Findings of the First Consensus Conference on Medical Emergency Teams*

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Background: **Studies have established that physiologic instability and services mismatching precede adverse events in hospitalized patients. In response to these considerations, the concept of a Rapid Response System (RRS) has emerged. The responding team is commonly known as a medical emergency team (MET), rapid response team (RRT), or critical care outreach (CCO). Studies show that an RRS may improve outcome, but questions remain regarding the benefit, design elements, and advisability of implementing a MET system.**

Methods: **In June 2005 an International Conference on Medical Emergency Teams (ICMET) included experts in patient safety, hospital medicine, critical care medicine, and METs. Seven of 25 had no experience with an RRS, and the remainder had experience with one of the three major forms of RRS. After preconference telephone and e-mail conversations by the panelists in which questions to be discussed were characterized, literature reviewed, and preliminary answers created, the panelists convened for 2 days to create a consensus document. Four major content areas were addressed: What is a MET response? Is there a MET syndrome? What are barriers to METS? How should outcome be measured? Panelists considered whether all hospitals should implement an RRS.**

Results: **Patients needing an RRS intervention are suddenly critically ill and have a mismatch of resources to needs. Hospitals should implement an RRS, which consists of four elements: an afferent, "crisis detection" and "response triggering" mechanism; an efferent, predetermined rapid response team; a governance/administrative structure to supply and organize resources; and a mechanism to evaluate crisis antecedents and promote hospital process improvement to prevent future events. (Crit Care Med 2006; 34:2463–2478)**

KEY WORDS: medical emergency teams; rapid response teams; cardiac arrest; resuscitation; process improvement; consensus panel; patient safety; critical care

The care of in-hospital patients is complex, a result of more advanced treatments being performed, rising patient age, and multiple comorbidities. A significant proportion of hospital patients experience serious adverse events during their stay, including cardiac arrest, unplanned admissions to the intensive care unit (ICU), and death. Studies have established that many of these events are preceded by warning signs in the form of physiologic instability (e.g., tachypnea, tachycardia, hypotension, decreased oxygen saturation, and changes in conscious state) (Franklin & Matthew 1994, Harrison GA [Appendix 1]). In theory, if abnormal physiology is identified and corrected, outcome may improve.

In response to these considerations, the concept of the Rapid Response System (RRS) has been developed (Figure 1). The

*See also p. 2507.

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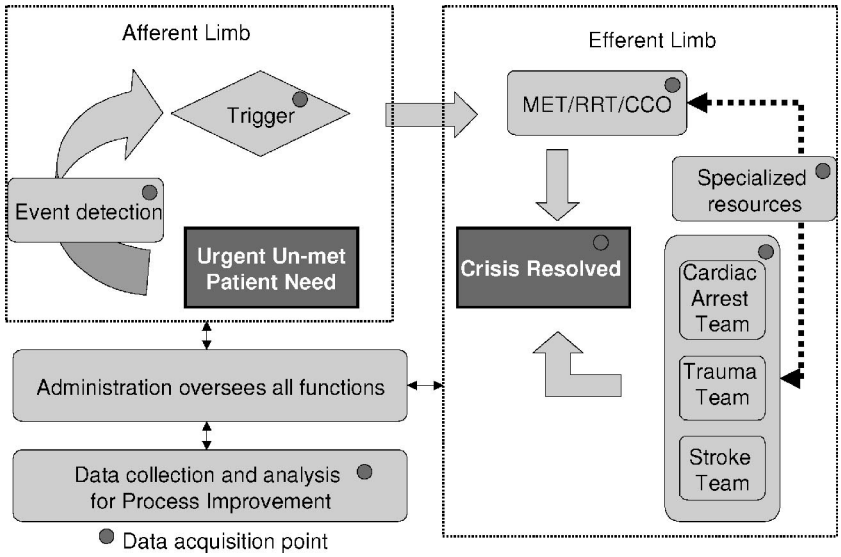

Figure 1. Rapid Response System structure. When patients have critical unmet needs and as a result are at risk for imminent danger, the afferent limb detects the event and triggers a systematic response. The response provides resources to stabilize and triage the patient to a location where services meet the patient's needs. Data are collected to determine event rate, resources needed, and outcomes and to enable an analysis of events to prevent or prepare for future events. An administrative mechanism is needed to oversee all components and to provide resources to facilitate the system. *MET*, medical emergency team; *RRT*, rapid response team; *CCO*, critical care outreach.

best known approaches have been named Medical Emergency Team (MET), Rapid Response Team (RRT), or Critical Care Outreach Team (CCO). Organizations like the American Heart Association, Institute for Healthcare Improvement (1), and Society for Critical Care Medicine are promulgating some form of RRS, and many hospitals are trying to implement them. Although the structure may vary, they are similar in that they rely on the prompt identification and treatment of acutely critically ill hospital patients.

Because of growing worldwide interest in these systems, several authors (MD, KH, RB) convened the first International Conference on Medical Emergency Teams (ICMET) in Pittsburgh in June 2005. This gathering of experts in patient safety, hospital and critical care medicine, and METs provided a unique opportunity to analyze the state of knowledge in this field, develop a consensus around the basic requirements for such a system, and frame a research agenda. In this article we relate the findings of the ICMET.

METHODS

ICMET borrowed several components from existing consensus methods (2). As in the National Institutes of Health (United States) and French national processes, this consensus conference was organized around a small set of key questions. ICMET chairpersons developed a set of four key questions, each with several subquestions for the panels to answer. The panelists were selected on the basis of expertise in patient safety (7) or experience with one of the three major forms of RRS and were divided into four groups, each of which took the primary responsibility for developing the answers to one key question and associated subquestions.

Before the consensus conference, panelists distributed to their group a set of references, literature reviews, draft responses, and other materials relevant to answering their questions. Studies reviewed were chosen by our consensus group organizers, following a comprehensive literature search by one of the authors (SG). An annotated bibliography was created (Appendix 2). (N.B. Citations in this text from the annotated bibliography are indicated by author; other citations not annotated are numeric). Our search strategy did not include unpublished data or data presented in abstract form only. Preconference interactions encouraged panelists to begin thinking about their questions and answers and to allow them to gain an understanding of the other members' approaches (3). Levels of evidence of studies were considered in discussion (4, 5); ICMET recommendations were not graded. The ICMET did not aim to make quantitative distinctions (and therefore did not make recommendations) between the various models of METs. Instead, our review focused on collecting information regarding the general characteristics that we identified as critical to understanding how to implement an emergency response mechanism within the hospital for patients in need, as well as the organizational features that should be reported in the future.

ICMET panelists were faculty members of the First International Conference on Medical Emergency Team (MET) Responses: Preventing Patient Crises, Protecting Patients in Crisis. The consensus panel met immediately following the last day of this symposium. On day 1 of the consensus conference, the panelists were instructed on the goals of the conference. Each group reported its preconference work and, with the full group, created a common understanding of each question.

For 2 days, the four panels drafted answers to their questions. Twice each day they convened, and each panel presented its progress to the group. The panelists critically reviewed each panel's responses. In addition, during these sessions, the group helped to focus panels and to remove any overlap of issues addressed by more than one panel.

Following the final group meeting at the end of the second day, the conference adjourned. In the weeks immediately after the conference, each panel modified its statements in response to the final input. Each group generated a report. The answers to all questions were then distributed to panelists for final comments.

RESULTS

What Is an In-Hospital Medical Emergency?

An in-hospital medical emergency occurs when a hospitalized patient has deteriorated, physiologically and/or psychologically, to the point where there is an imminent risk of serious harm. Such patients urgently require (often critical care) resources that are not readily available or not being implemented. *Thus, a mismatch between patient needs and resources available is the hallmark of an in-hospital emergency*. Clinical resources include knowledge, skills, equipment, and personnel. A medical emergency should be thought of in a broad context, including surgical, obstetrical, mental health, pediatric, and other events. *An institution may derive a set of criteria to help personnel identify patients who are at risk.*

Is There Evidence That Medical Emergencies Occur In-Hospital?

There is considerable evidence that medical emergencies occur in hospitals (Hillman et al., *Resuscitation* 2001, Hillman et al. 2002, Kause et al. 2004). This evidence is derived from observational epidemiologic

Table 1. Characteristics of a rapid response system (RRS)

Afferent (event detection and response triggering) component
Selection/diagnostic/triggering criteria
Human and technologic monitoring with alarm limits
Mechanism for triggering response
Efferent (crisis response) component
Resources arrive quickly (first response <15 mins)
• Personnel (possess a defined set of competencies)
• Equipment
Method for assessing urgent unmet needs
Patient safety/process improvement component
Feedback of event-related knowledge and evaluation of events
• To providers
• To care system designers
• To patient/family
Application of process improvement strategies to prevent future occurrences
Governance/administrative structure
• Implement and sustain the service
• Education/training of staff
• Interpret response team effectiveness data to manage resources
• Ensure ongoing training/education

and case control studies (Hillman et al., *Resuscitation* 2001, Hillman et al. 2002, Bellomo et al. 2003, Bellomo et al. 2004, Kause et al. 2004, Harrison GA). Evidence of the incidence of in-hospital medical emergencies can be derived from large retrospective epidemiologic studies of adverse events, in-hospital cardiac arrests, emergency ICU admissions, and unexpected deaths (Bristow et al. 2000, Bellomo et al. 2003, Bellomo et al. 2004).

Although all the studies demonstrate the occurrence of medical emergencies, they cannot provide an estimate of the incidence of in-hospital medical emergencies, for the following reasons: (1) none of the end points in these studies was a "medical emergency" as defined above, and regardless of definition, not all medical emergencies progress to end points evaluated by these studies; (2) all of the studies employed retrospective designs; and (3) most of the studies were conducted at a single institution, and the results may not be generalizable.

What Is a MET Patient?

A MET patient is one who has deteriorated, physiologically or psychologically (as described above), to the point that he or she is at risk of serious harm and therefore urgently requires a clinical response. The MET patient requires a clinical response that is currently not being provided, creating a mismatch between the patient's clinical condition and the resources present. A patient who is experiencing a medical emergency may be identified by objective or subjective criteria. These include abnormalities in vital signs, neurologic abnormalities (e.g., syncope, sudden weakness, delirium, or seizure), sudden-onset chest pain, or subjectively perceived risk of deterioration of the patient (Goldhill, White & Sumner 1999, Goldhill et al. 1999, Hillman et al. 2002). The perceived risk of harm or imminent deterioration may exist without the patient having abnormalities in vital signs that are routinely monitored (Hodgetts 2002). A diverse set of clinical conditions may contribute to a patient experiencing a medical emergency. These include traditional emergencies such as pulmonary edema, asthma, respiratory distress, cardiac arrhythmias, stroke, hypovolemia, or hemorrhage but may also extend to a range of other conditions, which may include acute psychiatric events and acute need for palliative care (DeVita 2004, Goldhill 1999). *For the purposes of reporting, authors should include their crisis criteria to help the reader understand the patient population being described*. In the future, it would be reasonable to assess the various identification criteria reported to determine whether a standard set is possible and desirable. No studies to date have compared the relative ability of various criteria to identify patients at risk for sudden death or patients most likely to derive outcome benefit from a MET intervention.

What Are the Characteristics of Rapid Response Systems?

Hospital systems must be able to detect and treat patients in crisis before adverse consequences arise. We achieved consensus that the new term Rapid Response System (RRS) be used to describe a whole *system* (and not just the individual components of the system) for providing a safety net for patients who suddenly become critically ill and have a mismatch of needs and resources. There are four components of an RRS, discussed in detail below and in Table 1. At a minimum, an RRS must have an afferent (case detection and response-triggering) limb and an efferent (medical response) limb to attempt to prevent deterioration and must be available 24 hrs a day, 7 days a week. The reported characteristics of these two components appear to vary between different programs. Mature forms of RRS (irrespective of the effector arm of the system) appear to share four common elements. We acknowledge that not all models reported in the literature appear to provide a complete and integrated system of all four components.

The term "Rapid Response System" (RRS) describes the entire system: the afferent and efferent limbs, as well as evaluative/process improvement and administrative limbs. We recommend that the terms MET and RRT be reserved for the efferent limbs of the RRS only. Given the preponderance of studies using the term MET to describe a response team that has "full" critical care capabilities, we endorse the idea that the term MET be used to describe response teams that have all of the following competencies: (1) ability to prescribe therapy; (2) advanced airway management skills; (3) capability to establish central vascular lines; and (4) ability to begin an ICU level of care at the bedside. In most hospitals utilizing METs, the team is physician-led. We propose that the term RRT be reserved for response teams that do not have all these capabilities but instead use an intermediate or "ramp up" approach in which the response team rapidly assesses patient needs, begins basic care to stabilize the patient, and can rapidly triage patients to a safer care setting (like an ICU). Such teams have the ability to call in other resources to provide ICU-level care on an expedited basis. We recognize that the term RRT has been used in a variety of ways not limited to our more narrow definition. However, the use of standardized terminology will improve communication and education.

Finally, the term CCO has been used to encompass RRSs but sometimes including other activities. Most CCO teams reported in the literature appear to function in a manner similar to our definition of an RRT but also provide outreach to prospectively identify and treat high-risk patients to pre-

vent crises. For clarity, we recommend the use of the term RRT to describe models of response to crisis and recommend that the term CCO continue to be used to describe a system that includes an RRS, as well as the prospective outreach/prevention capability.

Is There Consensus in the Literature on Nomenclature of Rapid Response Systems?

Review of the literature reveals wide variation in terminology (Table 2) and demonstrates no consensus as to how to describe existing RRS models. Terms such as Medical Emergency Teams, Rapid Response Teams, and ICU Outreach are often used interchangeably and are sometimes used to describe only the efferent limbs but other times are used for the entire RRS. Several MET programs were developed more than 10 yrs ago and are considered mature by today's standards (Goldhill et al. 1999, Hillman et al. 2001, Hillman 2002). These programs generally have intensivists in the response teams. A rapid-response system CCO has been implemented in the United Kingdom that usually utilizes critical care nurses (Goldhill Worthington 1999). More recently, there has been a sudden growth of new programs in the United States and Canada. These programs generally have ICU nurses as the first responders of the effector limb. The largest sponsor of this type of program is the Institute for Healthcare Improvement (1), whose Web site (www.ihi.org) has a manual for starting an RRT.

Afferent Limb (Crisis Detection). A necessary function of any RRS is a clear method of detecting "emergent unmet patient needs," defined as a disparity between what care a patient is receiving and what care he or she requires emergently. Most RRSs use a set of predetermined, largely objective criteria, which any hospital personnel can use to identify patients at risk. The sets of criteria were developed after institutions found that RRSs were underutilized if only subjective criteria were used to identify at-risk patients. *We recommend utilizing objective criteria to identify patients in need of an emergent team response.* All hospital personnel (nurses, physicians, etc.) should be trained in the use of their institution's "crisis" criteria. Several sets of criteria exist, but two good examples are the Modified Early Warning System (MEWS) and criteria published by Hillman et al. (Hillman et al. 2001). A crisis is indicated in the former by a sum score ≥ 5 and exceeding any one criterion in the latter. The latter criteria seem to be simple for most staff to apply. Physiologic monitoring devices such as pulse oximeters or blood pressure monitors may be used as detectors of crisis.

The majority of reports also encouraged use of clinical judgment or subjective assessments in deciding to summon a RRT/MET. Nearly all explicitly encouraged any member of the hospital staff (particularly nurses) to make these calls. *We recommend the use of subjective criteria to complement objective criteria.* Although subjective criteria do not replace the need for careful objective clinical assessment, they seem to reduce communication barriers between personnel with less clinical acumen, as well as provide a teaching opportunity. The aim is to empower staff at the bedside to call for help. Some centers suggest that detection of urgent unmet patient needs can be made by a variety of people, including nonnursing hospital personnel, family members, or patients themselves. Finally, some RRSs screen patients for urgent unmet needs (Kenward et al. 2004).

Afferent Limb (Triggering Mechanism). Triggering an RRS response (e.g., summoning the Response Team to the bedside of an acutely ill patient) should be the responsibility of all hospital personnel. Initiating an RRS response should not be associated with negative feedback (implying that a call was inappropriate or a sign of "weakness"). Reinforcing the benefits of RRS activation should be a MET/RRT function. The bedside nurse initiates most calls. RRS triggering should be easily accessed and available 24 hrs a day. Depending on resources, this may include overhead speaker calls or paging. ICMET panelists agreed that RRS tend to be underutilized even if the clinical criteria and triggering procedure are simple. The MERIT study reported that within MET hospitals, for those adverse events where patients satisfied triggering criteria, only 30% had a MET response triggered (Hillman 2005). It is likely that continued training and reinforcement are required to foster RRS growth (DeVita et al. 2004). More mature systems have implemented a single telephone number for triggering a response, have redundant team-notification methods (for example, both pagers and overhead speakers), and mnemonic devices (such as pocket cards, phone stickers, and posters) to foster system use. Some systems (e.g., critical care outreach) have active surveillance to prospectively identify high-risk patients who have not yet met crisis criteria. They try to intervene to prevent the crisis (Kvetan; Goldhill Worthington 1999).

Few study reports explicitly described the order in which the primary team, the RRS efferent (response) limb, or others were notified of the event; nor did they describe the time period between the initial identification of a patient "emergency" and subsequent calls to the Primary Team or the RRS responder.

No study reports to date have included "denominator data" (the overall number of patients who met clinical criteria for "emergency") from the period of study and compared it to the actual number of activations. Denominator data enable centers to test characteristics of the clinical criteria used to trigger RRS response, as well as test the efficacy of the RRS. A few study reports noted that the RRS responder was called for a small proportion of eligible patients but did not provide supporting information regarding the sources of these data (Schein et al. 1990, Franklin & Matthew 1994).

Efferent Limb (Response Teams). The two most common models for the response teams are the physician-led "high capability" teams (which we will refer to as Medical Emergency Teams, or METs) and the nurse-led "intermediate capability" or "ramp up" teams (which we will refer to as Rapid Response Teams, or RRTs). The ramp up approach is usually nurse-led and may include other providers (e.g., respiratory therapists) (Table 2) (Buist et al. 1999). The high-capability approach uses a more advanced treatment team (in terms of number of responders and skill sets), which is able to provide a greater range of treatment including airway management and central venous access (Garcea et al. 2004) (6, 7). The MET typically includes a physician and other personnel. Although this pattern may be considered a ramp-down approach, this does not necessary imply that any personnel or resources are removed once an initial assessment has occurred. Potential advantages and disadvantages of RRTs and METs are outlined in Table 3. There are no studies to date that demonstrate an outcome difference between approaches. Although the most obvious difference between different RRSs is in the nature and composition of the response teams, differences in the other components of an RRS appear to exist and have yet to be comparatively

Table 2. Organizational characteristics of rapid response systems

Term	Study	Call Priority	Triggering Mechanism	Performance of Screening Criteria (No. of Meeting Criteria and No. Receiving RRS)	Care Team Structure[a]			
					MD	RN	RT	Other
Critical care outreach team (CCO)	Priestley et al., *Intensive Care Med* 2004	Outreach team and primary (ward) team triggered simultaneously	Any personnel, qualitative trigger[b] present	Not specified		Nurse consultant and experienced nurses, 24 hrs		
Critical care outreach team (CCO)	Leary and Ridley, *Anesthesia* 2003	Outreach team follows patients discharged from ICU; mode and criteria for calling additional help unspecified	Not specified	Not specified		Not specified		
Critical care outreach team (CCO)	Ball et al., *BMJ* 2003	Outreach team follows patients discharged from ICU daily, calls primary team or consultants if criteria are met	Clinical criteria only, personnel type not specified	Not specified	5 Senior ICU nurses and consultant nurse			
Critical care outreach team (CCO)	Subbe et al., *Anesthesia* 2003	Nursing staff instructed to alert medical staff and the CCO if MEWS was ≤5	MEWS criteria, no qualitative triggers	Not specified[c]		Not specified		
Medical emergency team (MET)	Kenward et al., *Resuscitation* 2004	Not specified	Not specified; 80% triggered by nurses	Not specified		Not specified		
Medical emergency team (MET)	Salamonson et al., *Resuscitation* 2001	Not specified	Any personnel qualitative trigger present	Not specified	1 Physician and 1 medical registrar from the emergency department	1 Nurse from the ICU/CCU	2 other nonclinical staff	
Medical emergency team (MET)	Bellomo et al., *Crit Care Med* 2004; Bellomo, *MJA* 2003	Not specified	Any personnel, qualitative trigger present	Not specified	Duty intensive care fellow, medical registrar (if available), ICU consultant as needed	ICU nurse		
Medical emergency team (MET)	Parr et al., *Resuscitation* 2001	Not specified	Any personnel, qualitative trigger present	Not specified	Presumably similar structure to cardiac arrest team: MET replaces the hospital cardiac arrest team			
Medical emergency team (MET)	Bristow et al., *MJA* 2000	Not specified	Any personnel, qualitative trigger present	Not specified	Cardiac arrest team replaced by MET (at intervention hospital)			
Medical emergency team (MET)	Buist et al., *BMJ* 2002	Not specified (presumably similar to authors' 1997 study)	Any personnel, qualitative trigger present	Not specified	Not specified (presumably similar to authors' 1997 study)			
Medical emergency team (MET)	DeVita et al., *Qual Saf Health Care*, 2004	Not specified	Any personnel, clinical criteria only	Not specified	1 ICU team leader, 3 additional MDs, for specific tasks (e.g., compressions, procedures)	3 Nurses (2 ICU, 1 ward)	Anesthesia or critical care airway manager	
Medical emergency team (MET)	Hillman et al., *Lancet* 2005	Not specified; MET to be called if criteria met	Any personnel, qualitative trigger present	Not specified[c]	Not specified across sites—did not educate them on the treatment of critically ill or unstable patients			
Patient at risk team (PART)	Goldhill et al., *Anaesthesia* 1999	Primary team then PART if primary team nonresponsive	Any personnel, qualitative trigger present	Not specified	ICU consultant	ICU nurse	Duty registrar	
Rapid Response Team (RRT)	www.IHI.org	Bedside nurse	Any personnel	Not specified		ICU nurse	1 RT	

ICU, intensive care unit; MEWS, modified early warning score.

[a]Team structure describes personnel arriving at bedside at time the team is called (first responders), with other personnel available as second responders specified in text (RT, respiratory therapist); [a]qualitative triggers are those based on general clinical judgment or concerns over patient safety/deterioration (such as being worried about the patient); [c]reported that MET was triggered for minority of patients meeting clinical criteria (<50%).

Table 3. Proposed relative advantages and disadvantages of two effector limb response team models

Model Effect	High Capability	Intermediate Capability
Advantages	• Definitive care provided as quickly as possible • "One-stop shopping" for services	• May feel less intimidating, resulting in earlier calls • May be less expensive
Disadvantages	• May be intimidating to nurses, leading to delayed calls • Requires highly trained (first) responders; may be costly	• May be less efficient, resulting in a delay of care

studied. *We recommend further study to compare outcome benefits of the response models.*

Although different efferent limb models of RRSs exist, all models emphasize the importance of quickly resolving (i.e., within minutes) the mismatch between the patient's needs and the immediately available resources. At a minimum, response teams should be capable of assessment, diagnosis, at least some therapy, and rapid triage of the patient to a higher level of care. Different models use different approaches to achieve these goals. For example, facilitated telephone contact with prescribers or preprescribed orders for management of common problems have been reported. The efferent limb of the RRS must *(1) be able to provide initial diagnosis, (2) be able to undertake initial therapeutic intervention, and (3) have the authority to make transfer decisions and access other care providers to deliver definitive care*. Because delivering initial care requires good working knowledge of a wide range of equipment, members of the response should be adequately skilled to manage those resources. Larger teams may elect to include members with different skill sets so that these areas are covered by the team as a whole but not by any single individual. Details of the care provided by responding individuals or teams have been rarely reported. Instead, authors reported the model of crisis response.

Panelists also noted that RRS education is still evolving. Many programs may use resuscitation certification including ACLS or FCCS or PALS/APLS or their equivalent in order to provide training to their response team members. However, it is unclear the extent to which these programs are necessary or sufficient for various RRS effector limbs. Panelists achieved consensus that personality traits and clinical skills are both important. Responders should be trained in interacting within a team and with the primary caregivers (i.e., the patient, family, bedside nurse, and primary physicians).

Some hospitals implement the efferent limb by deploying the cardiac arrest team, whereas other centers have a separate team for the RRS efferent limb and the cardiac arrest response. There are no data to determine which model is more easily implemented or yields better outcome. In addition, it is possible that the two approaches could be combined. Finally, the RRS efferent limb should be active 24 hrs a day for a hospital to consider its patients fully protected by the system.

A variety of terms have been used to describe the efferent limbs. We will discuss the most common terminology reported: CCO, MET, and RRT.

Critical Care Outreach (CCO). Most commonly found in the UK, this term usually refers to an RRS that uses smaller response teams, generally staffed by ICU-trained nurses in close collaboration with ICU physicians. Physicians are not "first responders" in the majority of studies. Unlike other RRS response teams, which tended to focus on emergent events, CCOs also provided follow-up visits to patients discharged from the ICU. This surveillance function is an expanded part of the afferent limb and sets the CCO team apart from other strategies (Bellomo et al. 2003, Bellomo et al. 2004, Braithwaite et al. 2004). CCO teams appear to implement care either through standing physician orders and protocols or through telephone physician supervision. CCO teams utilize a ramp-up approach. A variant of the CCO is the Urgent Critical Care Consult. Montefiore Medical Center in New York City has developed an urgent critical care consult model that includes a physician. This program has evolved to integrate hospitalists and an acute palliation staff (Bristow et al. 2000).

Medical Emergency Team (MET). METs most often include a physician, with the major variability in team structure being related to the overall size of the team. Whereas both small and large METs usually have critical care physician leadership, larger teams tended to replace or replicate cardiopulmonary arrest teams and generally have more comprehensive capabilities than smaller MET teams. Being physician-led (i.e., at the bedside), METs prescribe therapy as needed and generally conform to a ramp-down model. Other terms such as PART (Patient At Risk Team) and Condition C (for Crisis) seem to be equivalent to MET.

Rapid Response Team (RRT). Promoted by the Institute for Healthcare Improvement (1), RRT has been used to describe an intermediate capability approach to the efferent limb of an RRS. In Australia, RRT and MET tend to be used synonymously, whereas in the United States, RRT generally implies a nurse-led team. Rapid Assessment Teams (RATs) are similar to RRTs. Pediatric models also exist, with similar distinctions between MD and RN responders.

Evaluative, Patient Safety, and Process Improvement Limb. One key component of oversight is regular evaluation of the antecedents to RRT/MET events, coupled with feedback to improve hospital processes as a quality improvement (QI) mechanism (Daly, Sidney & Fatovich 1998). The University of Pittsburgh (UPMC) MET program has demonstrated that significant quality assessment and patient safety initiatives can be derived from carefully investigating events preceding MET activations (Braithwaite). UPMC has organized several QI programs based on MET events, including hypoglycemia protocols, standardized equipment, standardized airway protocols, and transfer guidelines. MET antecedent evaluation feeds into hospital QI mechanisms. It does not supersede or replace those activities but may focus QI efforts. There are few studies on QI aspects of RRS, and this is an opportunity for investigation.

Governance and Administrative Structure. We recommend a formal overall governance and administrative structure to oversee the planning, implementation, and maintenance phases for RRS. As the RRS is developed and implemented, the focus and issues often change. It is strongly recommended that there be an RRS coordinator responsible for all aspects of the program, including competency maintenance, equipment maintenance, data collection and analysis, QI, and patient safety. This requires a formal committee structure. The coordinator should be a member of the ICU Committee and the "Code" or "Cardiac Arrest" Committee (if a different team is used for the RRS and cardiac arrest response) and should be a participant in hospital QI or patient safety committees. An alternative approach is to

have an overarching RRS Committee, with other key aspects of hospital governance reporting directly into the RRS Committee.

Senior administrative support and medical leadership are necessary for successful implementation and growth of an RRS. Governance should clarify the relationship between the RRT/MET and cardiac arrest team (if separate) as well as other rapid response teams such as the shock, chest pain, stroke, and trauma teams (DeVita et al. 2004). Special teams have been created to address the needs of specific subsets of patients, such as those with an acute myocardial infarction or septic shock.

Is a Standardized Classification System for RRS Necessary or Desirable?

Standardizing the classification (i.e., nomenclature or taxonomy) of any new treatment is essential for a variety of reasons, including enabling benchmarking across sites and promoting research. It facilitates training, planning, and financing. However, classification itself should not discourage innovation. Most RRSs reported in the literature fit into the broad taxonomy we have proposed in that most systems have clearly defined afferent and efferent limbs and many allude to some reporting and governance structures, as well as QI function. *We recommend more explicit reporting of RRS in future studies such that the characteristics outlined in* Table 1 *are described in detail. Furthermore, we endorse the use of the term MET to describe a physician-led response team that has broad treatment capacity and reserving other terms such as RRT and CCO to describe ramp-up models that often employ nonphysicians to assess patient needs and begin protocolized management* (Sebat).

How Should Hospitals Monitor the Impact of an RRS and, in Particular, the Effector (MET/RRT) Response?

Data should be collected for a period of at least 3 months before implementation of an RRS. Data should then be collected on a continual basis following RRS implementation (McQuillan et al. 1998) (8–12). The implementation can take more than a year for reliable crisis detection and response triggering, so one should consider the first few months an "implementation" phase.

Data collected as part of an RRS implementation plan may have multiple purposes, including as a tool to learn how RRS responses influence a broad range of hospital outcomes, the frequency of adverse events, the quantity and types of resources that are utilized, and staff satisfaction (Table 4). The data may be collected to indicate whether the RRS is working effectively on a system level (by measuring relevant processes and by more fully describing the environment in which these processes occur) (Table 5). Last, they may be collected to reveal whether the RRS is working effectively on an event level by tracking the minute-to-minute activities that an individual RRS response comprises (Table 6) (Buist et al. 1999, Bellomo et al. 2002) (13–16).

Although each of these purposes will be important to institutions adopting an RRS, not every institution will have the means to collect all data that may be useful. For this reason, one may divide the data elements into two categories: "primary," which should be collected by *every* institution with a MET regardless of size or setting, and "secondary," which may be collected if resources are sufficient.

Primary data are important for assessing whether the core quality improvement objectives of METs are being satisfied. The incidence of cardiopulmonary arrests, non-DNR (do not resuscitate) hospital deaths, and unexpected ICU admissions (excluding those from the emergency department and scheduled postoperative areas), as well as the frequency of MET utilization, is needed.

Secondary data are useful to allow more detailed evaluation of RRSs within institutions and to assess the impact between institutions. Examples of secondary data are changes in staffing and lengths of stay that are due to adoption of an RRS, or the proportion of patients meeting RRS response criteria without a timely response.

Table 4. Outcome measures

Measure	Primary	Secondary
Adverse events		
Cardiopulmonary arrests	Non-DNR cardiac arrests per 1,000 discharges	Proportion surviving cardiopulmonary arrest • Calendar day of arrest • 30 days after arrest • 180 days after arrest
Hospital deaths	Non-DNR deaths per 1,000 discharges	Deaths per 1,000 discharges
ICU admissions	Unplanned ICU admissions per 1,000 discharges (excludes emergency and postoperative admissions)	Proportion discharged from ICU readmitted during same hospitalization
Resources		
Length of Stay		Mean and median length of stay • Hospital • ICU • Cardiopulmonary arrest survivors
Costs		Cost per patient • Hospital • ICU • Cardiopulmonary arrest survivors
Census		Proportion of beds filled • Hospital • ICU
Staffing changes		Number of additional personnel • Nurse • Physician • ICU • Non-ICU
Satisfaction		
Turnover		Proportion turnover per year • Nurse • Physician
Survey		Mean survey score • Nurse • Physician

DNR, do not resuscitate; ICU, intensive care unit.

Table 5. Process measures and hospital characteristics

Variable	Primary	Secondary
Hospital characteristics	• University vs. nonacademic • Urban vs. rural • Tertiary vs. community • Acute vs. nonacute • Number of beds • Descriptive case-mix (including % adult, pediatrics, psychiatric)	Detailed DRG-based case mix description
MET characteristics	Yes vs. no • Based on cardiopulmonary arrest team • Covers entire hospital • Team members achieved core MET competencies	Detailed information on attendance for each call
MET process measures		
Frequency of utilization	MET activations per 1,000 discharges	Detailed information on activation according to time of day
Appropriateness of utilization	Proportion of MET responses followed by cardiopulmonary arrests	• Proportion of cardiopulmonary arrests preceded by MET responses • Proportion of MET responses with delayed activation (>15 mins) • Proportion of patients meeting MET criteria for >15 mins with no activation • Proportion of ED admissions followed by MET responses within 24 hrs
Impact on scope of care		Proportion of MET responses leading to DNR initiation
Integration into safety culture		Yes vs. no • Event record form • Tools to aid calling MET (posters, cards, phone stickers) • Tools to aid MET encounter (device/med kits, algorithms) • Specific MET education module
Link to medical error detection		Yes vs. no • Link to medical error detection

DRG, diagnosis-related group; MET, Medical Emergency Team; ED, emergency department; DNR, do not resuscitate.

Table 6. Medical Emergency Team (MET) response log

Variable	Primary	Secondary
Patient demographics	Age, sex, admitting diagnosis, location	May add additional information as per AHA reporting form (reference 13)
Reason for activation	The activation criteria that were satisfied	
Interventions	Oxygen Noninvasive ventilation Airway manipulation (e.g., tracheostomy) Intubation CPR Defibrillation IV fluids IV medications Chest tube Invasive monitoring • Central catheter • Arterial catheter Diagnostic tests	
Disposition	No change in location Transfer to non-ICU location Transfer to ICU Transfer out of hospital Died	
Time	Date Time of arrival Time of conclusion (or disposition implemented, if sooner)	
Scope of care decisions	Made DNR order Other limited scope of care (e.g., comfort measures only)	

CPR, cardiopulmonary resuscitation; IV, intravenous; AHA, American Hospital Association; ICU, intensive care unit; DNR, do not resuscitate.

For reporting in peer-review journals, case-controlled or randomized, controlled trials are needed rather than adding to the many historical-control reports.

Are There Enough Data to Support a Recommendation for Hospitals to Implement an RRS?

There are a sufficient number of reports of benefit to support a recommendation that hospitals implement and locally assess an RRS. However, more research is needed to determine the magnitude of benefit and the particular settings that benefit most from the intervention. Outcome benefit has been reported at teaching, community, small, and large hospitals, suggesting that the intervention may benefit many hospital settings. (Stronger evidence is required to justify implementation of interventions if the intervention is expensive, is difficult to implement, or may expose patients and personnel to harm ["proportionality of burden of proof"]. Some safety interventions carry a cost; others may require overcoming difficult hurdles to implement. Still others may have the potential for unforeseen risks. There is an ethical case for imple-

menting interventions with low cost, low risk, and ease of implementation sooner rather than later, without waiting for the strongest level of evidence to emerge.) Regarding RRSs, there is evidence that there are potentially preventable cardiac arrests/deaths in hospitals and unplanned admissions to ICUs that follow a failure to rescue in a timely fashion (Goldhill et al. 1999, Bristow et al. 2000, Salamonson et al. 2001, Buist et al. 2002, Ball et al. 2003, Bellomo et al. 2003, Pittard 2003, Bellomo 2004, DeVita et al. 2004, Garcea et al. 2004, Hodgetts 2002, Priestley et al. 2004, Sebat et al. 2005). RRSs have been developed to increase patient safety and address this patient population at risk.

Research on RRSs suggests an outcome benefit in terms of reduced deaths, cardiac arrests, hospital length of stay, ICU length of stay, and cost (Goldhill et al. 1999, Bristow et al. 2000, Salamonson et al. 2001, Buist et al. 2002, Ball et al. 2003, Bellomo et al. 2003, Pittard 2003, Bellomo 2004, DeVita et al. 2004, Garcea et al. 2004, Priestley et al. 2004, Sebat et al. 2005). These historical-control, single-center interventions controlled for secular trends poorly, if at all. Peer-review evidence in the United States arises primarily from the UPMC. The only randomized, controlled trial to date showed no benefit of a MET (Hillman et al. 2005). However, several factors should be considered in order to understand the results of this study. First, the study focused on MET responses only, yet the results showed an increase in MET-like activities in control hospitals during the study period. Second, there were significant reductions in the incidence of primary outcomes in both the intervention arm and the control arm (and the reduction in the latter may have resulted from unmeasured interventions). Third, there was a significant and unexpected variance in baseline event rates that contributed to the study being seriously underpowered to detect a clinical impact. Finally, the implementation phase was short, and the results show the effect of a brief intervention only.

Because there is reasonable evidence to support the seriousness and prevalence of medical emergencies, we recommend that hospitals implement a system that detects urgent unmet medical needs (the afferent arm of an RRS) and can respond to them rapidly and reliably (the efferent arm). Better monitoring may also benefit if there are methods in place to identify monitored events as crises, to trigger resources to be brought to the bedside, and to deliver care expeditiously. There are several reasons for this recommendation in the face of supporting data from studies with historic controls. First, the breadth of experience and similarity of results across teaching, community, small, and large hospitals add weight to the data. The participants concede that a randomized trial with significantly more power than the MERIT trial would add weight to the evidence supporting this recommendation. Second, the recommendation was made because of a potentially large benefit. In choosing this patient safety intervention, we recognize that stronger evidence is required to justify implementation of interventions if the intervention is expensive, is difficult to implement, or may expose patients and personnel to harm ("proportionality of burden of proof"). There is an ethical (and patient safety) case for implementing interventions with low cost, low risk, and ease of implementation sooner rather than later, with-

Table 7. Barriers to implementing a Rapid Response System to care for patients in crisis

1. Culture and professional role norms
   - Doctor-patient relationship (sanctity of the relationship as well as perceived "ownership" of patients)
   - Hierarchies within current system
   - Disengagement between doctors and nurses
   - Professional resistance (practicing according to norms taught years ago)
     - Physicians
     - Nurses
     - Managers
   - Front-line (bedside) healthcare workers and lack of empowerment to make the call for help
     - Nurses
     - Trainee doctors
2. Structure and tendency to work in professional "silos"
   - Specialist training fosters focus within very narrow practice realms
   - Work/budget; unwillingness to work on other disease processes
     - Individual units may want to carve out from medical emergency team process
     - Setting (academic/private/government-run facilities)
       - Reluctance to believe that findings apply across settings
     - Territorialism and turf battles
       - Departments
       - Units/wards
     - Uncoordinated, disengaged care silos between levels of care (operating rooms, intensive care units, general medical/surgical wards/units)
3. Adequacy and knowledge of evidence regarding medical emergency team
   - Few studies on natural history and epidemiology of hospitalized and seriously ill patients
   - Inadequate knowledge of outcome benefit of rapid response system
   - Inadequate current evidence of best implementation strategy
   - Inadequate evidence regarding effector arm structures and benefit
     - Few data to answer: "What is best for my hospital?"
4. Resource constraints
   - Caregivers responsible for response
     - Staffing
     - Financial
     - Work-load concerns (capacity issues to cover house; how to handle staffing gaps when nondedicated teams are used)
   - Management for oversight of response
     - Implementation requirements: data, personnel, organization
     - Sustaining and maintaining the system: data collection and analysis, personnel and organization
5. Lack of champions committed to a rapid response system, which are needed to promote cultural and practice change
   - Bedside clinicians
     - Registered nurses
     - Respiratory therapists
     - Physicians
     - Experts/external resources
   - Administrative managers and executives
   - Physician and nursing leadership
6. Training/education
   - Variable training/curricula in acute care medicine among physician and nurse staff
   - Perceived threat of implementing "expert" system to education and skill maintenance of trainees
   - Ambiguity regarding requisite training/core competencies in acute medicine and hospital systems
     - For clinicians engaged in patient care
     - For managers of hospital systems

out waiting for the strongest level of evidence to emerge. The participants agreed that an RRS meets the requirement of relatively large benefit for relatively low risk and cost. There is good evidence that potentially preventable cardiac arrests and deaths in hospitals that follow a failure to respond to physiologic deterioration in a timely fashion, and an RRS can prevent many of those deaths (Goldhill et al. 1999, Bristow et al. 2000, Salamonson et al. 2001, Buist et al. 2002, Ball et al. 2003, Bellomo et al. 2003, Pittard 2003, Bellomo 2004, DeVita et al. 2004, Garcea et al. 2004, Hodgetts 2002, Priestley et al. 2004, Sebat et al. 2005).

In its simplest forms, an RRS is not expensive (although hospitals with greater experience found reason to devote quite a lot of resources to the endeavor). Each healthcare organization needs to weigh the resources available, their perceived needs, the perceived benefit, and the strength of the evidence before undertaking any safety intervention.

There is the potential that an RRS could cause harm, perhaps from excess costs, particularly in small hospitals where resources are scarce. The participants were unable to identify reports of such harm either in the literature or in their own experience. Future studies should examine this potential risk of costs unbalanced by benefits. Finally, one might suggest that the intervention be targeted at higher-risk patients. However, the current evidence suggests that emergent critical care needs occur suddenly and unexpectedly throughout the hospital, including in radiology suites, on low-risk medical and surgical floors, and even amongst visitors. In these settings, the event rate is low but the potential benefit is quite large.

However, the heterogeneity of efferent arms of RRSs currently being utilized and the generally favorable impact of each makes it hard to endorse a preferred model for responding to patients in crisis. (Indeed, the control arm of MERIT seemed to implement some response mechanism that resulted in outcome improvement.) Healthcare organizations need to balance the resources available and the perceived needs, benefits, and strength of the evidence. Organizations should have an administrative group responsible for designing the team before and after implementation, tracking impact and gaps in care, and modifying the hospital's processes of care (including the hospital's response mechanism).

Are There Enough Data for this Group to Recommend that Accrediting Organizations and Governmental and Regulatory Agencies Require an RRS?

No consensus was reached regarding this question. The majority of the conference participants felt that there is robust evidence of unmet patient needs leading to adverse outcomes, buy there is insufficient evidence for accrediting organizations and governmental and regulatory agencies to require hospitals to provide an RRS. A minority of participants therefore felt that governmental and regulatory agencies should require an RRS because of low cost and potential for harm avoidance.

Irrespective of the requirement to implement an RRS, there is nevertheless sufficient evidence to support a consensus recommendation that accrediting organizations and governmental and regulatory agencies require hospitals to track unanticipated cardiac arrests, unplanned ICU admissions, and deaths. These data will foster QI activities and may improve the quality of data available on the impact of RRSs.

Should All Hospitalized Patients Have Some Sort of Continuous Physiologic, Automated Monitoring to Improve the Afferent Limb of an RRS (i.e., the Detection Rate of Physiologic Deterioration)?

There are Insufficient Data to Support this Recommendation. There was considerable discussion among conference participants that a significant barrier to preventing in-hospital unexpected cardiac arrest is the ability to discover as soon as possible physiologic deterioration. To find physiologic deterioration as early as possible, continuous (rather than episodic) monitoring would be required. Unpublished data reviewed at the ICMET suggest that about 5% of hospitalized patients meet crisis criteria on any given day (Bell M, in press), so the false-positive rate may greatly exceed the true-positive rate. These factors result in an unknown but probably very high cost per event detected. These facts make it premature to recommend monitoring all patients continuously. Research to investigate the benefits and costs of continuous physiologic monitoring is needed.

What are the Barriers to Implementing an RRS in Hospitals and in Particular the Effector (MET or RRT) Component?

There are no peer-reviewed study reports relating the types and prevalence of barriers to implementation of an RRS, although several authors have touched on techniques of implementation (Daly, Sidney & Fatovich 1998, Bellomo et al. 2003, Foraida et al. 2003). Therefore, there is no high-grade evidence to support recommendations. However, a number of panelists have considerable experience in MET/RRT implementation, and the group drew upon that experience to identify common and important barriers (Table 7). For example, some physicians may be resistant to the RRS because it is a different system for responding to patient deterioration; it creates new communication and treatment paradigms. We suggest that an RRS should be viewed as a complementary system to respond quickly when the patient's urgent needs are not being met by the usual medical care system. An RRS provides institutional support (building an "ICU") at an acutely critically ill patient's bedside. Appropriate triage to a safe location may be needed. Hand-off to the next set of providers (often the primary physicians for the patient) is essential to maintain safety and continuity, even if the patient is not moved. Reporting observed barriers, the relative importance and prevalence of each type, and methodologies for overcoming them would be helpful.

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Impact of hospital volume on operative mortality for major cancer surgery. *JAMA* 1998; 280:1747–1751
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APPENDIX 1

Group Participants

Group 1 (What is a MET response?): Dan Teres, MD; Andrew Auerbach, MD; Wen-Jon Chen, MD, PhD; Kathy Duncan, RN; Gary Kenward, MSc, BSc(Hons), RN, QARANC

Group 2 (Is there a MET syndrome?): Armando Rotondi, PhD; Max Bell, MD; Michael Buist, MBChB, FRACP, FJFICM; Jack Chen, MBBS, PhD

Group 3 (What are barriers to METs?): Julion Bion, FRCP FRCA MD; Ann Kirby, MD; Geoff Lighthall, MD, PhD; John Ovreveit, PhD, C Psychol, MIHM

Group 4 (What are the outcome measurements for METs?): R. Scott Braithwaite, MD; John Gosbee, MD; Eric Milbrandt, MD; Mimi Peberdy, MD; Lucy Savitz, PhD, MBA; Lis Young, MA, CCM, FFAFPHM; Luke Chelluri, MD

APPENDIX 2

Medical Emergency Team (MET) Annotated Bibliography (Sanjay Galhotra, MD)

Anderson K, Atkinson D, McBride J, et al: Setting up an outreach team in the UK. *Crit Care Nurs Eur* 2002; 2:8–12

The authors outline their experience in developing an "outreach" service at Portsmouth Hospital's NHS trust and examine strategies to overcome problems in implementation.

Ball C, Kirkby M, Williams S: Effect of the critical care outreach team on patient survival to discharge from hospital and readmission to critical care: A nonrandomized population based study. *BMJ* 2003; 327: 1014–1016a

Nonrandomized, population-based study in a tertiary care teaching hospital reveals that the introduction of a critical care outreach team resulted in increased survival to discharge from hospital after discharge from critical care by 6.8% (risk ratio, 1.08). Readmission to critical care decreased by 6.4% (0.48).

Bedell SE, Deltz DC, Leeman D, et al: Incidence and characteristics of preventable iatrogenic cardiac arrests. *JAMA* 1991; 265:2815–2820

Retrospective study of cardiac arrests during a 1-yr period in a University teaching hospital reveals that 18 of 203 arrests (9%) might have been prevented by stricter attention to the patient's history, findings on physical examination, and laboratory data. The most common causes of potentially preventable arrest were medication errors and toxic effects (44%) and suboptimal response by physicians to clinical signs and symptoms (28%), most frequently dyspnea and tachypnea.

Bellomo R, Goldsmith D, Uchino S, et al: Prospective controlled trial of effect of medical emergency team on postoperative morbidity and mortality rates. *Crit Care Med* 2004; 32:916–921

A prospective, controlled before-and-after trial reveals a reduction in incidence of postoperative adverse outcomes (301 vs. 127 adverse outcomes/1,000 surgical admissions; relative risk reduction, 57.8%; $p < .0001$), postoperative mortality rate (relative risk reduction, 36.6%; $p = .0178$), and mean duration of hospital stay (23.8 vs. 19.8 days; $p = .0092$) after the introduction of ICU-based METs in a teaching hospital.

Bellomo R, Goldsmith D, Uchino S, et al: A prospective before-and-after trial of a medical emergency team. *MJA* 2003; 179:283–288

Prospective before-and-after study in a tertiary referral hospital for METs reveals a relative risk reduction of 65% ($p < .001$) in cardiac arrests and 56% ($p < .005$) in cardiac arrest related mortality, 80% ($p < .001$) reduction in ICU bed-days and 88% ($p < .001$) reduction in hospital bed-days for survivors of cardiac arrest, and 26% ($p < .001$) reduction in overall in-hospital deaths.

Bion JF, Heffner JE. Challenges in the care of the acutely ill. *Lancet* 2004; 363: 970–977

Health care providers, hospital administrators, and politicians face competing challenges to reduce clinical errors, control expenditures, increase access and throughput, and improve quality of care. The authors present a framework in which responsibility for improvement and better integration of care for acutely ill inpatients can be considered at the level of patient, local environment, hospital, and health care system.

Braithwaite RS, DeVita MA, Mahidhara R, et al., and members of the Medical Emergency Response Improvement Team (MERIT): Use of medical emergency team (MET) responses to detect medical errors. *Qual Safety Health Care* 2004; 13:255–259

Three hundred sixty-five consecutive MET responses underwent chart review and 114 (31.3%) were associated with medical errors: 77 (67.5%) were categorized as diagnostic errors, 68 (59.6%) as treatment errors, and 30 (26.3%) as prevention errors. Eighteen separate hospital care processes were identified and modified as a result of this review, 10 of which involved standardization. MET review may be used for surveillance to detect medical errors and to identify and modify processes of care that underlie those errors.

Bright D, Walker W, Bion JF: Outreach: A strategy for improving the care of the acutely ill hospitalized patient. *Crit Care* 2004; 8:33–40

Authors examined the literature relating to the safe care of acutely ill hospitalized patients and found substantial opportunities for improvement, especially by using systems of outreach care that facilitate better integration, coordination,

collaboration, and continuity of multidisciplinary care. Various approaches being adopted are reviewed and the need for continuing evaluation of these systems is suggested as they are introduced into different health care systems.

Bristow PJ, Hillman KM, Chey T, et al: Rates of in-hospital arrests, deaths and intensive care admissions: The effect of a medical emergency team. *Med J Aust* 2000; 173:236–240

Cohort comparison study (at hospital 1, a MET could be called for abnormal physiologic parameters or staff concern; hospitals 2 and 3 had conventional cardiac arrest teams). The MET intervention hospital had fewer unanticipated ICU/HDU admissions (case-mix-adjusted OR: hospital 1, 1.00; hospital 2, 1.59 [95% CI, 1.24–2.04]; hospital 3, 1.73 [95% CI, 1.37–2.16]), with no increase in in-hospital arrest rate or total death rate.

Buist MD, Bernard S, Anderson J: Epidemiology and prevention of unexpected in-hospital deaths. *Surg J R Coll Surg E* 2003; 1:265–268

The authors conduct a review of available literature in the epidemiology and prevention of unexpected in-hospital deaths and conclude that in-hospital deaths are both predictable and preventable, but more research needs to be done to determine effective strategies to manage this problem.

Buist MD, Bernard S, Nguyen TV, et al: Association between clinically abnormal observations and subsequent in-hospital mortality: A prospective study. *Resuscitation* 2004; 62:137–141

Prospective study of patients admitted to five general hospital wards reveals six clinical observations as significant predictors of mortality: a decrease in Glasgow Coma Score by two points, onset of coma, hypotension (<90 mm/Hg), respiratory rate <6 min(−1), oxygen saturation <90%, and bradycardia >30 min(−1). The presence of any one of the six events was associated with a 6.8-fold increase (95% CI, 2.7–17.1) in the risk of mortality.

Buist MD, Jarmolowski E, Burton PR, et al: Recognizing clinical instability in hospital patients before cardiac arrest or unplanned admission to intensive care: A pilot study in a tertiary-care hospital. *Med J Aust* 1999; 171:22–25

Retrospective study of all patients having critical events (CEs) for 12 months: 122 CEs in 112 patients (median, 1; range, 1–4). Each CE was preceded by a median of two (range, 0–9) criteria for clinical instability. The median duration of instability before a CE was 6.5 hrs (range, 0–432 hrs), and in that time a median of two (range, 0–13) medical reviews took place.

Buist MD, Moore GE, Bernard SA, et al: Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: A preliminary study. *BMJ* 2002; 324:387–390

Nonrandomized, population-based before-and-after study (1996, n = 19,317; 1999, n = 22,847) of METs revealed a 50% reduction in the incidence of unexpected cardiac arrest (3.77/1,000 admissions in 1996 vs. 2.05/1,000 admissions in 1999; OR, 0.50; 95% CI, 0.35–0.73) after implementation of METs.

Cioffi J. Nurses' experiences of making decisions to call emergency assistance to their patients. *J Adv Nurs* 2000; 32:108–114

Descriptive study explored the experiences of registered nurses (n = 32) by means of unstructured interviews. The main findings were that nurses questioned whether they were doing the "right thing" calling the emergency team, sometimes collaborated with others before calling, and (most) felt nervous and anxious.

Cioffi J. Recognition of patients who require emergency assistance: A descriptive study. *Heart Lung J Acute Crit Care* 2000; 29:262–268

Qualitative study of RNs with ≥5 yrs' experience (n = 32) at one teaching hospital and one peripheral hospital in a Sydney area health service reveals that nurses relied on four patient characteristics to apply the MET criterion "seriously worried about a patient." These four characteristics were (1) feeling "not right," (2) color, (3) agitation, and (4) observations marginally changed or not changed at all.

Considine J: The role of nurses in preventing adverse events related to respiratory dysfunction: Literature review. *J Adv Nurs* 2005; 49:624–633

This examines the relationship between specific clinical indicators of respiratory dysfunction and adverse events and explores the role of nurses in preventing adverse events related to respiratory dysfunction.

Considine J, Botti M: Who, when and where? Identification of patients at risk of an in-hospital adverse event: Implications for nursing practice. *Int J Nurs Pract* 2004; 10:21–31

Ongoing physiologic assessment of patients is a nursing responsibility, and the assessment findings of nurses underpin many patient care decisions. The early recognition and correction of physiologic abnormality can improve patient outcomes by reducing the incidence of adverse effects (Aes), making nurses' ability to identify, interpret, and act on physiologic abnormality a fundamental factor in AE prediction and prevention. This examines the role of nurses in AE prevention, using cardiac arrest as an example.

Coombs M, Dillon A: Crossing boundaries, re-defining care: The role of the critical care outreach team. *J Clin Nurs* 2002; 11:387–393

The authors explore the developing concept of the critical care outreach team as an innovative approach to addressing the challenges facing the current practice of critical care medicine. Six-month audit data of two critical care outreach teams are presented. The article concludes with discussion on key opportunities and challenges for the outreach team in working across professional and organizational boundaries.

Cretikos M, Hillman K: The medical emergency team: Does it really make a difference? *Intern Med J* 2003; 33:511–514

The authors review METs as a way to prevent unexpected in-hospital deaths among the critically ill. The benefits of the MET in terms of absolute inpatient mortality and cardiac arrest rates are not yet well-defined, although preliminary studies are promising.

Crispin C, Daffurn K: Nurses' responses to acute severe illness. *Austr Crit Care* 1998; 11:131–133

Retrospective study of 178 patients who required MET assistance during 1994. MET calls occurred in the general wards (50%), ER (42.3%), and other areas (7.7%). The four main categories of emergency comprised cardiac arrest (25.6%), airway/breathing problems (22%), decreased level of consciousness (20.8%), and other, including prolonged chest pain, "fitting," and hypotension (31.6%). The predominant response to a clinical antecedent was to call the MET (68.4%). Other responses resulted in delays of 1 hr (18%) and up to 3 hrs (8%) on some wards before treatment specific to the clinical antecedent commenced.

Daffurn K, Lee A, Hillman KA, et al: Do nurses know when to summon emergency assistance? *Intens Crit Care Nurs* 1994; 10:115–120

A survey (n = 141) to determine RN opinions, knowledge, and use of a MET system 2 yrs after its implementation revealed a positive attitude to MET: 53% of nurses had called the MET in the previous 3 months, and all would call the team again in the same circumstances. Some nurses, despite severe deterioration and patient distress, called the resident rather than the MET.

Daly FFS, Sidney KL, Fatovich DM: The medical emergency team (MET): A model for the district general hospital. *Aust NZ J Med* 1998; 28:795–798

Prospective 1-yr study of MET activation—68 calls to 63 patients. Mean patient age was 60.4 yrs (range: neonatal to 94 yrs). The most common conditions leading to MET activation were chest pain (19.1%), cardiopulmonary arrest (14.7%), seizures (14.7%), and respiratory distress (13.2%). Conclusion: application of the MET model to the district general hospital improves the process of patient care.

DeVita MA, Braithwaite RS, Mahidhara R, et al., and members of the Medical Emergency Response Improvement Team (MERIT): Use of medical emergency team responses to reduce hospital cardiopulmonary arrests. *Qual Safety Health Care* 2004; 13:251–254

A retrospective analysis of 3,269 MET responses and 1,220 cardiopulmonary arrests during 6.8 yrs showed an increase in MET responses from 13.7 to 25.8 per 1,000 admissions ($p < .0001$) after instituting objective activation criteria. There was a coincident 17% decrease in the incidence of cardiopulmonary arrests, from 6.5 to 5.4 per 1,000 admissions ($p = .016$), suggesting that increased use of MET may be associated with fewer cardiopulmonary arrests.

DeVita MA, Schaefer J, Lutz J, et al: Improving medical crisis team performance. *Crit Care Med* 2004; 32(Suppl): S61–S65

The authors describe their preliminary experience in improving design of a crisis response and training multidisciplinary teams to respond to in-hospital crisis events. Simulation-based crisis team training improves efficiency and effectiveness of completing key tasks in a crisis situation, and authors predict that it will improve clinical outcome.

Foraida MI, DeVita MA, Braithwaite RS, et al: Improving the utilization of medical crisis teams (condition C) at an urban tertiary care hospital. *J Crit Care* 2003; 18:87–94

The authors found increased condition C responses and decreased numbers of disorganized responses (sequential STAT pages) during a 3-yr period after the implementation of four strategies to increase condition C utilization. One of the interventions—objective definition and dissemination of criteria for initiating the condition C response—was followed by 19.2 more condition Cs monthly (95% CI, 12.1–26.3; $p < .0001$) and 5.7 fewer sequential STAT pages monthly (95% CI, 3.2–8.2).

Franklin C, Mathew J: Developing strategies to prevent in-hospital cardiac arrest: Analyzing responses of physicians and nurses in the hours before the event. *Crit Care Med* 1994; 22:244–247

Twenty-month prospective study of 150 consecutive patients who had an in-hospital cardiac arrest (cardiac arrest rate, 7.0/1,000 patients; hospital mortality rate, 91%). In 99 of 150 cases, a nurse or physician documented deterioration in the patient's condition within 6 hrs of cardiac arrest. Former ICU patients (cardiac arrest rate, 14.7/1,000 patients) were more likely to suffer cardiac arrest than other patients (cardiac arrest rate, 6.8/1,000 patients; $p = .004$).

Garcea G, Thomasset S, McClelland L, et al: Impact of a critical care outreach team on critical care readmissions and mortality. *Acta Anaesth Scand* 2004; 48: 1096–1100

A retrospective review of 1,380 discharges from critical care identified readmissions (n = 176). Comparison of readmission rate, mortality, and other demographic data between the pre-outreach and post-outreach periods showed a decline in critical care mortality, in-hospital mortality, 30-day mortality, and overall mortality in the post-outreach period.

Goldhill DR, White SA, Sumner A: Physiologic values and procedures in the 24 h before ICU admission from the ward. *Anesthesia* 1999; 54:529–534

Prospective study of all ICU admissions at Royal London Hospital during a 13-month period (79 admissions for 76 patients). During the 6-hr period immediately before intensive care admission, 75% of patients received oxygen, 37% underwent arterial blood gas sampling, and oxygen saturation was measured in 61% of patients, 63% of whom had an oxygen saturation of <90%.

Goldhill DR, Worthington L, Mulcahy A, et al: The patient-at-risk team: Identifying and managing seriously ill ward patients. *Anesthesia* 1999; 54:853–860

Six-month prospective study of patient-at-risk team (69 assessments of 63 patients). Incidence of CPR before ICU admission was 3.6% for patients seen by the team and 30.4% for those not seen ($p < .005$). Of admitted patients seen by the team, 25% died on the intensive care unit, compared with 45% of those not seen (not significant; $p = .07$). Identification of critically ill patients on the ward and early advice and active management are likely to prevent the need for cardiopulmonary resuscitation and to improve outcome.

Harrison GA, Jacques TC, Kilborn G, et al: The prevalence of recordings of the signs of critical conditions and emergency responses in hospital wards: The SOCCER study. *Resuscitation* 2005; 65: 149–157

Retrospective cross-sectional survey of 3,160 admissions in general wards at five Australian hospitals found a high incidence of recordings of disturbed physiologic variables: 54.7% of admissions had at least one recording of early signs, 16.0% had late signs, and 6.4% had LES. When ranked in order of recordings per 100 admissions, the top five emergency responses were Spo2, 90–95% (193.7); systolic blood pressure (SBP), 80–100 mm Hg (85.2); pulse rate, 40–49 or 121–140 beats/min (32.0); SBP, 181–240 mm Hg (23.0); and "other" (22.1; mainly breathlessness or temperature >38°C). The top five late signs were Spo_2 <90% (31.5), pulse rate <40 or >140/min (6.6), SBP <80 mm Hg (4.2), GCS ≤8 (3.8), and unresponsiveness to verbal commands (2.4).

Hillman KM: Critical care without walls. *Curr Opin Crit Care* 2002; 8:594–599

The authors describe how critical care medicine is a relatively young specialty that has been largely practiced within the four walls of an intensive care unit (ICU). Critical care specialists are expanding their roles beyond the four walls of their ICUs and becoming involved with strategies such as the medical emergency team, a concept designed to recognize critical illness early and to respond rapidly to resuscitate patients wherever they are in the hospital.

Hillman KM, Bristow PJ, Chey T, et al: Antecedents to hospital deaths. *Intern Med J* 2001; 31:343–348

A prospective study of demographics and antecedent factors present within 0–8 and 8–48 hrs of all deaths within a

6-month period at three separate acute hospitals in Australia provides evidence that there is a high incidence of serious vital sign abnormalities in the period before potentially preventable hospital deaths. Of the 778 total deaths, 549 (71%) were "not for resuscitation," 171 (22%) were preceded by arrest, and 160 (21%) were preceded by admission to the ICU. In the remaining patients who died, 30% had severely abnormal physiologic abnormalities documented. Hypotension (30%) and tachypnea (17%) were the most common antecedents in the non–"do not resuscitate" deaths.

Hillman KM, Bristow PJ, Chey T, et al: Duration of life-threatening antecedents before intensive care admission. *Intensive Care Med* 2002; 28:1629–1634

Prospective follow-up study of all patients admitted to the ICU in three acute-care hospitals. Of the 551 patients (90 from the general ward, 239 from the operating room [OR], and 222 from the emergency department [ED]), 62 had antecedents during the period 8–48 hrs before admission to intensive care, and 53 had antecedents within both 8 hrs and 48 hrs before their admission. Patients from the general wards had a greater number of serious antecedents before admission to the ICU (43; 72%) than did those from the OR (150; 64.4%) or ED (126; 61.8%). The most common antecedents during the 8 hrs before admission were hypotension (n = 199), tachycardia (n = 73), tachypnea (n = 64), and sudden change in level of consciousness (n = 42).

Hillman KM, Chen J, Brown D: A clinical model for health services research: The medical emergency team. *J Crit Care* 2003; 18:195–199

The authors look at METs from a health services research perspective. The problems of implementing major health service change and evaluating the effectiveness of that change present a different challenge to evaluating a new drug or procedure and are approached within different research frameworks.

Hillman KM, Parr M, Flabouris A, et al: Redefining in-hospital resuscitation: The concept of the medical emergency team. *Resuscitation* 2001; 48:105–110

The authors review relevant literature on in-hospital cardiopulmonary arrests and factors preceding them. They suggest concentrating on the wider meaning of resuscitation (moving beyond CPR, focusing on factors preceding arrests) and propose medical emergency teams (METs) as one approach to address the problem of preventable in-hospital deaths.

Hillman K, Chen J, Cretikos M, et al, and MERIT Study investigators. Introduction of the medical emergency team (MET) system: A cluster-randomised controlled trial. *Lancet* 2005; 365:2091–2097

In a cluster-randomized controlled study of the impact of METs, 23 Australian hospitals were randomized to either METs or no intervention. After baseline data were collected and a 4-month implementation period, investigators observed the incidence of several outcome measures, including unexpected mortality. Authors found no difference between control and intervention hospitals. Both arms had significant improvement in comparison with baseline. Authors note that improvement in unexpected hospital death rate may be possible with use of methodologies other than MET.

Hodgetts TJ, Kenward G, Vlackonikolis L, et al: Incidence, location and reasons for avoidable in-hospital cardiac arrest in a district general hospital. *Resuscitation* 2002; 54:115–123

Expert panel review of case-notes from 139 consecutive adult in-hospital cardiac arrests for 1 yr (118 were primary in-hospital cardiac arrests) revealed that 61.9% of arrests (68% when ED arrests were excluded) were potentially avoidable. Multiple system failures included delays and errors in diagnosis, inadequate interpretation of investigations, incomplete treatment, inexperienced doctors, and management in inappropriate clinical areas.

Hodgetts TJ, Kenward G, Vlachonikolis IG, et al: The identification of risk factors for cardiac arrest and formulation of activation criteria to alert a medical emergency team. *Resuscitation* 2002; 54: 125–131

The authors study 118 consecutive adult patients suffering primary cardiac arrest in-hospital and 132 nonarrest patients, randomly selected. Multivariate analysis of cardiac arrest cases identified three positive associations for cardiac arrest: abnormal breathing indicator (OR, 3.49; 95% CI, 1.69–7.21), abnormal pulse (OR, 4.07; 95% CI, 2.0–8.31), and abnormal systolic blood pressure (OR, 19.92; 95% CI, 9.48–41.84). They identify, quantify, and formulate risk factors for cardiac arrest to generate a tool for activation of METs based upon graded clinical response that is sensitive and specific.

Kause J, Smith G, Prytherch D, et al: Intensive Care Society (UK). Australian and New Zealand Intensive Care Society Clinical Trials Group. A comparison of antecedents to cardiac arrests, deaths and emergency intensive care admissions in Australia and New Zealand, and the United Kingdom: The ACADEMIA Study. *Resuscitation* 2004; 62:275–282

A multicentre, prospective, observational study of incidence of antecedents (serious physiologic abnormalities) preceding primary events in 90 hospitals (69 in United Kingdom, 19 in Australia, and 2 in New Zealand) confirms that antecedents are common before death, cardiac arrest, and unanticipated ICU admission.

Kenward G, Castle N, Hodgetts T, et al: Evaluation of a medical emergency team one year after implementation. *Resuscitation* 2004; 61:257–263

Analysis of MET activation during a 12-month period revealed 136 activations (mean patient age, 73 yrs; survival to discharge, 40% [52/130]). Patients who died were more likely to have ≥3 physiologic abnormalities present (OR = 6.2) and had higher MET scores (p = .004). Multiple physiologic abnormalities are associated with increased mortality; therefore, wider and earlier application of the MET to the hospital population may save lives or expedite DNR decisions.

Kerridge RK, Saul WP: The medical emergency team, evidence-based medicine and ethics. *Med J Austr* 2003; 179: 313–315

Authors suggest that delay in implementing METs by many centers (institutional inertia) awaiting "gold standard" evidence of their effectiveness may be unethical. They propose that decisions about changes in healthcare should be made on the basis of scientific rationality, clinical reasonableness, and resource implications, as well as evidence and ethical implications.

Leary T, Ridley S: Impact of an outreach team on re-admissions to a critical care unit. *Anesthesia* 2003; 58:328–332

A retrospective before-and-after study involving METs found that outreach services appear not to affect re-admission in terms of reasons (χ^2 = 2.07, df = 3, p = .56) or numbers (re-admission rate before and after outreach team = 4%; 95% CI = 4.76–3.24%). The authors suggest that re-admission rate is not a useful measure to study effectiveness of outreach services.

Lee A, Bishop G, Hillman K, et al: The medical emergency team. *Anaesth Intensive Care* 1995; 23:183–186

Prospective study to describe the utilization and outcome of MET interventions during a 1-yr period at a teaching hospital in southwestern Sydney. CPR occurred in 148/522 calls (28%). Alerting MET on the basis of specific condition criteria occurred in 253/522 calls (48%) and on physiologic/pathologic abnormality criteria in 121/522 calls (23%). Survival rate to hospital discharge following cardiopulmonary arrest was low (29%), compared with that in other medical emergencies (76%).

Lee A, Lum ME, O'Regan WJ, et al: Early postoperative emergencies requiring an intensive care team intervention: The role of ASA physical status and afterhours surgery. *Anesthesia* 1998; 53:529–535

Matched nested case-control study (34 cases and 126 controls). During a 17-month period, the incidence of early postoperative emergencies occurring within 48 hrs of surgery was 0.21% (95% CI, 0.14%–0.30%). Significant associations with early postoperative emergencies were high ASA (≥IV) physical status grades (OR, 4.51; 95% CI, 1.24–16.40) and surgery performed outside normal working hours (OR, 4.40; 95% CI, 1.41–13.69).

McArthur-Rouse F: Critical care outreach services and early warning scoring systems: A review of the literature. *J Adv Nurs* 2001; 36:696–704

A review of the literature relating to critical care outreach services concludes that further study is required to evaluate the effectiveness of critical care outreach services and early warning scoring systems. The authors suggest further investigation to understand nurses' decision-making in relation to calling the outreach team.

McGloin H, Adam SK, Singer M: Unexpected deaths and referrals to intensive care of patients on general wards: Are some cases potentially avoidable? *J R Coll Phys Lond* 1999; 33:255–259

In a 6-month prospective study of adult general ward patients admitted to the ICU or dying unexpectedly, 317 of the 477 hospital deaths occurred on the general wards, of which 20 (6%) followed failed attempts at resuscitation; 13 of these were considered potentially avoidable. Eighty-six hospital inpatients were admitted on 98 occasions to the ICU, 31 of whom received suboptimal care before ICU admission because of either nonrecognition of (the severity of) the problem or inappropriate treatment. Both ICU mortality (52% vs. 35%) and hospital mortality (65% vs. 42%) were significantly higher among these patients than among well-managed patients ($p < .0001$).

McQuillan P, Pilkington S, Allan A, et al: Confidential inquiry into quality of care before admission to intensive care. *BMJ* 1998; 316:1853–1858

Prospective study of 100 consecutive adult emergency admissions. Twenty patients were well managed, 54 patients received suboptimal care (group 2), and there was disagreement on the quality of management of 26 patients (4.5–41% of admissions were considered potentially avoidable). The main causes of suboptimal care were failure of organization, lack of knowledge, failure to appreciate clinical urgency, lack of supervision, and failure to seek advice.

Parr MJ, Hadfield JH, Flabouris A, et al: The medical emergency team: 12-month analysis of reasons for activation, immediate outcome and not-for-resuscitation orders. *Resuscitation* 2001; 50: 39–44

Retrospective analysis of MET calls (year 1998) in an Australian tertiary care hospital revealed 713 MET calls to 559 inpatients. Of the 559 patients, 252 (45%) were admitted to ICU and 49 (6.9%) died during MET response. The three commonest criteria for calling the MET were a fall in GCS >2 (n = 155); a systolic BP <90 mm Hg (n = 142), and a respiratory rate >35 (n = 109). Cardiac arrests accounted for 61 calls and yielded an immediate mortality of 59%. The most common MET criterion associated with admission to ICU was a respiratory rate >35.

Peberdy MA, Kaye W, Ornato JP, et al: Cardiopulmonary resuscitation of adults in the hospital: A report of 14,270 cardiac arrests from the National Registry of Cardiopulmonary Resuscitation. *Resuscitation* 2003; 58:297–308

The three most common reasons for cardiac arrest in adults (14,720 between January 1, 2000, and June 30, 2002, in NRCPR) that met inclusion criteria were (1) cardiac arrhythmia, (2) acute respiratory insufficiency, and (3) hypotension. Overall, 44% of adult in-hospital cardiac arrest victims had a return of spontaneous circulation (ROSC); 17% survived to hospital discharge.

Pittard AJ: Out of our reach? Assessing the impact of introducing a critical care outreach service. *Anesthesia* 2003; 58: 882–885

Observational study of a recently introduced outreach service reveals reduction in emergency admission rate to ICU from 58% to 43% ($p = .05$), shorter lengths of stay (4.8 days vs. 7.4 days), and lower mortality (28.6% vs. 23.5%; $p = .05$). The re-admission rate also fell from 5.1% to 3.3% ($p = .05$). The outreach service had a significant impact on critical care utilization.

Priestley G, Watson W, Rashidian A, et al: Introducing critical care outreach: A ward-randomized trial of phased introduction in a general hospital. *Intensive Care Med* 2004; 30:1398–1404

Cluster randomized trial design with phased introduction of a critical care outreach service across 16 adult wards during a 32-week study period. Outreach intervention reduced in-hospital mortality compared with control (two-level odds ratio, 0.52; 95% CI, 0.32–0.85). A possible increased length of stay associated with outreach was not fully supported by confirmatory and sensitivity analyses.

Salamonson Y, Kariyawasam A, van Heere B, et al: The evolutionary process of medical emergency team (MET) implementation: Reduction in unanticipated ICU transfers. *Resuscitation* 2001; 49: 135–141

Prospective 3-yr study of MET calls and unanticipated ICU transfers in a suburban metropolitan hospital. Findings included a significant fall in unanticipated ICU transfers; increased use of METs, resulting in the proportion of calls for cardiopulmonary arrest dropping from 30% in year 1 to 13% in year 3; a slight decrease in the percentage of in-hospital deaths (0.74% in year 1 to 0.65% in year 3); and slight decrease (0.08–0.07%) in incidence of cardiopulmonary arrest per hospital admission.

Schein RMH, Hazday N, Pena M, et al: Clinical antecedents to in-hospital cardiopulmonary arrest. *Chest* 1990; 98: 1388–1392

Prospective study of 64 consecutive patients who arrested in a general ward, 161 ± 26 hrs following hospital admission. Pathophysiologic alterations preceding arrest were classified as respiratory in 24 patients (38%), metabolic in 7 (11%), cardiac in 6 (9%), neurologic in 4 (6%), multiple in 17 (27%), and unclassified in 6 (9%). Patients with multiple disturbances had mainly respiratory (39%) and metabolic (44%) disorders; 54 patients (84%) had documented observations of clinical deterioration or new complaints within 8 hrs of arrest.

Sebat F, Johnson D, Musthafa AA, et al: A multidisciplinary community hospital program for early and rapid resuscitation of shock in nontrauma patients. *Chest* 2005; 127:1729–1743

Historically controlled single-center study from January 1998 to May 2000 in a 180-bed community hospital to determine the effect of a hospital-wide program enabling nurses and prehospital personnel to mobilize institutional resources for the treatment of patients with nontraumatic shock. The protocol group (n = 103) had significant reductions in the median times to interventions: intensivist arrival, 2:00 hrs to 50 mins ($p <$ .002); ICU/operating room admission, 2 hrs 47 mins to 1 hr 30 mins ($p <$ .002); 2 L fluid infused, 3 hrs 52 mins to 1 hr 45 mins ($p <$ .0001); and pulmonary artery catheter placement, 3 hrs 50 mins to 2 hrs 10 mins (p = .02). The protocol group also had better outcomes (p = .02) and lower mortality rate (p = .035).

Smith AF, Wood J: Can some in-hospital cardio-respiratory arrests be prevented? A prospective survey. *Resuscitation* 1998; 37:133–137.

A survey of cardiopulmonary arrests in unmonitored wards of a 625-bed teaching hospital to look for premonitory signs and patterns of deterioration in patients so that arrest calls could be predicted and possibly prevented. During a 28-wk period, calls were made for 47 patients on these wards. Twenty-four (51%) had premonitory signs. These patients were also less likely to survive to hospital discharge (p = .02). Conclusion: some cardiorespiratory arrests are predictable.

Story DA, Shelton AC, Poustie SJ, et al: The effect of critical care outreach on postoperative serious adverse events. *Anesthesia* 2004; 59:762–766

A sequential cohort study of postoperative adverse events in patients reviewed by a CCM nurse for the first 3 days after return to general ward, with a surveillance-only phase (baseline; n = 319) followed by an intervention phase (n = 345). Subgroup analysis in the surveillance phase: 4 MIs per 100 patients; other 10 serious adverse events, 19 per 100 patients; in the intervention phase: 7 MIs per 100 patients; other 10 serious adverse events, 11 per 100 patients. Outreach may have led to greater detection of myocardial infarctions while reducing the incidence of other serious adverse events.

Subbe CP, Davies RG, Williams E, et al: Effect of introducing the Modified Early Warning Score on clinical outcomes, cardio-pulmonary arrests and intensive care utilization in acute medical admissions. *Anesthesia* 2003; 58:797–802

Prospective study of 1,695 acute admissions. Patients with MEWS >4 were referred for urgent medical and critical care outreach team review. Data were compared with those from an observational study performed in the same unit during the preceding year. There was no change in mortality among patients with low, intermediate, or high MEWS. Rates of cardiopulmonary arrest, intensive care unit admission, or high-dependency unit admission were similar.

Subbe CP, Kruger M, Rutherford P, et al: Patients at risk: Validation of a modified early warning score in medical admissions. *Q J Med* 2001; 94:521–526

Prospective cohort study of 709 medical emergency admissions to which MEWS was applied. Scores of 5 or more were associated with increased risk of death (OR, 5.4; 95% CI, 2.8–10.7), ICU admission (OR, 10.9; 95% CI, 2.2–55.6), and HDU admission (OR, 3.3; 95% CI, 1.2–9.2). A clinical pathway could be created, using nurse practitioners and/or critical care physicians, to respond to high scores and intervene with appropriate changes in clinical management.