An Evaluation of Rapid Response Team Impact

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Abstract

Rapid response teams (RRTs) are widely implemented in hospitals today. Little research exists in the use of RRTs in the pediatric population (Chan et al., 2010; Pringle et al., 2011; Winberg et al., 2008). Regardless of these findings, children experiencing acute clinical deterioration receive highly specialized monitoring, equipment, medications and trained staff to manage the clinical instability.

This research using a retrospective, pre- and post-intervention, descriptive design determined the pediatric rapid response team (PRRT) role in reducing code events and mortality in pediatric patients outside the ICU in an academic setting. The number of pediatric code events and PRRT events were determined for the years 2007, 2008, 2009 and 2010. The incidence density of pediatric code events and mortality prior to PRRT implementation was compared to the same outcomes post-intervention of PRRT. Other outcome measures included transfer to a higher level of care, remained on non-ICU unit after the code or PRRT event. The findings from this research demonstrate the PRRT decreased transfers to a higher level of care, code events and mortality of pediatric patients outside of ICU setting during the study period.

Background and Significance

In the late 1990s, investigators reported that cardiopulmonary arrests were often preceded by signs of physiologic instability (DeVita et al., 2004). This led hospitals in Australia to develop medical emergency teams (MET) that respond to patients before actual cardiopulmonary arrests occurred. Similarly, in the United Kingdom, initiatives to provide earlier critical care services to potentially unstable patients resulted in *patient-at-risk teams* and *critical care outreach services.* In 1996, early adopters in the United States used the term *rapid response team* (RRT) . MET, CCOT, PART, RRT and similar terms were names given to these response teams. During the first consensus conference these terms were defined based on structure and scope of practice (DeVita et. al, 2006). Pre- and post-implementation studies suggested that Rapid Response Teams (RRTs) could reduce unexpected cardiac arrests, transfers to a higher level of care and improve hospital mortality (DeVita, Hillman & Bellomo, 2011; Jones, Bleyer & Petree, 2010).

In 1999, the Institute of Medicine (IOM) released its epic report *To Err is Human,* galvanizing hospitals across the country to make patient safety a national priority in healthcare (Institute of Medicine [IOM], 2000). The IOM declared in 2001, in words that still echo the call today, “Between the health care we have and the care we could have lies not just a gap, but a chasm” (IOM, 2001). These reports sparked a transformational change in thought igniting conversations on patient safety and quality improvement through national forums.

In December 2004, The Institute for Healthcare Improvement (IHI) launched the *100,000 Lives Campaign,* a nationwide initiative designed to significantly reduce morbidity and mortality in American health care. The idea underlying the campaign is that if six evidence-based, proven interventions were reliably implemented in enough U.S. hospitals, 100,000 fewer patients would die each year. Deployment of RRTs is one of the six “planks" the IHI identified in the campaign

(Berwick, Calkins, McCannon & Hackbarth, 2006). IHI is a national and international asset aimed towards accelerating the improvement of health care systems through research, development and the organization's impact network. The goals of the IHI parallel the IOM six health care improvements: health care that is safe, patient centered, efficient, effective, equitable and timely (Institute for Healthcare Improvement, [IHI], 2011).

By 2006, the concept evolved as part of the rapid response system (RRS) functioning in the pediatric health care community. The four components of a RRS are the afferent limb, efferent limb, quality improvement limb and administrative limb. The afferent limb of the system consists of activation criteria which triggers a response. The RRT is the efferent limb of the RRS to prevent or interrupt clinical deterioration in patients. The quality improvement component evaluates the process and RRT for opportunities to better patient care. Lastly the administrative limb functions to enforce and sustain the overall program (Pringle, Hanson & Falk, 2011).

Patient safety and preventable hospital deaths remain compelling aspects of excellence in medical care and continue to receive public investigation. Providing critical care interventions to hospitalized patients gained momentum as a national campaign. Despite more than four decades of use with resuscitation techniques for in-hospital cardiopulmonary arrests, patient outcomes have remained bleak (Naeem & Montenegro, 2005). But signs of physiologic instability often precede overt clinical deterioration in many patients (Offner, Heit & Roberts, 2007). A concerted effort was launched to recognize and treat patients experiencing acute change in heart rate, respiratory status, oxygen saturation, blood pressure, mental status change, change in urinary output or an unidentifiable change in condition.

In October 2007, University of Mississippi Medical Center's (UMMC) Code 13 Committee within the Batson Children's Hospital was assigned the task of designing and

implementing a pediatric RRT (PRRT). The charge was to meet the IHI recommendation and The Joint Commission (TJC) National Patient Safety Goal (NPSG) 16. National Patient Safety Goal 16 envisioned improved recognition and response to changes in a patient's condition. The organization selects a method that enables health care staff to directly request assistance from specially trained individuals when the patient's condition appears to be worsening (The Joint Commission [TJC], 2008). RRTs were a logical choice for meeting the Joint Commission requirement. Benefits of the PRRT program are:

- Patient and family satisfaction.
- Improved assessments of clinically deteriorating patients.
- Patients experiencing a PRRT event and still requiring ICU are likely to transfer in better condition.
- Nursing satisfaction and retention.
- Increased physician confidence in patient care on non-ICU units.
- Improved through-put by keeping ICU beds open.
- Decreased overall length of stay by preventing serious deteriorations in patients.
- Opportunities for evaluation of policies, processes and practices of care.

Academic medical centers rely on innovative measures to improve quality of care and patient safety in order to achieve consistency in patient care delivery and satisfaction among patients and staff. PRRT programs are needed: To actively address patient safety concerns; to provide evidence to the public that health care today is safe; to serve as a model for evaluating the impact of an intervention in determining what works to make patients safer; to standardize practice and build highly reliable systems in health care; to foster peer to peer collaborations.

Review of Literature

Failure to rescue is a term used to denote quality and safety in recognizing and responding to clinical instability and adverse events in patients (Jones, DeVita & Bellomo, 2011). The 2006 HeathGrades Patient Safety Report recognized *failure to rescue* as having the highest prevalence of patient safety incidents. When a complication is recognized and interventions are started early patients are a better condition to avoid cardiopulmonary arrest and death. Rapid Response Teams are one such example of a rescue intervention. Rapid Response Team is a seemingly straightforward concept: When a patient shows signs of clinical deterioration, a team of critical care providers (physician, nurse and/or respiratory therapist) are summoned by the floor nurse to the bedside. The PRRT role is to provide intensive care unit (ICU) level clinical expertise, monitoring, equipment and medications in preventing further clinical deterioration, ICU admission, or other life-threatening event (Agency for Healthcare Research & Quality [AHRQ], 2010). Often there is a 6-8 hour window when signs of distress can be detected prior to a code event (Sharek et al., 2007). The criteria for deployment of RRTs that best indicate the patient's risk of cardiac arrest are deteriorations in respiratory rate, heart rate, blood pressure and level of consciousness (IHI, 2009). Despite the broad application of RRTs in hospitals today, the efficacy in meeting the intended objective of the teams remains uncertain. The efficacy of RRTs has been evaluated using various outcome measurements including in-hospital mortality, unanticipated ICU admission, incidence of cardiopulmonary arrest, ICU mortality, and hospital and ICU length of stay (DeVita et al., 2011).

In the medical community there remains an ongoing debate on the benefits of RRTs. The proponents' argument is supported by common sense, anecdotal reports and observational studies (Berwick et al., 2006). Opposing arguments of the debate assert recognizing, preventing

and treating patients with clinical deterioration *is* common sense (Ranji, Auerbach, Hurd, O'Rourke & Shojania, 2007).

Ranji et al. 2007 conducted an evaluation of the effects of RRSs on clinical outcomes through a systematic literature review. Randomized and nonrandomized controlled trials, interrupted time series, and before-after studies reporting effects of an RRS on inpatient mortality, cardiopulmonary arrests, or unscheduled ICU admissions were included in the study selection. Thirteen studies met inclusion criteria: 1 cluster-randomized controlled trial (RCT), 1 interrupted time series, and 11 before-after studies. The RCT failed to show effects on any clinical outcomes studied. Before-after studies showed reductions in inpatient mortality (RR 0.82, 95% CI: 0.74-0.91) and cardiac arrest (RR 0.73, 95% CI: 0.65-0.83). The investigators found these studies were of poor methodological quality and published studies of RRSs had not found consistent improvement in clinical outcomes. Ergo the effectiveness of the RRS concept remained unproven.

To determine rates of hospital-wide codes and mortality before and after implementation of rapid response team interventions, Chan et al. 2008 conducted a prospective cohort design of adult inpatients. Main outcome measures included hospital-wide code rates and mortality, adjusted for pre-intervention trends. Rapid response team education was conducted prior to program rollout. Twenty four thousand one hundred ninety three patient admissions were evaluated pre-RRT intervention and 24,978 admissions were evaluated after the intervention. The RRT intervention consisted of evaluation, treatment and triage of inpatients exhibiting clinical deterioration by an experienced ICU staff and a respiratory therapist. A total of 376 rapid response team activations were observed. Mean hospital-wide code rates decreased from 11.2 to 7.5 per 1000 admissions after rapid response team implementation. Hospital-wide mortality did

not differ between the pre-intervention and post-intervention periods 3.22 vs. 3.09 per 100 admissions. Under-treatment and underuse of rapid response teams were assessed by secondary analyses and were not found to affect hospital mortality. Consequently, implementation of rapid response teams in this large single-institution study did not reveal an association with reductions in hospital-wide code rates or mortality.

Winters et al. 2007 conducted a meta-analysis to evaluate the impact of rapid response systems on hospital mortality and cardiac arrest rates. The search was restricted to the English language and by age, > 19 years. Observational and randomized trials of rapid response systems that provided empirical data on hospital mortality and cardiac arrest in control and intervention groups were selected. Eight relevant studies meeting the criteria were identified out of the 10,228 abstracts reviewed. Five used historical controls one used concurrent controls, and two used a cluster randomized design. The pooled relative risk for hospital mortality comparing rapid response teams to control was 0.76 between the two randomized studies and 0.87 among the five observational studies. The pooled relative risk for cardiac arrest comparing rapid response systems to control was 0.94 in the single randomized study and 0.70 in four observational studies. The investigators found dismal evidence of rapid response systems associated with reductions in hospital mortality and cardiac arrest rates, but limitations in the quality of the original studies, the statistical analysis and the presence of heterogeneity limited the ability to conclude that rapid response systems are effective interventions. The study recommended large randomized controlled trials to clarify the efficacy of rapid response systems before implementing them as the standard of care.

The widespread adoption of RRTs in hospitals led Chan et al. 2010 to conduct a meta-analysis to assess the effect of RRTs on reducing cardiopulmonary arrest and hospital mortality

rates in adult and pediatric populations. Randomized clinical trials and prospective studies of RRTs that reported data on changes in hospital mortality or cardiopulmonary arrest cases were included. The systematic review consisted of 18 studies. A 33.8% reduction in rates cardiopulmonary arrest outside the intensive care unit was seen with implementation of an RRT in adults. A 37.7% reduction in rates of cardiopulmonary arrest outside the ICU and a 21.4% reduction in hospital mortality rates in children were seen with implementation of an RRT. The investigators acknowledged the pediatric data were not robust to sensitivity analyses and the disproportionate number of deaths to cardiopulmonary arrests prompted questions about the mechanisms of improvement. Rapid response teams have broad appeal but lack robustness to support the effectiveness of the interventions.

A recent literature review on current themes in rapid response systems (RRSs) research by Pringle et al. 2011, concluded RRS implementation elicit benefits and positive outcomes. The authors cautioned further research with controlled variables is needed to actuate the impact of RRSs on clinical outcomes. Systematic reviews and meta-analysis have shown modest benefits of RRTs but note that RRT studies were often of poor quality and clinicians frequently failed to call the RRT when necessary (Chan, Jain, Nallmothu, Berg & Sasson, 2010; Litvak & Pronovost, 2010; Pringle et al., 2011; Winters et al., 2007).

Little research exists in the use of PRRT in the pediatric population (Chan et al., 2010; Pringle et al., 2011; Winberg et al., 2008). Robust evidence to support the effectiveness in reducing hospital mortality remains a need to determine the magnitude of the effect on outcomes despite the broad appeal of RRTs (Chan, et al., 2010). Often there are specific challenges regarding calling criteria for age related physiological changes and chronic disease in pediatric patients (Winberg, Nilsson & Aneman, 2008). Studies published on RRS implementation in

pediatric hospitals have been non-controlled, non-randomized, single-center observational studies using historical controls. In all cases educational training preceded implementation (Winberg et al, 2008).

Sharek et al. (2007) conducted a study at Lucile Packard Children's Hospital using a cohort study design with historical controls. Hospital-wide mean monthly mortality rate outside of the ICU setting decreased by 18% (1.01 to 0.83 deaths per 100 discharges). The hospital mean monthly code rate outside of the ICU setting decreased by 71% (0.52 to 0.15 codes per 1,000 patient days). This finding was the first to reveal lower death rates and cardiopulmonary arrest rates resulting from RRTs in a pediatric setting. Two likely explanations for the significant reductions seen in the code event rates outside the ICU and the overall mortality rate were: 1.) The greater occurrence of children on the floor units at risk for code events; 2.) Longer post-intervention period studied in this inquiry and the result of the education roll out as opposed to the actual team interventions.

Brilli et al. (2007) conducted a retrospective chart review and program implementation study after implementation of a medical emergency team (MET) in a free-standing children's hospital. The specific aim of the study was to reduce the rate of respiratory and cardiopulmonary arrests outside the intensive care units by 50% for > 6 months following MET implementation. The records of patients who required cardiopulmonary resuscitation outside the critical care areas were reviewed before MET implementation to determine activation criteria for the MET. A statistical significant difference in code events outside of the ICU was revealed, decreasing from 0.27/1000 patient days to 0.11/1000 patient days. There was a non-significant decrease in the post-MET mortality rate compared to the pre-MET mortality rate.

In Melbourne, Australia at Royal Children's Hospital a comparison of transgression of MET call criteria in patients who arrested and died before and after introduction of MET was conducted. The aim of the study was to determine the impact of a pediatric medical emergency team (MET) on cardiac arrest, mortality and unplanned admission to intensive care in a pediatric tertiary care hospital. Cardiac arrest decreased from 0.19/1000 to 0.11/1000 admissions and death decreased from 0.12/1000 0.06/1000 admissions during this periods. Unplanned admissions to intensive care increased from 20 (SD 6) to 24 (SD 9) per month. The incidence of transgression of MET call criteria in patients who arrested decreased from 17 to 0 and in those who died, decreased from 12 to 0 after introduction of MET (Tibballs & Kinney, 2009).

Combined rate of respiratory arrests and cardiopulmonary arrests, on the wards and agreement between independent reviewers on categorization of cardiopulmonary arrests was studied by Hunt et al. (2008). The study was conducted in a tertiary care, academic children's hospital. A before-and-after interventional trial design was utilized to study inpatients who subsequently had the code team or pediatric medical emergency team (PMET) called or who had a respiratory arrest or CPA on the wards. The investigators found no change in the rate of cardiopulmonary arrests on the wards associated with the implementation of a pediatric MET. However, there was a 73% decrease in the incidence of respiratory arrests (0.23 respiratory arrests/1000 patient-days) pre-PMET vs.0.06 post-PMET. One hundred percent agreement between reviewers on categorization of cardiopulmonary was achieved.

In 2008 Winberg et al. conducted a systematic literature review to evaluate and summarize the current knowledge about pediatric RRSs. The investigators found pediatric cardiorespiratory arrest carries a poor prognosis due to respiratory insufficiency or hypotension/shock, which can be reversible. The systematic literature review identified pediatric

RRSs in use in several places around the world. One study shows a statistically significant decrease in mortality rate after implementation. Two studies show a non-significant association with decreased mortality rate. Cardiac and/or respiratory arrest rates decreased in all four before-after studies with statistical significance in two. The study concluded cardiac arrest and death are uncommon in pediatric hospitals. This offers a reasonable explanation for the difficulties to demonstrate statistically significant benefits of pediatric rapid response teams. Physiological changes as well as chronic disease account for problems regarding calling criteria due to age. The investigators concluded there is no consensus on which approach is best practice for the PRRT thereby making study design more difficult for comparison.

In summary, although the trend is favorable, the ability to study RRTs and their effectiveness is somewhat limited by the nature of the intervention. The implementation cannot be blinded, patient randomization is virtually impossible and confounders can be difficult to control (DeVita et al., 2011). Even though evidence is lacking, children experiencing a PRRT event receive highly specialized care at the bedside, theoretically decreasing the chance of a cardiopulmonary arrest, the need for a critical care admission, or mortality. PRRT as a part of RRS is widely accepted. Hence an impact evaluation at the institutional level was necessitated.

Problem Statement

UMMC is the health sciences campus of the University of Mississippi. University of Mississippi Health Care (UMHC) implements the patient care mission of UMMC. UMHC has the only Level 1 trauma hospital in Mississippi. With a total of 722 beds, UMHC it is the largest diagnostic, treatment and referral care system in the state. Inpatient stays total about 29,000 annually with more than 209,000 outpatient and emergency visits every year (University of Mississippi Health Care [UMHC], 2011).

Blair E. Batson Children's Hospital of UMHC is the only medical facility in Mississippi exclusively designated to care and treat sick and injured children. The hospital provides multidisciplinary teams of pediatric specialists in more than 30 specialty areas. Services available include: pediatric emergency room, children's surgery, intensive care units, rehabilitation services, newborn nursery, and a pediatric pharmacy (UMHC, 2011).

In January 2008, Batson first implemented the use of PRRT with the goal of preventing pediatric patients from reaching the point of cardiac and respiratory arrest. Since the establishment of the PRRT, the Code 13 Committee has released monthly PRRT event outcome reports. The purpose of this study is to evaluate the impact of the PRRT in decreasing transfers, code events and mortality.

Definition of Terms

The following section provides definitions of various terms that are be used throughout this document.

1. **Pediatric Rapid Response Team –** a team of clinicians who bring critical care expertise to the patient bedside (IHI, 2009).
2. **Transfer –** the move of the clinically deteriorating patient to a higher level of care after a code or PRRT.
3. **Code Event** – an episode in which the patient requires cardiopulmonary resuscitation or intubation.
4. **Mortality –** deaths in pediatric patients that experienced a code event.

Theoretical Framework

The theoretical framework chosen for this inquiry is based on the IHI usage of the Model for Improvement (see Figure 1). The PDSA cycle is shorthand for testing a change by

developing a plan to test the change (Plan), carrying out the test (Do), observing and learning from the consequences (Study), and determining what modifications should be made to the test (Act). “A primary purpose of PDSA quality improvement research is to establish a functional relationship between process changes in systems of health care and variation in outcomes” (Speroff & O’Conner, 2004).

Improvement requires setting time-specific and measurable aims of this impact evaluation to determine if PRRT decreased transfers, code events and mortality making this framework ideal in implementing and evaluating PRRT’s efficiency and effectiveness. Quantitative measures can be used to determine if the specific change actually leads to improvements. With innovations in health care such as PRRT, the PDSA cycle’s integrated approach is used to guide establishing the measurement, selecting ideas for changes, testing a change in the real work setting, learning from each test, and refining the change. This is the model used by Batson Code 13 committee in implementing the PRRT.

Figure 1. IHI Model for Improvement

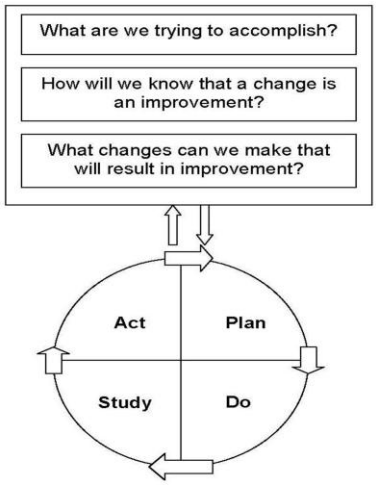


Figure 1. IHI uses the Model for Improvement developed by *Associates in Process Improvement* as the framework to guide improvement work. The model has two parts: Three fundamental questions, which can be addressed in any order. The Plan-Do-Study-Act (PDSA) cycle to test changes in real work settings. The PDSA cycle guides the test of a change to determine if the change is an improvement. This model is not meant to replace change models that organizations may already be using, but rather to accelerate improvement. Adapted from G. L. Langley, K. M. Nolan, T. W. Nolan, C. L. Norman, and L. P. Provost. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* (2nd edition). San Francisco: Copyright 2009 by Jossey-

Significance of the Study

When initiatives such as PRRT are implemented, there is a greater level of responsibility using the highest scrutiny to adopt policies and procedures to govern the practice (Gosfield & Reinertsen, 2005). Evaluating the PRRT program outcomes at Batson aided in determining the potential benefit of the PRRT program and provided evidence to determine future investments of resources into the program. Benefits of the PRRT quantify costs savings with the general assumption that improving quality increases the number of patients who can receive care, reduces length of stay, and increases patient flow through the health care system without change

in total cost. Hospitals experience significant cost reductions by avoiding unnecessary transfers to the ICU, cardiopulmonary arrests, and complications that cause longer stays in the hospital (Ward, 2006).

Methodology

Developing and implementing best practices in patient safety to sustain high levels of reliability and quality health care are crucial. PRRT is one such initiative designed to decrease the number of hospital deaths each year. Evaluation of the impact of PRRT is vital to ensuring that quality care is delivered to patients and that hospitals achieve economic longevity. The purpose of the PRRT is to restore balance when the patient's needs exceed the available resources and time is of the essence.

Design

The design for the study is an interrupted time series design. That is fundamental in the PDSA model. "The time series design is the fundamental paradigm for demonstrating such functional relationships (Figure 2). The rigor of a PDSA quality improvement study design is strengthened using replication schemes and research methodology to address extraneous factors that weaken validity of observational studies" (Speroff & O'Connor, 2004).

Figure 2. Interrupted Time Series Design

2007	2008	2009	2010
O_1	X O_2	X O_3	X O_4

O = Observation (code events, # of transfers, mortality
X= Treatment (Pediatric Rapid Response Team Implementation)

Advantages

1. Allows for trends over time
2. Can be used without a comparison group

Disadvantages

1. Doesn't control well for influences of history (other hospital wide interventions)
2. Need multiple time periods for sufficient data with only one group

Reference Brink & Wood (1999). Advanced design in nursing research. 2nd ed. Sage: Thousand Oaks, CA

This time series design is a pre and post-intervention comparative design to determine the role in reducing code events and mortality in pediatric patients. The pre-intervention period was January 1, 2007 through December 31, 2007. The post-intervention period was January 1, 2008 through December 31, 2010.

The treatment variable (independent variable) is PRRT. Rather than waiting until a child is in a state of cardiopulmonary arrest to call a Code 13, the PRRT was called at the first sign that a child's condition was deteriorating and responded within minutes. The PRRT was available 24 hours a day, 7 days a week, and any member of the hospital's staff could call the PRRT. The PRRT was called when there were acute changes in the patient's heart rate, blood pressure, respiratory rate, oxygen saturation, or mental status; a new or prolonged seizure occurs; or the patient had difficult-to-control pain or agitation. The PRRT model used in Batson Children's Hospital is comprised of pediatric critical care registered nurses and respiratory therapists (See Appendix A).

The establishment of the PRRT intervention took place January 1, 2008 to present. The dependent variables for this study were code events as measured by code incidence density, PRRT events as measured by PRRT incidence density and mortality as measured by mortality incidence density.

The operational definitions for the dependent variables were:

1. **Incident density –** the frequency of new events per person time (Jekel, 1996).
2. **Code incidence density** – the number of code events per 10,000 patient days.
3. **PRRT incidence density** – the number of PRRT events per 10,000 patient days.
4. **Mortality incidence density** – the frequency of deaths per 10,000 patient days.

Other outcome variables of interests were transfers to a higher level of care. Descriptive data that was available for this inquiry was gender and age.

Population/ Accessible Population

Patient inclusion criteria for code and PRRT events for this inquiry were all patients aged 16 years or younger who experienced a code or PRRT event outside of an ICU setting. Patient exclusion criteria were all patients aged 16 or younger whose event occurred in an ICU setting, operating rooms, post anesthesia care unit or emergency department. These patients were excluded from the inquiry because these areas have highly specialized monitoring, equipment, medications and trained staff to manage an acute clinical deterioration event.

Data

Data were obtained from three separate databases: the Rapid Response Code 13 database, the Code 13 database and the Fiscal Year Patient Statistics from Revenue Usage reports. These databases are maintained by the Batson Code 13 Committee and the Performance Improvement department. The Rapid Response Code 13 database and the Code 13 database include information on patient age, gender, location when the code or PRRT event occurred and patient disposition after the code or PRRT event. Patient disposition was entered as transfer or remained on the floor unit after a PRRT event. Patient disposition was entered as lived or expired after a code event. The Fiscal Year Patient Statistics from Revenue Usage reports determine the usage patterns of resources in the hospital. The Fiscal Year Patient Statistics from Revenue Usage reports included annual patient days by nursing units. These data were collected for the years 2007, 2008, 2009 and 2010.

Data Collection Procedure

Prior to acceptance of the inquiry proposal by the capstone committee in the school of nursing, permission was verbally granted to conduct the study by the Code 13 Committee chairperson. Exemption from IRB full review was requested and granted (Appendix B). To secure access to the Rapid Response Code 13 and the Code 13 databases, an electronic request was submitted to the Code 13 Committee chair for approval (Appendix C). Permission was then requested from the Performance Improvement clinical data manager to provide the Fiscal Year Patient Statistics from Revenue Usage reports for 2007, 2008, 2009 and 2010.

Data were manually abstracted from all of databases by the investigator for the 2007, 2008, 2009 and 2010. Extracted pediatric code and PRRT event data were organized in an Excel spreadsheet. The investigator examined the accuracy of the data two additional times.

Data Analysis

SPSS statistical software version 19.0 was used for data analysis. The mortality rate and code event rates per 10,000 patient days (incidence density) in the pre- and post-intervention periods were used to obtain the relative risk and the absolute risk reduction in code events and mortality associated with implementation of the PRRT. Relative risk is often used to measure the association between potential benefit or harm and the intervention (Replogle & Johnson, 2007). Absolute risk reduction was selected for this inquiry to measure a more realistic quantification of the PRRT intervention effect on all code events and mortality. The PRRT event rate per 10,000 patient days in the post-intervention period was used to calculate the PRRT incidence density. Descriptive statistics were calculated on PRRT events, code events, mortality, transfers, age and gender. An alpha level of .05 was used to determine statistical significance throughout the analyses.

Results of the Study

Two hundred ten Code 13 records and 143 PRRT records were reviewed from the study period. After data verification and cleaning, records not meeting the inclusion criteria or records found to be incomplete were eliminated. The remaining code events were 56 between the years of 2007 and 2010. PRRT events were 132 between the years of 2008 and 2010. The mean age of patients experiencing a code event from January 1, 2007 through December 31, 2010 was 61 months (5.1 years) old, the SD 65.54 with a range of 0 to 192 months. The mean age of patients receiving a PRRT event January 1, 2008 through December 31, 2010 was 53 months (4.5 years), the SD 60.45 with a range of 0 to 195 months. Fifty-seven percent were males and 53% were males in the pre- and post-PRRT intervention periods, respectively.

In the 12 months prior to PRRT implementation, the incidence density of code events was 9.65 per 10,000 patient days (see Table 1). In the subsequent 36 months post-program implementation, the incidence density of code events decreased to 5.51 per 10,000 patient days. PRRT incidence density for 2008, 2009 and 2010 was 13.71, 26.27 and 18.60 per 10,000 patient days, respectively.

Table 1

Code Events and PRRT Events

Year	Code Events	Code Event rate/10,000 patient days	PRRT Events	PRRT Events rate/10,000 patient days
2007	19	9.65		
2008	18	8.81	28	13.71
2009	10	4.45	59	26.27
2010	9	3.72	45	18.60
2008-2009-2010 combined	37	5.51	132	19.68

Comparing the code event incidence density in 2007 to the combined incidence density of 2008, 2009 and 2010 resulted in a significant relative risk= 1.75 ($p < .05$) indicating a 75% greater code event incidence density in the pre-PRRT period (see Table 2). The absolute risk reduction for the post-PRRT period failed to reach statistical significance. However, comparing the three PRRT years individually to 2007 resulted in relative risks of 1.09 ($p > .05$), 2.16 ($p < .05$, and 2.59 ($p < .05$), respectively. Absolute risk reductions for the same comparisons resulted in 0.84 ($p > .05$), 5.20 ($p < .05$), and 5.93 ($p < .05$), respectively. Thus, there were no statistically significant differences in code event incidence density between 2007 and 2008 – the first year of PRRT implementation. However, comparing 2007 to both 2009 and 2010 individually, a statistically significant increased relative risk in the pre-PRRT implementation period and statistically significant absolute risk reductions in the post-PRRT implementation period was found.

Table 2

Measure of Code Risk

Year	Relative Risk	95% CI	Absolute Risk Reduction	95% CI
2007 vs. 2008	1.09	[.56, 2.09]	0.84	[-5.10, 6.79]
2007 vs. 2009	2.16*	[1.01, 4.67]	5.20*	[0.06, 10.34]
2007 vs. 2010	2.59*	[1.17, 5.73]	5.93*	[.96, 10.91]
2007 vs. 2008-2010	1.75*	[1.01, 3.04]	4.13	[-0.55, 8.83]

Note. CI = confidence interval.

* $p < .05$

Using the average daily census for 2009 (61.53) and 2010 (66.25), the number of calendar days that PRRT had to have been implemented in 2009 and 2010 to prevent an additional code event was 31.22 and 25.43, respectively (see Table 3).

Table 3

Days Calculated to Prevent an Additional Code Event

Year	Patient Days	Average Daily Census	Number of Days to Prevent One Additional Code Event
2008	20,413	55.93	211.87
2009	22,459	61.53	31.22
2010	24,182	66.25	25.43

Comparing the mortality incidence density in 2007 to the combined mortality incidence density of 2008, 2009 and 2010 resulted in a non-statistically significant relative risk = 2.27 ($p > .05$) (see Table 4). The absolute risk reduction =.56 ($p > .05$) failed to reach statistical significance.

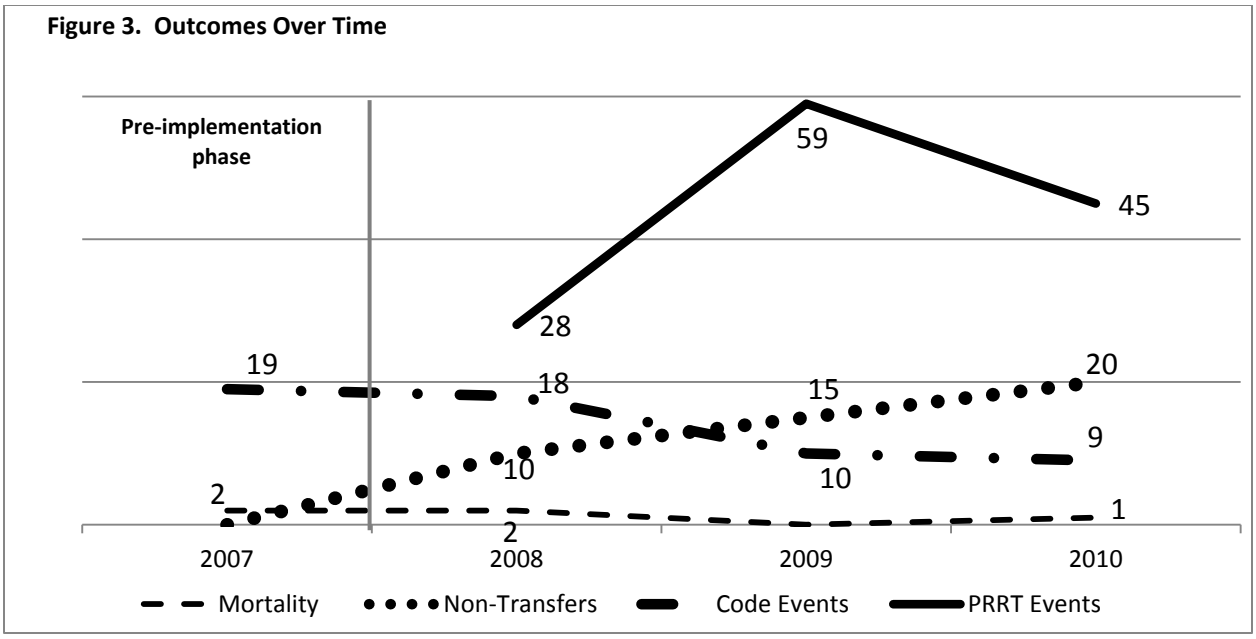
Table 4

Measure of Mortality Risk

Year	Relative Risk	95% CI	Absolute Risk Reduction	95% CI
2007 vs. 2008 - 2010	2.27	[0.38, 13.60]	.56	[-0.90, 2.07]

Note. CI = confidence interval.
* $p < .05$

Patient transfers to a higher level of care after a code event for the years 2007, 2008, 2009, 2010 were 76.8%. Patient transfers to a higher level of care after a PRRT for the years 2008, 2009, 2010 were 65.8%. This represented for 2008, 2009, 2010 the number of patients not transferred to a higher level of care 10, 15, 20 respectively. Figure 3 summarizes the PRRT events, code events, transfers and mortality for this study period.



Discussion of Findings

This study found PRRT utilization was associated with a consistent decrease in code events over the study period. During the first year there were 50% more PRRT events than code events that occurred on the general nursing units. The momentum continued the following year with the number of PRRT events doubling and the number of code events decreasing by half the number seen in the prior year. By the third year of the PRRT program a plateau was seen in code and PRRT events.

During the initial post-PRRT year there was not a statistical significant difference in the risk of a code event. However, the absolute risk reduction of a code event was statistically significant in the second and third years of the program's existence. This indicates that the PRRT program's success improved over time by managing clinically deteriorating patients and preventing them from declining to a code event.

The percent of patients experiencing a PRRT event that did not require transfer to a higher level of care was 34%. Patients after a code event that did not require a transfer to a

higher level of care included 14% remaining on the floor unit and 9% that expired after the event. This indicates that patients who experience clinical instability and were treated with PRRT interventions earlier and faster, were stabilized and able to remain on the general nursing unit.

The pre-PRRT mortality incidence density of code events was 1.02 deaths per 10,000 patient days. The mortality incidence density post-PRRT intervention was 0.45 deaths per 10,000 patient days. Because of the very small number of deaths in the pre- and post-PRRT intervention periods there were no statistical significant differences in the mortality rates. Howbeit, these results are clinically significant in that the risk of death pre-PRRT implementation was greater than two times the risk post-PRRT implementation.

With the establishment of the PRRT program, no change was seen in the number of days needed to prevent one additional code event the first year. In the second year, the number of days to prevent one additional code event was 31.22 days and continued to decline the following year to 25.43. No changes were identified in the patient days and average daily census in the hospital. This indicates that the number of days the program needed to be implemented decreased, signifying that the PRRT program became more efficient in preventing clinically deteriorating patients from experiencing a code event.

Limitations of the Study

The ability to measure the impact of PRRT in this study was subject to several limitations. PRRT intervention is not easily studied using traditional evaluation methods such as randomized control trials. The data used in study were obtained from secondary sources. The principal investigator was not involved in the collection of the data. The Code 13 database, pre-program implementation was retrospectively collected and may have undercounted code events because the tracking system was not formalized prior to that time.

The findings within this single institution may not be generalizable outside of this academic setting. There is no single cause that can be identified for the outcome results. Possible contributors to the statistically and clinically significant findings seen in this study are the comprehensive educational in-service training, the real-time review of the PRRT's performance for quality improvement, and utilization of a dedicated team in responding to PRRT events. These measures were not directly examined in this study but may have caused the decreases as seen in the outcomes studied in this inquiry after the PRRT program was implemented. Between 2007 and 2010, PRRT was the only initiative implemented to assist patients earlier during signs of clinical instability or deterioration. As an additional safety measure, a transition unit was opened for closer monitoring of patients that were higher risk for instability or deterioration. No other programs can account for the change seen.

Conclusion and Recommendations from the Study

The results from this study support PRRT as an important intervention in increasing opportunities to rescue, thereby slowing the clinical deterioration of pediatric patients. The PRRT is intended to operate as part of the RRS in which all components of the RRS are essential in providing resuscitative care to clinically deteriorating patients at the bedside. The findings of this study extend the findings of previous investigations that have explored the relationship between rapid response team implementation and code event incidence and mortality (Bellomo et al., 2003; Brilli et al, 2007; Tibballs et al., 2009). The PRRT program at Batson Children's Hospital is an important component of the children's safety net. The PRRT program offers a plausible method of delivering a higher level of health care to clinically deteriorating pediatric patients outside the ICU in an academic medical center. The study findings are a baseline to

understanding PRRT prevention and/or interruption of clinical deterioration in pediatric patients as hospitals implement the next generation of RRT – Family Activated RRT.

General recommendations for future research include developing evidence based guidelines for PRRT and determining PRRT cost savings and economic impact. Recommendations from this study specific to Batson Children's Hospital are:

1. Exclude patients in ICU, the operating room, PACU and the ED experiencing a PRRT event, a code event or mortality from the combined or overall data analysis.
2. Conduct interval PDSA evaluations of the PRRT program to drill down on factors contributing to the plateau begun in the 3rd year of the program's operation.
3. Observe the rate of transfers to a higher level of care after a PRRT event to assess the impact the PRRT has made in stabilizing and retaining these patients on the general floor units.
4. Submit the findings from this study to the IHI as a success story.
5. Enroll in the IHI Rapid Response Team mentor hospital registry.

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Appendix A

University of Mississippi Health Care University Hospitals and Health System Jackson, MS	**BATSON CHILDREN'S HOSPITAL POLICY AND PROCEDURE MANUAL**	MANUAL CODE: CH/R-3
SUBJECT: PEDIATRIC RAPID RESPONSE TEAM		
Effective Date: 12/08	Review/Revision Date: 12/2011	PAGE 1 OF 3
PREPARED BY: Batson Children's Hospital Practice & Standards Sub-council	APPROVED BY: Terri Gillespie, MSN, RN Chief Nursing Officer _____	

PRRT Policy

I. Purpose:

The purpose of the Pediatric Rapid Response Team (PRRT) is to enable health care staff members to directly request additional assistance from a specially trained individual(s) when the patient's condition appears to be worsening.

Definitions:

"Patient": Pediatric patients within the Batson Children's Hospital, Pediatric Clinics, or areas where pediatric care or testing is provided within the UMHC main campus.

"Staff members caring for the patient": Any UMHC staff member regardless of professional discipline.

"PRRT or Pediatric Rapid Response Team": Specially trained staff members who respond to requests for assistance in pediatric patient care.

II. Policy:

A. The PRRT will be in operation 24 hours a day, 7 days a week.

B. The team will consist of specially trained individuals that include a Respiratory Care Practitioner and a Pediatric Critical Care RN.

C. Any person may alert the PRRT for any of the following criteria **OR** if the primary care team does not respond within a timely manner to the initial call for assistance.

1. Acute change in heart rate from baseline

2. Acute onset or worsening in respiratory distress

3. Oxygen requirement > 50% by face mask OR an increase of more than 50% from baseline

4. Oxygen saturation less than 90% despite supplemental oxygen unless patient's baseline is less than 90%

5. New-onset cyanosis or grey skin color

6. Acute change in blood pressure from baseline

7. Acute mental status change from baseline

8. New-onset seizure **OR** seizure lasting longer than 5 minutes not controlled by medications

9. Acute change in urine output from baseline and/or < average of 1-2 ml/kg/hour

10. Acute change in pain status or uncontrolled pain

11. Person concerned and/or worried of an unidentifiable change in condition

12 Staff member feels that additional assistance is needed to prevent clinical deterioration.

D. Both Adult and Pediatric Rapid Response Teams are activated by dialing 4-1111. The person requesting assistance must state "Pediatric Rapid Response" and specify the area and room number to differentiate Pediatric from Adult teams and units. Persons activating will remain on the phone to verify accuracy of the team and unit area in need. Staff members caring for the patient are responsible for paging the patient's primary physician if not already present or notified.

E. The PRRT will be notified by pager.

F. The PRRT will respond to the call promptly.

G. The PRRT will go directly to the patient bedside.

H. Staff member(s) caring for the patient will remain with the patient to provide face-to-face report.

I. All communication will follow the Situation, Background, Assessment, and Recommendation (SBAR) Format.

J. The PRRT record will be initiated at the time of the incident and completed upon disposition.

III. Scope:

Physicians
Nurses
Respiratory Care Practitioners

The University Hospitals and Clinics The University of Mississippi Medical Center Jackson, Mississippi	**BATSON CHILDREN'S HOSPITAL POLICY AND PROCEDURE MANUAL**	MANUAL CODE: CH/R-3
SUBJECT: PEDIATRIC RAPID RESPONSE TEAM		
Effective Date: 12/08	Review/Revision Date: 12/2011	PAGE 3 OF 3

IV. Procedure:

A. Staff member(s) caring for the patient will activate the PRRT by dialing 4-1111 and notify the primary care team.

B. The staff member(s) caring for the patient will obtain the patient's chart, labs, MAR, and any documentation available for review with the PRRT.

C. The PRRT will arrive and assess the patient. Documentation is initiated by the PRRT members on the PRRT record.

D. The staff member(s) caring for the patient will facilitate report to a physician if not at the bedside.

E. If indicated, the PRRT will assist in the stabilization of the patient by orders of the primary care team physician. If the primary care team physician is unavailable, the staff member(s) caring for the patient or the PRRT can notify the pediatric resident on call or PICU physician for assistance.

F. If patient condition warrants, the PRRT will assist in transporting the patient to a higher level of care upon orders of a physician.

G. If the patient's status does not warrant an elevation in care, a PRRT member will follow up within 4 hours of the response and document patient status. (If remains in a non-critical care area)

H. If patient status continues to deteriorate or if the patient exhibits respiratory and/or cardiopulmonary failure, Code 13 must be initiated.

I. PRRT documentation will include pertinent information and communication along with signatures of the PRRT members. The completed PRRT record will remain in the patient's chart.

Appendix B

UNIVERSITY OF MISSISSIPPI MEDICAL CENTER
2500 North State Street
Jackson, Mississippi 39216-4505

Institutional Review Board
Telephone (601) 984-2815
Facsimile (601) 984-2961
#00000061

DHHS FWA #00003630
IORG #0000043
IRB 1 Registration

IRB 2 Registration #00005033

Approval Notice
Initial Application

10/17/2011

Sheila Keller, PhD
School of Nursing
University Of Mississippi Medical Center
2500 North State Street
Jackson, MS 39216

RE: IRB File #2011-0198
An Evaluation of Rapid Response Team Impact

Your Initial Application was reviewed and approved by the Exempt Review process on 10/17/2011. You may begin this research.

Please note the following information about your approved research protocol:

Protocol Approval Period: 10/17/2011 - 10/15/2012
Approved Enrollment #: 300
Participant Population: Minors < 18
Performance Sites: Blair E. Batson Hospital for Children
Exempt Review Category(ies): (5) Research and demonstration projects which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) Public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.;

Documents / Materials:

Type	Description	Version #	Date
Document	Protocol v1.docx	1	10/04/2011

Review History:

Date	Type	Decision
10/12/2011	Exempt Review	Revisions Required
10/17/2011	Exempt Review	Approved

Please remember to:

- Use the IRB file number (2011-0198) on all documents or correspondence with the IRB concerning your research protocol.

- Review and comply with all requirements on the enclosure, UMMC Investigator Responsibilities, Protection of Human Research Participants.

The IRB has the prerogative and authority to ask additional questions, request further information, require additional revisions, and monitor the conduct of your research and the consent process.

Please note, if this study involves an intervention (whether or not it involves a drug or device) you (or the "responsible party") must register the study before enrollment begins and report results within 12 months of study closure through Clinicaltrials.gov http://www.clinicaltrials.gov/. Penalties for responsible parties who fail to register applicable clinical studies are significant and include civil monetary penalties and, for federally-funded studies, withholding or recovery of grant funds. For additional information please go to http://irb.umc.edu/GuidanceInfo/ClinTrialRegistry.htm.

We wish you the best as you conduct your research. If you have questions or need additional information, please contact the Human Research Office at (601) 984-2815.

IRB 2

Enclosure(s): (1) Investigator Responsibilities, Protection of Human Research Participants
cc: Sharon Lobert, Ph.D.
Office of Integrity and Compliance

Appendix C

From: Service Desk [servicedesk@umc.edu]
Sent: Tuesday, October 25, 2011 6:21 PM
To: Jessylen M. Age
Subject: Service Desk Ticket # 355555 - Ticket Open

Request 355555 Initial Notification
A Service Desk ticket has been logged for: Jessylen Age

Request Description

Request Date: 10/25/11 02:23 PM
Request #: 35941
Requestor Employee #: [redacted]
Requestor Name: Jessylen Age
Requestor Charge Code #: [redacted]
Requestor Department Name: SER-Depart of Chief of Staff

Designated Computer: Existing Computer
Existing/New Property Control # : [redacted]
Old Property Control #: N/A
Designated Employee: Existing Employee
Existing/New Employee #: [redacted]
Employee Name: Jessylen Age
Contractor Number/Name:
Old Employee #:

Phone #: [redacted]
Room #: [redacted]
Dept Charge Code #: [redacted]

Resources:
Network Drive Access

Other: Code13 on 'ntummc\datashares\Dept\Hosp_Adm'(M)
Comments:

Supervisor Name: WELANDER, MICHELLE
Supervisor Employee #: [redacted]
Supervisor Phone #: [redacted]
Supervisor Comments:
Status: Request Approved
Help Desk Ticket Number:
Last Modified by: Jessylen Age

Supervisor Approve Date: 10/25/11 02:28 PM
Helpdesk Assign Ticket Date:

Affected End User	**Request Area**	**Current Ticket Status**
Age, Jessylen	Access Mgmnt	Open
Ticket Logged By	**Current Assignee**	**Group**
Smith, Mary E	Smith, Mary E	NET-SERVICES SERVICE DESK SUPPORT

From: Service Desk [servicedesk@umc.edu]
Sent: Thursday, October 27, 2011 3:11 PM
To: Jessylen M. Age
Subject: Service Desk Ticket # 355555 - Ticket Closed

Request 355555 Close Notification

The drive is mapping correctly now.

Problem Description

Request Date: 10/25/11 02:23 PM
Request #: 35941
Requestor Employee #: [redacted]
Requestor Name: Jessylen Age
Requestor Charge Code #: [redacted]
Requestor Department Name: SER-Depart of Chief of Staff

Designated Computer: Existing Computer
Existing/New Property Control # : [redacted]
Old Property Control #: N/A
Designated Employee: Existing Employee
Existing/New Employee #: [redacted]
Employee Name: Jessylen Age
Contractor Number/Name:
Old Employee #:

Phone #: [redacted]
Room #: [redacted]
Dept Charge Code # [redacted]

Resources:
Network Drive Access

Other: Code13 on 'ntummc\datashares\Dept\Hosp_Adm'(M)
Comments:

Supervisor Name: WELANDER, MICHELLE
Supervisor Employee [redacted]
Supervisor Phone #: [redacted]
Supervisor Comments:
Status: Request Approved
Help Desk Ticket Number:
Last Modified by: Jessylen Age

Supervisor Approve Date: 10/25/11 02:28 PM
Helpdesk Assign Ticket Date:

Affected End User	Request Area	Status	Priority
Age, Jessylen	Access Mgmnt	Closed	6-Projects

Reported By	Assignee	Group
Smith, Mary E	Lehmann, Yancey	CLIENT-SERVER OPERATIONS-DIRECTORY SVCS