A guide to your Case Mix Programme Version 3.0 electronic Data Analysis Report
Your eDAR consists of the following four documents.

**Quality Indicators and Outcomes**
This document summarises proposed quality indicators and outcomes for this period of data.
The eDAR is divided into the following sections:

- *Participation* – summary of data processing
- *Data completeness* – summary of data completeness
- *At admission* – potential quality indicators at admission, and summaries of admission characteristics
- *Local monitoring* – trends in specific, large groups of admissions to aid local monitoring
- *Delivery of care* – potential quality indicators for delivery of care, organ monitoring and support, levels of care, and HRGs for Payment by Results
- *Unit-acquired infections* – rates of unit-acquired infections
- *Outcome* – potential quality indicators for outcome, and summaries of discharge characteristics
- *Mortality* – crude and risk-adjusted mortality, including process control charts
- *Activity* – numbers of admissions, lengths of stay, and occupancy

**Case Mix Summary**
This document summarises the distribution of, and trends in, the case mix of patients admitted to your unit.

**Presentation Summary**
This document highlights the key results from the Quality Indicators and Outcomes in a form that can easily be used to share your results both internally and externally. The document is a landscape format pdf that can be directly displayed as a full screen presentation (ctrl+L in Acrobat or Adobe Reader) or copied and pasted into your preferred presentation software.

**Data Appendix**
This document reports the detailed numbers.
Using your eDAR

The purpose of the Case Mix Programme is to aid local performance management through the provision of timely, validated data to participating critical care units. The primary method for doing this is through this eDAR.

This report draws comparisons with your unit over time, with other similar units and with national figures giving you an accurate picture of the quality of care you are delivering within your critical care unit.

We would encourage you to disseminate the information in this eDAR to all staff in your unit to promote discussion. Some suggestions for doing this are:

- hold a seminar to present the results of the eDAR to unit staff using the accompanying ‘Presentation Summary’
- post key results from the ‘Quality Indicators and Outcomes’ document on your staff notice board
- discuss the results at clinical and nursing meetings
- share the results with unit managers during planning meetings
- email the results from the eDAR to colleagues
- save the eDAR on to your local IT network for colleagues to view and access
The eDAR reports on two risk prediction models, the ICNARC (2009) model and APACHE II. The purpose of both of these models is to take data from early in the patient’s stay in your unit (the first 24 hours following admission) and use this to predict the probability that the patient will die before ultimate discharge from acute hospital (a risk prediction). By summing these predicted probabilities for a group of patients we obtain the expected number of deaths, as predicted by the model. This can be compared with the observed number of deaths among the same group of patients to establish whether more or fewer patients than expected are dying.

The ICNARC (2009) model

The ICNARC model was developed using data from over 200,000 admissions in the Case Mix Programme Database (Harrison et al, 2007). It was the culmination of many years of work to establish the best risk prediction model for use in the Case Mix Programme. We continue to seek improvements to this model to ensure that the risk predictions in your eDAR are as accurate as possible.

Over time, the fit of the ICNARC model to the CMP data becomes less accurate as the case mix of admissions changes over time. To improve the fit of the model to the data, in 2009 the ICNARC model was recalibrated based on data from admissions to adult, general critical care units in the CMP database from 2006 to 2008. This recalibrated model is the ICNARC (2009) model. Regular recalibrations ensure that each unit is being compared to current CMP data.

Risk predictions in the ICNARC (2009) model are based on:

- The ICNARC physiology score – a score from 0 to 100 based on weightings for deviations from normal in the following twelve physiological parameters during the first 24 hours in the unit
  - heart rate
  - systolic blood pressure
  - temperature
  - respiratory rate
  - \( \text{PaO}_2/\text{FiO}_2 \) ratio (weighted differently depending on whether the patient was ventilated at any time during the first 24 hours in the unit, or the entire stay if less than 24 hours)
- arterial pH
- serum urea
- serum creatinine
- serum sodium
- urine output
- white blood cell count
- 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 the entire stay if less than 24 hours)

- Age at admission to your unit in years
- Reason for admission (weightings for 67 non-surgical conditions and 34 surgical conditions, plus nine body systems)
- Interactions between physiology score and reason for admission (for 19 non-surgical conditions and four surgical conditions), allowing for a different relationship between physiology score (acute severity) and outcome for certain conditions
- CPR within 24 hours prior to admission, and
- Source of admission.

Exclusions
No admissions are excluded from calculation of ICNARC (2009) model risk predictions. In rare cases, there may be insufficient data to calculate a risk prediction. Readmissions of the same patient within the same hospital stay and admissions missing ultimate hospital outcome are excluded from comparisons of observed and expected mortality.

Reference

APACHE II
The APACHE II model was originally published in 1985 based on data from the US (Knaus et al, 1985). It has been recalibrated twice for use in the UK, first following the Intensive Care Society’s APACHE II study in Britain and Ireland (Rowan, 1992; Rowan et al, 1993) and
subsequently using data from the Case Mix Programme Database (Harrison et al, 2006). Coefficients from the most recent recalibration based on Case Mix Programme data are used in the eDAR.

Risk predictions in APACHE II are based on:

- The APACHE II score – a score from 0 to 71 consisting of weights for age at admission to your unit (0 to 6 points) and severe conditions in the past medical history (0 to 5 points) plus an Acute Physiology Score (0 to 60 points) based on weightings for deviations from normal in the following twelve physiological parameters during the first 24 hours in the unit
  - temperature
  - mean arterial pressure
  - heart rate
  - respiratory rate
  - A-aDO₂ (if FiO₂ ≥ 0.5) or PaO₂ (if FiO₂ < 0.5)
  - arterial pH (or serum bicarbonate if no arterial blood gas recorded)
  - serum sodium
  - serum potassium
  - serum creatinine (with double weighting for acute renal failure)
  - haematocrit (estimated from haemoglobin)
  - white blood cell count
  - Glasgow Coma Score (assumed to be normal for patients sedated or paralysed and sedated for the whole of the first 24 hours in the unit, or the entire stay if less than 24 hours)

- Admission directly from theatre following emergency surgery

- Diagnostic category (weightings for 58 non-surgical diagnoses and 50 surgical diagnoses, plus seven body systems, and a weighting for CPR within 24 hours prior to admission that overrides any other diagnostic category)

**Exclusions**

Admissions are excluded from the calculation of the APACHE II score if:

a. age at admission to your unit is less than 16 years; or

b. length of stay in your unit is less than 8 hours.

Additionally, admissions are excluded from the calculation of an APACHE II risk prediction if:
c. the admission is for primary burns;
d. the admission is following coronary artery bypass graft (CABG) surgery;
e. the admission is transferred in from another ICU; or
f. all twelve physiological variables are missing.

Readmissions of the same patient within the same hospital stay and admissions missing ultimate hospital outcome are excluded from comparisons of observed and expected mortality.

References


Graphical display

All graphical displays in the eDAR except trend lines (see below) are based on the current period of data for your unit only.

Spider plots

Spider plots (or radar plots) are used to summarise our potential quality indicators. Each indicator is plotted on a scale from zero (outside edge of the plot) to a predetermined central point. The points are joined to form a filled shape. The ideal situation is for the entire shape to be filled with colour, indicating zero admissions against each potential quality indicator.

Reference


Trend lines

Trend line plots show the trend in a particular measure over time. Values are plotted for each quarter for the past five years (Q1: January to March; Q2: April to June; Q3: July to September; Q4: October to December). The only exception to this is for trends in data processing, which are shown as one point for each period of data (plotted at the end date of the period).

In each trend line plot, the trend line for your unit is shown as connected orange dots. The following additional features are included on each trend plot, where appropriate:

- 95% confidence intervals are placed around the figures for your unit (orange shaded area)
- comparator trend lines are shown for all NHS adult, general critical care units in the Case Mix Programme Database (dashed green line) and for similar units (dashed orange line)
- values not reproduced exactly for Version 2.0 data, but a close approximation, are plotted in a paler orange
- data items completely new to Version 3.0 (e.g. unit-acquired infections) are plotted from the start of Version 3.0.
Similar units
For NHS, adult, general critical care units (ICUs and combined ICU/HDUs), similar units are defined according to university teaching status, the size of the unit (reported number of beds), and the percentage of patients admitted from theatre, in the following categories:

- university hospital, more than 10 beds
- university hospital, 10 beds or fewer
- non-university hospital, more than 6 beds, >40% of admissions from theatre
- non-university hospital, more than 6 beds, ≤40% of admissions from theatre
- non-university hospital, 6 beds or fewer, >40% of admissions from theatre
- non-university hospital, 6 beds or fewer, ≤40% of admissions from theatre

Neurosciences units, combined general/neurosciences units, standalone HDUs and units in non-NHS hospitals are not compared to all NHS adult, general critical care units. However, they are compared with similar units of the same type. This comparison appears on the trend graphs as the dashed green line.

Due to small numbers of participating units, it is not possible at this time to compare cardiothoracic units or multiple injuries units to other units of the same type. These units are only compared to all NHS adult, general critical care units in the Case Mix Programme Database.

Pie charts
Pie charts illustrate the percentage of all eligible admissions (or patient days) in each of a number of mutually exclusive categories. The admissions eligible for a particular pie chart are indicated in the chart title (e.g. “all admissions” or “unit survivors”). Admissions with missing data are excluded from the calculations.
Bar charts
A bar chart is used to illustrate the percentage of admissions (or patient days) in each of a number of categories that are not mutually exclusive.

The only bar chart in the Version 3.0 eDAR reports days of organ monitoring and support (see: Delivery of care). Basic and advanced respiratory support are mutually exclusive and are shown as stacked bars, as are basic and advanced cardiovascular support. Support of each individual organ is shown in a separate bar, as an individual patient may have no organs supported, one organ supported, or multiple organs supported on any given day.

Histograms
Histograms are used to illustrate the distribution of a continuous variable.

There is only one histogram in the main eDAR document, describing the distribution of the number of occupied beds (see: Activity). In this histogram, the height of each bar represents the percentage of the period for which that number of beds was occupied. Additional histograms are presented in the Case Mix Summary document. In these histograms, the height of each bar represents the percentage of admissions for which the variable is within the specified range.

Data processing timeline
The data processing timeline (see: Participation) summarises the time from the end of the period of data (date of last admission to your unit in the current period) to your eDAR being produced. The timeline is colour-coded to indicate the time it took for the data to be received at ICNARC, subsequent data processing at ICNARC and at your unit, and final production of the eDAR.

Data completeness plots
The data completeness plots (see: Data completeness) indicate the percentage of admissions with complete data for individual variables or for combinations of variables on a scale from 0% to 100% complete. The variables are split into two sections: core variables are expected to be 100% complete for all, or nearly all, admissions; physiology variables are anticipated to routinely be not 100% complete. In the plots for core variables, a blue bar indicates that the variable is 100% complete and an orange bar indicates that the variable is less than 100% complete. In the
plots for physiology variables, all bars are orange and, for comparison, the median completeness for each variable across all participating units is marked with a cross.

Kaplan-Meier survival curve
The Kaplan Meier survival curve (see: Mortality) plots the probability of survival over the first 28 days following admission to your unit. Each point on the curve represents the probability of surviving to at least this time. The curve starts at 1 and takes a step downwards at each time an admission dies. Admissions discharged alive from hospital before 28-days are assumed to remain alive to 28 days. Admissions for whom the date and time of death or discharge from hospital are not known but who are known to be alive at some earlier time (e.g. at discharge from your unit) are included as censored observations – that is, they are included in the denominator of all admissions up until the last time they were known to be alive.

The numbers of admissions on which the curve is based at 0, 7, 14, 21 and 28 days (all those known to still be alive and in hospital at this time or having been discharged alive from hospital before this time) are shown at the foot of the figure.

This plot enables you to see whether deaths are occurring soon after admission to your unit or later in the hospitalisation.

Funnel plots
The funnel plot (see: Mortality) is a plot of the mortality ratio (number of observed deaths divided by number of deaths predicted by the risk prediction model) against the number of eligible admissions. As the number of admissions increases, the precision with which the mortality ratio can be calculated increases and so, if the model is perfectly predicting hospital mortality, we expect the points to form a funnel shape centred on a mortality ratio of 1.0.

The blue lines represent control limits at $P = 0.05$ (dashed line) and $P = 0.002$ (solid line), equivalent to 2 standard deviations and 3 standard deviations, respectively. If the variation between units is random, then on average 95% of points should lie within the inner control limits and only two in every one thousand points should lie outside the outer control limits. Points that lie outside the control limits are said to exhibit special cause variation: the mortality observed in these units is different to that predicted by the model, and more so than would be expected to occur by chance. This difference may be due to a number of different factors, including the data.
and the model, and should not, on its own, be taken as a marker of quality. However, the reason for the difference should be investigated.

For each risk prediction model (the ICNARC (2009) model and APACHE II), two funnel plots are presented:

- a funnel plot for your unit, this period, compared to the last six months of available data for all other participating units
- a funnel plot for your unit, this period, compared to the last six months of available data for each similar unit.

Each hollow green marker represents six months’ data from a single unit. The solid orange marker relates to data from the current period.

References


Resetting SPRT charts
Resetting SPRT charts (see: *Mortality*) allow you to monitor risk-adjusted mortality over time. The sequential probability ratio test (SPRT) is the most powerful statistical method for discriminating between two hypotheses (termed the null hypothesis and the alternative hypothesis). The chart plots a running log-likelihood ratioa updated for each admission depending on the event that occurred. If the chart goes up this represents information supporting the alternative hypothesis, and if the chart goes down this represents information supporting the null hypothesis. The horizontal blue lines represent thresholds at which we can either reject the null hypothesis (lines above zero) or reject the alternative hypothesis (lines below zero) with certain pre-specified error rates. The error rates are given in terms of alpha (α),

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*a log(L₁/L₀) where L₁ is the probability of observing the data if the alternative hypothesis is true and L₀ is the probability of observing the data if the null hypothesis is true*
the probability of eventually rejecting the null hypothesis when it is true, and beta (β), the probability of eventually rejecting the alternative hypothesis when it is true. If the lowest threshold is crossed (rejecting the alternative hypothesis with error rates of α = β = 0.0001), the SPRT resets to zero, preventing too much credit being built up in favour of the null hypothesis.

For each risk prediction model (the ICNARC (2009) model and APACHE II), two resetting SPRT charts are presented:

- a resetting SPRT to detect a doubling in the odds of ultimate hospital mortality
- a resetting SPRT to detect a halving in the odds of ultimate hospital mortality.

In the first chart, the alternative hypothesis that the odds of ultimate hospital mortality in your unit are twice as high as predicted by the model is compared with the null hypothesis that the odds of ultimate hospital mortality in your unit are accurately predicted by the model. If the line crosses the upper thresholds, there is evidence that the mortality in your unit is higher than predicted by the model (with stronger evidence if higher thresholds are crossed).

When an admission dies in hospital, the chart goes up by the value \( \log(2) - \log(1 + p) \), where \( p \) is the predicted mortality probability. When an admission survives hospital, the chart goes down by the value \( \log(1 + p) \).

In the second chart, the alternative hypothesis that the odds of ultimate hospital mortality in your unit are half that predicted by the model is compared with the null hypothesis that the odds of ultimate hospital mortality in your unit are accurately predicted by the model. If the line crosses the upper thresholds, there is evidence that the mortality in your unit is lower than predicted by the model (with stronger evidence if higher thresholds are crossed).

When an admission survives hospital, the chart goes up by the value \( -\log(1 - \frac{1}{2}p) \), where \( p \) is the predicted mortality probability. When an admission dies in hospital, the chart goes down by the value \( \log(2) + \log(1 - \frac{1}{2}p) \).

References

**Occupancy plot**

Occupancy of the unit is plotted as the number of occupied beds over time (see: *Activity*). The occupancy line takes a step up by one each time a patient is admitted and takes a step down each time a patient is discharged or dies (at the point when the body is removed from the unit).
Admission numbers for local audit

For each set of potential quality indicators, lists of the Case Mix Programme Admission numbers for those admissions meeting each indicator are provided in order to facilitate local auditing of these admissions.

In addition, Admission numbers are provided for admissions with a low predicted risk of death (<20%) that subsequently died, together with the risk prediction for the same admission from the other risk prediction model (ICNARC (2009) model or APACHE II).

If you require further data for these admissions from the Case Mix Programme Database, please contact your Case Officer.
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>APACHE</td>
<td>Acute Physiology And Chronic Health Evaluation</td>
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<td>C diff</td>
<td>Clostridium difficile</td>
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<td>CCMDS</td>
<td>Critical Care Minimum Data Set</td>
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<tr>
<td>CI</td>
<td>confidence interval, an interval that has a specified chance (e.g. 95%) of containing the true value of a parameter</td>
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<tr>
<td>CMP</td>
<td>Case Mix Programme</td>
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<td>CMPD</td>
<td>Case Mix Programme Database</td>
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<tr>
<td>CPR</td>
<td>cardiopulmonary resuscitation</td>
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<tr>
<td>eDAR</td>
<td>electronic Data Analysis Report</td>
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<tr>
<td>HDU</td>
<td>high dependency unit, a unit providing predominantly level 2 care</td>
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<tr>
<td>HRG</td>
<td>Healthcare Resource Group</td>
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<tr>
<td>ICNARC</td>
<td>Intensive Care National Audit &amp; Research Centre</td>
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<tr>
<td>ICU</td>
<td>intensive care unit, a unit providing predominantly level 3 care</td>
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<tr>
<td>ICU/HDU</td>
<td>a combined unit providing both level 2 and level 3 care</td>
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<tr>
<td>IQR</td>
<td>interquartile range, the range from the lower quartile (value below which 25% of the data lie) to the upper quartile (value above which 25% of the data lie)</td>
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<tr>
<td>LOS</td>
<td>length of stay</td>
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<tr>
<td>mean</td>
<td>the ‘average’ value (obtained by summing all values and dividing by the number of values)</td>
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<tr>
<td>median</td>
<td>the value below which 50% of the data lie</td>
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<td>MRSA</td>
<td>methicillin resistant Staphylococcus aureus</td>
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<tr>
<td>PROWESS</td>
<td>Protein C Worldwide Evaluation in Severe Sepsis</td>
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<tr>
<td>SD</td>
<td>standard deviation, a measure of the average spread of the data around the mean</td>
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<tr>
<td>SIRS</td>
<td>systemic inflammatory response syndrome</td>
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<tr>
<td>SPRT</td>
<td>sequential probability ratio test</td>
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