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TITLE PAGE

Features, Risk Factors, and Outcomes of Older Internal Medicine Patients Triggering a Medical Emergency Team Call

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ABSTRACT

Background: Information about the epidemiology of older Internal Medicine patients receiving medical emergency team (MET) calls is limited. We assessed the prevalence, characteristics, risk factors, and outcomes of this vulnerable group.

Methods: Internal Medicine patients aged ≥75 years who were admitted via the Emergency Department to a tertiary hospital between January 2015 to December 2018 and who activated a MET call were compared to patients without MET call activation during the same time period. Outcome measures included management post-MET call, Intensive Care Unit (ICU) admission rates, discharge disposition, length of hospital stays (LOS), and in-patient mortality.

Results: There were 10,803 Internal Medical admissions involving 10,423 patients; median age 85 (IQR 81-89) years. Of these, 995 (10%) patients received at least one MET call. MET call patients had greater physiological instability in the Emergency Department and higher median Charlson comorbidity index values (2, IQR 1-3 vs 1, IQR 0-2; $p<0.0001$) than non-MET call patients. Overall, 10% of MET call patients were admitted to ICU. MET patients had a longer median length of stay (9 [IQR 5-14] vs 4 days [IQR 2-7]; $p<0.001$) and higher in-hospital mortality (29% vs 7%; $p<0.001$). However, mortality of MET call patients without treatment limitations was 48/357 (13%).

Conclusion: One in ten Internal Medicine patients aged ≥75 years and admitted via ED had a MET call. Physiological instability in ED and comorbidities were key risk factors. Mortality in MET patients approached 30%. These data can help predict at-risk patients for improving goals of care and pre-MET interventions.

Editorial Comment: In this large retrospective study of acutely hospitalized patients aged 75 years or more, approximately 1/10 cases have a medical emergency team acitvation call due to physiological instability, with a 30% related mortality. These findings support a need for better monitoring of deterioration and interventions in this fragile patient group.

Keywords: Rapid Response Team, Medical Emergency Team, Internal Medicine

INTRODUCTION

The Rapid Response System (RRS) describes a hospital-wide patient safety system to improve the recognition of, and response to deteriorating patients with the aim of reducing the risk of failure to rescue [1,2]. Four systematic reviews have reported that the introduction of RRSs is associated with decreased hospital mortality and in-hospital cardiac arrest [3-6].

The Medical Emergency Team (MET) is the "efferent" [1,2] arm of the RRS and, at least in Australia, is often made up of staff from the Intensive Care unit (ICU) [7]. Such METs typically treat patients who are at increased risk of in-hospital mortality and ICU admission and have end of life care issues in approximately one-third of cases [8]. These issues pose important medical, social, and ethical challenges, especially in older patients.

Unfortunately, very few studies have focused on the epidemiology of MET calls in older patients. One study compared patient characteristics and outcomes amongst elderly medical and surgical patients (≥75 years of age) vs non-elderly patients and found older patients accounted for one third of all MET calls and experienced higher in-hospital mortality rates [9].

Another small study suggested that many MET calls in such patients may be avoidable and consume unnecessary resources [10]. However, there is also concern that elderly patients may have higher failure to rescue rates in general [11], which may contribute to mortality, and which could be prevented by METs. These observations suggest there is a lack of data and a degree of uncertainty about the value of MET intervention in the acute care of older patients.

Patients admitted under Internal Medicine are typically older and have many co-morbidities [12-14]. Thus, they constitute an ideal population to investigate the above issues. Accordingly, we conducted a retrospective observational study to explore the epidemiology of older Internal Medicine patients in our hospital. Specifically, we aimed to assess the prevalence, characteristics, and risk factors for triggering a MET call. In addition, we evaluated the frequency and impact of limitations of medical therapy (LOMT) orders and the outcome of older patients who triggered a MET call in the presence or absence of such LOMTs.

METHODS

Study Setting

Austin Health is a major tertiary health provider in Melbourne, Australia. It is affiliated with the University of Melbourne and comprises 560 acute beds with approximately 80,000 admissions per annum. The ICU has 22 beds and provides multi-system support to over 2,200 patients per annum. The Department of Internal Medicine (called "General Medicine" in Australia) has 74 in-patient beds and provides acute care for patients with single or multi-organ diseases. The hospital has a policy regarding the discussion and documentation of limitations of medical treatment (LOMTs) which is conducted by the treating medical staff in conjunction with the patient and/or their surrogate decision maker.

Medical Emergency Team (MET)

Austin Health introduced a MET service in 2000, which comprises of an ICU doctor, an ICU nurse and an Internal Medicine doctor [15-17]. Any staff member can activate a MET call based on pre-set criteria (Suppl Appendix S1) or clinical concern. This triggers assessment by the MET within less than 10 minutes. A treatment plan is enacted by the MET, which is informed by the patient's clinical status and goals of treatment [18], and decisions regarding follow up care.

Study Design

We conducted a retrospective, single center observational cohort study of Internal Medicine in-patients aged ≥75 years who were admitted between 1 January 2015 and 31 December 2018 via the Emergency Department subjected to a MET call. We also included a comparison cohort of Internal Medicine patients admitted during the same study period who did not receive a MET call. Patients admitted directly from the out-patients department or transferred from other specialty units were excluded. Patients admitted directly to ICU or Coronary Care Unit (CCU)under General Medicine were also included in the study. This study was approved by the Austin Health Human Research Ethics Committee (Approval Number: Audit 19/60) and the need for patient consent was waived due to the de-identified and observational nature of the study.

Data Collection

Data on the timing, nature and outcome of MET calls were entered into a dedicated database by the ICU MET doctor in real-time. MET call data for all Internal Medicine patients were extracted and merged with hospital administrative data via a unique patient identifier. Variables of interest included patient demographics, Charlson Comorbidity index [19] (Suppl Appendix Table S2), admission source, day of admission, timing of admission (after-hours admission defined as an admission between 6pm to 7am), number of hospital visits within the previous 12 months, bed allocation status to a ward not designated to care for Internal Medicine patients, ICD-10 diagnostic codes, and presence of LOMT. All patients were admitted under the Department of Internal Medicine. which has specifically dedicated wards. However, a proportion of patients could not be admitted to such dedicated wards due to lack of bed capacity and were therefore admitted to alternative inpatient wards.

During this study period, in our hospital, LOMT was categorized and documented in the MET database as follows: (1) For full resuscitation (2) For MET calls and ICU but not for Code Blue (defined as not for cardiopulmonary resuscitation or intubation) (3) For MET calls but not for ICU or Code Blue (4) Not for MET calls, ICU or Code Blue.

Additionally, we obtained information on patient characteristics at the time of ED admission including ED Triage category (Suppl Appendix Table S3), ED length of stay, vital

signs and pathology results. For patients with multiple MET calls, only details surrounding the first MET call were used (Suppl Appendix Table S4).

Outcome measures

The primary outcome measure was in-hospital mortality. Secondary outcome measures included the need for ICU or CCU (Coronary Care Unit) admission, hospital length of stay, discharge destination, and readmission rate after 28 days. Finally, we evaluated the associations (predictors) with triggering of a MET call.

Data analysis and statistics

Baseline characteristics were expressed as frequencies (n, %), means (standard deviation [SD]), or medians (interquartile range [IQR]), as dictated by data type and distribution. Between-group comparisons were performed using the chi-squared test, unpaired t-test, or Wilcoxon rank sum test, as appropriate.

Predictors of having a MET call, ICU admission and mortality were analyzed using univariable and multivariable logistic regression models. The final multivariable model included all variables associated with the outcome of interest either on univariable analyses (p value <0.2) or based on biological plausibility. Linearity assumptions were validated by dividing continuous data into quartiles and fitting as categorical variables. Multiple imputation using chained equations was performed for missing data. Data were analyzed using Stata/SE16.0 (College Station, TX). Two-sided p values <0.05 were considered statistically significant.

RESULTS

Details of the patient cohort and associations with need for a MET call

Between January 2015 to December 2018, there were 10,803 Internal Medicine admissions involving 10,423 patients aged ≥75 years. Overall, 995 (10%) of these patients triggered 1,375 MET calls (Suppl Appendix Figure S5).

Baseline characteristics of MET call and non-MET call patients are presented in Table 1. Patients were elderly with a median age of 85 years (81 to 89). Compared to the non-MET call cohort, patients in the MET call cohort had a higher median Charlson comorbidity index (CCI), including a higher prevalence of acute myocardial infarction

(AMI), congestive cardiac failure (CCF), chronic obstructive pulmonary disease (COPD), diabetes mellitus, and chronic kidney disease.

Data regarding pre-existing goals of care documentation was only available for the MET call cohort. Of these, 36% of patients (357/995) were for full resuscitation and 64% (638/995) had documented LOMT (MET calls and ICU but not Code Blue [53%], MET calls but not ICU or Code Blue [4%], Not for MET calls, ICU or Code Blue [7%]).

Overall, 45% (615/1,375) and 28% MET calls (383/1,375) occurred after-hours and during the weekends, respectively. In addition, 62% of MET calls (849/1,375) occurred in patients managed on wards not specifically designated for the Internal Medicine unit.

Differences in patient characteristics at ED presentation

MET call patients demonstrated greater illness severity at ED presentation. As shown in Table 2, MET call patients were more likely to be triaged Category 2 (31% vs 20%; $p<0.001$) on arrival requiring assessment within 10 minutes based on the Australasian Triage scale (Suppl Appendix Table S3). Patients in the MET call group had slightly worse renal function (Creatinine 135 vs 121 μmol/L; $p<0.001$); however, the percentages of patients with an eGFR ≥60 (male 8%, female 8%) or <60 (male 10%, female 11%) who had MET calls were similar. ED stay in MET call patients was also longer (7.28 hours vs 6.80 hours; $p<0.001$) compared to the non-MET call group.

Multivariable logistic regression analysis found several independent predictors of MET activation at the time of ED presentation (Figure 1 and Suppl Appendix Table S6). Presence of CCF and COPD were associated with the highest odds ratio of MET activation (OR 1.54 and OR 1.53, respectively; $p<0.001$).

MET call trigger

The most common triggers for MET activation in this study population were tachypnea (24%), tachycardia (20%), hypotension (16%), hypoxia (12%) and change in conscious state (11%) (Suppl Appendix Table S7). Most MET calls occurred within the first 24-48 hours of admission. Thus, 502 MET calls (37%) occurred within 24 hours and 729 MET calls (53%) within 48 hours.

Admission to the ICU and CCU: frequency and associations

Of all MET calls, 97 (5%) resulted in ICU admission and 7 (<1%) resulted in CCU admission. In the MET call group, 10% (n=98) of patients were admitted to the ICU and 3% (n=33) were admitted to the CCU (Table 3) during the same hospital admission. Compared to patients transferred to these care areas without a MET call, CCU length of stay was longer in the MET call group (1.9 vs 1.2 days; p=0.01), whereas ICU length of stay was not significantly different (2.1 vs 1.9 days; p=0.01). Although more MET patients required mechanical ventilation (1% vs <1%; p<0.001) and non-mechanical ventilation (2% vs <1%; p<0.001), the duration of therapies were similar.

Multivariable logistic regression analysis identified several predictors of ICU admission following MET activation (Figure 1 and Suppl Appendix Table S8). Younger age (OR 0.92; P<0.001) and multiple MET calls (OR 1.46; P<0.001) were associated with higher likelihood of ICU admission. Patients from aged care facilities were less likely to be admitted to ICU (OR 0.23; P=0.007). MET calls frequently resulted in a change in goals of treatment to a more conservative approach after consultation with the surrogate decision maker (Suppl Appendix Table S9).

Details of hospital length of stay and discharge destination

Compared with the non-MET cohort, the patients in the MET cohort had a longer median hospital stay (9 [IQR 5-14] vs 4 days [IQR 2-7]; p<0.001 Table 4) and were less likely to be discharged home (45% vs 64%, p<0.001). Amongst the patients who received a MET call, outcomes differed according to the presence of a LOMT (Figure 2, Suppl Appendix Figure S5). Thus, patients that were for full resuscitation (no LOMTs) were more likely to be discharged home and be readmitted to hospital within 28 days (p<0.001). In addition, patients with no LOMTs had an in-hospital mortality of 13% (48/357), compared with 37% (239/638) for those with a LOMT (P<0.001).

Associations with in-hospital mortality

In hospital mortality was significantly higher (29% vs 7%; p<0.001) in the MET group, especially for patients with limitations of treatment directives (37%). However, 10% of the MET cohort were admitted to ICU and 72% of these survived to hospital discharge (Suppl Appendix Figure S10). Multivariable logistic regression analysis to identify predictors of mortality following MET activation is shown in Figure 1 (Suppl Appendix Table S11 and S12). Amongst the survivors, the proportion of patients readmitted to hospital at 28 days were similar between the two groups (12% vs 13%; p=0.24).

DISCUSSION

Key Findings

In our study of more than 10,000 Internal Medicine patients aged ≥75 years, approximately one in ten patients triggered a MET review. Patients who received a MET review were more likely to have cardio-respiratory disease, diabetes and renal disease and increased acuity of illness at ED presentation. Approximately one in ten patients who received a MET call were admitted to ICU during the index hospital admission. MET patients had a longer median length of stay and higher in-hospital mortality. However, the in-hospital survival of MET call patients was 87% for patients without limitations of medical treatment (LOMT) orders and 63% even in the presence of LOMT.

Comparison with previous studies

Although previous studies [20-22] have reported that 64-79% of all MET calls occur in non-surgical patients, to the best of our knowledge, no studies have specifically investigated the outcome of patients triggering MET calls in older Internal Medicine patients. Previous studies reported that the in-hospital mortality of patients reviewed by the MET is approximately 25% overall, and approximately 15% for those without documented LOMTs and 50% for those with documented LOMTs, respectively [18,23]. However, such studies did not focus on outcomes for patients with a median age >80 years of age. Tirkkonen and co-workers reported an in-hospital mortality of 25% amongst patients aged ≥75 years who triggered a MET [9]. The outcomes of older patients (median of 85 years) in our study

revealed a mortality of 29%, with an increase to 37% with the presence of LOMT. The biggest predictor of mortality following MET activation was presence of LOMT (OR 4.73 for those who were not for MET calls, ICU or code blue but still received a MET call). However, in such patients, in-hospital mortality was only 37%.

Data from the USA involving surgical units suggest that failure to rescue may be particularly common among older patients [11]. However, similar issues also affect medical patients [24], who typically have multiple comorbidities, limitations of medical treatment orders and are often admitted from aged care facilities. In such patients, the appropriateness and utility of MET intervention remains uncertain. In this regard, our study provides support for the view that such intervention is justified and required.

Considine and co-workers have examined predictors for triggering a MET call in patients admitted via the ED [25-27]. Similar to our study, they found that patients with abnormalities of vital signs and conscious state in the ED were more likely to receive a MET call within the first 72 hrs of hospital admission.

In our study, more than half of the MET calls (53%) occurred within the first 48 hours, which is likely due to the fact that this is the greatest period of physiological instability and the period of greatest uncertainty in relation to the patient's trajectory and diagnosis.

A significant proportion of MET calls (62%) occurred in wards not designated for Internal Medicine perhaps reflecting the overall business of the hospital at that time. This finding may also reflect the fact that staff on nondedicated wards may be less familiar with the care requirements for such high-risk patients.

Despite the presence of slightly worsened renal function in the MET call group, there was no differences amongst the proportion of MET calls occurring in the high and low eGFR groups. This could be a subject for further analysis in future studies.

Our understanding on the impact of LOMT on patient outcomes is limited to the MET call group. However, the high survival rate of patients in the absence of LOMT supports the ongoing need for MET reviews and appropriate escalation of care, when necessary, in this group of patients.

Strengths and limitations

There are several epidemiologic studies of MET call patients, however none are specifically focused on older Internal Medicine patients. Moreover, no such information can be separately extracted from other papers that would inform investigators on this specific high-risk population where unique treatment and ethical challenges apply. This study provides the insight into the baseline characteristics and outcomes of older Internal Medicine patients admitted to hospital via the ED who deteriorate and trigger a MET call. Our results were extracted from a large comprehensive database comprising over 10,000 patients over a four-year period with a comparison control group. To the best of our knowledge, this is the largest analysis of MET calls amongst older Internal Medicine patients. The large sample size improves the precision of estimates. Finally, our findings are likely generalizable to other tertiary hospitals with similar rapid response systems.

We acknowledge several limitations. This is a retrospective analysis based on existing documentation and carries the limitations associated with this approach. Our conclusions are limited to associations given the observational nature of this study. This is a single center study and MET practices may differ in other health care institutions. Readmission rates could be underestimated since we do not know about admissions to other hospitals following discharge. We also did not collect data on the cause of death and detailed interventions during MET review. As such, we cannot comment on the degree of preventability of these deaths. We do not have LOMT data on non-MET patients and thus, our understanding is only confined to the specific population under analysis. This could be a further subject for future research studies. In addition, we did not evaluate differences in the features and causes of MET calls occurring early in the hospital admission, compared with those occurring late. Early MET calls may be due to greater physiological instability, uncertainty of diagnosis, suboptimal triage and discharge from ED[28], or disposition to wards not designated to medical patients. Causes for Late MET calls likely include, errors in diagnosis/treatment, poor response to treatment, issues around end of life care[29]or conditions acquired due to prolonged hospitalization. Finally, we cannot comment on the functional outcomes of survivors of MET review.

Implications for clinicians and policy makers

We believe our findings have important implications for the management of clinically important deterioration amongst hospitalized older Internal Medicine patients. They imply

that MET intervention in response to physiological deterioration in such patients is associated with overall excellent outcome and, thus, is justified. They also imply that associations or predictors for the triggering a MET review can be identified. Thus, our findings suggest that we may be able to identify high-risk patients in ED who may benefit from focused preventive interventions and greater monitoring intensity.

Finally, the finding that, among a geriatric population with co-morbidities, ICU-based MET treatment leads to survival in more than 70% of patients provides justification for intervention in such patients.

Conclusion

Amongst older Internal Medicine patients, intervention by the MET is more likely to occur in those with greater physiological instability in the ED. However, despite older age, physiological disturbances, and multiple co-morbidities and even despite limitations of medical treatment orders, their survival to hospital discharge remains relatively high, justifying the use of the MET to respond to clinical deterioration in such patients.

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Author Contributions
Study conception and design: DJ, DS, RB
Data acquisition. RR, RB, PW
Data analysis. ES, DJ, RB
Drafting and revision of manuscript. All authors

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Descriptive Figure Legends

Figure 1: **Independent predictors of MET activation, ICU admission and mortality**

CCF = Congestive cardiac failure; CCI = Charlson Comorbidity index; COPD = Chronic obstructive pulmonary disease; ED = Emergency Department; ICU = Intensive care unit; LOMT = Limitations of medical therapy; LOS = Length of stay; MET = Medical Emergency Team; NH = Nursing Home

Figure 2: Hospital outcomes of older internal medicine patients admitted via the emergency department who had a MET call according to limitation of medical treatment status.

LOMT = limitation of medical treatment, MET = Medical Emergency Team, ICU = Intensive Care Unit, LOS = length of stay.

REFERENCES

1. Devita MA, Bellomo R, Hillman K, et al. Findings of the first consensus conference on medical emergency teams. *Crit Care Med.* 2006;34(9):2463-2478.
2. Jones DA, DeVita MA, Bellomo R. Rapid-response teams. *N Engl J Med.* 2011;365(2):139-146.

3. Solomon RS, Corwin GS, Barclay DC, Quddusi SF, Dannenberg MD. Effectiveness of rapid response teams on rates of in-hospital cardiopulmonary arrest and mortality: A systematic review and meta-analysis. *J Hosp Med.* 2016;11(6):438-445.
4. Maharaj R, Raffaele I, Wendon J. Rapid response systems: a systematic review and meta-analysis. *Crit Care.* 2015;19:254.
5. De Jong A, Jung B, Daurat A, et al. Effect of rapid response systems on hospital mortality: a systematic review and meta-analysis. *Intensive Care Med.* 2016;42(4):615-617.
6. Chan PS, Jain R, Nallmothu BK, Berg RA, Sasson C. Rapid Response Teams: A Systematic Review and Meta-analysis. *Arch Intern Med.* 2010;170(1):18-26.
7. Joint College of Intensive Care M, Australian, New Zealand Intensive Care Society Special Interest Group on Rapid Response S, Outcome ACf, Resource E. Resource use, governance and case load of rapid response teams in Australia and New Zealand in 2014. *Crit Care Resusc.* 2016;18(4):275-282.
8. Jones D, Moran J, Winters B, Welch J. The rapid response system and end-of-life care. *Curr Opin Crit Care.* 2013;19(6):616-623.
9. Tirkkonen J, Setala P, Hoppu S. Characteristics and outcome of rapid response team patients >/=75 years old: a prospective observational cohort study. *Scand J Trauma Resusc Emerg Med.* 2017;25(1):77.
10. Subramaniam A, Green C, Omair M, Soh L, Yeoh AC, Tiruvoipati R. Cost implications of avoidable rapid response call activations in older patients. *N Z Med J.* 2018;131(1472):38-52.
11. Sheetz KH, Guy K, Allison JH, et al. Improving the care of elderly adults undergoing surgery in Michigan. *J Am Geriatr Soc.* 2014;62(2):352-357.
12. Lowe J, Candlish P, Henry D, Wlodarcyk J, Fletcher P. Specialist or generalist care? A study of the impact of a selective admitting policy for patients with cardiac failure. *Int J Qual Health Care.* 2000;12(4):339-345.
13. Greenberg PB. A place for general medicine among the subspecialties. *Med J Aust.* 1994;160(3):100-102.
14. Jenkins PF, Thompson CH, MacDonald AB. What does the future hold for general medicine? *Med J Aust.* 2011;195(1):49-50.
15. Jones D, Bates S, Warrillow S, et al. Effect of an education programme on the utilization of a medical emergency team in a teaching hospital. *Intern Med J.* 2006;36(4):231-236.

16. Bellomo R, Goldsmith D, Uchino S, et al. A prospective before-and-after trial of a medical emergency team. *Med J Aust.* 2003;179(6):283-287.
17. Bellomo R, Goldsmith D, Uchino S, et al. Prospective controlled trial of effect of medical emergency team on postoperative morbidity and mortality rates. *Crit Care Med.* 2004;32(4):916-921.
18. Jones DA, Bagshaw SM, Barrett J, et al. The role of the medical emergency team in end-of-life care: a multicenter, prospective, observational study. *Crit Care Med.* 2012;40(1):98-103.
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987;40(5):373-383.
20. So RKL, Bannard-Smith J, Subbe CP, et al. The association of clinical frailty with outcomes of patients reviewed by rapid response teams: an international prospective observational cohort study. *Crit Care.* 2018;22(1):227.
21. Shappell C, Snyder A, Edelson DP, Churpek MM, American Heart Association's Get With The Guidelines-Resuscitation I. Predictors of In-Hospital Mortality After Rapid Response Team Calls in a 274 Hospital Nationwide Sample. *Crit Care Med.* 2018;46(7):1041-1048.
22. Bannard-Smith J, Lighthall GK, Subbe CP, et al. Clinical outcomes of patients seen by Rapid Response Teams: A template for benchmarking international teams. *Resuscitation.* 2016;107:7-12.
23. Jones D. The epidemiology of adult Rapid Response Team patients in Australia. *Anaesth Intensive Care.* 2014;42(2):213-219.
24. Burke JR, Downey C, Almoudaris AM. Failure to Rescue Deteriorating Patients: A Systematic Review of Root Causes and Improvement Strategies. *J Patient Saf.* 2020.
25. Considine J, Jones D, Pilcher D, Currey J. Patient physiological status during emergency care and rapid response team or cardiac arrest team activation during early hospital admission. *Eur J Emerg Med.* 2017;24(5):359-365.
26. Considine J, Jones D, Pilcher D, Currey J. Patient physiological status at the emergency department-ward interface and emergency calls for clinical deterioration during early hospital admission. *J Adv Nurs.* 2016;72(6):1287-1300.
27. Considine J, Jones D, Pilcher D, Currey J. Physiological status during emergency department care: relationship with inhospital death after clinical deterioration. *Crit Care Resusc.* 2015;17(4):257-262.

28. Litvak E, Pronovost PJ. Rethinking rapid response teams. JAMA. 2010 Sep 22;304(12):1375-6. doi: 10.1001/jama.2010.1385. PMID: 20858881

29. Medical Emergency Team End-of-Life Care investigators. The timing of Rapid-Response Team activations: a multicentre international study. Crit Care Resusc. 2013 Mar;15(1):15-20. PMID: 23432496.

Table 1: Baseline patient characteristics for older internal medicine patients

Characteristic	No MET calls	Received a MET call	P-value
Number of patients	9,428	995	
Male gender; N(%)	4,238 (45%)	453 (46%)	0.73
Age; median (IQR) years	85 (81, 89)	86 (81, 90)	0.07
Charlson comorbidity index; median (IQR)	1 (0, 2)	2 (1, 3)	<0.001
Acute myocardial infarction; N(%)	261 (3%)	60 (6%)	<0.001
Congestive cardiac failure; N(%)	2258 (24%)	385 (39%)	<0.001
Peripheral vascular disease; N(%)	85 (1%)	16 (2%)	0.03
Cerebrovascular disease; N(%)	151 (2%)	9 (1%)	0.09
Dementia; N(%)	794 (8%)	86 (9%)	0.81
Chronic obstructive pulmonary disease; N(%)	1038 (11%)	197 (20%)	<0.001
Rheumatological diseases; N(%)	49 (1%)	12 (1%)	0.007
Liver disease; N(%)	144 (2%)	14 (1%)	0.77
Diabetes with no complications; N(%)	898 (10%)	82 (8%)	0.19
Diabetes with complications; N(%)	3043 (32%)	353 (35%)	0.04
Renal disease; N(%)	1391 (15%)	237 (24%)	<0.001
Any malignancy without metastases; N(%)	316 (3%)	53 (5%)	0.001
Metastatic solid tumor; N(%)	173 (2%)	29 (3%)	0.02
Patient located in a non-designated medical unit ward; N(%)	5108 (54%)	598 (60%)	<0.001
Weekend Admission; N(%)	2757 (29%)	325 (33%)	0.03
Afterhours Admission; N(%)	5354 (57%)	570 (57%)	0.76

Admission Source; N(%)			0.16
Home	7994 (85%)	821 (83%)	
Nursing home	1397 (15%)	169 (17%)	
Other	36 (<1%)	5 (1%)	
ED presentation count in the previous 12 months; median (IQR)	1 (0, 2)	1 (0, 2)	0.18
Inpatient admission count in the previous 12 months; median (IQR)	1 (0, 2)	1 (0, 2)	0.21

ED = Emergency Department; IQR= Interquartile range; MET = Medical Emergency Team

Table 2: Patient characteristics of older internal medicine patients at Emergency Department presentation

Factor	No MET calls	Received a MET call	p-value
Number	9,428	995	
Triage Category; N(%)			<0.001
1	140 (1%)	17 (2%)	
2	1927 (20%)	306 (31%)	
3	5000 (53%)	533 (54%)	
4	2291 (24%)	133 (13%)	
5	68 (1%)	6 (1%)	

ED Length of stay in minutes mean (SD)	408 (204)	437 (218)	<0.001
Temperature (^{o}C); mean (SD)	37.0 (6.4)	37.0 (1.4)	0.79
Pulse Rate; mean (SD)	88 (21)	93 (23)	<0.001
Respiratory Rate; mean (SD)	21 (7)	23 (8)	<0.001
Systolic BP (mmHg); mean (SD)	134 (27)	129 (28)	<0.001
Diastolic BP (mmHg); mean (SD)	73 (14)	72 (14)	0.04
$SpO_{2;}$ mean (SD)	96 (14)	95 (4)	0.10
GCS; mean (SD)	14.6 (16.2)	14.4 (4.3)	0.69
BSL (mmol/L); mean (SD)	9.5 (4.9)	9.8 (4.9)	0.18
Hb (g/L); mean (SD)	122 (21)	122 (21)	0.72
WCC (x10^{9}/L); mean (SD)	10.4 (6.6)	11.2 (6.1)	<0.001
Albumin (g/L); mean (SD)	33.8 (4.9)	32.6 (5.4)	<0.001
Na^{+} (mmol/L); mean (SD)	139 (5)	138 (6)	0.009
K^{+}(mmol/L); mean (SD)	4.5 (0.6)	4.5 (0.7)	0.15
HCO_3(mmol/L); mean (SD)	23.9 (3.8)	23.7 (4.6)	0.18
Creatinine (μmol/L); mean (SD)	121 (67)	135 (86)	<0.001
eGFR (mL/min); mean (SD) eGFR <60 male; N(%) eGFR ≥60 male; N(%) eGFR <60 female; N(%) eGFR ≥60 female; N(%)	49.9 (21.2) 2,569 (27%) 1,669 (18%) 3,232 (34%) 1,958 (21%)	45.6 (21.3) 301 (30%) 152 (15%) 381 (38%) 161 (16%)	<0.001
Urea (mmol/L); mean (SD)	11.6 (7.4)	13.1 (7.9)	<0.001
Lactate (mmol/L);mean (SD)	2.0 (1.3)	2.3 (1.6)	<0.001

BP = Blood pressure; BSL = Blood sugar level; ED = Emergency Department; eGFR =Estimated glomerular filtration rate; GCS = Glasgow coma scale; Hb = Haemoglobin; HCO_3 = Bicarbonate; K = Potassium; MET =

Medical Emergency Team; Na = Sodium; SD = Standard Deviation; SpO_2= pulse oxygen saturation; WCC = White cell count

Table 3: ICU and CCU use for older internal medicine patients admitted from the emergency department

Factor	No MET call (N = 9,428)	Received a MET call (N = 995)	P value
ICU Admissions; N(%)	180 (2%)	98 (10%)	<0.001
CCU Admissions; N(%)	95 (1%)	33 (3%)	<0.001
ICU LOS (days, median, IQR)	1.9 (0.9, 3.1)	2.1 (1.1, 3.9)	0.12
CCU LOS (days, median, IQR)	1.2 (0.7, 2.0)	1.9 (1.2, 3.3)	0.01
Mechanical ventilation N(%)	35 (<1%)	12 (1%)	<0.001
Duration of mechanical ventilation (hours, median, IQR)	29 (8, 88)	43 (27, 182)	0.37
Non-mechanical ventilation N(%)	16 (<1%)	17 (2%)	<0.001
Duration of non-mechanical ventilation (hours, median, IQR)	6 (3, 15)	10 (5, 22)	0.22

CCU = Coronary Care Unit; h = hours; ICU = Intensive Care Unit; LOS = length of stay; MET = Medical Emergency Team; IQR = Interquartile range

Table 4: Hospital outcomes of older internal medicine patients admitted via the emergency department

Patient Outcomes	No MET call (N = 9,428)	Received a MET call (N = 995)	P value
Hospital LOS (days, median, IQR)	4 (2, 7)	9 (5, 14)	<0.001
Discharged home; N(%)	6,002 (64%)	449 (45%)	<0.001
Discharged to a nursing home; N(%)	1,012 (11%)	99 (10%)	0.45
In-hospital mortality; N(%)	645 (7%)	287 (29%)	<0.001
Readmitted to hospital at 28 days (N, %)	1,214 (13%)	115 (12%)	0.24

LOS = length of stay; MET = Medical Emergency Team; IQR = Interquartile range