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Medical Emergency Team Calls in the Radiology Department: Patient Characteristics and Outcomes

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Abstract

Objective—We sought to identify characteristics of patients who experience medical emergency team calls in the radiology department (MET-RD) and the relationship between these characteristics and patient outcomes.

Design/Participants—Retrospective review of 111 in-patient MET-RD calls (5/2008-4/2010).

Setting—Academic medical center with a well-established MET system.

Measurements—We extracted from medical records and administrative databases the characteristics of patients before, during, and after transport to Radiology. We compared these characteristics between patients with good and poor outcomes.

Main Results—The majority of patients experiencing MET-RD had a Charlson Comorbidity Index 4 and were from non-ICU units (60%). Almost half (43%) of MET-RD occurred during hospitalization day one. MET-RD patients commonly arrived with nasal cannula oxygen (38%), recent tachypnea (28%) and tachycardia (34%). A minority (16%) fulfilled MET call criteria in the

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Contributors

Study design: LO, MP, LH, SPC, SC, DR, MH; Data collection: LO; Data analysis and interpretation: LO, MP, DR, MH; Drafting, critical revision and final approval of manuscript: LO, MP, LH, SPC, SC, MH.

Competing Interests

There are no competing interests.

Data sharing statement

The data obtained in this study are the property of the principal researcher, the first named author.

12 hours before MET-RD. MET-RD etiologies were cardiac (41%), respiratory (29%) or neurologic (25%), and occurred most frequently during computed tomography (CT) (44%) and magnetic resonance imaging (MRI) (22%) testing. Post MET-RD, the majority (70%) required a higher care level. Death before discharge (25%), was associated with need for cardiovascular support prior to RD transport ($p=0.02$), need for RD monitoring ($p=0.02$) and need for heightened RD surveillance ($p=0.04$).

Conclusions—The majority of MET-RD patients came from non-ICU units, with comorbidities and vital signs alterations prior to the RD. Risk appeared to be increased for those requiring CT and MRI. These findings suggest that prior identification of a subset of RD patients at risk of instability may be possible.

Keywords

patient safety; Medical Emergency Team; Radiology; patient outcomes; intrahospital transport

INTRODUCTION

Medical Emergency Teams (MET) have emerged as a means to provide critical care expertise when additional resources are needed for the management of compromised patients outside the ICU.[1-4] MET represent the efferent or response arm of a Rapid Response Systems (RRS). Despite mixed findings regarding the efficacy of MET,[1,5,6] the Institute of Healthcare Improvement's 100,000 lives campaign recommends that institutions implement a RRS as a means to reduce potentially preventable deaths.[7] Additionally, the Joint Commission includes RRS implementation in their 2008 Patient Safety Goals.[8]

Prior studies describe MET activation and outcomes in various hospital settings.[1-4,6,9] However, few studies have examined MET utilization in the Radiology Department (RD). In-patients are frequently transported for diagnostic tests and procedures, and some of these patients become unstable and require a MET call (MET-RD).[10-13] Early recognition of patient instability and complications in the RD may be hindered by the wide range of patient conditions and acuity levels seen in this department. At least one study found that service/unit mismatch, i.e., care not provided on designated unit or by staff not typically assigned to the unit was predictive of more MET calls.[14] This finding highlights the potential vulnerability of patients cared for by nurses in a setting, such as the RD.

There is literature to demonstrate that patients may exhibit signs of physiologic compromise before bedside providers have recognized a problem and initiated a patient rescue or trigger the MET.[14-18] There is also literature demonstrating that patients may become unstable during transport or require transport to determine the cause of instability.[11,19] However, little is known about instability incidence and care of patients after they arrive in the clinical care area of the RD. Better characterization of patient characteristics prior to a MET-RD may aid in more appropriate determination of risk factors and preemptive determination of surveillance needs. Therefore, the purpose of this exploratory descriptive study was to identify characteristics of in-patients who experience MET-RD activation, and the relationship between these characteristics and patient outcomes.

MATERIALS AND METHODS

After obtaining IRB approval, we performed a retrospective review of all MET-RD activations for patients age 18 years and older between May 1, 2008 and April 30, 2010 at a tertiary care academic medical center with a well-established MET system. The RD at this hospital performs diagnostic tests and procedures including computerized tomography (CT), magnetic resonance imaging (MRI), interventional radiology (IR), nuclear medicine (NM),

ultrasound (US), fluoroscopy and general reontenographic studies (XR) for approximately 160,000 in-patients annually. Eligible patients were identified through the facility's Medical Emergency Response Improvement Team (MERIT) database which maintains data on all MET calls occurring in the study hospital. All visits for patients who experienced a MET-RD call during the study period were reviewed. Patients who experienced a MET activation while in transit to or from the RD were excluded from the study, as were MET-RD calls for outpatients (e.g., ambulatory test). The final sample consisted of 111 MET calls.

The RD staff members utilize the same MET trigger criteria (Table 1) to respond to patient instability as the personnel on the general hospital units. The standard of care is to call the MET for all patients (non-ICU and ICU) who meet MET criteria outside of the ICU. Any nurse, physician, patient, or visitor is able to call for the MET by dialing a pre-determined, well publicized number. The MET team consists of a critical care medicine physician, two critical care nurses, and a respiratory therapist.

Data Collection and Variables of Interest

We recorded the number of MET-RD calls and the time of day and day of week at which they occurred. Time of day was categorized by 4 hour increments for analysis. The characteristics of patients before RD transport (demographics, admitting diagnosis by ICD-9 code, Charlson Comorbidity Index individual and total scores,[20] transfer from intensive care unit (ICU) or non-ICU unit of origin, care needs and vital signs in the 12 hours before RD arrival) and during RD care (RD modality, RD care needs, type of RD caregivers) were extracted from the electronic medical record or the administrative database.[20] Admitting ICD-9 codes were categorized into 8 related categories representing primary diagnosis.

The care needs in the 12 hours prior to RD transport were identified from the patient record. Respiratory support was defined as the need for any supplemental oxygen delivery system or type of respiratory support (nasal cannulae, face mask, mechanical ventilation). Cardiovascular support was defined as documentation of inotropic medications and/or fluid resuscitation and need for blood products. Cardiac arrhythmias were identified using cardiac assessments documented by nurses. Sedation prior to the RD was recorded and included propofol, diazepam, morphine, fentanyl, alprazolam, hydromorphone, midazolam, succinylcholine and/or vecuronium. Vital signs were categorized according to MET call criteria (Table 1). In addition, tachycardia was defined as a heart rate > 100 beats per minute, and tachypnea on cut points of rate 24 breaths per minute and 30 breaths per min.

The RD modalities at the time of the MET-RD as well as the etiology of the MET-RD call were obtained from the MET call records. MET etiology was classified as a cardiac, respiratory, neurologic or other cause. Sedation in the RD consisted of administration of lorazepam, hydromorphone, midazolam, fentanyl, propofol, succinylcholine or vecurium. Monitoring in the RD consisted on any combination of cardiac, blood pressure or pulse oxymetry. The level of RD surveillance (the type of health care worker monitoring the patient) was described according to four caregiver categories: (a) RD technician (responsible for conducting the test ordered for the patient), (b) staff RN (general ward, resource pool or ICU staff) who accompanied patient to the RD, (c) RD RN (RD-unit assigned), or (d) advanced patient care technicians (unlicensed care providers trained in reading cardiac monitors who accompany monitored patients during intrahospital transport).

Two separate patient outcomes were examined. The first patient outcome examined whether or not patients required a more intense level of care post-MET-RD. "Higher level of care" was considered to exist when patients experienced any of the following: increased respiratory support (nasal cannulae, high flow oxygen, mechanical ventilation); increased cardiac support (fluid resuscitation, blood products, pharmacologic blood pressure support

or pharmacologic cardiac rhythm support); emergent diagnostic or surgical procedure (angiography, cardiac cath lab, central venous catheterization, electroencephalogram, electrocardiogram, CT, MRI, operating room); transfer to a higher acuity patient care unit. The second patient outcome examined was death between the MET-RD call and discharge. Study data were extracted by the study PI (LKO) and a graduate research assistant. To assess data collector quality control, 10% of records were reviewed separately by both data collectors and values for study variables compared, with no discrepancies noted between data collectors.

Statistical Analysis

Statistical analysis was performed using SAS© 9.2. Continuous variables were reported as mean $\pm$ standard deviation, and comparisons were made using univariate binary logistic regression. Categorical variables were reported as frequencies with percentages, and comparisons were made using χ^2 tests and Fisher's exact test. Statistical significance was set at a p value of <0.05 .

RESULTS

The distribution of the 111 MET-RD calls across day of week and time of day are illustrated in Figure 1. MET-RDs occurred more frequently in the middle of the week (Wednesday) and between 0800-1200 (30%).

Over 70% of patients required a higher level of care post-MET-RD (Figure 2). Half required increased respiratory support and, of those not on mechanical ventilation prior to transport, 26% required mechanical ventilation. Of the 67 patients not admitted to an ICU prior to the MET-RD, 38 were transferred to a higher acuity unit, 28 were newly admitted to an ICU, and 10 were sent to monitored non-ICU beds. Of the 26 patients who required an emergent procedure post-MET-RD, 7 were sent to the operating room. In addition, 11 patients underwent further RD procedures (CT, Angiography and MRI) post MET-RD prior to leaving the RD. One in four MET-RD patients (25%) died prior to hospital discharge.

Characteristics of the patients prior to their RD-transport were middle aged, Caucasian (81%) and with an equal distribution of females and males (Table 2. Panel A.). Patients were evenly distributed across admitting diagnosis categories with a slightly higher proportion with a neurologic diagnosis (24%). The average Charlson Comorbidity Index was approximately 4, with the most common comorbidities being renal (61%), cerebral vascular disease (28%), diabetes (22%), myocardial infarct (21%) and cardiopulmonary disease (20%). The majority of the patients (60%) originated in non-ICU units. Almost half (43%) experienced the MET-RD on their first day of hospitalization. Many (65%) were on respiratory support, most commonly by nasal cannula oxygen (38%). In addition prior to transport to the RD, 25% received cardiovascular support and 23% received sedation. Cardiac arrhythmias were documented in 27%. In the 12-hours prior to MET-RD, 16% of the patients had at some point met or exceeded MET call vital sign thresholds. While only 5% and 2% exceeded MET criteria for respirations and heart rate respectively, 28% experienced tachypnea (breaths per min ≥ 24) and 34% experienced tachycardia at levels *below* MET call thresholds (i.e. between 100 bpm and 160 bpm).

When evaluating the association between patient characteristics prior to RD transport and the outcome of need for a higher level of care post-MET (Table 2. Panel B), no significant differences were identified between patients requiring higher levels of care and those who did not. However, several trends were noted. Not surprisingly, non-ICU patients more often required a higher level of care as did patients who arrived on nasal cannula oxygen (28%,

$p=0.15$). Of the patients with respirations ≥ 30 breaths per min, 92% required a higher level of care compared to 77% of the patients with respirations ≤ 24 breaths per minute.

In terms of patient characteristics prior to RD transport and associated in-patient mortality post-MET call (Table 2, Panel C), we observed a non-statistically significant trend toward increased mortality for males compared to females (68% vs. 32%, $p=0.09$). A significantly greater proportion of the patients who died originated from an ICU (57%) than a ward (43%, $p=0.03$), and had been receiving cardiovascular support prior to the RD (39% vs. 17%; $p=0.02$). However a prior cardiac arrhythmia did not confer any significant mortality risk. Of the 28 patients who did not survive to discharge, 2 patients died in the RD.

The majority of MET-RD calls were for patients receiving either CT (44%) or MRI (22%) scans (Table 3, Panel A). MET-RD etiology was most commonly cardiac (41%) with the MET triggers of hypotension (17%), cardiac arrhythmias (16%) and chest pain (7%). Respiratory MET-RD etiology (29%) triggers were hypoxia (23%) and airway protection (7%). Neurologic MET-RD etiology (25%) triggers were seizures (14%), altered mental status (9%) and stroke (1%). Other MET-RD triggers were falls, dislodged central venous catheters (2%) and the need for additional ICU personnel (2%).

There also appeared to be differences in surveillance. A majority of the MET-RD patients (57%) received at least one form of continuous vital sign monitoring while in the RD; less than half were under the surveillance of a staff nurse (general ward, resource pool, ICU). The patients who were continuously monitored in the RD and those who were monitored by staff nurse surveillance in the RD were more likely to die during hospitalization suggesting prior identification of instability. Of the 18 patients (12 ICU and 6 non-ICU) with VS that met the MET criteria in the 12 hours prior to the MET-RD (Table 2, Panel A), 15 patients were monitored by an RN while in the RD, 2 patients were monitored by an APCT and one patient was not monitored.

The comparisons of the MET-RD sample by unit of origin are illustrated in Table 4. The post MET-RD outcomes showed that ICU patients were more likely to die prior to discharge. There was no statistical difference in the proportion of non-ICU patients requiring a higher level of care post MET-RD. The ICU patients were older, requiring greater respiratory and cardiac support with documented arrhythmias. Additionally, the ICU patients were more likely to have alterations in their vital signs and require sedation in the RD. There were no statistical differences in the MET-RD etiologies and RD modalities.

DISCUSSION

Our study found variations in the time, unit of origin, type of testing and vital sign alterations among the 111 patients who experienced a MET-RD over a two years period at a tertiary care academic hospital. To our knowledge, this is the largest study to date of patient instability in the RD. MET-RD calls were concentrated in the daylight hours and during weekdays. The majority of patients who experienced a MET-RD arrived from non-ICU units. Patients having CT scans had the highest percentage of MET-RD calls. Patients often had documented alterations in vital signs, notably tachycardia and tachypnea, in the 12 hours prior to MET-RD. Over half of the MET-RD patients' received continuous monitoring of vital signs while in the RD. A large majority (70%) required a higher level of care post-MET-RD and 25% died during hospitalization post-MET-RD.

The post-MET-RD in-hospital death rate of 25% is somewhat higher than the estimates of 11-19% reported for in-patient mortality post-MET calls to all patient care areas in other centers.[6,10] This reflects the increased acuity of ICU patients cared for in the RD. The non-ICU post MET-RD mortality rate (18%) was similar to the mortality rate of reported in

prior studies, however the ICU mortality rate (36%) was double the non-ICU rate. Interestingly, of the 70% of patients requiring a higher level of care, 34% required a higher acuity care unit and 23% required post-MET-RD procedures. The patients requiring a higher acuity care unit were all non-ICU patients however the patients requiring post MET-RD procedures were equally divided between ICU and non-ICU patients. Chen et al. (2008), examining post-MET outcomes for a general ward patients, reported only 46% required a higher level of care, but of these 45% required a higher acuity care unit and only 0.6% required a procedure post-MET. ICU patients arrive in the RD already critically ill and potentially having been sent to the RD for investigation of deteriorating conditions. Despite the increased surveillance accompanying ICU patients to the RD activation of the MET is needed in response to patient deterioration.[21]

Charlson Comorbidity Index total scores ≥ 5 have been associated with high mortality and co-morbid related complications in hospitalized patients.[22,23] The Charlson Comorbidity Index total scores (48% with CCI scores ≥ 4) may also reflect on the 25% mortality seen in this sample. Compared to the in-patient population CCI scores reported in other instability studies of (8.9 - 20% of the patients had a CCI ≥ 4);[18,23,24] the MET-RD sample had an increased comorbidity burden. Given that there was no significant difference between the CCI scores of the ICU and non-ICU patients, the inclusion of ICU patients does not explain the increase comorbidity burden of the RD sample.

The diurnal variations in MET-RD calls noted in this study followed a pattern previously reported in the hospital-wide MET literature, with the highest number of calls from 0800-1200 hours (representing the beginning of the day shift) and the majority of the calls being made on the weekdays.[14,18,25] The RD procedural units at our study site serve both inpatients and outpatients, with outpatient procedures more heavily scheduled on weekdays. Care demands for outpatient on weekdays may have influenced this pattern; however, it may also reflect differences in characteristics of the in-patients receiving procedures during the week.

The most common radiologic modality for a MET-RD was CT (44%). Over half of the MET-RD patients who died during hospitalization (54%), experienced their MET-RD in relation to a CT procedure. This is consistent with findings from a prior study in this institution and with intrahospital transport literature.[21,26] CT has been identified as one of the most common types of procedures performed for in-patients and as a procedure involving patients at greatest risk for adverse events. From a review of 8 studies examining 650 ICU patients transported for testing, 50% involved a CT scanner.[19] There was no significant difference in RD modalities for ICU and non-ICU patients in the MET-RD sample. Therefore the documented high incidence of CT scans for ICU patients does not explain the high mortality for MET-RD patients in CT.

In a prospective study of 125 intrahospital transports of ICU patients, one third experienced an instability event that was potentially life-threatening, and the majority of these events (75%) occurred in the RD or the operating room.[11] Equipment failure has been cited as a cause of adverse events during intrahospital transport of ICU patients to the RD, alterations in blood pressure, heart rate and oxygenation are also cited.[27] Patients often show signs of physiologic compromise hours before clinicians recognize the need for rescue interventions. [15-18] Therefore, our examination of the recorded vital signs for all MET-RD patients in the 12 hours prior to the MET-RD call showed that 16% reached MET call vital signs threshold of concern in one or more of the vital sign parameters (although a MET was not called). Perhaps more importantly, there were signs of physiologic compromise prior to sending the patient to the RD, as evidenced by 34% of the patients with recorded heart rates >100 beats per min and 28% of the patients with recorded respiratory rates ≥ 24 breaths per

min (11% 30 breaths per min). While not meeting the MET call threshold, these changes likely signaled physiological compromise. In prior studies, a respiratory rate 24 breaths per min has been associated with critical illness and 30 breaths per min has been predictive of higher acuity care needs and hospital mortality.[28,29] Our study did not evaluate whether care was modified to manage these vital sign changes. Therefore, it is unknown whether preventive actions might have averted the MET-RD call. The ICU patients were statistically more likely to have alterations in vital signs, however, this finding reinforces the need to closely monitor vital signs and the importance of this parameter as a signal of compromise.

Interestingly, the majority of MET-RD patients were on continuous electronic vital sign monitoring while in the RD. Staff RNs (general ward, resource pool or ICU) accompanied 43% of the patients to the RD, of whom only 8% of were non-ICU patients. This suggests that the non-ICU patient acuity may be underestimated prior to transfer to the RD potentially resulting in decreased nursing surveillance in the RD. Among the patients who were not accompanied by a staff nurse to the RD, the technician responsible for conducting the radiologic scan was the only source of patient surveillance for 40% of the MET-RD patients. The RD RN (a member of the regular RD staff) provided surveillance for 14% of patients prior to the MET-RD call. In the study site, a 1:1 RD RN to patient ratio for direct nursing surveillance occurs only for select high risk procedures (i.e.: conscious sedation, lung biopsy) or when specific medications are required by the institution's protocol for the procedure (i.e.: coronary artery CT angiography, cholescintigraphy). Although an RD-RN can be requested to respond to increased surveillance needs including instability, the technician or radiologist must specifically request this assistance. Our study design did not examine if the instability was of rapid onset or the recognition of instability by RD technicians. Direct nursing surveillance of all patients in the RD is neither practical nor necessary. However, the challenge is to identify compromise in patients prior to the need for a MET call in order to better allocate resource to provide for preemptive nursing surveillance. Our findings suggest that close monitoring of changes in heart and respiratory rate may provide important initial warning.

In this study, the etiology for the MET call was most commonly of a cardiac nature (41%), which may in part be due to the comorbidity prevalence of myocardial infarct (21%) and cardiopulmonary disease (20%) in the sample. Only a third of the MET call etiology was due to a respiratory cause, while this is the most common reason for a MET call in general ward patients.[4,30] One explanation may be that, unlike the general ward MET studies, our sample includes ICU patients and 15% of our sample arrived in the RD already intubated and accompanied by a respiratory therapist per hospital policy. However, there was no significant difference between the MET-RD etiology of ICU and non-ICU patients. Additionally, we did not find the type of MET-RD etiology to be significantly associated with need for post-MET higher level of care or mortality.

Limitations

The data here are from a single tertiary academic medical center with a well-established MET system, which may limit the generalizability of these findings to the in-patient populations seen by other radiology departments. Also, despite the two year time frame, the study examined a relatively small sample of events. Data were collected retrospectively from various existing data sources. The data available for review did not provide information regarding specific RD tests, their emergent nature, exam outcomes or physician rationale for sending patients to the RD, all of which would have strengthened the study. Additionally, we did not include patients who experienced a MET in-transit to RD because the event was outside the influence of RD. In addition, the volume of in-transit calls was very low. We recognize that clinical data sources, such as the medical record, are not designed for research purposes, and missing or inconsistently recorded data may introduce

threats to validity. Finally, we did not describe our MET-RD daily prevalence relative to the number of procedures done per time of day or day of the week. Thus, the patterns of MET-RD calls in the morning hours and mid-week may be proportional to work flow. Our administrative data set did not allow us to determine the time-specific workload. The findings, nevertheless, suggest the need for further prospective studies in radiologic settings.

Conclusions

The characteristics and outcomes of in-patients who experience a MET call while in the radiology department may differ from those of in-patients who experience a MET on the general ward, both with regard to MET etiology and comorbidity burden. MET-RD patients are a mix of ICU and non-ICU patients, and therefore they are potentially more clinically complex than other MET patients. Experiencing a MET call away from the usual-care unit in the hospital in an area such as the RD may place patients at increased risk for a need for escalation of care or death. Further research in this area is needed. Transient care of patients outside of their usual care areas in the RD potentially places patients at risk. Better mechanisms for identifying at risk patients may improve the utilization of resource for nursing surveillance in the RD thus improving patient outcomes. Improved communication and handoff between the RD and the nursing staff from the referring units could increase the RD nurses' ability to identify patient care needs, appropriate monitoring and surveillance. RD patients clearly represent a special clientele for METs and RRSs and merit further study.

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Figure 1. Distribution of 111 MET-RD (Medical Emergency Team to Radiology Department) Calls according to day of the week (Panel A) and time of day (Panel B).

Figure 2.

Patient outcomes for 111 patients post-Medical Emergency Team (MET) call in the Radiology Department categorized by those patients requiring a higher care unit, cardiac support, respiratory support and/or an immediate procedure.

Table 1

University of Pittsburgh Medical Center Medical Emergency Team calls criteria during study period.[1]

<i>Respiratory</i> <ul style="list-style-type: none"> • Rate <8 or >36 • New onset of difficult breathing • New pulse oximeter reading <85% for >5 min without known chronic hypoxia • New oxygen requirement to keep SpO₂>85% 	<i>Other</i> <ul style="list-style-type: none"> • >1 STAT page required to assemble team needed to respond to a crisis • Patient complaint of chest pain (unresponsive to nitroglycerine or MD unavailable) • Color change (patient or extremity): Pale, dusky, gray or blue • Unexplained agitation of >10 min. • Narcan use without immediate response • Suicide attempt • Uncontrolled bleeding • Bleeding into airway • Large acute blood loss • Crash cart must be used for rapid delivery of meds
<i>Cardiovascular</i> <ul style="list-style-type: none"> • Heart Rate <40 or >140 with new symptoms or any rate >160 • Blood pressure <80 or >200 systolic or 110 diastolic with symptoms (neurologic changes, angina, dyspnea) 	
<i>Acute Neurologic Change</i> <ul style="list-style-type: none"> • Acute loss of consciousness • New onset lethargy • Sudden collapse • Seizure (outside of seizure monitor unit) • Sudden loss of movement or weakness in the face, arm or leg 	

Table 2

The total sample demographic and care requirement characteristics of 111 patients who required a Medical Emergency Team call to the radiology department (MET-RD) prior to their transport (Pre-RD) (Panel A), and comparisons of characteristics according to their outcomes of post-MET care requirements (Panel B) and mortality (Panel C).

Characteristics		Post-MET-RD Patient Outcomes			
A. Pre-RD Patient Demographics and Care Requirements	n (%) Mean ($\pm$ SD) n=111	B. Higher Care n=78	C. Death n=28	p**	
Age	60 (18)	61 (18)	67 (14)	0.02	
Median (range)	62(18-93)				
Female	51 (46%)	32 (41%)	9 (32%)	0.09	
Male	60 (54%)	46 (59%)	19 (68%)		
Admitting Diagnosis (%yes)					
Other	9 (8%)	6 (8%)	6 (7%)	0.48	
Cardiovascular	13 (12%)	11(14%)	7 (8%)		
Peripheral Vascular	5 (5%)	4 (5%)	4 (5%)		
Abdominal	16 (14%)	11 (14%)	12 (14%)		
Neurologic	27 (24%)	19 (24%)	20 (24%)		
Respiratory	9 (8%)	6 (7%)	7 (8%)		
Infection	11 (10%)	8 (10%)	8 (10%)		
Skeletomuscular	21 (19%)	13 (17%)	19 (23%)		
Charlson Co-Morbidity Score					
Mean	3.6 (2.7)	3.8 (2.9)	4.3 (2.2)	0.17	
Median (range)	3.0 (0-15)				
3 comorbidities	58 (52%)	40 (51%)	12 (43%)	0.25	
4 comorbidities	53 (48%)	38 (49%)	16 (57%)		
Unit of Origin					
ICU	44 (40%)	29 (37%)	16 (57%)	0.03	
Non-ICU	67 (60%)	49 (63%)	12 (43%)		

Characteristics		Post-MET-RD Patient Outcomes			
A. Pre-RD Patient Demographics and Care Requirements	n (%) Mean (±SD) n=111	B. Higher Care n=78	p [*]	C. Death n=28	p ^{**}
MET-RD on Admission Day One (%yes)	48 (43%)	35 (45%)	0.59	13 (46%)	0.69
Respiratory Support upon arrival to RD % yes	72 (65%)	45 (60%)	0.21	18 (67%)	0.65
Nasal Cannula	41 (38%)	30 (28%)	0.15	9 (8%)	0.20
Face Mask	13 (12%)	9 (8%)		2 (2%)	
Ventilator	16 (15%)	6 (6%)		7 (6%)	
Cardiovascular Support prior to RD (%yes)	23 (25%)	17 (22%)	0.78	11 (39%)	0.02
Cardiac Arrhythmias prior to RD (%yes)	30 (27%)	19 (24%)	0.33	4 (14%)	0.09
Sedation prior to RD (%yes)	25 (23%)	16 (21%)	0.44	6 (21%)	0.87
VS 12 hours prior to RD Meets MET Criteria (%yes)	18 (16%)	15 (19%)	0.26	5 (18%)	0.77
Respiratory	5 (5%)	4 (5%)	1.00	3 (11%)	0.10
Heart Rate	2 (2%)	1 (1%)	0.51	0 (0%)	1.00
Systolic	10 (9%)	8 (10%)	0.72	3 (11%)	0.71
Diastolic	6 (5%)	6 (8%)	0.18	1 (4%)	1.00
Tachycardia	38 (34%)	25 (32%)	0.46	7 (25%)	0.26
Tachypnea					
Breaths 24 per min	31 (28%)	23 (29%)	0.57	10 (36%)	0.29
Breaths 30 per min	12 (11%)	11 (14%)	0.09	4 (14%)	0.49

* p-values refer to comparisons within columns of higher care (transfer to a higher care unit, increased respiratory support, increased cardiac support or transfer for procedure) and return to previous level of care.

** p-values refer to comparison within columns of death and survival to discharge.

Table 3

The total sample demographic and care requirement characteristics of 111 patients who required a Medical Emergency Team call to the radiology department (MET-RD) during their radiology care Intra-RD (Panel A), and comparisons of characteristics according to their outcomes of post-MET care requirement (Panel B) and mortality (Panel C).

Characteristics		Post-MET-RD Patient Outcomes			
A. Intra-RD Patient Demographics and Care Requirements	n (%) Mean (±SD)	n=111	B. Higher Care n=78	C. Death n=28	p**
Radiology Modality					
Computerized Tomography	49 (44%)		33 (42%)	15 (54%)	0.28
Magnetic Resonance Imaging	24 (22%)		19 (24%)	4 (14%)	
Interventional Radiology	14 (13%)		10 (13%)	5 (18%)	
General X-ray	14 (13%)		7 (9%)	1 (4%)	
Other (Nuclear Medicine, Peripheral Vascular, Ultrasound)	10 (9%)		9 (12%)	3 (11%)	
MET-RD Etiology (%yes)					
Cardiac	45 (41%)		29 (37%)	11 (39%)	0.86
Respiratory	32 (29%)		26 (33%)	9 (32%)	
Neurologic	28 (25%)		19 (24%)	6 (21%)	
Other	6 (5%)		4 (5%)	2 (7%)	
Sedation in RD (%yes)	18 (16%)		11 (14%)	7 (25%)	0.30
Monitor in the RD (%yes)	63 (57%)		45 (58%)	21 (75%)	0.02
RD Level of Surveillance					
RD Tech only	36 (40%)		27 (35%)	4 (15%)	0.04
RD RN	15 (14%)		9 (12%)	4 (15%)	
ICU/non-ICU RN	49 (43%)		35 (45%)	16 (59%)	
Advanced Patient Care Technician	5 (5%)		5 (6%)	2 (8%)	

* p-values refer to comparisons within columns of higher care (transfer to a higher care unit, increased respiratory support, increased cardiac support or transfer for procedure) and return to previous level of care.

** p-values refer to comparison within columns of death and survival to discharge.

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Table 4

The total sample demographic and care requirement characteristics of 111 patients who required a Medical Emergency Team call to the radiology department (MET-RD) dichotomized by unit of origin.

Patient Characteristics	Unit of Origin		p *
	ICU n=44 (40%)	nonICU n=67 (60%)	
Post MET-RD Outcomes			
Death	16 (36%)	12 (18%)	0.03
Higher Level of Care	29 (66%)	49 (73%)	0.42
Transfer to a Higher Care Unit	0 (0%)	38 (57%)	0.00
Increased Respiratory Support	23 (52%)	35 (52%)	0.64
Increased Cardiac Support	9 (21%)	11 (16%)	0.59
Transfer for Procedure	10 (23%)	16 (24%)	0.89
Pre-RD Patient Demographics and Care Requirements			
Age Mean (SD)	66 (2.3)	56 (2.3)	<0.01
Female	16 (36%)	35 (52%)	0.10
Male	28 (64%)	32 (48%)	
Charlson Co-Morbidity Score Mean (SD)	3.89 (2.7)	3.52(2.8)	0.50
4 comorbidities	24 (55%)	29 (43%)	0.25
MET-RD on Admission Day One (%yes)	23 (52%)	25 (37%)	0.12
Respiratory Support upon arrival to RD % yes	36 (86%)	33 (40%)	<0.01
Nasal Cannula	16 (38%)	25 (37%)	<0.01
Face Mask	6 (14%)	7 (10%)	
Ventilator	14 (33%)	0 (0%)	
Cardiovascular Support prior to RD (%yes)	21 (48%)	4 (6%)	<0.01
Cardiac Arrhythmias prior to RD (%yes)	18 (41%)	12 (18%)	<0.01
Sedation prior to RD (%yes)	11 (25%)	14 (21%)	0.61
VS 12 hours prior to RD Meets MET Criteria (%yes)	12 (27%)	6 (9%)	0.01
Tachycardia	24 (55%)	14 (21%)	<0.01
Tachypnea			
Breaths 24 per min	23 (52%)	8 (12%)	<0.01
Breaths 30 per min	9 (20%)	3 (4%)	<0.01
Intra-RD Patient Demographics and Care Requirements			

Patient Characteristics	Unit of Origin		p [*]
	ICU n=44 (40%)	nonICU n=67 (60%)	
Radiology Modality			
Computerized Tomography	22 (50%)	27 (40%)	0.06
Magnetic Resonance Imaging	10 (23%)	14 (21%)	
Interventional Radiology	8 (18%)	9 (9%)	
General X-ray	1 (2%)	13 (19%)	
Other (Nuclear Medicine, Peripheral Vascular, Ultrasound)	3 (7%)	7 (10%)	
MET-RD Etiology (%yes)			
Cardiac	24(55%)	21(31%)	0.11
Respiratory	9(21%)	23(34%)	
Neurologic	9(21%)	19(28%)	
Other	2(5%)	4(6%)	
Sedation in RD (%yes)	13 (30%)	5 (7%)	<0.01
Monitor in the RD (%yes)	41(93%)	22 (33%)	<0.01
RD Level of Surveillance			
RD Tech only	0 (0%)	41 (61%)	<0.01
RD RN	3(7%)	13 (19%)	
ICU/non-ICU RN	40 (91%)	9 (13%)	
Advanced Patient Care Technician	1 (2%)	4 (6%)	

*
p-values refer to comparisons within columns