

Reducing Failure to Rescue rates in a paediatric in-patient setting: a 9-year quality improvement study

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ABSTRACT

Background: Annually in England over 1.5 million children and young people (CYP) are admitted to hospital. However, a proportion of these CYP will experience Failure to Rescue (FtR), a failure to recognise, respond and escalate clinical deterioration, which can result in significant harm or death.

Aim: To identify and quantify FtR episodes from emergency events at a 110-bedded tertiary children's hospital located within a University Teaching Hospital and evaluate the impact of targeted interventions on reducing FtR.

Methods: A quality improvement approach was adopted. From 170,446 patients admitted between 2011 to 2019, all emergency event calls were systematically reviewed to identify FtR episodes. Root-cause analysis was performed to identify practice deficiencies. The Plan-Do-Study-Act fundamentals were used.

Results: A total of 520 emergency events were reviewed over the 9-year period. One hundred and thirty-two (n=132; 25%) were cardiac arrest events, with the majority occurring within the PCCU setting. Three hundred and twelve (60%) of the events were in children who had been inpatient for more than 48 hours. FtR trend declined over the study period from 23.6% in 2011 when the project commenced to 2.5% or less over the following 8 years.

Conclusion: Identifying rates of FtR events from routinely collected emergency events data can be used as a patient safety measure to identify emergency concerns. This enables progressive dynamic problem solving through delivery of strategic targeted interventions. The proposed interventions outlined in this quality improvement study have application to

critical care nursing as mechanisms for reducing unplanned admissions to paediatric critical care unit (PCCU), mortality and PCCU and non-PCCU cardiac arrests.

Keywords: patient safety; communication; education; children; cardiac arrest, Failure to Rescue

INTRODUCTION

Approximately, 1.5 million children and young people (CYP) are admitted to hospitals in England every year (National Health Service (NHS) Digital, 2020). Acute clinical deterioration is the most common reason for unplanned admission (> 85%) to the Paediatric Critical Care Unit (PCCU) (Paediatric Intensive Care Audit Network 2017). Unrecognised deterioration is a major contributing factor to many of the 1500 avoidable paediatric deaths in UK hospitals each year (Deighton et al., 2016) - that is, deaths that are potentially preventable, if the deterioration is recognised early, escalated, and acted upon sooner (Deighton et al., 2016). Failure to Rescue (FtR) is defined as, *“the failure to prevent a death resulting from a complication of medical care or from complication of underlying illness”* (Burke et al., 2020 page 1). FtR is a significant cause of harm to patients in the NHS (Findlay et al., 2012, Luettel et al., 2007).

FtR cases are frequently preceded by signs of physiological instability. Therefore, assessment, measurement and monitoring of essential core physiological patient observations is crucial for timely recognition of acute deterioration (Bonafide et al., 2013). To mitigate FtR risk, some healthcare organisations have in place rapid response systems (RRS) for identification of unstable patients for early treatment (Sorensen and Petersen, 2015). The RRS consist of two limbs; afferent and efferent (Moore et al., 2012, Sorensen and Petersen, 2015). Fundamentally, the afferent limb involves bedside care givers who assess and monitor patients' condition for early identification of any form of deterioration and when necessary, trigger an alert to the efferent limb for rescue response (Moore et al., 2012). The efferent limb is primarily a medical emergency team consisting of clinicians and/or nurses with special knowledge and skills in critical care and emergency medicine (Sorensen and Petersen, 2015).

A quality improvement (QI) project was carried out to identify and quantify FtR episodes from emergency events at a large children's hospital using inpatient paediatric emergency events

data; and to develop, implement and understand the impact of targeted interventions on reducing FtR.

METHODS

Setting

This prospective quality improvement project was conducted at a 110 bedded children's hospital (including 92 ward beds, 10 paediatric critical care beds and 8 high dependency care beds), and is part of an acute NHS trust (including a trauma centre) that provides services to over 2.5 million people. The children's hospital employs nearly 800 nurses and has 22,000 (approx.) inpatient admissions per annum. The hospital has a RRS, which consists of the Paediatric Early Warning Score (PEWS) as part of the afferent limb, and the Paediatric Critical Care Outreach Team (PCCOT) as the efferent limb. FtR had been identified in multiple incident inquiries and was implicated in five of the top 10 organisation's clinical risks. In response, the children's hospital (led by SM and NT) designed a method to collect data to systematically review all inpatient paediatric medical emergency calls and emergency events.

The project was commenced in January 2011 and used a model for improvement; which entails the application of an aim statement, Plan-Do-Study-Act (PDSA) cycles, as well as iterations of the workflow based on the observations from these tools (Langley et al., 2009). Overall, the project intended to improve the recognition of the deteriorating patient and reduce harm from deterioration by reducing avoidable delays to urgent treatment and appropriate escalation of care (Simmonds et al., 2015). Specifically, the aim was to reduce rates of FtR to <5% within 5 years, and sustain this year on year thereafter.

Using the research project definition as outlined by the Health Research Authority (2013) this study was classified as a quality improvement audit and therefore formal ethical approvals were not required. However, the project conduct complied with Good Clinical Practice (GCP) standards set forth in the Declaration of Helsinki of 1975 (World Health Organisation, 1995). The project was registered with the local hospital clinical governance department [Registration number: 52300].

Data collection

The study was led by the hospital Paediatric Critical Care Outreach Team (PCCOT). The study population consisted of all CYP admitted to hospital from 2011 to 2019 (approximately 170,446 patients). All hospital medical emergency calls were logged by switchboard on a Nerve Centre® database, which is part of the hospital patient electronic records system. Emergency calls from all inpatient clinical areas within the children's hospital were monitored and included. PCCOT also monitored the database for any paediatric emergency calls or cardiac arrests in PCCU. All events were reviewed within one week of occurrence. A standard project data collection form was completed (see Supplementary File 1), recording patient demographic data, type of event (cardiac arrest, respiratory arrest, peri-arrest, seizure, and medical emergency), clinical area where the emergency call was raised, time from admission to hospital event occurrence, and whether the patient required critical care admission or not.

FtR operational definition

The National Patient Safety Agency (NPSA) (Luettel et al., 2007 p. 8) outlined FtR criteria that define potential points of failure prior to initiating appropriate intervention which constitutes one or more of the following: a) 'failure to measure basic observations'; b) 'lack of recognition of the importance of worsening vital signs'; c) 'failure to clearly and appropriately articulate patient assessment by healthcare professional'; d) 'delay in response to deteriorating vital signs'; and e) failure of the clinical team to appreciate the severity of the patient's condition (Clarke, 2004).

In this study, FtR (numerator) was defined as avoidable complications and/ or mortality due to failure in measuring, identification, recognition, and communication of the patient's condition by healthcare staff. FtR cases were identified from total yearly reported clinical emergencies (denominator). Clinical emergencies consisted of only paediatric events where a '2222' call was raised and cardiac arrest of patient on the PCCU ('2222' is the

standardised hospital emergency number in the UK). Data were collected from patient notes, observation charts, patient electronic records and DATIX® (online electronic incident reporting system) where applicable. Additionally, all emergency call events were also discussed with staff involved.

Dissemination

All cases were reviewed at ward/department and hospital levels, lessons learned from each event were then disseminated and actions implemented into practice to mitigate future risk (Department of Health, 2000). Findings were disseminated through bespoke educational forums and governance strategies. Potential FtR events identified during the reviews were discussed with the hospital Patient Safety Team, senior team involved and if required the Clinical Director. Where necessary a further independent review was considered. Findings were also presented at various corporate meetings.

Statistical Analysis

Descriptive statistics of observed rates for total FtR and demographic data are presented. Patient characteristics were described using percentages for categorical data. Yearly total emergency events data for the 9-year period and survival to discharge rates following in hospital cardiac arrests are presented as means and standard deviations (SD). Total mortality was calculated per 1000 admissions. The chi-squared test was used to calculate statistical significance on yearly reduction in failure to rescue frequency with $p \leq 0.05$ considered significant. Data were analysed on Microsoft Excel 2010.

RESULTS

A total of 520 emergency events fitting study criteria were recorded during the study period (Table 1). Mean emergency events were 58 per year, (SD=13), ranging from 42 - 81.

Cardiac arrests were the most frequent events (n=132/520, 25.8%), however the majority of these (n=116/132, 88%) were inpatients located in PCCU or theatre areas (Supplementary File 2, Table 1). Collectively the following event categories (respiratory arrest, peri-arrest, seizures and other) accounted for the majority of events (n=388/520, 74.6%). 'Other' event classifications included: major haemorrhage, anaphylaxis, requirements for emergency intubation, dislodged tracheostomy, and apnoea.

**Table 1: Number and percentage of emergency events reported between 2011-2019 by event type and year. **

More than half (n=310/520, 59.6%) of events were from children who had been inpatients for > 48 hours. Nearly half (n=217/520, 41.7%) of emergency events were observed in the < 1 year age group (Table 2). This event distribution was consistent throughout the years and was not accounted for or reflected in the admission by age numbers.

Table 2: Number and percentage of Emergency events reported between 2011-2019 by age group and year

Mortality and cardiac arrest survival rates

Table 3 shows the mortality and cardiac arrest survival rates. Total in-hospital mortality rate was 0.22 per 1000 admission, with yearly mortality rates varying from 0.12 to 0.41 per 1000 admissions. Similarly yearly survival to discharge rates following in-hospital cardiac arrest varied across study period ranged from 43% - 80% (mean=65%; SD=11%).

Table 3: Mortality and survival to discharge rates following in-hospital cardiac arrest between 2011-2019

Failure to Rescue rates

FtR rates (shown in Figure 1) decreased over the study period nine years with a high rate (23.6%) in 2011 when the project commenced, followed by a sharp decrease (14.2%) in 2012, and sustained decrease in the following years. In comparison to baseline rate of FtR (2011: 23.6%), a statistically significant reduction in the rate of FtR was observed for the years: 2014 (chi square: 5.72; 95% CI: 0.04 – 0.34; P value: 0.02); 2015 (chi square: 12.70; 95% CI: 0.09-0.35; P value: <0.001); 2016 (chi square: 14.64; 95% CI: 0.12 – 0.37; P value: <0.001); 2017 (chi square: 8.82; 95% CI: 0.08-0.35; P value: 0.003); 2018 (chi square: 10.69; 95% CI: 0.06 – 0.33; P value: 0.001); and 2019 (chi square: 10.70; 95% CI: 0.06 – 0.33; P value: 0.001) (see Supplementary File 2, Table 2).

****Figure 1. Percentage of emergency events classified as Failure to Rescue between 2011 – 2019, with the years interventions implemented identified ****

Using the descriptors from the NPSA (Luettel et al., 2007), all the cases identified in this study as FtR incidents were linked to one or more of the following; failure to recognise the deteriorating patient (for example, poor recording or delay in interpretation of observations and Paediatric Early Warning Score (PEWS)), failures in communication (for example missed information during verbal communication, handovers and documentation) and systems errors (for example where patient transfer or step-down processes were not fully complied with).

Strategies to mitigate FtR

Recognition and documentation: Arising from thematic analysis of FtR case reviews, a programme of work was setup to address specific FtR deficiencies. These included educational programmes led by the PCCOT and other wider patient safety initiatives (such as the introduction of electronic observations (E-obs), and the severe sepsis care bundle).

Staff education programmes initiated included a mock arrest programme and the Paediatric Recognition and Acute Management of the ill child (PRAM) in-house course. This is now a requirement for all registered nurses working in the Children's Hospital to undertake a yearly mandatory full day in-house course on recognition and immediate management of the deteriorating child. For new nursing staff, a five-day Acute Care Skills (ACS) course is part of the induction programme which focuses on recognise and rescue education and simulation, including accurate recording and interpretation of PEWS. Moreover, one to one or ward specific fundamental training on emergency care requirements, such as oxygen therapy, setting up humidifiers and nasopharyngeal airways, is now readily available.

Communication: The situation, background, assessment, recommendation (SBAR) QI and patient safety communication tool has been built into PRAM and ACS programmes to offer structured and standardised communication. The tool is now being utilised in nursing handover documents and all patient transfer documentation have been developed using an SBAR format.

Systems: Intra-hospital transfer documentation with a patient safety checklist was developed and the PCCOT worked with wards in introducing daily patient safety briefings and SBAR handovers. The development and implementation of the NerveCentre® electronic observations system (E-obs), with automated escalation and electronic handover, was also embedded into practice during this time.

DISCUSSION

In this prospective QI project, we sought to demonstrate the value of FtR rates from emergency events in paediatric patient population as a potential, readily available means of monitoring patient safety. After identification, quantification and reviewing of FtR individual cases and addressing deficiencies, we observed a sharp fall of FtR rates from 23.6% in 2011 to 0% in 2018 and 2.5% in 2019. Our observation asserts that improving recognition of deteriorating patients and reducing avoidable delays to urgent treatment and appropriate escalation of care during care delivery using specific targeted organisational interventions has a potential to improve patient safety. Yearly collection and review of data allowed systematic problem identification (knowledge of emerging concerns) resulting in progressive and dynamic problem solving (improving staff knowledge and skills). The project enabled the children's hospital to proactively and not reactively approach patient safety issues. Required improvements and changes were addressed in a timely manner through specific processes, clinical practices, and education strategies.

Our results support previous studies that reported several associations between FtR and patient safety quality indicators (Burke et al., 2020, Griffiths et al., 2013, Simmonds et al., 2013). Simmonds et al (2013) demonstrated clinicians' change of behaviour in response to a rapid response feedback mechanism that informed individual clinicians of their response to the treatment of critically ill patients from which they could learn and improve. After the intervention, the study reported an improvement in early treatment of patients identified as at risk; antibiotic administrations in less than one hour after admission increased from 35% to 75% while pre-critical care unit care bundle compliance increased from 25% to 70%. Griffiths et al. (2013) observed that lower rates of FtR were associated with a greater number of nurses and doctors per bed. Furthermore, the study reported that higher total clinically qualified staffing per bed was significantly associated ($p < 0.05$) with lower mortality based FtR. Burke et al. (2020) concluded that the earlier the identification and recognition of the

patient at risk the better the outcome. The authors also concluded more adequate nurse to patient ratios were associated with lower FTR rates.

Over the 9-year study period, survival to discharge post in-hospital cardiac arrest ranged from 43% - 80%. This is comparable to three previous USA studies. Girotra et al. (2013) showed that risk adjusted survival to discharge rate increased from 14.3% in 2000 to 43.4% in 2009. Bhanji et al. (2017) reported survival rate of 36.3% on cardiac arrests during nights and weekends only, while Holmberg et al. (2019) reported rates between 19% - 66%. The wide survival rates range could be due to differing case mixes within study population environments. Only 12% of cardiac arrests occurred in general paediatric wards compared to 88% in PCCU and theatres. Comparable results were reported by Berg and colleagues who noted a shift of paediatric cardiac arrests from the wards to critical care (Berg et al., 2013). Their figures suggest that only 4 - 6% of in-hospital paediatric cardiac arrests occur in the ward areas versus critical care. This variation could be accounted for by the plausible notion that once the patient is observed to be deteriorating requiring input from the efferent limb of the RRS, they are more likely to be transferred from the normal ward environment to critical care. Due to physiological instability sicker patients are more likely to suffer cardiac arrest (Berg et al., 2013).

In this QI project we used FtR definition descriptors from NPSA (Luettel et al., 2007), which has also been used in other previous studies (Luettel et al., 2007, Griffiths et al., 2013, Findlay et al., 2012) as an approach to identify cases of FtR, providing some evidence of reliability. Specific variable characteristics derived from FtR definition descriptors include, not taking and recording observations, not recognising early signs of deterioration, and failure to communicate (both verbally and in writing). These characteristic variable items have face validity; they are all known predictors of or surrogates for patient safety (Griffiths et al., 2013, Aiken et al., 2002, Silber et al., 1992). Mitchell (2008) described the origins of patient safety inadequacies by classification in terms of type (error), communication (failures between professionals or between patient and professional, and between professionals and non-

medical staff), and system failure (failure in clinical performance and patient management). Additionally, effective communication has been reported as one of the key ways to improve patient safety (Belim and Vaz de Almeida, 2017).

Strategies to reduce FtR rates

Various specific targeted interventions primarily focusing on moving away from resuscitation to rescue were used to address identified concerns. Current literature outlines some of the strategies to reduce FtR rates and improve healthcare system processes. These include the use of simulators, bar codes, and computerized entry via clinical applications, as well as team resource management (Mitchell, 2008). Patient safety education training provision by healthcare organisations have been recognised as essential in providing a supportive system enabling healthcare workers to keep patients safe and enabling continuous professional development.

Given the high rates of FtR in the first year of the study [Year 2011], there was a huge stakeholder campaign to put systems in place to address the concerns and themes highlighted during individual case reviews. Key to this drive were improvements in education and training across the Children's Hospital. Bespoke structured educational programmes were designed, changes to the admission process were introduced and an electronic observation system (e-obs) was implemented in all paediatric clinical areas to standardise vital signs recordings and escalation process and which is easy to access and review. To drive improvement in staff knowledge and skills, the courses provided include the five-day new starter 'Acute Care Skills Course' for newly qualified nurse to bridge transformation from student to a qualified practitioner, and a registered nurse yearly mandatory Paediatric Recognition and Acute illness Management (PRAM) course. These courses are updated annually in line with the hospitals' Recognise and Rescue patient safety strategy as well as specific learning/themes from FtR events.

Study limitations

The present QI project results should be interpreted in view of the following limitations.

Firstly, data was collected at a single site, limiting the generalisations that can be made due to context specific factors. However, our main results do complement findings from previous similar studies thus providing confidence of the transferability of the conclusions drawn from this study.

Secondly, this study only included '2222' emergency calls from specific paediatric inpatient areas and cardiac arrests of children on PCCU. This may have excluded events outside of these clinical areas and for those children where a '2222' call was not made but still resulted in a FtR.

Lastly, we acknowledge that the decrease in FtR rates may not be due to the implemented interventions alone, but could also have been influenced by overall improvement of care across the organisation.

CONCLUSION

To our knowledge, this is the first such QI project to identify, quantify and demonstrate the use of FtR rates to address paediatric patients' safety and quality of care delivery. Although resource intensive, this QI process continues to be a useful tool for measuring and monitoring patient safety, particularly in respect to FtR, within a large Children's Hospital. This is a dynamic process where issues can be addressed in a timely way to help inform systems, pathways, guidelines, and policy reviews. Opportunities for learning are maximised by the prompt, systematic reviews of the events leading to action plans for individuals, teams, or specific ward areas. Education strategies around recognise and rescue are based on themes highlighted from the audit. There is scope for further research in this area as all outlined interventions need further evaluation and modification (where necessary) to ensure effectiveness.

What is known about the subject

- Failure to Rescue (FtR) is a major patient safety concern and a cause of significant harm to patients.
 - FtR can be used as a quality measure for the care delivered to the patients.
 - FtR may be used as a patient safety indicator.

What this paper contributes.

- This study demonstrates the use of emergency events routine data to identify failure to rescues cases in paediatric in-patients and it also shows the benefits of approaching patient safety concerns proactively and not reactively.
 - The study suggests that targeted interventions implemented for a specific paediatric population within a hospital wide safety culture reduced rates of FtR.

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