Impact of Increased Rapid Response Team (RRT) Activations on Reduction in Code Blue Events: A Retrospective Comparative Quality Improvement Study (2024-2025)

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ABSTRACT

Background: In-hospital cardiac arrest is often preceded by identifiable physiological deterioration. Timely recognition and escalation through Rapid Response Team (RRT)systems may improve patient safety outcomes.

Objective: To evaluate the association between improved Rapid Response Team activation and changes in Code Blue events following structured quality improvement interventions.

Keywords: Rapid Response Team; Code Blue; Patient Safety; Quality Improvement; Early Warning System; Clinical Deterioration

Methods: A retrospective comparative quality improvement study was conducted in a tertiary care teaching hospital. Data from January–December 2024 was compared with January–September 2025 following implementation of staff education, mock drills, reinforcement of RRT activation criteria, and strengthening of Modified Early Warning Score (MEWS) practices. Data regarding RRT activations, Code Blue events, mortality trends, and average length of stay (ALOS) were analyzed using descriptive statistics and Chi-square testing.

Results: A total of 14,501 admissions in 2024 and 11,120 admissions in 2025 were analyzed. RRT activations increased from 35 to 80, while Code Blue events decreased from 14 to 8. The Code Blue rate declined from 0.97 to 0.72 per 1000 admissions; however, the difference was not statistically significant ($\chi^2 = 0.45$, $p = 0.50$). Average length of stay decreased from 3.28 to 3.03 days.

Conclusion: Increased RRT utilization was associated with a declining trend in Code Blue events and reduced average length of stay. However, causality cannot be established due to the observational design and lack of statistically significant differences. Further multicenter studies are recommended.

INTRODUCTION

In-hospital cardiac arrest remains a major cause of morbidity and mortality in acute care settings [1]. Evidence suggests that most patients exhibit signs of physiological deterioration several hours before cardiac arrest, providing a window for early intervention [2]. Rapid Response Teams (RRT) were developed to identify and manage clinically deteriorating patients outside intensive care settings [3]. When appropriately utilized, RRT systems have been associated with improved patient safety outcomes, including reduced cardiac arrests and unplanned ICU admissions [4]. Despite these benefits, underutilization of RRT services remains a challenge in many institutions. Barriers include delayed recognition of deterioration, lack of awareness of activation criteria, and hierarchical communication issues. During an internal audit in 2024, persistent Code Blue events were observed despite availability of RRT services. This led to implementation of a structured quality improvement initiative aimed at improving early recognition and escalation practices.

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Objectives

Primary Objective

To determine whether increased RRT activations are associated with reduction in Code Blue events.

Secondary Objectives

• To evaluate trends in hospital mortality

• To assess changes in average length of stay

• To improve early recognition of patient deterioration

• To strengthen escalation practices among healthcare staff

METHODS

A retrospective comparative quality improvement study was conducted in a tertiary care teaching hospital. Data from January 2024 to December 2024 were compared with data collected between January 2025 and September 2025 following implementation of quality improvement interventions. The hospital has approximately 162 inpatient beds with an average monthly admission load of approximately 1000. The study included data from inpatient wards, dialysis units, and outpatient clinical areas where Rapid Response Team (RRT)services were operational. Multiple interventions were introduced during the study period, including staff education sessions, reinforcement of RRT activation criteria, mock drills, strengthening of Modified Early Warning Score (MEWS) practices, and reinforcement of regular patient monitoring. Data regarding RRT activations, Code Blue events, mortality trends, and average length of stay (ALOS) were collected from hospital quality records and patient safety databases. No identifiable patient information was collected, and confidentiality was maintained throughout the study. A run chart was used to evaluate temporal trends in Code Blue events across the study period.

Definitions

Code Blue was defined as any hospital emergency call initiated for actual or suspected cardiopulmonary arrest requiring immediate resuscitation response. Repeat activations for the same patient episode were counted as a single event.

Statistical Analysis: Data were analyzed using descriptive statistics. Comparison of Code Blue events between groups was performed using Chi-square test. A p-value <0.05 was considered statistically significant.

Ethics Statement: Institutional Ethics Committee approval was obtained prior to data analysis. Patient confidentiality was maintained throughout the study.

Study Design

This study was conducted as a retrospective comparative quality improvement study in a tertiary care hospital.

Two study periods were compared:

• January 2024 to December 2024 (pre-intervention phase)

• January 2025 to September 2025 (post-intervention phase)

Study Population

Inclusion Criteria

• All admitted hospitalized patients

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• Documented RRT activations

• Recorded Code Blue events

• In-hospital mortality records

Exclusion Criteria

• Out-of-hospital cardiac arrests

• Dead on arrival cases

• Incomplete records

Root Cause Analysis

A detailed review was carried out to identify factors contributing to low RRT utilization and delayed escalation of care. The major issues identified were:

• Limited awareness regarding RRT activation criteria

• Hesitation among staff members to escalate patients early

• Fear of criticism from senior clinicians

• Inconsistent adherence to monitoring protocols

• Lack of regular reinforcement of escalation policies

No major equipment-related issues were identified during the analysis.

RRT Activation Criteria

RRT activation was initiated for patients with any of the following conditions:

• Oxygen saturation below 90% despite oxygen support

• Heart rate below 40 bpm or above 130 bpm

• Systolic blood pressure below 90 mmHg

• Respiratory rate below 10 or above 30 breaths per minute

• Sudden neurological deterioration

• Altered mental status

• Seizure activity

• Stroke symptoms

• Major bleeding

• Sudden dislodgement of chest or tracheostomy tubes

• Concern raised by staff or patient attendants regarding clinical condition

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Interventions

Multiple interventions were implemented from January 2025 onwards as part of the quality improvement initiative.

• Staff Awareness and Education: Educational posters, daily briefings, and awareness sessions were conducted to improve understanding regarding early recognition of patient deterioration and timely RRT activation.

• Practical Training and Mock Drills: Hands-on training sessions and simulation-based mock drills were organized for nursing staff and doctors working in wards, dialysis areas, and outpatient departments.

• Encouraging Early Escalation: Senior clinicians and department heads encouraged a supportive and non-punitive environment to reduce hesitation among healthcare staff regarding RRT activation.

• Reinforcement of Monitoring Practices: Compliance with 4-hourly vital signs monitoring was reinforced. Nursing supervisors regularly reviewed documentation practices and provided feedback to staff.

• Strengthening of MEWS: Modified Early Warning Signs (MEWS) were reinforced to support early identification of clinically deteriorating patients.

• Patient and Family Awareness: Patients and attendants were educated regarding warning signs and encouraged to report any sudden clinical changes immediately.

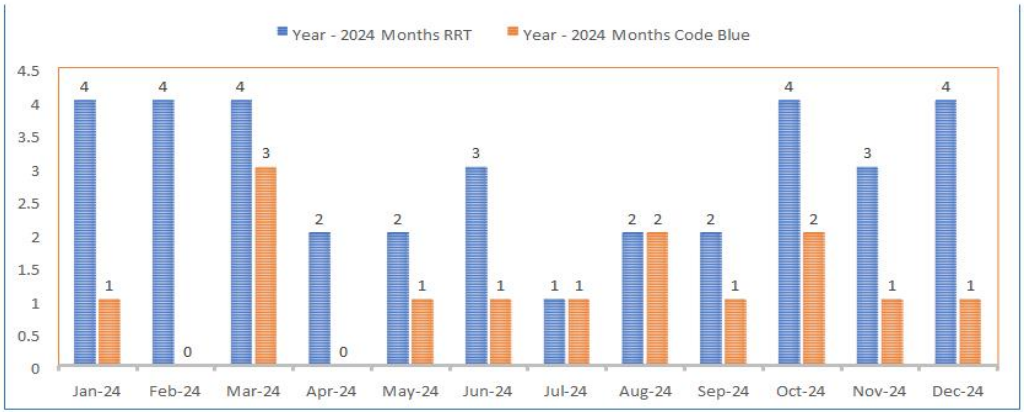

Figure 1. Baseline distribution of RRT activations and Code Blue events (2024).

Total Number of RRT from Jan 2024-Dec 2024: 35 Total Number of Code Blue event Jan 2024-Dec 2024: 14

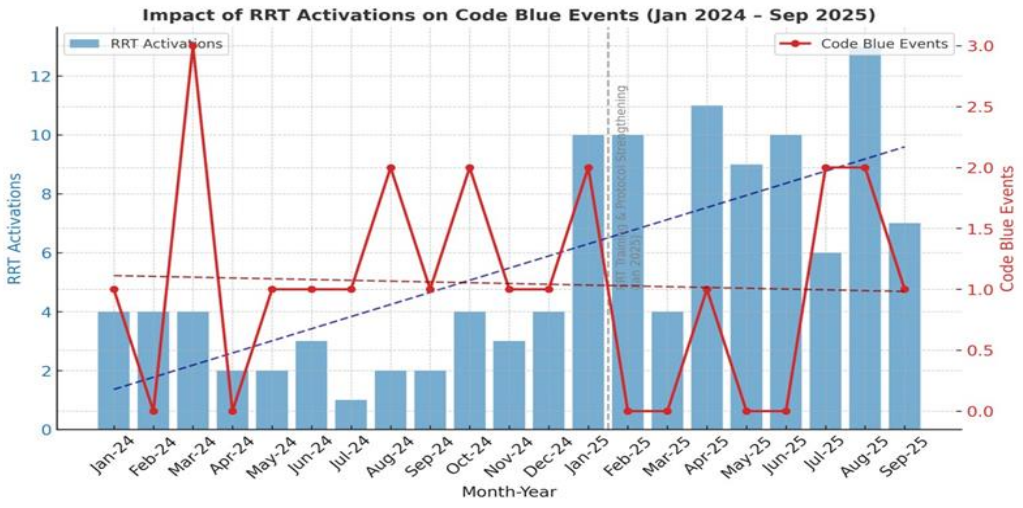

Figure 2. Post-intervention trend of RRT activations and Code Blue events (2025).

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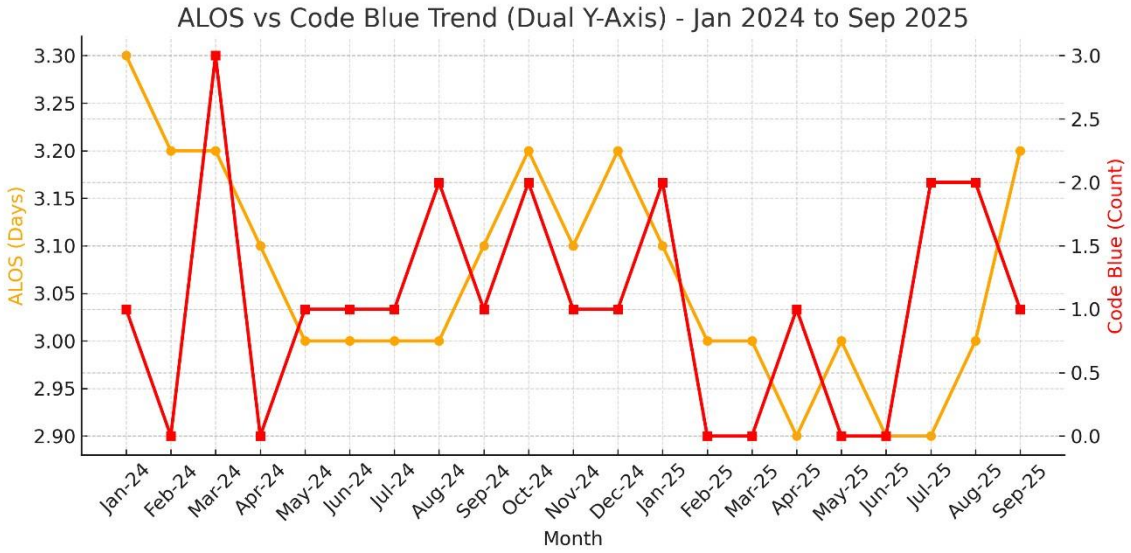
Total Number of RRT from Jan 2025-Sep 2025: 80 Total Number of Code event Jan 2025-Sep 2025: 08

RESULTS

A total of 14,501 admissions in 2024 and 11,120 admissions in 2025 were included in the analysis. In 2024, Code Blue events were observed to decrease from 14 in 2024 to 8 in 2025. The Code Blue rate decreased from 0.97 per 1000 admissions in 2024 to 0.72 per 1000 admissions in 2025.

However, the difference between the two periods was not statistically significant ($\chi^2 = 0.45$, $p = 0.50$). A mild reduction in average length of stay was also observed (3.28 days to 3.03 days), suggesting improved clinical stabilization and workflow efficiency. Overall, a downward trend in Code Blue events was observed in association with improved RRT utilization. Mortality data were reviewed descriptively; however, detailed statistical comparison was not performed due to incomplete standardized documentation.



Year	RRT	Code Blue	ALOS
2024	**35**	**14**	**3.28**
2025 [Jan-Sep]	**80**	**8**	**3.03**

Summary:

- Average ALOS (2024): 3.28 days • Average ALOS (2025 till Sep): 3.03 days
- % Reduction: ~7.6% decrease in ALOS from 2024 to 2025

DISCUSSION

This study suggests that increased utilization of Rapid Response Team services may be associated with a declining trend in Code Blue events. Most in-hospital cardiac arrests are preceded by warning signs of deterioration, and early recognition plays a key role in prevention [1,2]. In this study, structured interventions such as staff education, mock drills, and reinforcement of MEWS appeared to improve early recognition and escalation behavior. Human factors such as hesitation, fear of criticism, and hierarchical barriers were observed as important contributors to delayed escalation. Similar findings have been reported in previous studies on rapid response systems [3,4]. Although a decline in Code Blue events was observed, the difference was not statistically significant. This may be attributed to the relatively small number of events and the observational nature of the study. Therefore, findings should be interpreted as an association rather than causation. The study highlights that strengthening communication culture and early warning systems may be as important as clinical protocols in

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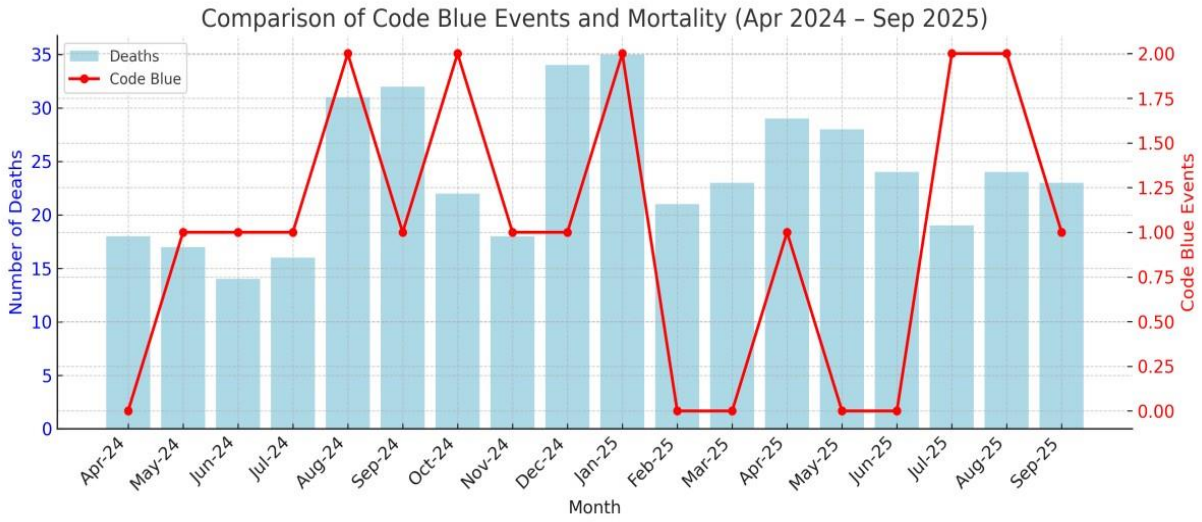
improving patient safety. The comparative trend between Code Blue events and in-hospital deaths demonstrates a broad parallel pattern - months with higher Code Blue activation generally coincide with increased mortality rates. In 2024, an upward trend in both Code Blue activations and deaths was seen between August and December 2024, indicating a possible period of higher patient acuity or delayed recognition of deterioration. Following the implementation of improvement measures (staff awareness, RRT training, and timely escalation protocols), a relative decline in Code Blue activations was observed during 2025, accompanied by stabilization or reduction in monthly deaths. This suggests a temporal association between increased RRT utilization and improved outcomes; however, causality cannot be established in this study.



Limitations

This study has certain limitations. It is a single-center retrospective analysis without risk adjustment, limiting causal inference and generalizability. The comparison periods were unequal (12 months vs 9 months), which may affect direct rate comparisons. Although a Chi-square test was performed for Code Blue events ($\chi^2 = 0.45$, $p = 0.50$), no multivariable analysis or adjustment for confounders was performed. Mortality analysis was descriptive only without formal statistical testing or patient-level stratification. In addition, process measures such as MEWS compliance, RRT response time, and escalation delay were not assessed, limiting evaluation of the mechanism behind observed improvements.

Sustenance Plan

To maintain long-term improvement, the following measures will continue:

• Monthly review of RRT and Code Blue data

• Regular feedback sessions with clinical units

• Inclusion of RRT protocols in staff induction programs

• Quarterly mock drills and reinforcement training

• Ongoing involvement of senior clinicians in promoting early escalation practices

CONCLUSION

Increased Rapid Response Team utilization was associated with a declining trend in Code Blue events and a mild reduction in length of stay. However, the differences were not statistically significant ($\chi^2 = 0.45$, $p = 0.50$), and findings should be interpreted as an association rather than causation. Further multicenter studies with larger sample sizes are recommended to validate these observations.

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