Review

Bench-to-bedside review: The MET syndrome – the challenges of researching and adopting medical emergency teams

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Abstract

Studies of hospital performance highlight the problem of 'failure to rescue' in acutely ill patients. This is a deficiency strongly associated with serious adverse events, cardiac arrest, or death. Rapid response systems (RRSs) and their efferent arm, the medical emergency team (MET), provide early specialist critical care to patients affected by the 'MET syndrome': unequivocal physiological instability or significant hospital staff concern for patients in a non-critical care environment. This intervention aims to prevent serious adverse events, cardiac arrests, and unexpected deaths. Though clinically logical and relatively simple, its adoption poses major challenges. Furthermore, research about the effectiveness of RRS is difficult to conduct. Sceptics argue that inadequate evidence exists to support its widespread application. Indeed, supportive evidence is based on before-and-after studies, observational investigations, and inductive reasoning. However, implementing a complex intervention like RRS poses enormous logistic, political, cultural, and financial challenges. In addition, double-blinded randomised controlled trials of RRS are simply not possible. Instead, as in the case of cardiac arrest and trauma teams, change in practice may be slow and progressive, even in the absence of level I evidence. It appears likely that the accumulation of evidence from different settings and situations, though methodologically imperfect, will increase the rationale and logic of RRS. A conclusive randomised controlled trial is unlikely to occur.

All truth passes through three stages.
First, it is ridiculed.
Second, it is violently opposed.
Third, it is accepted as being self-evident.

Arthur Schopenhauer (1788-1860), German philosopher

Introduction

Hospitals now treat increasingly complex patients. Despite the growth of technology and the development of new medications, 10% to 20% of hospitalised patients develop adverse events, with an overall hospital mortality of 5% to 8% [1-3]. Importantly, an estimated 37% of these events may be preventable [3]. Multiple studies from Europe, the US, and Australia have also confirmed deficiencies in the way hospitals and 'traditional' models of care respond to acute illness in the wards [4-7]. One deficiency of the hospital system's approach to acute illness is the problem of 'failure to rescue' [8]: failure to deliver rapid and competent care to an acutely ill ward patient. Traditionally, hospitals have left such rapid responses to either the parent unit or cardiac arrest teams. Unfortunately, the parent unit doctors are often unable to attend the patient rapidly or are not specifically or sufficiently trained in acute resuscitation [4-7]. Although cardiac arrest teams have been around for decades, they often arrive at the end of the disease cascade, are unsuccessful in greater than 85% of patients, and patients so treated may survive the arrest but carry a high risk of hypoxic brain injury [9-11]. These observations suggest that earlier recognition of disease progression provides the opportunity to avert major adverse events in many cases. In others, it provides the opportunity to put in place a terminal care plan that prevents unnecessary interventions and an undignified death.

Early recognition of an 'at-risk' situation is important in ensuring patient safety. Physiological warning signs (instability) of impending cardiac arrest have been repeatedly demonstrated to be common [6,8-10] and to precede such events by several hours, with 60% to 84% of cardiopulmonary arrest patients showing physiological instability within 6 to 8 hours of the event [12,13]. However, in traditional systems, the hospital's response is often late and inadequate [12-24]. The outcome of this approach has not improved in 50 years. Clear evidence of inadequate ward care was provided by a study from the UK [6] which found that, prior to intensive care unit (ICU) admission, suboptimal management of oxygen therapy,

ICU = intensive care unit; MERIT = Medical Emergency Response Improvement Team; MET = medical emergency team; RRS = rapid response system.

airway, breathing, circulation, and monitoring occurred in over half of patients. These errors were essentially due to the failure to apply or appreciate the need for basic resuscitation measures. Major causes of suboptimal care included failure of organisation, failure to appreciate clinical urgency, and failure to seek advice [6]. In summary, there is much evidence that 'failure to rescue' is common in patients at risk for major adverse events. There is also evidence that failure to appreciate the clinical urgency of situations is common, that the knowledge and skills to deal with such situations are limited among ward doctors and nurses, and that, in most patients, there are warning signs for a long enough period to allow appropriate action to be taken.

Critical care for the critically ill anywhere in the hospital

The concept of rapid and early rescue is well established in various fields of medicine, especially in trauma, cardiology, and, more recently, severe sepsis and septic shock [25-27]. It would make sense to apply these concepts to critical illness in general, wherever it may occur in the wards, and to use an RRS to deliver early intervention by specifically trained teams. In this regard, it is important to realise that, in most hospitals, the expertise exists to rapidly deliver the skills and knowledge to the bedside when necessary to deal with critical illness. Critical care physicians and critical care nurses can theoretically deliver such expertise anywhere in the hospital within minutes.

The field of critical care medicine has made considerable progress in improving outcomes of critically ill patients. Given that most acute illness develops through stages of deterioration, the logical step surely would be to bring intensive care equipment and expertise to any acutely ill patient, irrespective of location within the hospital, in what has been described as creating a 'critical care system without walls' [28]. The medical emergency team (MET) brings this expertise to the patient in a timely manner and supplies the 'efferent arm' of this process of identification of at-risk patients and rapid delivery of appropriate care, designated recently as the rapid response system (RRS) [29].

Because the care of critically ill patients is their core specialty competency, intensive care doctors and nurses are ideally placed to provide immediate care to patients who are critically ill: they are acute illness specialists. The value of specialists in expert management of specific disease conditions is widely accepted. Specialists are so named because they are trained with particular skills and in-depth knowledge. It would seem illogical for inadequately trained doctors to treat acutely ill patients instead of critical care physicians and nurses being responsible for their management [30].

Common sense or science

The concepts presented above seem, at face value, to simply represent common sense. However, in an era of 'evidence-based medicine', the efficacy of the MET and utility of the RRS have been criticised for lacking sufficient high-quality evidence in the form of randomised controlled trials. Meta-analytical techniques have been used to demonstrate the weakness of such evidence [31,32]. For example, in a recent meta-analysis by Winters and colleagues [32], although the respective relative risks (95% confidence intervals) for hospital mortality and cardiac arrest were 0.76 (0.39 to 1.48) and 0.94 (0.79 to 1.13) (suggesting a benefit), the authors concluded that the heterogeneity of the studies and wide confidence interval suggest that adopting RRS as a standard of care is premature and possibly wrong.

In our opinion, however, there are unique issues surrounding RRS which need to be taken into account when interpreting the available evidence. First, these systems are not simple tablets whose efficacy or effectiveness can be tested in double-blind randomised controlled trials [33]. Second, these systems are complex human activities. They require consideration of several important anthropological, organisational, political, logistic, and administrative aspects [29]. These aspects profoundly affect the implementation, performance, and efficacy of such systems. Third, acceptance of the cultural changes associated with the introduction of RRS requires time, making early assessment of such systems flawed and non-representative of their later performance [29,34]. Accordingly, the challenges surrounding the implementation of such systems require detailed discussion.

The challenges of implementing rapid response systems

Even when the concept of RRS is believed to be advantageous, the actual implementation entails overcoming a myriad of barriers: political, financial, educational, cultural, logistic, anthropological, and emotional (Table 1). Some of these challenges are particularly important to consider.

Rapid response system breaks with 'tradition'

The culture of ward doctors managing acutely unwell patients is changed by the introduction of RRS. We have seen this at our institution, where ICU doctors and nurses are no longer viewed as experts confined to the 'ivory tower' of the ICU but are now constantly assessing and helping to treat 'at-risk' patients in general wards [35]. This paradigm shift in our hospital culture and medical practice has changed how the roles of ICU and hospital doctors and nursing staff are being viewed. Nevertheless, allegiance to the traditional approach of initially calling the parent medical unit doctors when there are objective early signs of clinical deterioration is difficult to eradicate: 72% of nurses surveyed continue to choose to call the parent unit first, despite several years of RRS operation [36]. It is an extraordinary challenge to change 'culture'.

Rapid response systems challenge medical 'power'

The MET patient is created by the environment and the disease and not by the disease *per se*. This implies a

Table 1

Implementation difficulties with the rapid response system

Difficulties of implementing the rapid response system
Breaks from traditional hierarchy of medical consults
Challenges medical 'power'
Gives ward nurses more independent authority
Perceived shame in calling the MET
Inefficient ward monitoring of physiological signs
Delay in activating the MET
Non-clinical challenges
logistics
financial
educational
cultural
emotional
anthropological
political

MET, medical emergency team.

mismatch between resources and needs as a component of the syndrome. The arrival of the MET brings a critical care environment to the bedside. In a sense, when an MET syndrome develops, it could be argued that both the hospital and the patient are 'sick' [37]. Occasionally, errors that underlie the development of the MET syndrome naturally surface during an MET review [38]. This often causes parent medical unit doctors and ward nurses to worry about criticism. It is important to emphasise that the MET service is 'hospital policy' and that no hospital staff should be reprimanded for calling the MET. Similarly, it is vital to reiterate that the MET intervention does not represent an attempt by the ICU staff to take over patient management [35]. Despite these assurances, many doctors remain uncomfortable over the perceived loss of control and the fact that nurses can activate the MET without requiring permission from them. Ignoring these problems and not seeking to reassure medical staff is likely to increase the chance of failure of an RRS.

Rapid response systems give ward nurses more power

As nurses are in direct patient contact most of the time, they also need and call an MET most. Surveys have shown that a majority of nurses welcome the availability of an MET service, with 84% feeling that it improves their work environment and 65% considering it a factor when seeking a new job in an institution [39,40]. The MET enables the nurse to exercise independent judgement and to call for immediate assistance should the patient fulfill a predetermined set of clinical criteria. He or she can bypass the delay often apparent with calling for help through a hierarchy of medical and nursing staff. This is seen even in experienced nurses, who in an Australian survey were found to be more likely to activate an MET [40]. Nurses are the most powerful and numerous allies of RRS.

Staff may be ashamed to call a medical emergency team

The issue of professional pride or fear of blame has to be overcome. Activation of an MET does not imply that ward personnel are incapable or unwilling to manage the patient themselves. This aspect must be emphasised in educational and preparation sessions. Hospital administration supporting the MET system needs to engage all staff in a re-orientation from individual to system thinking [41]. Policies should be widely available and regularly reinforced and communicated by senior hospital staff. As data collection and audits are part of the feedback arm of the MET [29], positive action should be taken to encourage favourable staff behaviour.

Ward monitoring needs constant improvement

Several studies have shown a circadian pattern of activation of MET [42-44]. This peculiar variation is most likely explained by the interaction between ward staff caring for the patient and the monitoring tools used. Such variation is absent in the ICU, where more extensive monitoring and a higher nurse/patient ratio are standard [43]. Recordings of early signs of critical conditions were 7.7 times more frequent than late signs, with nurses accounting for 86.1% of these [45]. Interestingly, in that study, 17.8% of all recordings of early signs and 9% of late signs were judged by nurses to be 'usual for the patient'. These commonly included mild hypoxaemia, hypercarbia, and hypotension. As the MET call criteria depend heavily on physiological alteration of signs, poor monitoring equipment, methods, and recognition by staff may be a major stumbling block in improving outcomes and RRS performance. Regular staff educational programs and audits of technology and processes of care are necessary to minimise these problems.

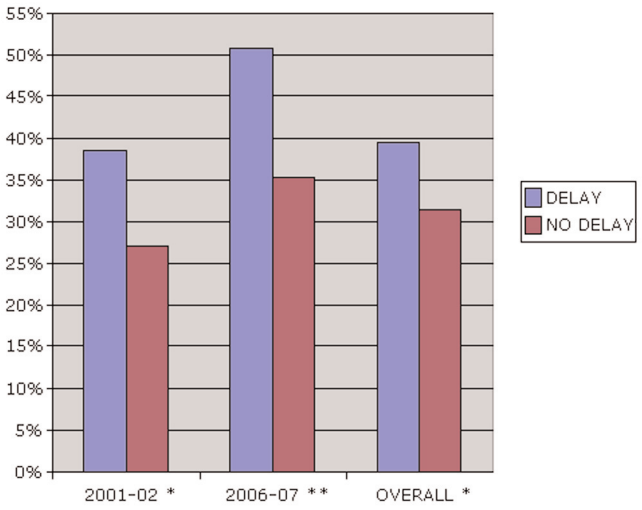
Major delays in calling a medical emergency team

Despite positive attitudes toward the MET system, nurses may not always follow the predetermined MET activation criteria or may fail to recognise when assistance is required. Daffurn and coworkers [46] showed, in a study conducted 2 years after implementation of an MET system, that nurses variably correctly identified scenarios warranting an MET call in 17% to 73% cases. Hypotension did not appear to alert nurses to summon assistance, and some nurses would still call a resident rather than the MET in the presence of severe deterioration and patient distress. Unpublished data from our experience confirm that delays in calling an MET are associated with increased in-hospital mortality (Figure 1) and that even a minor delay has a substantial effect on outcome. These observations highlight another challenge in the adoption and research of such systems. If deficient MET systems are tested, they may fail to show a clinical benefit. No matter how good the system is, major methodological challenges need to be overcome to evaluate such systems in a rigorous and clinically relevant way.

Evaluating the medical emergency team system

Medical technologies and drugs are assessed using methodology favouring the statistical power of large numbers

Figure 1



The effect of delay in medical emergency team (MET) calls on mortality in two cohorts of patients at the start of an MET program and 5 years later. *p <0.001; **p <0.004.

and certain study designs. This approach dismisses real-life relevance, Bayesian logic, and common sense as too biased and methodologically flawed. Though scientifically valid, this approach fails to achieve a balance between rigour and real-life evidence in assessing process improvement [33]. The effectiveness of the MET is related to a systematic change in the way hospitals deliver care. An alternative, 'pragmatic science' approach by Berwick [47] promotes tracking effects over time, integrating detailed process knowledge into the work of interpretation, using small samples and short experimental cycles of change, and using multifactorial designs in evaluating system change. According to this paradigm, common sense practices like bringing critical care expertise to acutely ill ward patients might not require randomised controlled trials and other evidence-based methodology before incorporation into practice. We note that no randomised multicentre double-blind controlled trials exist to test the effectiveness of hand-washing by doctors and nurses.

Even if one intended to conduct a randomised controlled trial of METs within an institution, this would be made nearly impossible by the Hawthorne effect [48]. This effect would artificially lead to an improvement in the care of control patients, with doctors and nurses imitating the intervention being studied. It is also unethical to randomly assign acutely ill patients, as it would deny potentially life-saving interventions to those randomly assigned to 'placebo'. Adequately matched case-control studies, though not considered sufficiently rigorous, may avoid some of the shortcomings [49]. As a consequence, only hospitals can become the unit of randomisation (cluster randomisation) [50]. In the largest cluster randomised study of METs [51], the Medical Emergency Response Improvement Team (MERIT) study, investigators randomly assigned participating hospitals to standard care or the introduction of an MET. The result was an increased overall MET calling rate in MET hospitals but no substantial effect on cardiac arrest, unplanned ICU admissions, or unexpected death. However, that study had major shortcomings from severe lack of statistical power due to the large variance in outcome incidence and wide standard deviation and the lower-than-expected incidence of the outcome measures under investigation. Given the incidence and variance of such outcomes, more than 100 hospitals would have been needed to show a 30% difference in the composite outcome, whereas only 23 hospitals were actually recruited. Inadequate and non-uniform implementation of the MET was also an issue in MERIT as there was a lack of a continued educational process throughout the study period. Furthermore, the call rate in MERIT was much lower (<20%) than that seen in hospitals implementing successful MET programs. This is not surprising as the evaluation time was only 6 months. Typically, such systems require more than a year or two to mature.

Before-and-after studies

The current literature on MET shows many examples of before-and-after studies dealing with single-centre data [52-56]. Inherent within this type of evidence is the lack of rigour and generalisability. Furthermore, the magnitude of the effect of the MET may be influenced by institution-specific administrative features and policies. Buist and coworkers [52] showed a 50% reduction in the incidence of cardiac arrests, whereas a study by DeVita and colleagues [54] reported a 17% decrease. Data from our institution [53] revealed a 65% relative risk reduction in a 4-month comparison study in surgical patients. Of note, almost all studies point to an effect of the MET in reducing cardiac arrests. The type of patients evaluated does appear to differ in outcomes, with surgical postoperative cases benefiting the most in terms of mortality reduction [55,56]. Despite methodological shortcomings, the MET has proliferated in hospitals, although controversy continues over whether it should be a standard of care (Table 2). Even if one believed in the concept of MET, adopting the MET poses major political and logistic challenges. One has to convince colleagues, educate nurses and doctors, maintain awareness, and ensure collegiality and performance [34,57-59]. Time is needed for the MET concept to 'bed in' [58] in order to reap its benefits in a substantial manner. Repeated education and periodic assessment of site-specific obstacles to utilisation of MET should be addressed [59]. If education and staff awareness can be maintained after the initial introduction, the MET system continues to increase in efficacy. Short-term studies may therefore underestimate its impact [34]. RRSs with their MET components are not easy, nor are they simple. Yet, they are worth the effort.

Table 2

Research difficulties with the rapid response system

Difficulties with researching the rapid response system
Dismisses real-life relevance and common sense
Dependence of randomised trial methodology on numerical strength, which requires patient randomisation
Hawthorne effect improves outcomes in control patients
Unethical to randomly assign patients to 'placebo'
Cluster randomisation of hospitals requires large numbers of centres
Before-and-after studies lack rigour and generalisability

Gaps and knowledge and future research

Our understanding of the issues that surround RRSs is very limited. Only a few studies have been conducted in even fewer centres. The gaps in our knowledge define the future research agenda. We know little about the epidemiology of abnormal vital signs in hospital patients and the outcome of patients who experience them. We know little about the specificity and sensitivity of specific vital sign abnormalities and/or of clusters of such signs. We do not know whether improved monitoring technology with increased automation of vital sign recording and with advisory response systems can decrease adverse events or improve team activation. We do not know about the anthropology and psychology of how nurses and doctors currently respond to changes in patient status and why they do or do not activate RRSs. We do not know what teams do at the bedside which is useful and what they do at the bedside which is not useful. We have very little information on how such teams affect the issuing of not-for-resuscitation orders in ward patients who are acutely ill. We have limited knowledge of how such systems might affect surgical patients differently from medical patients and how activation may occur differently in different specialty areas. In short, the gaps in our knowledge are wide and the research agenda equally big. Yet the process has just begun and there is growing momentum in terms of clinical application and investigation. It is likely that, once critical care physicians realise this is a new frontier for the specialty, we will be able to start filling these gaps step by step.

Conclusion

Translating common sense into evidence for a complex intervention like MET poses enormous challenges, and only progressive accumulation of evidence from different settings and situations will ultimately sway physician behaviour. A conclusive randomised controlled trial is unlikely to occur. Medical leadership needs to acknowledge the fact that acutely ill patients in the wards should be identified rapidly and that critical care expertise, resources, and personnel should be delivered to the bedside of the critically ill wherever they are. In the words of the slogan of the American Society of Critical Care Medicine, we need to deliver the 'right care, right now'. Hospital wards should be no exception.

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Competing interests

The authors declare that they have no competing interests.

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