Evaluation of rapid response team implementation in medical emergencies: A gallant evidence based medicine initiative in developing countries for serious adverse events

Mohammed Fayyaz Rashid, Mohammed Imran¹, Yash Javeri², Monika Rajani³, Shadab Samad⁴, Omender Singh²

ABSTRACT

Background: Rapid response team (RRT) has been implemented in developed countries with the aim of early recognition and response to critical care triggers for the better patient outcome. However, the data concerning their efficacy is hardly available until date from Indian subcontinent.

Aims: To evaluate the impact of RRT implementation on patient outcome during medical emergencies.

Settings and Design: Retrospective observational study of RRT records of in-bed patients of super specialty academic teaching hospital.

Materials and Methods: RRT record forms during the first half of the year from January 2012 to June 2012 were included for all inpatients and out-patients irrespective of their age, gender and diseases profile after their inclusion in the system. Outcomes such as patient stayed in the room, patient transfer to intensive care unit (ICU), patient discharge and generation of code blue event, mortality and length of stay in hospital/ICU were measured.

Statistical Analysis: Descriptive analysis was performed with the help of statistical software STATA 9.0 and R 2.13.2 (StataCorp LP, Lakeway Drive College Station, Texas, USA).

Results: Analysis of 41 RRT calls showed decreased code blue calls by 2.44% and decrease in mortality by 4.88%. Average length of stay in ICU and hospital post RRT assistance for patients was 2.55 and 6.95 days respectively. Conversely percentage of patients requiring a higher level of care was more (75.61%) than those who stayed in their rooms/wards (24.39%).

Conclusion: Implementation of RRT in this hospital was associated with reduced code blue events and its attendant mortality outside the ICU settings. However, more number of patient requiring higher levels of care delineates the need for a larger evidence based medicine study.

Key Words: Code blue events, evidence based medicine, medical emergency team, rapid response team, rationale therapeutics, serious adverse events

INTRODUCTION

The rate of serious adverse events in hospitalized patients ranges from 2.9%-17% of cases.[1,2] In another study, fourth to sixth the most common cause of deaths have been ascribed to the drug related problems.[3] Many of such presentation may not be related to the patient’s original diagnosis, underlying medical conditions or drug related problems including the serious adverse events. However, outcome of such events may result in prolongation of
existing hospitalization, permanent disability and death. Incomplete assessment of such unexpected events may result in increased fatalities.

Incomplete assessments of patients, breakdowns in communication (i.e., between patients and nurses, between nurses and physicians), insufficiencies in therapies and lack of adequate follow-up of patients after an intervention not only contribute to failure to rescue, but also lead to suboptimal patient care. Several studies show that abnormal vital signs [Table 1] can help identify clinical deterioration in patients minutes to hours before a serious adverse event occurs.\(^{[4,5]}\) Most of the conditions eventually lead to organ failure and can culminate into cardiopulmonary arrests.

Cardiopulmonary arrests and its attendant mortality in patients coming to or admitted in hospitals are common and their delayed intervention is associated with lower survival rate and poor neurological outcome.\(^{[6]}\) It has been observed that almost half of the cases of cardiopulmonary arrests are preceded by deterioration in vital signs or other clinical indices 6-8 h prior to arrest.\(^{[7-10]}\) Therefore, early recognition of activating triggers and generating codes may provide a window of opportunity for averting early recognition of activating triggers and generating codes.\(^{[11]}\)

RRTs have gained interest all over the world as a means of providing medical care of the highest quality and process of getting improvement in patient outcome. Moreover, implementation of RRT program has been considered as a solution to inappropriate and/or inadequate treatment of patients.\(^{[13-18]}\) In an initiative, known as “100,000 Lives Campaign” promoted by the institute for health-care improvement, one out of six recommended strategies was the recommendation of instituting RRT to reduce the number of preventable in-patient deaths in the United States between the period of 2004-2006.\(^{[19]}\) However, this trend has not been percolated in the developing countries like India where still a framed process is not in vogue.

RRT is a group of health-care professionals involving an intensivist on call such as physician/respiratory therapist and a registered nurse. RRT team members must be available 24 h for a day and 7 days a week for evaluation of those patients who are not in the intensive care unit (ICU) but develop signs and symptoms of clinical deterioration\(^{[20]}\) so as to deliver critical care expertise in an attempt to avoid further clinical deterioration and cardiopulmonary arrests and codes.\(^{[21]}\) Hence RRT is activated when a patient begins to deteriorate and before the patient experiences a cardiac or pulmonary arrest.

Because there was no proper system of evaluation of emergencies in this part of the world, this pilot study was planned to evaluate the outcome of the recently introduced RRT activation in an Indian tertiary care corporate academic hospital set up.

### MATERIALS AND METHODS

The study was carried out after the approval both form scientific committee and Institutional Ethics Committee of the Max, Super Speciality Hospital, Saket, New Delhi, India. Since it was a retrospective study, requirement for

| Table 1: Abnormal vital sign triggers for activating rapid response team |
|---------------------------|---------------------------|
| **Vital signs** | **Triggers** |
| Airway/breathing | Threatened airway |
| | Respiratory rate < 8 or > 28 |
| | Acute changes in oxygen saturation < 90% despite oxygen therapy or prescribed treatment |
| | New requirement for > 50% oxygen to keep saturation above 90% |
| | Acute, new onset shortness of breath and difficulty speaking |
| Circulation | Heart rate < 50 or > 130 with new symptoms or any rate > 140 |
| | Systolic blood pressure < 90 or > 180 or diastolic > 100 with symptoms (neurologic change, chest pain, difficulty breathing) |
| | Acute blood pressure change of > 20% from baseline |
| | Color change (of patient extremity): Pale, dusky, grey or blue |
| Neurological | Any unexplained change in the level of consciousness |
| | New onset repeated or prolonged seizures |
| | Sudden loss of movement (or weakness) of face, arm or leg |
| | Unexplained agitation or delirium |
| Renal | Any decrease in urine output < 30 ml/h times 2 h without history of renal dysfunction |
| Miscellaneous | Staff concerned worried: The patient does not look/act right |
| | Gut instinct that patient is beginning a downward spiral even if none of the physiological triggers have yet occurred |
| | Unexpected, excessive or uncontrolled bleeding |
| | New onset of chest pain |
| | Uncontrolled pain despite intervention |
| Critical lab values | See Table 2 |
informed consent was waived. It involved evaluation of the effect of RRT activation on patient outcome in medical emergencies. We conducted a retrospective analysis of the RRT data of patients available for the period of January 2012 to June 2012 at a tertiary care corporate academic hospital in South Delhi.

The RRT in this tertiary care hospital consisted of mainly five members namely a critical care consultant on duty as team leader, junior consultant/ICU senior resident internal medicine and a nursing supervisor. It can be activated by assigned nurse or floor/duty doctor or by any other staff (first responder) by dialing a two digit number at the designated call center of the hospital. Once an activation call is made, the RRT team is expected to reach at the spot within 5 min to assess the patient and assign the intervention required to stabilize the condition of the patients.

| Date: | Time: |
|------|------|
| Arrival Time: | Event Ended: |

**Primary Reason For Call**
- Staff Concerned/worried
- Specify:
- Heart rate <50 or >130 with new symptoms or any rate >140/min
- SBP less <90mmHg or >180mmHg,
- DBP >100 with symptoms
- Acute blood pressure change of >20% from baseline
- Acute, new onset shortness of breath
- SpO2 less than 90%
- RR <8 or >28 per min
- Acute significant bleed

**Assessment:**
- HR:
- BP:
- RR:
- SpO2:
- GCS:
- Temp:

**Recommendations/Interventions:**
- Acute Mental status change
- Sudden loss of movement (or weakness) of face, arm or leg or Seizures
- New requirement for >50% oxygen to keep saturation above 90%
- New onset of chest pain
- Oliguria
- Sudden color change (of pt extremity)
- Critical Lab Values

**Circulation**
- IV Fluid Bolus
- EKG
- CPR
- Defibrillation
- Cardioversion
- No intervention

**Suggested treatment plan:**

**Medications**

**Other Interventions (specify)**

**Outcome:**
- Stayed in room
- Transferred to__________
- Other; please specify________

**Notified Treating Consultant:**
- Date:
- Time:

**Signature:**
- RRT Team Leader Name:
- Date & Time:

To Be filled by the RRT Team Leader within 24 hours of the event

*Figure 1: Rapid response team record form*
addition, the RRT would discuss management with the patient’s primary physician and determine the need for additional intensive monitoring. Because different hospitals have different facilities, RRT team differs accordingly for each block at our hospital as well. RRT record forms [Figure 1] of all in-patients and out-patients, irrespective of their age, gender and disease, were included. Forms, which were not filled properly or were unclear, excluded from the study.

**Outcome measures**

Primary outcome measures evaluated for the purpose of study included: Patient stayed in the room and was shifted to ICU, occurrence of code blue event, mortality, patient discharged and length of stay of patient in ICU or hospital.

As a part of the study protocol, RRT records were also assessed for determining the primary reasons for RRT activation (staff concerned/worried, altered heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure, respiratory rate (RR) and SpO2, acute blood pressure change, new onset shortness of breath, acute significant bleed, acute mental status change, sudden loss of movement, new requirement of O2 to keep saturation above 90%, new onset of chest pain, critical lab values [Table 2]), activation occurring per month, age profile of patients, gender profile of patients and activation for patients in different diseased condition.

**Statistical analysis**

The evaluation of the impact of RRT activation in medical emergencies on patient outcome from the respective RRT data was carried out by descriptive analysis. Descriptive analysis such as the number of subjects (n), mean, median, standard deviation, minimum and maximum for continuous data and frequencies and percentages for categorical data was used.

For patients who stayed in the room and for those who were transferred to a higher level of care i.e., transfer to ICU, percentage was calculated out of the total RRT activation. Similarly, percentage was calculated for other factors, which included occurrence of code blue event

| Test                                      | Low                        | High                        |
|-------------------------------------------|----------------------------|-----------------------------|
| Critical lab values - adults              |                            |                             |
| Serum total carbon dioxide                | <10 mEq/L                  | >45 mEq/L                   |
| Serum sodium                              | <120 mEq/L                 | >160 mEq/L                  |
| Serum potassium                           | <2.7 mEq/L                 | >6.5 mEq/L                  |
| Serum potassium (hemolyzed)               | <2.7 mEq/L                 | >8.0 mEq/L                  |
| Serum glucose                             | <40 mg/dL                  | >700 mg/dL                  |
| Serum calcium                             | <6 mg/dL                   | >13 mg/dL                   |
| Ionized calcium                           | <0.78 mmol/L               | >1.57 mmol/L                |
| Serum phosphate                           | <1.1 mg/dL                 | None                        |
| Serum salicylate                          | None                       |                             |
| Serum magnesium                           | None                       |                             |
| Troponin I                                | None                       |                             |
| Fibrinogen                                | <50 mg                     | None                        |
| Prothrombin time                          | None                       | INr > 5.0                   |
| Blood platelets (adult)                   | >30,000/mm³                | None                        |
| Blood platelets (neonates)                | >20,000/mm³                | None                        |
| Packed cell volume                        | >15 vol %                  | None                        |
| Blood hemoglobin                          | <5 g/dL                    | None                        |
| Blood WBC                                 | None                       | >150,000/mL                 |
| TDM drugs                                 | <therapeutic range         | >therapeutic range          |
| PO2                                        | <40 mm Hg                  | >70 mm Hg                   |
| PCO2                                       | <20 mm Hg                  | >7.6 units                  |
| pH                                         | <7.2 units                 | None                        |
| CK-MB                                      | None                       | None                        |
| Critical laboratory values - pediatric     |                            |                             |
| Serum potassium (new born)                | <2.7 mEq/L                 | >6.5 mEq/L                  |
| Serum glucose (new born)                  | <30 mg/dL                  | >300 mg/dL                  |
| Serum bilirubin total (new born)          | None                       | >18 mg/dL                   |
| Blood platelets (new born/ped)            | >20,000/mm³                | None                        |
| Packed cell volume (new born)             | <25 vol %                  | None                        |
| Blood hemoglobin (new born)               | <8 g/dL                    | None                        |
| PO2                                        | <40 mm Hg                  | >100 mm Hg                  |
| Others (adults and pediatrics)            |                            |                             |
| Positive blood culture                    | Positive blood or CSF gram stain |
| Positive CSF cultures                     | Positive CSF antigen detection |
| Presence of blast cells (previously undiagnosed leukemia) | Presence of tumor or blast cell in body fluid |

INr: International normalized ratio, WBC: White blood cell, TDM: Therapeutic drug monitoring, CK-MB: Creatine kinase-MB, CSF: Cerebral spinal fluid

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and mortality. Since all RRT activation occurred for in-patients, none of them was discharged immediately after the RRT assistance. For the length of stay of patients either in a hospital or in ICU, mean was calculated to get a rough estimate of stay of patients in hospital/ICU after RRT assistance.

Primary reasons for activation, disease profile and gender profile of patients were all calculated in terms of percentage. However, the age of patients requiring RRT assistance was calculated in terms of mean. Final analysis of the data was performed on STATA 9.0 and R 2.13.2 statistical software.

**RESULTS**

Since our primary objective was to evaluate the impact of RRT assistance on patient outcome, we didn’t intend to calculate the RRT dose (i.e., RRT generated per 1000 patients admitted or discharged) or total number of patients coming to or admitted in the hospital. Hence we concentrated only on those patients for whom RRT was activated in emergency situations and the primary reasons [Table 3].

For the period of January 2012 to June 2012, a total of 51 RRT calls were activated in west block of our hospital where mainly cancer patients admitted. However, out of the total, 10 records were excluded from the study as they met exclusion criteria.

For cases requiring RRT assistance majority of patients were transferred to a higher level of care (75.68%) and relatively low number of patients stayed in the room (19.51%). There was just a single conversion to code blue event (2.44%) while the number of deaths were 2 (4.88%) out of the total cases. Since all RRT activations were for in-patients, patients either stayed in the room or they were returned to their rooms from ICU after stabilization. Survival to discharge post RRT assistance for the patients was found to be 95.12%. Mean length of stay for patients in hospital and in ICU was found to be 6.95 and 2.55 days respectively. A change in readings of oxygen saturation pressure, HR and RR were the most frequent triggers that lead to RRT activation. Change in SpO2 constituted more than 50% of cases. Shortness of breath was observed in 29% of cases followed by 27% of cases with altered SBP. Nearly, 17% of the total cases reflected a change in the mental status of patients that lead to RRT trigger. 12% of the RRT activation occurred because staff had a strong feeling that something is grossly wrong with the patient, which can not be pointed out. RRT was activated mostly (41%) for the cancer patients. Cardiac and respiratory triggers constituted second largest fraction (22% each). Neurological triggers constituted 7.32% cases followed by cardiopulmonary diseases 4.88% and gastrointestinal tract triggers 2.44%. Mean age of patients requiring RRT assistance was 59.80 years. The incidence of emergencies requiring RRT assistance was higher in males (65.85%) than in females (34.15%).

**DISCUSSION**

This study was conducted retrospectively to evaluate the effect of RRT at a corporate tertiary care academic hospital on patient outcome. To our knowledge this is the first of its kind study conducted, documenting the need and efficacy of RRT in an Indian hospital. Earlier when there was no RRT in our hospital there had been the high rate of patients being admitted to ICU through wards. Many of these were urgent transfers after a code blue. Code blue team was doubling up as RRT in the present set up. For non-code situations, the process for ICU transfer was complex. The situation in the ward was perplexed regarding calling criteria for a non-cardiac arrest scenario and the response team. The response to such emergencies was not always urgent and protocol based. The hospital was in dire need of a protocol based system like RRT. Consequently RRT was implemented for the management of hospital emergencies. Implementation of RRT may be associated with reduction of code blue and a trend toward reduced mortality. However, despite a decrease in code blue events fair fraction of patients required a higher level of care i.e., there were more numbers of transfers to ICU. It was considerably higher than those who stayed in the room. Reason for this may be attributed to the fact that either there was a delay in RRT activation or it was due to more critical subset of the patients admitted in hospital wards.

Our study, though, underpowered (due to shorter duration and comparatively smaller sample size) to detect a decrease in the hospital mortality corresponding to the observed 17% and 33.8% decrease in cardiopulmonary arrests, but is a rise up initiative.[11,17] The evidence on RRT world-wide is overwhelming and this just serve as a primer for our health-care settings. A larger study may
provide data for the generalization to other hospitals or RRT programs.

As a part of the primary outcome measures we also calculated the average length of stay of the patients post RRT assistance both for ICU (2.55 days) and for the hospital (6.95 days). Due to lack of previous studies in the same hospital or anywhere else for this particular outcome measure, it was difficult to predict whether the values obtained for the length of stay in ICU/hospital were significant.

Among the primary reasons for activation, change in SpO2, HR and RR were the most frequent triggers. Out of all, change in SpO2 constituted 61% cases that lead to RRT activation. In 17% of all the cases analyzed, RRT was called because there was change in the mental status of the patients. It was an interesting finding since these patients were not admitted because of any neurological or behavioral problem. Such patients who are hospitalized on non-behavioral health units can be difficult to address by staff members. Thus, pressing the need for specialized staff like behavior emergency response team[22] to be instituted in future. In this study, it was found that maximum RRT activation were in oncology patients (41.46%) followed by cardiac and respiratory triggers (21.95% each). Most of the seriously ill older patients required long-term critical care support.

The minimum age of the patient requiring RRT assistance was 27 while maximum was 85. Present study indicated a direct relation between the advancing age and requirement for RRT activation since patients with age of 60 years or above required critical care activation most. Mean age was found to be 59.80 years. Interestingly cases of RRT activation were found to be higher in males than in females. A longer duration of such study is required to be performed to know whether this finding is consistent or not. In this hospital, an average of 6.9 RRT activations per month occurred during the period of 6 month with most RRT activation occurring in the first 3 month.

CONCLUSION

Implementation of RRT in our hospital was found to be associated with reduced code blue events and its attendant mortality. For the purpose of evaluating the impact of RRT up to a satisfactory level, randomized controlled trial with sufficiently longer duration should be considered to rigorously evaluate the need and efficacy of RRT.

Training of RRT team members should be considered as one of the most important assets to successful implementation and working of RRT. Calling criteria should be followed strictly and there should be a change in the documentation of RRT to assess its efficacy accurately. For this real time documentation can be looked for integration to hospital information system.

RRT augmentation is particularly effective in long-term ill patients who often require urgent critical interventions. We need to develop objective and subjective criteria to trigger RRT. Implementation and resource allocation of an effective RRT program is paramount to improve critical care in non-designated areas. These programs will set new milestones in clinical quality and safety of ward patients. Critical care is a level of care and expertise that seriously ill patients require.

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