} such as the standardised mortality ratio (SMR) (the number of observed deaths divided by the number of predicted deaths). A “poorly” performing hospital or intensive care unit is expected to have more deaths than predicted, generating a high SMR, and vice versa.

The SMR is thus a useful screening tool for monitoring clinical performance but it requires an accurate prediction model. The model needs to be relevant to the study population to adjust for factors, other than clinical care, that will influence outcome, for example patient age and severity of illness. There are now several such prediction models, including the Acute Physiology and Chronic Health Evaluation (APACHE) III,³ the Simplified Acute Physiology Score (SAPS) 3,⁴ the Mortality Probability Model (MPM) II⁵ and several locally developed models (the Paediatric Index of Mortality [PIM] 3,⁶ Critical Care Outcome Prediction Equation [COPE] 4,⁷ and Australian and New Zealand Risk of Death [ANZROD]⁸ models [Table 1]). The ANZROD model will soon supersede APACHE III scoring in Australia and New Zealand.¹

It is increasingly likely that clinicians will be presented with SMR values for their hospital and invited to interpret the results or to review their clinical practice when results diverge from the benchmark. It is therefore prudent to be aware of common reasons for a misleading SMR.²

First, check the number of deaths (the numerator). This determines the precision of the SMR. With fewer than 100 deaths, the true SMR may be more than ±20% of the calculated SMR, which is of little clinical value. If so, simply extend the duration of analysis to achieve the desired number.

Second, the denominator requires a reliable prediction model. An ideal model includes easy-to-collect variables that are present on admission and will be independent of the treatment being evaluated.⁴⁻⁶ Data errors should be minimal and can be quantified by auditing a random sample.⁹

Missing data in the prediction model will be substituted with default (normal) values.³ Unknown outcome data (more common in long-stay survivors) will result in those cases being omitted.^{6,8} Both will produce a misleadingly high SMR.

Model variables based on continuous (rather than binary [yes or no]) data or complex definitions (such as the chronic illness and coma scores of the APACHE III and ANZROD models) have a greater risk of error⁹ or manipulation.¹⁰ This creates a misleadingly low SMR. COPE 4 is simple and austere (Table 1) but only adjusts for illness severity on hospital (not ICU) admission and may not suit all hospitals.⁷

Third, the model should undergo regular recalibration to a contemporary local population to adjust for secular improvements in survival rates.^{11,12} A prediction model that is calibrated to a historical or geographically remote cohort, such as APACHE III,¹ will produce misleadingly low SMR values.

Finally, be aware of the phase of care that each model evaluates (Figure 1). COPE 4 selects data present at the time of hospital (not ICU) admission to predict hospital outcome. Therefore it evaluates the quality of care over the entire hospital stay. In contrast, PIM 3 selects data present on admission to the ICU and predicts ICU (not hospital) outcome, thus limiting the evaluation period to the ICU stay.

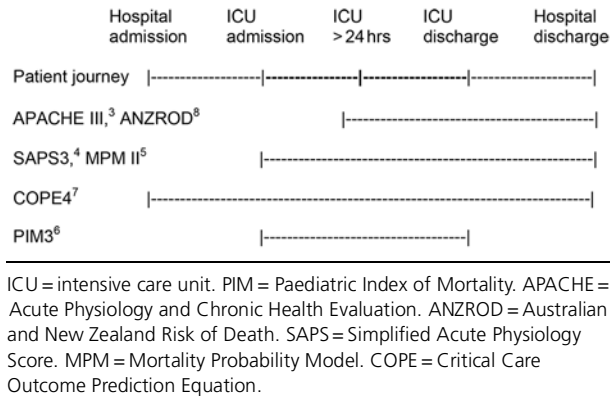
The chief component of the APACHE III and ANZROD models is the acute physiology score¹ (APS) collected up to 24 hours after ICU admission.³ Therefore, these models can only evaluate the quality of care beyond the first 24 hours in

Table 1. Characteristics of prediction models

Prediction model	Age (years)	Exclusions	Last calibration	Diagnostic categories	Variables, total (continuous)	Screening time
APACHE IIIj	≥ 16	Transfer,* readmission, [†] < 4 hrs in ICU	2003	94	31 (18)	First 24 hours in the ICU
ANZROD	≥ 16	Palliative care, readmission [†]	Biennial	124	38 (18)	First 24 hours in the ICU
MPM II	≥ 18	Transfer,* readmission [†]	1992	5	15 (3)	ICU admission
SAPS III	≥ 18	Transfer,* readmission [†]	2002	17	22 (11)	ICU admission
COPE 4	≥ 15	Readmission [†]	Annual	15	6 (1)	Hospital admission
PIM 3	≤ 17	None	Annual	10	13 (4)	At time of ICU contact

APACHE = Acute Physiology and Chronic Health Evaluation. ICU = intensive care unit. ANZROD = Australian and New Zealand Risk of Death. MPM = Mortality Probability Model. SAPS = Simplified Acute Physiology Score. COPE = Critical Care Outcome Prediction Equation. PIM = Paediatric Index of Mortality. * To another hospital. † ICU readmission during the same hospital admission.

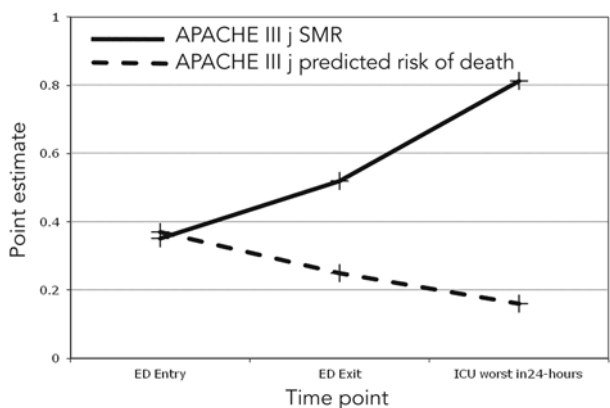
Figure 1. Timeline of patient hospital stay and time of entry and exit (of evaluation period) for each prediction model



the ICU, by which time 30% of all deaths (and discharges) have occurred (Figure 2). This short-stay subgroup will have an SMR close to unity, irrespective of the quality of care, and (unless excluded from the analysis) will bias the nett SMR.

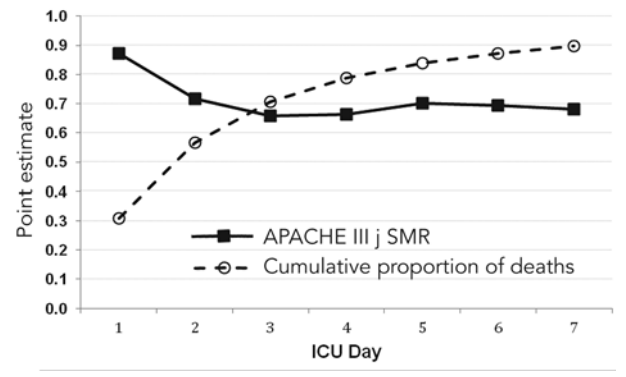
A patient mismanaged in a poorly performing ICU will have a higher APS than a similar patient managed in a better performing ICU. The high mortality in a poorly performing ICU will be incorrectly attributed to its “sicker” patients. This confusing situation can be appreciated by calculating the APACHE III SMR for the same patient at several time points during resuscitation.¹³⁻¹⁵ The APACHE III SMR remains low until resuscitation is complete (Figure 3).

Figure 3. Point estimate of APACHE IIIj predicted risk of death and associated SMR, calculated at three consecutive time points for 148 emergency admissions to an Australian metropolitan ICU¹⁶



APACHE = Acute Physiology and Chronic Health Evaluation. SMR = standardised mortality ratio. ICU = intensive care unit. ED = emergency department.

Figure 2. Point estimate of APACHE IIIj SMR and cumulative proportion of deaths, according to ICU length of stay in Australian and New Zealand ICUs, 2009–12 (n = 460 329)



APACHE = Acute Physiology and Chronic Health Evaluation. SMR = standardised mortality ratio. ICU = intensive care unit. Source: ANZICS Centre for Outcome and Resource Evaluation.

Despite these cautionary notes we strongly endorse the SMR as an effective screening tool for monitoring clinical performance. Until better prediction models become available, we advocate more than one model to monitor outcomes in adult ICUs: caveat emptor.

Competing interests

None declared.

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