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## Reaching out beyond the ICU

BY STUART REYNOLDS, MD, PIERRE CARDINAL, MD, AND ALAN BAXTER, MD

There is a disturbing and pervasive body of literature suggesting that patients who are acutely ill or recovering from surgery may receive suboptimal care as changes in their status either go unrecognized or, if detected, are treated inadequately. This observation is in contrast to the current view that earlier intervention in acutely ill patients improves outcome. These observations challenge the current model of providing intensive care within the confines of a specialized unit. This issue of *Critical Care Rounds* presents the rationale for developing early intervention teams, whose mandate is to identify and treat hospitalized patients when they develop signs of distress or worsening clinical status.

### Cardiopulmonary arrest on hospital wards

The survival to discharge of patients who sustain a cardiopulmonary arrest on hospital wards varies from 1% to 2%<sup>1</sup> to approximately 14%.<sup>2</sup> In spite of the enormous resources – including numerous publications, books, conferences, courses, and international organizations dedicated to the subject of cardiopulmonary resuscitation (CPR) – the mortality rate of patients who sustain an arrest has not changed over the last 30 years.<sup>3</sup> Yet, it is recognized that the great majority of cardiac arrest victims display anomalies in vital signs in the hours preceding their arrests. Schein and colleagues<sup>4</sup> demonstrated that 84% of patients had identifiable deterioration (eg, changes in breathing pattern, pulse rate, and level of consciousness) long before they had their arrest. That cardiac arrests are preventable is further supported by the very low cardiac arrest rates observed in intensive care units (ICUs) where patients are monitored continuously.<sup>5</sup> In the ICU, the majority of patients die as a result of withdrawal or withholding care and not as a result of an unexpected cardiopulmonary arrest. It would, therefore, appear that cardiopulmonary arrests on hospital wards result from a failure in the system, related to the failure to either recognize or adequately treat patients who are deteriorating.

### A system failure

A complex system is composed of different elements (eg, various healthcare professionals, different nursing units, patient heterogeneity, and illness severity), as well as the interactions between these elements. The reasons for the system failing are many.<sup>3</sup> Nurses, who are the first to identify the patient with abnormal vital signs, are often not empowered or encouraged to call for help or may not understand the significance of early abnormalities in detecting the patient-at-risk. In teaching institutions, the first physician to come on the scene is frequently the most junior resident, who has often received only minimal training in the care of critically ill patients. Training in advanced cardiac life support (ACLS) may not provide sufficient skills to care for patients who are acutely ill. Without specific training, physicians may be ill-prepared to manage patients who are acutely ill. In addition, time constraints and heavy workload demands may present obstacles to care providers in ensuring the adequate provision of care and monitoring response to therapy.

The system may also fail because physicians with limited experience in resuscitating critically ill patients may hesitate to consult or to give away some of the ownership of their patients. Conversely, the critical care consultant may prefer to stay within the confines of the



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ICU and, therefore, may be unavailable to consult on general ward patients, many of whom never deteriorate to the point of requiring admission to the ICU. Similarly, the cardiac arrest team is often only activated for patients without pulse and is not available for patients who only display abnormal vital signs. However, recent literature indicates that early intervention, such as goal-directed therapy for patients with severe sepsis and septic shock, can save lives. Interventions introduced late in the course of a patient's illness are much less likely to be effective once the patient has been exposed to the full effect of a cytokine storm and suffers multiple organ failure.<sup>6</sup>

It is the recognition that the healthcare system cannot solve the problem of patients who deteriorate and become acutely ill on general hospital wards that has led to the development of the "acute resuscitation team."

### Organizational structure

Acute resuscitation teams differ in their organizational structure based on whether they are nurse- or physician-led. The first acute resuscitation team was introduced by Liverpool Hospital in New South Wales in Australia in 1990, to enable the early identification and aggressive management of seriously ill patients before the advent of a cardiac arrest. This team was often referred to as the Medical Emergency Team or "MET" and was physician-led. Most of the acute resuscitation teams introduced in other Australian hospitals since then have also been physician-led and are referred to as METs or as outreach teams. In contrast, patient-at-risk teams tend to be nurse-led and have developed primarily in England and Wales.<sup>7</sup> Whether the acute resuscitation team is led by a nurse or a physician, its activation is based on standardized calling criteria that identify key abnormalities indicating that a patient is deteriorating.

Any member of the hospital staff can activate the team, which then responds within minutes either to the overhead paging system in the hospital (eg, code MET), or to pagers carried by team members, or both. In some hospitals, the physician-led teams have replaced the cardiac arrest teams and are also responsible for the resuscitation of patients with cardiopulmonary arrests. In other hospitals, both a cardiac arrest and an acute resuscitation team (MET) are maintained. Some patient-at-risk teams are solely responsible for the follow-up of patients discharged from the ICU.

### A broader view of the team

Emphasis is usually placed on the role and function of the 2 or 3 healthcare professionals experienced in the care of the critically ill patients who make up the acute resuscitation team. However, when considering the overall success of the team, the most important healthcare professionals are the ward nurses and physicians who first identify patients-at-risk and activate the system. Viewing the team from a broader perspective is important insofar as the most important step in caring for critically ill patients

**Table 1: Call criteria**

Parameter (acute change in)	Threshold
Airway	Threatened Stridor Excessive secretions
Breathing	Respiratory rate $\leq 8$ or $\geq 30$ Distressed breathing Saturation $< 90\%$ on $\geq 50\%$ O <sub>2</sub> or 6 litres/min
Circulation	Systolic BP $\leq 90$ mm Hg or $\geq 200$ mm Hg Systolic BP decrease $> 40$ mm Hg Heart rate $\leq 40$ or $\geq 130$
Neurology	Decreased level of consciousness (GCS* decrease $\geq 2$ points)
Other	Urine output $\leq 100$ ml over 4 hours (not on dialysis) Serious concerns about the patient

BP = blood pressure  
\* Glasgow coma scale

located outside the ICU is early recognition and activation of the system. Adopting a broader view also helps in the planning phase when committees are formed to administer the team and plan the various educational activities required to ensure that the acute resuscitation team works effectively and properly.

### Development of the call criteria

The call criteria were originally identified via expert consensus, with relatively little evidence to support the choice and threshold value of each criterion. To date, there has been little work to support the choice and threshold value of the call criteria, which may explain why different call criteria are used by different hospitals. The call criteria used in Ottawa and Toronto are shown in Table 1. These criteria are similar to those used by others<sup>7-9</sup> and provide a means of assessing impairment in airway, breathing, and circulation. Most call criteria also include a provision for the healthcare professional who is concerned about a patient who appears to be seriously ill, but does not meet any of the call criteria. This provision is important because it allows ward clinicians to use their own judgment and common sense for patients who may be critically ill and deteriorating, yet do not exceed any call criteria.

It should also be noted that the "threshold" used may have an important impact on the number of calls and types of patients referred to the team. For example, defining tachycardia as a heart rate of  $> 100$  beats per minute (BPM) would significantly increase the number of referrals as compared to a heart rate  $> 130$  BPM. It may, therefore, be wise to consider the organizational structure of the team and the available resources when selecting threshold values. It may be appropriate to select a lower heart rate for nurse-led teams, in which nurses are available 24 hours/day and free from other clinical activities and thus, are capable of responding to a greater number of calls. Conversely, it may be preferable to use a higher heart rate

threshold if the team is physician-led and the team physician is also responsible for covering a busy ICU. However, while the selection of a higher threshold for heart rate will result in fewer calls and avoid referrals for patients with relatively minor anomalies who improve spontaneously without any intervention, it will also delay the identification and treatment of seriously ill patients who could benefit from an earlier intervention. Most call criteria do not consider patient-specific factors, such as diagnosis, age, and co-morbidities that may influence thresholds for the call criteria.

### Call criteria – the evidence

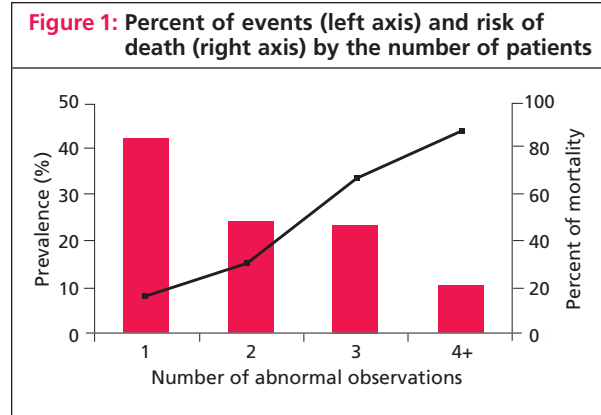
Hodgetts et al<sup>10</sup> conducted a case-control study to evaluate the risk factors for in-hospital cardiac arrest. These authors identified 118 consecutive patients suffering primary cardiac arrest in whom resuscitation was attempted and a comparative sample formed from the chart records of 132 non-arrest patients matched for gender and age who served as controls. Using logistic regression, the authors identified 3 variables as independent predictors of cardiac arrest:

- abnormal breathing indicator (abnormal rate or shortness of breath)
- abnormal pulse
- reduced blood pressure.

The authors then incorporated these 3 variables and other clinical variables believed to be clinically relevant, but had not been retained as significant in their logistic regression model. Each variable was then weighted from “0” to “4” depending on its value. Using these activation criteria, a score of “1” would have a sensitivity of 100% to identify patients with cardiac arrest, but a specificity of only 17%. However, a score of “8” would decrease the sensitivity of the score to 52%, but increase its specificity to 99%. Note that this score was developed to identify patients at risk of a cardiac arrest and, therefore, these results should not be extrapolated to all patients at risk of deterioration and requiring ICU care. Furthermore, the score has not been validated in patient populations from other institutions.

Buist et al,<sup>11</sup> conducted a prospective observational study to evaluate the frequency of abnormal call criteria and their prognostic significance. In this study, the charts of all patients (regardless of their do not resuscitate [DNR] status) from 5 wards with a total of 164 beds were reviewed on a daily basis over a period of 33 weeks. The authors found that the incidence of abnormal observations was 4.2 per 100 bed-days in 8.9% of patients. The 2 criteria found to be abnormal most frequently were an oxygen saturation <90% and a systolic pressure <90 mm Hg, which comprised 51% and 17.3% of all events, respectively. A greater number of abnormal observations was associated with a higher mortality (Figure 1).

Using logistic regression, the authors identified 6 variables that were independent predictors of death. Note that even patients with a DNR status were included in this trial,



as well as patients in whom care was being withdrawn, and this may explain why variables such as “decrease or loss of consciousness” or “a decrease in respiratory rate” were found to have such a strong association with mortality (Table 2).

In summary, there is no strong evidence to support the use of one specific set of activation criteria over other variations on the theme when activating an acute resuscitation team. Given the difficulties in predicting how a set of criteria will perform in a particular clinical setting, it is likely preferable to adopt criteria that are simple and easy to use by the entire hospital staff. It is always possible to modify criteria later, based on the hospital’s experience with its acute resuscitation team, its resources, and the needs of its patients. It remains to be seen if newer technologies in the future will facilitate the earlier detection of patients who become critically ill on general wards and allow for intervention at a time when it is most likely to be beneficial.

### Physician-led versus nurse-led teams

The interventions performed by an acute resuscitation team vary, depending on whether the team is physician- or nurse-led and whether the team is also responsible for responding to cardiopulmonary arrest. Table 3 lists the types of interventions performed by physician-led teams (that also respond to cardiac arrest<sup>15</sup>) and those performed by nurse-led teams (who are responsible for the follow-up of patients discharged from the ICU).<sup>6</sup>

**Table 2: Six variables that are independent predictors of death**

Event	Odds ratio (95% CI)
Decrease in level of consciousness	6.4 (2.6 - 15.7)
Hypotension	2.5 (1.6 - 4.1)
Loss of consciousness	6.4 (2.9 - 13.6)
Respiratory rate <6 per minute	14.4 (2.6 - 80.0)
Saturation	2.4 (1.6 - 4.1)
Tachypnea >30 per minute	7.2 (3.9 - 13.2)

**Table 3: Types of intervention performed by an acute resuscitation team**

**Types of intervention performed by a physician-led team**

- Nasopharyngeal/oropharyngeal suctioning and additional oxygen
- Administration of IV fluid bolus
- Administration of IV furosemide bolus
- Initiation of noninvasive positive pressure ventilation by mask
- Nebulized salbutamol
- Temporary ventilation by bag and mask
- Suctioning of tracheostomy tube
- Initiation of IV glyceryltrinitrate infusion
- Administration of anticonvulsants
- Administration of IV vasopressors

**Types of intervention performed by a nurse-led team responsible for follow-up after discharge from the ICU**

- Guiding tracheostomy management
- Performing tracheal suction and chest physiotherapy
- Guiding management of continuous positive airway pressure
- Optimizing patient positioning
- Requesting prescription or administration of nebulizer therapy
- Requesting blood testing (CBC, urea, electrolytes)
- Increasing the frequency of cardiac/respiratory observations
- Starting hourly fluid balance recording
- Requesting samples to be sent for microculture and sensitivity

CBC = complete blood count

**Limitations of the current literature**

It is difficult to draw any firm conclusions from most of the articles published to date on acute resuscitation teams. Most studies,<sup>8,12,13</sup> with one exception,<sup>9</sup> have used historical controls to evaluate the impact of a team on patient care (Table 4). However, this methodology is flawed since it does not adjust for the effects of other known or unknown variables that might also influence the outcomes of interest. This is not to say that acute resuscitation teams are of no use; but rather, it is difficult to evaluate them using the current literature.

**The MERIT Study**

The MERIT study<sup>9</sup> is the first and only randomized trial to evaluate the impact of physician-led acute resuscitation teams (METs). In this study, 23 Australian hospitals were randomized either to continuing to function as usual or introducing a MET during a 6-month study period. The authors did not observe any changes in the incidences of cardiac arrest, unplanned

**Table 4: Studies evaluating the impact of acute resuscitation teams on patient care**

Authors	Design	Team	Outcome
Bellomo <sup>15</sup>	Prospective, pre- and post- trial	Physician-led	Decrease in number of cardiac arrests
Ball <sup>7</sup>	Prospective, pre- and post- trial	Nurse-led	Increase in survival-to-discharge Decrease in % readmitted Risk ratio 0.48 (0.26 to 0.87)
Kenward <sup>12</sup>	Prospective, pre- and post- trial	Physician-led	No significant differences in hospital mortality or the number of cardiac arrests
Bellomo <sup>13</sup>	Prospective, pre- and post- trial	Physician-led	Decrease in adverse outcomes post-surgery Decrease in emergency intensive care admissions Decrease in the number of post-op deaths
MERIT Study investigators <sup>9</sup>	Prospective, randomized trial	Physician-led	No difference in the incidence of cardiac arrest, unplanned ICU admission, unexpected death

ICU admission, or unexpected death. However, while this was by far the trial with the best methodology, it remains very difficult to conclude whether or not acute resuscitation teams are beneficial. The MET system is very complex and difficult to implement and the duration of the study may have been too short to achieve the consistent changes in use of vital signs required for the activation of the teams. One of the major limitations of this study appears to be that the healthcare professionals on the ward simply did not activate the MET. The number of calls received by the control hospitals was 3.1 per 1000 (activation of the cardiac arrest team); this was increased to only 8.7 per 1000 admissions in the MET hospitals. The small difference in the proportion of activations between the control and MET hospitals is likely because the cardiac arrest teams in the control hospitals were referred patients without cardiac arrest, while in the MET hospitals, the MET was not contacted for all patients meeting the MET criteria. For example, the MET was activated in only 34% of the patients sick enough to require an ICU admission, yet all of these patients must have met  $\geq 1$  of the calling criteria.

The MERIT study underlines the difficulties in implementing acute resuscitation teams, yet it does not provide sufficient evidence to conclude that they have no added benefits. We should also be careful not to conclude that the lack of evidence for a benefit is equivalent to a lack of benefit.<sup>14</sup> This is particularly

the case for interventions performed by the acute resuscitation team that carries little risk to the patient.

### **The phases involved in creating an acute resuscitation team**

The phases described below should be considered when introducing an acute resuscitation team into a hospital. Further information for interested readers can be found at the Institute for Health Improvement website: <http://www.ihl.org/IHI/Topics/CriticalCare/IntensiveCare/Changes/EstablishaRapidResponseTeam.htm> (Accessed: November 3, 2005)

#### ***The planning phase***

The planning phase includes the:

- creation of a steering committee
- creation of a broader acute resuscitation team committee
- identification of all important deadlines
- determination of the calling criteria
- identification of the strategies used to activate the team
- identification of the equipment needs
- educational plans for the hospital personnel
- marketing strategies to inform all interested parties
- budgeting.

Probably the most important aspects of this phase is consultation with and obtaining support from the various players who have a stake in the creation of the acute resuscitation team. Administrators, nurses, respiratory therapists, critical care specialists, ward physicians, and any other key players must all be consulted before implementation. Since there is no perfect model for an acute resuscitation team, it is usually preferable for the project leader to start this consultation process with an open mind and obtain as much feedback and suggestions as possible.

#### ***The implementation phase***

Although there are serious limitations inherent in using historical data, ongoing data collection is crucial to determine the success of the project. Data collection usually starts during the implementation phase. The focus is more on the “process” than on the “outcome.” It is important to know how often the team is activated, if the team is being activated appropriately, etc. This phase includes educating hospital personnel about the project, the calling criteria, and the importance of early resuscitation. It is not unusual to end up giving multiple presentations to the nursing and medical staff in every department, to the hospital board, and others. In addition, the implementation phase permits one-on-one meetings with hospital personnel at the time when calling cards are being

distributed and posters are being planted throughout the hospital. During the implementation phase, acute resuscitation team members have to be hired, which requires the development of job descriptions, interviews, etc. Depending on the structure of the team, courses may need to be developed to educate the team members, since their responsibilities may be quite different (in particular for nurses on teams where nurses are the first-responders on the scene).

#### ***The activation phase***

While proper planning will save a lot of headache, expect the unexpected. It is, therefore, very useful to review the data on an ongoing basis and hold regular meetings to review the performance of the team. It is again preferable to adopt an approach that is not too rigid, since the ongoing data collection enables you to identify problems and modify the intervention, thus further improving patient care. It takes time to change long-established practice patterns and repeated and ongoing education and reinforcement are required. Specific problem issues may need to be addressed (eg, turf wars), but the Ottawa and Toronto experience has indicated that the service has been very well received by both the medical and nursing personnel. Examples of successfully managed cases can be collected, documented, and used for teaching and reinforcement. Improvements in parameters such as the “Code Blue” rates can be documented and used for publicity within the hospital. It should be remembered that nursing and junior medical staff (in teaching hospitals) change frequently and a mechanism should be established to ensure that new recruits are made aware of the system and their role in it.

#### **Conclusion**

Although the existing literature is imperfect, the outreach concept makes sense. There are challenges in the implementation and we hope this issue of *Critical Care Rounds* will be of assistance in addressing these. Our early experience in Ottawa and Toronto has been very positive and we encourage other hospitals to develop their own outreach teams and document their results.

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## Abstract of Interest

### Introduction of the medical emergency team (MET) system: a cluster-randomised controlled trial.

HILLMAN K, CHEN J, CRETIKOS M, ET AL,  
MERIT STUDY INVESTIGATORS.

**BACKGROUND:** Patients with cardiac arrests or who die in general wards have often received delayed or inadequate care. We investigated whether the medical emergency team (MET) system could reduce the incidence of cardiac arrests, unplanned admissions to intensive care units (ICU), and deaths.

**METHODS:** We randomised 23 hospitals in Australia to continue functioning as usual (n = 11) or to introduce a MET

system (n = 12). The primary outcome was the composite of cardiac arrest, unexpected death, or unplanned ICU admission during the 6-month study period after MET activation. Analysis was by intention to treat.

**FINDINGS:** Introduction of the MET increased the overall calling incidence for an emergency team (3.1 vs 8.7 per 1000 admissions, p = 0.0001). The MET was called to 30% of patients who fulfilled the calling criteria and who were subsequently admitted to the ICU. During the study, we recorded similar incidence of the composite primary outcome in the control and MET hospitals (5.86 vs 5.31 per 1000 admissions, p = 0.640), as well as of the individual secondary outcomes (cardiac arrests, 1.64 vs 1.31, p = 0.736; unplanned ICU admissions, 4.68 vs 4.19, p = 0.599; and unexpected deaths, 1.18 vs 1.06, p = 0.752). A reduction in the rate of cardiac arrests (p = 0.003) and unexpected deaths (p = 0.01) was seen from baseline to the study period for both groups combined.

**INTERPRETATION:** The MET system greatly increases emergency team calling, but does not substantially affect the incidence of cardiac arrest, unplanned ICU admissions, or unexpected death.

*Lancet* 2005;365(9477):2091-7.

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