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ORIGINAL ARTICLE

What impact did a Paediatric Early Warning system have on emergency admissions to the paediatric intensive care unit? An observational cohort study

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Summary The ideology underpinning Paediatric Early Warning systems (PEWs) is that earlier recognition of deteriorating in-patients would improve clinical outcomes.
Objective: To explore how the introduction of PEWs at a tertiary children's hospital affects emergency admissions to the Paediatric Intensive Care Unit (PICU) and the impact on service delivery. To compare 'in-house' emergency admissions to PICU with 'external' admissions transferred from District General Hospitals (without PEWs).
Method: A before-and-after observational study August 2005—July 2006 (pre), August 2006—July 2007 (post) implementation of PEWs at the tertiary children's hospital.
Results: The median Paediatric Index of Mortality (PIM2) reduced; 0.44 vs 0.60 ($p < 0.001$). Fewer admissions required invasive ventilation 62.7% vs 75.2% ($p = 0.015$) for a shorter median duration; four to two days. The median length of PICU stay reduced; five to three days ($p = 0.002$). There was a non-significant reduction in mortality ($p = 0.47$). There was no comparable improvement in outcome seen in external emergency admissions to PICU. A 39% reduction in emergency admission total beds days reduced cancellation of major elective surgical cases and refusal of external PICU referrals.
Conclusions: Following introduction of PEWs at a tertiary children's hospital PIM2 was reduced, patients required less PICU interventions and had a shorter length of stay. PICU service delivery improved.

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Implications for Clinical Practice

Following the introduction of a Paediatric Early Warning system at a tertiary children's hospital, 'in-house' emergency admissions to PICU:

- Had a lower Prognostic Indicator of Mortality score (PIM2) at first contact with the PICU team: 0.44 vs 0.60 ($p < 0.001$).
- Had a lower requirement for intubation and mechanical ventilation 62.7% vs 75.2% ($p = 0.015$) for a shorter median duration; four to two days.
- Had a reduced median length of PICU stay five to three days ($p = 0.002$).

There was a 39% reduction of the total bed days used for emergency admissions to PICU which improved PICU service delivery

- Cancellation of major elective surgical cases reduced by 90%.
- Refused regional PICU referrals reduced a 79%.

Introduction

The reported incidence of cardiopulmonary arrest in hospitalised children is low: 0.2—2.5/1000 (Berg et al., 2008). However, mortality (52%) and morbidity remain high despite advances in resuscitation training, technology and treatment (Tibballs et al., 2005). The devastating physical consequences of deterioration leading to cardiopulmonary arrest are well documented (Meert et al., 2009), as are the psychological effects that emergency admission to the Paediatric Intensive Care Unit (PICU) has on the family (Balluffi et al., 2004). There are significant additional financial costs to the National Health Service of 'failing to rescue' deteriorating children in hospital (Duncan and Frew, 2009). Therefore, there is a pressing social and financial need to improve the early identification and treatment of deterioration in hospitalised children.

Research in adults demonstrated that cardiopulmonary arrest or emergency admissions to Intensive Care were often preceded by a period of physiological instability which, once recognised, provided an opportunity for the healthcare team to intervene to improve outcome (Hodgetts et al., 2002; Kause et al., 2004). A similar window of opportunity may exist for hospitalised children (Haines, 2005; Tasker, 2005; Tume, 2004, 2006).

Paediatric Early Warning systems (PEWs) have been identified as a mechanism to improve safety for hospitalised children (CEMACH, 2008). To date, published studies evaluating PEWs have focused on the performance of individual tools in single centres and their impact on the incidence of respiratory or cardiopulmonary arrest. However, this does not capture other sick children admitted to the PICU as emergencies following acute deterioration or the impact that PEWs has on PICU service delivery.

Study objectives

The study objectives were

1. To understand how the introduction of a Paediatric Early Warning system at a tertiary children's hospital affects emergency admissions to the PICU.
2. To compare the 'in-house' cohort of emergency admissions to PICU with a comparable group; emergency admissions transferred to PICU from wards at District General Hospitals (without PEWs in place).
3. To explore the impact that a PEW system had on PICU service delivery.

Methods

Setting

The setting was a tertiary children's hospital in the Northwest of England, with 337 in-patient beds, handling 37,000 annual admissions (excluding day-cases). Tertiary specialties include cardiology/cardiac surgery, neurology/neurosurgery, renal, oncology, burns/plastics and neonatal surgery. The hospital has a 24 hour emergency department, a 22 bed PICU and two separate High Dependency Units (total beds 21). The PICU admits 1100 patients annually. Half of those admissions are elective, following major surgery including cardiac surgery or neurosurgery. The remaining admissions are unplanned; from the emergency department, theatre, wards within the hospital or urgent transfers from any of 28 District General Hospitals (DGHs) within the region.

Intervention—implementation of PEWs at tertiary children's hospital

In 2006, a study based at this hospital (Tume, 2006) showed that emergency admissions to PICU or High Dependency were often preceded by a period of documented abnormal observations which were either not recognised or not responded to quickly enough to halt deterioration. A decision was made to implement locally adapted based on the Bristol PEW; (Haines, 2005) (Fig. 1) to improve the early recognition of deterioration so that the healthcare team had a greater opportunity to intervene to improve outcome.

A project group [Resuscitation Training Officer, General Paediatrician, Critical Care Physiotherapist, Advanced Nurse Practitioner PICU, Intensivist, PICU and High Dependency Lecturer Practitioners, PEWs project nurse, senior ward