

BMJ Open Observational cohort study of the triggers, diagnoses and outcomes of the medical emergency team (MET) response in adult psychiatry inpatients colocated with acute medical services in Australia

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ABSTRACT

Objectives Medical emergencies in psychiatric inpatients are challenging due to the model of care and limited medical resources. The study aims were to determine the triggers and outcomes of a medical emergency team (MET) call in psychiatric wards, and the risk factors for MET activation and mortality.

Design Retrospective multisite cohort study.

Setting Psychiatry units colocated with acute medical services at three major metropolitan hospitals in Melbourne, Australia.

Participants We studied 487 adult inpatients who experienced a total of 721 MET calls between January 2015 and January 2020. Patients were relatively young (mean age, 45 years) and had few medical comorbidities, but a high prevalence of smoking, excessive alcohol intake and illicit drug use.

Outcome measures We performed a descriptive analysis of the triggers and outcomes (transfer rates, investigations, final diagnosis) of MET calls. We used logistic regression to determine the factors associated with the primary outcome of inpatient mortality, and the secondary outcome of the need for specific medical treatment compared with simple observation.

Results The most common MET triggers were a reduced Glasgow Coma Scale, tachycardia and hypotension, and 49% of patients required transfer. The most frequent diagnosis was a drug adverse effect or toxidrome, followed by infection and dehydration. There was a strong association between a leave of absence and MET calls, tachycardia and the final diagnosis of drug adverse effects. Mortality occurred in 3% after MET calls. Several baseline and MET clinical variables were associated with mortality but a model with age (per 10 years, OR 1.61, 95% CI 1.29 to 2.01) and hypoxia (OR 3.59, 95% CI 1.43 to 9.04) independently predicted mortality.

Conclusion Vigilance is required in patients returning from day leave, and drug adverse effects remain a challenging problem in psychiatric units. Hypoxic older patients with cardiovascular comorbidity have a higher risk of death.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ To our knowledge, this is the first study to comprehensively investigate the triggers, diagnoses and outcomes after a medical emergency team (MET) call in a psychiatric inpatient setting.
- ⇒ We examined the outcomes at multiple sites and across a range of psychiatric diagnoses, which improves the generalisability of the results.
- ⇒ Due to the retrospective study design, missing data resulted in exclusion of 11% of MET calls identified from the central incident reporting system, which may have introduced bias into the analysis.
- ⇒ The small number of deaths limited our ability to include more variables in the multivariable logistic regression model for mortality.
- ⇒ Some of our findings may be less relevant in psychiatric units which do not allow short-term or day leave for voluntarily admitted patients.

INTRODUCTION

In most hospitals in Australia and New Zealand, a rapid response team, better known as the medical emergency team (MET), is called to attend deteriorating patients with the aim of preventing cardiorespiratory arrest or death. The MET call can be triggered by worsening vital signs or clinical concern. The MET call provides a formal systematic process of medical evaluation and critical care expertise for the stabilisation and management of deteriorating patients, and may improve mortality in acute hospitals.¹

An increasing number of patients admitted under psychiatric services have medical comorbidities.² Conditions such as cardiovascular disease, infection and diabetes may cause instability and increased mortality during psychiatric admission.^{3 4}

Many toxicological issues may destabilise the vital signs or present as a diagnostic dilemma. Psychotropic medications may cause autonomic dysfunction, resulting in tachycardia and haemodynamic instability, which may be usually self-limiting.⁵ However, some toxidromes may be related to overdose or drug interaction, either from self-harm or illicit drug use.^{6,7} Thus, medical emergencies commonly occur in psychiatric wards and the psychiatry team may not have the resources to manage these problems. In stand-alone psychiatric hospitals, such patients are often transferred off-site for further management.⁸

In psychiatric units colocated with acute medical services, patients have access to the MET system. Although there are potential benefits of having medical and psychiatric expertise colocated,⁹ there are no studies of the epidemiology and clinical outcomes in psychiatric inpatients following a MET response. To detect potential areas of clinical risk and improve safety, we sought to examine patients in psychiatric wards who had a MET response. We aimed to determine the reasons for MET calls, transfer rates to acute medical wards, final diagnosis after assessment and clinical outcomes including the risk factors for in-hospital mortality.

METHODS

Study design and setting

We conducted a retrospective cohort study of patients admitted to psychiatric services within Monash Health from January 2015 to January 2020. Monash Health is a large hospital network located in the south-eastern region of Melbourne, in the state of Victoria, Australia. We are the largest hospital network in the state and service around one-quarter of the population of Melbourne across all sites. This study included three hospitals in the network which have inpatient psychiatric services colocated with acute medical services and an on-site 24-hour MET system. There is a total of 188 adult inpatient psychiatry beds at the three hospitals. They include 112 beds for general psychiatry, 50 beds for the secured extended care unit (SECU) which provides medium to long-term inpatient treatment for patients with severe or unremitting symptoms, 20 beds for aged psychiatry (65 years and over) and 6 beds for mother-baby unit.

Criteria for MET activation

Our health network guidelines mandate the activation of a MET call for specific clinical criteria, which include: (1) respiratory distress, (2) concern of the airway, (3) respiratory rate >30 /min or <6 /min, (4) oxygen saturation $<90\%$, (5) systolic blood pressure <90 mm Hg, (6) heart rate >130 /min or <30 /min, or (7) a sudden decrease in conscious state. MET trigger zones based on vital signs are colour coded in the observation charts as a visual cue. The protocol also allows for MET activation based on trends or a broader criterion of *clinical concern* even if vital signs are not within these trigger zones. A code blue is called if the patient is unconscious, not breathing

or has no palpable pulse. During the time frame of the study, there were around 26 000 MET calls and code blues at the three hospitals.

Participants

All adult patients ≥ 18 years admitted to a psychiatric ward who had a MET call or code blue during the study time frame were eligible. MET calls were identified from a centralised electronic incident reporting system (RiskMan), which also captures information on the trigger and overview of the patient assessment at the MET response. Clinical data were obtained from electronic medical records. Patients were excluded if there was inadequate or missing documentation of the MET response, or duplicated entries. Patients of other units and outpatients incorrectly identified as a psychiatric inpatient were also excluded.

Patient and public involvement

Neither patients nor the public were involved in the study design, conduct, analysis, interpretation and dissemination of the study results.

Main outcomes and independent variables

In the descriptive analysis, we examined the common triggers for MET calls, rates of transfer, distribution of receiving medical units, length of stay and the final diagnosis after clinical assessment. We followed the patients from the MET call to discharge or death, and determined the final diagnosis ascertained by the treating medical team. In the quantitative analysis, we examined the primary outcome of inpatient mortality and the secondary outcomes of the need for specific treatment (compared with simple observation or monitoring). We considered several baseline independent variables including age, sex, body mass index categories (ideal, underweight or obese), psychotropic medications, illicit drug use and the comorbidities of diabetes, coronary artery disease, heart failure, chronic kidney disease (CKD) with an estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m², cirrhosis, chronic lung disease (asthma, chronic obstructive pulmonary disease, interstitial lung disease), stroke and epilepsy. We also examined the recorded MET observations (vital signs, temperature and oxygen saturation) for an association with mortality.

Statistics

For normally distributed continuous data, we report the mean and SD. For data with a skewed distribution, we report the median and IQR. We used a χ^2 analysis or Fisher's exact test to test the association between categorical variables. Logistic regression was used to analyse the primary outcome of mortality and the secondary outcome of the need for specific treatment. To account for recurrent MET calls in individual patients, we used a mixed effects logistic regression model by treating individual patients as clusters. We performed a limited multivariable analysis for mortality due to the low mortality rate. From the univariable analysis, we selected two variables

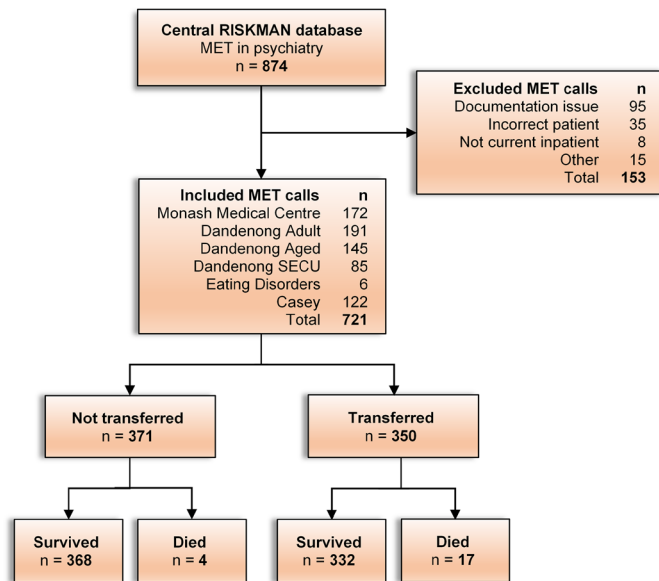


Figure 1 Study flow diagram showing patient selection, exclusions and distribution across the study sites. MET, medical emergency team; RiskMan, centralised electronic incident reporting system; SECU, secured extended care unit.

which were statistically significant, showed a strong association with mortality and demonstrated the best precision (narrowest CI). In the final model, we tested the significance of the random effects with a likelihood ratio test. If the intraclass correlation (r) was not significantly different from zero, we fit an ordinary logistic regression model and use Akaike and Bayesian information criteria to compare models. To assess discrimination, we examined the area under the receiver operating characteristic curve and the scatterplot of outcome versus predicted. To assess model calibration, we used the Hosmer-Lemeshow test. All analyses were performed with STATA V.16.1. (StataCorp, Texas, USA). A $p < 0.05$ was considered statistically significant.

RESULTS

Patient characteristics

We included 487 patients who experienced a total of 721 MET calls during the study period. The search strategy, along with the number of eligible and excluded patients, is shown in [figure 1](#). The baseline characteristics of the included patients are summarised in [table 1](#). Overall, the patients were relatively young and had few comorbidities. The comorbidities with a greater than 10% prevalence included obesity, diabetes and chronic lung disease. In terms of cardiovascular drugs, there was a greater than 10% prevalent use of antiplatelets, beta blockers and renin-angiotensin system inhibitors. On the other hand, there was a high prevalence of smoking, excessive alcohol intake and illicit drug use.

Inpatient psychiatric care

The inpatient population comprised acute admissions and long-term residents. The length of stay ranged from 2 days to over 1 year. Categorically, 8.6% of admissions were 7 days or less, 36.5% were 8–30 days, 34.3% were 1–3 months and 20.6% were longer than 3 months. Long-stay patients were predominantly in aged psychiatry and SECU.

The principle psychiatric diagnosis was schizophrenia or other psychotic disorders (39.2%), anxiety-depressive disorder (20.3%), bipolar affective disorder (9.2%), behavioural and psychological symptoms of dementia (8.8%), psychoactive substance abuse (6.2%), stress and adjustment disorder (3.5%), alcohol and drug detoxification (1.4%) and miscellaneous (11.3%). The main psychotropic medications used were atypical (second-generation) antipsychotics (69.4%), benzodiazepines (61.8%) and selective serotonin or norepinephrine reuptake inhibitors (33.5%). The demographics and comorbidities of the inpatients by site and unit are detailed in online supplemental table 1. Compared with other units, aged psychiatry had older patients, and had a higher proportion of patients with diabetes, cardiovascular disease and CKD.

In the context of MET calls, 7.1% (51/721) of patients had returned from a leave of absence on the same day, while another 4.7% (34/721) had returned from leave the day before. There were 3.6% (26/721) of patients who had electroconvulsive treatment within 24 hours, and 14/721 (1.9%) between 24 and 72 hours of the MET call. A medical unit consult team was actively reviewing 77/721 (10.7%) of the patients prior to the MET call, with 40/77 occurring within 24 hours of the MET call, 18/77 between 24 and 48 hours and 19/77 were last reviewed greater than 48 hours prior.

MET triggers and observations

The top triggers for a MET call were a drop in Glasgow Coma Scale (GCS) or altered mental status, tachycardia and hypotension ([table 2](#)). On MET assessment, tachycardia and hypotension were the most common findings, affecting one in five patients. The top three investigations were an ECG, chest X-ray and cardiac troponin ([table 2](#)). Almost half of ECGs were considered abnormal. The abnormalities on ECG were sinus tachycardia (59.7%), prolonged QTc interval (10.2%), atrial fibrillation with rapid ventricular rate (7.8%), sinus bradycardia (8.3%), supraventricular tachycardia (4.9%), conduction abnormalities (4.4%), T-wave inversion (3.4%) and others (1.0%).

Transfers to acute medical service

Of the 721 MET calls, 48.5% (350/721) required a transfer to an acute hospital ward. General medicine received 248/350 (70.9%) of these transfers, while 59/350 (16.9%) were admitted to the intensive care unit (ICU) or high-dependency unit, and the remainder were received by cardiology (17/350, 4.9%), surgical

Table 1 Baseline characteristics of psychiatric inpatients experiencing MET calls

| Characteristic | All n=487 | Survived n=466 | Died n=21 |
|---|--------------|-------------------|--------------|
| Age, mean (SD), years | 44.8 (19.3) | 44.1 (18.9) | 67.1 (21.4) |
| Male, n (%) | 248 (50.9) | 237 (48.7) | 11 (52.3) |
| BMI category, n (%) | | | |
| Underweight, <18 kg/m ² | 23 (4.7) | 22 (4.7) | 1 (4.8) |
| Ideal, 18–30 kg/m ² | 391 (80.3) | 374 (80.3) | 17 (81.0) |
| Obese, >30 kg/m ² | 73 (15.0) | 70 (15.0) | 3 (14.3) |
| Diabetes, n (%) | | | |
| No | 402 (82.5) | 386 (82.8) | 16 (76.2) |
| Type 1 | 11 (2.3) | 10 (2.1) | 1 (4.8) |
| Type 2 | 74 (15.2) | 70 (14.9) | 4 (19.0) |
| Coronary artery disease, n (%) | 41 (8.4) | 39 (8.4) | 2 (9.5) |
| Heart failure, n (%) | 20 (4.1) | 17 (3.6) | 3 (14.3) |
| Stroke, n (%) | 25 (5.1) | 22 (4.7) | 3 (14.3) |
| Cardiovascular disease, n (%)* | 69 (14.2) | 64 (13.7) | 5 (23.8) |
| Cardiac pacemaker or ICD, n (%) | 10 (2.1) | 8 (1.7) | 2 (8.5) |
| Chronic lung disease, n (%) | 66 (13.6) | 62 (13.3) | 4 (19.0) |
| Cirrhosis, n (%) | 16 (3.3) | 15 (3.2) | 1 (4.8) |
| eGFR <60 mL/min/1.73 m ² , n (%) | 25 (5.1) | 22 (4.7) | 3 (14.3) |
| Epilepsy, n (%) | 34 (7.0) | 34 (7.3) | 0 (0) |
| Smoking, n (%) | 232 (47.6) | 224 (48.1) | 8 (38.1) |
| Excessive alcohol, n (%) | 121 (24.6) | 116 (24.9) | 4 (19.0) |
| Illicit drug use, n (%) | 211 (43.3) | 206 (44.2) | 5 (23.8) |
| Medications, n (%) | | | |
| Antiplatelets | 61 (12.5) | 57 (12.2) | 5 (23.8) |
| Anticoagulation | 32 (6.6) | 27 (5.8) | 5 (23.8) |
| Antianginals | 7 (1.4) | 7 (1.5) | 0 (0) |
| Beta blockers | 73 (15.0) | 67 (14.4) | 6 (28.6) |
| RAS inhibitor | 60 (12.3) | 59 (12.7) | 1 (4.8) |
| Calcium channel blocker | 20 (4.1) | 20 (4.3) | 0 (0) |
| Diuretics | 28 (5.7) | 24 (5.2) | 4 (19.0) |
| Oral hypoglycaemic | 58 (11.9) | 56 (12.6) | 2 (9.5) |
| Insulin | 34 (7.0) | 31 (6.7) | 3 (14.3) |
| Inhaled bronchodilators | 59 (12.1) | 56 (12.0) | 3 (14.3) |
| Opioids | 82 (16.8) | 77 (16.5) | 5 (23.8) |
| Psychotropics, n (%) | | | |
| First-generation (typical) antipsychotic | 38 (7.8) | 38 (8.2) | 0 (0) |
| Second-generation (atypical) antipsychotic | 338 (69.4) | 320 (68.7) | 18 (85.7) |
| Clozapine | 17 (3.5) | 15 (3.2) | 2 (9.5) |
| SSRI or SNRI | 163 (33.5) | 158 (3.4) | 5 (2.4) |
| Tricyclic antidepressants | 30 (6.2) | 30 (6.7) | 0 (0) |
| Tricyclics and SSRI or SNRI | 20 (4.1) | 20 (4.3) | 0 (0) |
| Lithium | 23 (4.7) | 23 (4.9) | 0 (0) |
| Sodium valproate | 95 (19.5) | 88 (18.9) | 7 (33.3) |
| Other | 26 (5.3) | 25 (5.4) | 1 (4.8) |

Continued

Table 1 Continued

| Characteristic | All n=487 | Survived n=466 | Died n=21 |
|-----------------|--------------|-------------------|--------------|
| Benzodiazepines | 301 (61.8) | 286 (61.4) | 15 (71.4) |

*Composite of coronary artery disease, heart failure and stroke.

BMI, body mass index; eGFR, estimated glomerular filtration rate based on Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation; ICD, implantable cardioverter-defibrillator; MET, medical emergency team; RAS, renin-angiotensin system; SNRI, serotonin and norepinephrine reuptake inhibitor; SSRI, selective serotonin reuptake inhibitor.

units (9/350, 2.6%) and other specialty units (17/350, 4.9%). Patient transfers were completed under 1 hour in 116/350 (33.1%) of cases, between 1 and 4 hours in 151/350 (43.1%), between 4 and 12 hours in 67/350 (19.1%) and between 12 and 24 hours in 16/350 (4.6%).

Diagnosis

The final diagnosis for patients transferred to the acute wards is summarised in table 3. The most frequent diagnosis was drug adverse effects or toxidrome, followed by infection and dehydration. The most common drug adverse effect was oversedation, leading to a reduced GCS and type 2 respiratory failure. In most cases, sedation was due to prescribed psychotropic medications, and there was evidence that benzodiazepine use was associated with the MET trigger of altered GCS or mental status ($\chi^2=5.46$, $p=0.019$). However, there was little or no evidence that benzodiazepine use by itself was associated with an abnormal respiratory rate ($\chi^2=5.04$, $p=0.08$), transfers to acute medical services ($\chi^2=1.15$, $p=0.29$), ICU admission ($\chi^2=0.01$, $p=0.94$) or increased mortality ($\chi^2=0.86$, $p=0.35$). Several cases categorised as drug adverse effects were due to illicit drug overdose, such as from amphetamines and heroin (table 3). Some were intentional overdoses from self-harm. The common toxidromes associated with prescribed psychotropic medications were serotonin syndrome, anticholinergic syndrome and neuroleptic malignant syndrome. The most common causes of infection were hospital-acquired pneumonia, urinary tract infection and cellulitis.

Need for specific treatment

In terms of treatment, 47% of the transferred patients only needed clinical observation or medication adjustment. Another 45% needed intravenous fluid or antibiotics. Less than 8% required ventilatory or haemodynamic support (table 3). Among the MET observations, the odds of needing intravenous treatment or ventilatory support (compared with observation or medication adjustment only) were higher in patients with tachycardia (OR 1.65, 95% CI 1.05 to 2.58, $p=0.03$) and hypotension (OR 2.60, 95% CI 1.52 to 4.46, $p=0.001$). In contrast, the odds of needing intravenous intervention or ventilatory support were lower in patients who had altered GCS (OR 0.42, 95% CI 0.29 to 0.60, $p<0.001$). There was very strong evidence that a MET call for altered GCS was associated with a final diagnosis of drug adverse effects, when

compared with other MET call triggers (64.4% vs 35.6%, $\chi^2=50.7$, $p<0.001$). Drug adverse effects were often self-limited and often only required monitoring.

Mortality

The mortality following MET calls was 2.9% (21/721). Four patients did not survive the initial resuscitation efforts and did not contribute to the data on transfer time or length of stay. The causes of death were: infection related (urosepsis 1, pneumonia 4, cellulitis 1, unclear source 1), self-harm (hanging 2, overdose 1), respiratory arrest (asphyxiation 1, exacerbation of COPD 1, asthma 1), cardiac arrest (asystole 1, ventricular fibrillation 2, acute myocardial infarct 1), metabolic (hypoglycaemia 1, hepatic encephalopathy 1), stroke (1) and functional decline related to dementia (1). There were some baseline differences between patients who survived and patient who died (table 1). On average, patients who died were 23 years older than those who survived, and had a higher prevalence of heart failure, stroke and CKD. There were differences in medication use which matched the profile of comorbidities, including greater use of cardiovascular medications in patients who died. Most patients who died came from the aged psychiatry ward (57%).

Factors associated with mortality

The results of logistic regression are shown in table 4. In the univariable analysis, the baseline variables associated with mortality were age, eGFR <60 mL/min/1.73 m² and a history of stroke or heart failure, and treatment location in aged psychiatry. The MET observations associated with mortality were a heart rate <30 /min, respiratory rate <6 /min, blood pressure <90 mm Hg, oxygen desaturation $<90\%$ and temperature (above 38°C or below 35°C). In the multivariable analysis, CKD, heart failure, stroke and treatment in aged psychiatry were not independent of age in predicting death. Blood pressure and temperature were also not significant after allowing for age and oxygen saturation. Oxygen saturation showed more precision (narrower CI) than respiratory rate or heart rate in the model. Furthermore, a heart rate <30 /min was rare (1.1% of MET calls) which makes it less useful in a prediction model. For parsimony and to avoid overfitting (due to few deaths), we included just age and hypoxia in the final model. In the final model, the likelihood ratio test for the random effects was not significant ($p=0.50$) and the intracluster correlation was minuscule ($\rho=0.002$).

Table 2 Medical emergency team triggers, observations and investigations (n=721)

| MET trigger | n (%) |
|---------------------------------|---------------------|
| Altered GCS or mental status | 225 (31.2) |
| Tachycardia | 140 (19.4) |
| Hypotension | 114 (15.8) |
| Hypoxia or respiratory distress | 57 (7.9) |
| Clinical concern* | 56 (7.8) |
| Seizure or seizure-like | 52 (7.2) |
| Hypoglycaemia | 23 (3.2) |
| Chest pain | 22 (3.1) |
| Behavioural and self-harm | 21 (2.9) |
| Bradycardia | 11 (1.5) |
| MET observations | n (%) |
| Systolic BP (mm Hg) | |
| <90 | 144 (20.0) |
| >180 | 18 (2.5) |
| Heart rate | |
| >130/min | 167 (23.2) |
| <30/min | 8 (1.1) |
| Respiratory rate | |
| >30/min | 22 (3.1) |
| <6/min | 11 (1.5) |
| Oxygen saturation <90% | 74 (10.3) |
| Temperature | |
| >38°C | 49 (6.8) |
| <35°C | 4 (0.6) |
| Blood glucose <4 mmol/L | 53 (7.4) |
| Investigations | Abnormal/tested (%) |
| ECG | 206/437 (47.1) |
| Cardiac troponin | 10/196 (5.1) |
| Chest X-ray | 40/203 (19.7) |
| Cerebral CT scan | 26/128 (4.9) |
| Urine microscopy and culture | 26/107 (24.3) |
| Urine drug screen | 39/75 (52.0)† |
| Blood cultures | 5/98 (5.1) |

*Includes deterioration not meeting mandatory criteria for MET call, falls and other trauma, abdominal pain, severe hypertension and serious electrolyte abnormalities.

†Possibly due to prescribed medications in 29 patients.

BP, blood pressure; GCS, Glasgow Coma Scale; MET, medical emergency team.

For the ease of interpretation, we fit an ordinary logistic regression model (table 4). The information criteria for the mixed effects model and the standard model favoured the latter. The area under the receiver operating characteristic curve was 0.83 (online supplemental figure 1) and the Hosmer-Lemeshow deciles of risk test suggested a reasonable fit ($\chi^2=8.88$, $p=0.35$).

Table 3 Diagnosis and treatment following transfer (n=350)

| Final diagnosis (in order of frequency) | n (%) |
|---|-----------|
| Drug effect or toxidrome | 87 (24.9) |
| Prescribed psychotropics (see table 1) | 67 (19.1) |
| Heroin, codeine, fentanyl | 7 (2.0) |
| Amphetamines or methamphetamines | 5 (1.4) |
| Alcohol intoxication | 3 (0.9) |
| Gamma-hydroxybutyrate | 2 (0.6) |
| Uncertain agent | 3 (0.9) |
| Infection or sepsis | 70 (20.0) |
| Dehydration or malnutrition | 58 (16.6) |
| Stroke or seizure | 39 (11.1) |
| Psychosis or behavioural | 32 (9.1) |
| Gastrointestinal or liver disease | 17 (4.9) |
| Exacerbation of asthma or COPD | 14 (4.0) |
| Arrhythmia | 12 (3.4) |
| Acute coronary syndrome | 10 (2.9) |
| DVT or pulmonary embolism | 5 (1.4) |
| Diabetic complication | 4 (1.1) |
| Severe electrolyte disorder | 2 (0.6) |
| Highest level of treatment needed* | |
| Observation only | 91 (26.0) |
| Medication adjustment† | 75 (21.4) |
| Intravenous fluids or transfusion | 94 (26.9) |
| Intravenous antibiotics | 62 (17.7) |
| Non-invasive ventilation | 6 (1.7) |
| Inotropic support | 3 (0.9) |
| Mechanical ventilation | 15 (4.3) |
| Ventilatory and inotropic support | 4 (1.1) |

*Mutually exclusive categories, even though multiple treatments may be needed. For example, a patient needing intravenous antibiotics and inotropic support is allocated the inotropic support category only.
†Includes oral antibiotics.
COPD, chronic obstructive pulmonary disease; DVT, deep vein thrombosis.;

Inpatient leave of absence

Of the 721 MET calls, 85 (11.8%) occurred in patients who returned from a leave of absence within the last 24 hours, of which 51/721 (7.1%) of MET calls occurred in patients who had returned from leave the same day. The frequencies of leave during the study period according to the main unit type were general adult psychiatry (11.1%), aged psychiatry (4.1%) and SECU (29.4%). The differences in leave between these three main groups of patients were statistically significant ($\chi^2=33.8$, $p<0.001$).

There was strong evidence of an association between a recent leave of absence and a heart rate >130/min at a MET call ($\chi^2=7.97$, $p=0.005$), with 35.3% of patients returning from leave experiencing tachycardia compared

Table 4 Logistic regression analysis of mortality

| Baseline variable | Univariable | | Multivariable* | |
|--------------------------------------|----------------------|---------|----------------------|---------|
| | OR (95% CI) | P value | OR (95% CI) | P value |
| Age, per 10 years | 1.76 (1.39 to 2.22) | <0.001 | 1.61 (1.29 to 2.01) | <0.001 |
| Female | 0.95 (0.40 to 2.24) | 0.90 | | |
| Body mass index (kg/m ²) | | | | |
| Ideal, 18 to <30 | 1.00 (reference) | | | |
| Underweight, <18 | 0.81 (0.11 to 6.22) | 0.98 | | |
| Overweight, ≥30 | 1.03 (0.30 to 3.60) | | | |
| Diabetes | 1.19 (0.43 to 3.29) | 0.74 | | |
| Coronary artery disease | 1.31 (0.30 to 5.78) | 0.72 | | |
| Heart failure | 5.14 (1.41 to 18.7) | 0.013 | 2.59 (0.64 to 10.5) | 0.18 |
| Lung disease | 1.38 (0.46 to 4.18) | 0.57 | | |
| Stroke | 3.72 (1.04 to 13.3) | 0.043 | 1.55 (0.41 to 5.90) | 0.52 |
| Epilepsy | Not estimable† | | | |
| Cirrhosis | 1.30 (0.17 to 10.0) | 0.80 | | |
| eGFR <60 mL/min/1.73 m ² | 3.86 (1.08 to 13.8) | 0.038 | 1.88 (0.47 to 7.43) | 0.37 |
| Aged psychiatry unit | 5.68 (2.35 to 13.8) | <0.001 | 0.57 (0.14 to 2.32) | 0.43 |
| MET vitals | | | | |
| Heart rate | | | | |
| 30–129/min | 1.00 (reference) | | 1.00 (reference) | |
| <30/min | 35.4 (8.07 to 155.1) | <0.001 | 53.8 (8.50 to 340.4) | 0.002 |
| ≥130/min | 0.43 (0.10 to 1.90) | | 0.88 (0.19 to 4.19) | |
| Systolic BP <90 mm Hg | 2.55 (1.04 to 6.28) | 0.041 | 1.97 (0.78 to 4.97) | 0.15 |
| Respiratory rate | | | | |
| 6–29/min | 1.00 (reference) | | 1.00 (reference) | |
| <6/min | 15.7 (3.82 to 64.9) | <0.001 | 12.9 (2.22 to 74.6) | 0.02 |
| ≥30/min | 4.20 (0.90 to 19.5) | | 2.33 (0.44 to 12.5) | |
| Oxygen saturation <90% | 5.91 (2.36 to 14.8) | <0.001 | 3.59 (1.43 to 9.04) | 0.007 |
| Temperature | | | | |
| 35.0°C–38.0°C | 1.00 (reference) | | 1.00 (reference) | |
| <35°C | 13.6 (1.34 to 137.7) | 0.011 | 3.03 (0.91 to 10.4) | 0.07 |
| >38°C | 3.62 (1.16 to 11.3) | | 7.00 (0.52 to 93.9) | |
| Altered mental status | 1.68 (0.70 to 4.05) | 0.25 | | |

*Adjusted for age and oxygen saturation.
 †No deaths in patients with epilepsy to estimate OR.
 BP, blood pressure; eGFR, estimated glomerular filtration rate; MET, medical emergency team.

with 21.5% of patients who did not have leave. There was also very strong evidence of an association between recent leave and a final diagnosis of drug adverse effects ($\chi^2=11.7$, $p=0.001$), with 87.4% of patients returning from leave receiving a diagnosis of drug adverse effects compared with 12.6% of patients who did not have leave. We also noted that a history of illicit drug use was associated with a higher proportion of patients experiencing tachycardia than patients without a history of illicit drug use (29.7% vs 18.1%, $\chi^2=13.4$, $p<0.001$). Similarly, a history of illicit drug use was associated with a higher proportion

of patients with a final diagnosis of drug adverse effects (32.2% vs 19.8%, $\chi^2=6.92$, $p=0.009$).

Recurrent MET calls

Recurrent MET calls were common, with 123 of 487 (25.3%) patients experiencing more than one MET call. Of patients with recurrent MET calls, 101/123 (82.1%) experienced two or three MET calls and 22/123 (17.9%) experienced more than three MET calls. There was evidence that recurrent MET calls occurred more often in patients with recent leave compared with patients who

did not have leave (14.3% vs 9.3%, $\chi^2=4.24$, $p=0.04$). There was no evidence that recurrent MET calls were associated with higher mortality, when comparing patients who had a single MET to patients with recurrent METs (3.9% vs 2.0% mortality, $\chi^2=2.27$, $p=0.13$). However, this analysis did not consider the time interval between MET calls.

Length of stay and discharge

Following transfer to acute medical services ($n=350$), the median length of stay in the acute setting was 3 days (IQR, 2–6 days). The distribution of the acute length of stay was highly skewed, ranging from 0 days (same-day discharge back to psychiatric unit) to 135 days. For the 58 patients who required ICU admission, 86.3% were discharged from ICU within 24 hours and the rest stayed in ICU between 2 and 32 days. Most patients (84.0%) were transferred back to the inpatient psychiatric unit for ongoing management. Several were discharged home (8.3%) or to a rehabilitation facility (2.0%).

DISCUSSION

Few studies have examined the comorbidities and cause of death in psychiatric inpatients.¹⁰ There are even fewer studies of MET calls in psychiatry. A single-centre study of 140 patients reported the triggers for MET calls as mainly due to altered conscious state and hypotension.¹¹ We additionally found that severe tachycardia was a frequent trigger, and sinus tachycardia was the most common rhythm. A prolonged QT interval was detected at 10% of MET calls where an ECG was performed, which is consistent with the 6%–8% reported in psychiatric inpatients.^{12 13} Most MET calls were due to drug adverse effects, infection and dehydration and 49% of MET calls resulted in transfer. This is a relatively high rate of transfers where only half of these patients required intravenous treatment or a higher level of intervention. Theoretically, further training and higher staffing ratios may improve the efficiency of medical management and avoid transfers. However, a transfer may facilitate the diagnostic process and provide a supported environment for close physiological monitoring including cardiac telemetry for suspected arrhythmias. More importantly, for quality improvement initiatives to have a long-term impact, we should explore a system of preventative measures, and not just rely on the MET system as the fail-safe mechanism. An integrated care or consultation-liaison model may have merit, where general medicine (internal medicine) specialists collaborate with psychiatry specialists to address the acute and chronic physical comorbidities within the psychiatric unit.⁹ As a first step, understanding the triggers, diagnoses and outcomes from MET calls has allowed us to identify potential areas for prevention and risk reduction.

In our cohort, drug adverse effects and toxidromes were the most common diagnoses, but in some patients it was difficult to determine the relative contribution of prescribed drugs versus illicit drugs to the clinical deterioration. There

was a suggestion that the relatively frequent prescribing of benzodiazepines may be contributing to MET calls associated with altered GCS. While benzodiazepines are not first-line medications for many psychiatric disorders, they are useful adjuncts for acute behaviour management and for managing withdrawal symptoms in drug-dependent patients. We did not detect an association between benzodiazepine prescribing and clinical outcomes such as transfer rates to acute medical services, ICU admission or inpatient mortality. However, further data collection and analysis should be considered to inform the risks and benefits of benzodiazepine use in psychiatric units.

The issue of illicit drug use during inpatient management is not unique to psychiatry.^{14 15} However, there is a higher prevalence of illicit drug use among psychiatric patients compared with the general population.¹⁶ The prevalence of drug and alcohol misuse in the UK was estimated at 20%–37% in mental health settings, and was even higher in inpatient and crisis team settings (38%–50%).¹⁷ Illicit drug use by patients is often known to staff.¹⁸ Most inpatients with a history of alcohol or drug misuse reported continued use of alcohol and/or illicit drugs while admitted.¹⁹

We further identified that a leave of absence was strongly associated with clinical deterioration on return, recurrent MET calls and a final diagnosis of drug adverse effects. A leave of absence may provide some patients with the opportunity to obtain and use illicit drugs.²⁰ We suspect that the combination of prescribed and illicit drugs contributed to many cases of tachycardia and reduced GCS.^{14 21} The period of 24 hours after a patient returns from leave represented a period of increased risk of clinical deterioration. Further consideration is needed when managing an agitated recently returned patient, and careful tailoring of antipsychotics and other medications is needed to avoid compounding the effects of sedation or tachycardia due to illicit drugs.²² Despite policies and protocol to deal with concealment of illicit drugs,¹⁴ this issue will remain unresolved if illicit drugs are used or procured during a leave of absence. A recent systematic review concluded that there was little available evidence on the clinical decision-making and implementation of leave from inpatient mental health services. In particular, most risk assessment focused on suicidality or forensic offending.²³ We suggest that previous MET calls following return from leave should be a consideration when considering leave requests.

Mortality occurred after 2.9% of MET calls in our cohort. In several studies, cardiovascular disease is the most common cause of death in psychiatric inpatients.^{4 24} In our univariable analysis, a history of heart failure, stroke and CKD was associated with mortality. However, these factors were not independent of age. This suggests that older patients with cardiovascular comorbidities may benefit from joint medical and psychiatric management. The association between severe bradycardia and hypopnoea with death is not surprising as they are markers of impending cardiorespiratory arrest. On the other hand, MET calls purely for reduced GCS were not associated with higher mortality. Furthermore, these

patients were less likely to require intravenous therapy or ventilatory assistance. In many of these cases, the reduced GCS was associated with drug adverse effects, which only required monitoring and medication changes. Finally, a simple model including age and hypoxia could be useful in predicting death. We estimated that a 10-year increase in age was associated with a 61% higher odds of death following a MET call, when keeping oxygen saturation constant. Holding age constant, patients with an oxygen saturation <90% during a MET call had 3.6-fold higher odds of death than patients with a saturation of 90% or higher.

Strengths and limitations

To our knowledge, this is the first study to comprehensively investigate the triggers, diagnoses and outcomes after a MET call in a psychiatric inpatient setting. We also examined the outcomes at multiple sites and across a range of psychiatric diagnoses, which improves the generalisability. A mixed effects logistic regression model was used to assess the influence of random effects (recurrent MET calls) on the parameter estimates. This study has provided novel data on the outcomes following MET calls. The main limitation is the retrospective design and missing data. We excluded 11% of MET calls from the RiskMan database due to poor documentation which prevented a complete analysis. It was also not possible to account for missed or delayed MET calls. The small number of deaths limited our ability to include more variables in the multivariable model for mortality. The model requires external validation, and a more sophisticated model incorporating MET observations may improve its accuracy. Finally, there is practice variation in other countries in relation to day leave (day pass) for voluntary psychiatric inpatients. In some countries or health services, temporary or short-term leave is not allowed or severely limited to extenuating circumstances only, and some of our findings may be less relevant in these settings.

CONCLUSIONS

Drug adverse effects are a major reason for MET calls in psychiatric inpatients. A leave of absence is associated with an increased risk of clinical deterioration from reduced GCS and tachycardia. Older patients, patients in aged psychiatry and patients with cardiovascular morbidity have a higher risk of death.

Implications for practice

In psychiatric units that allow temporary leave during inpatient care, we recommend increased monitoring for 12–24 hours after a patient returns from leave, especially if there is a history of substance misuse. A thoughtful plan to address the issue of leave could reduce MET calls and transfers. Recurrent MET calls following return from leave could be part of the risk assessment for future leave requests. A lower threshold to transfer older and comorbid patients to an acute medical service is justified.

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REFERENCES

- 1 Jones D, Bellomo R, DeVita MA. Effectiveness of the medical emergency team: the importance of dose. *Crit Care* 2009;13:313.
- 2 Rodrigues-Silva N, Ribeiro L. Impact of medical comorbidity in psychiatric inpatient length of stay. *J Ment Health* 2020;29:701–5.
- 3 DE Hert M, Correll CU, Bobes J, et al. Physical illness in patients with severe mental disorders. I. prevalence, impact of medications and disparities in health care. *World Psychiatry* 2011;10:52–77.
- 4 Barbosa S, Sequeira M, Castro S, et al. Causes of death in an acute psychiatric inpatient unit of a Portuguese General Hospital. *Acta Med Port* 2016;29:468–75.
- 5 Paton C, Lelliott P, Harrington M, et al. Patterns of antipsychotic and anticholinergic prescribing for hospital inpatients. *J Psychopharmacol* 2003;17:223–9.
- 6 Zhu H, Wu L-T. Multiple drug use disorder diagnoses among drug-involved hospitalizations in the United States: results from the 2016 national inpatient sample. *Drug Alcohol Depend* 2020;213:108113.
- 7 Karim RS, Kwan MM, Finlay AJ, et al. Mortality in hospital patients with and without mental disorders: a data-linkage cohort study. *J Psychiatr Res* 2019;111:104–9.



- 8 Leung MW, Xiong GL, Leamon MH, *et al.* General-medical hospital admissions from a public inpatient psychiatric health facility: a review of medical complications over 30 months. *Psychosomatics* 2010;51:498–502.
- 9 Chan AC, Burke CA, Coffey EM, *et al.* Integrated inpatient medical and psychiatric care: experiences of 5 institutions. *Ann Intern Med* 2018;168:815–7.
- 10 Sartorius N. Comorbidity of mental and physical disorders: a key problem for medicine in the 21st century. *Acta Psychiatr Scand* 2018;137:369–70.
- 11 Porter JE, Cant R, Missen K, *et al.* Physical deterioration in an acute mental health unit: a quantitative retrospective analysis of medical emergencies. *Int J Ment Health Nurs* 2018;27:1364–70.
- 12 Ansermot N, Bochatay M, Schläpfer J, *et al.* Prevalence of ECG abnormalities and risk factors for QTc interval prolongation in hospitalized psychiatric patients. *Ther Adv Psychopharmacol* 2019;9:204512531989138.
- 13 Girardin FR, Gex-Fabry M, Berney P, *et al.* Drug-Induced long QT in adult psychiatric inpatients: the 5-year cross-sectional ECG screening outcome in psychiatry study. *Am J Psychiatry* 2013;170:1468–76.
- 14 Strike C, Robinson S, Guta A, *et al.* Illicit drug use while admitted to hospital: patient and health care provider perspectives. *PLoS One* 2020;15:e0229713.
- 15 Eaton EF, Westfall AO, McClesky B, *et al.* In-Hospital illicit drug use and Patient-Directed discharge: barriers to care for patients with Injection-Related infections. *Open Forum Infect Dis* 2020;7:ofaa074.
- 16 Nahas MA, Melo APS, Cournos F, *et al.* Recent illicit drug use among psychiatric patients in Brazil: a national representative study. *Rev Saude Publica* 2017;51:74.
- 17 Carrà G, Johnson S. Variations in rates of comorbid substance use in psychosis between mental health settings and geographical areas in the UK. A systematic review. *Soc Psychiatry Psychiatr Epidemiol* 2009;44:429–47.
- 18 Dolan M, Kirwan H. Survey of staff perceptions of illicit drug use among patients in a medium secure unit. *Psychiatr Bull* 2001;25:14–17.
- 19 Phillips P, Johnson S. Drug and alcohol misuse among in-patients with psychotic illnesses in three inner-London psychiatric units. *Psychiatr. bull.* 2003;27:217–20.
- 20 Eaton EF, Westfall AO, McClesky B, *et al.* In-hospital illicit drug use and Patient-Directed discharge: barriers to care for patients with Injection-Related infections. *Open Forum Infect Dis* 2020;7:ofaa074.
- 21 Wilson MP, Pepper D, Currier GW, *et al.* The psychopharmacology of agitation: consensus statement of the American association for emergency psychiatry project beta psychopharmacology workgroup. *West J Emerg Med* 2012;13:26–34.
- 22 Hankin CS, Bronstone A, Koran LM. Agitation in the inpatient psychiatric setting: a review of clinical presentation, burden, and treatment. *J Psychiatr Pract* 2011;17:170–85.
- 23 Barlow E-M, Dickens GL. Systematic review of therapeutic leave in inpatient mental health services. *Arch Psychiatr Nurs* 2018;32:638–49.
- 24 Shinde SS, Nagarajaiah NJC, Narayanaswamy JC, *et al.* Mortality among inpatients of a psychiatric Hospital: Indian perspective. *Indian J Psychol Med* 2014;36:142–6.