

The effectiveness of implementation of the medical emergency team (MET) system and factors associated with use during the MERIT study

Michelle A Cretikos, Jack Chen, Ken M Hillman, Rinaldo Bellomo, Simon R Finfer, Arthas Flabouris and the MERIT study investigators

The medical emergency team (MET) system is designed to identify and respond in a rapid and appropriate fashion to patients at risk of adverse events in non-critical care areas of the hospital.¹ The MET system depends on the activation of the MET by hospital staff when one of the objective physiological activation criteria is satisfied, or when a staff member is seriously worried about a patient's medical condition.²

Implementation of the system is complex, requiring a fundamental change in the culture and operation of the hospital. The process of implementing the MET system has been little studied to date,^{3,4} but may be important to understand in order to improve the effectiveness of the system. The recently published MERIT (Medical Early Response, Intervention and Therapy) study identified a failure of implementation as a possible reason for the lack of effect of the MET system on rates of adverse events.⁵

We conducted staff surveys to measure the process of implementation of the MET system, and to identify factors associated with the level of MET utilisation in all 12 intervention hospitals during the MERIT study.

Methods

Approval for the study was obtained from each hospital's human research ethics committee. The implementation surveys were conducted at two points in time: at the end of the MERIT study implementation period in December 2002, and at the end of the 6-month MERIT study period in June 2003, before any analysis of the MERIT study data.⁵

Survey procedure

The same survey instrument was used for all hospitals (Appendix). The survey was conducted in a standard fashion over a 24-hour period by the same investigator (M A C) in each hospital. This investigator was not affiliated with any of the hospitals studied.

Survey forms were placed in boxes on all relevant wards and clinical areas, as well as the cafeteria and staff rooms as appropriate. A sign with instructions was placed next to each box. Envelopes were provided with the box, and respondents were instructed to place their completed sur-

ABSTRACT

Objective: The potential of the medical emergency team (MET) system to reduce adverse events may depend on the effectiveness of its implementation. We aimed to evaluate the effectiveness of the implementation of the MET system during the MERIT (Medical Early Response, Intervention and Therapy) study and to determine factors associated with the level of MET system utilisation.

Methods: Surveys were conducted on the nursing staff from the general adult wards of all 12 MERIT study intervention hospitals after the 4-month implementation period and again after the 6-month study period. Hospital-level variables were assessed for their correlation with MET utilisation. We measured awareness and understanding of the MET system, attendance at a MET education session, knowledge of the activation criteria, intention to call the MET, attitude to the MET system and the level of MET utilisation.

Results: Across the 12 intervention hospitals, a median of 85.6% (interquartile range, 81.3%–88.8%) of MET activations were not related to a cardiac arrest or death. This measure of MET system utilisation varied significantly across the 12 hospitals ($P = 0.002$), and was significantly associated with knowledge of the activation criteria ($P = 0.048$), understanding of the purpose of the MET system ($P = 0.01$), perceptions of the hospital's readiness for a change in the way care was provided ($P = 0.004$), and an overall positive attitude to the MET system ($P = 0.003$).

Conclusions: Measures of the process of implementation of the MET system were significantly associated with the level of MET system utilisation.

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vey in an envelope and then into the box to maintain confidentiality and anonymity. The boxes were cleared of completed surveys every few hours, and the surveys were available to be completed for all three nursing shifts over the 24-hour period.

We assessed the level of awareness of the MET system, attendance at MET education sessions, knowledge of the activation criteria, knowledge and understanding of the MET system, level of intention to activate the MET, attitudes to the MET system, and perception of hospital readiness for the MET system among nursing staff who worked on general adult wards. These comprised all inpatient wards within the study hospitals, excluding the coronary care unit, high-dependency unit, intensive care unit, operating theatres, postoperative recovery areas, and emergency departments.

The survey statements were constructed empirically in consultation with clinical staff familiar with the MET concept, as no validated surveys for assessing the implementation of the MET system were found in the literature. A seven-point Likert scale, from strongly disagree (score of 1) to strongly agree (score of 7), was used to categorise the responses. Questions were balanced for expected positive and negative responses. The statements were phrased in a neutral fashion and trialled in a pilot questionnaire to assess face validity. The final survey, which included an open-ended request for comments, was then developed.

Statistical analyses

A positive response was defined as one where the respondent either agreed or strongly agreed with the statement. The survey statements were assessed for changes in the proportion of positive responses between the initial and follow-up surveys, differences in the proportion of positive responses between hospitals, and differences in the proportion of positive responses according to nursing position, sex, and years of service of respondents. Missing responses were included in the analysis but treated as non-positive responses.

Categorical measures were assessed for statistical significance using the χ^2 test or Fisher's exact test. When a continuous variable deviated from a normal distribution, the Mann-Whitney test was used. The non-parametric trend test was used to test for a trend in the proportion of responses that were positive, by position and experience. This is a non-parametric test for trend across ordered groups, and is an extension of the Wilcoxon rank-sum test.⁶ All data were analysed using Stata statistical software, version 8.2 (Stata Corp, College Station, Tex, USA).

We obtained the proportion of MET system activations from the general wards that were not related to cardiac arrest or death during the MERIT study period, and used this as a measure of MET system utilisation. The responses to the statements about the MET system from the two surveys were combined to determine the association with the level of MET system activation for the study period. The

Table 1. Demographic characteristics of respondents compared between initial and follow-up surveys

Demographic characteristic	Number of respondents (% of all respondents)		P
	Initial survey (n = 708)	Follow-up survey (n = 781)	
Hospital			0.80
1	24 (3.4%)	23 (2.9%)	
2	58 (8.2%)	58 (7.4%)	
3	72 (10.2%)	90 (11.5%)	
4	75 (10.6%)	64 (8.2%)	
5	62 (8.8%)	78 (10.0%)	
6	67 (9.5%)	71 (9.1%)	
7	43 (6.1%)	42 (5.4%)	
8	41 (5.8%)	46 (5.9%)	
9	123 (17.4%)	134 (17.2%)	
10	54 (7.6%)	68 (8.7%)	
11	45 (6.4%)	64 (8.2%)	
12	44 (6.2%)	43 (5.5%)	
Position			0.95
Enrolled nurse	101 (14.3%)	114 (14.6%)	
Registered nurse	512 (72.3%)	557 (71.3%)	
Nurse specialist*	71 (10.0%)	85 (10.9%)	
Nurse manager	24 (3.4%)	25 (3.2%)	
Years of experience			0.99
Not stated	27 (3.8%)	32 (4.1%)	
< 1	86 (12.2%)	95 (12.2%)	
1–5	218 (30.8%)	248 (31.8%)	
6–10	113 (16.0%)	124 (15.9%)	
11–15	84 (11.9%)	93 (11.9%)	
16–20	68 (9.6%)	67 (8.6%)	
> 20	112 (15.8%)	122 (15.6%)	
Proportion female			0.61
Female	624 (88.1%)	695 (89.0%)	

* Nurse specialist includes clinical nurse consultants, clinical nurse educators and clinical nurse specialists. ◆

combined-survey proportion of positive responses was interpreted as the average proportion of positive responses to each statement over the 6-month study period. Hospital-level variables were then used to assess the association between the proportion of positive responses to the knowledge and understanding statements, the attitude to the MET system, and perceptions of hospital readiness with the measure of the level of MET utilisation, using a Spearman's (non-parametric) correlation analysis.

Figure 1. Percentage of general-ward nursing staff who had heard about the MET system, by hospital

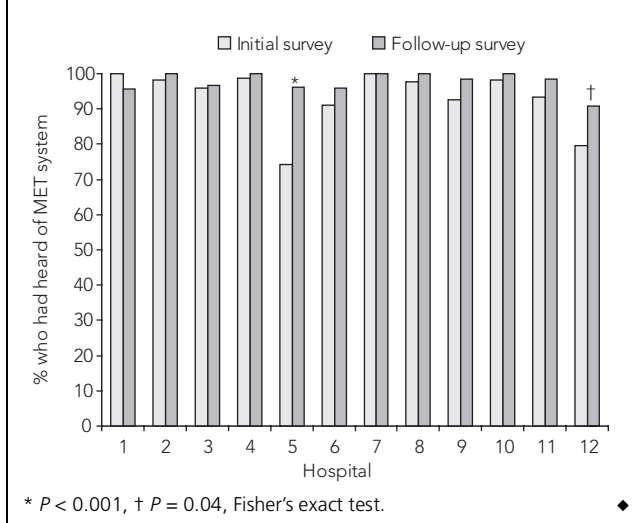
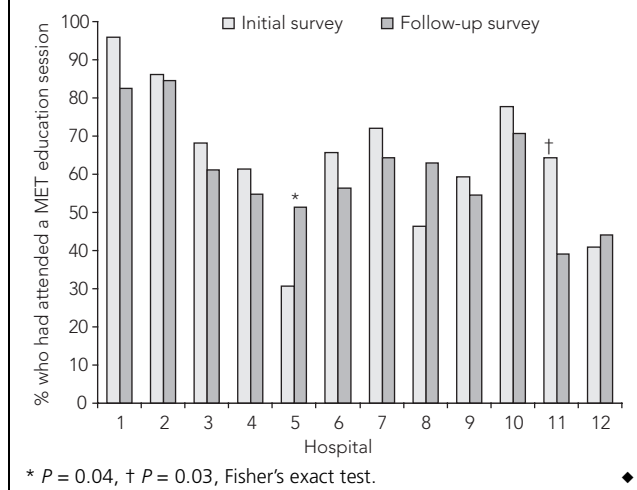


Figure 2. Percentage of general-ward nursing staff who had attended a MET education session, by hospital



Results

Overall, 708 initial surveys and 781 follow-up surveys were obtained from nursing staff from the general wards of the 12 intervention hospitals. This represented a median hospital response rate of 41% (interquartile range [IQR], 35%–50%) for the initial survey, and 47% (IQR, 40%–51%) for the follow-up survey, where the denominator included all nursing staff on the general wards during the 24-hour period of the survey. The demographic characteristics of the intervention hospitals have been reported previously.⁵ Fewer than 6.7% of responses were missing.

There were no significant differences between the initial and follow-up surveys in the proportion of respondents by hospital ($P = 0.80$), or by clinical position ($P = 0.95$), in the years of experience of respondents ($P = 0.99$), or in the proportion of female respondents ($P = 0.61$) (Table 1).

Most respondents (71.8%) were registered nurses, followed by enrolled nurses (14.4%). Most respondents had less than 10 years' experience in hospitals: 31% of respondents had between 1 and 5 years' experience, and a further 12% had less than 1 year's experience.

Awareness and education about the MET system

At the end of the 4-month implementation period, a median of 96.7% (IQR, 91.9%–98.5%) of respondents were aware of the MET system (Figure 1), and a median of 65.1% (IQR, 52.8%–75.0%) of respondents had attended a MET education session (Figure 2). By the end of the 6-month study period, a median of 98.5% (IQR, 96%–100%) of respondents were aware of the MET system, and a median of 58.7% (IQR, 52.9%–67.5%) had attended an education session. There was a significant increase in overall awareness, and a

significant decrease in overall attendance at an education session over the 6-month study period ($P < 0.001$ for awareness, $P = 0.005$ for attendance, Mann–Whitney test).

The median score for correct identification of the activation criteria by nursing staff who were aware of the MET system was 4 out of 6. Staff who had attended a MET education session correctly identified more of the MET activation criteria than those who had not attended a session (5 versus 4 out of 6, $P < 0.001$, Mann–Whitney test). There were significant differences among the hospitals for number of correctly identified MET activation criteria ($P < 0.001$, Mann–Whitney test).

Attitudes to the MET system

In general, responses to the statements about the MET were positive in both the initial and follow-up surveys. The proportions of positive responses to these statements during the initial and follow-up surveys are shown in Table 2.

The proportion of respondents who gave positive responses increased significantly for three of the 13 statements by the time of the follow-up survey. These comprised "This hospital will be able to adopt and utilise the MET system" (55.3% v 65.8% agreed or strongly agreed for the initial and follow-up surveys, respectively, $P < 0.001$); "It is important to have a system like MET in this hospital" (82.5% v 87.0%, $P = 0.02$); and "My overall attitude to the MET system is positive" (83.9% v 89.1%, $P = 0.004$).

Attendance at a MET education session increased the proportion of positive responses to the statement, "I understand the purpose of the MET system", compared with non-attendance (85.3% v 55.6%, $P < 0.001$). There was a significant difference between hospitals in the proportion of

Table 2. Proportion of responses to statements about the MET system that were positive, from general-ward nursing staff who were aware of the MET system

Statement about the MET	Number who agreed/strongly agreed (%)			P*
	Initial survey (n = 658)	Follow-up survey (n = 764)	Combined (n = 1422)	
I understand the purpose of the MET system	476 (72.3%)	582 (76.2%)	1058 (74.4%)	0.10
I have been given adequate information about the MET system	331 (50.3%)	418 (54.7%)	749 (52.7%)	0.10
I would call a MET if an ill patient fitted a MET criterion	540 (82.1%)	624 (81.7%)	1164 (81.9%)	0.85
It would be difficult for me to call the MET myself [†]	63 (9.6%)	77 (10.1%)	140 (9.8%)	0.75
Implementing the MET in this hospital is a bad idea [†]	23 (3.5%)	11 (1.4%)	34 (2.4%)	0.01
The MET system offers me significant advantages in patient care	518 (78.7%)	586 (76.7%)	1104 (77.6%)	0.36
I feel a lack of support for the MET system from my direct supervisors [†]	35 (5.3%)	43 (5.6%)	78 (5.5%)	0.80
The MET system is irrelevant to my clinical practice [†]	37 (5.6%)	41 (5.4%)	78 (5.5%)	0.83
I would feel uncomfortable calling the MET system [†]	88 (13.4%)	89 (11.6%)	177 (12.4%)	0.33
My overall attitude to the MET system is positive	552 (83.9%)	681 (89.1%)	1233 (86.7%)	0.004
This hospital will be able to adopt and utilise the MET system	364 (55.3%)	503 (65.8%)	867 (61.0%)	< 0.001
This hospital is ready for a change in the way care is provided	467 (71.0%)	496 (64.9%)	963 (67.7%)	0.02
It is important to have a system like MET in this hospital	543 (82.5%)	665 (87.0%)	1208 (85.0%)	0.02

* P values for difference between the two surveys derived from the χ^2 test. † Note that these statements were negatively worded. ◆

positive responses to this statement ($P < 0.001$). Respondents from Hospital 1 indicated the greatest understanding of the MET system (positive responses, 89.1%), while those from Hospital 12 indicated the least understanding (positive responses, 59.5%).

Nurses who were more senior indicated a significantly greater intention to call the MET than more junior nurses (P for trend < 0.001 , Figure 3), but most nurses either agreed or strongly agreed that they would activate the MET system when a patient reached one of the activation criteria, and this did not change significantly between the two surveys (82.1% v 81.7%, $P = 0.85$). More experienced nurses had a greater intention to call the MET than less experienced nurses (P for trend = 0.03).

There were significant differences in intention to call the MET by attendance at a MET education session, with those who had attended a MET education session being more likely to agree or strongly agree with the statement on intention to call the MET than those who had not (87.0% v 72.9%, $P < 0.001$).

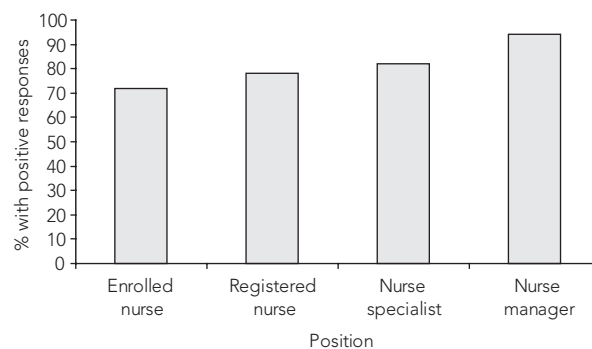
Overall, the attitude to the MET system was strongly positive, with 86.7% of nursing staff either agreeing or strongly agreeing with the statement, "My overall attitude to the MET system is positive". All levels of nursing staff had very positive attitudes to the MET. Nurses who had attended a MET education session had a significantly more positive attitude to the MET than those who had not (proportion of responses positive, 91.5% v 78.5%, $P < 0.001$).

A minority of nursing staff either agreed or strongly agreed that they would be uncomfortable calling the MET,

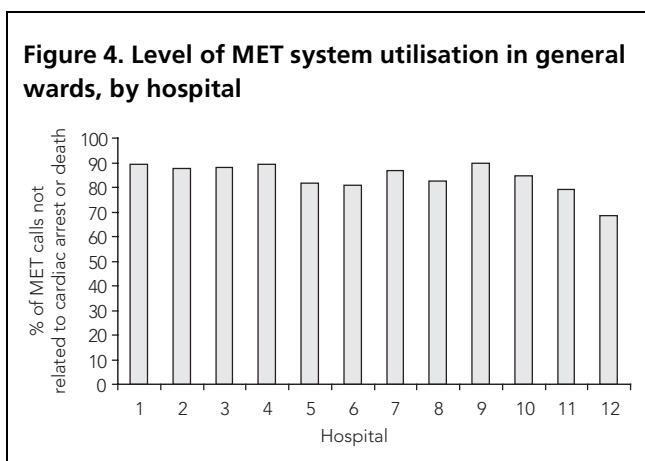
and this did not change between the two surveys (proportion of positive responses 13.4% at initial survey v 11.6% at follow-up survey, $P = 0.33$). There was no trend in the proportion of responses that were positive by level of experience (P for trend = 0.27).

The open-ended comments relating to the MET system were classified as positive, negative or neutral. Most comments were positive. Negative comments typically expressed concern about the appropriateness of activating the MET system in certain specialist areas of the hospital, such as the labour ward and the operating theatre. An

Figure 3. Percentage of responses that were positive to the statement "I would call the MET if a patient fitted a MET criterion" from general-ward nursing staff, by position*



* P for trend = 0.001. ◆



additional concern was the attitude of the MET team towards staff who had called the team — rude, condescending behaviour was noted by a number of nurses from different hospitals. Another common concern related to the withdrawal of staff resources from existing areas of the hospital, such as the ICU and emergency department, to staff the MET.

Utilisation of the MET system

Across the 12 intervention hospitals, a median of 85.6% (IQR, 81.3%–88.8%) of MET activations were not related to a cardiac arrest or death. This measure of MET system utilisation varied significantly across the 12 hospitals ($P = 0.002$, Figure 4), and was significantly positively correlated with knowledge of the activation criteria ($P = 0.048$), and understanding of the purpose of the MET system ($P = 0.01$, Table 3). The strongest positive association was with the hospital's perceived readiness for change in the way care is provided, and with an overall positive attitude to the MET system (Spearman's ρ , 0.76 and 0.78, $P = 0.004$ and $P = 0.003$, respectively, Table 3).

Discussion

We conducted a study of 12 intervention hospitals to assess the process of implementation of the MET system during the MERIT study, and to investigate whether the level of use of the MET system related to the success of implementation. We found that the MET system was implemented with variable success, and that several measures of successful implementation of the MET were associated with greater use of the MET system. In addition, the comments about the MET system indicated that the attitude and behaviour of members of the MET may also have influenced the level of MET utilisation on the general wards.

As expected, our study found a significant increase in overall awareness of the MET system, and a significant

decrease in overall attendance at an education session over the 6-month study period. During this period, the MET system was activated in all the hospitals, raising awareness of the system. Very few education sessions were conducted over this period which, combined with hospital staff turnover, meant that fewer staff had attended MET system education sessions by the end of the study period.

In addition, our study demonstrated that attitudes toward the MET system and the hospital's capacity to operate a MET system improved during operation of the system. Staff had a more positive attitude to the MET system once the system had been implemented for 6 months and also perceived it as more important.

To date, only single-centre studies have been performed on awareness of the MET system, and on focused interventions to improve the use of a MET.^{3,4} These studies found that the development of focused criteria, and dissemination of this information throughout the hospital increased the use of the MET,⁴ but also found that relatively high rates of awareness do not necessarily translate into appropriate use of the MET system.³ Our multicentre study found that a number of measures of the process of implementation are associated with a measure of the level of use of the MET system.

This measure of MET system use was constructed to take into account the background level of calls for cardiac arrests and deaths, providing a measure of MET activity that could be used to compare MET system utilisation across hospitals. Higher levels of knowledge and understanding of the MET system, a perception that the hospital was ready for a change in the way care was provided, and an overall positive attitude to the MET system were positively associated with increased use of the MET system.

The surveys were designed and conducted in a standardised fashion, to improve the ability to compare results between hospitals and survey periods. However, response rates varied, with potential for selection bias in all hospitals.^{7,8} Selection bias relating to the attitude to the MET system cannot be excluded, nor can its extent be estimated. However, all nurses present on the general wards during one complete 24-hour period were selected for inclusion in the study sample, and care was taken to make the surveys available to all of these nursing staff. The study day was a week-day, and therefore the sample could reasonably be expected to be representative of the nurses who would normally be available on the wards during any weekday. Where the nursing staff did provide a response, the responses relating to the MET system were consistently positive.

Other weaknesses of this study include the lack of validation of the survey instrument, a lack of power (as only 12 hospitals were studied), and limited sampling of nursing staff. As most potentially preventable events in the MERIT

Table 3. Correlation between hospital-level response to statements about the MET and hospital level of MET utilisation

Statement about the MET	Correlation coefficient*	P
Heard about MET	0.41	0.18
Attended a MET education session	0.57	0.06
Number of activation criteria correctly identified	0.58	0.048
I understand the purpose of the MET	0.69	0.01
Hospital will be able to adopt the MET	0.18	0.57
I have been given adequate information about the MET	0.56	0.06
I would call a MET	0.57	0.05
Hospital is ready for a change in the way care is provided	0.76	0.004
It would be difficult for me to decide to call the MET	-0.28	0.38
MET implementation in this hospital is a bad idea	-0.24	0.46
The MET system offers significant advantages	0.45	0.15
I feel a lack of support for the MET system	0.05	0.88
The MET system is irrelevant to my clinical practice	0.26	0.42
I would feel uncomfortable calling the MET	-0.19	0.56
It is important to have a system like MET	0.55	0.06
My overall attitude to MET is positive	0.78	0.003

* Spearman's correlation coefficient for correlation with hospital level of utilisation of the MET, measured as the proportion of MET activations not related to cardiac arrests or deaths on the general wards. ◆

study originated from the general wards (88% of events after exclusion of events with prior not-for-resuscitation orders), and most calls to the MET system are made by nursing staff, the investigation of the determinants of MET utilisation used only survey responses from nursing staff on the general wards.^{5,9-11} However, the attitudes of other staff members who were not surveyed may have been important in determining the attitude of the nurses to the MET system, and therefore in their level of utilisation of the MET system. In particular, the attitudes of both the senior and junior medical staff, and of the medical and nursing administrative staff, may have had an impact on nurses' attitudes. This possibility remains to be explored in future studies of implementation of the MET system.

This study has demonstrated that trials of interventions that rely on systems and culture change within organisations such as hospitals need to pay close attention to the

details of implementation, to achieve optimal levels of utilisation of the intervention.

Future studies need to focus on the optimal level of utilisation of the MET system, and to ensure that factors that may inhibit adoption of the new system are addressed. Future studies should also pay particular attention to ensuring that clinical staff, in particular the nursing staff on general wards, have a positive attitude to the new system, and should optimise the rates of attendance at MET education sessions. Attention should also be paid to ensuring that members of staff who do activate the MET are not subject to recrimination or abuse from MET members, and that MET members are available when required.

In conclusion, we have conducted the first multicentre study of awareness and attitudes to the MET system. We demonstrated variable awareness of the MET during the MERIT study, which was linked to variable attendance at MET education sessions, and translated into variable activation of the MET. Although most staff had a positive attitude to the MET system, we detected a number of specific areas of concern. Addressing these may increase the effectiveness of the MET system.

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SURVEYS

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SURVEYS

Appendix. The MET implementation survey instrument

This survey is intended to obtain information relating to your attitude towards and understanding of the Medical Emergency Team (MET) system. We are also interested in information about your hospital in general. The information is for research purposes only. We would like to try to improve the way the MET is introduced into hospitals. This survey is completely anonymous, voluntary and confidential. Please respond freely.

Gender (please circle): Male / Female
 Position (please circle): EN / RN / CNE / CNS / CNC / Nurse Manager / JMO / Registrar / Allied Health Admin or Clerical / Support services / Other (please specify).....
 Usual hospital location (please circle): ED / ICU / CCU / General wards / Other (please specify).....
 Years of service in hospitals in total (please circle): < 1 / 1-5 / 6-10 / 11-15 / 16-20 / 21-25 / 26-30 / > 30

SECTION 1

Firstly, we would like to know some basic information about how well the MET has been introduced into your hospital. Please answer the following questions by circling your response.

Have you heard about the MET? (If No, skip to SECTION 3)	Yes	No
Have you attended a MET educational session?	Yes	No
Are the following observations part of the MET activation criteria?		
Systolic blood pressure < 100 mmHg	Yes	No
Any patient you are seriously worried about	Yes	No
Saturations < 90%	Yes	No
Heart rate > 140	Yes	No
Respiratory rate > 36	Yes	No
Fall in GCS of > 2 points	Yes	No

SECTION 2

This section deals with your opinions on the MET. Please read the following statements, and indicate whether you agree or disagree by circling the appropriate number

	Strongly disagree						Strongly agree
I understand the purpose of the MET system	1	2	3	4	5	6	7
This hospital will be able to adopt and utilise the new MET system effectively	1	2	3	4	5	6	7
I have been given adequate information about the MET system	1	2	3	4	5	6	7
I would call a MET if I became aware of an ill patient that fitted a MET criterion	1	2	3	4	5	6	7
This hospital is ready for a change in the way care is provided to severely ill patients on the wards	1	2	3	4	5	6	7
It would be difficult for me to make the decision to call the MET myself	1	2	3	4	5	6	7
The MET being implemented in this hospital is a bad idea	1	2	3	4	5	6	7
The MET system offers me significant advantages in caring for patients on the ward that I am seriously worried about	1	2	3	4	5	6	7
I feel a lack of support for the MET system from my direct supervisors	1	2	3	4	5	6	7
The MET system is irrelevant to my clinical practice	1	2	3	4	5	6	7
I would feel uncomfortable calling the MET for a seriously ill patient before informing the primary care team	1	2	3	4	5	6	7
It is important to have a system like MET in place in this hospital	1	2	3	4	5	6	7
My overall attitude to the MET system is positive	1	2	3	4	5	6	7

SECTION 3

COMMENTS

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THANK YOU FOR YOUR PARTICIPATION