Objective patient-related outcomes of rapid-response systems — a pilot study to demonstrate feasibility in two hospitals

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ABSTRACT

Objective: To establish and test the feasibility of measurement of a comprehensive set of mutually exclusive outcomes in the 7 days after referral of patients to a rapid-response team (RRT), to facilitate audit and aid analysis of failure-to-rescue events.

Design, setting and participants: Observational cohort study of RRTs in a district general hospital and a university hospital in the United Kingdom.

Participants: Patients seen by two RRTs after local track-and-trigger systems were triggered.

Main outcome measures: An agreed set of patient-centred outcomes tested at Days 1, 3 and 7 after RRT call-out. Positive outcomes were defined as transfer to a critical care unit (CCU) within 4 hours of the trigger event, improved track-and-trigger scores, death without attempted cardiopulmonary resuscitation, decision about treatment limitation, new pathology, chronic pathology or hospital discharge. Negative outcomes were delayed transfer to a CCU, lack of improvement in track-and-trigger scores, death after cardiopulmonary arrest, or loss to follow-up.

Results: In the initial pilot study, 75% of patients achieved positive outcomes on Day 1 after RRT call-out, and there were no significant changes to outcomes on Days 3 and 7. A higher rate of negative outcomes was seen in patients who triggered an RRT call-out at night. There was significant variation in outcomes between clinical specialties. In neither of the centres were events reported that could not be classified using our matrix of outcomes.

Conclusion: It is possible to classify RRT episodes using readily available data, and areas with suboptimal performance can be targeted. Our matrix may additionally facilitate comparison of rapid-response systems.

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Rapid-response teams (RRTs) deal with many different scenarios,[1] ranging from acute illnesses in need of critical care-type interventions to declining chronic health problems requiring a predominantly palliative approach.[2] RRT interventions can include education of staff in recognition of critical illness, timely administration of first-line treatments (eg, oxygen, fluids and antibiotics), intubation and mechanical ventilation, placement of central venous catheters for inotropic support before transfer to a critical care unit (CCU), and instigation of end-of-life care.

While there is little doubt that delayed treatment of critical illness contributes to mortality,[3] it is less clear under which circumstances early detection and treatment improve outcomes.[4] Randomised controlled trials of rapid-response systems (RRSs) in single[5] or multicentre[6] settings have yielded mixed results.[7,8] As a consequence, RRSs have been criticised for a lack of evidence about their effect on patient outcomes.[9]

Much of the literature has concentrated on surrogate outcomes of "serious adverse events" (often in patients not seen by RRTs)[10] or of cardiopulmonary arrests.[11,12] However, the number of cardiopulmonary arrests that occur can be altered by reductions in mortality as well as by increases in "do not attempt resuscitation" (DNAR) orders (with resultant unchanged mortality). Therefore, it is important to define positive outcomes after RRT interventions in a more systematic manner, with due regard to the various situations that RRTs may encounter, in a way that can be applied independent of setting and team composition.

After reviewing published standards for reporting,[13] we set out to develop a simplified audit tool (multidisciplinary audit and evaluation of outcomes of rapid response [MAELOR] tool) to categorise and quantify outcomes of RRT intervention that can be collected during routine clinical practice. The tool is intended to serve as a starting point for discussions on the measurability of the work of RRSs.

We hypothesised that most outcomes could be classified into a finite number of categories, with the aim of measuring performance. These could then be used to provide a starting point for reflective practice and service improvement work.

Methods

Hospital setting

The evaluation took place at Wrexham Maelor Hospital (WMH), a district general hospital in Wrexham, United Kingdom, which serves a population of around 300 000. There are 457 medical and surgical beds over 21 wards, and 13 beds in the CCU.

Table 1. Possible outcomes of intervention by RRTs, and the 24-hour recorded outcomes

	Positive outcomes			Negative outcomes			Totals	
Outcome	Outcome	WMH (*n*) (%)	UCH (*n*) (%)	Outcome	WMH (*n*) (%)	UCH (*n*) (%)	WMH (*n*) (%)	UCH (*n*) (%)
Admission to intensive care unit, high dependency area or theatre	1. Timely admission (< 4 hours after MEWS trigger recorded; ie, STDT < 4 hours)	8 (5%)	53 (22%)	2. Delayed admission (> 4 hours after MEWS trigger recorded; ie, STDT > 4 hours)	13 (9%)	1 (<1%)	21 (14%)	54 (22%)
Alive on ward	3. No longer triggering	67 (45%)	143 (59%)	4. Still triggering	23 (15%)	9 (4%)	90 (62%)	152 (63%)
Died	5. With terminal-care pathway and had DNAR order	2 (1%)	2 (1%)	6. Cardiopulmonary arrest	1 (<1%)	6 (2%)	3 (2%)	8 (3%)
Other	7. Alive, with documented treatment limitations and DNAR order	27 (18%)	22 (9%)	9. Outcome not known; lost to follow-up	0 (0%)	0 (0%)	32 (22%)	27 (11%)
	8. Others	5 (3%)	0 (0%)					
	a) Trigger from new pathology unrelated to previous RRT call	0 (0%)	0 (0%)					
	b) Chronic condition leading to continuous trigger*	0 (0%)	3 (1%)					
	c) Discharged from hospital	0 (0%)	2 (1%)					
Total		*109 (75%)*	*225 (93%)*		*37 (25%)*	*16 (7%)*	*146 (100%)*	*241 (100%)*

RRT = rapid-response team. WMH = Wrexham Maelor Hospital. UCH = University College Hospital. MEWS = modified early warning score. STDT = score-to-door time.[12] DNAR = do not attempt resuscitation. * For example, raised respiratory rate in advanced pulmonary fibrosis.

At the time of the evaluation, a variation of the modified early warning score (MEWS)[14] was in use across the medical and surgical wards of the hospital. If a patient had a total MEWS of three or more, the protocol suggested that a referral was made to the RRT.

The RRT consists of two groups of specialist nurses: critical care outreach nurses working closely with the CCU from 07:30 to 21:00, Monday to Friday, and a group of advanced nurse practitioners who form part of the hospital night team.

University College Hospital (UCH) is a major inner city university hospital in London, UK with 688 beds and 35 CCU beds. The RRT operates 24 hours a day and is led by a nurse consultant. UCH has a range of specialist and tertiary services as well as an emergency department managing 112 000 attendances a year. The nurse-led RRT is made up of nine critical care outreach nurses, and the team works 24 hours a day and forms part of the hospital night team. At the time of the evaluation, a single parameter track-and-trigger system was used to alert the RRT to deteriorating patients.

Clinical outcomes

The service evaluation was registered with and approved by the local audit office at WMH. A focus group of three investigators in collaboration with the local RRT was set up to determine possible clinical outcomes following a call-out of the RRT. A comprehensive matrix of mutually exclusive outcome categories was developed and tested over a period of 10 weeks (Table 1).

Outcomes were defined from the point of view of the patient, rather than by the nature or extent of the intervention. For example, a patient who improves within 24 hours of an RRT review (outcome 3) might have improved because of RRT interventions or spontaneously. A patient whose deterioration is recognised early and is transferred to a CCU or a similar area within 4 hours (outcome 1) demonstrates effective working of the RRS. If the transfer is delayed despite the identified need for critical care (outcome 2), this is classified as suboptimal performance of the RRS. From a patient's perspective, it is irrelevant whether delays are due to delayed recognition, slow referral or lack of CCU resources. A patient who has a cardiopulmonary arrest within 24 hours after RRT review (outcome 6) might have deteriorated despite appropriate treatment by the RRT, or because of inappropriate treatment by the RRT (i.e. overloading with fluids or delayed referral to a CCU).

Data were collected using a standardised proforma. A prospective pilot was conducted over a 10-week period

between January and March 2010. A sample of patients was reviewed by two of the investigators (A M and H M O) to confirm the comprehensive nature of the list of outcomes and reproducibility. Additional testing was undertaken by members of a second RRT at UCH.

Population

All patients seen by the RRT over the investigation period were included to determine the feasibility of collecting outcomes, the best time for data collection, and the frequency distribution of outcomes. Progress was charted on Days 1, 3 and 7 after the initial call-out. To generate data for follow-up, patient notes and bedside observations were reviewed. Patients were omitted from further follow-up once they were admitted to the CCU, had a DNAR order as a consequence of the RRT visit, or after they died or were discharged from hospital.

We excluded two groups of patients where the impact of the RRT was thought to be limited by definition: patients with cardiac arrest calls as a trigger and patients with DNAR orders. Patients with DNAR orders were seen by the RRT if requested and were managed jointly with the palliative care and pain teams, but were not included in our analysis.

Data analysis

Data were collated onto a database using Excel 2007 (Microsoft) and analysed using SPSS version 17.0 (SPSS Inc). Rates of outcomes were compared using the Pearson χ^2 test. Normally distributed data were analysed using mean and standard deviation (SD).

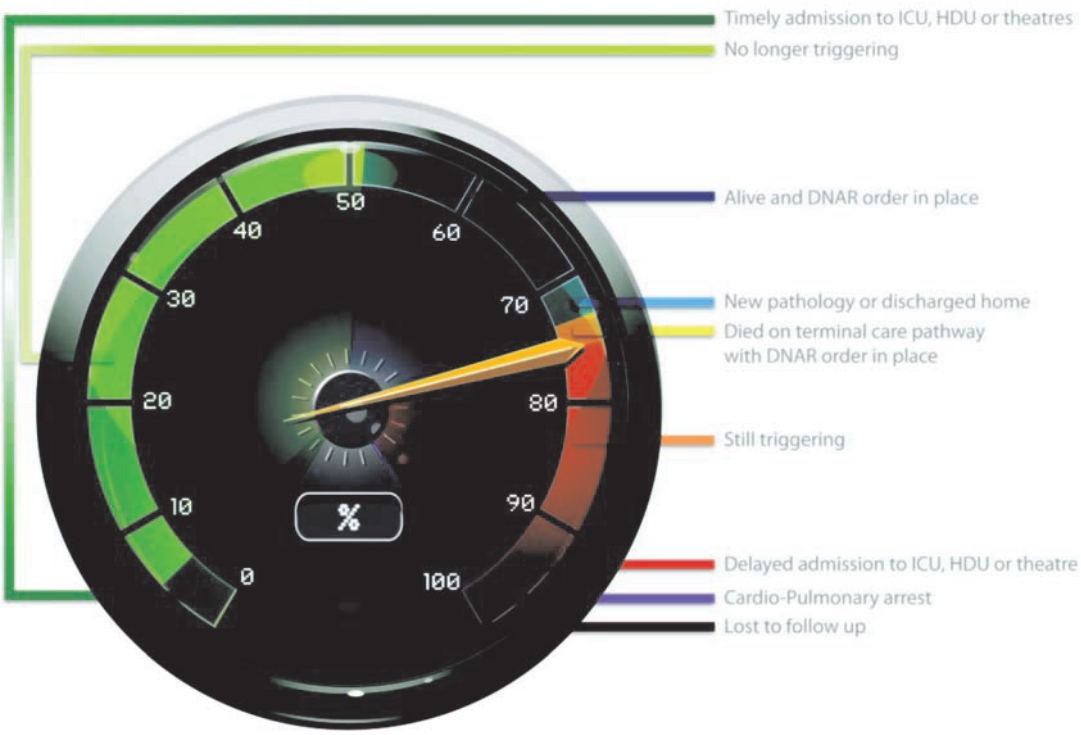
Results

Case mix

We collected data on 170 consecutive patients who were seen as first contacts by the RRT at WMH between 6 January and 12 March 2010. Twenty-four patients were excluded because they presented as cardiac arrest calls or already had a DNAR order in place. Data from the remaining 146 patients were analysed.

The mean age of patients was 67 years (SD, 20 years), and 78 patients (53%) were male. Physiological data at time of trigger and at time of first review by the RRT are summarised in Table 2. The first trigger score at the time of RRT call-out was a median MEWS of 4 (interquartile range [IQR], 3–5). In 27 patients, the main call-out criterion was that staff were worried.

Figure 1. Graphic summary of outcomes 24 hours after initial rapid-response team trigger, as a percentage of positive outcomes from all patients followed up, using the MAELOR tool



ICU = intensive care unit. HDU = high-dependency unit. DNAR = do not attempt resuscitation.
Green, blue, yellow = positive outcomes. Orange, red, purple, black = negative outcomes. As rapid-response systems mature (improve), the indicator (dividing positive from negative outcomes) will move further around clockwise. MAELOR = multidisciplinary audit and evaluation of outcomes of rapid response.

Most RRT calls came from the general surgical (43), medical (90) and trauma and orthopaedics wards (eight). Other specialties where RRT calls originated were obstetrics and gynaecology; ear, nose and throat; and rehabilitation. The two wards with most calls were the acute medical unit (41) and the surgical admissions unit (16).

Follow-up data

Outcomes were reviewed on Day 1 after the first RRT visit for 146 patients, on Day 3 for 86 patients, and on Day 7 for 67 patients.

On the first day after the first RRT contact, 109 patients (75%) had achieved positive outcomes of their RRT (Figure 1). Thirty-one patients were transferred to the CCU, although transfer for 23 of these was delayed (more than 4 hours). Of patients remaining on the ward, 23 patients were still triggering the local MEWS after 24 hours. One patient had had a cardiopulmonary arrest. Of patients with an initial MEWS of five or more, 35 of 51 (69%) had positive outcomes.

After 3 days, of 86 patients still eligible for follow-up, 77 (90%) had positive outcomes, but nine had a persistent early warning score above the trigger threshold.

After 7 days, of 67 patients still eligible for follow-up, 59 (88%) had positive outcomes. There was one patient who had a late cardiopulmonary arrest (Figure 2).

Variation in positive outcomes

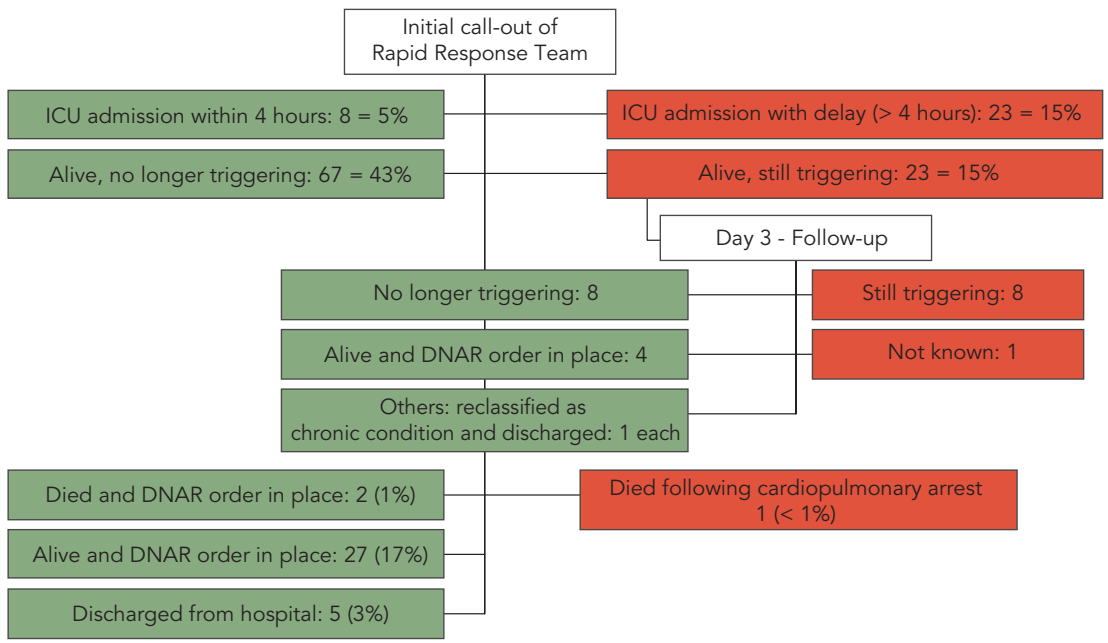
The percentage of positive outcomes varied between specialty areas, from 63%–77%. In wards with more than 10 call-outs, positive outcomes ranged from 64%–80%. The percentage of early RRT call-outs (< 4 hours from first score above the recommended trigger threshold to call-out) also varied between areas (65% in medical wards and 77% in surgical wards). In addition, the proportion of positive outcomes varied with the time of the first-trigger score: outcomes from call-outs resulting from a first trigger during the day (09:00 to 21:00) were significantly better than outcomes from call-outs occurring at night ($P < 0.05$).

We found there was a higher percentage of negative outcomes in patients for whom the time to call-out was more than 4 hours ($P < 0.032$) (Table 3). However, there was no relationship between the likelihood of a positive outcome and the severity of illness (as measured by the MEWS), either at time of first possible trigger or at time of RRT review, or with the rate of decline between these two times. That is, a higher severity of illness or faster decline in condition did not lead to a greater urgency to achieve positive outcomes.

Examples of clinical applications

Results from an audit of the outcome matrix in the original setting (WMH) and in a second hospital (UCH) are summa-

Figure 2. Follow-up data at Days 1 and 3 after initial visit of rapid-response team (RRT)



Green = positive outcomes, on left. Red = negative outcomes, on right. Patients who still triggered the RRT after 24 hours were followed up further.
ICU = intensive care unit. DNAR = do not attempt resuscitation.

Table 2. Physiological parameters at first trigger and at actual call-out of the rapid-response team

	At first trigger		At RRT call-out		
Parameter	Mean	SD	Mean	SD	*P**
Systolic blood pressure (mmHg)	124	35	130	37	< 0.75
Pulse rate (beats/minute)	102	28	109	22	< 0.49
Respiratory rate (breaths/minute)	23	7	23	5	< 0.24
Temperature (ºC)	36.6	1.2	36.7	1.1	< 0.30

RRT = rapid-response team. SD = standard deviation. * Calculated using the student *t*-test.

Table 3. Relation between time from first call-out trigger and outcomes

Time from first trigger to call-out (hours)	Positive outcomes (total call-outs) *(%)*
< 1	58 (76) *(76%)*
1–2	13 (14) *(93%)*
2–4	7 (10) *(70%)*
4–6	6 (11) *(55%)*
6–12	7 (12) *(58%)*

rised in Table 1. In WMH, the rate of patients continuing to trigger an RRT call-out after 24 hours decreased after improvements in handovers between the day and night teams and an educational intervention in the clinical areas with the worst outcomes. A more recent joint audit by the RRT and the out-of-hours team showed positive outcomes in 85% of patients with a high trigger score of 5 or more in a sample of 158 patients from the same clinical areas as this audit. In UCH, better results were achieved overall, including a much higher rate of timely transfer to the CCU.

Discussion

Currently, there is no generally accepted system to assess what represents a successful episode of care by an RSS. Our concept of positive and negative outcomes introduces a simple split of rapid-response episodes into two groups, highlighting areas where performance of systems might need detailed review and can possibly be improved. This enables benchmarking of systems. Analysis of the different outcomes, as well as scrutiny of other factors, such as the rates of delayed call-outs, may help identify particular hospital areas with increased need for support.

Better results were achieved with patients from WMH who first triggered during the day. This is likely to be a function of the service structure of the local RRT, which worked predominantly extended office hours, and then linked with the out-of-hours team during the study period.

The tool was developed in a single centre and has several potential areas for criticism. Reproducibility of the tool was only informally assessed, although, given the simplicity of the outcomes (death: yes/no; ICU admission: yes/no; etc.), formal testing is unlikely to add value. The rarer outcomes listed under outcome 8 in Table 1 (trigger scores from new pathology unrelated to previous RRT call; chronic condition leading to continuous trigger; and discharged from hospital) might need further refinement. We did not have enough data points to evaluate their clinical usefulness. We stress that the tool does not describe the cause for poor outcomes, but serves as a starting point for reflective practice. Negative outcomes will need a case-by-case review to improve the functioning of the RRS.

Admission to a CCU is a process that is both complex and often outside the control of an RRT.[15] Nonetheless, a hospital system that consistently fails to escalate appropriate patients in a timely manner must be considered substandard. The target time frame for admission to a CCU (score-to-door time <4 hours) was chosen pragmatically, based on recent data which suggest higher APACHE II (Acute Physiology and Chronic Health Evaluation) scores on admission in patients with a longer time to CCU admission.[16] It may be that the time from trigger score to initiation of critical care-type interventions on the ward (when these are performed) is as useful an indicator as the time to physical arrival at a CCU. Future research including the SPOTlight study (http://spotlightstudy.org) may provide more information about what is an acceptable time frame for escalation of patients at risk of deterioration.

It is also possible that teams could generate more DNAR orders to avoid "negative" outcomes such as delayed admission to the CCU or ongoing triggering of the RRT. However, in hospitals using comparable track-and-trigger systems, it should be possible to identify those with a disproportionate number of patients put on palliative care pathways or for whom similar measures are taken.

We were unable to evaluate the outcomes of patients who met the local trigger criteria but were not brought to the attention of the RRT. In our experience, most deteriorating patients are seen by the RRT. Patients who are not brought to the attention of the RRT because they improved spontaneously or were being appropriately treated by the "parent" team might represent a different cohort of patients.

There is currently no system for benchmarking clinical outcomes of patients in hospitals with an RRS. For clinical[17] and research purposes, data collection of physiological parameters before call-out of a team and during the care episode has been suggested.[18] Commercial systems that are

run on personal digital assistants or personal computers are now used to alert RRTs to abnormal bedside observations,[19] and could be used to simultaneously record responses. Given that there is no clear clinical rationale for the collection of these data in relation to patient outcomes, we suggest that the MAELOR tool is a useful alternative that allows teams to collect relevant activity and outcome data with minimum additional workload.

All hospitals in Wales have recently introduced the same national early warning score,[20] with hospitals in the Republic of Ireland, England, Northern Ireland and the central region of Denmark currently introducing the same system. It is therefore conceivable that different hospitals will be able to compare outcomes directly.

We hope RRTs will use the proposed outcomes matrix to define acceptable levels of "failure-to-rescue" and to develop strategies to minimise harm to the deteriorating patient on general wards.

Conclusions

The absence of a simple tool for auditing and benchmarking is hampering development of effective RRSs. Our matrix of outcomes gives RRTs an opportunity to quantify failure-to-rescue with minimal additional administrative workload. With its ability to classify and measure frequency of clinical outcomes, the tool could facilitate quality initiatives in clinical networks to improve the safety of deteriorating patients on general wards. There were no new negative outcomes after the initial 24 hours, suggesting that follow-up at 24 hours is a reasonable time for data collection.

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Competing interests

None declared.

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