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ORIGINAL ARTICLE

Pediatric care by a rapid response team in a Brazilian tertiary general university hospital

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Abstract

Objectives: Describe the experience of implementing a rapid response team (RRT) in a general university hospital in Brazil with code yellow and blue care; specify the characteristics of pediatric care and outline the profile of these patients. **Methods:** This retrospective observational study was conducted from 2015 to 2017 with analysis of forms completed by the RRT and of medical records of patients younger than 18 years old who were treated in a high-complexity tertiary and quaternary hospital. **Results:** There were 62 code yellow calls: 18 (29%) in 2015, 13 (21%) in 2016 and 31 (50%) in 2017. Seventy-four percent were related to the primary disease. The main complications that led to the activation of this code were seizures, syncope, respiratory discomfort and sepsis; sepsis was associated with the three patients that died. Six calls were code blue and all patients had an underlying disease. The cause attributed to cardiorespiratory arrest was hemodynamic instability secondary to sepsis in three patients and acute respiratory failure in the other three patients. The RRT changed the procedure or site of the patient in 64.9% of cases. The response time was less than five minutes for code yellow calls and less than three minutes for code blue calls. **Conclusion:** There was a progressive increase in the number of code yellow calls and the RRT staggered the level of care and assistance. Sepsis was the main cause of death in both modalities. The response time was fast and within the established goal.

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INTRODUCTION

Despite medical and technological advances, in-hospital cardiac arrest (CA) in a pediatric population has high mortality[1,2]. Both adult and pediatric patients generally show signs of instability hours before progression to CA[3-5]. Thus, implementing a rapid response team (RRT) would allow early identification of patients with clinical deterioration, enabling rapid and effective interventions and reducing the incidence of in-hospital CA[6].

In the last 20 years, comparative studies between before and after the activity of an RRT have shown controversial results. Some observed a reduction in the incidence of in-hospital CA, mortality in intensive care units (ICUs), length of hospitalization and severity of disease[7-10]; however, others did not find sufficient evidence to corroborate the need for this type of urgent medical care[11-13]. Despite this, several American, Canadian, Australian and European services have RRTs in their hospitals. In Brazil, some services have already implemented an RRT[14-16], leading to positive results in the reduction in in-hospital CA in adults[15].

The *Instituto Central do Hospital das Clínicas (ICHC) da Faculdade de Medicina da Universidade de São Paulo (FMUSP)* is one of the eight institutes of the hospital complex of FMUSP and implemented its RRT in 2014. It is a tertiary and quaternary university service connected to the Unified Health System (Sistema Único de Saúde - SUS), which concentrates most of the clinical and surgical specialties (total of 31). The ICHC has 917 hospital beds, 29 of which are pediatric. There are approximately 40,000 total hospitalizations per year.

The RRT of the ICHC began with internal disclosure of the service, in parallel with employee training (security guards, nurses and doormen). Its coverage area encompasses the central building (hospitalization site), the outpatient clinic and the area surrounding the hospital, except for the emergency room, surgical center and ICU, thus providing care for hospitalized patients. The team operates in two different codes: blue, indicated only for CA conditions and yellow, indicated for risk and clinical deterioration situations.

In both situations, the activation is performed through a specific bell present in the wards or via a telephone. After activation, the RRT center immediately contacts the caller to obtain information about the case. Concurrently, the RRT receives a message, by beeper, containing the activated code type (blue or yellow) and the location of the call. The team is multidisciplinary, consisting of an attending physician, nurse and physiotherapist, as well as anesthesiology, clinical medicine and pediatrics residents.

At the end of care, a form is completed with information about the patient's personal history, schedule, the reason for the call, interventions performed, immediate outcome (remained on-site or referred to the emergency room or ICU) and hospital outcome (death or discharge). Although there are specific activation criteria for the pediatric population, the ICHC is primarily aimed at the care of adults and therefore fulfills the same standard form for all age groups (Appendices 1 and 2).

The time goals to respond to code yellow calls are eight minutes for the ICHC and ten minutes for the area surrounding the hospital. For code blue calls, the time goals are three minutes for the ICHC, four minutes for the outpatient clinic building and six minutes for the surrounding area.

For pediatric cases (younger than 18 years), pediatric intensivist physicians on the shift in the ICHC surgical support ICU are also activated, becoming in charge of care with the help of the rest of the team.

This study describes the experience of implementing an RRT at a high-complexity university hospital.

METHODS

This is a retrospective observational study conducted by analyzing medical and RRT records from the ICHC of FMUSP.

Pediatric patients treated after yellow and blue code calls from January 2015 to December 2017 were included in the study. Patients aged 18 years or older and cases with clinical complications and in-hospital CA outside the RRT coverage area were excluded.

Calls that took place from 7a.m. to 7p.m. were considered during the day and those that occurred from 7p.m. to 7a.m. were considered during the night. The RRT response time was calculated as the difference between the activation time and the arrival of the team at the site. Activation criteria for code yellow calls were enumerated as the standard RRT form was completed (Appendix 1).

Quantitative characteristics are described as the mean, standard deviation (SD), median, interquartile range and qualitative characteristics are provided as absolute and relative frequencies. Comparisons between groups were performed using the T-test for continuous data and the chi-square test for categorical data.

All analyses were performed using IBM SPSS Statistics for Macintosh software, version 25. *P*-values lower than 0.05 were considered statistically significant.

RESULTS

Results will be presented separately according to the type of code that led to the activation of the RRT, namely, code yellow and blue.

Code yellow calls

In the three years of the study, 62 cases were coded yellow calls: 18 (29%) in 2015, 13 (21%) in 2016 and 31 (50%) in 2017. The mean age of the patients was 10.04 years, with an SD of 6.16 and a median of 12 years (interquartile range of 3 to 16 years), with 43.5% male and 32.3% female.

In 24.2% of the forms, there was no information on patient sex or hospital records for consultation, with 33% of the forms referring to care provided in the surrounding areas.

Most patients (74.1%) were already undergoing treatment for a previous disease. The specialties responsible for the follow-up of these patients are provided in Table 1.

Table 1. Main follow-up specialty for patients treated after code yellow calls.

Main follow-up specialty (N=46)	Number (%)
Neurology	29 (63.0)
Cardiology	5 (10.8)
Hematology-oncology	4 (8.6)
Psychiatry	4 (8.6)
Immunology	3 (6.5)
Nephrology	3 (6.5)
Otolaryngology	3 (6.5)
Dermatology	2 (4.3)
Endocrinology	2 (4.3)
Ophthalmology	2 (4.3)
Traumatology	2 (4.3)
Plastic surgery	1 (2.1)
Vascular surgery	1 (2.1)
Orthopedics	1 (2.1)
Rheumatology	1 (2.1)

The criteria used for care activation are provided in Table 2.

The main complications that motivated code yellow care were of neurological, cardiovascular and respiratory origin, followed by sepsis and psychomotor agitation (Figure 1). The least frequent complications included falls, hypoglycemia, bleeding, vomiting, anxiety and chest pain.

Table 2. Code yellow activation criteria.

Activation criteria (N=62)	Number (%)
Concern with the patient	44 (70.9)
Alteration of the level of consciousness	14 (22.5)
Respiratory rate > 36bpm	9 (14.5)
Heart rate > 130bpm	6 (9.6)
Systolic blood pressure < 90mmHg	3 (4.8)
Respiratory rate < 5bpm	1 (1.6)
Heart rate < 50bpm	0 (0)

Most code yellow calls occurred during the day (88.7% versus 11.3% overnight). Regarding the place of care, 25 (40.3%) patients were seen outside the hospital.

The mean RRT response time was 4.93 minutes (SD 3.44) with a median of 4 minutes (interquartile range 3 to 5 minutes).

After treatment, the RRT changed the clinical care specialty and/or patient location in 69.4% of cases. A total of 16.1% of patients were referred to the ICU: 50% were due to seizures, 30% to sepsis and 20% due to respiratory distress.

Among those who were referred to the ICU, the vast majority were admitted to the ICHC (90%) and were younger [mean 4.6 years (SD: 4.06) versus 10.04 years (SD: 6.16) among all patients seen by code yellow; p=0.002].

Of the total number of code yellow cases, three (4.8%) progressed to death, all diagnosed with sepsis. There was no association between death occurrence and RRT response time (mean response time of 5.05 minutes (SD: 0.92) for those who survived versus 2.66 minutes (SD: 0.24) for those who died; p=0.246).

There was also no difference in mortality about the time of care (p=0.526) or the place of care (p=0.097).

Code blue calls

There were a total of 307 code blue calls in the period of study, of which six (1,9%) were pediatric: five in 2015, zero in 2016 and one in 2017. The mean age was 10.83 years and the median was 14 years (interquartile range, 1 to 17 years). Four patients were male and two were female.

Of the six calls, four occurred during the day and two occurred during the night. All patients already had an underlying disease, including three with a neurological disease, two with an oncological disease and one with a cardiological disease. Five of the six patients were hospitalized at the time of calling the code blue and the other was waiting for an outpatient appointment.

Hemodynamic instability was the cause attributed to CA in three cases and two progressed to death immediately after RRT care. The other three patients had acute respiratory failure as the cause of CA.

The mean RRT response time was 2.33 minutes, SD 1.75 and the median was 1.50 minutes (interquartile range, 1 to 4 minutes).

The initial rhythm observed in CA was pulseless electrical activity in five patients and asystole in one. All six patients received chest compressions, two were under advanced airway management, two received peripheral venous access and five received at least one dose of epinephrine. One of the patients underwent chest puncture for the treatment of pneumothorax.

After 30 days, two patients were alive and at the end of one year, one was lost to follow-up. The other patient maintained regular outpatient appointments for 2 years after the event with a slight neuropsychomotor development delay for the patient's age.

DISCUSSION

To our knowledge, this is the first study in Brazil on pediatric care by an RRT. We observed that the RRT was a determinant of the change in clinical care specialty and place of care, staggering the level of care and assistance.

In the case of a high-complexity tertiary and quaternary hospital responsible for the care of critically and chronically ill patients, a greater complication potential is expected, justifying the implementation of an RRT. Most children already had some underlying disease and were also hospitalized at the time the RRT was called, corroborating the severity of these patients compared to those treated at the outpatient clinic or surrounding areas of the hospital, who required fewer interventions.

We observed an increase of more than 40% in the number of code yellow calls between 2015 and 2017, which may be explained by the widespread disclosure of the RRT

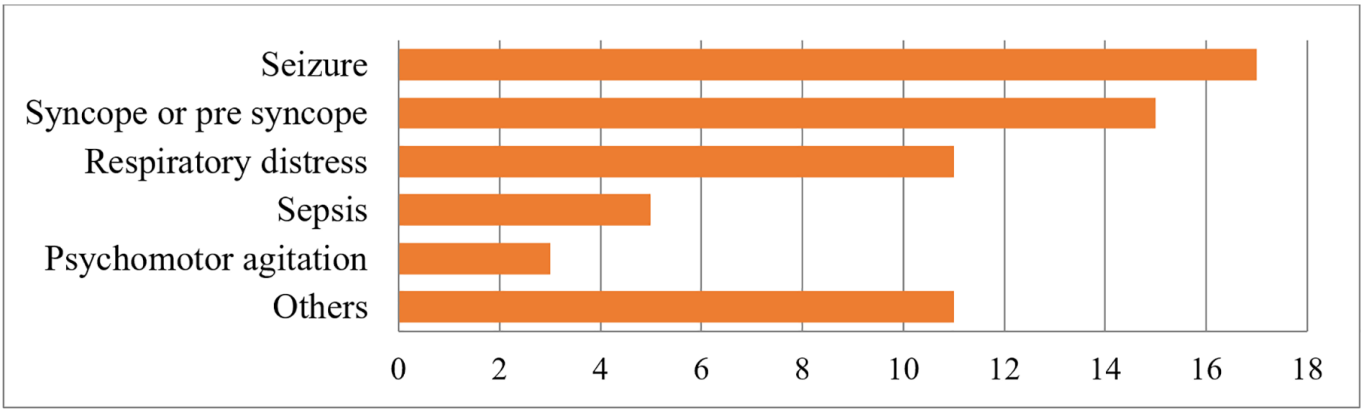


Figure 1. Complications leading to the activation of code yellow calls.

over time and by the continuing education of staff members, a phenomenon previously reported[17].

In addition, we noted that the RRT forms were not filled completely in part of the cases, leading to loss of information and impairing analysis. This incomplete or incorrect form completion phenomenon was also previously reported in in-hospital CA studies[18].

Even so, we observed a higher prevalence of consultations among males in both modalities of the RRT, similar to that reported by other authors for pediatric patients[8] and adults[6,14].

Although there are specific criteria for activating the RRT for the pediatric population, the ICHC adopts the criteria of adult patients for all ages. As it is a general hospital, most patients are adults and therefore, care is directed to this population, as pediatric patients, also served by the RRT, correspond to a small portion of cases. Establishing different activation criteria for each age group could hinder and delay activation of the RRT by the care teams.

Code yellow activation during the day was predominant. We hypothesize that during this interval, patients are usually evaluated more frequently by the care team, thus increasing the possibility of identifying early clinical signs of clinical deterioration. It was not possible to establish this relationship for the code blue activation due to the small sample size.

The response time for the calls was, on average, less than five and less than three minutes for the yellow and blue code calls, respectively. Although there are no data in the literature that establish the ideal response time, the values found are within the goal established for the RRT by the ICHC, which demonstrates the efficiency and organization of the RRT structure.

The RRT changed the clinical care specialty and location aftercare of almost 70% of patients treated after code yellow calls, demonstrating that there was a need to stagger the level of care and assistance to these patients. This reinforces the importance of early identification of signs of clinical deterioration, allowing the necessary interventions to be established quickly.

In this study, the clinical reasons for the activation of the RRT were diverse and there was great variety in the underlying disease of each patient. Even so, all those treated after code yellow calls who subsequently died had a sepsis diagnosis in RRT evaluation. For code blue calls, the two patients who died had hemodynamic instability secondary to sepsis as a cause of CA. This indicates that the rapid recognition and proper management of infectious diseases can have a major impact on the morbidity and mortality of children, leading to the possibility of improvements in the institutional sepsis protocol.

Data from this study showed a mortality rate of 4.8% among code yellow patients. In a large American multicenter pediatric study, hospital mortality was 6.7% among those who had been treated by a RRT, but the reason for death was not specified[19]. Among adults, sepsis and septic shock correspond to a significant portion of RRT-treated patients, with a reduction in mortality in some hospitals, partly attributed to the wide dissemination of campaigns for early and targeted management[20].

The study has some limitations. First, it is a retrospective analysis and thus subject to the biases associated with this type of study. Second, data loss and small sample size, especially for code blue calls, hinder data analysis. Third, the absence of data before the implementation of the RRT prevents a comparison between the before and after periods, as described in previous studies[7-10]. Fourth, the criteria used for code yellow calls may not reflect the actual severity of pediatric patients because cutoff values for the adult population, which corresponds to the vast majority of cases at ICHC, were used.

A pediatric RRT is a recent care modality in the Brazilian health system. Its implementation may be beneficial for pediatric patients, but there is still no consensus on the positive effect it would have on reducing the incidence of in-hospital CA or mortality. The rapid recognition of septic patients and their adequate management by the health teams responsible for the patient, together with RRT care, could increase the survival of the pediatric population, especially in patients hospitalized with previous diseases.

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APPENDIX

HOSPITAL DAS CLÍNICAS DA FACULDADE OF THE SCHOOL OF MEDICINE OF THE UNIVERSITY OF SÃO PAULO
Central Institute - Clinical Directory
Clinical Intercurrent Care Form – **Code Yellow**

TICKET	**Birth date:** ____/____/____ **Admission date:** ____/____/____ **Date and time of the event** ____/____/____ ___:___ **Bed and Unit:** _____
1. Admission diagnosis:	
2. Time when the presence of some criterion was noticed: ____:____	
3. Time of Code Yellow activation ____:____	
4. Time of team arrival in the Unit: ____:____	
5. End time: ____:____	

NURSE		**7. Reason for activation:**
		Respiratory rate less than 5 ipm
		Respiratory rate greater than 36 ipm
		Heart rate less than 50 bpm
		Heart rate greater than 130 bpm
		Systolic blood pressure less than 90 mmHg
		Decreased level of awareness
		Suspected stroke
		Seriously concerned about the patient's condition

Nurse:	Professional register number:

DOCTOR	**8. Pre-existing Disease** ( ) Diabetes ( ) SHBP ( ) Coronary ( ) CHF ( ) Neurological ( ) Kidney ( ) Liver ( ) Cancer ( ) Hematological ( )Other:_____	**10. Description of actions taken:**
	9. Diagnosis of Decompensation Cause:	
	11. Patient in Palliative Care ( ) Yes ( ) No	

Doctor:	Professional register number:

Appendix 1. Code yellow form.

HOSPITAL DAS CLINICAS DA FACULDADE OF THE SCHOOL OF MEDICINE OF THE UNIVERSITY OF SÃO PAULO
Central Institute - Clinical Directory
Clinical Intercurrent Care Form – **Code Yellow**

QUALITY ASSURANCE ASSESSMENT OF THE ADMISSION UNITS
Was the patient already monitored? ( ) Yes ( ) No
Was the patient already receiving CPR? ( ) Yes ( ) No
Was the nurse at the bedside? ( ) Yes ( ) No
Was the equipment needed for care already available? ( ) Yes ( ) No
Was the patient already being cared for? ( ) Yes ( ) No
Was the unit doctor present? ( ) Yes ( ) No
Was there any difficulty during care? If yes, please specify.

Appendix 1. Code yellow form.

HOSPITAL DAS CLINICAS DA FACULDADE OF THE SCHOOL OF MEDICINE OF THE UNIVERSITY OF SÃO PAULO
Central Institute – Nursing Division
CPR care registration tool

TICKET	**Birth date:** ____/____/____ **Admission date:** ____/____/____ **Date and time of the event** ____/____/____ ___:___ **Bed and Unit:** _____
1. . Admission diagnosis: _____	
2. Pre-existing Disease ( ) Diabetes ( ) SHBP ( ) Coronary ( ) CHF ( ) Neurological ( ) Kidney ( ) Liver ( ) Cancer ( ) Hematological ( ) Other:_____ CPC prior CPR: ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) ND	**10. Schedule of interventions** Activation _____:_____ ( ) código blue ( )other team / doctor on call Help arrical _____:_____ CPR start _____:_____ ( ) NP 1st shock _____:_____ ( ) NP Advanced airway _____:_____ ( ) NP 1st epinephrine dose _____:_____ ( ) NP
3. Location ( ) ER: _____ ( ) ICU: _____ ( ) Surgery center:_____( ) Ward:_____ ( ) Ambulatory: _____ Outro: _____	**11. Imediate outcome** ( ) Resuscitated ( ) Death Time _____:_____
4. Witnessed ( ) Yes ( ) No ( ) NA	**12. Post-resuscitation care** Hypothermia (indicated if there is resuscitation) ( ) Yes ( ) No ( ) No indication ( ) NA Start Time____:____ End time____:____ Technique _____
5. Previous interventions ( ) None ( ) Catheter/ Mask O_2 ( ) Advanced airway ( ) Non invasive ventilation ( ) ECG monitor ( ) Antiarrhythmics ( ) Central access ( ) Vasoactive drugs	Target temperature ( ) Yes ( ) No ( ) NA Glycemia Protocol ( ) Yes ( ) No ( ) NA CO_2 Protocol ( ) Yes ( ) No ( ) NA $SatO_2$ Protocol ( ) Yes ( ) No ( ) NA Vasoactive drugs ( ) Yes ( ) No ( ) NA EEG monitoring ( ) Yes ( ) No ( ) NA Anticonvulsants ( ) Yes ( ) No ( ) NA CAT/PCI Date __/__/___ Hour __:__ ( ) No ( ) ND
6. Immediate cause (check only one) ( ) Hypotension / Shock ( ) Respiratory ( ) Sudden Arrhythmia ( ) Metabolic ( ) NA	
7. Attempted resuscitation ( ) Yes ( ) No or suspended - reason: ( ) Considered futile ( ) DNR Determination	**13. Hospital outcome** ( ) Discharge ( ) Death Date ____/____/_____ CPC on discharge:( ) 1( ) 2 ( ) 3 ( ) 4 ( ) NA **Cause of death:** _____
8. Initial rhythm (check only one) ( ) VF ( ) Pulseless TV ( ) PEA ( ) Asystole ( ) Severe bradycardia in children ( ) NA	
9. Interventions performed during CPR ( ) None ( ) Venous acess ( ) Intraosseus ( ) Advanced airway. Which? _____ ( ) Compression ( ) Manual ( ) Mecanic _____ ( ) AED ( ) Manual defibrillator ( ) CO_2 Monitor ( ) Intra-arterial catheter Other: _____	**14. Evolution** **30 days** ( ) Alive ( ) Death Date ____/____/_____ CPC: ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) NA **180 days** ( ) Vivo ( ) Óbito Date ____/____/_____ CPC: ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) NA
15. Observations_____	

CPC - Cerebral performance category: 1 Normal; 2 Mild dysfunction; 3 Alert, but with severe dysfunction; 4 Coma; CAT indicates catheterization; EEG, electroencephalogram; PCI, percutaneous coronary intervention; NA not available; NP, not performed and DNR, do not resuscitate

Médico - Assinatura e carimbo

Enfermeira - Assinatura e carimbo

Appendix 2. Code blue form.

QUALITY ASSURANCE ASSESSMENT OF THE ADMISSION UNITS
Was the patient already monitored? ( ) Yes ( ) No
Was the patient already receiving CPR? ( ) Yes ( ) No
Was the nurse at the bedside? ( ) Yes ( ) No
Was the equipment needed for care already available? ( ) Yes ( ) No
Was the patient already being cared for? ( ) Yes ( ) No
Was the unit doctor present? ( ) Yes ( ) No
Was there any difficulty during care? If yes, please specify.

Appendix 2. Code blue form.