The effects of introduction of new observation charts and calling criteria on call characteristics and outcome of hospitalised patients

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ABSTRACT

Objective: To determine the impact on call characteristics and patient outcomes since the implementation of a two-tiered rapid-response system along with new observation charts and calling criteria.

Design and setting: A retrospective before-and-after study in an Australian tertiary referral hospital.

Participants: Consecutive adult patients (⩾ 18 years), who had a rapid-response call between June and October 2009 ("before") and between June and October 2010 ("after").

Main outcome measures: Incidence of "serious adverse events" (cardiac arrests, unexpected deaths, and unplanned intensive care unit/high-dependency unit [HDU] admissions); subsequent illness severity and ICU/HDU and hospital mortality and length of stay; episodes of repeat calls for the same patient, time since admission and treatment limitation/not-for-resuscitation order profiles.

Results: Statistically significant increase in number of rapid-response calls from 14.3 to 21.2 per 1000 hospital admissions before and after, respectively ($P < 0.001$); this was associated with a 16% decrease in composite serious adverse events (not significant). There were no significant differences in the number of unplanned ICU/HDU admissions, admission severity scores and subsequent ICU/HDU and hospital mortality and length of stay. There was a significant increase in number of calls for patients who were admitted to hospital within 24 hours (2.5 v 4.7 per 1000 hospital admissions before and after, respectively; $P < 0.05$) and for patients who were transferred from acute care areas within 24 hours (3.7 v 6.2 per 1000 hospital admissions before and after, respectively; $P < 0.05$). There was a significant increase in number of repeat calls for the same patient (1.6 v 4.2 per 1000 hospital admissions before and after, respectively; $P < 0.001$); this was associated with higher mortality compared with single review in the after period (35.8% v 18.5%, respectively; $P = 0.005$).

Conclusions: Implementation of a two-tiered rapid-response system and new observation charts and calling criteria increased the number of rapid-response calls with a non-significant trend towards a decreased incidence of serious adverse events. Further improvements in care of hospitalised patients may be possible by preventing repeat calls or calls within 24 hours of hospital admission and discharge from acute care areas.

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Rapid-response systems aim to improve the safety of hospital patients whose conditions deteriorate unexpectedly. Studies have shown that hospital rapid-response systems can reduce the incidence of adverse patient outcomes, including cardiac arrests.[1-3]

As part of the Between the Flags program,[4-6] New South Wales Health has implemented a two-tiered system of escalation and review of patients whose conditions are deteriorating and new calling criteria for early recognition of deteriorating conditions, which are incorporated in the new Standard Adult General Observation (SAGO) Chart. SAGO charts were introduced across NSW hospitals in January 2010. Their underlying assumption is that the new program would identify patients in deteriorating conditions earlier and thus allowing for earlier interventions, which hopefully would lead to better patient outcomes.

This study aimed to analyse the impact of these changes on rapid-response call characteristics and patient outcomes, including outcomes of patients admitted to the intensive care unit or high-dependency unit (HDU) after rapid-response calls.

Methods

Study design

A retrospective before-and-after analysis was conducted at John Hunter Hospital (JHH), Newcastle, an Australian tertiary hospital, admitting around 70 000 patients per year. JHH has 17 ICU beds and four HDU beds, admitting 1200 and 500 patients each year, respectively.

Rapid-response system before January 2010

In 2003, a medical emergency team (MET) was introduced at JHH as part of a large multicentre cluster randomised trial (Medical Early Response, Intervention and Therapy [MERIT] study)[2] and the MET system continued until 2010. The calling criteria were displayed prominently in each ward (Box 1). All clinical and non-clinical staff in the hospital received ongoing orientation to these criteria.

Implementation of the new rapid-response system

SAGO charts were introduced in January 2010 along with a two-tiered system of escalation. The calling criteria were

divided into early and late warning signs (Table 1). Presence of any one of the early warning signs triggers the first tier of clinical review by the ward team, which must be attended to within 30 minutes. Delayed clinical review, progression to or occurrence of a late warning sign at any time triggers the second-tier escalation, which is a rapid-response call.

The colour-coded SAGO charts incorporate a track-and-trigger system, as recommended by the Australian Commission on Safety and Quality in Health Care. The introduction of these charts was accompanied by hospital-wide orientation and an education package (Detecting Deterioration, Evaluation, Treatment, Escalation and Communicating in Teams [DETECT]), comprising an online and face-to-face interactive training course.

DETECT training is mandatory for all clinical staff. The DETECT training course includes presentations and case scenario-based skills training to reinforce learning from the online DETECT course in relation to management of a patient in a deteriorating condition.

During both study periods, the rapid-response call could be activated by any hospital staff member. The rapid-response team structure remained unchanged during both the study periods and comprised an ICU senior resident medical officer, a designated ICU nurse and medical registrar. The team was supervised by an ICU consultant or ICU senior registrar. The ICU nurse recorded rapid-response call data into an Access 2003 (Microsoft Corporation, Redmond, Wash, USA) database.

Box 1. Medical emergency team calling criteria

- All respiratory and cardiac arrests
- Threatened airway
- Respiratory rate < 5 or > 36 breaths/min
- Pulse rate < 40 or > 140 beats/min
- Systolic blood pressure < 90 mmHg
- Sudden fall in level of consciousness (fall in Glasgow Coma Scale score of > 2 points)
- Repeated or prolonged seizures
- Staff member is worried about the patient

Inclusion and exclusion criteria

Consecutive adult patients (≥ 18 years) who had a rapid-response call while admitted to JHH were included.

Two study periods were chosen, a "before" period (1 June – 30 October 2009) and an "after" period (1 June – 30 October 2010); with an implementation period (January–May 2010) in between. Similar months were chosen for both study periods to minimise effects of seasonal variation.

Table 1. New calling criteria (since January 2010)

Clinical review criteria (early warning signs)	Rapid-response criteria (late warning signs)
	All respiratory and cardiac arrests
	Airway obstruction or stridor
	Seizures
	Arterial blood gas: PaO_2 < 60 mmHg (8 kPa), $PaCO_2$ > 60 mmHg (8 kPa), pH < 7.2 or base excess < – 5 mmol/L
	Venous blood gas $PvCO_2$ > 65 mmHg (8.7kPa), or pH < 7.2
Respiratory rate 5–10 or 25–30 breaths/min	Respiratory rate < 5 or > 30 breaths/min
SpO_2 90%–95% and/or increase in oxygen requirement	SpO_2 < 90% and/or increase in oxygen requirement
Poor peripheral circulation	
Pulse rate 40–50 or 120–140 beats/min	Pulse rate < 40 or > 140/min
SBP 90–100 mmHg or 180–200 mmHg	SBP < 90 mmHg or > 200 mmHg
Decrease in LOC from alert (A) to rousable only by voice (V) in the AVPU scale, or new onset of confusion	Unresponsive to verbal commands or sudden fall in LOC of ≥ 2 points on Glasgow Coma Scale score
BGL 1–4 mmol/L	BGL < 1 mmol/L
Body temperature < 35.5°C or > 38.5°C	Serious concern by any staff member
Excess or increasing blood loss	
Anuria, failure to void in 24 hours or urine output < 200 mL over 8 hours	
Greater than expected drain fluid loss or polyuria (> 200 mL/hour for 2 hours in the absence of diuretics)	
New, increasing or uncontrolled pain (including chest pain)	

AVPU = Alert, Voice, Pain, Unresponsive. BGL = blood glucose level. LOC = level of consciousness. SBP = systolic blood pressure.

Table 2. Rapid-response call characteristics

	"Before" period ($n = 375$)	"After" period ($n = 582$)	P
Rapid-response calls, per 1000 hospital admissions	14.3	21.2	< 0.001
Patient-related			
Mean age in years (SD)	68.2 (18.2)	70.5 (17.6)	0.06
Medical patients, %	63.7%	61.3%	0.48
< 24 hours since transfer from acute care areas,* per 1000 hospital admissions	3.7	6.2	< 0.05
< 24 hours since admission to hospital, per 1000 hospital admissions	2.5	4.7	< 0.05
Treatment limitations/not-for-resuscitation order before call activation, no. (% of total calls)	39 (10.4%)	73 (12.5%)	0.52
Location			0.35
Ward	84%	90.6%	
Procedure area	6.7%	4.7%	
Coronary care unit	9.3%	4.7%	
Reason for activation			
Cardiovascular	33%	38.7%	0.13
Respiratory	21%	20.6%	0.89
Neurological	27.6%	24%	0.26
Multiple reasons	11.4%	9%	0.29

* Emergency department and operating theatre recovery, intensive care unit and high-dependency unit.

The coronary care unit (CCU) and procedure areas (eg, radiology, endoscopy) not supervised by anaesthetists were considered general ward for the purpose of rapid-response call. The ICU, HDU, operating theatres, recovery areas and emergency department were excluded because these areas did not use SAGO charts and the rapid-response team does not routinely respond to patients in these areas.

Data collection and outcome variables

Data were extracted from the rapid-response call database, digital medical records and an ICU-specific database.

Rapid-response call characteristics recorded were patient age, medical or surgical admission, ward location, reason for call, time since hospital admission, time of transfer from acute care areas (emergency department, operating theatre recovery, ICU and HDU) and documentation of treatment limitation or not-for-resuscitation (NFR) order before the rapid-response call.

"Serious adverse events" included cardiac arrest, unexpected death, and unplanned ICU/HDU admissions after the rapid-response call. Unexpected deaths were defined as all deaths without a pre-existing treatment limitation or NFR order.

A composite of the incidence of serious adverse events was calculated. The incidence was defined as the total number of events divided by the total number of adult patients admitted to the hospital, excluding day-only admissions. Multiple events during one rapid-response call were counted as one in the calculation of the composite.

Events occurring in the setting of treatment limitation/NFR order documented before, or recommended at the time of, the rapid-response call were excluded from the outcome measures, because admission to ICU/HDU and mortality were likely to be influenced by these orders.

Illness severity on admission to ICU was established using admission Acute Physiology and Chronic Health Evaluation (APACHE) II score, APACHE III score and Simplified Acute Physiology Score (SAPS II). ICU and hospital mortality and length of stay were recorded, as were overall hospital mortality of all rapid-response-call patients, repeat calls for the same patient, and treatment limitation/NFR orders recommended at the time of the call.

Ethics approval

Ethics approval was sought but not required, as per the Hunter New England Area Health Service Human Research Ethics Committee (dated 10 March 2011).

Statistical analysis

Statistix, version 9 (Analytical Software, Tallahassee, Fla, USA) was used for primary data analysis and descriptive statistics. Continuous variables were compared using the unpaired Student t test. Nominal data with incidence > 1% was compared using the Pearson χ^2 test. Data with

Table 3. Composite and individual serious adverse events

Outcome measures	"Before" period, per 1000 hospital admissions	"After" period, per 1000 hospital admissions	*P*
Composite serious adverse events	3.8	3.2	0.28
Cardiac arrest	1.3	0.95	0.25
Unexpected deaths	0.8	0.6	0.41
Unplanned intensive care unit or high-dependency unit admission	2.7	2.5	0.61

incidence < 1% was compared using the Fisher exact test using SAS, version 8.03 (SAS Institute Inc, Cary, NC, USA). A two-tailed *P* less than 0.05 was considered statistically significant.

Results

Total numbers of adult hospital admissions were similar during the before and after study periods (26 217 and 27 448, respectively). However, in comparison, the total number of rapid-response calls increased significantly from 14.3 to 21.2 per 1000 hospital admissions in the before and after periods, respectively ($P < 0.001$).

Characteristics associated with rapid-response calls are presented in Table 2. There was a significant increase in number of calls for patients who had been admitted to hospital within 24 hours (2.5 v 4.7 per 1000 hospital admissions) and similarly for patients who were transferred from acute care areas within 24 hours (3.7 v 6.2 per 1000 hospital admissions).

The composite serious adverse event rates were 3.8 and 3.2 per 1000 hospital admissions in the before and after periods, respectively, although this 16% decrease was not statistically significant. Similarly, there was a non-significant 20% decrease in unexpected deaths and a 26% decrease in cardiac arrests (Table 3).

Seventy-one patients were admitted to ICU/HDU following a rapid-response call in the after period, compared with 68 patients in the before period, with no significant differences in the admission severity scores and subsequent ICU and hospital outcomes of these patients (Table 4).

Eight per cent (29/375 calls) of rapid-response calls had treatment limitation and NFR orders recommended at the time of call in the before period compared with 9% (53/582) in the after period ($P = 0.46$). A total of 68 rapid-response calls in the before period and 126 in the after period had

Table 4. Illness severity and outcomes for patients admitted to the intensive care unit or high-dependency unit

	"Before" period ($n = 71$)	"After" period ($n = 68$)	*P*
Mean APACHE II score (SD)	20.1 (7.9)	22.0 (9.6)	0.21
Mean APACHE III score (SD)	70.3 (30.1)	77.0 (32.8)	0.21
Mean SAPS II (SD)	43.0 (15.5)	47.3 (17.3)	0.13
ICU mortality, no. (%)	16 (22.5%)	12 (17.6%)	0.47
Mean ICU LOS (SD)	4.9 (6.8)	4.7 (8.9)	0.89
Hospital mortality, no. (%)	21 (29.6%)	21 (30.9%)	0.87
Mean hospital LOS (SD)	17.1 (24.4)	19.9 (21.2)	0.46

APACHE = Acute Physiological and Chronic Health Evaluation. LOS = length of stay. SAPS II = Simplified Acute Physiology Score.

Table 5. Hospital mortality of rapid-response call patients

	Overall	Single review	Repeat review	*P**
"Before" period ($n = 291$)	87/291 (29.9%)	76/255 (29.8%)	11/36 (30.6%)	0.95
"After" period ($n = 473$)	104/473 (22.0%)	70/378 (18.5%)	34/95 (35.8%)	0.005

n = actual number of patients. * For single versus repeat review.

treatment limitation or NFR orders recommended before the call or at the time of call (18% v 21.6%; $P = 0.28$).

A significant increase in number of repeat calls for the same patient was seen (1.6 v 4.2/1000 hospital admissions; $P < 0.001$).

In the before period, 255 patients received one rapid-response call and 36 received two or more calls; their respective mortality was 29.8% and 30.6% ($P = 0.95$). In the after period, there was a significant increase in mortality of patients with two or more calls (35.8% v 18.5%, respectively; $P = 0.005$; Table 5).

Discussion

In our study, there was a 50% increase in the number of rapid-response calls after the introduction of a two-tiered rapid-response system and new observation charts and calling criteria (from 14 to 21 calls per 1000 hospital admissions). It has been suggested that mature rapid-response systems should expect at least 25 calls per 1000 hospital admissions.[7,8]

The cardiac arrest rate in our "before" period of 1.3 per 1000 hospital admissions was similar to the intervention arm of previous studies evaluating the impact of MET system, including Buist and colleagues (2.05/1000 hospital admissions),[9] Bellomo and colleagues (1.05/1000 hospital admissions),[1] and the MERIT study (1.31/1000 hospital admissions).[2] In our study, the cardiac arrest rate decreased to 0.95 per 1000 hospital admissions after the implementation of the new charts and calling criteria. Although this observed decrease did not reach statistical significance, the trend may be important clinically in view of high mortality of inhospital cardiac arrests.[10] As suggested in previous studies, an increase in call rate was associated with progressive reduction in cardiac arrest rates.[3,11,12]

Of note, there was an increase in the number of treatment limitation/NFR orders before or recommended at the time of call among the rapid-response patients (126 calls in the "after" period compared with 68 in the before period), which could have contributed to observed trends. However, we did not collect information regarding hospital-wide treatment limitation/NFR rate and the proportion of these calls with total calls as denominator was similar in the two study periods.

It is interesting to speculate about contributing factors to this rise in treatment limitation/NFR orders. The new system may have increased awareness among treating teams of the need to address this issue early, before or at the time of deterioration. Previous studies support the idea that hospital rapid-response systems can help address the planning of end-of-life care.[2,13]

There were no significant differences in the number of unplanned ICU/HDU admissions, admission severity scores and subsequent ICU and hospital outcomes of these patients. These findings may suggest that the JHH ICU/HDU admission criteria were not influenced by earlier detection of seriously ill patients. However, inability to admit patients to ICU/HDU may have also been a factor, with the average JHH ICU bed occupancy rate being very high in the after period (> 90% during the before period and > 95% during the after period).

There was a significant increase in the number of calls for patients who were admitted to hospital for less than 24 hours and similarly for patients who had been transferred from acute care areas within 24 hours. Although this may be expected, as these patients are more likely to be in acute phase of their illness, it could also reflect a failure of management plan for these patients.

There was a significant increase in episodes of repeat rapid-response calls for the same patient. The reasons for this are unclear, and could include a failure of the rapid-response system to appropriately address the issues, a progression of disease process despite appropriate interventions, or the lack of ICU/HDU beds.

In the after period, there was a statistically significant increase in mortality of patients requiring repeat rapid-response calls compared with those needing one review (35.8% v 18.5%; $P = 0.005$). These results are similar to a study by Calzavacca and colleagues, which showed a statistically significant increase in mortality in the multiple rapid-response review group compared with the single review group (42.8% v 31.8%).[14]

Our study has important limitations. The small number of adverse events may explain our inability to reach statistical significance. This is a retrospective study and other unknown factors in the process of hospital care could have influenced patient outcomes between the study periods.

Conclusions

Our study shows that the implementation of the two-tiered rapid-response system along with new observation charts and calling criteria increased the number of rapid-response calls with a non-significant trend towards a decreased incidence of serious adverse events. Further studies should include the evaluation of outcomes of patients who were not admitted to ICU/HDU, received treatment limitation/NFR orders recommended at the time of call, had repeat rapid-response calls, had calls within 24 hours of hospital admission or within 24 hours of transfer from acute care areas and overall hospital outcomes as well. The effect of resource limitations, such as ICU/HDU bed unavailability, and resource implications for increased rapid-response calls need to be established.

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Competing interests

None declared.

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