# The ERC Guidelines for Resuscitation 2005 and the Medical Emergency Team

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**ABSTRACT:**

**The outcome of in-hospital cardiac arrest remains poor and largely unchanged despite the long introduction of cardiac arrest teams. In-hospital cardiac arrest is usually not a sudden, unpredictable event but is preceded by signs of significant physiological instability for several hours, providing an opportunity for early recognition and treatment. Previous research has established what physiological variables can predict impending cardiac arrest. Such variables include significant changes in heart rate, respiratory rate, oxygen desaturation, and decreased level of consciousness and onset of seizures. By improving monitoring routines, a track-and-trigger system can be designed that alerts the need for further medical intervention, such as calling a medical emergency team (MET). The MET provides intensive care expertise to the patient's bedside irrespective of location in the hospital. The introduction of MET has been demonstrated to reduce the incidence and mortality of in-hospital cardiac arrests in several before-and-after trials, but further studies are needed to clarify optimal methods and the resource implications of delivering a MET service. Nonetheless, implementation of MET is being recommended by several medical organisations including most recently, the European Resuscitation Council, to improve the in-hospital management of patients at risk for cardiac arrest. This brief review highlights the background for these recommendations.**

## Cardiac arrests – treat or prevent?

Medical emergency teams (METs) are discussed in section 4 on adult advanced life support in the European Resuscitation Council Guidelines for Resuscitation 2005 (1). In the accompanying consensus document (2) it is recommended that introduction of a MET system for adult hospital in-patients should be considered. Details of implementation should be given special attention, as should the introduction of an early warning system to identify patients at risk for cardiac arrest.

While cardiac arrest teams have been widely implemented in hospitals, the outcome of in-hospital cardiac arrest patients remains dismal with survival rates to hospital discharge in the range of 15-20% (3, 4) often with poor neurological performance. In fact, one study demonstrated that only patients with return of spontaneous circulation prior to arrival of the cardiac arrest team survived to be discharged from hospital (5). In the resuscitation debate, the cardiac arrest team has, somewhat unfairly, at times been called "the team that is always too late".

Up to 80% of patients show signs of significant physiological deterioration in the hours before the cardiac arrest (6–8). Half of patients dying in hospital (excluding patients not for resuscitation) have abnormal vital signs in the 8 hours period preceding death and for approximately one-third of the patients, concern about the condition has been expressed in the medical notes, but with no further action recorded (9).

In comparison to general wards, outcome from cardiac arrest is significantly better in monitored ward areas such as coronary care units (CCU), intensive care units (ICU) and emergency departments (ED) where the medical staff is appropriately trained in symptoms recognition and resuscitation (10, 11). It may thus be inferred that a system to detect early warning signs of impending cardiac arrest and to summon adequate medical expertise for treatment could improve outcome in general ward areas. This is the rationale for establishing medical emergency teams to aim at preventing cardiac arrests as opposed to the de facto approach using traditional cardiac arrest teams.

## Signs preceding cardiac arrest - lack of recognition?

It has been suggested that in-hospital cardiac arrests should not be considered sudden or unexpected since they occur in a theoretically protected environment (12). The problem seems to lie with failure to recognize symptoms of significant deterioration preceding cardiac arrest and to institute appropriate therapy. Up to two-thirds of in-hospital arrests have been claimed to be potentially preventable (13). Less than optimal care in the period preceding cardiac arrest involve shortcomings in treating cardiorespiratory failure and incorrect use of oxygen therapy, failure to monitor patients, and breakdown of communication with other members of the team and senior medical colleagues (13, 14).

Berlot and colleagues (15) reviewed 148 cardiac arrest patients to identify relevant clinical antecedents and whether these had been recognized and adequately responded to. In 86%

of the patients, the nursing notes or medical records reported new symptoms or deterioration in the six hours preceding cardiac arrest. The main clinical antecedents were dyspnoea, arrhythmia (brady-, tachycardia and ventricular ectopic beats) and neurological changes (reduced level of consciousness, agitation and seizures). Therapy was instituted in less than half of the patients and included oxygen via facial mask, administration of diuretics, sedatives and intravenous fluids. In no patient was input from ICU or CCU requested before the cardiac arrest. Inconsistencies between medical and nursing notes were demonstrated with concern expressed only in nursing notes in 30% of cases. Only 23 patients survived to be discharged from hospital and of those only eight made a full neurological recovery. These results are similar to previous reports (8, 12).

Buist et al prospectively studied the association between predefined abnormal observations and risk of death (16). The observations included signs of respiratory failure (desaturation < 90%, tachy- or bradypnoea), cardiovascular failure (hypotension or severe hypertension, tachy- or bradycardia), and decreased level of consciousness or seizures. Oxygen desaturation below 90% and hypotension with blood pressure less than 90 mm Hg were the most frequent abnormal observations and were associated with an 1.4-fold and 1.8-fold respective increase in hospital mortality. Overall, abnormal observations were found at some stage in nine percent of patients admitted to hospital. The most predictive observations associated with increased risk of mortality were respiratory rate < 6 (13.7 fold increase), loss of consciousness (6.1 fold increase), and decreased level of consciousness by more than 2 Glasgow Coma Scale points (5.5-fold increase). The majority of abnormalities spontaneously resolved (67% of cases) or were normalized on the ward following treatment (22% of cases). It must be remembered that this study was performed in a hospital with an established MET. The mortality associated with the abnormal observations might be different in a hospital not operating MET. In addition, patients with not for resuscitation orders were not excluded in the study. However, the results are largely corroborated by similar findings in a study by Hodgetts et al that identified risk factors for cardiac arrest using a control population to discern the sensitivity and specificity of selected abnormal observations (17) as well as by other reports (18).

It thus seems that there are physiological warning signs preceding cardiac arrests that could be used as calling criteria to involve additional medical staff to ensure that the patient receives adequate medical treatment (19). Subjective calling criteria based on the ward staff being worried about the patient's condition is often added to the robust physiological objective variables to include subtle cues that, although difficult to quantify, alert nurses and doctors.

Table 1 presents one example of such calling criteria used for the MET at Liverpool Hospital, Sydney, Australia.

*Table 1. Medical emergency team (MET) calling criteria used at Liverpool Hospital, Sydney, Australia.*

| ACUTE CHANGES IN: | PHYSIOLOGY |
|---|---|
| AIRWAY | Threatened |
| BREATHING | ALL RESPIRATORY ARRESTS<br>Respiratory Rate < 5<br>Respiratory Rate > 35 |
| CIRCULATION | ALL CARDIAC ARRESTS<br>Pulse Rate < 40<br>Pulse Rate > 140 |
| NEUROLOGY | Sudden fall in level of consciousness<br>(fall in GCS of > 2 points)<br>Repeated or prolonged seizures |
| Other | Any patient who you are seriously worried about that does not fit the above criteria |

How should the management of the patient be organised once signs of deterioration are apparent? Traditionally, the ward nurse would call junior medical staff who would act with or without consultation from senior medical staff. The delay in this communication can be considerable allowing the patient to further deteriorate before proper action is taken. Moreover, the skills and experience required to care for patients when they become seriously ill are usually not possessed by staff caring for general ward patients (14, 20, 21).

### Signs preceding cardiac arrest – time to bring in the medical emergency team?

The medical emergency team consists of members trained in intensive care medicine on different levels, usually a doctor and a nurse. The composition might vary and in the UK outreach services, which operate with an aim similar to the MET system, are mainly staffed with senior, experienced ICU nurses working in liaison with an ICU consultant. The members of the MET fulfil several roles when called to a patient, such as to provide basic intensive care at the bedside, establish rapid communication with the team managing the patient as well as the ICU should referral be indicated, and to make collaborative decisions with the managing team for further treatment in case the patient is left on the ward. It should be recognised that the MET can play an important role to help identify patients in whom cardiac resuscitation should not be attempted and to support the documentation of such decisions (22).

The MET thus brings in hardware, such as monitoring tools, specific techniques and drugs, as well as software like knowledge and skills in prioritisation and communication, often under severe time constraints. Obviously, all these qualities need proper training and assessment within the MET system.

The concept of providing fast and easy access to intensive care expertise for acutely ill patients on general wards has been described as "critical care without walls" (23). Such a system strategy is promoted by several influential initiatives. In the US, the "100k Lives" campaign coordinated by the Institute for Healthcare Improvement aims at saving 100.000 lives (24), in part by implementing rapid response teams similar to MET. In Australia, where the pioneering work regarding MET was done by professor Ken Hillman and co-workers, the "Safer Systems – Saving Lives" campaign has a similar ambition (25). The strategy has been supported in the UK by the publication of "Comprehensive Critical Care: A review of adult critical care services" from the Department of Health that recommends implementation of outreach services (26).

## Medical emergency teams and in-hospital cardiac arrest

Several studies have to date been published on the implementation of METs to reduce the incidence and improve the outcome of in-hospital cardiac arrest. The majority of the studies are non-randomized, before-and-after trials, representing at best level 2 evidence (high-quality cohort studies of case-control design).

Buist et al (27), in a paper that evoked much debate, reported a reduction in the incidence of unexpected cardiac arrest from 3.77 to 2.05 per 1000 hospital admissions following implementation of MET. The mortality from cardiac arrest decreased in parallel from 77% to 56%. Bellomo et al (28) studied the effect of a MET on the number of cardiac arrests and overall hospital mortality in a prospective before-and-after trial. The incidence of cardiac arrest and related mortality, bed occupancy related to cardiac arrests and overall in-hospital mortality all decreased between the control and MET periods. This effect was sustained with a further progressive reduction over a four-year period (29).

Reports from the UK evaluating the implementation of outreach services have demonstrated similar positive effects (30) although unchanged incidence and mortality related to cardiac arrests have also been reported (31). The MET was recently introduced in a paediatric setting and resulted in trends towards decreased incidence of cardiac arrests and related mortality but with increased unplanned ICU admissions (32).

To date, only one trial with a true randomized design has evaluated the effects of introducing the MET system (33). In this logistically challenging project, 23 public hospitals across Australia were included and randomized to introduce a MET system (12 MET hospitals) or to continue functioning as usual (11 control hospitals) using a cardiac arrest team. The study comprised of a baseline period of two months, an educational period of four months and a six months follow-up period after establishing MET. A total of 56756 patients were admitted in control hospitals and 68376 patients admitted in MET hospitals. No significant differences between the MET and control hospitals were recorded for the incidence of cardiac arrests, unexpected deaths or unplanned ICU admissions. Notably, the incidence of cardiac arrest was reduced in both groups. These results may be explained by the lack of efficiency of the MET system. Alternative explanations include inadequate statistical power, contamination bias in control hospitals, unrecognized differences between hospitals relevant for the selected outcomes, poor compliance with the MET system, and insufficient periods for implementation and evaluation.

## Implementing medical emergency teams – time to move ahead?

Although there is limited data to support the evidence-based implementation of medical emergency teams (34, 35), it might still be argued that existing evidence for the efficacy of MET do support the concept and further delays in providing this service would be unethical (36). Taking this argument to its extreme, it is difficult to imagine ethical approval for a study in which patients were randomized to either receive proactive treatment with level 2 evidence to avoid impending cardiac arrest or to be resuscitated following cardiac standstill.

The recommendation in the ERC 2005 Guidelines identifies several issues that will need special attention in the implementation of MET. These include composition and availability of the team, calling criteria and method of activation of the team, and education and awareness of hospital staff. From the Scandinavian perspective, data on the incidence and outcome of in-hospital adverse events needs to be collected to guide the most efficient implementation of MET, given the significant efforts and resources involved. The scientific body of evidence for MET originates almost exclusively from Australia, the UK and the USA, where the health systems in many ways operate quite differently compared to Scandinavia and many other European countries. Cost-benefit analyses including staffing issues following the implementation of METs are eagerly awaited. The recently initiated mobile intensive care groups (MIG) in Scandinavia will most definitely need to find their own optimal mode of operation. Established clinical and research networks within critical care medicine might prove valuable for evaluation, audit and governance of MET implementation (e.g. the Scandinavian Society of Anaesthesiology and Intensive Care Medicine, www.ssai-nordic.org, and the Scandinavian Critical Care Trials Group, www.scctg.org).

Although there are no published reports on adverse effects of a MET system, the risk of deskilling of medical staff needs to be considered. The MET should assist in disseminating basic intensive care skills to enhance and not simply replace skills on the ward. The ownership of the patient needs detailed and transparent discussions. The MET should not take over responsibility unless the patient is directly transferred to ICU.

Several documents published by organizations endorsing medical emergency services exist to guide implementation and evaluation strategies (23-25, 37-39). A series of consensus conferences on medical emergency teams has recently been initiated and an associated web site was recently launched (www.metconference.com).

In conclusion, the introduction of medical emergency teams to improve the management of acutely ill ward patients at risk for deteriorating to cardiac arrest is supported by before-and-after trials (level 2 evidence) and is recommended by several institutions including the European Resuscitation Council. However, additional research into implementation strategies, audit and governance is needed, especially when MET systems are established in healthcare systems outside the original context.

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