

Prospective Longitudinal Study on Mortality and Quality of Care for Ward Patients Following Rapid Response Team Implementation in Brazil

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Abstract

Background: A Rapid Response Team (RRT) is a multidisciplinary team trained to assist hospitalized patients experiencing cardiac arrest (CA) or sudden clinical deterioration. Its effectiveness, however, remains debatable.

Objectives: This study aimed to characterize the changes that occurred in a quaternary, highly complex hospital following the adoption of the RRT and to ascertain whether its implementation was associated with a decline in the mortality rates of patients admitted to wards.

Methods: This was a prospective observational study conducted from April 1st, 2014, to December 31, 2019. The study compared patient mortality and clinical outcomes after the implementation of the RRT, focusing on the frequency and outcomes of “code blue” (CA) and “code yellow” (other types of clinical deterioration) calls. Pearson’s chi-squared test (χ^2) was employed to compare categorical variables, while the Student’s t-test was utilized to compare continuous variables for independent samples. P-values < 0.05 were considered statistically significant.

Results: The team responded to a total of 2,194 inpatient calls, 495 for code blue and 1,699 for code yellow. In the years following the team’s implementation, the number of deaths and code blue calls decreased, while the number of code yellow and total RRT calls increased. When comparing the first and second three-year terms, there were no significant differences regarding code blue mortality (276/293 [94.2%] vs. 184/200 [92%], $p = 0.338$). Still, survival rates for patients assisted during code yellow calls increased (348/609 [57.1%] vs. 648/1,005 [64.5%], $p = 0.003$). This improvement in code yellow outcomes was associated with a reduction in the overall ward mortality rate (1,078/96,866 [1.1%] vs. 788/85,019 [0.9%], $p < 0.001$).

Conclusion: The implementation of the RRT was associated with a decrease in the number of in-hospital CA and unexpected deaths over six years, as well as an increase in the number of code yellow and overall RRT calls. Overall ward mortality also declined.

Keywords: Hospital Rapid Response Team; Heart Arrest; Cardiopulmonary Resuscitation; Hospital Care; Quality of Health Care.

Introduction

A Rapid Response Team (RRT) is a multidisciplinary group trained to assist inpatients who are deteriorating rapidly. Typically, the RRT serves patients on general wards, as intensive care units (ICUs), emergency departments (EDs), and operating rooms already have professionals equipped to manage clinical

instability. These teams help prevent unexpected deaths by delivering prompt and appropriate treatment to patients with severe acute complications before they progress to cardiac arrest (CA), a crucial occurrence with an in-hospital mortality rate of approximately 85%.¹⁻⁴

RRTs are a component of the Rapid Response System, which consists of four branches: 1) the afferent limb, which is responsible for recognizing patients with acute signs of deterioration and triggering the response, and includes the criteria for calling the RRT; 2) the efferent limb, which is the RRT itself, typically composed of a physician, a nurse, and a respiratory therapist; 3) patient safety and quality of care, which involves data collection and analysis, feedback for all personnel involved, and ongoing education and training; and 4) administrative limb, which encompasses human and financial support, material acquisition, and resource management.⁵

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Central Illustration: Prospective Longitudinal Study on Mortality and Quality of Care for Ward Patients Following Rapid Response Team Implementation in Brazil

Rapid Response Team Implementation in Brazil



DECREASED CODE BLUE
CALLS (IN-HOSPITAL
CARDIAC ARREST)



DECREASED UNEXPECTED
DEATHS



INCREASED CODE YELLOW
AND OVERALL RAPID
RESPONSE TEAM CALLS



REDUCED WARD
MORTALITY RATES

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Establishing a Rapid Response System is crucial to ensure that unstable patients are promptly identified and treated, thereby reducing the likelihood of adverse events.⁴ Nevertheless, the effectiveness of these teams remains debatable. Although the sole multicenter randomized trial on RRT implementation failed to demonstrate a reduction in in-hospital cardiac arrest (IHCA) and unexpected deaths rates,⁶ other studies have shown that these teams were associated with lower in-hospital mortality rates,^{2,7,8} highlighting the need for investigation into the value of RRTs in complex healthcare settings.

Material and methods

The primary objectives of the study were to assess the changes that occurred in a quaternary, highly complex hospital following the adoption of the RRT over time, by comparing the first three-year term (2014, 2015, and 2016) to the second three-year term (2017, 2018, and 2019), both of which occurred prior to the COVID-19 pandemic, and to ascertain whether its implementation was associated with a decline in mortality among ward patients experiencing severe acute complications. Additionally, the study sought to examine the characteristics of patients attended to by the RRT, the team's performance in achieving ROSC, and the factors influencing RRT performance.

The study was performed in a quaternary teaching hospital complex in São Paulo, Brazil, and was approved by the local Ethical Committee (process number 3.796.602). It was a prospective observational study, and due to its observational nature and the fact that the RRT assisted patients with severe instability, where delays could have had a negative impact on survival, informed consent was waived.

The demographics of our hospital have been described elsewhere.⁹ It is a 2,400-bed hospital complex, with its main building comprising 917 beds, including 90 ICU beds, and an annual average of 30,000 admissions.

Prior to 2014, there were no records of emergency assistance provided outside the ICU, ED, and operating rooms. Data collection began only with the start of RRT activities. Infrastructure work commenced in 2013, with the installation of buttonholes for calling RRT in all wards and outpatient clinics, as well as a pager system. Automated external defibrillators (AEDs) were also placed in high-traffic areas, such as the main entrance of the building, outpatient clinics, and the cafeteria. Hospital staff received training in basic life support and instructions on how to activate the RRT. Additional training in Advanced Cardiovascular Life Support (ACLS), according to American Heart Association international guidelines,¹⁰ was provided to the nurses and respiratory therapists, who were required to be qualified for ICU or emergency care and certified for emergency response. The emergencies were divided into two categories: code blue, which included only CA assistances, and code yellow, for all other emergencies excluding CA. The same emergency team assisted both codes due to limited financial resources. Code yellow could be optionally triggered if any of the following criteria (based on MERIT study⁶) were observed, and depending on the attending physician's confidence in managing the instability: respiratory rate < 5 or > 36 breaths/min, heart rate < 50 or > 130 beats/min, systolic blood pressure < 90 mmHg, impaired neurological status, possible stroke, or if any member of the staff was seriously worried about the patient's condition. Code blue activation was mandatory for any patient experiencing CA. The RRT operated 24 hours a day, 7 days a week, and also assisted

patients outside the wards, including outpatient clinics and the surrounding area of the complex. The team consisted of an ACLS-certified senior physician, usually specialized in cardiology or internal medicine; a medical resident; a nurse; and a respiratory therapist. It was also equipped with its own clinical apparatus, including a manual defibrillator, advanced airway materials, and medications. The response time goal (defined as the interval between activation of the RRT and its arrival at the patient's bedside) was 3 minutes for code blue if the CA occurred in the wards; 4 minutes if it occurred in the outpatient clinic; and 6 minutes if it occurred in the surrounding area, as a result of the challenges associated with dispatching the crew across a vast coverage area. The goal for code yellow was 10 minutes regardless of location. The response time goal was distinct for each type of call, as the severity of the emergency determined it. Code blue required a faster response due to its status as an ultimate emergency, whereas code yellow had a larger response time goal because patients were not yet in CA. Furthermore, there was only one team in charge of taking all calls, and occasionally, several requests would come in simultaneously, so the group had to decide which call to prioritize. After evaluating the patient, the senior physician was required to fill out a form detailing the assistance provided, based on the Utstein Resuscitation Registry recommendations.¹¹ Times for interventions, such as administration of first epinephrine dose, first shock, and insertion of an advanced airway, were monitored by the nurse and also reported on the form. CA was defined as a loss of circulation requiring resuscitation with chest compressions, defibrillation, or both,¹² and return of spontaneous circulation (ROSC) was defined as the maintenance of signs of circulation for at least 20 consecutive minutes without the need for chest compressions.^{11,13} All code blue calls, including sequential CA events for the same patient, were analyzed.

Statistical analysis

To describe the characteristics of the samples, descriptive statistics were presented as frequencies and percentages for categorical variables, and means with standard deviation (SD) for continuous variables. Parametric tests were applied due to the sample size. Pearson's chi-squared test (χ^2) was employed to compare categorical variables, while the Student's t-test was utilized to compare continuous variables for independent samples. The ward mortality rate was calculated by dividing the number of deaths by the number of admissions, and the incidence of IHCA was obtained by dividing the number of code blue calls by the number of admissions. P-values < 0.05 were considered statistically significant. The program used was SPSS, version 22 (IBM Corporation).

Results

Between April 1st, 2014, and December 31, 2019, the team responded to a total of 4,805 calls, 551 for CA (code blue) and 4,254 for other emergencies (code yellow). Of these, 495 code blue calls and 1,699 code yellow calls were for inpatients in the main building. The remaining 2,611 calls were for patients outside the wards, including outpatient care, pharmacy, diagnostic imaging, and the surrounding area.

For code blue calls in the main building, the mean age was 60.5 years (± 17.3), 62.4% were male, and 31.2% had four or more comorbidities, including hypertension (39.5%), diabetes (35.8%), chronic kidney disease (29.4%), neurological disorders (22.7%), heart failure (21.8%), coronary artery disease (15.8%), and cancer (16.3%). Approximately 10% had CA with an initial shockable rhythm. Although admitted to wards, more than half of the patients were being monitored at the time of the CA; 42.4% already had an advanced airway in place, and 32% were receiving vasoactive drugs. The average hospitalization time was 21.3 days (± 24.7) prior to the CA and 5.45 days (± 17.3) afterward; the median was 13 days and 0 days, respectively. Eighty-two percent of the calls were responded to within the target time of 3 minutes. Table 1 displays the characteristics of code blue calls, and Table 2 shows the performance indicators for the RRT. When comparing the first and second three-year terms, no significant differences were observed in terms of age, gender, period, type of ward, witnessed CA, initial rhythm (although there was an increase in CA caused by arrhythmia or metabolic disturbance, $p=0.002$), ROSC, or hospital outcome. Furthermore, performance metrics for the RRT did not differ, except for a longer time interval to secure an advanced airway ($p=0.013$) and total time in CPR ($p=0.017$).

Figure 1 illustrates the evolution of ROSC and survival rates. Between 2014 and 2018, ROSC rates ranged from 49.0% to 61.5%, but declined to 35.7% in 2019. Throughout the entire period, survival rates at discharge, as well as at 30 and 180 days post-CA, remained low. Survival at discharge ranged from 3.9% to 12.5%, and after 180 days, from 2.6% to 9.9%. The highest survival rates were observed in the third, fifth, and sixth years of RRT implantation, while the lowest occurred in the fourth year (2017).

For code yellow calls in the main building, the mean age was 55.7 years (± 20.3), and 48.6% were male. The average response time was 4.6 minutes (± 5.2), and all calls were responded to within the 10-minute goal. The most common criteria for calling the team were neurological impairment (26.6%), respiratory rate > 36 breaths per minute (20.7%), and systolic blood pressure < 90 mmHg (19%). The team placed 206 central venous catheters, administered vasoactive drugs in 309 cases, inserted 351 advanced airways (primarily orotracheal intubation), and directed 479 ICU transfers. Forty-six code yellow calls progressed to CA (code blue) during the team's assistance. The average hospitalization time was 30.1 days (± 32.4) for patients who survived to hospital discharge, and 35.5 days (± 34.6) for those who died. The characteristics of code yellow calls are detailed in Table 3. No discernible distinctions were observed in terms of age, gender, or period between the initial and subsequent three-year terms. Nevertheless, the incidence of sepsis-related calls decreased from 16.1% to 10.6%, while the percentage of patients discharged alive significantly increased from 57.1% to 64.5% during the second three-year term ($p = 0.003$). Table 4 displays the annual number of admissions, deaths, ward mortality rates, and RRT activations for inpatients at the main building. In the years following the team's implementation, the number of deaths and code blue calls decreased, while the number of code yellow and total RRT calls increased

Table 1 – Characteristics of code blue calls

Characteristics	1 st three-year term (N = 295)	2 nd three-year term (N = 200)	p
Mean age (±SD)	60.8 (± 18.8)	59.9 (± 16.7)	0.590
Gender n(%)			0.535
Male	181 (61.6)	128 (64.3)	
Female	113 (38.4)	71 (35.7)	
Period n(%)			0.254
Day (7 am – 7 pm)	157 (53.2)	96 (48.0)	
Night (7 pm – 7 am)	138 (46.8)	104 (52.0)	
Type of ward n(%)			0.138
Clinical	169 (57.5)	95 (48.5)	
Surgical	106 (36.1)	84 (42.9)	
Non-ward (CT, MRI, etc.)	19 (6.5)	17 (8.7)	
Witnessed CA? n(%)			0.685
Yes	256 (86.8)	171 (85.5)	
No	39 (13.2)	29 (14.5)	
CA reason n(%)			0.002*
Hypotension/shock	98 (33.2)	45 (22.5)	
Arrhythmia	16 (5.4)	19 (9.5)	
Respiratory	119 (40.3)	74 (37.0)	
Metabolic	35 (11.9)	37 (18.5)	
Non available	27 (9.2)	25 (12.5)	
CA rhythm n(%)			0.393
Ventricular fibrillation	23 (7.8)	19 (9.5)	
Ventricular tachycardia	4 (1.4)	7 (3.5)	
Pulseless electrical activity	167 (56.6)	101 (50.5)	
Asystole	89 (30.2)	66 (33.0)	
Non available	12 (4.1)	7 (3.5)	
Immediate outcome n(%)			0.504
ROSC	158 (53.6)	101 (50.5)	
Death	137 (46.4)	99 (49.5)	
Outcome n(%)			0.338
Discharged alive	17 (5.8)	16 (8.0)	
Death	276 (94.2)	184 (92.0)	

CA: cardiac arrest; CT: computed tomography; MRI: magnetic resonance imaging; ROSC: return of spontaneous circulation.

*Statistically significant

(Central Figure). The RRT activation rate per 1,000 admissions varied between 6.4 and 16.4. The incidence of IHCA ranged from 2.1 to 3.2 per 1,000 admissions. Figure 2 depicts the results presented in Table 4.

Finally, outcomes during the first and second three-year terms following the RRT's implementation can be seen in

Table 5. Both the percentage of patients discharged alive from wards (98.9% vs. 99.1%, $p < 0.001$) and the number of patients discharged alive in response to code yellow calls (57.1% vs. 64.5%, $p = 0.003$) increased over time. No significant disparity in survival was observed among patients assisted during code blue calls (5.8% vs. 8.0%, $p = 0.338$).

Table 2 – Performance metrics for the Rapid Response Team in code blue calls

Parameter (mean time [min] $\pm$ SD)	1 st three-year term	2 nd three-year term	p
Start of CPR to RRT call	1.5 ($\pm$ 2.7)	1.5 ($\pm$ 2.5)	0.990
RRT response time	2.5 ($\pm$ 1.7)	2.7 ($\pm$ 1.6)	0.165
Start of CPR to 1 st shock**	4.0 ($\pm$ 3.2)	5.5 ($\pm$ 6.1)	0.148
Start of CPR to advanced airway	7.8 ($\pm$ 6.6)	10.1 ($\pm$ 7.9)	0.013*
Start of CPR to 1 st epinephrine	3.6 ($\pm$ 4.5)	4.2 ($\pm$ 3.9)	0.172
Total time in CPR	22.7 ($\pm$ 20.7)	27.9 ($\pm$ 24.8)	0.017*

CPR: cardiopulmonary resuscitation; min: minutes; RRT: rapid response team. *Statistically significant. **If initial rhythm was shockable (ventricular tachycardia or ventricular fibrillation).

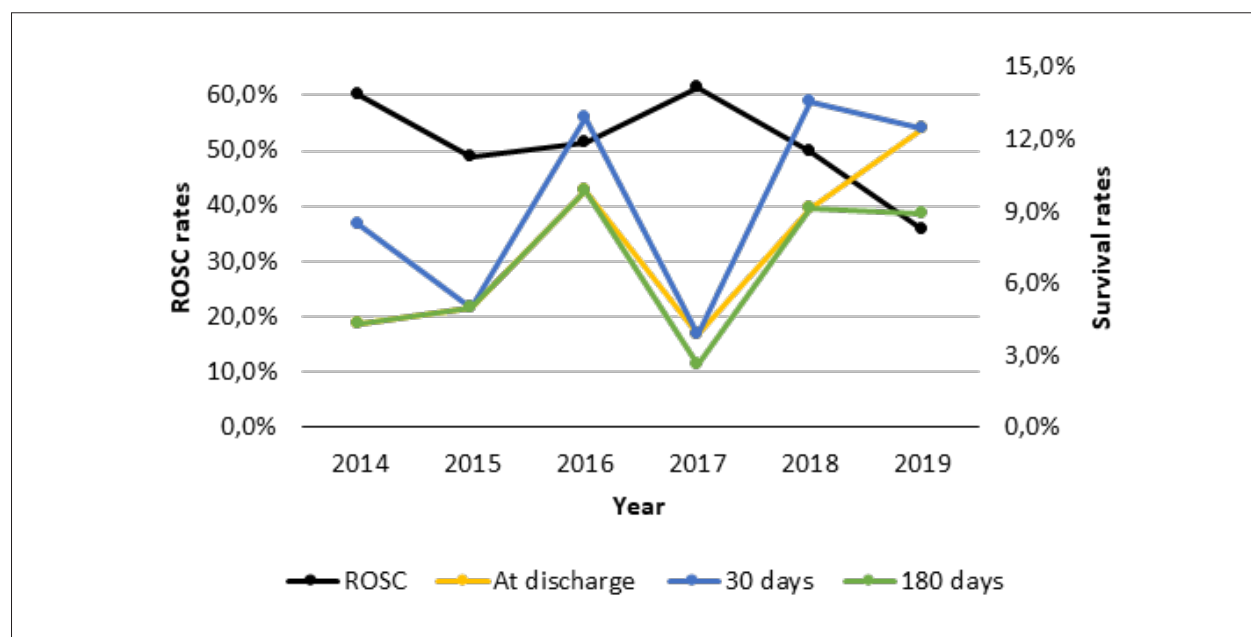


Figure 1 – ROSC and survival rates at discharge, as well as 30 and 180 day post-CA.

Discussion

The successful implementation of a Rapid Response System is reliant upon the interaction between its components, particularly in the early activation of the RRT.^{14,15} By evaluating and treating unstable patients, these teams contribute to a decline in IHCA and deaths.^{2,3,7,8,16} This is likely why code blue and code yellow assistances are so closely related.

Our incidence of IHCA ranged from 2.1 to 3.2 per 1,000 admissions, which is comparable to the 0.78 to 6.0 per 1,000 admissions previously described.^{17,18} In accordance with other studies, more than half of the patients achieved ROSC.^{13,15,17,19} However, survival to hospital discharge (of approximately 10%) was low compared to other centers, which have reported rates from 30% to 40%.^{13,15,17-20} High ROSC rates may have resulted from short response time and the prompt initiation of CPR maneuvers. On the other

hand, our rate of CA with an initial shockable rhythm of only 10.7% may have contributed to the low survival rates, when compared to 35% to 50% reported in other studies.^{18,20,21} It is well known that CA with shockable rhythms typically has a better prognosis and is more often seen in patients with cardiologic diseases,^{12,15} but in our hospital, these patients are usually admitted to a different building (not the main one), and for that reason, they were not properly represented in our sample. Another possible reason for the low survival rates observed is the fact that many patients seen during code blue calls had complex illnesses, with nearly one-third having four or more comorbidities, and were severely ill despite being admitted to wards, with more than half already under monitored, over 40% having a previous advanced airway. Almost a third receiving vasoactive drugs prior to the occurrence of the CA. These patients should have been in the ICU and, therefore, not attended by the RRT. Unfortunately,

Table 3 – Characteristics of code yellow calls

Characteristics	1 st three-year term (N = 683)	2 nd three-year term (N = 1016)	p
Mean age (±SD)	56 (± 21)	56 (± 20)	0.930
Gender n(%)			0.483
Male	146 (50.2)	224 (47.6)	
Female	145 (49.8)	247 (52.4)	
Period n(%)			0.072
Day (7 am – 7 pm)	433 (63.4)	687 (67.6)	
Night (7 pm – 7 am)	250 (36.6)	329 (32.4)	
Type of ward n(%)			0.005*
Clinical	194 (28.7)	362 (36.3)	
Surgical	371 (54.8)	448 (48.9)	
Non-ward (CT, MRI, etc.)	112 (16.5)	148 (14.8)	
Reason of call n(%)			<0.001*
Anaphylaxis	14 (2.1)	20 (2.0)	
Technical aid (CVC, difficult airway)	55 (8.1)	61 (6.0)	
Stroke	12 (1.8)	78 (7.7)	
Bradycardia	11 (1.6)	25 (2.5)	
Tachycardia	50 (7.3)	74 (7.3)	
Seizure	26 (3.8)	53 (5.2)	
Anxiety	13 (1.9)	11 (1.1)	
DM decompensation	13 (1.9)	9 (0.9)	
Dyspnea	173 (25.4)	236 (23.2)	
Abdominal pain	10 (1.5)	9 (0.9)	
Chest pain	36 (5.3)	58 (5.7)	
Other types of pain (ortho, etc.)	3 (0.4)	5 (0.5)	
Hypertension	4 (0.6)	10 (1.0)	
Hypotension	35 (5.1)	58 (5.7)	
Exogenous intoxication	2 (0.3)	0 (0.0)	
Syncope/pre-syncope	27 (4.0)	33 (3.2)	
Fall	5 (0.7)	4 (0.4)	
Impaired neurological status	69 (10.1)	130 (12.8)	
Bleeding	14 (2.1)	34 (3.3)	
Sepsis	110 (16.1)	108 (10.6)	
Mean RRT response time (min) ±SD)	4.1 (± 4.4)	4.9 (± 5.6)	0.004*
Hospital outcome n(%)			0.003*
Discharged alive	348 (57.1)	648 (64.5)	
Death	261 (42.9)	357 (35.5)	

CT: computed tomography; CVC: central venous catheter; DM: Diabetes Mellitus; MRI: magnetic resonance imaging; ortho: orthopedic. *Statistically significant.

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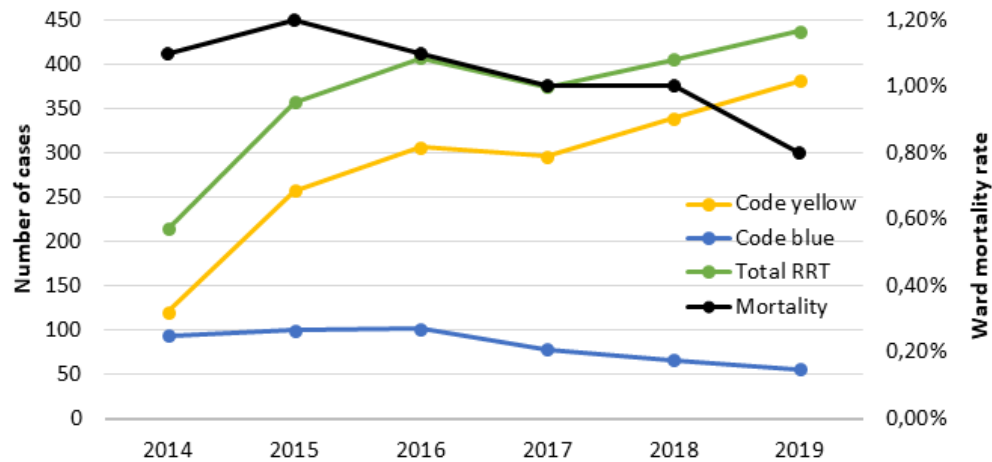


Figure 2 – Rapid Response Team calls and ward mortality rates.

Table 4 – Rapid Response Team characteristics

Year	Ward admissions	Deaths	Ward mortality rate	Code blue calls	Code yellow calls	Total RRT calls
2014*	33353	367	1.1%	94	120	214
2015	31361	363	1.2%	100	257	357
2016	31074	348	1.1%	101	306	407
2017	29277	284	1.0%	78	296	374
2018	28340	279	1.0%	66	339	405
2019	26614	225	0.8%	56	381	437

RRT: Rapid Response Team. *From April to December.

Table 5 – Outcomes

Characteristics	1 st three-year term	2 nd three-year term	p
Wards n(%)			<0.001*
Discharged alive	95788 (98.9)	84231 (99.1)	
Death	1078 (1.1)	788 (0.9)	
Code blue n(%)			0.338
Discharged alive	17 (5.8)	16 (8.0)	
Death	276 (94.2)	184 (92.0)	
Code yellow n(%)			0.003*
Discharged alive	348 (57.1)	648 (64.5)	
Death	261 (42.9)	357 (35.5)	

*Statistically significant.

there is a disparity between the need for ICU beds and the number of available spaces at our hospital; as a result, critically ill patients sometimes remain on the ward, even after suffering CA. This is one of the obstacles to assisting patients in a public hospital with low funding. It is also likely one of the key reasons why RRTs are so crucial, since the team can deliver specialized care to critically ill patients even in the absence of an ideal infrastructure.

The mean time for the RRT to place an advanced airway was 7.8 minutes in the first three-year term and 10.1 minutes in the second three-year term. Guidelines recommend considering an advanced airway in the first 2-minute cycle of CPR for CA with a non-shockable rhythm or the 2nd cycle (3 to 4 minutes) for those with a shockable rhythm.¹⁰ However, these are theoretical times, not always feasible, especially when opting for endotracheal intubation, a complex and skill-demanding procedure, which was successfully performed in 95.1% of the cases. The first epinephrine dose was administered an average of 3.6-4.2 minutes, and the first shock 4.0-5.5 minutes after the start of CPR. We have not found published data for RRT's target times that could serve as a comparison, but there is undoubtedly room for improvement, which can be accomplished by training all personnel, including ward staff and RRT members.³ It is also important to note that the time goals for advanced airway placement, first shock, and first epinephrine dose were measured from the start of CPR, which was usually initiated by ward staff prior to the RRT's arrival. Although fast, the RRT response time ended up increasing these target times by around 2.5 seconds. Overall, the absence of improvement in survival rates among code blue patients from the initial to the second three-year term may be attributed to the factors mentioned previously.

Also, by the end of data collection, our team was only five years old, which might be considered an RRT still in its maturation phase,^{17,22} as it may take years to disseminate the rapid response system concept throughout the hospital and to train staff to request immediate assistance for critically ill patients.³ The overall activation rate for the team varied between 6.4 and 16.4 per 1,000 admissions, which was lower than the 20 to 56 reported in other studies involving well-established RRTs.^{17,23,24} It is also likely that code yellow was underused, since its activation was optional, which may have contributed to worse prognosis. However, despite this possible underutilization, all the procedures performed by the team during code yellow assistances, including the insertion of central venous catheters, advanced airway placement, and administration of vasoactive drugs, may have helped to stabilize the patient's condition and reduce the likelihood of adverse events or death. One probable reason for the reduction in ward mortality during the second three-year term was that patients who were seen during code yellow calls had better survival rates, thereby increasing the overall ward survival rate. This demonstrates the criticality of assisting unstable patients in the early stages of deterioration, prior to the onset of CA.

As observed by Jones et al., our study revealed a decline in the number of code blue calls over time,³ as well as a progressive increase in code yellow calls, which may be

associated with a decrease in the number of deaths in the wards. Our results are similar to the findings of Maharaj et al., who demonstrated a reduction in the occurrence of IHCA and mortality rates following the implementation of the RRT,⁷ and are also consistent with those of Jung et al., who reported a 20% decrease in unexpected deaths after the implementation of the team.¹⁶ Possible reasons for the reduction in code blue and deaths related to the increase in code yellow and overall RRT activations include continuous education and training for the ward personnel, emphasizing prompt recognition of critically ill patients and activation of the team, resulting in an increase in overall RRT call rates; improvements in documentation and medical records, with a greater number of registered calls; increased rates of DNAR (do not attempt resuscitation), as the implementation of RRT is typically accompanied by greater debate on palliative care,²⁵ reclassifying the final events as deaths and not unexpected CA; and, most importantly, the assistance and early treatment of patients who are deteriorating rapidly prior to the development of CA, thereby preventing serious adverse events.²⁶

Importantly, our research focused on examining the ward mortality rate after the establishment of the team. Because RRTs do not assist patients in the ICUs, EDs, or operating rooms, variations in the number of deaths in these areas are likely attributable to factors other than the team's activities. For this reason, instead of using the overall in-hospital mortality rate as a measure of quality of care, we decided to investigate the ward mortality rate. We also opted to use this parameter, rather than the isolated number of ward deaths, in order to control for potential confounding factors, as a decline in the number of deaths could simply be due to a reduction in admissions, regardless of the RRT's actions.

Limitations of our study include the fact that we have solely examined the performance of the team. However, it is important to note that the RRT is merely one component of the Rapid Response System and, as such, is not the sole factor directly impacting mortality. Also, it was a single-center study with a specific population that included patients with a high degree of complexity, which may have compromised its external validity. Other important points are the brief follow-up, of only six years, which may not have been sufficiently extended to fully substantiate the claimed benefits of the RRT;²² the low overall number of calls for the RRT, reflecting a possible underutilization of the team; and, lastly, the lack of comparative data from the period prior to implementation, which precluded the possibility of conducting a "before and after" comparison and restricted the analysis to an annual prospective study.

The number of patients assisted is our study's greatest strength. In a six-year period, there were nearly 5,000 emergency assistances, including more than 550 IHCA. The reduction in code blue calls and the number of unexpected deaths indicate that the RRT may have had an impact on survival.

Conclusion

This prospective observational study showed that the implementation of the RRT in a quaternary hospital was

associated with a decrease in the number of IHCA and unexpected deaths over six years, as well as an increase in the number of code yellow and overall RRT calls, allowing for a reduction in ward mortality rates.

Author Contributions

Conception and design of the research: Salvadori FA, Perondi MB, Paiva EF; Acquisition of data and Writing of the manuscript: Salvadori FA; Analysis and interpretation of the data: Salvadori FA, Kobayasi R, Paiva EF; Statistical analysis: Kobayasi R; Critical revision of the manuscript for content: Paiva EF.

Potential conflict of interest

No potential conflict of interest relevant to this article was reported.

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Study association

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Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo under the protocol number 3.796.602. All the procedures in this study were in accordance with the 1975 Helsinki Declaration, updated in 2013.

Use of Artificial Intelligence

The authors did not use any artificial intelligence tools in the development of this work.

Data Availability Statement

The underlying content of the research text is contained within the manuscript.

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