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The ICNARC$_{H\text{-}2018}$ model:

The ICNARC model was originally published in 2007.[1] It was the culmination of many years of work to establish the best risk prediction model for use in the Case Mix Programme. Although the ICNARC model has been demonstrated to have better performance among patients admitted to UK critical care units than other risk models, ongoing improvement work is essential to further improve accuracy.

In developing the new ICNARC model, we addressed further areas for improvement, including handling of missing data, continuous nonlinear modelling of physiological predictors and making better use of available data from the hierarchical coding of reasons for admission to the critical care unit. We continue to seek improvements to this model to ensure that the risk predictions in all of ICNARC's reports are as accurate as possible. The new ICNARC model was published in 2015 as the ICNARC$_{H\text{-}2014}$ model,[2] and was subsequently recalibrated as the ICNARC$_{H\text{-}2015}$ model. The ICNARC$_{H\text{-}2018}$ is the latest recalibration using data for 202,293 admissions to 259 critical care units between 1 January 2017 and 31 December 2017. Recalibration ensures that comparisons are relative to current, not historic, performance.

Please note: although we still report using the ICNARC Physiology Score as a measure of severity of illness, this is not used in the calculation of risk in the new ICNARC model. In the ICNARC$_{H\text{-}2018}$ model, physiology data feed directly into the prediction of mortality and no physiology score is used.

Risk predictions in the ICNARC$_{H\text{-}2018}$ model are based on:

- Physiological parameters during the first 24 hours following admission to the critical care unit:
  - highest heart rate (min^{-1});
  - lowest systolic blood pressure (mmHg);
  - highest temperature (°C) – if no central temperature was recorded, the highest non-central temperature +1°C is used;
  - lowest respiratory rate (min^{-1}) – either ventilated or non-ventilated;
  - ratio of the lowest PaO_2 (kPa) to the associated FiO_2;
  - lowest arterial pH;
  - associated $PaCO_2$ (kPa) from the arterial blood gas with the lowest arterial pH;
  - highest blood lactate (mmol l^{-1});
  - total urine output (ml) – for admissions with a length of stay less than 24 hours, the total over the entire stay is recorded and scaled to represent a 24-hour equivalent;
  - highest urea (mmol l^{-1});
  - highest creatinine (µmol l^{-1});
  - highest sodium (mmol l^{-1});
  - lowest white blood cell count ($\times 10^9$ l^{-1});
  - lowest platelet count ($\times 10^9$ l^{-1}); and
  - Glasgow Coma Score plus additional weightings for patients sedated or paralysed and sedated for the whole of the first 24 hours in the unit (or entire stay, if less than 24 hours).
- Age in whole years at admission to the critical care unit.

- Past medical history, evident during the six months prior to admission to the critical care unit and documented prior to or at admission to the unit, of:
    - severe liver disease – biopsy-proven cirrhosis, portal hypertension or hepatic encephalopathy;
    - metastatic disease – distant metastases documented by surgery, imaging or biopsy;
    - haematological malignancy – acute or chronic myelogenous leukemia, acute or chronic lymphocytic leukemia, multiple myeloma or lymphoma;
    - severe respiratory disease – permanent shortness of breath with light activity due to pulmonary disease or receiving home ventilation; and/or
    - immunocompromise – daily high-dose steroid treatment, chemotherapy, radiotherapy, congenital immunohumoral or cellular immune deficiency state or AIDS.
- Dependency prior to admission to acute hospital – assessed as the best description for the dependency of the patient in the two weeks prior to admission to acute hospital and prior to the onset of the acute illness and categorised as able to live without assistance, some (minor/major) assistance or total assistance with daily activities.
- Cardiopulmonary resuscitation (CPR) prior to admission – internal or external cardiac massage received within 24 hours prior to admission to the critical care unit, categorised as in-hospital CPR, community CPR or no CPR.
- Mechanical ventilation – mechanical ventilation at any time during the first 24 hours following admission to the critical care unit, identified via the recording of a ventilated respiratory rate.
- Source of admission – categorised as emergency department/not in hospital (split by planned vs. unplanned admission), theatre following elective/scheduled surgery (split by planned vs. unplanned admission), theatre following emergency/urgent surgery, ward/intermediate care area, other critical care unit (split by repatriation vs. planned/unplanned transfer) and other acute hospital (not critical care).
- Primary reason for admission – categorical combinations of body system and pathological/ physiological process (e.g. respiratory infection) or individual conditions from the hierarchical ICNARC Coding Method.
- Interactions between physiological parameters and:
    - other physiological parameters;
    - past medical history (severe liver disease);
    - interventions (CPR, mechanical ventilation); and
    - primary reason for admission.
- Interactions between age and past medical history of:
    - metastatic disease;
    - haematological malignancy; and
    - immunocompromise.

Exclusions

Admissions are excluded from calculation of the ICNARC$_{H\text{-}2018}$ model predicted risk of death if they are admitted solely for the purposes of organ donation or if they are dead or have had all active treatment withdrawn on admission to the unit. In rare cases, there may be insufficient data to calculate a risk prediction; this includes admissions with no evidence available to abstract physiology data. Readmissions of the same patient within the same acute hospital stay and admissions missing ultimate acute hospital outcome are excluded from comparisons of observed and expected mortality.

References

1. Harrison DA, Parry GJ, Carpenter JR, Short A, Rowan K. A new risk prediction model for critical care: the Intensive Care National Audit & Research Centre (ICNARC) model. *Crit Care Med* 2007; **35**:1091–8.
2. Harrison DA, Ferrando Vivas P, Shahin J, Rowan KM. Ensuring comparisons of health-care providers are fair: development and validation of risk prediction models for critically ill patients. *Health Serv Deliv Res* 2015; 3(41).