An Evaluation of Medical Emergency Team Activation in Hospitalized Patients Designated as Not for Resuscitation

by

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Abstract

The Medical Emergency Team (MET) responds to acute deterioration in hospitalized patients. The MET aims to reduce morbidity and mortality through early recognition and intervention in deteriorating patients. An adjunct role of the MET in limitations of medical therapy (LOMT) and end-of-life care (EOLC) has been reported in recent literature. LOMT frequently involve Not-for-Resuscitation (NFR) orders and patients who cannot be admitted to the Intensive Care Unit (ICU). Little is known of MET utilization in this population of patients. My objective was to report the incidence of MET activations in patients with LOMT and investigate their clinical and demographic characteristics, as well as outcomes. The two studies in this thesis are based on a retrospective cohort study of all adult in-patients with a MET activation at the University of Alberta Hospital from January 1, 2013, to December 31, 2015. There were a total of 2703 MET activations in 2218 patients during the study period. Patients with a LOMT were older, more likely to be admitted to a medical service, more likely to be female, had more comorbidities, and a longer MET call. These patients had a high in-hospital mortality rate of 58% compared to 23% in patients without a LOMT. In those who died, deaths occurred on average two days after index or last MET activation. A multivariable model showed an independent association between these patients GOC status and in-hospital mortality, OR: 3.49 (2.79 – 4.36 95% CI). A comparison of patients with a MET activation and NFR GOC status (GOC: M1 or below) who died and survived to hospital was performed. I found that patients who died in hospital were more likely to be male, have a greater burden of comorbidities, a MET activated for concerns over breathing, and a shorter hospital length of stay compared to those who survived to hospital discharge. This comparison revealed several areas requiring further research. In conclusion, the MET frequently responds to patients

with LOMT who are NFR whose care would imply they not be admitted to the ICU. These patients have a high in-hospital mortality rate and die shortly after their MET activation, suggesting that they are near the end of life at the time of MET. MET policy should be revisited in an attempt to optimize resource utilization and quality of patient care.

Preface

This thesis is an original work by Rami Zibdawi. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name “An Evaluation of Medical Emergency Team (MET) Activation in Hospitalized Patients Designated as Not For Resuscitation: A Retrospective Cohort Study”, No. 00058181, 07/07/2015.

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List of Abbreviations

NFICU: Not for Intensive Care Unit Admission

MET: Medical Emergency Team

NFR: Not-for-resuscitation

DNR: Do-not-resuscitate

ICU: Intensive Care Unit

UAH: University of Alberta Hospital

GOC: Goals of Care

SAE: Serious Adverse Events

AHS: Alberta Health Services

DAD: Discharge Admission Database

DIMR: Data Integration, Management, and Reporting

RRS: Rapid Response System

RRT: Rapid Response Team

Chapter One: Introduction

The Medical Emergency Team (MET)

The Medical Emergency Team is a hospital-wide, systematic approach to the management of acute deterioration in patients on general hospital wards. This mobile team of clinicians and allied healthcare professionals specializing in critical care medicine can be activated by hospital ward staff in response to objective and subjective signs of deterioration in patients. The overall aim of the MET system is to reduce morbidity and mortality in the hospitals within which they operate.

The Nature of Adverse Events

Modern hospital systems are complex organizations providing healthcare to populations with increasing age, acuity, and comorbidities [1]. Rapid scientific and technological advancements have introduced the use of sophisticated medical and surgical interventions in the treatment of hospitalized patients [1,3]. Hospitals often treat a broad case-mix of patients diverse in epidemiological and pathophysiological/clinical backgrounds with high rates of sub-specialty admissions, and different levels of care and intervention [3]. The result is remarkably variable health outcomes amongst hospitalized patients. Such disparity in clinical outcomes may be partially attributable to intrinsic differences in patient populations and disease. However, a significant proportion may also be attributable to the variable performance of healthcare providers and the hospital systems they work within [3].

Serious adverse events (SAEs) occur with surprising frequencies in patients admitted to hospitals [2,4,9,17,32]. In fact, adverse events and patient safety have become a significant area of

concern in healthcare delivery worldwide for policymakers, healthcare professionals, and patients [2,3,4,6,10]. An adverse event (AE) is defined as "an unintended injury or complication, which results in disability at discharge, death, or prolongation of hospital stay, and is caused by healthcare management rather than the patient's disease" [2,4,46]. SAEs such as cardiac arrest, unplanned admission to the intensive care unit (ICU), and unexpected mortality typically have a bleak or fatal prognosis [5].

Several studies around the world have focused on the incidence and outcomes of such adverse events [2,6,7,9]. Large epidemiological studies have shown that iatrogenic patient deaths during hospitalization are the sixth most common cause of death in the United States, and the fourth most common cause of death in the United Kingdom [2]. Broad estimates of mortality rates in acute care hospitals are 2-4%, with 10% of patients suffering a SAE during their hospitalization [1,3]. Some studies have found the rate of adverse events in acute care hospitals to be anywhere from 3-33.2%, while other observational studies have demonstrated that approximately 15-20% of hospitalized patients experience SAEs [2-4,6,7]. Extensive observational studies in the United States and Australia have shown between 200,000 to 400,000 patients annually may die as a result of errors from substandard care within a hospital system [1-3]. The cause of such adverse events is typically unrelated to the primary admission diagnosis of a patient and may result in an increased length of hospital stay, disability, and even death [4].

Despite considerable advancements in several aspects of healthcare, SAE's such as in-hospital cardiac arrests are associated with high mortality rates of approximately 80%, and an overall poor prognosis [4]. Research in the United Kingdom and Australia have shown up to 27% of deaths are potentially preventable and between 4.9 and 13.6% of adverse events in a hospital lead to death [4,6]. In 1991 the Harvard Medical Practice Study established the standard for

measurement of adverse events. The researchers found the incidence rate of adverse events to be 3.7% in patients admitted to hospital [2]. Negligence was the cause of approximately 28% of adverse events which lead to permanent disability or death in 16% of cases [2]. Negligence has been defined in the literature as "care that fell below the standard expected of physicians in their community" [2]. Subsequently, the Utah and Colorado medical practice study employed similar methods and found a comparable rate of adverse events at their institutions [2,7]. The Quality in Australian Healthcare study estimated that approximately 17% of hospital admissions resulted in an adverse event [2,3,7]. After adjustment for the methods used in the Australian study, the rates of adverse events were found to be similar between the United States and Australia [2,7]. Both of these large-scale studies (the Harvard medical practice study and the quality in Australian health care study), examining thousands of hospital admissions from various institutions, found that an estimated 51% of deaths from adverse events were due to negligence [2,7]. Importantly, the Harvard Medical Practice study and Utah-Colorado study also found that patients aged 65 and older were at double the risk of suffering an adverse event [2,7]. In addition to the study mentioned in Australia, the methods and results of the Harvard Medical Practice Study have since been replicated in many developed nations around the world including Canada, Denmark, France, New Zealand, and the UK [2,3]. Specifically, the Canadian Adverse Events Study showed a 7.5% incidence of SAE's [60]. This study determined that 36.8% of cases of adverse events were preventable, and 20.8% of cases resulted in death [60].

In the year 2000, the United States Institute of Medicine published a landmark report called *To Err is Human* [2-3,6-7]. The report identified medical errors as an essential issue adversely affecting the quality of medical care in healthcare systems [2]. After its publication, efforts to

reduce medical errors and improve patient safety within healthcare systems have increased significantly [2-3,12,18].

Preventability

Data revealing that several cases of adverse events result in permanent disability or death demonstrate the considerable burden of iatrogenic injury in society [2-3,6]. The fact that a high proportion of adverse events are due to negligence and errors suggests that many cases may be preventable. Identification of risk factors for adverse events is a preliminary steps towards the prevention of such events, regardless of whether they were due to negligence or error [2,4]. The Quality in Australian Health Care Study found that approximately 70% of deaths and 60% of cases which resulted in significant disability had a high degree of preventability [14]. Various studies reported a similar degree of preventability at their institutions. Accordingly, several studies began to retrospectively examine the period preceding SAEs such as a cardiac arrest, unplanned ICU admission, or unexpected death [7,14]. These were predominantly retrospective case reviews examining the charts of patients before their index adverse event. In 1996, an Australian study of over 50,000 hospital admissions during a 6-month period estimated that 8% of deaths were unexpected [11]. Approximately 50% of the patients who died had severe abnormalities in their vital signs or concerns by the nursing staff which was documented in their medical record in the 8 hours before their death [11]. Also, 33% of these patients had abnormal vital signs and concerns documented in their medical record up to 48 hours before their death [11]. The retrospective review found that hypotension (systolic blood pressure less than 90 mmHg) and tachypnea (respiratory rate greater than 36 per minute) were the most common abnormalities in vital signs documented [11]. Multiple studies have confirmed the presence of prolonged periods of clinical instability documented in patients prior to a SAE [1,3,5,11,12]. For example, research has shown that

abnormalities in vital signs before a cardiac arrest exist in 90% of in-hospital cardiac arrest cases [13].

An extensive study in the United States estimated that as many as 200,000 American adults suffer a cardiac arrest per year, with up to 75% of them not entirely recovering [3]. Estimates are similar in Canada, Australia, and the United Kingdom. The association between in-hospital cardiac arrests and mortality is staggering. Patients suffering a cardiac arrest have an overall poor prognosis, and the majority do not survive to hospital discharge [3,5,13]. Studies have estimated the in-hospital mortality rate of patients suffering a cardiac arrest to be anywhere from 70-90% [5,13,19]. The high incidence and mortality rates of cardiac arrests on the ward have led to these events being assessed, predominantly retrospectively, in great detail. A significant proportion of cardiac arrest cases have been found to have had documented antecedents before the arrest [5,12-13]. Schein et al. demonstrated that approximately 84% of patients in their study had identifiable deterioration long before cardiac arrest, which included alterations in breathing patterns, heart rate, and level of consciousness [5]. The study found that only 8% of patients suffering a cardiac arrest, who had attempted cardiopulmonary resuscitation, survived to discharge [5]. In 2002, a retrospective review found that 60% of patients transferred unexpectedly to the ICU had documented deterioration in vital signs in the 8 hours preceding admission to the ICU [12]. A study in 2012 examined the preventability of adverse events which resulted in ICU admissions and found that up to 76% of such events were potentially preventable [5,12,13]. In fact, Hillman et al. showed that death was frequently preceded by cardiac arrest or ICU admission in a large cohort of over 50,000 inpatients [8]. This large cohort, drawn from 3 different hospitals, displayed severe abnormalities and deterioration in their vital signs in the 8 hours preceding cardiac arrest, similar to the findings of other studies [8]. It is important to note that while mortality is an important and

universally accepted indicator of healthcare performance, differences in mortality across settings may be a reflection of a diverse mix of patient populations rather than variations in hospitals' quality of care [8]. However, studies adjusting for patient case-mix factors have still found upwards of 30% of deaths to be preventable and that 5-14% of adverse events lead to death [8]. These investigations and the data resulting suggest that adverse events in hospitals are seldom sudden or unpredictable, and several warning signs often precede their occurrence [18]. The slow deterioration present in readily observable and documented vital signs in the hours to days before an event which is not recognized indicates that adverse events are due to a systems failure rather than the error of any single healthcare provider [8].

Studies have identified general wards of acute care hospitals as places associated with poor outcomes and high mortality following adverse events such as cardiac arrest [3,5,10]. Various studies have also shown a high rate of potentially preventable deaths or adverse events in acute care hospitals [3,5,8,12]. In contrast to general wards, patients admitted to the ICU rarely die suddenly [5,30,31]. The majority of patients admitted to the ICU die as a result of the withdrawal or withholding of life-sustaining treatment [5]. In addition to cardiac arrest or death, a patient deteriorating on the ward may deteriorate to the point of requiring admission to the ICU which is often referred to as an unexpected ICU admission [5].

A limitation of all the studies described above is that they were completed retrospectively. A few studies attempted to overcome this limitation by prospectively following patients admitted to hospitals [33]. Bellomo et al. prospectively followed 1125 post-surgical patients admitted for greater than 48 hours in a large Australian hospital over a six month period [33]. The rate of SAE's was found to be approximately 40%, with 8% of patients from the cohort dying as a result of such events [33]. Age was identified as a significant risk factor for adverse events, with 20% of patients

aged 75 and over dying [33]. Another prospective cohort study undertook a daily review of patient bedside observation charts. Abnormal observations were found to be common amongst the cohort of both surgical and medical patients [34]. The two most frequent abnormal observations were oxygen desaturation, measured by pulse oximetry, and hypotension, which occurred in 50% and 17% of abnormal observations respectively [34]. An important finding of this study was the determination of significant predictors of mortality [34]. The authors found that decreasing levels of consciousness, hypotension, changes in respiratory rate, and tachypnea were significant predictors of in-hospital mortality [34]. The occurrence of even one of these events was associated with a seven-fold increase in the risk of in-hospital mortality [34]. Although these prospective studies helped identify risk factors and predictors of mortality, and confirm data from retrospective studies, they suffer from a lack of generalizability as they were brief and took place in single centers [34].

As clearly outlined above, mounting evidence suggests that a significant number of hospital adverse events leading to disability or death were potentially preventable. Moreover, adverse events do not occur suddenly, and are preceded by hours to days of transient or continuous deterioration, making them predictable and potentially avoidable [3,13]. This period antecedent to an adverse event is typically characterized by physiological instability which manifests itself in derangements of frequently measured and documented vital signs. Early recognition of deterioration and at-risk patients on general hospital wards, may provide an opportunity for intervention before a patient develops progressive and irreversible deterioration. Such early intervention may prevent adverse events or limit their impact on patient outcomes [18]. Therefore, serious adverse events in patients may be the result of clinical deterioration which was not detected and left uncompensated [3]. A “failure to rescue” is the term

used to describe the inability to recognize signs and symptoms indicative of early deterioration in a patient [18]. A prospective cohort study in Europe showed a high proportion of deaths associated with a failure to rescue, as 73% of patients who died were not admitted to an ICU at any stage during their hospitalization [9]. A failure to rescue has been shown to emerge from three systemic issues within a hospital system. Failures in planning, communication, and recognition of a deteriorating patient all contribute to a failure to rescue and suboptimal care for patients [18]. The notion that a failure to rescue may be a systems issue within hospitals themselves, and the fact that intervention based on early recognition may prevent adverse events from happening lead to several logical approaches to avoid adverse events and increase patient safety and quality of care [3].

Development of the Medical Emergency Team (MET)

Given the data showing that many adverse events are preceded by abnormal clinical and pathophysiologic antecedents, along with a concern over the high incidence of potentially preventable deaths, efforts to develop logical and rational approaches to intervention in deteriorating patients have been widespread [1,2,3,26]. One such initiative is the Medical Emergency Team (MET) or Rapid Response Team (RRT) system. The MET system was initially developed and described in the early 1990's and has since become a standard of care in multiple healthcare systems around the world [3,19]. The MET system is widely advocated for by multiple healthcare organizations, regulatory agencies, and patient safety and quality care initiatives, and is considered an essential tool for patient safety and healthcare quality improvement.

The MET system is analogous to the traditional hospital 'code blue' or cardiac arrest team. However, the MET's role is much broader and aims to identify and intervene before patients reach the point of cardiorespiratory arrest. The MET is a method of projecting care for acutely decompensating patients outside of the ICU and across the entire hospital. As a mechanism of pre-

emptive ward care, critical care resources and expertise can be rapidly mobilized and deployed to the patient's bedside.

The Medical Emergency Team (MET), or as it is also commonly referred to, the Rapid Response Team (RRT) is part of a hospital-wide system comprised of afferent and efferent limbs, along with an administrative component [1,24]. The afferent limb components of the MET system includes specific activation criteria and the methods of activation, whereas the efferent limb represents the MET response (assessment and intervention) to a patient [1,24,42]. MET systems aim to identify early clinical deterioration in patients on general hospital wards to provide rapid and focused intervention. The goal of such intervention is to reduce the incidence of avoidable serious adverse events such as cardiac arrest, unexpected death, and unplanned ICU admission, thereby improving the overall quality of patient care by avoiding suboptimal outcomes [3,16]. The reduction of avoidable morbidity and mortality should lend itself to improved quality of care and improved patient safety in acute care hospitals [3,19].

Hospitals and the healthcare systems within which they operate are highly complex organizations that deliver medical care to patients which requires the coordination of a significant number of professionals, services, and interventions [3,38]. Technological and scientific advancements have increased the sophistication and number of available treatments in health care systems [3,28]. However, patient populations in high-income nations are presenting with increasing age, acuity, comorbidities, and age-related frailty [1,3-4]. The juxtaposition of the increasing availability of healthcare and complexity of interventions, with the treatment of an increasingly unwell patient population, has strained hospital systems' capacity to ensure patient safety and high quality of care [3]. Hospital systems deliver remarkably variable outcomes for any specific medical or surgical condition [3]. A reasonable proportion of such differences in outcomes

is attributable to a patient's inherent biological variability and disease state variability; a significant proportion is also attributable to the variable performance of healthcare clinicians and the systems within which they work [3,21]. To reiterate an earlier point, adverse events that may result from such variability are a result of system failure rather than the failure or error of any one individual within the system [3,18]. The increasing needs of an aging population with complex disease patterns treated with sophisticated high-risk interventions, coupled with the cultural and hierarchical nature of hospital systems, creates an environment ripe for medical errors [3]. This is why a system-based approach such as the MET system is thought to improve patient safety, as every component of care is considered and barriers within hospital systems are broken [3]. Therefore, the implementation of MET systems has been favored in hospital systems around the world [3,26]. The prevalence of MET systems has increased dramatically since the introduction of the system in the 1990's, with nearly ubiquitous adoption in developed nations [23].

As described earlier, adverse events are often preceded by physiological instability and deteriorating vital signs in the hours to days before the event [11]. Such deterioration may be continuous or transient and may occur within the 8 hours leading to the adverse event and up to 48 hours before the event [8,11,12]. Therefore, acute changes in vital signs delineated by pre-defined clinical criteria parameters are the basis of activation for the MET. Such parameters for activation are meant to be simple, objective, non-invasive, reproducible, and be easily measurable [3,21]. For example, at the University of Alberta hospital, the MET system was implemented in 2004, and the MET may be activated for any one or more of the following reasons shown in Appendix 1. These are the standardized MET activation criteria used during the period of the study at the University of Alberta Hospital. In Canada, patients requiring the services of the MET are typically identified using single parameter systems [29]. These systems rely on periodic

observation of specific physiological variables which are compared to a predefined set of parameters [21;29]. Different systems for early identification of deterioration have been proposed and utilized. For example, the United Kingdom employs the use of an aggregate weighted scoring system [38]. Such a system allocates points relative to the level of derangement in any physiological parameter. Once a preset level of the overall "early warning" score is reached, a cascade of activation is triggered for the patient [38]. Despite relatively standardized criteria, great heterogeneity exists in systems around the world both in the use of activation methods and in the composition of METs [3,27]. Furthermore, several studies have expressed concern about the reliability of such parameters to detect deterioration in a timely matter [38,43]. Studies have shown that within mature MET systems, the "worried" criterion is the most frequent trigger of the MET rather than any of the physiological parameters [38]. The sensitivity of single parameter activation criteria continues to be examined and appraised throughout the world [38,43].

As previously shown, patients have a prolonged period of physiological instability before adverse events [12,21,38]. Studies have shown that many patients are acutely unwell up to 48 hours before admission to ICU [38]. The intensive care unit of a hospital must care for the sickest patients within the hospital [38]. In order for the intensive care unit (ICU) to efficiently operate it must have a mechanism in place for achieving optimal care for deteriorating ward patients outside of the ICU [38;39]. The MET system is essential to such imperatives.

Current Evidence of MET Effectiveness

Despite nearly ubiquitous adoption of MET system in hospital centers across the world, there remains much debate about their effectiveness [17, 23]. Before and after studies, multi and single-center observational studies, and one large randomized controlled trial have shown inconclusive and controversial data regarding the effectiveness of the MET in reducing adverse events [17]. Many single-center studies have shown a benefit associated with MET system implementation and reduced adverse events [26;28]. In 2014, a systematic review of the efficacy of MET systems concluded that implementation of a MET is associated with a significant reduction in in-hospital cardiac arrest, but not overall mortality [25]. However, most studies examining implementation of the MET are observational cohort or before and after studies, which limits our confidence in the findings. Conducting a randomized control trial would be very challenging, and indeed only one large randomized controlled trial has been performed to date [35]. The Trial of Medical Emergency Teams in Australia (MERIT study), is the only large multicenter cluster randomized controlled trial to date on the MET system. The MERIT study found no significant difference in the primary endpoint (a composite outcome of cardiac arrests, unplanned ICU admissions, and death) and secondary endpoints (independent rates of cardiac arrest, unplanned ICU admissions, and unexpected death) between MET hospitals and control hospitals [35]. The authors concluded that the MET did not decrease adverse events such as cardiac arrests, unplanned ICU admissions, and unexpected deaths [35]. However, the MERIT study had several limitations which rendered its results inconclusive [35]. Proponents of the MET render its implementation as intuitive, in a similar way as early intervention in stroke patients improves outcomes [35]. Since the MERIT study, there has been widespread uptake of the MET around the world and it is now difficult and, perhaps, considered unethical by some to perform a randomized controlled trial of the MET [35].

Several studies examining the MET's effect on cardiac arrest rates have consistently shown a decline in rates post-MET implementation. In a retrospective study, Chen et al. compared a hospital with a mature MET system to three hospitals which had not yet introduced a MET system over a seven-year period [35]. During the seven-year period before the introduction of the MET in the three non-MET hospitals, the hospital with a mature MET system had a 50% lower rate of in-hospital cardiac arrests, a 40% lower in-hospital cardiac arrest related mortality, and a 6% lower overall hospital mortality rate [25]. Despite the encouraging results, the study had some limitations. There was no randomization of patients to the hospitals with and without a MET system as this was a retrospective before and after study [25]. Another limitation of the study was that the patient case-mix was different between the hospital with a MET system compared to the hospitals without a MET system [25]. The authors found that the hospital with a MET system had a significantly higher percentage of patients from poor socioeconomic backgrounds [25]. This makes it difficult to generalize the results of the study as social determinants are a well documented and widely accepted contributor to health outcomes [25]. A more recent study in Australia conducted an interrupted time series population-based study to assess the impact of the implementation of a MET system across a large healthcare jurisdiction on outcomes [17]. The authors found that overall rates of mortality, cardiac arrest, and failures to rescue were progressively decreasing before a MET system was introduced [17]. After the introduction of the MET system, the trend of declining rates of such adverse events continued, and the authors noted that a subgroup of their study which they called a low disease mortality related group had a significant reduction in mortality rates after implementation of the MET [17]. An observational study in Australia similarly found that cardiac arrest calls decreased from 5.5/1000 patients to 3.3/1000 patients after a MET was introduced in their hospital [26]. In 2014, Herod et al. examined

approximately 20,000 MET activations over a 12 year period in a single-center retrospective observational study [41]. The authors found that the worried criteria was the most common trigger for MET activation followed by hypotension [41]. This study also found no change in the rates of cardiac arrests or unplanned ICU admissions over the twelve year period. However, a reduction in hospital mortality was observed [41]. The authors found that MET activations increased significantly over the study period and therefore concluded that the decrease in hospital mortality independent of cardiac arrests and ICU admission shows that the MET is beneficial to patients [41]. Some studies have examined patients post-MET activation, specifically those who died post-MET. An analysis of MET activations in the United States from 2005 to 2015 using a nationwide database showed that patients who died following a MET activation were older, more likely to be admitted for noncardiac illnesses, and had a greater hospital length of stay [23]. The study generated a prediction model suggesting that systolic blood pressure, time since admission, and respiratory rate were the most critical variables in the prediction of mortality [23]. In general, results of most available studies suggest that introduction of a MET system is associated with a significant decrease in in-hospital cardiac arrests [42]. However, this may have to do with increased not for resuscitation orders (NFR) instituted by the MET [42]. A large prospective international study examined the outcomes of patients attended by the MET over a seven day period [10]. The study collected data from hospitals across Australia, Denmark, United States, and the United Kingdom [10]. The authors found the 24-hour mortality rate post-MET to be 10%, with urgent transfer to the ICU occurring in 24% of cases [10]. Another observation of the study was that involvement of the MET led to new limitations of care in 28% of patients which were not transferred to the ICU [10]. This finding is in line with several other studies which found a similar rate of NFR orders or limitations of medical therapy (LOMT) in patients after MET activation

[10,17,43]. Interestingly, several studies have noted that patients receiving a MET activation out of regular hours have a higher rate of in-hospital cardiac arrest [17,32]. This finding has implications for resource allocation and staffing across hospitals [17,32]. In 2015, an important study by Chen et al. showed that delays in activation of the MET result in an increased risk of ICU admission and death [36]. This study suggested that timely intervention is a critical component of preventing adverse events in documented acute deterioration [36].

A 2010 retrospective observational cohort study examining patients receiving multiple MET activations found that patients with multiple MET reviews were more likely to be surgical than medical patients, and more likely to have a longer hospital length of stay [15]. The study also found that patients receiving more than a single MET were at a 34% higher chance of mortality compared to those with a single MET activation [15]. Together, these findings suggest that the MET frequently responds to seriously unwell patients in general wards of the hospital. Similar to the study noted above, researchers in Portugal found that patients with cardiac dysfunction had higher rates of MET activation and that failure to activate the MET was associated with higher rates of immediate and discharge mortality [22].

There is immediate availability of life support for cardiac arrest, however, in-hospital cardiac arrest outcomes remain poor, with a survival to hospital discharge rarely exceeding 20% [42]. Large systematic reviews of MET systems have shown an overall reduction in mortality in both adult and pediatric patient populations [40]. Furthermore, systematic reviews have shown a reduction in the rates of cardiac arrest and ICU admissions [40]. A 2017 systematic review found that the overall mortality rate in patients attended to by the MET is approximately 26% [21]. This is in line with several other studies suggesting that the MET responds to critically ill patients on the ward.

The Medical Emergency Team at the University of Alberta Hospital

The following section will give a brief background and overview of the MET system at the University of Alberta Hospital (UAH), the institution where the present study was conducted. The UAH is a major academic quaternary care center located in Edmonton, Alberta, Canada. Similar to many other hospitals around the world, the UAH only had a cardiac arrest team in place before the introduction of the MET. Physicians and hospital leadership at the UAH noted issues in providing timely care to seriously ill patients on medical and surgical wards. Also, a large proportion of ICU admissions at the UAH came from medical and surgical wards. Introduction of the MET began with a staged implementation process in September 2004. The department of hematology was the first department to consult the MET in 2004, followed by gastroenterology later in 2004, and nephrology and general medicine in 2005. In 2006, two years after staged implementation began, the rest of the UAH adopted the MET.

The UAH introduced the MET system in fall of 2004 with the aim of reducing cardiac arrests by 30%, reducing the rates of ICU admissions, and hospital length of stay. Several issues were encountered such as late activations, cultural issues within the hospital and between departments. However, early results from the UAH were promising and educational sessions and discussion improved the utilization and outcomes of MET. The hospital observed a decrease in cardiac arrest team activations over a two year period, and a decrease in cardiac arrest rates and ICU admissions in several units across the hospital. The UAH has been operating a mature, intensivist led MET since 2004.

The Medical Emergency Team and End of Life Care

The Medical Emergency (MET) team is a systematic, hospital-wide approach to the early recognition and treatment of acutely deteriorating patients on the ward. The MET aims to improve outcomes and patient safety by providing timely critical care resources and expertise to a diversified mix of patients on the ward experiencing an acute deterioration in their clinical status [1,3,16]. Most studies to date on the MET have focused on outcomes such as cardiopulmonary arrest rates, unplanned ICU admissions, and mortality, to delineate a relationship between MET implementation and a reduction in such adverse events. The MET had initially been implemented in an effort to prevent such adverse events. Therefore, much of the attention of researchers of the MET system has gone towards measuring such outcomes. Over the course of examining and characterizing MET activations in the subsequent decade after widespread implementation, studies have brought to light several adjunct roles the MET may serve in hospitals [37]. Evidence examining the characteristics and outcomes of patients attended by the MET has found that the MET is frequently being activated to respond to deterioration among patients with LOMT, who are already designated not for ICU admission, or those already receiving end of life care (EOLC) [37]. Patients with LOMT and those at the end of life, typically have medical orders of care in place precluding them from invasive interventions such as resuscitation or surgery. Furthermore, they are usually not admitted to the ICU for care. Studies have shown that patients with LOMT or requiring EOLC represent a significant proportion of total MET activations, anywhere from 20-30% at some institutions [37,39]. Understanding the role that the MET plays in the care of patients with LOMT may shed insight into gaps in knowledge regarding EOLC on general wards or discrepancies in patient care. Moreover, this may help shape the policy of the MET system for

optimal allocation and utilization of resources in order to maximize the quality and safety of patient care.

At the UAH, the institution of the present study, following discussions with the care team, each admitted patient has a set of medical orders, known as their Goals of Care (GOC) designation, which defines the specific interventions which may be provided by healthcare professionals during the care of these patients, namely resuscitation and transfers to intensive care units for advanced monitoring and life support treatments. The following section will discuss the different designations in further detail.

Advance Care Planning and Goals of Care Designation

Alberta Health Services (AHS) operates as a fully integrated healthcare system serving as primary authority and provider of healthcare services in the province of Alberta. The UAH is an AHS hospital, governed by AHS policy. In early 2014, AHS enacted policy with regards to Advance Care Planning (ACP) and GOC designations (Appendix 2). The primary objective of the policy enactment was to help guide healthcare professionals and patients (or their alternate decision makers) as to "the general intentions of clinically indicated health care, specific interventions, and the service locations where such care will be provided" [44]. ACP and GOC designations have emerged as important themes within the broad operation of healthcare systems, especially within Canada [44]. A focus on early discussions in the community setting regarding ACP is being heavily advocated by health authorities nationwide to improve outcomes and quality of care for patients who are later hospitalized [44]. Advance Care Planning is the overall process by which healthcare professionals and patients (or their alternate decision makers) "consider the clinically indicated future care for a patient" [44]. Conversation and consultation between

healthcare professionals and patients (or their alternate decisions makers) allows for an understanding of a patient's wishes regarding their general focus of care and initiation, continuation, and limitation of specific interventions [44]. Such conversations aim to establish a GOC designation for a patient which acts as a medical order describing the current and future care of a patient [44]. GOC designations allow healthcare professionals to describe and communicate the general focus of care and intentions of care for a patient, including the direction and specific actions within the context of that focus of care [44]. GOC designations typically include specific clinically indicated interventions, transfer decisions, and the locations within a hospital in which patient care may take place [44]. GOC designations ideally incorporate the values and wishes of a patient and guide clinically indicated interventions in accordance with those values and wishes [44].

As described above, GOC designation medical orders which provide direction regarding specific health interventions, transfer decisions, locations of care, and limitations of interventions for a patient as established after consultation between most responsible health practitioner and patient or alternate decision maker [44]. The most recent GOC designations can be found in the appendix section [Appendix 2]. GOC designations are comprised of three different levels of care, each with subsets of differing levels care and interventions as well. The three categories of care levels are "R" or Resuscitative Care, "M" or Medical Care, and "C" or Comfort Care [44]. The aim of resuscitative care is to cure or control a patient's disease and symptoms, including medical and resuscitative care if required. These patients may utilize advanced life support treatment or be transferred to the ICU and are perceived to likely benefit from ICU care if appropriate [44]. Medical Care is directed at cure and control of a patient's disease or symptoms without admission to the ICU or resuscitation [44]. These patients have chosen not to receive ICU and resuscitative

care or there is a perception that they would not benefit from such efforts. Lastly, comfort care aims to provide symptom control and relief in patients which are expected to die due to their underlying condition [44]. These patients typically have a diagnosis of a medical condition which is expected to result in death, for example, a terminal cancer diagnosis. Discussions between patients and healthcare professionals are geared towards assigning patients to one of the above levels of care which is deemed most appropriate for the patient's clinical status and in line with their values. Engaging in dialogue regarding GOC designations will help enable both patients and clinicians to clearly understand the focus of care of a patient and the decision making involved in patient care [44]. Such conversations create a more transparent environment surrounding patient care and lead to an overall improvement in patient care, physician satisfaction, and healthcare source utilization [44].

In patients with a GOC designation in the R (resuscitative) level experiencing an acute deterioration on the ward, it would seem logical that focused and timely intervention by a highly mobile and dynamic system such as the MET can improve outcomes [3]. This is the fundamental basis for the creation and implementation of the MET, and the reason why many health systems worldwide have implemented or mandated MET systems despite ongoing controversy regarding the efficacy of the MET and its relative benefits on patient outcomes [1,3,16,18]. Patients with a GOC designation in the Medical or Comfort care levels have LOMT, and are Not for Resuscitation (NFR), and are generally not admitted to the ICU. Interestingly, several studies have shown that despite the LOMT and NFR orders present in this cohort of patients, they represent a significant proportion of total MET activations. Furthermore, it has been shown that the MET frequently tends to patients with EOLC issues [1,37].

Evidence for the Medical Emergency Team's involvement in EOLC and LOMT

MET activation criteria are both broad and non-specific. It comprises a range of physiological values pertaining to abnormal vital signs in the major organs and a worried criterion [24]. There are two fundamental concepts at the core of MET activation in patients with EOLC issues and LOMT. Firstly, the MET is responding to patients whom at the very least have LOMT which may differ between hospitals but is described by their GOC designation at the University of Alberta Hospital. A patient with a GOC designation in the Medical or Comfort care levels does not preclude the MET from intervening or administering care. However, the MET is a resource-intensive critical care intervention, and patients with a GOC of M or below have been deemed Not For Resuscitation and Not for ICU admission. Such directions for care significantly handicap the ability of the MET to perform critical care based interventions (whether beneficial or not) that they are equipped to perform, such as intubation, starting vasoactive support or ICU admission for advanced life support. Therefore, assuming the GOC designation is not changed (which is difficult and sometimes not possible in acute situations), the MET would predominantly employ ward based interventions to stabilize a patient. The second concept is that the MET may be responding to a subset of these patients with a GOC designation of M or C who are approaching or at the end of life [16]. Patients who are in the active process of dying may trigger the MET activation criteria, and it can be difficult to differentiate between patients requiring the MET to correct reversible deterioration, from patients whose deterioration is a part of the normal and expected dying process [16,31]. Evidence suggests the MET delivers several end of life interventions such as palliation and administration of narcotics in such situations [16,]. One study found that the MET involvement in EOLC increases palliative care consultations by up to 20% [29]. Another study

found that EOLC was enhanced by the deployment of the MET, as the administration of opioids and number of chaplain visits increased [47].

Two questions have been the focal point of inquiry and discussion in the literature regarding the MET's attendance to patients with LOMT or those at the end of life. Firstly, should critical care based resources such as the MET be deployed to stabilize deteriorating patients with LOMT? It has been found that patients with LOMT are predominantly stabilized with ward based interventions, not requiring critical care expertise [31,49]. Also, patients with EOLC issues may benefit more from a palliative care team consult [37,47]. The other question rests on whether the MET is genuinely benefiting this group of patients. Patients with a GOC designation of Medical or Comfort care levels are typically very ill, and older in age [37,49]. Many have hypothesized that the high proportion of MET activations in this population of patients reflects a gap in knowledge and resources on general hospital wards [31,37]. Several questions arise from such considerations. Perhaps, the MET is diagnosing "the dying process" in these patients on the ward and thereby improving their EOLC through early recognition of irreversible deterioration or serving as a guide to the reassessment of patients GOC [29,47,48]. It is very plausible that all or some of the aforementioned occur in MET activations to patients with LOMT or EOLC issues [29]. This makes sense as the critical care personnel of the MET may be more skilled at prognosticating a patient's disease as they are frequently exposed to acute care situations, many of which may result in death. Studies have shown the MET improves access to EOLC resources and frequently institutes DNR orders [29,37,47]. This information reveals another gap in knowledge or mismatch between patient care and ward resources, which hospital systems sought to fill with regards to acute ward destabilization of a patient with the original inception of the MET [31]. The

following section will present and discuss the current evidence and literature for the METs activation in patients with EOLC issues and LOMT.

Numerous studies have demonstrated a significant proportion of total MET activations are to patients with EOLC issues [1]. In a study of 1217 MET activations over a one-year period, Calzavacca et al. found that 29% of patients had an NFR order, with 21.7% of the patients having the order in place prior to the MET activation and 7.3% having a newly implemented NFR order by the MET [1,50]. Similarly, in 2008 Casamento et al. found that approximately 20% of MET calls were associated with a LOMT before the MET activation, and 8% had a LOMT put in place after the MET activation [1,51]. Furthermore, a retrospective review of MET activations at a major tertiary center in Australia found that 15.7% of patients attended by the MET had a pre-existing NFR order [1]. In the most extensive study examining the role of the MET in EOLC to date, seven hospitals across Australia, Canada (focused at the UAH in Edmonton), and Sweden prospectively audited MET activations over a one-month period [37]. The study found that 31.1% of patients had a LOMT, with 20.3% pre-existing before the MET activation and 10.3% being instituted by the MET activation [37]. These studies suggest that the MET frequently attends to patients with LOMT, and patients requiring EOLC.

The MERIT study initially spurred much interest in the MET's involvement in EOLC [35]. As described earlier, the MERIT study was a large multi-center cluster randomized controlled trial which investigated the effect the MET system in 23 Australian hospitals [35]. The MERIT study reported that introduction of the MET system increased the number of NFR orders documented in the hospitals [35]. Furthermore, a retrospective study in hospitals across Toronto, Canada, found that 1 in 6 MET calls led to a patient or family conference to reassess the patient's resuscitation order status [52]. However, the previous resuscitation status of the cohort of patients was unknown

[52]. An observational cohort study in Sweden, examining MET calls over a 5-year span found that approximately 35% of patients were assigned a LOMT, with 46.1% of these being documented at the first MET call [53]. The authors found that the patients with a LOMT frequently received multiple MET calls and that the LOMT did not preclude them from subsequent MET activations [53]. Although only a few systematic reviews have been performed to assess the MET in EOLC, they have agreed with the evidence above [54].

The above studies show that the MET is frequently involved in the application of LOMT and DNR orders. It is also clear that patients with LOMT and patients requiring EOLC represent a significant proportion of total MET activations. Studies have shown that this occurs due to the original care team of a patient not having sufficient time to hold EOLC discussions, not being comfortable with such discussions, or being unwilling to accept the institution of LOMT or comfort care [37,52,53].

In 1998, Parr et al. first showed that the MET perceived that a prior NFR order would have been appropriate in approximately 25% of cases [39]. The authors suggested that the MET system "provides an opportunity to identify a subgroup of patients for whom an NFR order should be considered but where none is documented" [39]. Many patients may experience a clinical deterioration sufficient enough to activate and fulfill the MET criteria before they have a fatal event. Therefore, the MET could be one of the first to document an NFR, LOMT, or not-for-ICU (NFICU) order, or initiate the process which may lead to the institution of such orders in patients who would not benefit from resuscitative measures or intervention by the MET [1,37,50,52]. The institution of such measures may prevent the inappropriate or non-beneficial use of aggressive interventions or unnecessary admissions to the ICU, and lead to improved EOLC [47]. One of the

first studies to directly investigate the association between EOLC and MET systems was a 2008 single center study in the United States [47]. The authors hypothesized that the MET system would facilitate the identification of patients who would not benefit from resuscitation and aggressive treatment, or who did not want such treatment, and therefore accelerate the process of EOLC and improve quality of death [47]. The retrospective study compared characteristics and outcomes in patients during pre-and-post MET system time periods in their hospital. It was found that a significantly higher proportion of patients in the post-MET implementation period had orders for comfort care as compared to the pre-MET implementation period [47]. The post-MET implementation patients were also significantly more likely to receive opioid medications prior to death and had lower pain scores in the 24 hours before death when compared to the pre-MET patients [47]. Amongst these findings, the investigators also noted that in the post-MET implementation period, there was significantly less patient distress, and increased visits by a chaplain 24 hour before death [47]. Furthermore, the study found that after adjustment for several demographic variables, the post-MET period patients were more likely to receive formal end of life medical orders, opioid medications, and documentation of suffering in these patients was less than one fourth that of the pre-MET patients [47]. The authors concluded that deployment of the MET system in their hospital was associated with improved quality of death [47]. This study importantly sheds light on the potentially beneficial effect of the METs involvement in EOLC. Tam et al. reported that the EOLC status was changed in 27% of patients experiencing a MET activation in a single center study, with those patients receiving more palliative services and passing away within 24 hours of MET activation [55]. The authors of the study concluded that the MET was able to identify and treat patients who would benefit from palliative services [55]. However, they also noted that the context of a MET activation might not be the optimal time for a

discussion of goals of care designations and EOLC, suggesting that there was room to enhance EOLC before deterioration occurs [55].

As previously mentioned, several studies have shown that adverse events are not sudden and are typically preceded by hours of deterioration in vital signs. This window of time may present an opportunity to assess the GOC of patients at the start of the deterioration process before the point of critical illness has been reached. A study in 2013 by Heyland et al. showed that 76% of elderly patients had considered EOLC and that only 12% of patients preferred life-prolonging care [56]. However, only 30% of medical records accurately reflected and documented the patient's wishes, showing that there is a mismatch between the EOLC resources available and resources that patients need [56]. In an Australian study, Orosz et al. defined a “palliative MET call” as one where the MET initiated the withdrawal or withholding of active therapy or initiated EOLC [57]. The study found that palliative MET activations were commonly triggered by neurological and respiratory deterioration and were more likely to result in no interventions during the MET activation [57]. The study also showed that these patients are more likely to be older, have a shorter length of stay in the hospital, and are more likely to have a malignant disease and severe comorbidities [57]. Lastly, the study also found that these patients have multiple MET calls after their initial index MET activation [57]. Characterization of these clinical and demographic features may be the key to improving the recognition of patients requiring EOLC discussions prior to the MET being activated [57]. Such an approach may improve the access and utilization of healthcare professionals who are specialized in EOLC and advance care planning (such as palliative care teams). A randomized controlled trial in elderly patients showed that advance care planning improved EOLC and reduced anxiety and depression amongst patients and families [58].

Collectively, these studies show that the MET is frequently involved in EOLC and LOMT in patients it attends to.

Rationale for the Present Study

Since the inception of the MET, many studies have investigated the outcomes and characteristics of patients receiving MET activations. In recent years more attention has been given to patients with LOMT attended to by the MET, particularly after the MERIT study described an increase in NFR orders after MET activation. However, relatively little remains known about the MET utilization, characteristics, and outcomes of patients with LOMT and EOLC issues who receive a MET activation. Further investigations and discourse are required to weigh the potential benefits and burdens of utilizing a critical care-based resource such as the MET in patients deemed NFR and who are designated to not be admitted to the ICU. The MET system is an expensive healthcare resource, responding to patients with significant comorbidities in an acute state of deterioration. Studies have shown that MET activations in patients with EOLC issues and LOMT are significantly longer in duration and cost the healthcare system approximately three times more than a MET activation to patients with no LOMT [37,49,59]. Perhaps the MET provides limited to no significant benefit in patients with LOMT and does not improve their outcomes. If this is true, the METs resources are potentially being diverted away from patients, particularly in the ICU, who are more likely to derive benefit from the more aggressive intervention and restorative therapy which the MET is capable of providing. Ensuring optimal utilization of the MET is essential to both patient care and resource allocation within hospital systems. This topic remains a complex and incompletely understood issue, and more studies are needed to inform decisions and

policy surrounding the MET, particularly in patients with medical orders precluding them from resuscitative care and ICU admission.

Hypothesis

General Hypothesis

This thesis examines the demographic and clinical characteristics, as well as outcomes, of patients with a MET activation. I hypothesize that patients with a GOC: M1 or below represent a significant proportion of total MET activations. Furthermore, I hypothesize that in patients with a MET activation, in-hospital mortality is higher in patients with a GOC: M1 or below compared to patients with a GOC: R1 status.

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Chapter Two

Study One: An Evaluation of Medical Emergency Team Activations in Hospitalized Patients Designated as Not-for-Resuscitation

Introduction

Modern hospital systems are complex organizations delivering health care to a diverse case-mix of patients with increasing age, acuity, and comorbidities [1]. Studies have shown that serious adverse events (SAEs) such as cardiac arrest, death, and unplanned admission to the Intensive Care Unit (ICU) occur in a significant proportion of patients admitted to hospitals [1,2].

Medical Emergency Team (MET) systems have been introduced in hospitals to provide a systematic approach to the identification, review, and treatment of acutely deteriorating patients on general hospital wards. SAE's are often preceded by objective signs of deterioration in the 8-48 hours prior to an event [2]. Therefore, early recognition of deterioration and timely intervention are imperative to improving patient outcomes and reducing the incidence of SAEs in hospitalized patients [3]. Studies have consistently shown a reduction of in-hospital cardiac arrests associated with the implementation of a MET system [1,2]. Furthermore, a 2015 systematic review found a 17% reduction in hospital mortality associated with MET implementation [2]. The MET system was initially described in 1995 and has since been widely adopted by several hospitals worldwide and is considered a general patient safety intervention by the Canadian Patient Safety Institute [1,5].

An additional role of the MET may involve discussions and decisions regarding a patient's end-of-life care (EOLC) and the institution of limitations of medical therapy (LOMT) [4]. Definitions of limitations in care differ across institutions, but in general, multiple studies have shown the MET responds to a significant number of patients with not-for-resuscitation (NFR) and not-for-ICU (NFICU) orders, who may also be approaching the end-of-life. A large prospective cohort study reported 31.1% of MET activations involved a patient with a LOMT, with the MET instituting a LOMT in 10.8% of cases [4]. Calzavacca et al. found 21.7% of patients attended by

the MET had a pre-existing NFR order, and 7.3% of patients had an NFR order implemented by the MET [1]. Furthermore, Parr et al. reported that the MET felt an NFR order was appropriate in 23% of MET activations [1,4]. Studies have also shown that the MET delivers several EOLC interventions to patients such as palliative care and the administration of narcotics [6,7,14]. Lastly, investigations have also reported an increased quality of death and enhanced EOLC associated with the deployment of a MET [7,8-10,14].

The MET was initially developed to address a gap between the acuity of patients and the care which could be provided to them on the ward [2]. Investigations into the role of the MET in LOMT and EOLC have identified a potential disparity between the EOLC needs of patients and the resources available for such care on the ward. Several questions remain surrounding the appropriateness and effectiveness of the MET in such contexts. In order to ensure optimal quality of patient care and the most efficient and effective use of hospital resources, it is essential to conduct further studies to understand the clinical and demographic characteristics of these patients, as well as their utilization of the MET and subsequent outcomes.

The current study took place at the University of Alberta Hospital (UAH). At this institution, a Goals of Care (GOC) designation describes a patient's LOMT. Chapter one of this thesis provides a detailed description of GOC designations at the UAH. Patients with a medical or comfort GOC designation are NFR and are generally not admitted to the ICU due to patient preferences for care or discussions with the healthcare team. The purpose of this study was to describe and compare clinical and demographic characteristics, MET activations, and subsequent outcomes in patients with a full resuscitative GOC designation (GOC: R1) to patients with a medical or comfort GOC designation (GOC: M1 or below).

Hypotheses and Study Questions

I hypothesized that patients with a Goals of Care designation of M1 or below would represent a significant proportion of total MET activations at the University of Alberta Hospital. I also hypothesized that their outcomes, such as in-hospital mortality, would be significantly greater compared to patients with full resuscitative Goals of Care designation of R1.

Primary Study Question

What proportion of MET activations at the University of Alberta Hospital are for patients with a Goals of Care designation of M1 or below?

Secondary Study Questions

1. What is the mortality rate in patients with a MET activation and a Goals of Care designation of M1 or below compared to those with a Goals of Care designation of R1?
2. What proportion of patients with a MET activation and Goals of Care designation of M1 or below are admitted to the ICU compared to patients with a Goals of Care designation of R1?
3. What is the disposition of patients following MET activation?
4. What is the discharge disposition of patients surviving a MET activation following hospitalization?
5. What is the hospital length of stay in patients with a MET activation and Goals of Care designation of M1 or below compared to patients with a Goals of Care designation of R1?

Methods

Study Design

Retrospective cohort study.

Patients and Study Setting

The study population included all adult patients (age >= 18 years) admitted to the UAH who experienced a MET activation from January 1, 2013, to December 31, 2015.

The UAH in Edmonton, Alberta, Canada, is a major academic quaternary care center with medical and surgical services for adult and pediatric patient populations. All health care services are provided at the UAH with the exception of obstetrics and gynecology, ophthalmology, vascular and thoracic surgery, and allo-bone marrow transplantation. Alberta Health Services is the governing body managing operations and policies at the UAH. Alberta Health Services is a provincial, fully-integrated healthcare system, responsible for the delivery of healthcare services to over four million people living in Alberta, as well as to some residents of Saskatchewan, B.C., and the Northwest Territories. The UAH has over 800 beds and treats more than 700,000 adult and pediatric patients annually from across western and northern Canada [12].

Operational Definitions

MET Activation: A MET activation was defined as the activation of the MET by the hospital ward staff for patients with evidence of clinical deterioration fulfilling one or more of the pre-defined activation criteria, followed by subsequent response and attendance by the MET service to the patient bedside. Depicted below are the standardized MET activation criteria at the time of the study.

Table 2.1: Standardized MET activation criteria at the time of the study

Airway Threatened	Stridor; Excessive secretions
Breathing	Acute change in respiratory rate <8 or >30; Acute change in SpO2 <90 on O2 >50% or 8 L/min
Circulation	Acute change in heart rate <40 or >140; Acute change in systolic blood pressure <90 mmHg or >200 mmHg
Neurological (Level of Consciousness)	Acute change in level of consciousness
Worried	Staff concerned; Other

Comorbidities: Pre-existing comorbidities were evaluated and assessed using the Charlson Comorbidity Index (CCI). The CCI index was initially developed to predict one-year mortality among medical patients and is one of the most frequently used measures of burden of comorbidity [11]. The CCI was used to estimate the level and extent of comorbidities. In the calculation of the score, a weighting of 1, 2, 3, or 6 is ascribed to each of 19 distinct comorbid disease categories [11]. The CCI score is the sum of the weights. Table 2.2 below depicts the CCI scoring criteria.

Table 2.2: Charlson Comorbidity Index Scoring

Charlson Comorbidity Index Score (Weight)	Charlson Comorbidity Category
1	Myocardial infarction; Congestive heart failure; Peripheral vascular disease; Cerebrovascular disease; Dementia; Chronic pulmonary disease; Connective tissue disease; Ulcer disease; Mild liver disease; Type 1 and Type 2 Diabetes; Age (1 for each 10-year increase over 40 years of age)
2	Hemiplegia; Moderate to several renal disease; Diabetes with end-organ damage (Type 1 and Type 2); Any tumor; Leukemia; Lymphoma
3	Moderate to severe liver disease
6	Metastatic solid tumor; AIDS

Goals of Care designations: The Goals of Care (GOC) designation used for a patient in the study was the GOC designation recorded or present at the start of a MET activation. A patient's GOC designation was defined according to the Alberta Health Services Advance Care Planning and Goals Of Care Designation policy form, effective April 1, 2014 [Appendix 2, 13]. The Goals of Care Designation of a patient is a medical order which guides medically indicated interventions that are ideally in line with a patient's beliefs and values. GOC designations are utilized to establish and communicate general care directions, locations of care and transfer opportunities for current and future care for patients [13]. Chapter one of this thesis provides a full description of the GOC designations in AHS institutions such as the UAH. The following section provides a brief description of the different levels of GOC designations and their relevance to the study.

The three major levels of GOC designations are Resuscitative care, Medical care, and Comfort care. Resuscitative level GOC are directed at cure or control of a patient's condition and allow for ICU care as a patient with such designation is thought to benefit from such care [13]. The R1 level is full resuscitative care including ICU admission, intubation, and chest compressions [13]. Patients with R2 or R3 designations may receive medical care including ICU admission, but have restrictions in the measures undertaken during resuscitation [13]. Patients with a medical GOC designation are precluded from ICU admission and have either chosen not to receive care in an ICU or are deemed not to benefit from such care [13]. The M1 and M2 levels allow medical care without the option for resuscitation and life support interventions [13]. Comfort care GOC designations have their treatment focussed on symptom control rather than cure or control of a patient's underlying condition which is expected to result in death [13]. The C1 GOC designation is for general symptom comfort care in patients with a diagnosis that is expected to result in

eventual death. The C2 GOC designation is for the care of terminal conditions with the aim of preparing for the imminent death of a patient [13].

The GOC designation guides healthcare teams such as the MET as to the interventions they may provide a patient in accordance with their preferences and wishes. The key difference for the purpose of the study is that patients with a GOC designation of M1 or below are generally NFR and NFICU, whereas patients with a resuscitative GOC designation may be admitted to the ICU and would have full resuscitative measures undertaken, or in the case of an R2 or R3 GOC, limited resuscitative measures. Figure 2.1 below depicts the different levels of GOC designations and the interventions that are acceptable under each designation.

Figure 2.1: Goals of Care Designations (Alberta Health Services)

Patients with a GOC: R2 and R3

Patients with an R2 or R3 GOC designation represented approximately 10% of all MET activations. We included these patients in our overall description of the study cohort. However, we excluded these patients from comparative analysis in the study. As mentioned, patients with

an R2 or R3 GOC designation may be admitted to the ICU, and may still undergo resuscitation, but have limitations in resuscitative measures which can be undertaken. For the purposes of the study, we focused on comparing patients with full resuscitative GOC (GOC: R1) to patients with a GOC designation of M1 or below to better understand the relationship between significant limitations in medical care and their impact on outcomes after MET activation.

Data Sources

Patients with a MET activation were identified using a pre-existing MET database. The MET database is maintained by the General Systems Intensive Care Unit, Department of Critical Care Medicine, at the UAH. The MET database contains data recorded on the MET documentation forms at the time of the MET. The MET documentation form used during the period of the study is attached in Appendix 3. The MET database contains a patient's provincial unique lifetime identifier (ULI number), first and last name, date of birth, sex, admitting service, MET activation date, GOC designation at the time of MET, the MET diagnosis, reason(s) for activation, duration of MET, and post-MET disposition.

Data were extracted from several administrative databases maintained by Alberta Health Services' Data Integration, Management, and Reporting (DIMR). The Discharge Abstract Database (DAD) was used to gather data on admissions, discharges, deaths, and site transfers. Data from DAD also included a coded diagnosis for patients from the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10-CA). The ICD-10-CA diagnostic codes were then used to calculate a patient's comorbidity index score. Data were also collected from eCritical Alberta, a provincial clinical information system, data warehouse, and clinical analytics system [15]. The TRACER component of eCritical provides a comprehensive, multimodal and integrated data repository of patient-specific ICU data [15].

eCritical and TRACER are governed by rigorous methods of data quality assurance and audit, and have previously been used to support health services research [15]. I used eCritical/TRACER to obtain information on patients who were admitted to the ICU including date and time of admission, and whether the patient died in the ICU.

Outcomes

The primary outcome was the in-hospital mortality rate for patients with a MET activation. The mortality rate was defined as the number of deaths in patients with a MET activation that occurred during the index hospitalization and is reported as a proportion. Mortality rates were then stratified by GOC designation to understand the impact of GOC on mortality after MET activation. Secondary outcomes included post-MET ICU admission, hospital length of stay (LOS), duration of MET activation, post-MET disposition, and hospital discharge disposition. A multivariable model was created to assess the association between GOC designation and in-hospital mortality.

Data Analysis

Data from the MET database, eCritical TRACER, and DAD were exported and merged into a master database in Excel 2016 (Microsoft Corporation). Analysis of the data was performed using STATA version 15 (StataCorp LLC). Descriptive statistics were used to analyze and inspect all variables independently for their underlying distribution. Normally distributed variables were reported using means with standard deviations (SD). Non-normally distributed data were reported using medians with interquartile ranges (IQR). Differences in continuous variables were analyzed using the Mann Whitney U test. Differences in categorical variables and proportions were analyzed using the chi-square test. A multivariable logistic regression model was developed to understand

the effects of different predictor variables on the primary outcome variable. A p-value of less than 0.05 was considered significant for all comparisons.

Ethical Considerations

The study involved a review of data from administrative and clinical databases. Before any data acquisition or audit, ethical review and approval were obtained from the Research Ethics Office of the University of Alberta (Research Ethics Board Study ID: Pro00058181). Permission for waiver of consent to access patient health information was granted. The data used in the study was password protected at all times, and the computer used was stored in a locked office.

Results

Characteristics of Overall Cohort

During the three-year study period from January 1, 2013, to December 31, 2015, there was a total of 2703 MET activations in 2218 patients. Data were available for 2692 (99.5%) of the MET activations. Of the 2218 patients with MET activations and data available, 1860 received a single MET activation while 358 patients had repeat MET activations which totaled 843 MET activations (Figure 2.2). The median (IQR) age of the 2218 patients was 66.7 years (54.7-78.8), 57% of MET activations were for male patients, and the admitting service was predominantly a medical service (52%). The median (IQR) Charlson Comorbidity Index (CCI) score was 5 (3-8). The median (IQR) length of hospital stay for the overall cohort was 21.5 days (10-49), and post-MET disposition was predominantly to remain on the ward (70%). Admission to the ICU occurred in 27% of patients post-MET. A large proportion of patients with MET activations did not survive to hospital discharge with an in-hospital mortality rate of 38%. Table 2.3 below details the characteristics of the patients.

Figure 2.2: Overall cohort of patients and MET activations, including repeat MET activations.

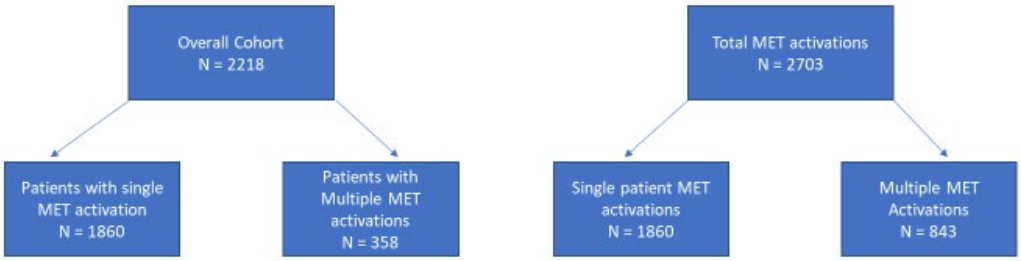


Table 2.3: Differences in patient characteristics and outcomes for patients with a GOC: M1 or below and those with GOC: R1.

Patient Characteristics	R1 GOC	M1 or Below GOC	P-value
Number of patients, n (%)	1515 (68)	461 (21)	
Number of MET activations, n (%)	1849 (69)	563 (21)	
Age, median (IQR)	63 (51-73)	78 (66-85)	<0.001
Sex (female), n (%)	777 (42)	271 (48)	<0.01
Charlson Comorbidity Index, median score (IQR)	5 (3-8)	6 (4-8)	<0.01
Admission Source, n (%)			<0.001
Medical	832 (45)	372 (66)	
Surgical	806 (44)	147 (26)	
Other[1]	211 (11)	47 (8)	
Hospital LOS, median days (IQR)	22 (11-49)	20 (8-43)	<0.001
In-hospital Mortality, n (%)	358 (24)	268 (58)	<0.001
Discharge disposition n (%)			
Discharged alive	821 (55)	84 (18)	<0.01
Transfer to another facility	335 (22)	109 (24)	

[1] Patients admitted to a Neurosciences ward, which is comprised of a mix of medical and surgical services

MET Activations and GOC Designations

Of the 2692 MET activations in 2218 patients, there were 1849 (69%) activations in 1515 patients with a GOC designation of R1, 280 (10%) activations in 210 patients with a GOC designation of R2 or R3, and 563 (21%) activations in 461 patients with a GOC designation of M1 or below. Patients with a GOC M1 or below were significantly older than patients with a GOC of R1 (63 (IQR 51-73) vs. 78 (IQR 66-85) years; $p<0.001$; Table 2.3). Patients with a GOC M1 or below were also more likely to be female ($p<0.001$). Furthermore, patients with a GOC M1 or below were more likely to be admitted under a medical service ($p<0.001$; Table 2.3). The proportions of MET activations and patients by GOC designation are shown below in Table 2.4.

Figure 2.3: Proportion of MET Activations by GOC Status

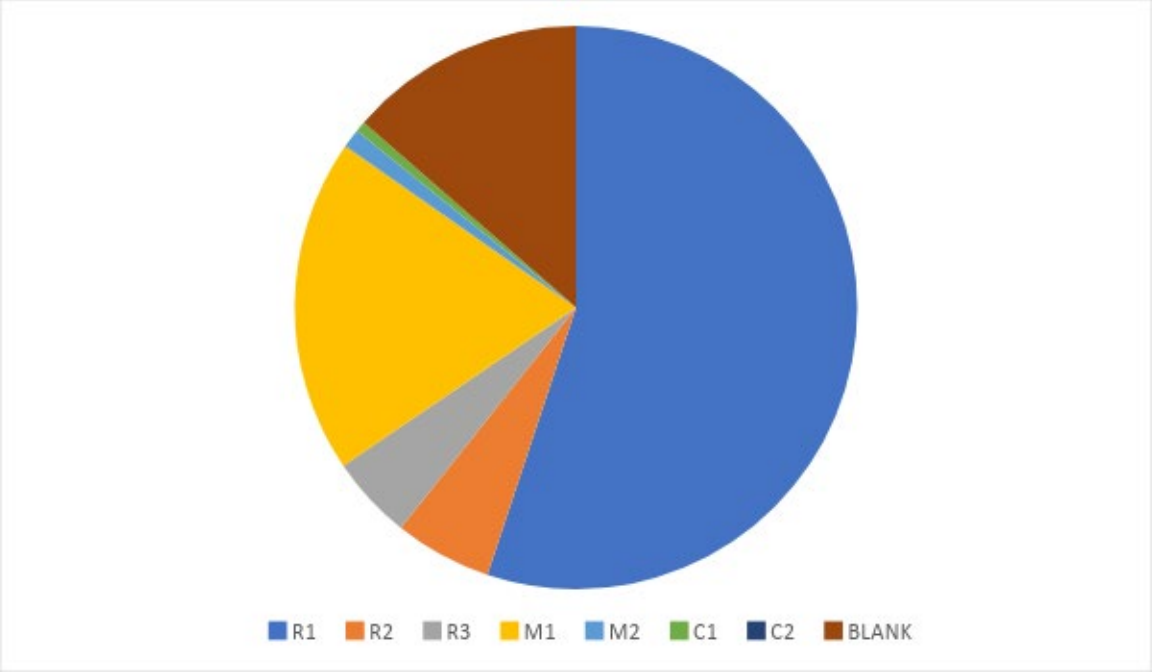


Table 2.4: MET activations by GOC designation

GOC	R1	R2	R3	M1	M2	C1	C2	BLANK	Total
Number of calls, n (%)	1482 (55.1)	152 (5.6)	128 (4.8)	516 (19.2)	30 (1.1)	17 (0.6)	0	367 (13.6)	2692
Number of patients, n (%)	1238 (55.8)	117 (5.3)	93 (4.2)	416 (18.8)	29 (1.3)	16 (0.7)	0	307 (13.8)	2218

Primary Admission Diagnosis

ICD-10-CA diagnostic codes were used to determine what category of major organ system a patient's primary admission diagnosis involved. The primary admission diagnosis categories stratified by GOC designation are shown in table 2.5 below.

Table 2.5: Primary admission diagnosis by GOC designation (n patients (%))

Organ system	GOC: R1	GOC: M1 or below
Circulatory System	156 (8.6%)	92 (16.3%)
Respiratory System	265 (14.7%)	120 (21.3%)
Neoplasms	406 (22.5%)	78 (13.9%)
Digestive System	224 (12.4%)	29 (5.2%)
Genitourinary System	74 (4.1%)	19 (3.4%)
Musculoskeletal System	59 (3.3%)	12 (2.1%)
Nervous System	58 (3.2%)	14 (2.5%)
Endocrine and Metabolic Diseases	60 (3.3%)	11 (2.0%)
Injury, Poisoning, and Other Consequences of External Causes	252 (14.9%)	106 (18.8%)
Infectious and Parasitic Diseases	119 (6.6%)	31 (5.5%)
Mental and Behavioural Disorders	47 (2.6%)	16 (2.8%)

The proportions varied across all diagnostic categories for patients with a GOC: M1 or below compared to patients with a GOC: R1 ($p<0.001$). This indicates that patients with different GOC designations presented to the hospital with significantly different illnesses. Diseases involving the respiratory and circulatory systems were the most common primary admission diagnoses for patients with a GOC: M1 or below and were significantly higher than in patients with a GOC: R1. There was a high rate of neoplasms in patients with a GOC: M1 or below as well, although this was significantly higher in patients with a GOC: R1. Patients with a GOC: R1 had significantly higher rates of digestive system disorders and neoplasms compared to patients with a GOC: M1 or below. A high proportion of patients from both GOC designations suffered from injury, poisoning, and other consequences of external causes.

The overall cohort had significant comorbidities and a median (IQR) CCI score of 5 (0-35). Patients with a GOC: R1 had a median (IQR) CCI score of 5 (3-8) as compared to patients with a GOC: M1 or below who had a median (IQR) CCI score of 6 (4-8) ($p<0.01$). Therefore,

patients with a GOC: M1 or below had significantly more comorbidities than patients with a GOC: R1.

MET Activation Characteristics

There was no significant difference in the reason(s) for MET activation between patients with different GOC designations (Table 2.6). The most common reasons for MET activation was concerns over patients breathing (often hypoxemia), followed by concerns over a patient's circulatory condition and neurological status. The worried criterion was not a frequent reason for activating the MET (Table 2.6). Patients with a GOC: M1 or below had a slightly higher proportion of out-of-hours MET activations. However, the difference was not statistically significant (60% vs. 54%; $p=0.14$). Patients with a GOC: M1 or below's MET activations were significantly longer in duration compared to patients with a GOC: R1 (54 minutes vs. 46 minutes; $p<0.001$).

In patients with a GOC: M1 or below, disposition post-MET was predominantly to remain on the ward (98%), with only 11 patients (2%) being admitted to the ICU following their MET activation (Table 2.6). In contrast, 66% of patients with a GOC: R1 remained on the ward post-MET activation, and 34% were admitted to the ICU (Table 2.6). A significantly higher proportion of patients with a GOC: R1 were admitted to the ICU post-MET compared to patients with a GOC M1 or below (34% vs. 2%; $p<0.001$).

Discharge Disposition

Discharge disposition was significantly different between patients with a GOC: M1 or below and patients with a GOC: R1 (Table 2.3). While 54% of patients with a GOC: R1 were discharged alive from hospital, only 18% of patients with a GOC M1 or below survived to hospital discharge ($p<0.001$). A similar proportion of patients with a GOC: M1 or below and GOC: R1

were transferred to another care facility at discharge, with no statistically significant difference (Table 2.3).

Hospital Length of Stay

The median (IQR) length of stay (LOS) for the overall cohort was 21.5 days (10-49). Patients with a GOC: R1 had a median (IQR) LOS of 22 days (11-49), while patients with a GOC: M1 or below had a median (IQR) LOS of 20 days (8-43). The LOS was found to be significantly shorter in patients with a GOC: M1 or below ($p<0.001$) (Table 2.6). Furthermore, patients with a GOC: R1 had a median (IQR) pre-MET LOS of 5 days (2-14), in contrast to patients with a GOC: M1 or below who had a median (IQR) pre-MET LOS of 7 days (2-22) ($p<0.001$). Lastly, patients with a GOC: R1 had a median (IQR) post-MET LOS of 14 days (6-32), while patients with a GOC: M1 or below had a significantly shorter median (IQR) post-MET LOS of 6 days (1-17) ($p<0.001$).

Table 2.6: Differences in MET Activations for patients with a GOC: M1 or below and GOC: R1.

MET Activation Characteristics	GOC: R1	GOC: M1 or below	P-value
Number of MET Activations	1849	563	
Reason for MET; n(%)			
Airway Threatened	177 (9.6%)	42 (7.4%)	0.13
Breathing	748 (40.5%)	238 (42%)	0.44
Circulation	586 (31.7%)	165 (29.3%)	0.29
Neurological	515 (27.9%)	176 (31%)	0.10
Worried	200 (10.8%)	58 (10.0%)	0.73
Number of MET Criteria for Activations	2226	679	
Time of MET Activation; n(%)			
In-hours	850 (46%)	225 (40%)	0.14
Out-of-hours (17:00 – 07:00)	999 (54%)	338 (60%)	
Duration of MET, Median minutes (IQR)	47 (28-75)	54 (32-81)	0.001
Disposition Post-MET			
Ward (%)	66%	98%	
ICU (%)	36%	2%	0.001
Hospital Length of Stay, median days (IQR)	22 (11-49)	20 (8-43)	0.001

Mortality in Patients with MET Activations

In-hospital mortality was high for the overall cohort of patients with MET activations. Seven hundred and two patients (32%) with a MET activation died prior to discharge from the hospital. Patients with a GOC: M1 or below had a significantly higher in-hospital mortality rate compared to patients with a GOC: R1 at the time of MET (58% vs. 24%; $p<0.001$). Also, in patients who died, those with a GOC: M1 or below died one day (IQR, 0-6) after their index MET activation or last MET activation, compared to 8 days (IQR, 2-19) after index or last MET activation in patients with a GOC: R1 ($p=0.01$). In patients admitted to the ICU post-MET activation, there was a significantly higher mortality rate in patients with a GOC: M1 or below compared to those with a GOC: R1 (56% vs. 27%; $p<0.001$). Of the 11 patients with a GOC: M1 or below admitted to the ICU post-MET, 27% died in the ICU, compared to 16% of patients with a GOC: R1 ($p<0.001$).

Multivariable Logistic Regression Model for Mortality Outcome

A multivariable logistic regression model was developed to determine the independent association between GOC designation and in-hospital mortality. The outcome (dependent) variable was in-hospital mortality. The independent variables were GOC status (M1 and below, and R1), age, sex, hospital length of stay, admitting service, and comorbidity index score. These variables were chosen on the basis of their statistical and clinical significance. All unadjusted and adjusted Odds Ratios along with their 95% Confidence Intervals are presented in Table 2.7 below.

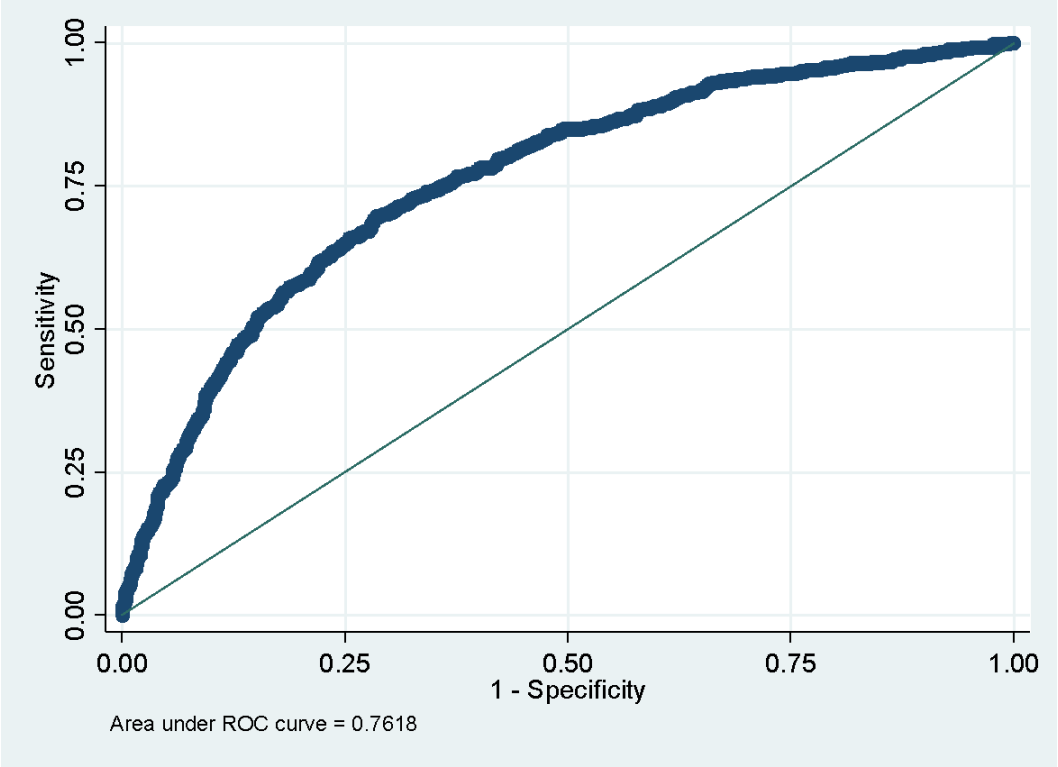
Table 2.7: Unadjusted and Adjusted Odds Ratios for in-hospital mortality. Odds Ratios (OR) and 95% Confidence Intervals (CI).

Factor	Crude OR (95% CI)	Adjusted OR (95% CI)
GOC Designation		
M1 or Below	4.67 (3.82 – 5.71)	3.49 (2.79 – 4.36)
Age	1.02 (1.02 – 1.03)	1.02 (1.01 – 1.02)
Gender		
Male	1.20 (1.02 – 1.43)	1.23 (1.01 – 1.50)
Hospital Length of Stay	0.99 (0.98 – 1.01)	1.00 (0.99 – 1.02)
CCI (comorbidity index) Score	1.12 (1.09 – 1.14)	1.12 (1.09 – 1.15)
Admitting Service		
Medicine	1.06 (0.76 – 1.49)	0.84 (0.58 – 1.21)
Surgery	0.43 (0.30 – 0.61)	0.39 (0.27 – 0.58)

Assuming age, sex, length of stay, admitting service, and CCI score were held constant; we found that the odds of in-hospital mortality increased by 3.49 times for patients with a GOC of M1 or below compared to patients with a GOC: R1 following MET activation.

The model fit was assessed using the Hosmer-Lemeshow's goodness of fit test. This test yielded no evidence of lack of fit (Chi2 =9.17, p=0.33). Furthermore, the model was found to have strong discrimination as was determined by a 0.76 area under the receiver operator characteristic curve (Figure 2.4).

Figure 2.4: Area under the Receiver Operating Characteristic (ROC) curve



Discussion

A retrospective cohort study of 2218 patients with MET activations at the University of Alberta Hospital, from January 1, 2013 – December 31, 2015, was conducted. There were several significant findings from the study. Approximately one in five MET activations were to patients with a GOC designation of M1 or below. These patients represented a significant proportion (21%) of total MET activations at the University of Alberta Hospital during the study period. Patients with a GOC: M1 or below were significantly older than patients with a GOC: R1 and were more likely to be female. Patients with a GOC: M1 or below were also more likely to be admitted under a medical service rather than surgical service.

A high proportion (60%) of MET activations in patients with a GOC: M1 or below occurred out of hours. However, this was not significantly different from patients with a GOC: R1. The duration of MET activations in patients with a GOC: M1 or below were significantly longer than MET activations in patients with a GOC: R1, suggesting the MET spent more time attending to issues in these patients who are often designated as not for ICU admission or advanced life support interventions due to a priori established limitations in their care (as described by their GOC designation).

Patients with a GOC: M1 or below had a high baseline comorbidity index score. Our findings suggest that these patients were older and had greater burden of comorbidities than patients with a GOC: R1. The principal organ system involved in the primary admission diagnosis differed significantly between patients with a GOC: M1 or below and GOC: R1, suggesting further differences in the two patients' populations. We found that patients with a GOC: M1 or below often were admitted for issues related to the respiratory or cardiovascular system, both of which were significantly more frequent than patients with a GOC: R1.

We found no differences in the reasons for MET activation between patients with a GOC: M1 or below and those with a GOC: R1. The most common reason for MET activation was concerns regarding breathing (often hypoxemia). Together with the high comorbidity index and mortality rate, this suggests that the GOC: M1 or below patients were seriously ill, frequently near the end of life, and exhibited similar signs and symptoms of deterioration as patients with a GOC: R1 leading to the activation of the MET by ward staff. These patients with a GOC: M1 or below (designated as NFR and NFICU), may have reversible, or irreversible deterioration which is part of the trajectory of dying. However, this exists independently of the patient's preferences for care as described by their GOC designation.

Post-MET disposition was significantly different in patients with a GOC: M1 or below and GOC: R1. The difference in post-MET disposition reflects the limitations in treatment and care guided by the GOC designation. Patients with a GOC: M1 or below remained predominantly on the ward post-MET. However, a small percentage of patients (2% or 11 patients) were admitted to the ICU after their MET consult. Although this occurred in a small number of patients with a GOC: M1 or below, it suggests that the MET may have been involved in discussions and decisions to change these patients GOC designations and escalate their care. This finding requires further study to identify the source of change in a patient's GOC designation or reason for admission to the ICU. Perhaps the MET did not believe the M1 status to be appropriate for the patient. It is also plausible that there may have been a conflict in the EOLC decisions between a patient or their family and medical staff. Lastly, the MET may have deemed a patient's condition quickly reversible in such cases. Therefore, a time-limited trial of ICU care was deemed reasonable to reverse such condition. In contrast, just over 1/3 patients with a GOC: R1 were admitted to the ICU post-MET. The

majority of patients with a GOC: R1 survived to discharge, so it is reasonable to infer that many may have benefited from MET intervention or transfer to the ICU.

Discharge disposition was also significantly different in patients with a GOC: M1 or below compared to those with a GOC: R1. Both groups of patients with MET activations had a high in-hospital mortality rate. However, more than half of patients with a GOC: R1 survived to discharge, while only 18% of patients with a GOC: M1 or below were discharged out of the hospital. The in-hospital mortality rate in patients with a GOC: M1 or below was significantly higher than patients with a GOC: R1, with 58% of those patients dying. Also, we found that in patients who died, those with a GOC: M1 or below died on average within 24 hours after their index MET activation or last MET activation. In contrast, patients with a GOC: R1 died eight days after their index or last MET activation. Our finding suggests many of the patients with a GOC: M1 or below are near the end-of-life at the time of MET consultation. This finding is also in line with several other studies that have reported the involvement of the MET in EOLC decisions and treatment such as palliation [6,8-10,14]. We also found that patients with a GOC: M1 or below experiencing a MET activation had a shorter hospital length of stay compared to patients with a GOC: R1. This finding makes sense in light of the higher mortality rate and shorter time to death following MET activation in patients with a GOC: M1 or below.

A multivariable logistic regression model controlling for age, sex, admitting service, hospital length of stay, and comorbidities found a near four-fold increase in the adjusted odds of in-hospital mortality associated with a GOC: M1 or below compared to a GOC: R1.

Limitations of Study

We adjusted for potentially confounding factors such as age, gender, hospital length of stay, admitting service, and CCI score in the logistic regression model to determine the independent relationship between GOC status and in-hospital mortality. However, there are several other demographic and clinical factors which may impact in-hospital mortality. For example, a patient's smoking status, alcohol consumption, socioeconomic status, genetic diseases, frailty, medical and surgical procedures, and complications developed during a hospital stay. These variables were not included in the dataset, and therefore could not be adjusted for. Therefore, the effect of these variables and other unknown confounders on the association between GOC status and mortality is unknown. Another weakness of the study is that the GOC designation was captured at the time of MET activation and are unable to comment on whether a patient's GOC status changed during their index hospitalization and what new GOC status they may have been re-assigned. It would be important to note any changes to GOC designation and in what direction they changed, in order to understand the impact of MET consultation on changes to GOC designations. Furthermore, the study was conducted at a single center major quaternary referral hospital, and therefore its findings may not be generalizable to centers outside of Canada and non-quaternary referral or acute care hospitals. The study findings may also not be generalizable to centers with different interpretations of Goals of Care designations, or not-for-ICU and not-for-resuscitation orders. Furthermore, the study did not document which member of the ward staff activated the MET to understand if there were any differences in MET activations initiated by different members of the ward staff. The retrospective nature of the study allowed us to collect data on a much larger sample of patients. However, this data came from administrative datasets which were not optimized and collected for the purposes of the study and relied upon the strength

of the documentation of data that was collected in the past. We also did not have a comparison group in the study, such as patients who had the same GOC designation but did not experience a MET activation. Since there are no controls, and MET activations or GOC designations cannot be randomly allocated, it is difficult to establish a causal effect between the outcomes and GOC designations in patients with MET activations. As mentioned, there are several potentially confounding variables which were either not collected or documented at the time of the MET and confounding variables which are unknown or have an unknown effect on the results and are not accounted for in the study.

Conclusion and Implications of the Study

Approximately 21% of MET activations at the University of Alberta Hospital involved patients with a GOC designation of M1 or below. These MET activations frequently occurred out of hours and had a longer duration than MET activations in patients with a full resuscitative GOC designation. Patients with a GOC: M1 or below attended by the MET were predominantly admitted to medical services, more likely to be female, were older and had a high burden of comorbidities. These patients had a high in-hospital mortality rate and died sooner after their last MET activation. The high mortality rate in patients with a GOC: M1 or below after MET activation suggests that the MET may not be intervening to benefit these patients, and may be intervening to change GOC to palliation.

The findings of this study suggest that many patients with a GOC: M1 or below are nearing the end of life when they are attended to by the MET. The high in-hospital mortality rate in these patients, along with the increased odds of death associated with their GOC: M1 or below, and the fact that they die on average within 24 hours of their last MET activation, would support policy change initiatives surrounding the MET response to patients with a GOC: M1 or below. This may

include palliative and end of life care consultations for these patients, and education programs for ward staff regarding end of life care in patients. On the basis of these findings, clinicians and ward staff treating patients with a GOC: M1 or below may begin the end of life care process for these patients as opposed to activating the MET. However, further research is required to determine the characteristics of patients who likely have irreversible deterioration and are at the end of life. Perhaps MET activation criteria may need to change for patients with a GOC: M1 or below based on their GOC status, and clinical and demographic characteristics. Further studies are also needed to investigate the optimal composition of the MET responding to patients with a GOC: M1 or below.

My findings are in line with several other studies indicating a significant rate of MET activations in patients with LOMT, who may be approaching the end of life. This study may contribute to the growing body of literature and research aimed at the advancement and optimization of the MET system. I believe researching different models of the MET and building a clinical profile of patients with LOMT that have a high likelihood of death should be the focus of research in this field. This may assist ward staff in the management of patients near the end of life, increase the quality of care for patients, and optimize resource utilization within hospital systems.

In conclusion, I believe the findings of this study suggest there is a need for change in the policy and procedures for MET activations to patients with a GOC: M1 or below. In specific, such patients may benefit from palliative care consults and increased provision of palliative care, rather than MET intervention. Furthermore, increased education of ward staff in end-of-life symptoms and care may decrease MET consultation in patients not likely to benefit from the aggressive critical care based therapies the MET was designed to provide. Such a change may allow the MET

to devote its time and resources more efficiently and effectively to patients who are likely to benefit from its care and intervention.

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Chapter Three

Study Two: Medical Emergency Team Activations in Hospitalized Patients Designated as Not-for-Resuscitation

Introduction

The Medical Emergency Team (MET) is a hospital-wide, systematic approach to the identification and management of acutely deteriorating patients on hospital wards [1]. Deployment of the MET, a mobile team of critical care clinicians and allied healthcare professionals, to patients bedsides provides a mechanism for rapid assessment and stabilization of acute deterioration. MET intervention aims to reduce the incidence of serious adverse events (SAEs) such as cardiac arrest, unexpected death, and unplanned admission to the Intensive Care Unit (ICU) [2]. Several hospitals around the world have adopted the MET system, and it is considered a general patient safety intervention by the Canadian Patient Safety Institute [9].

Patients who are in the process of dying trigger the MET activation criteria often [1]. Existing literature has shown the MET may play an additional role in the discussions and decisions surrounding patients end-of-life care (EOLC) and the institution of limitations of medical therapy (LOMT). Several studies have found that patients with LOMT such as a not-for-resuscitation (NFR) and not for Intensive Care Unit (NFICU) admission orders represent approximately 20-30% of total MET activations [1,3,4]. In addition, studies have demonstrated that the MET frequently institutes LOMT in patients [1,3]. A 2014 systematic review found that the MET instituted a LOMT in 1.7% to 30.8% of MET calls [5]. Mortality in patients with a pre-existing LOMT at the time of MET activation is high at approximately 30-50% [2,4]. A large cluster randomized controlled trial of MET implementation in Australia reported that 90% of deaths were associated with a pre-existing NFR order [6]. Some studies have reported a beneficial effect of MET implementation on EOLC including increased palliative care consultation, increased chaplain visits, and reduced patient distress [7,10]. However, this may not provide the optimal utilization of limited hospital resources. A recent study in Australia demonstrated the use of the

MET system in patients at the end of life to be of relatively low value to the healthcare system since clinical outcomes are predictably poor [8]. The authors suggested that the cost-effectiveness of EOLC discussions before MET calls is high due to the probability of intervention being largely futile [8].

Patients with LOMT represent a significant proportion of total MET activations and are often near the end of life at the time of MET activation. Differentiation of patients with reversible deterioration that is amenable to treatment, from patients who are at the end of life and requiring palliation, is not always clear [11]. The evidence to date seems to suggest a disparity in the EOLC resources available on the ward and those required by patients near the end of life. Research aimed at developing a profile of patients near the end of life who are unlikely to benefit from MET activation is needed. Such investigations may help aid in adapting different facets of MET and hospital policy in order to increase the quality of patient care, as well as ensure the most effective and efficient utilization of hospital resources.

The current study takes place at the University of Alberta Hospital (UAH), where a Goals of Care (GOC) designation describes a patients LOMT. Patients with a medical or comfort care designation (GOC: M1 or below) are NFR and NFICU. In patients with a MET activation and a GOC: M1 or below, I compared the clinical and demographic characteristics, as well as outcomes in patients who died to those who survived to hospital discharge.

Hypothesis

Amongst patients with MET activations, I hypothesize that patients with a GOC: M1 or below have a high in-hospital mortality rate. Furthermore, I hypothesize that patients in this cohort who died have significantly different clinical and demographic features compared to patients who survived to hospital discharge. To test this hypothesis, this study was designed to describe and assess the clinical and demographic characteristics of patients with a GOC: M1 or below who survived to discharge compared to those who died in-hospital after MET activation.

Methods

Study Design

Descriptive retrospective cohort study

Patients and Study Setting

The Study was conducted at the University of Alberta Hospital (UAH) in Edmonton, Alberta, Canada. The study population included all adult patients (age>= 18 years) admitted to the University of Alberta Hospital who experienced a MET activation from January 1, 2013 to December 31, 2015, and had a GOC: M1 or below at the time of MET.

Operational Definitions

A MET activation was defined as the activation of the MET by the hospital ward staff for patients with evidence of clinical deterioration fulfilling one or more of the pre-defined activation criteria, followed by subsequent response and attendance by the MET to the patient bedside. Depicted below are the standardized MET activation criteria at the time of the study.

Table 3.1: Standardized MET activation criteria at the time of the study

Airway Threatened	Stridor; Excessive secretions
Breathing	Acute change in respiratory rate <8 or >30; Acute change in SpO2 <90 on O2 >50% or 8 L/min
Circulation	Acute change in heart rate <40 or >140; Acute change in systolic blood pressure <90 mmHg or >200 mmHg
Neurological (Level of Consciousness)	Acute change in level of consciousness
Worried	Staff concerned; Other

Pre-existing comorbidities were evaluated and assessed using the Charlson Co-morbidity Index (CCI). The CCI index was initially developed to predict one-year mortality among medical patients and is one of the most frequently used measures of comorbidity [14]. The CCI was used to estimate the level and extent of comorbidities. In the calculation of the score, a weighting of 1, 2, 3, or 6 is ascribed to each of 19 distinct comorbid disease categories [14]. The CCI score is the sum of the weights. Table 3.2 below depicts the CCI scoring criteria.

Table 3.2: Charlson Comorbidity Index Scoring

Charlson Comorbidity Index Score (Weight)	Charlson Comorbidity Category
1	Myocardial infarction; Congestive heart failure; Peripheral vascular disease; Cerebrovascular disease; Dementia; Chronic pulmonary disease; Connective tissue disease; Ulcer disease; Mild liver disease; Type 1 and Type 2 Diabetes; Age (1 for each 10-year increase over 40 years of age)
2	Hemiplegia; Moderate to several renal disease; Diabetes with end-organ damage (Type 1 and Type 2); Any tumor; Leukemia; Lymphoma
3	Moderate to severe liver disease
6	Metastatic solid tumor; AIDS

The Goals of Care (GOC) designation used for a patient in the study was the GOC designation recorded or present at the start of a MET activation. A patient's GOC designation was defined according to the Alberta Health Services Advance Care Planning And Goals Of Care Designation policy form, effective April 1, 2014 [Appendix 2, 12]. GOC designations are utilized to establish and communicate general care directions, locations of care and transfer opportunities for current and future care for patients [12]. Chapter 1 of this thesis provides a full description of the Goals of Care designations in Alberta Health Services institutions such as the University of Alberta Hospital. The present study focuses on patients with a MET activation and a medical or comfort GOC designation (GOC: M1 or below) at the time of MET. Patients with a GOC: M1 or below may have limited intervention with medical care, but are precluded from ICU admission

and are NFR. The figure below depicts the different levels of GOC designations and the interventions that are acceptable under each designation.

Figure 3.1: Goals of Care Designations (Alberta Health Services)

Ward based interventions and Critical Care based interventions

The interventions provided by the MET can be seen in the attached MET activation form (Appendix 3). The interventions were classified as ward based, critical care based, and resuscitative measures. Critical care based interventions were defined as interventions which cannot be sustainably provided outside of an ICU setting (arterial lines, vasoactive medications, mechanical ventilation and non-invasive ventilation, antiarrhythmic medications). Cardiopulmonary resuscitation was classified separately. All other interventions were classified as ward based on the basis that they can be sustained outside of the ICU, and initiated by ward staff.

Data Sources

Patients with a MET activation were identified using a pre-existing MET database. The MET database is maintained by the General Systems Intensive Care Unit, Department of Critical Care Medicine, at the University of Alberta Hospital. The MET database contains data recorded on the MET documentation forms at the time of the MET. The MET documentation form used during the period of the study is attached in Appendix A. The MET database contains a patient's provincial unique lifetime identifier (ULI number), first and last name, date of birth, sex, admitting service, MET activation date, GOC designation at the time of MET, the MET diagnosis, reason(s) for activation, duration of MET, and post-MET disposition.

Data were extracted from several administrative databases maintained by Alberta Health Services' Data Integration, Management, and Reporting (DIMR). The Discharge Abstract Database (DAD) was used to gather data on admissions, discharges, deaths, and site transfers. Data from DAD also included a coded diagnosis for patients from the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10-CA). The ICD-10-CA diagnostic codes were then used to calculate a patient's comorbidity index score. Data were also collected from eCritical Alberta, a provincial clinical information system, data warehouse, and clinical analytics system [13]. The TRACER component of eCritical provides a comprehensive, multimodal and integrated data repository of patient-specific ICU data [13]. eCritical and TRACER are governed by rigorous methods of data quality assurance and audit, and have previously been used to support health services research [13]. I used eCritical/TRACER to obtain information on patients who were admitted to the ICU including date and time of admission, and whether the patient died in the ICU. This study also included a review of MET activation

charts in patients with a GOC: M1 or below at the time of MET in order to determine the interventions performed by the MET during the call.

Outcomes

The primary outcome was the in-hospital mortality rate in patients with a MET activation and GOC: M1 or below. The mortality rate was defined as the number of deaths in patients that occurred during the index hospitalization and is reported as a proportion. Secondary outcomes included hospital length of stay, post-MET ICU admission, disposition post-MET, and the same outcome measures in patients with greater than one MET activation during their index hospitalization.

Data Analysis

Data from the MET database, eCritical TRACER, and DAD were exported and merged into a master database in Excel 2016 (Microsoft Corporation). Analysis of the data was performed using STATA version 15 (StataCorp LLC). Descriptive statistics were used to analyze and inspect all variables independently for their underlying distribution. Normally distributed variables were reported using means with standard deviations (SD). Non-normally distributed data were reported using medians with interquartile ranges (IQR). Differences in continuous variables were analyzed using the Mann Whitney U test. Differences in categorical variables and proportions were analyzed using the chi-square test. A p-value of less than 0.05 was considered significant for all comparisons.

Ethical Considerations

The study involved a review of data from administrative and clinical databases, as well as patient charts. Before any data acquisition or audit, ethical review and approval was obtained from the Research Ethics Office of the University of Alberta (Research Ethics Board Study ID: Pro00058181). Permission for waiver of consent to access patient health information was granted. The data used in the study were password protected at all times, and the computer used was stored in a locked office.

Results

There were 563 MET activations in 461 patients with a GOC: M1 or below during the study period. 389 patients experienced a single MET activation, and 72 patients had greater than one MET activation. The median (IQR) age of the patients was 78 years (66-85). Male patients represented 52% of the MET activations in patients with a GOC: M1 or below. A higher proportion of patients were admitted to a medical service rather than surgical service (66% vs. 26%, respectively). In-hospital mortality was high in this cohort of patients with 58% dying in-hospital, while 42% survived to hospital discharge. Post-MET disposition was predominantly to remain on the ward (98%). Of the patients who survived, only 18% were discharged home, while 24% were transferred to another facility, and 58% died in hospital.

There was no significant difference in the age of patients who died compared to those who survived to discharge (Table 3.3). In patients with a MET activation and GOC: M1 or below, those who died were significantly more likely to be male (Table 3.4). In patients who died, a higher proportion were admitted to a medical service compared to those who survived (70% vs. 60%, $p<0.001$). Furthermore, patients who died in-hospital had a significantly higher mean comorbidity index score (7.6 vs. 5.1, $p<0.001$). The duration of MET activation was also significantly longer in patients who died compared to those who survived to discharge (56 minutes vs. 51 minutes, $p<0.01$). There was no statistically significant difference in the primary admission diagnosis in patients who died compared to those who survived to hospital discharge.

The most common reason for MET activation in patients who died was concerns over breathing (hypoxemia). This was significantly higher compared to patients who survived to hospital discharge. Other reasons for MET activation were not significantly different in patients who died compared to those who survived to hospital discharge. Furthermore, the MET

interventions performed in patients who died and those who survived to hospital discharge were not significantly different, with similar proportions of ward-based interventions and critical care based interventions performed. The MET predominantly performed ward-based interventions in patients with a GOC: M1 or below (Table 3.3). There were no resuscitative measures undertaken by the MET in patients with a GOC: M1 or below.

Table 3.3: Characteristics of patients with MET activation and GOC: M1 or below based on survival status.

Patient Characteristics (n(%))	Survived to Discharge	Died in Hospital	P-value
Number of patients	194	268	
Age, median years (IQR)	79 (69 – 86)	77 (66 – 85)	0.32
Sex, male	85 (44)	157 (59)	<0.001
Admission Source Medical Surgical	 82 (60) 54 (40)	 199 (70) 85 (30)	<0.01
CCI Score, mean (SD)	5.1 (4.2)	7.6 (6.4)	<0.001
Duration of MET, Median minutes (IQR)	51 (35-79)	56 (37-84)	<0.01
MET Interventions Ward based (%) Critical Care based	 94 6	 97 3	0.24

Table 3.4: Survival Status in patients with a GOC: M1 or below following MET activation stratified by gender.

Sex	Survived to Discharge (n, %)	Died in-hospital (n, %)
Male	85 (44)	157 (59)
Female	109 (56)	110 (41)
Total	194	268

Analysis of hospital length of stay was performed in patients with a MET activation and GOC: M1 or less who died in-hospital compared to those who survived to hospital discharge. We found significant differences in overall hospital length of stay, length of stay from index or last MET activation to hospital discharge or death, and days from admission to first MET activation, in patients who died compared to those who survived. Patients who died in hospital had a significantly shorter overall hospital length of stay (Table 3.5). Furthermore, patients who died in-hospital following MET activation died within one day of their index or last MET activation (Table 3.5). In contrast, patients who survived to hospital discharge were discharged 14 days after their index or last MET activation. Lastly, patients who survived to hospital discharge had a significantly shorter time from admission date to first MET activation (Table 3.5).

Table 3.5: Hospital length of stay overall, after index or last MET activation, and prior to MET activation in patients with a GOC: M1 or below stratified by survival status.

Median (IQR) Length of Stay (Days)	Survived to Discharge (n=204)	Died in-hospital (n=284)	P-Value
Hospital	24 (12 – 48)	13 (5 – 35)	<0.001
After index or last MET	14 (7 – 32)	1 (0-6)	<0.001
Prior to MET	5 (2 – 16)	8 (2-27)	<0.007

A total of 11 patients with a GOC: M1 or below were admitted to the ICU after their MET activation. Six (55%) of these patients died, with 3 (27%) dying in the ICU. There were no significant differences in patients characteristics in patients with a GOC: M1 or below admitted to the ICU compared to those who remained on the ward.

A total of 389 patients in the GOC: M1 or below cohort had a single MET activation, while 72 patients had greater than one MET activation. This totaled 563 MET activations in 461 patients. I found no significant differences in the clinical and demographic characteristics of patients with a single MET activation compared to those with greater than one MET activation. However, hospital length of stay in patients with more than one MET activation during their index hospitalization was significantly longer compared to those with a single MET activation (median days, IQR) (28 (12-52) vs. 17 (7-36), $p<0.001$). Furthermore, patients with greater than one MET activation had a significantly higher in-hospital mortality rate compared to patients with a single MET activation (69% vs. 55%, $p<0.03$).

Limitations of the Study

The study performed was retrospective in nature. We did not have controls of patients who had a GOC: M1 or below, and no MET activation to better study the association between this GOC status and mortality. The study was also descriptive. There was no analysis performed involving regression of potential confounders of mortality. Furthermore, the study was conducted at a large quaternary care center, and therefore the results of this study may not be generalizable to other centers. Lastly, data were not collected specifically for the purposes of the study and was extracted from administrative databases. Therefore, we were not able to validate the accuracy of the data and control for several potential biases and errors which may have been introduced.

Discussion

In this retrospective study of patients with a GOC: M1 or below attended to by the MET, approximately 3/5 patients died in hospital. In comparison to patients who survived to hospital discharge, patients who died in hospital were more likely to be male, be admitted to a medical service, have a greater burden of comorbidities, and a longer duration of MET activation. Furthermore, the MET was more often activated for concerns regarding a patient's breathing (hypoxemia) in patients who ultimately died compared to those who survived to hospital discharge. These patients also had a shorter overall hospital length of stay, a shorter time to death following index or last MET activation, and a longer time from admission to index MET. We also found that the MET performed predominantly ward based interventions in patients with a GOC: M1 or below. A small proportion of these patients were admitted to ICU, with half of those admitted to ICU ultimately dying in the ICU. Lastly, patients with more than one MET activation had a significantly longer hospital length of stay and a higher in-hospital mortality rate compared to those with a single MET activation.

These findings suggest that patients with a GOC: M1 or below, that experience a MET activation, are frequently near the end of life at the time of MET attendance. The most striking observation was that in patients who died, their death was within one day of their index or last MET activation. This suggests that the MET may be directly involved in the end of life care of patients with a GOC: M1 or below, and that these patients may already be in the process of dying at the time of MET attendance. Another important finding of the study, is that LOMT do not preclude patients from having more than one MET activation. This suggests that the staff on general hospital wards requires support in the management of patients at the end of life who are NFR and NFICU.

Previous studies have confirmed a significant number of MET activations to patients with LOMT and EOLC issues [1,4]. We have demonstrated that these patients have a high in-hospital mortality rate. The study identifies a number of key factors which could help ward staff and METs in the treatment and management of patients with LOMT (GOC: M1 or below). A recent study in Australia examining MET intervention in patients at the end of life suggested a profile of those who have a high probability of death be developed [8]. We believe further research should be devoted to developing such a clinical profile of patients who are likely to die. Our findings identify patients with LOMT (GOC: M1 or below) as having a high in-hospital mortality rate and dying shortly after their index or last MET activation (within 24 hours). A patient designated as NFR and not for ICU admission, as described by their GOC designation, should be the first sign of a poor prognosis often resulting in death for both ward staff, and the MET. By virtue of their GOC designation and LOMT, these patients have been deemed not likely to benefit from aggressive therapy or such therapy is thought not to be appropriate. Therefore, deployment of the MET, a resource-intensive, critical care based resource may not be an optimal utilization of limited hospital resources. Although several studies have shown an increased quality of death and reduced patient distress levels at the end of life following MET activation, these studies do not take into account the downstream effect of diverting MET time and resources away from patients more likely to benefit from MET intervention. Furthermore, the MET typically has a short period of time to become acquainted with a patient, their family, and coordinate with the ward staff managing the patients care. Although the MET has a high level of expertise in acute care and end of life care, utilization of the MET at the end of life in these patients may not provide the most optimal quality of patient care, as discussions surrounding end of life care may happen in a condensed time period after a patient has already begun deteriorating. It is plausible that the reduction in patient, family,

and ward staff distress reported in several studies after MET intervention, is due to the MET responding at a time when the patient's vitals status has already deteriorated significantly, and the ward staff requires support in the acute management of the patients EOLC. Earlier involvement of the ward staff and family in proactive end of life care measures may prove far more beneficial to patient quality of care and death. This may also improve ward staff satisfaction, as well as patient and family satisfaction.

These findings, along with those from other investigations, identify a mismatch in the care available to patients near the end of life on the ward, and the care required by these patients. The findings of the study also support a revisitation of the MET policy surrounding patients with LOMT such as NFR and not for ICU orders. Changes in policy regarding the MET response to patients with LOMT may involve changing the composition of the MET, implementation, and consultation with palliative care services, changing the MET activation criteria to these patients, and implementing educational programs for ward staff regarding end of life care and management. Furthermore, the development of a clinical and demographic profile of patients who are likely near the end of life may assist clinicians and ward staff in the management of these patients.

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Chapter Four: Conclusion

Healthcare systems revolve around patient care. Many recent initiatives in modern medicine, such as the MET system, are aimed at providing safer and higher quality patient care. With the goal of continual advancement, research is always needed to inform healthcare policy and practice. The studies presented in this thesis examine a relatively new and not extensively documented area of research. Modern hospital systems are rapidly changing due to the constantly evolving nature of patients, medicine, and technology. Healthcare policy and delivery should also continuously advance and be adapted to accommodate such changes.

Studying patients who may be near the end of life is important because the MET system is a resource-intensive and costly intervention. Therefore, it is important to understand and investigate the role of the MET in the management of patients who may not significantly benefit from MET intervention.

The overall aim of the thesis was to report the incidence of MET activations, and in-hospital mortality amongst other outcomes in patients with LOMT (GOC: M1 or below). Furthermore, the thesis set out to examine the clinical and demographic characteristics of patients with a GOC: M1 or below.

In the first study, we compared characteristics and outcomes in patients with LOMT (GOC: M1 or below) to those with no LOMT (GOC: R1). We found that patients with a GOC: M1 or below at the time of MET activation represented approximately 1/5 total MET activations. These patients had several characteristics which differed significantly from patients with a GOC: R1. Importantly, these patients were older, more likely to be female, had a greater burden of comorbidities, were more likely to be admitted to a medical service, and more likely to be admitted

with a primary admission diagnosis relating to the respiratory or cardiovascular system. These patients also had a longer duration of MET activation, and a high proportion of MET activations occurred out of hours. After MET activation, patients with a GOC: M1 or below were more likely to remain on the ward, as opposed to 1/3 patients with a GOC: R1 being admitted to the ICU. This finding may suggest that the MET was beneficial to patients by escalating the care of patients with a GOC: R1 in an effort to reduce avoidable morbidity and mortality. The in-hospital mortality rate was significantly higher in patients with a GOC: M1 or below. A multivariate logistic regression model of the independent association between in-hospital mortality and GOC designation found the odds of in-hospital mortality to be four-times higher in patients with a GOC: M1 or below.

Study two of the thesis aimed to take a closer look at patients with a GOC: M1 or below in order to understand this cohort better and identify characteristics associated with death following MET activation. The study found that in patients with a MET activation and GOC: M1 or below, those who died compared to those who survived were more likely to be male, had a greater burden of comorbidities, and were more likely to have been admitted to a medical service. In those patients who died, the MET was frequently activated for concerns over breathing. In-hospital mortality was significant in the cohort of patients with a GOC: M1 or below. Lastly, patients who died following MET activation died within one day of their MET activation and had a shorter overall hospital length of stay.

In conclusion, I believe these studies support change surrounding policy of the MET in patients with a GOC: M1 or below. These studies, along with other recent studies in the literature, identify factors associated with a high chance of in-hospital mortality in patients attended by the MET. These include LOMT (GOC: M1 or below), older age, male gender, greater comorbidities, primary admission diagnosis involving respiratory or cardiovascular system, admission to medical

service, and activation of the MET for concerns over a patient's breathing. This may help build a patient profile which can assist clinicians in recognizing which patients are near the end of life before, during, or after MET activation. Furthermore, the data may support the deployment of palliative care services to patients with a GOC: M1 or below who trigger MET activation criteria. Lastly, if the MET is to continue to respond to patients with LOMT who are frequently near the end of life, it is important to devote future research to identify the ideal composition of the MET responding to such patients, in an effort to optimize resource utilization within hospitals. Health care policy, as always, should remain dynamic and based on the latest evidence, with the aim of balancing limited hospital resources while delivering the highest quality of patient care.

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Appendix 1: MET Activation Criteria

Appendix 1: Current standardized MET activation criteria

Airway Threatened – Stridor, excessive secretions.
Breathing - Acute change in RR <8 or >30
- Acute change in SpO2 <90 on O2 >50% or 8L/min
Circulation - Acute change in heart rate <40 or >140
- Acute change in SBP <90mmHg, >200mmHg
LOC - Acute change in level of consciousness
Worried

Appendix 2: Advance Care Planning and Goals of Care

Goals of Care Designations – Guide for Clinicians

R: Medical Care and Interventions, Including Resuscitation if required followed by Intensive Care Unit admission.

Focus of Care and interventions are for cure or control of the Patient's condition. The Patient would desire and is expected to benefit from attempted resuscitation and ICU care if required.

R1: Patient is expected to benefit from and is accepting of any appropriate investigations/interventions that can be offered including attempted resuscitation and ICU care.

- **Resuscitation:** is undertaken for acute deterioration, and may include intubation and chest compression
- **Life Support Interventions:** are usually undertaken
- **Life Sustaining Measures:** are used when appropriate
- **Major Surgery:** is considered when appropriate.
- **Transfer:** is considered for diagnosis and treatment, if required

R2: Patient is expected to benefit from and is accepting of any appropriate investigations/interventions that can be offered including attempted resuscitation, intubation and ICU care, but excluding chest compression

- **Resuscitation:** is undertaken for acute deterioration, but chest compression should not be performed
- **Life Support Interventions:** may be offered **without** chest compression
- **Life Sustaining Measures:** are used when appropriate
- **Major Surgery:** is considered when appropriate
- **Transfer:** is considered for diagnosis and treatment, if required

R3: Patient is expected to benefit from and is accepting of any appropriate investigations/interventions that can be offered including attempted resuscitation and ICU care, but excluding intubation and chest compression

- **Resuscitation:** is undertaken for acute deterioration but intubation and chest compression should not be performed
- **Life Support Interventions:** may be offered **without** Intubation and **without** chest compression
- **Life Sustaining Measures:** are used when appropriate
- **Major Surgery:** is considered when appropriate
- **Transfer:** is considered for diagnosis and treatment, if required

M: Medical Care and Interventions, Excluding Resuscitation.

Focus of Care and interventions are for cure or control of the Patient's condition. The Patient either chooses to not receive or would not be expected to benefit from attempted resuscitation followed by life-sustaining care in an ICU. In Pediatrics, ICU can be considered if that location is deemed the best location for delivery of specific short-term symptom-directed care.

M1: All clinically appropriate medical and surgical interventions directed at cure and control of condition(s) are considered, excluding the option of attempted life-saving resuscitation followed by ICU care. See above, regarding Pediatrics and ICU.

- **Resuscitation:** is **not** undertaken for cardio respiratory arrest.
- **Life Support Interventions:** should **not** be initiated, or should be discontinued after discussion with the Patient.
- **Life Sustaining Measures:** are used when appropriate.
- **Transfer:** to another location of care is considered if that location provides more appropriate circumstances for diagnosis and treatment
- **Major Surgery:** is considered when appropriate. Resuscitation during surgery or in the recovery room can be considered, including short term physiologic and mechanical support in an ICU, in order to return the Patient to prior level of function. The possibility of intra-operative death or life-threatening deterioration should be discussed with the Patient in advance of the proposed surgery and general decision-making guidance agreed upon and documented.

M2: All clinically appropriate interventions that can be offered in the current non-hospital location of care are considered. If a patient does not respond to available treatments in this location of care, discussion should ensue to change the focus to comfort care. Life-saving resuscitation is not undertaken except in unusual circumstances (see below in Major Surgery). See above, regarding Pediatrics and ICU.

- **Resuscitation:** is **not** undertaken for cardio respiratory arrest.
- **Life Support Interventions:** should **not** be initiated, or should be discontinued after discussion with the Patient.
- **Life Sustaining Measures: are** used when appropriate.
- **Transfer:** is not usually undertaken, but can be contemplated if symptom management or diagnostic efforts aimed at understanding symptoms can be best undertaken at that other location.
- **Major Surgery:** can be considered, in order to prevent suffering from an unexpected trauma or illness. Resuscitation during surgery or in the recovery room can be considered, including short term physiologic and mechanical support in an ICU, in order to return the Patient to prior level of function. The possibility of intra-operative death or life-threatening deterioration should be discussed with the Patient in advance of the proposed surgery and general decision-making guidance agreed upon and noted as special circumstances on the GCD Order Form and Tracking Record.

C: Medical Care and Interventions, Focused on Comfort.

Focus of Care and interventions are for the active palliative treatment of the Patient who has a terminal illness, and support for those close to them. This includes medical care for symptom control and psychosocial and spiritual support in advance of death. Care can be provided in any location best suited for these aims, including an ICU, a Hospice or any location that is the most appropriate for symptom-based care for this particular Patient.

C1: All care is directed at maximal symptom control and maintenance of function without cure or control of an underlying condition that is expected to cause eventual death. Treatment of intercurrent illnesses can be contemplated only after careful discussion with the Patient about specific short-term goals.

- **Resuscitation:** is not undertaken.
- **Life Support Interventions:** should **not** be initiated, or should be discontinued after discussion with the Patient.
- **Life Sustaining Measures: are** used only for goal directed symptom management.
- **Major Surgery:** is not usually undertaken, but can be contemplated for procedures aimed at symptom relief. Resuscitation during surgery or in the recovery room can be considered, including short term physiologic and mechanical support in an ICU, in order to return the Patient to prior level of function, but this would be a rare circumstance. The possibility of intra-operative death or life-threatening deterioration should be discussed with the Patient in advance of the proposed surgery and general decision-making guidance agreed upon and documented.
- **Transfer:** to any appropriate location of care can be considered at any time, to better understand or control symptoms.

C2: All care is directed at preparation for imminent death [usually within hours or days] with maximal efforts directed at symptom control.

- **Resuscitation:** is not undertaken.
- **Life Support Interventions:** should not be initiated, or should be discontinued after discussion with the Patient.
- **Life Sustaining Measures:** should be discontinued unless required for symptom management.
- **Major Surgery:** is not appropriate.
- **Transfer:** is usually not undertaken but may be considered if required.

Note that specific interventions can be acceptable acts within multiple Goals of Care Designations. It is the goal or intention of the intervention that determines consistency with a Designation.

Life Support Interventions mean interventions typically undertaken in the Intensive Care Unit but which occasionally are performed in other locations in an attempt to restore normal physiology. These may include chest compressions, mechanical ventilation, defibrillation, other resuscitative measures, and physiological support.

Life Sustaining Measures mean therapies that sustain life without supporting unstable physiology. Such therapies can be used in multiple clinical circumstances. When viewed as life sustaining measures, they are offered in either a) the late stages of an illness in order to provide comfort or prolong life, or b) to maintain certain bodily functions during the treatment of intercurrent illnesses. Examples include enteral tube feeding and parenteral hydration.

Resuscitation means the initial effort undertaken to reverse and stabilize an acute deterioration in a Patient's vital signs. This may include chest compressions for pulselessness, mechanical ventilation, defibrillation, cardioversion, pacing, and intensive medications. Patients who have opted to not have chest compressions and/or mechanical ventilation may still be considered for other resuscitative measures (see Designation R3).

In the above descriptions, when indicating "discussions with the Patient", it is to be assumed that this means a capable Patient, a Mature Minor, or a designated Alternate Decision Maker (ADM). If a patient is incapable and there is no designated ADM, appropriate people within the patient's close circle can be consulted.