Great Ormond Street Hospital for Children

PICU Management Issues and Outcome Scoring

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Associated clinical guidelines/protocols:
- ALL

Curriculum Notes for Year 1: Information for Year 1 ITU Training (basic):

Year 1 ITU curriculum

Outcome prediction
- Criteria for admission to and discharge from intensive care.
- Risk factors for ICU readmission following discharge to the ward.
- ICU mortality rates and common reasons for death following discharge.
- Some outcome prediction scores: reliability, problems. PRISM, PIMS, TISS, PELOD, SNAP, etc. Case –mix adjusted mortality scores.

Criteria for admission & discharge

Planning services for critically ill children requires identification of overall critical care activity as well as an assessment of population needs. Intensive Care has been defined as “a service for patients with potentially recoverable diseases who can benefit from more detailed observation and treatment than is generally available in the standard wards and departments” [1]. Intensive care is usually reserved for patients with threatened or established organ failure that may have arisen as a result of an acute illness, trauma or a predictable phase in a planned treatment programme [2].

Adult ICU admission criteria [3] and PICU admission criteria are similar, but are clearly influenced by local policy and implementation. A guideline is available for admissions to GOS PICU.

Factors to be considered when assessing suitability for admission to intensive care
- Diagnosis
- Prognosis
- Severity of illness
- Coexisting disease
- Physiological reserve
- Availability of suitable treatment
- Response to treatment to date
- Recent cardiopulmonary arrest
- Anticipated quality of life
- Previous ICU admissions
- The patient & parental wishes

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Children requiring high dependency care can be readily identified [4]. The **Paediatric Intensive Care Society (PICS)** has listed indications for referral to a PICU in its 2001 guidance [5] as follows:

Paediatric intensive care admission is essential for patients likely to require advanced respiratory support (i.e. acute, short, or medium term mechanical ventilation). But the following children should also be considered for discussion with the PICU:

- If it is highly likely that they will need an intensive care dependent procedure (see below).
- Who have symptoms or evidence of shock, severe respiratory distress or respiratory depression.
- Who have the potential to develop airway compromise.
- Who have an unexplained deteriorating level of consciousness.
- Who have required resuscitation or who are requiring some form of continuing resuscitation.
- Who have received a significant injury.
- After prolonged surgery or any surgical procedure that is medium or high risk or of a specialist nature, even if this surgery is elective.
- Who have potential or actual severe metabolic derangement, fluid or electrolyte imbalance.
- Who have an acute organ (or organ-system) failure.
- Who have established chronic disease (or organ-system failure) and who experience a severe acute clinical deterioration or secondary failure in another organ-system.
- Who require one to one nursing because of the complexity of an acute or acute on chronic illness.

The **Paediatric Intensive Care Society (PICS)** regards the following “procedures” as being “intensive care dependent”:

- Nasopharyngeal and endotracheal intubation,
- Endotracheal continuous positive airway pressure (CPAP) (acute short and medium term)
- Artificial/mechanical ventilation (acute, short and medium term)
- Continuous invasive cardiovascular monitoring (e.g. central venous or arterial line or Swan Ganz catheter),
- Use of antiarrhythmic, inotropic or vasoactive drug infusions,
- Acute renal support (haemodialysis, haemofiltration, plasmapheresis and peritoneal dialysis),
- Cardioversion or DC countershock,
- Acute or external cardiac pacing,
- Mechanical circulatory support,
- Intracranial pressure monitoring,( for acute illness this requires PICU care but elective pressure monitoring can be carried out on wards or HDUs)
- Complex intravenous nutrition and drug scheduling, ( in e.g. oncology, similar care can be carried out on wards or HDUs)
- Complex anticonvulsant therapy
- Frequent or pressurised infusions of blood products,
- Active or forced diuresis,
- Induced hypothermia,
- Balloon tamponade of oesophageal varices,
- Emergency thoraco- or pericardiocentesis.

A number of patient related considerations need addressing prior to admission to a paediatric ICU (see below) and early discussion with the consultant intensivist is imperative.

1. Is it in the 'Best Interest' of the child to be admitted to PICU?
2. From personal & evidence-based practice what is the likelihood of discharge from the PICU.
3. In cases with clinically severe disease in which no diagnosis had been made, will having a diagnosis significantly influence outcome.
4. In cases with clinically severe disease in which no diagnosis had been made, what is the resuscitation status of the child?

Discharge from ICU may occur to any child no longer fulfilling the admission criteria but is also influenced by the resources of the planned discharge area.

**Risk factors for ICU readmission**

Unsurprisingly increased readmission rates have been associated with premature discharge and as such may be prevented. Acutely ill patients are commonly found on general hospital wards; some of these are patients who have been recently discharged from an intensive care unit. These patients may require a higher level of care than other ward patients and, due to the acuity of their illness, are at risk of readmission to ICU. A systematic review reported adult patients readmitted to an ICU have a worse prognosis, with death rates two to ten times higher than death rates for patients who were not readmitted [5]. Numerous studies have retrospectively examined these readmissions but, despite this, there is still no clear indication of why ICU readmissions occur or what the common characteristics of readmitted patients are. Unstable vital signs and those with residual organ dysfunction are at greatest risk of readmission [6]. However the number of therapeutic interventions and time of discharge also influence adult mortality [7], with crude mortality significantly higher for late (20.00 h to 7.59 h) than for early (8.00 h to 19.59 h) discharges (18.8% versus 11.2%, p=0.0004). Adjusted for disease severity, the mortality risk was 1.70-fold (CI: 1.28–2.25) increased for late ICU discharges. The need for readmission can be mitigated by discharge to an intermediate care area (HDU/transitional care). Patients discharged from the ICU at night have an increased risk of mortality compared with those discharged during the day. (37)

**ICU mortality rates**

The ICU mortality rate in children is considerably lower than that of adults. The United Kingdom Pediatric Intensive Care Outcome Study (UK PICOS) [8] is a recently published large, prospective, study conducted between March 2001 and February 2002, that aimed to assess and optimize some commonly used mortality prediction tools (see ‘outcome prediction’ below). Of the 10,197 admissions from 18 PICU’s included in the analysis 633 (6.2%) patients died in the admitting PICU. An additional 301 (3.0%) died before discharge from the hospital and 516 (5.4%) were lost to follow-up, making total hospital mortality 9.2%. No information is given on mode or management of death.

**Factors increasing risk of death after intensive care [9]**

- Increasing age
- Greater severity of acute illness
- History of severe clinical conditions
- Emergency surgery immediately before admission
- Clinical condition necessitating admission

**Outcome prediction scores: reliability, problems**

Critical care has led the way in developing risk-adjustment mortality models and standardized mortality ratios. These have been developed by collecting information on large numbers of ICU patients. This information can be based on the number of therapeutic interventions required (TISS) or physiological variables as a marker of severity of illness. This has been done at presentation (or soon thereafter) for the adult (APACHE III [10], SAPS II [11], MPM II [12]) paediatric (PIM: Pediatric Index of Mortality [13], PRISM: Pediatric Risk of Mortality [14]) or neonatal (SNAP [15], CRIB [16]) populations. Logistic regression is then used to see which variables predict death and derive a model that describes their relationship. The standardised mortality rate is the observed mortality divided by the expected mortality from the prediction model. It compares the number of deaths to those that would have occurred if the same patients would have been looked after in the units used to derive the score (at the time the...
score was derived). Most incorporate adjustments for severity of illness and case-mix.

**Criteria for selecting a scoring system**
- Proposed use
- Validity of score
- Reliability of score
- Discrimination of scoring system
- Calibration of scoring system

Commonly used prediction methodologies have now been validated in large cohorts of critically ill patients in many countries. They enable benchmarking at regional, national and international levels. Pediatric Risk of Mortality (PRISM, now updated to PRISM III) provides the current risk-adjustment tool for the United States based Pediatric Intensive Care Unit Evaluations (PICUEs) system, which provides comparative reports to participating units under a licensing arrangement. The Pediatric Index of Mortality (PIM) is derived from 10 PICUs in Australia and New Zealand and 4 PICUs in the UK. The updated PIM II [17] is used by PICANet to report on mortality outcomes to the Department of Health. Both prediction models are validated in Australia & New Zealand [18], the UK [19] and the Netherlands [20] with variable degrees of fit.

Risk-adjusted prediction models have important limitations and cannot fully assess the quality of care in an individual institution or ICU:
- **Data inaccuracy:** validation of the results requires accurate data [21] collection by properly trained data collectors [22].
- **Historical bias:** models are based on historical populations and require recalibration every few years [8] [14] [23] [24].
- **Exclusivity:** Some models exclude certain populations eg. Cardiac surgery and burns.
- **Population base:** results are only applicable to large groups and cannot be used as a quality measure or prediction tool for the care of the individual patient.
- **Mathematical Coupling:** APACHE & SAPS, unlike PIM, include a number of therapy-dependent variables to predict (therapy-dependent) outcome. Data collated from worst variables within 24 hours (as with APACHE) may only serve to diagnose death rather than predict it [25]
- **Bias:** Models do not adjust for all factors that affect survival e.g. referral source, pre-admission transfer, delayed admission
- **Weighting:** Morbidity rather than mortality may be a more useful outcome measure in the paediatric population. Thus calibration may be more important than absolute predictive value.

‘Drotrecogin alpha’ better known as recombinant Activated Protein C, was the first drug to be licensed in conjunction with a threshold APACHE II score by the FDA. As a result of poor calibration [8, 24] mortality prediction tools are unlikely to be useful for risk stratification in the paediatric population for prospective trials or therapeutics. However paediatric cumulative organ dysfunction scores, such as PELOD [26, 27] and P-MODS [28], may offer better specificity. Pediatric Risk of Mortality III, Pediatric Index of Mortality 2, and Pediatric Logistic Organ Dysfunction scores are the best available tools to estimate the severity of illness in critically ill children.

**Other sources of information:**

Websites.

**References.**
1. "Intensive Care in the United Kingdom": King’s Fund Panel; May 1989
4. HIGH DEPENDENCY CARE FOR CHILDREN - REPORT OF AN EXPERT ADVISORY GROUP FOR DEPARTMENT OF HEALTH 2001
6. Philipp G. H. Metnitz, Fabienne Fieux, Barbara Jordan, Thomas Lang, Rui Moreno, Jean-Roger Gall. Critically ill patients readmitted to intensive care units – lessons to learn?
18. Anthony Slater, MB BS, FRACP, FJFICM; Frank Shann, MB, BS, MD, FRACP, FJFICM, for the ANZICS Paediatric Study Group. The suitability of the Pediatric Index of Mortality (PIM), the Pediatric Risk of Mortality (PRISM), and PRISM III for monitoring the quality of pediatric intensive care in Australia and New Zealand. Pediatr Crit Care Med 2004 Vol. 5, No. 5
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29. J. Randall Curtis, MD, MPH; Deborah J. Cook, MD; Richard J. Wall, MD, MPH; Derek C. Angus, MD, MPH, FRCP; Julian Bion, FRCP, FRCA, MD; Robert Kamarek, PhD, RRT; Sandra L. Kane-Gill, PharmD, MSc; Karin
Information for Year 2 ITU Training (advanced):

### Year 2 ITU curriculum
- Unit organization - Closed vs open units
- Measures of quality

### Unit Organization

Quality of healthcare has been described as care that is safe timely, effective, efficient, equitable and patient centred. Three classic quality of care components: structure, process & outcome, provide a framework for improving ICU care [29], and compliments that of clinical governance.

Structure can be defined as the way care is organised within the hospital or healthcare system (e.g. centralised PICU care [30,31]). There is evidence that the presence of an intensivist in the ICU decreases morbidity, mortality and costs of care. Perhaps the strongest evidence comes from a systematic review of 17 randomized and observational controlled trials [32]. These authors found that high-intensity (mandatory intensivist consultation or ‘closed ICU’ where all care was directed by intensivists) was associated with a 39-percent relative risk reduction (RRR) in ICU mortality, a 29-percent RRR in hospital mortality and reduced hospital and ICU length of stay. There is an association between lower severity-adjusted mortality among higher volume PICUs, best outcomes are among mid- to large-sized PICUs. These data support minimum annual admission criteria for PICUs but raise the concern that PICUs with very high annual admission volumes may operate beyond an ideal capacity (37).

Process refers to what we do or fail to do for patients and their families, and may include transition of care to other parts of the hospital. Outcomes refer to the results we achieve.

Planners have suggested that one strategy to accommodate disaster surges of 500 inpatients per million population would involve altering standards of care. Extending resources by hypothetical alterations of standards of care would usually satisfy targets for hospital surge capacity, but ICU capacity would remain inadequate for large disasters (38).

### Measures of quality

A good ICU quality measure should be important, valid, reliable, responsive, interpretable, and feasible [29]. Difficult to quantify, lack of quality is more readily identifiable.

Mortality prediction models cannot accurately assess the quality of care in an ICU. Hospital survival may reflect quality of care across the institution, not just the ICU. Furthermore
survival is not synonymous with quality, with withdrawal of therapy more appropriate than prolongation of a futile therapy or an intolerable state.

Other clinical indicators may include length of stay (LOS), accidental extubation, nosocomial infection rate, serious adverse event rate or readmission rate [33]. Many indicators lack sufficient information about what they are measuring. Length of stay may indeed be prolonged by increased iatrogenic morbidity, it is also decreased by death. As such LOS (the indicator may be longer in units with better quality of care and survival rates. Accidental extubation rates may be lower in an ICU that uses excessive sedation at the expense of prolonged ventilation, increased length of stay and costs. Readmission could be considered more an indicator of clinical resources than quality of ICU care.

Driven by policy-makers further research continues into what constitutes ‘good quality care’ and how best to measure both immediate and long-term outcomes. Variations in which clinical indicators are the best predictors of changing care standards? Quality of life after paediatric ICU admission is an important and under-researched area [34, 35, 36].

A large proportion of deaths at GOSH (95%) occur in the intensive care unit or after a stay in the ICU. Defining or looking at the quality of care these patients and their families receive is difficult. To date, however, little research on interventions to improve end-of-life care in the PICU has occurred. Measures to improve the care of children dying in the PICU include 1) support of the family unit; 2) communication with the child and family about treatment goals and plans; 3) ethics and shared decision making; 4) relief of pain and other symptoms; 5) continuity of care; and 6) grief and bereavement support. Future reports will need to examine the ability of interventions to improve outcomes of palliative care in the ICU. (39)

**Other sources of information:**

**Websites.**

http://www.sccm.org/SCCM/Professional+Resources/Quality+Corner/
http://www.picanet.leeds.ac.uk/HOME.HTM

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