Your Call Is Important to Us. Do Not Put Your Medical Emergency Team On Hold*

Eldar Søreide, MD, PhD
Department of Anesthesiology and Intensive Care
Stavanger University Hospital
Stavanger, Norway
Department of Clinical Medicine
University of Bergen
Bergen, Norway

Anders Åneman, MD, PhD, EDIC, FCICM
Department of Intensive Care Unit
Liverpool Hospital
South Western Sydney Area Health Service; and
University of New South Wales
Sydney, NSW, Australia

Rapid response systems (RRSs) have been introduced in an effort to reduce serious adverse events in hospitalized patients, typically identified as unexpected deaths, cardiac arrests, and unplanned intensive care admissions. Although the efficacy of RRS arguably makes intuitive sense and is clinically plausible, there is still insufficient evidence to guide the optimal design, organization, implementation, and governance of RRS (1).

The complex nature of an RRS makes its ultimate performance critically dependent on the adequacy of a diverse range of functions from the monitoring, recording, and interpretation of physical signs via the establishment of effective and timely communication across different professions and medical specialties to access of specialized clinical knowledge, skills, and resources. No chain is stronger than its weakest link and this certainly applies to RRS. In particular, the shortfall to activate the efferent response in the presence of agreed criteria constitutes an afferent limb failure that has remained an intriguing and challenging aspect of operating RRS since their inception. Afferent limb failure has previously been reported even in mature RRS and found to be associated with adverse outcomes, including death, particularly when the duration of afferent limb failure was long (2–5). Indeed, in the only attempt to date to study RRS using a hospital cluster randomized controlled study design, afferent limb failure was significant since the RRS was only activated in 30% of patients who fulfilled calling criteria (6). It has recently been suggested that the "score to door time" for RRS-triggered ICU admission represents a benchmarking tool for quality assurance of RRS (7). Obviously, no intervention to improve the outcome of deteriorating ward patients, irrespective of its sophistication and potential benefit, can ever work if not actually deployed. The barriers to activating RRS seem to involve predominantly sociocultural factors that are both complex and usually not explicit (8).

In this issue of *Critical Care Medicine*, Boniatti et al (9) report the findings in a prospective observational study of the prevalence of delayed medical emergency team (MET) calls and the associated 30-day mortality in an 800-bed (70 ICU beds) Brazilian university-affiliated hospital 20 months following the introduction of an RRS. The external validity of the study appears adequate with RRS design, team composition, and trigger criteria similar to international practice. A relatively high MET "dose" was observed with approximately 40 MET calls/1,000 admissions and given that 10% of hospital beds were allocated to the ICU, access to intensive care should not have been a limiting factor.

Approximately one fifth of all MET calls were delayed, predominantly when made by physicians rather than nursing staff, and this delay was associated with a significant increase in 30-day mortality. The results of their study are well aligned with previous reports and form another piece in the puzzle of corroborating evidence for the intuitively reasonable claim that an early, rather than late, MET response to clinical deterioration improves clinical outcomes.

The authors have previously (10) reported the prognostic value of their MET calling criteria that are based on a track and trigger design, including a MET score reflecting the number of MET call criteria present. Using this documentation the authors went on to study 1,481 MET calls and divided them into timely (within 30 min) and delayed (30 min to 8 hr and > 8 hr to 24 hr) MET calls (9). To fully appreciate the implications of this study, it is essential to understand their approach to document a delayed MET call. The investigators reviewed the medical records to assess whether any MET criteria had been present and documented more than 30 minutes and less than 24 hours before the actual MET call. Because of the limitations inherent with a "retrospective" review of the MET call, the investigators had to omit the MET calling criteria of threatened airway, seizures, altered level of consciousness, and "concern for

*See also p. 26.

Key Words: medical emergency team; patient outcome; rapid response system

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patient" for which variable interpretation and documentation precluded further analysis. This is an obvious weakness of the study design, and it could be argued that the patient groups with timely and delayed MET responses are hardly reconcilable with a bias toward physiological numerical calling criteria. Even in a prospective review, the interpretation of the "concern for patient" criterion is difficult to ascertain for a delayed response with several members of the clinical team involved over time. Nevertheless, the "concern for patient" criterion is important and represented about 40% of all MET calls in the the Medical Early Response, Intervention and Therapy (MERIT) study (11).

Another potential concern with their study design involves the timeliness and frequency of documenting deteriorating vital signs that is crucial for the definition of a delayed MET call. The investigators had, however, previously reported complete documentation of vital signs four-hourly in all patients at their institution (10), which is an enviable level of documentation definitely not seen in every RRS-equipped hospital.

One striking finding in this study was the overall high rate of ICU admissions and deaths in both groups following MET activation. Although a relatively low proportion of delayed MET calls occurred more than 8 hours (25%), the mortality in this group was somewhat surprisingly not different from that observed in patients with a delayed MET call within 8 hours. Furthermore, the mortality did not increase with the number of MET criteria present (MET score). Several reasons might explain these findings, including the fact that only objective physiological criteria were used to identify the delayed MET call group.

Notwithstanding these considerations, the authors overall conclusion that delayed MET calls were associated with worse outcomes appears valid. The next question will be how to remedy afferent limb failure. This is an important task for everyone involved in operating an RRS. Even continuous automated monitoring to identify the presence of MET calling criteria can be associated with delays, possibly related to a deceptive sense that the level of care has been escalated (12). The pivotal step is to establish effective communication between attending clinical staff and the MET. Use of standardized communication formats may facilitate this and improve outcomes (13). The recommendation from the efferent limb to the afferent limb of any RRS should be "Call, don't wait. Your call is important to us. Do not put your MET on hold!"

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Delayed Medical Emergency Team Calls and Associated Outcomes*

Márcio M. Boniatti, PhD, MD[1]; Neusa Azzolini, MD[2]; Marina V. Viana, MD[2]; Berenice S. P. Ribeiro, MD[2]; Renata S. Coelho, MD[2]; Rodrigo K. Castilho, MD[2]; Márcio R. Guimarães, MD[2]; Lia Zorzi, MD[2]; Luis F. Schulz, MD[2]; Edison M. Rodrigues Filho, MD[2]

Objective: To determine whether there was an association between delayed medical emergency team calls and mortality after a medical emergency team review.

Design: This was a prospective observational study.

Setting: A university-affiliated tertiary referral hospital in Porto Alegre, Brazil.

Patients: All patients were reviewed by the medical emergency team from July 2008 to December 2009.

Interventions: None.

Measurements and Main Results: There were 1,481 calls for 1,148 patients. Delayed medical emergency team calls occurred for 246 patients (21.4%). The criterion associated with delay was typically the same criterion for the subsequent medical emergency team call. Physicians had a greater prevalence of delayed medical emergency team calls (110 of 246 [44.7%]) than timely medical emergency team calls (267 of 902 [29.6%]; $p < 0.001$). The mortality at 30 days after medical emergency team review was higher among patients with delayed medical emergency team activation (152 [61.8%]) than patients receiving timely medical emergency team activation (378 [41.9%]; $p < 0.001$). In a multivariate analysis, delayed medical emergency team calls remained significantly associated with higher mortality.

Conclusions: Delayed medical emergency team calls are common and are independently associated with higher mortality. This result reaffirms the concept and need for a rapid response system. (*Crit Care Med* 2014; 42:26–30)

Key Words: delayed intervention; medical emergency team; mortality; patient outcome; rapid response system; vital signs

***See also p. 195.**

[1]Critical Care Department, Hospital Nossa Senhora da Conceição, Porto Alegre, Rio Grande do Sul, Brazil.

[2]Critical Care Department, Santa Casa de Misericórdia, Porto Alegre, Rio Grande do Sul, Brazil.

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For information regarding this article, E-mail: marciobt@terra.com.br

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Serious adverse events are common in hospitalized patients (1). It is possible to prevent such events by recognizing that they are preceded by signs of instability in up to 80% of cases and offering an opportunity for intervention (2, 3). The rapid response system (RRS) is based on this concept and was introduced for early intervention in any situation in which the patient's clinical condition deteriorated acutely (4). The premise of this system is that an early intervention during the course of clinical deterioration can improve patient outcome.

The medical emergency team (MET), one of the defined response teams, is activated in response to established criteria (triggers) (5). The identification of these criteria and timely activation of the team are functions of the afferent limb of the RRS (6). Some studies suggested that a delay between the identification of a trigger and the actual MET call is associated with higher mortality (7–9). However, a more recent study did not confirm this finding, and there are doubts about this association (10). Thus, we evaluated whether there is an association between delayed MET calls and mortality and examined the prevalence of and factors associated with this delay.

MATERIALS AND METHODS

This was a prospective observational study performed at a university-affiliated hospital in Porto Alegre, Brazil. The hospital has 794 beds with approximately 31,000 admissions per year. There are six separate ICUs with 71 beds. The RRS was introduced at this hospital in October 2006 after a process of preparation and education. The MET comprises a senior intensivist and intensivists who are on call 24 hr/d, 7 d/wk. The system can be activated by any member of the hospital according to preset criteria.

The criteria to activate the team are based on acute changes in heart rate (< 40 or > 140 beats/min), systolic blood pressure (< 90 mm Hg), respiratory frequency (< 5 or > 36 breaths/min), level of consciousness (decrease in Glasgow Coma Scale ≥ 2 points), oxygen saturation (< 90%), threatened airway (necessity for intubation, intratracheal suctioning or tracheostomy care), repeated or prolonged seizures (> 5 min), and concern about the patient (which includes any possible emergency situation). The calls are made via a pager system.

All patients reviewed by the MET from July 2008 to December 2009 were included. The data collected included patient demographics, reason for the call, the immediate outcome of the patient after care, presence of a do-not-resuscitate order, and the MET score (11) (each of the physiological triggers is considered 1 point, and scores of zero indicate calls made due to concern for the patient, without another trigger). A delayed MET call was defined as documented MET criteria for which no MET call was made during the period 30 minutes to 24 hours prior to a MET review. A call within 30 minutes of the documentation of MET criteria was not considered delayed. The duration of the delay was divided into two time periods: 30 minutes to 8 hours and more than 8 hours. The documented MET criteria were any of the criteria based on vital signs. The criteria of concern about the patient, threatened airway, seizures, and alteration of level of consciousness were not used to define delayed activation. This was due to the variable interpretation and recording of these criteria on the patients' medical records. The patients were followed for 30 days after the MET review.

Statistical Analysis

The data are presented as the mean ± SD. The chi-square test or Fisher exact test was used as appropriate for categorical data, and Student *t* test was used for continuous data. All variables associated with 30-day mortality in a univariate analysis with *p* value of less than 0.10 were included in a multivariate analysis using a Cox regression model with backward elimination. We computed a survival curve from this Cox model. Significance was set at 0.05. Statistical analysis was performed using the commercially available statistical program SPSS 15.0 (SPSS, Chicago, IL).

The study was approved by the institutional ethics committee. The need for informed consent was waived.

TABLE 1. Demographic and Clinical Variables and Outcome

Variable	Timely MET Call (%)	Delayed MET Call (%)	*p*
n	902 (78.6)	246 (21.4)	
Age, yr	63.2 ± 17.0	61.7 ± 16.9	0.74
Gender, male, *n*	464 (51.4)	117 (47.6)	0.41
Medical, *n*	587 (65.1)	147 (59.8)	0.13
Who generated the call			< 0.001
Nurse	635 (70.4)	136 (55.3)	
Resident	204 (22.6)	88 (35.8)	
Attending physician	63 (7.0)	22 (8.9)	
Calling criteria, *n*			
Threatened airway	100 (11.1)	32 (13.0)	0.43
Systolic blood pressure < 90 mm Hg	139 (15.4)	88 (35.8)	< 0.001
Decrease in Glasgow Coma Scale ≥ 2 points	138 (15.3)	40 (16.3)	0.69
Repeated or prolonged seizures	31 (3.4)	0	< 0.001
Respiratory rate (< 5 or > 36 breaths/min)	89 (9.9)	62 (25.2)	< 0.001
Heart rate (< 40 or > 140 beats/min)	70 (7.8)	30 (12.2)	0.08
Oxygen saturation (< 90)	297 (32.9)	143 (58.1)	< 0.001
Concern about the patient	331 (36.7)	17 (6.9)	< 0.001
MET score groups, *n*			< 0.001
Score 0	331 (36.7)	17 (6.9)	
Score 1	373 (41.4)	122 (49.6)	
Score 2	140 (15.5)	66 (26.8)	
Score ≥ 3	58 (6.4)	41 (16.7)	
Do-not-resuscitate order, *n*	104 (11.5)	43 (17.5)	0.02
Admission to the ICU, *n*	333 (36.9)	155 (63.0)	< 0.001
30-d mortality, *n*	378 (41.9)	152 (61.8)	< 0.001

MET = medical emergency team.

RESULTS

During the study period, 1,481 calls were made for 1,148 patients, representing approximately 40 calls/1,000 admissions. The demographic, clinical, and outcome variables are shown in **Table 1**.

Delayed MET calls occurred in 246 patients (21.4%). Among these patients, 43 patients (17.5%) simultaneously presented two or more criteria with delay, and the duration of the delay was less than 8 hours for 184 patients (74.8%).

There was no difference in gender, age, or type of admission (medical or surgical) among the patients with or without a delayed call. Saturation less than 90% and systolic blood pressure less than 90 mm Hg were the main triggers for patients for whom delay occurred. The criterion associated with the delay was typically the same criterion for the subsequent MET call. For the patients without delay, the main trigger was concern about the patient.

The prevalence of delayed calls was significantly higher for physicians (110 of 377, 29.2%) when compared with nurses (136 of 771, 17.6%; $p < 0.001$).

TABLE 2. Univariate Analysis of Variables Predictive of 30-Day Mortality

Variable	Nonsurvivors	*p*
Gender		0.004
Male	293 (50.3)	
Female	237 (41.9)	
Glasgow Coma Scale		< 0.001
15	206 (35.1)	
12–14	145 (57.3)	
7–11	93 (54.4)	
3–6	71 (65.1)	
Do-not-resuscitate order		< 0.001
Yes	115 (78.2)	
No	411 (41.4)	
Delayed MET call		< 0.001
Yes	152 (61.8)	
No	378 (41.9)	
Medical		< 0.001
Yes	380 (51.8)	
No	150 (36.2)	
MET score groups		< 0.001
Score 0	115 (33.0)	
Score 1	232 (46.9)	
Score 2	107 (51.9)	
Score ≥ 3	76 (76.8)	

MET = medical emergency team.

The mortality at 30 days after the MET review was higher among patients with delayed MET activation (152 [61.8%]) than patients receiving timely MET activation (378 [41.9%]; $p < 0.001$) (**Table 2**; **Fig. 1**). In the multivariate analysis, delayed MET calls remained significantly associated with higher mortality (**Table 3**). Patients with only one criterion associated with delay presented similar mortality to patients with two or more simultaneous criteria (124 of 203 [61.1%] vs 28 of 43 [65.1%]; $p = 0.73$). Mortality was also similar among patients with a delay time of less than 8 hours (110 of 184, 59.8%) compared with patients with a delay time greater than 8 hours (42 of 62 [67.7%]; $p = 0.29$).

DISCUSSION

The main finding of our study was the independent association between a delayed MET call and mortality after a MET review. To our knowledge, this is the largest prospective study aimed at evaluating this association.

The RRS has been proposed as a strategy to identify and treat patients with deteriorating clinical status, thus reducing the occurrence of adverse events, such as cardiac arrest, unexpected death, and unplanned admission to the ICU (12–14). Because previous studies have demonstrated that the time of intervention may impact the outcome of patients with stroke (15), myocardial infarction (16), sepsis (17), and trauma (18), greater attention has been given to the afferent limb in recent years (19–21).

The relationship between delayed MET calls and mortality has previously been reported in other smaller studies (7–9). More recently, however, Trinkle and Flabouris (10) did not confirm this association. It is possible that the patients receiving timely MET activation in the study by Trinkle and Flabouris (10) were in a worse condition, as 90.3% of their reported cardiac arrests occurred in this group (21). Additionally, the duration of the delay, which was shorter in the study by Trinkle

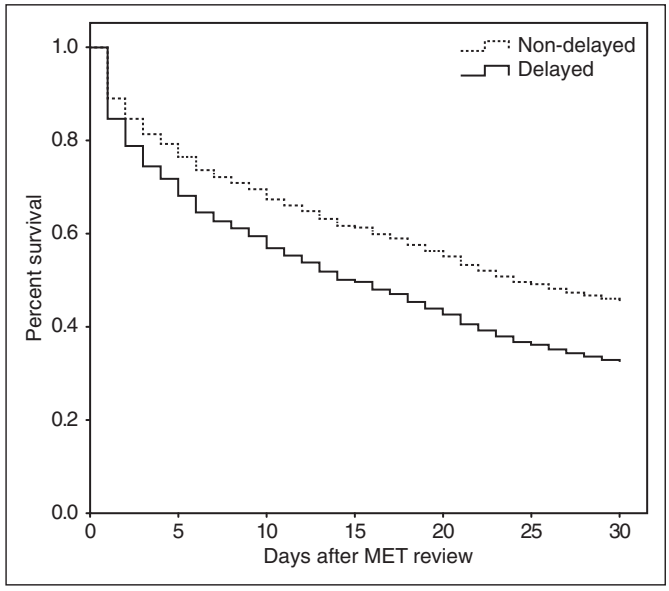

Figure 1. Cox regression curve for 30-d mortality in delayed (*continuous line*) vs nondelayed (*dotted lines*) medical emergency team (MET) calls ($p < 0.001$).

TABLE 3. Variables Predictive of 30-Day Mortality in a Multivariate Analysis

Variable	*p*	OR	95% CI
Gender, male	0.006	1.28	1.07–1.52
Glasgow Coma Scale			
15	< 0.001	1.00	
12–14		1.57	1.26–1.95
7–11		1.20	0.92–1.55
3–6		1.69	1.27–2.27
Do-not-resuscitate order	< 0.001	2.71	2.18–3.36
Delayed MET call	< 0.001	1.47	1.20–1.79
Medical	< 0.001	1.47	1.20–1.79
MET score groups			
Score 0	< 0.001	1.00	
Score 1		1.04	0.82–1.32
Score 2		1.03	0.78–1.37
Score ≥ 3		2.29	1.65–3.19

OR = odds ratio, MET = medical emergency team.

and Flabouris (10), may have played a role; corroborating this hypothesis, patients with a greater delay duration presented higher mortality (10). In our study, we found an independent association between delayed MET activation and higher mortality, supporting the concept and need for an RRS. This also suggests that implementing an RRS is not sufficient. After implementation, the operation of the RRS must be evaluated to determine the prevalence of and reasons for delayed intervention (22) because the adoption of measures to reduce this delay could potentially reduce mortality. Although the exclusion of some criteria (for instance, concern for the patient) from the definition of a delayed call may have created two different groups, the trigger was an objective criterion in almost half of the calls in the group without delay. Independent of the trigger, this group presented a lower mortality. This supports the association between delayed MET activation and mortality, even if only criteria based on vital signs were evaluated.

The prevalence of delayed MET calls was 21.4% in our study. This prevalence varies from approximately 20% to 50% in the literature and is primarily dependent on the criteria evaluated and the time between implementing the RRS and data collection (7–10, 23–25). Studies evaluating delays related to criteria including concern about the patient and alteration of the level of consciousness in addition to vital sign criteria have reported a trend of a higher prevalence of delays (7, 24, 25). Furthermore, the prevalence of delays appears to be greater when evaluated in the first years after the implementation of the RRS, and the delay prevalence tends to diminish as the system matures (9, 25). The delay found in our study is among the smallest reported in the literature, most likely because we only evaluated the criteria based on vital signs and this evaluation was performed 2 years after the RRS began to operate. Despite this great variation, these data show that afferent limb failure continues to be a serious problem for RRSs, even in mature systems.

Identifying the causes of this delay is an important step in the system evaluation process. In our study, the criterion associated with delay was typically the same criterion used as the trigger to generate the call. This suggests that there may be an error of judgment and not simply a failure to identify the problem, indicating that the staff have a greater belief in their own clinical judgment (10). Corroborating this hypothesis, Shearer et al (20) found that the most common cause for not calling the MET was that the staff believed that the situation was under control on the ward despite the physiological instability. Other possible explanations appear to include a fear of calling the MET, the manner in which the team interacts with the staff, and the preference for calling the attending team (10). As to the last reason, we found an increased prevalence of physician calls in the delayed cases. This may suggest another error in judgment; although the physiological instability was identified by altered vital signs, the nurses preferred to await assessment by the attending physician, and the latter finally made the call. The increased prevalence of physician calls in the delayed cases may also have been due to the decision of the physician not to call the MET and the fact that we excluded the criterion of concern for the patient (a criterion that is widely used by nurses) from the definition of a delayed call. Interestingly, in the delayed MET calls, the criterion of concern about the patient had a very low prevalence. Two key messages can be learned from these results. The first is that the subjective criterion can increase the low sensitivity already described for the objective criteria (26), resulting in earlier MET calls without waiting for a physiological change. The second is that staff calls for the MET were primarily based on subjective assessments. They chose to call the MET out of concern, without any alteration of vital signs, and decided not to call even when physiological instability was present. This acknowledgment of the impact of a delay and its reasons is important for defining strategies that can improve the operation of the RRS. Continued education appears to be the answer to all these barriers (21). Continuous evaluations of the system, feedback, and training can reduce the prevalence of delayed calls and, consequently, improve the associated outcomes (9).

Our study has strengths and limitations. It is the largest study to date verifying the importance of delayed MET calls after a MET review and confirms the association between delayed calls and mortality. Furthermore, our study showed a difference in the prevalence of delay according to who generated the call and the trigger used, which may help to identify delay-related factors that may potentially be corrected with continued education. However, the study was performed at a single center and may present unique cultural and organizational characteristics. Nonetheless, our hospital has the structure and organization of a typical tertiary referral hospital. The follow-up time may have been very short, and a longer observation time may show different results concerning mortality. Additionally, we did not

evaluate the impact of comorbidities or initial diagnosis on the delay. Furthermore, the exclusion of some criteria when defining a delayed call may have influenced the results, although the association with mortality was independent of the MET score. Finally, this was an observational study, and therefore, the association between delayed calls and mortality cannot be used to infer causality. However, this is most likely the best evidence available because it would be unethical to randomize patients to deliberately delayed intervention.

CONCLUSIONS

We found that delayed MET calls were common and that delays were independently associated with higher mortality. This result reaffirms the concept and need for an RRS. Future studies should give more attention to the reasons for delayed calls to establish strategies for improving the action of the afferent limb and, consequently, the outcomes.

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