VITAL SIGNS AS PREDICTORS FOR AGGRESSION IN HOSPITAL PATIENTS (VAPA)

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ABSTRACT

Aims and objectives: To examine and describe the relationship between physiological status and violent and aggressive behaviours in hospital patients.

Background: The majority of adverse events are preceded by physiological abnormalities; whether physiological deterioration is a predictor of violent or aggressive behaviours remains unknown.

Design: prospective case control study

Methods: prospective audit of 999 patients from two major health services in Melbourne, Australia. There were 333 cases who required an emergency response for aggressive or violent behaviour (Code Grey) in the emergency department, medical or surgical units, or inpatient mental health unit between January and June 2015. Two control patients who did not have a Code Grey were randomly selected from the same unit and same day that the Code Grey occurred for the case patient.

Results: Patient locations were 54.4% medical or surgical units, 23.7% emergency department and 21.9% mental health units. Code Grey patients had less documentation of physiological assessment and were more likely to have respiratory rate, heart rate and conscious state abnormalities in the 12 hours preceding Code Grey. After adjusting for confounders, the risk of Code Grey was highest for patients with confusion.

Conclusion: Patients experiencing behavioural disturbance had lower standards of patient assessment, greater incidence of physiological abnormalities and more inpatient deaths. Early recognition of, and response to, patient and physiological predictors of Code Grey should be a strategy to prevent behavioural escalation to the point of Code Grey.

Relevance to Practice: Strategies are needed to improve physiological assessment of patients with behavioural disturbance while ensuring staff safety. There are patient and

physiological factors associated with increased risk of Code Grey that may be used to prevent behavioural escalation to the point of an emergency response.

Key words (MeSH): nursing; nursing assessment; patient safety; risk management; aggression; violence;

Summary box:

- Violent and aggressive behaviour exhibited by patients is a significant and increasing problem in healthcare however little consideration has been given to the link between physiological deterioration as the catalyst for violent or aggressive behaviours.
- Patients requiring an emergency response for aggressive behaviour (Code Grey) had lower quality of physiological assessment and twice as many in-hospital deaths when compared to controls.
- Code Grey patients had significantly higher frequency of documented respiratory rate, heart rate and conscious state abnormalities than controls so **s**trategies are needed to improve physiological assessment of patients with behavioural disturbance while ensuring staff safety.

VITAL SIGNS AS PREDICTORS OF AGGRESSION IN HOSPITAL PATIENTS (VAPA)

INTRODUCTION

Two decades of research related to serious in-hospital adverse events (cardiac arrests and unplanned intensive care unit admissions) clearly show that the majority of adverse events are preceded by physiological abnormalities (Skrifvars et al. 2006, Lighthall et al. 2009, Kause et al. 2004, Hodgetts et al. 2002b, Hillman et al. 2002, Franklin and Matthew 1994, Camarata et al. 1971, Buist et al. 2002, Berlot et al. 2004, Bellomo et al. 2003). However, lack of recognition of physiological abnormalities, or lack of the response to recognised physiological abnormalities is an ongoing issue among general ward patients (Hillman et al. 2005, Bucknall et al. 2013, Shearer et al. 2012). In 2014, the Australian Commission for Safety and Quality in Health Care (ACSQHC) launched a scoping paper: "Recognising and Responding to Deterioration in Mental State" (Australian Commission on Safety and Quality in Health Care (ACSQHC) 2014) building on the work undertaken as part of the

"Recognising and Responding to Clinical Deterioration Program", which has to date, focused on acute physiological deterioration for patients within acute care facilities (Australian Commission on Safety and Quality in Health Care (ACSQHC) 2011). There is now a clear shift in the safety and quality agenda as to how best recognise and manage the patient who suffers an acute deterioration in mental state, however, the focus remains in a mental health paradigm with little consideration given to the link between physiological deterioration as the catalyst for violent or aggressive behaviours (Australian Commission on Safety and Quality in Health Care (ACSQHC) 2014). There is clear evidence that physiological deterioration can manifest as change in behaviour or conscious state, for example, hypoxaemia and hypotension (Considine 2005). Altered mental status is a common reason for escalation of care, such as activation of the medical emergency team or rapid response system and precedes many adverse events such as cardiac arrest or unplanned intensive care unit admission (Hillman et al. 2002, Considine and Botti 2004, Buist et al. 2004). To date, there are no published studies that have examined physiological deterioration as a predictor of violent or aggressive behaviours.

BACKGROUND

Violent and aggressive behaviour exhibited by patients is a significant and increasing problem in Australian hospitals (Roche et al. 2010, McKinnon and Cross 2008, Lau et al. 2004, Downes et al. 2009, Hodge and Marshall 2007, Hopper et al. 2012, O'Connell et al. 2000, Considine et al. 2010, Benveniste et al. 2005, Adang 2008, Williamson et al. 2014). In the two years from 2000-2002, 42,338 incidents were reported to the Australian Incident Monitoring System (AIMS), of which 9% of incidents (n=3621) involved episodes of violence towards staff, perpetrated by patients (Benveniste et al. 2005). Although violent and aggressive behaviours from patients are predominately experienced by staff working in mental health units and emergency departments (EDs), patient violence and aggression is increasing in other hospital areas including general medical and surgical, paediatric and critical care units (Hodge and Marshall 2007, O'Connell et al. 2000, Knott et al. 2005, Hopper et al. 2012).

Initiation of a structured team response to patient perpetrated violent and aggressive behaviour, such as the 'Code Grey' response is now well embedded in most major hospitals in Australia (Williamson et al. 2014, Knott et al. 2005, Hopper et al. 2012, Downes et al. 2009). A Code Grey is a hospital-wide internal security response to aggressive behaviour (Victorian Government Feruary 2005) and is activated when staff feel threatened or where

there is potential for violence or aggressive behaviour (Branch 2005). In Victoria, the Code Grey rate in EDs is reported to be 3.2 per 1,000 adult attendances (Knott et al. 2005). Most Code Greys (69%, n=104) were activated in response to verbal or physical threats of violence made to staff or perceived threat of patient self-harm (76%,n=114) (Knott et al. 2005). At the same hospital, the Code Grey rate in the general medical – surgical units was 1.9% with 121 Code Greys from 6472 admissions (Williamson et al. 2014). In Melbourne's only paediatric hospital, there were 135 episodes of behaviour requiring the activation of a Code Grey response in a fourteen-month period (Hopper et al. 2012).

The impact of violent and aggressive behaviours by hospital patients are wide-ranging, affecting staff, the aggressor, other patients, families and bystanders (Lau et al. 2004, Browne et al. 2011). Staff injury rates as a result of violence by patients is as high as 16% for staff working in EDs and 28% for staff working in mental health units (Benveniste et al. 2005). Operational and system impacts of violent and aggressive behaviours are considerable with 20% of staff taking time off work (sick leave) following an episode of violent and aggressive behaviour (O'Connell et al. 2000, McKinnon and Cross 2008). Violent and aggressive behaviours by patients affect not only the patient aggressor and staff but also have wide reaching effects on other patients. Quality of care deteriorates in an unsafe hospital work environment, predominantly due to delayed or omitted care (Lau et al. 2004, Roche et al. 2010). Further, physical violence is associated with increased falls, increased medication errors, and higher frequency of late administration of medications (Roche et al. 2010).

There are certain patient characteristics that are associated with violent and aggressive behaviours. In general ward patients, most episodes of violent or aggressive behaviour occur in patients over the age of 65 years (Williamson et al. 2014) however in EDs, violent and aggressive behaviours are most common in patients aged under 30 (Hodge and Marshall 2007). A number of studies have shown that males have a greater incidence of violent and aggressive behaviours in general wards, EDs and mental health units (Hodge and Marshall 2007, Williamson et al. 2014) and other studies have shown similar rates of violence between males and females (Sands et al. 2012). Further, males are more likely to be physically restrained as a result of violent and aggressive behaviours in mental health units (Knutzen et al. 2011). Emergency admission is associated with a higher incidence of Code Grey activations on medical and surgical wards (Williamson et al. 2014). The diagnoses known to be associated with increased risk of Code Grey are delirium (OR=11.4, $p<0.001$) and dementia (OR=7.0, $p<0.001$) (Williamson et al. 2014). Other precipitating factors to violent

and aggressive behaviours are alcohol use, substance abuse and organic disease such as dementia and metabolic disorders (Hodge and Marshall 2007, Hopper et al. 2012, Knott et al. 2005). Dual-diagnosis, that is a mental health diagnosis and concurrent substance-abuse diagnosis, is a predictor of violence within mental health units (McKinnon and Cross 2008). In mental health patients, a past history of violent and aggressive behaviours is the most pertinent predictor of future violent and aggressive behaviours (Amore et al. 2008).

It is well recognised that mental health patients have a high incidence of co-morbidities and poor physical health (Stanley and Laugharne 2011, Kelbrick and Haw 2008, Felker et al. 1996). Patients with a mental illness are two and a half times more likely to die from all main causes of death when compared to the general population (Stanley and Laugharne 2011). Mental health patients are three times more likely to smoke and two to three times more likely to be obese. Further, there are adverse side effects of antipsychotic medications, particularly increased risk of metabolic syndrome which is characterised by obesity, hypertension, dyslipidaemia and glucose intolerance (Kelbrick and Haw 2008). Despite the high risks of obesity, cardiovascular disease, and type 2 diabetes in mental health patients the screening of mental health patients for physical health disorders is suboptimal (Stanley and Laugharne 2011, Kelbrick and Haw 2008). Further, mental health patients are at particular risk of missed diagnoses, and most commonly it is physical health issues that are overlooked (Tintinalli et al. 1994, Kelbrick and Haw 2008, Carson et al. 2010).

Aim

The aim of this study was to examine and describe the relationship between physiological status (vital signs) and violent and aggressive behaviours in hospital patients. For the purposes of this study, violent and aggressive behaviours were defined as any behaviour triggering the requirement to call a 'Code Grey' hospital emergency response. A Code Grey is a hospital-wide internal security response to aggressive behaviour (Victorian Government 2005).

The research questions addressed by this study were:

i) What is the frequency and nature of physiological assessment in the 12 hours preceding a hospital wide emergency response for aggressive behaviour (Code Grey)?
ii) What is the frequency and nature of physiological abnormalities in the 12 hours preceding a hospital wide emergency response for aggressive behaviour (Code Grey)?

iii) Are there differences in the physiological assessment and physiological abnormalities in patients who require a hospital wide emergency response for aggressive behaviour (Code Grey) and those who do not?

iv) Can physiological abnormalities be used to predict violent and aggressive behaviours in hospital patients?

For the purposes of this study, the 12 hours preceding Code Grey was based on the Code Grey activation for the cases. Although the controls did not have a Code Grey activation, their physiology was assessed during that same time period.

METHOD

Design

A prospective case control design was used to examine and describe the relationship between vital signs and clinical aggression in hospital patients. The study was approved by the Human Research and Ethics Committees at the two study sites and Deakin University.

Setting

The study settings were two major health services in Victoria, Australia. Health Service A was a metropolitan health service with three acute care hospitals. During 2014-15 there were 135,636 patients admitted to hospital for acute care, 151,810 ED attendances and 3234 people admitted to mental health inpatient units at Health Service A (Eastern Health 2015).

Health Service B was one of the largest and most comprehensive regional health services in Victoria. Health Service B had one acute care site. During 2014-15 there were approximately 71,069 patients admitted to hospital for acute care, 62, 971 ED attendances and 965 admissions to mental health inpatient units at Health Service B (Barwon Health 2015).

Participants

The study population was all patients receiving care in the ED, medical or surgical units, and acute mental inpatient health units located on the acute care sites during the data collection periods. Cases were consecutive adult patients (≥ 18 years) receiving care in the aforementioned units who had a Code Grey activation. Patients receiving care in critical care areas (intensive care, coronary care, cardiac catheter laboratory) and maternity care were excluded. For every case, two control patients who did not have a Code Grey were randomly

selected from the same ward and same day that the Code Grey occurred in the case patient. For prediction studies, there is little empirical evidence to suggest optimum sample size and more importantly the number of events required (Vergouwe et al. 2005). Simulation studies recommend a minimum of 100 events and 100 non-events is needed and at least 20% more events should be added to the sample size for each extra covariate in the model (Figueroa et al. 2012). There were a total of 1014 patients included in the study; 333 cases and 666 controls. The sampling per health service is shown in Table 1.

** Table 1 here

Data collection

Data were collected by medical record audit. Health Service A data were collected between 9th February and 11th June 2015 and Health Service B data were collected between 1 January and 30th March 2015. To ensure consistency of data collection, a project specific data collection tool and detailed data dictionary were developed and piloted by the research team. Data were collected by one research nurse per site; the two research nurses had specific training in the use of the tool and data dictionary by members of the research team (JCo and DB). The following data were recorded for each patient:

- Patient characteristics: age, gender, Mental Health Act / compulsory treatment order (assessment order, temporary treatment order, treatment order),
- Clinical status in 12 hours preceding cases' Code Grey activation: episodes of restraint or seclusion; number of documented assessments of respiratory rate, oxygen saturation, heart rate, systolic blood pressure, temperature, conscious state, pain; number of normal vs abnormal measures of respiratory rate, oxygen saturation, heart rate, systolic blood pressure, temperature, conscious state, confusion, pain score. Assessment data was obtained from the nursing observation charts and nursing progress notes. The presence of absence of confusion was assessed by: i) the verbal response rating on the Glasgow Coma Score for ED patients and ward patients having neurological observations, ii) documentation of the word 'confusion' in the nursing notes, or iii) if the patient was documented as confused on a behaviour chart.
- System characteristics: type of admission (emergency mental health admission, emergency medical / surgical admission, elective mental health admission, elective medical / surgical admission), mode of arrival to hospital (private car, ambulance, police, mental health team); hospital length of stay; hospital discharge destination. If an emergency admission: ED triage category and ED length of stay were also collected.

- Code Grey characteristics for cases only: date, time, location, reason, outcome (stayed in clinical area, transferred, restraint use, sedation use), hospital length of stay at time of emergency response for aggressive behaviour.

For the purposes of this study normal physiological parameters were defined as respiratory rate 12-22 breaths / minute, oxygen saturation ≥95%, heart rate 60-100 beats per minute, systolic blood pressure 90-140 mmHg, alert conscious state, temperature 35.0-37.8^{0}C, pain score zero out of ten, no confusion, no increased work of breathing, skin colour pink and skin moisture dry (Considine et al. 2009).

Data analysis

Study data were analysed using SPSS Version 23.0.{IBM Corporation, 2015 #2614} Descriptive statistics were used to summarise the data. As the data were not normally distributed (Kolmogorov–Smirnov test), medians (Mdn) and interquartile ranges (IQR) are presented. Relationships between patient and clinical characteristics and emergency response for aggressive behaviour were examined using Chi Square (categorical data), Mann Whitney U (continuous data) and logistic regression. Statistical significance was indicated by p value of less than 0.05.

RESULTS

Participant characteristics

There were a total of 999 patients included in the study; 333 cases and 666 controls. Just over half the patients (54.4%, n=181 cases and 362 controls) were from medical or surgical units, 23.7% of patients (n=79 cases and 158 controls) were in the ED, and 21.9% of patients (n=73 cases and 146 controls) were in mental health units.

Participant characteristics are shown in Table 2. Cases were statistically significantly younger with a median age of 49 years (IQR = 32 to 75) compared controls who had a median age of 65 years (IQR = 41 to 80) ($p<0.001$). Cases were more likely to be male, more likely to be an emergency mental health admission (39.3% vs 23.4%, $p<0.001$) and less likely to be an emergency medical or surgical admission (55.2% vs 64.4%, $p=0.005$) (Table 2). It is important to note that although majority of patients who were emergency mental health admissions were in the ED (10.8%, 108/999) or mental health units (13.0%, 130/999), there were also patients who were emergency mental health admissions admitted to the medical or surgical units (2%, 20/999).

Cases were more likely to have compulsory treatment orders in place on admission (22.7% vs 12.6%) and in place on the day that Code Grey was activated (25.7% vs 11.3%, p<0.001). Cases were also more likely to be admitted with a designated observer (7.4% vs 0.9%, p<0.001). The majority of patients in both groups had ambulance involved in their transport to hospital (85.5% vs 88.1%, p=0.328) and a small number of patients in both groups also had the Crisis Assessment and Treatment Team (7.8% vs 4.4%, p=0.064). Cases were more likely to have police involvement (25.7% vs 11.0%, p<0.001) in transport to hospital (Table 2), and were more likely to experience sedation (49.2%, n=164 vs 7.5%, n=50; p<0.001), physical restraint (16.5%, n=55 vs 1.2%, n=8; p<0.001) and seclusion (6.0%, n=20 vs 9.0%, n=9; p<0.001) in the 12 hours preceding the cases' Code Grey call when compared to controls.

Cases were more likely to be discharged to residential aged care (27.6% vs 14.3%), subacute care (7.7% vs 5.2%), supported residential services (6.4% vs 4.1%) or custodial services (3.8% vs 0.8%) and less likely to be discharged home (45.7% vs 64.2%) or transferred to another hospital (5.4% vs 10.3%) (p<0.001) (Table 2). There were no significant differences in the requirement for ICU or MET calls during admission but cases had significantly more in hospital deaths (3.3% vs 1.2%, p=0.022). None of the patients who had a Code Grey activated in emergency department died in hospital. In hospital death occurred in 5.6% (n=4) of cases whose Code Grey was activated in mental health units and 3.9% (n=7) of cases whose Code Grey occurred on medical or surgical units (p=0.134). The median acute care length of stay was 11 days for cases (IQR = 3 – 22.5) and 8 days for controls (IQR = 3 -17) (p=0.012).

** Table 2 here

When ED patients were examined separately (Table 3), cases were more likely to be triaged to category 2 and less likely to be triaged to category 4 when compared to controls. They were also more likely to be alcohol (50.0% vs 4.9%, p<0.001) or drug affected (36.5% vs 1.8%, p<0.001). The most common drugs affecting cases were cannabis (n=14) and methamphetamines (n=8). Twelve patients were clearly documented as being both drug and alcohol effected and they were all cases.

** Table 3 here

Code Grey interventions and outcomes (cases only)

The location of the Code Greys was as follows: 54.4% (n=181) were on medical or surgical units, 23.7% (n=79) were in the ED, and 21.9% (n=73) were in mental health units. During the Code Grey process, sedation was used in 61.3% (n=204) of patients, 28.8% of patients (n=96) were restrained and seclusion was used in 11.7% of patients (n=39). Following Code Grey activation, the majority of patients (84.4%, n=281) remained in the same clinical area, nine ED patients and three medical / surgical ward patients were admitted to mental health units.

Physiological assessment and physiological abnormalities in the 12 hours preceding Code Grey

In the 12 hours preceding Code Grey, documentation of one or more of the core parameters that comprise physiological observations as defined by ACSQHC(Australian Commission on Safety and Quality in Health Care (ACSQHC) 2010) (respiratory rate, oxygen saturation, heart rate, blood pressure, conscious state and temperature) occurred in the majority of patients (Table 4). Cases had significantly less documentation of respiratory rate, oxygen saturation, heart rate, blood pressure, conscious state, temperature, and pain but had more documentation of confusion (Table 4). There were no significant differences between groups in the documentation of work of breathing or skin status, which were poorly assessed in both groups.

** Table 4 here

As there were no significant between group differences in the median ED (Mdn = 2 hours IQR 0.67 to 5.8 hours vs Mdn = 3.2 hours IQR 1.6 to 6.1 hours, p=0.129) or acute care length of stay at the time of Code Grey activation (Mdn = 3.4 days IQR 0.9 to 11 days vs Mdn = 4.4 days IQR 1.3 to 11 days, p = 0.068), the median number of physiological assessments in the 12 hours preceding Code Grey activation were compared between groups (Table 5). The median number of documented assessments of respiratory rate, oxygen saturation, heart rate, systolic blood in the 12 hours preceding Code Grey was 2 in both groups. The median number of documented assessments of conscious state, temperature, and pain in the 12 hours preceding Code Grey was 1 in both groups. When inter-quartile ranges were considered, cases had significantly less frequent documentation of respiratory rate, oxygen saturation,

heart rate, systolic blood pressure, conscious state, temperature, and pain but had more documentation of confusion (Table 5).

** Table 5 here

The frequency of abnormalities in documented assessments was examined in both groups (Table 6). Cases were significantly more likely to have documented respiratory rate, heart rate and conscious state abnormalities.

** Table 6 here

For the 208 patients with one or more abnormal heart rates documented, there were 352 measures of tachycardia documented in 16 patients (138 measures in 6 cases and 210 measures in 10 controls) and 17 measures in 13 patients (12 measures in 4 controls and 92 measures in 9 controls). The median highest value for heart rate was 110 for cases (IQR = 105-115) and 108 for controls (IQR = 101-117) (p=0.111). The median lowest value for heart rate was 95 for cases (IQR = 75-109) and 90 for controls (IQR = 57-105) (p=0.035).

Predictors of violent and aggressive behaviours in hospital patients

Variables that were statistically significant on bivariate analysis were included in the logistic regression. Using Code Grey activation as the dependent variable, a test of the full model with 714 patients against a constant only model was statistically reliable ($\chi 2$ = 229.258, p<0.001). Application of the Hosmer–Lemeshow statistic confirmed good model fit ($\chi 2$ = 7.045, p= 0.532) and the model correctly classified 79.1% of cases. After adjusting for confounding factors, the risk-adjusted odds ratio (OR) for Code Grey activation were highest for patients with confusion (OR 16.508, 95%CI 9.923 – 27.463, p = <0.001). Male gender, younger age, police involvement in transport to hospital, and respiratory rate and heart rate abnormalities in the preceding 12 hours were also associated with an increased risk of Code Grey activation (Table 7).

** Table 7 here

DISCUSSION

This study had four major findings. First, just over half the Code Grey activations in this study occurred in medical or surgical units. Australian data shows the Code Grey rate of 0.32% (3.2 per 1000 attendances) in one major ED data and 1.9% (121 Code Greys / 6472 admissions) in medical and surgical units (Williamson et al. 2014). Australian studies in mental health show that 13.7% of inpatient mental health patients were recorded as being aggressive (Barlow et al. 2000) and that reportable aggressive incidents occur in 11.2% of admissions (Carr et al. 2008). There are few studies comparing violent and aggressive behaviours across settings. One United Kingdom study showed that 42% of medical department staff, 36% of surgical department staff and over t30% of the Accident and Emergency staff had experienced assault (Winstanley and Whittington 2004). In our study, the lower frequency of Code Grey in mental health units and the ED may be a function of staff training: while all hospital staff receive training in aggression management, the training for mental health and ED nurses is more frequent and of higher intensity. Although it was not the aim of this study to compare clinical areas, there is a need to better understand the profile of aggressive and violent behaviours across different clinical settings.

Second, cases had lower quality of physiological assessment in terms of fewer parameters assessed and decreased frequency of assessment when compared to controls. Cases had a median of two measures of blood pressure, heart rate, oxygen saturation and respiratory rate in the 12 hours preceding Code Grey, which exceeds the minimum of eight hourly assessment recommended by ACSQHC (2010) However, the ACSQHC (2010) also state that the frequency of assessment should be commensurate with the patient's clinical situation so two assessments in 12 hours seems infrequent, particularly in patients who required an emergency response for disturbance. Cases had a median of one measure of temperature and pain assessment in the 12 hours preceding Code Grey compared with median of 2 measures for controls. Temperature has been reported in other studies as a commonly missing vital sign (Bleyer et al. 2011). The lack of temperature measures is concerning given that sepsis is known to be one cause of aggression (Fulde and Preisz 2011), temperature abnormalities are key indicator of the development of sepsis and sepsis carries a mortality rate of 14.3% (Burrell et al. 2016).

Cases were more likely to have incomplete assessment when compared to the recommendations of the ACSQHC (blood pressure, respiratory rate, heart rate, oxygen

saturation, conscious state and temperature) (ACSQHC, 2010). One possible reason for this finding may be that patient behaviours made it difficult or impossible for nurses to undertake assessments that required close patient contact, and this may specifically explain the lower frequency of temperature measurement in the cases. Respiratory rate is the most sensitive indicator of serious illness, is a more reliable indicator of serious illness than other vital signs, and can be measured from a distance (Cretikos et al. 2008, Fieselmann et al. 1993). Yet, respiratory rate assessment was missing in 14.7% of control patients and 27.3% of cases. Strategies are urgently needed to improve physiological assessment of patients with behavioural disturbance while ensuring staff safety.

Third, there were clear associations with physiological abnormalities in the 12 hours preceding Code Grey and need for Code Grey activation. Cases were four times more likely to have confusion documented than controls, which may not be an unexpected finding in patients whose behavioural disturbance culminated in an emergency response. Cases also had a higher frequency of documented conscious state abnormalities than controls however when adjusted for confounders, confusion strongly associated with Code Grey activation (OR=16.508) and altered conscious state lost statistical significance. Cognitive impairment (memory impairment, disorientation and confusion) is a known risk factor for violent behaviour in inpatient psychiatric units and aged psychiatric settings (Sands et al. 2012). There are a number of possible reasons for cognitive impairment that are relevant to this study. ED cases were significantly more likely to be drug or alcohol affected than controls: 50% of cases were alcohol affected and one in three were drug affected. Delirium is also a significant, and often under-detected cause of cognitive impairment and has a clear association with in-hospital mortality (Travers et al. 2013). Approximately 10% of patients aged over 70 years had delirium at hospital admission and another 7.6% of patients developed delirium during their hospital stay (Travers et al. 2013). All study sites used the AVPU scale (alert, response to voice, responds to pain, unresponsive) to assess conscious state but AVPU does not assess for cognitive impairment. The addition of assessment for confusion and cognitive impairment to routine physiological assessment should be considered.

Cases also had a significantly higher frequency of documented abnormalities in respiratory rate and heart rate in the 12 hours preceding Code Grey and these differences between groups remained significant when adjusted for confounders. These findings are clinically important as tachypnoea is a highly sensitive indicator of serious illness and well known antecedent to

adverse events such as in hospital death, cardiac arrest and unplanned intensive care unit admission (Subbe et al. 2003, Fieselmann et al. 1993, Hodgetts et al. 2002a, Harrison et al. 2005, Cretikos et al. 2007, Bleyer et al. 2011). Tachycardia is also a vital sign abnormality of clinical importance. Heart rate abnormalities, and specifically tachycardia have been associated with increased risk of in-hospital death (Olsson and Lind 2003, Ashworth 2002, Bleyer et al. 2011). Further tachycardia was a factor in 30% of patients requiring MET activation (excluding calls for cardiac arrest) (Lee et al. 1995) and tachycardia following ICU discharge was more common in patients who unexpectedly died or required readmission to ICU (Rubins and Moskowitz 1988). Altered conscious state has also been associated with increased risk of inpatient death (Ashworth 2002, Bleyer et al. 2011) and is an antecedent to in-hospital cardiac arrest (Berlot et al. 2004). As discussed previously, confusion is also a known risk factor for violent behaviours (Sands et al. 2012). In our study, the adjusted risk of Code Grey activation was highest for patients with confusion in the preceding 12 hours. Abnormal respiratory rate and heart rate in the preceding 12 hours were also associated with increased risk of Code Grey activation following adjustment for confounders.

Finally, cases had more than twice as many in-hospital deaths as controls. The reason for this finding is unclear and it was beyond the scope of the study to examine the causes of death in detail. However, there are a number of possible explanations for this finding that warrant further investigation. Suboptimal assessment may mean that physiological deterioration was unrecognised and therefore resulted in delayed or absent response. As discussed previously in this paper, cases had a higher frequency of physiological abnormalities, and particularly respiratory rate, heart rate and conscious state, all of which are associated with increased risk of in-hospital death (Skrifvars et al. 2006, Buist et al. 2004, Bleyer et al. 2011).

Rapid response teams have decreased high mortality events such as cardiac arrest and unplanned intensive care unit admission by having standardised criteria that define clinical deterioration, a clear process for escalation of care, and a response that brings expertise in the management of critically ill patients to the point of care (Jones et al. 2011). Currently no such system exists to identify behavioural deterioration, enact an urgent response, and bring clinicians with expertise in managing behavioural disturbance to the bedside. Prevention of Code Grey should be resourced in the same manner that Medical Emergency Teams have been resourced to prevent high mortality events such as in-hospital cardiac arrest and unplanned intensive care admission.

Limitations

There are several limitations that should be considered when interpreting the study findings. Study limitations include the use of organisational data however data collection was performed by specifically trained research nurses who were guided by a data dictionary to optimise data reliability. Physiological observation data were collected from patient records, so it is impossible to understand the accuracy of measurement of this data. Further, there were issues with missing data for some patients however, this in its self is an important finding as it may reflect a lower level of assessment. Patients were selected from four hospitals from two health services minimising the possibly of selection bias however our results may not be generalisable to other organisations.

CONCLUSION

Aggressive and violent behaviour is an issue across all sectors of health care including inpatient medical and surgical units. Patients in whom behavioural disturbance was present had lower standards of patient assessment, greater incidence of physiological abnormalities and more inpatient deaths than control patients. Strategies are needed to improve physiological assessment of patients with behavioural disturbance while ensuring staff safety and all patients with behavioural disturbance should have regular measurement of respiratory rate as minimum standard of assessment. There were clear physiological predictors of Code Grey responses. Early recognition of, and response to, Code Grey predictors should be a strategy to prevent behavioural escalation to the point of Code Grey.

RELEVANCE TO CLINICAL PRACTICE

Strategies are needed to improve physiological assessment of patients with behavioural disturbance while ensuring staff safety. There are patient and physiological factors associated with increased risk of Code Grey therefore early recognition of, and response to, Code Grey predictors should be a strategy to prevent behavioural escalation to the point of Code Grey.

REFERENCES

Adang, E.M.M. (2008) Economic evaluation of innovative technologies in health care should include a short-run perspective. European Journal of Health Economics, **9**(4), 381-384.

Amore, M., Menchetti, M., Tonti, C., Scarlatti, F., Lundgren, E., Esposito, W. & Berardi, D. (2008) Predictors of violent behavior among acute psychiatric patients: clinical study. Psychiatry and Clinical Neurosciences **62**(3), 247-55.

Ashworth, S. (2002) A prelude to outreach: prevalence and mortality of ward patients with abnormal vital signs. 15th Annual Congress of the European Society of Intensive Care Medicine, **28 S1**, S21.

Australian Commission on Safety and Quality in Health Care (ACSQHC) (2010) National Consensus Statement: essential elements for recognising and responding to clinical deterioration. Australian Commission on Safety and Quality in Health Care,, Sydney. Retrieved 31 August 2015 from http://www.safetyandquality.gov.au/our-work/recognising-and-responding-to-clinical-deterioration/implementing-r-and-r-systems/the-national-consensus-statement/.

Australian Commission on Safety and Quality in Health Care (ACSQHC) (2011) National Safety and Quality Health Service Standards. Australian Commission on Safety and Quality in Health Care,, Sydney. Retrieved 4 February 2015 from http://www.safetyandquality.gov.au/publications/national-safety-and-quality-health-service-standards/.

Australian Commission on Safety and Quality in Health Care (ACSQHC) (2014) Recognising and Responding to Deterioration in Mental State: A Scoping Review. ACSQHC.Retrieved 20 July 2014 from http://www.safetyandquality.gov.au/publications/recognising-and-responding-to-deterioration-in-mental-state-a-scoping-review/, Darlinghurst, NSW. .

Barlow, K., Grenyer, B. & Ilkiw-Lavalle, O. (2000) Prevalence and precipitants of aggression in psychiatric inpatient units. Australian and New Zealand Journal of Psychiatry, **34**(6), 967-974.

Barwon Health (2015) Annual Report 2014-15. Barwn Health. Retrieved 20 January 2016 from http://www.barwonhealth.org.au/annual-reports, Geelong.

Bellomo, R., Goldsmith, D., Uchino, S., Buckmaster, J., Hart, G., Opdam, H., Silverster, W., Doolan, L. & Gutteridge, G. (2003) A prospective before-and-after trial of a medical emergency team. Medical Journal of Australia, **179**(6), 283 - 287.

Benveniste, K., Hibbert, P.D. & Runciman, W.B. (2005) Violence in health care: the contribution of the Australian Patient Safety Foundation to incident monitoring and analysis. Medical Journal of Australia, **183**(7), 348 - 351.

Berlot, G., Pangher, A., Pettrucci, L., Bussani, R. & Lucangelo, U. (2004) Anticipating events of in-hospital cardiac arrests. European Journal of Emergency Medicine, **11**, 24-28.

Bleyer, A.J., Vidya, S., Russell, G.B., Jones, C.M., Sujata, L., Daeihagh, P. & Hire, D. (2011) Longitudinal analysis of one million vital signs in patients in an academic medical center. Resuscitation, **82**(11), 1387-1392.

Branch, N.P. (2005) Victorian Government Department of Human Services, Melbourne Victoria. Victorian taskforce on violence in nursing, 41-46.

Browne, V., Knott, J., Dakis, J., Fielding, J., Lyle, D., Daniel, C., Bruce, M. & Virtue, E. (2011) Improving the care of mentally ill patients in a tertiary emergency department: development of a psychiatric assessment and planning unit. Australasian Psychiatry **19**(4), 350-3.

Bucknall, T.K., Jones, D., Bellomo, R., Staples, M. & for the RESCUE Investigators (2013) Responding to medical emergencies: System characteristics under examination (RESCUE). A prospective multi-site point prevalence study. Resuscitation, **84**(2), 179-183.

Buist, M., Bernard, S., Nguyen, T.V., Moore, G. & Anderson, J. (2004) Association between clinically abnormal observations and subsequent in-hospital mortality: a prospective study Resuscitation, **62**(2), 137-141.

Buist, M., Moore, G.E., Bernard, S.A., Waxman, B.P., Anderson, J.N. & Nguyen, T.V. (2002) Effects of a medical emergency team on reduction of incidence of and mortality from unexpected cardiac arrests in hospital: preliminary study. British Medical Journal, **324**(7334), 387-90.

Burrell, A.R., McLaws, M.-L., Fullick, M., Sullivan, R.B. & Sindhusake, D. (2016) SEPSIS KILLS: early intervention saves lives. Medical Journal of Australia, **204**(1), 1.e1 - 1.e7.

Camarata, S.J., Weil, M.H., Hanashiro, P.K. & Shubin, H. (1971) Cardiac arrest in the critically ill. I: A study of predisposing causes in 132 patients. Circulation, **44**(4), 688 - 695.

Carr, V.J., Lewin, T.J., Sly, K.A., Conrad, A.M., Tirupati, S., Cohen, M., Ward, P.B. & Coombs, T. (2008) Adverse incidents in acute psychiatric inpatient units: rates, correlates and pressures. Australian and New Zealand Journal of Psychiatry, **42**(4), 267-282.

Carson, N., Katz, A., Gao, S. & Alegría, M. (2010) Assessment of physical illness by mental health clinicians during intake visits. Psychiatric Services, **61**(1), 32-37.

Considine, J. (2005) The reliability of clinical indicators of oxygenation: A literature review. Contemporary Nurse, **18**(3), 258 - 267.

Considine, J. & Botti, M. (2004) Who, when and where? Identification of patients at risk of an in-hospital adverse event: Implications for nursing practice. International Journal of Nursing Practice, **10**(1), 21-31.

Considine, J., Mitchell, B. & Stergiou, H.E. (2010) Frequency and nature of reported incidents during Emergency Department care. Emergency medicine journal.

Considine, J., Thomas, S. & Potter, R. (2009) Predictors of critical care admission in emergency department patients triaged as low to moderate urgency Journal of Advanced Nursing, **65**(4), 818-827.

Cretikos, M., Chen, J., Hillman, K., Bellomo, R., Finfer, S. & Flabouris, A. (2007) The objective medical emergency team activation criteria: a case-control study. Resuscitation, **73**(1), 62-72.

Cretikos, M.A., Bellomo, R., Hillman, K., Chen, J., Finfer, S. & Flabouris, A. (2008) Respiratory rate: the neglected vital sign. Medical Journal of Australia, **188**, 657–659.

Downes, M.A., Healy, P., Page, C.B., Bryant, J.L. & Isbister, G.K. (2009) Structured team approach to the agitated patient in the emergency department. Emerg Med Australas, **21**(3), 196-202.

Eastern Health (2015) Quick Facts about Eastern Health. pp. 2 page flyer giving over view of Eastern Health services.

Felker, B., Yazel, J.J. & Short, D. (1996) Mortality and medical comorbidity among psychiatric patients: a review. Psychiatric Services.

Fieselmann, J., Hendryx, M., Helms, C. & Wakefield, D. (1993) Respiratory rate predicts cardiopulmonary arrest for internal medicine inpatients. Journal of General Internal Medicine, **8**(7), 354-360.

Figueroa, R.L., Zeng-Treitler, Q., Kandula, S. & Ngo, L.H. (2012) Predicting sample size required for classification performance. BMC Medical Informatics and Decision Making, **12**(1), 8.

Franklin, C. & Matthew, J. (1994) Developing strategies to prevent in hospital cardiac arrest: analyzing responses of physicians and nurses in the hours before the event. Critical Care Medicine, **22**(2), 244 - 247.

Fulde, G. & Preisz, P. (2011) Managing aggressive and violent patients. Australian Prescriber, **34**(4), 116-118.

Harrison, G.A., Jacques, T.C., Kilborn, G. & al., e. (2005) The prevalence of recordings of the signs of critical conditions and emergency responses in hospital wards — the SOCCER study. Resuscitation, **65**, 149 - 157.

Hillman, K., Bristow, P., Chey, T., Daffurn, K., Jacques, T., Norman, S., Bishop, G. & Simmons, G. (2002) Duration of life-threatening antecedents prior to intensive care admission. Intensive Care Medicine, **28**(11), 1629-1634.

Hillman, K., Chen, J., Cretikos, M., Bellomo, R., Brown, D., Doig, G., Finfer, S. & Flabouris, A. (2005) MERIT study investigators: Introduction of the medical emergency team (MET) system: a cluster-randomised controlled trial. Lancet, **365**, 2091 - 2097.

Hodge, A.N. & Marshall, A.P. (2007) Violence and aggression in the emergency department: a critical care perspective. Aust Crit Care, **20**(2), 61-7.

Hodgetts, T.J., Kenward, G., Vlachonikolis, I.G., Payne, S. & Castle, N. (2002a) The identification of risk factors for cardiac arrest and formulation of activation criteria to alert a medical emergency team. Resuscitation, **54**(2), 125-131.

Hodgetts, T.J., Kenward, G., Vlackonikolis, I., Payne, S., Castle, N., Crouch, R., Ineson, N. & Shaikh, L. (2002b) Incidence, location and reasons for avoidable in-hospital cardiac arrest in a district general hospital. Resuscitation, **54**(2), 115.

Hopper, S.M., Babl, F.E., Stewart, C.E. & Woo, J.W. (2012) Aggression management in a children's hospital setting. The Medical Journal of Australia, **196**(3), 198-201.

Jones, D.A., DeVita, M.A. & Bellomo, R. (2011) Rapid-Response Teams. New England Journal of Medicine, **365**(2), 139-146.

Kause, J., Smith, G., Prytherch, D., Parr, M., Flabouris, A. & Hillman, K. (2004) A comparison of antecedents to cardiac arrests, deaths and emergency intensive care admissions in Australia and New Zealand, and the United Kingdom - the ACADEMIA study. Resuscitation, **62**, 275 - 282.

Kelbrick, M. & Haw, C. (2008) An audit of physical examinations in a Psychiatric Intensive Care Unit. Journal of Psychiatric Intensive Care, **4**(1-2), 35-42.

Knott, J.C., Bennett, D., Rawet, J. & Taylor, D.M. (2005) Epidemiology of unarmed threats in the emergency department. Emergency Medicine Australasia, **17**(4), 351-358.

Knutzen, M., Mjosund, N.H., Eidhammer, G., Lorentzen, S., Opjordsmoen, S., Sandvik, L. & Friis, S. (2011) Characteristics of psychiatric inpatients who experienced restraint and those who did not: a case-control study. Psychiatric Services, **62**(5), 492-497.

Lau, J.B., Magarey, J. & McCutcheon, H. (2004) Violence in the emergency department: a literature review. Australian Emergency Nursing Journal, **7**(2), 27-37.

Lee, A., Bishop, G., Hillman, K.M. & Daffurn, K. (1995) The Medical Emergency Team. Anaesthesia and intensive care, **23**(2), 183-6.

Lighthall, G.K., Markar, S. & Hsiung, R. (2009) Abnormal vital signs are associated with an increased risk for critical events in US veteran inpatients. Resuscitation, **80**(11), 1264-1269.

McKinnon, B. & Cross, W. (2008) Occupational violence and assault in mental health nursing: a scoping project for a Victorian Mental Health Service. International Journal of Mental Health Nursing, **17**(1), 9-17.

O'Connell, B., Young, J., Brooks, J., Hutchings, J. & Lofthouse, J. (2000) Nurses' perceptions of the nature and frequency of aggression in general ward settings and high dependency areas. Journal of clinical Nursing, **9**(4), 602-610.

Olsson, T. & Lind, L. (2003) Comparison of the Rapid Emergency Medicine Score and APAHE II in nonsurgical emergency department patients. Academic Emergency Medicine Journal, **10**(10), 1040-1048.

Roche, M., Diers, D., Duffield, C. & Catling-Paull, C. (2010) Violence toward nurses, the work environment, and patient outcomes. Journal of Nursing Scholarship, **42**(1), 13-22.

Rubins, H.B. & Moskowitz, M.A. (1988) Discharge decision-making in a medical intensive care unit. Identifying patients at high risk of unexpected death or unit readmission. American Journal of Medicine, **84**(5), 863-9.

Sands, N., Elsom, S., Gerdtz, M. & Khaw, D. (2012) Mental health-related risk factors for violence: using the evidence to guide mental health triage decision making. Journal of psychiatric and mental health nursing, **19**(8), 690-701.

Shearer, B., Marshall, S., Buist, M.D., Finnigan, M., Kitto, S., Hore, T., Sturgess, T., Wilson, S. & Ramsay, W. (2012) What stops hospital clinical staff from following protocols? An analysis of the incidence and factors behind the failure of bedside clinical staff to activate the rapid response system in a multi-campus Australian metropolitan healthcare service. BMJ Quality and Safety, **21**(7), 569-575.

Skrifvars, M., Nurmi, J., Ikola, K., Saarinen, K. & Castren, M. (2006) Reduced survival following resuscitation in patients with documented clinically abnormal observations prior to in-hospital cardiac arrest. Resuscitation, **70**(2), 215-222.

Stanley, S.H. & Laugharne, J.D. (2011) Clinical guidelines for the physical care of mental health consumers: a comprehensive assessment and monitoring package for mental health and primary care clinicians. Aust N Z J Psychiatry, **45**(10), 824-9.

Subbe, C.P., Davies, R.G., Williams, E., Rutherford, P. & Gemmell, L. (2003) Effect of introducing the Modified Early Warning score on clinical outcomes, cardio-pulmonary arrests and intensive care utilisation in acute medical admissions. Anaesthesia, **58**(8), 797-802.

Tintinalli, J.E., Peacock IV, F.W. & Wright, M.A. (1994) Emergency medical evaluation of psychiatric patients. Annals of emergency medicine, **23**(4), 859-862.

Travers, C., Byrne, G.J., Pachana, N.A., Klein, K. & Gray, L. (2013) Delirium in Australian hospitals: a prospective study. Current Gerontology and Geriatrics Research, **2013**.

Vergouwe, Y., Steyerberg, E.W., Eijkemans, M.J. & Habbema, J.D.F. (2005) Substantial effective sample sizes were required for external validation studies of predictive logistic regression models. Journal of clinical epidemiology, **58**(5), 475-483.

Victorian Government, D.o.H.S. (Feruary 2005) Occupational violence in nursing: An analysis of the phenomenon of code grey/black events in four Victorian hospitals. Policy and Strategic Projects Division, Victorian Government, Department of Human Services. Retrieved 18 July 2014 from http://www.health.vic.gov.au/__data/assets/pdf_file/0008/17585/codeblackgrey.pdf, Melbourne.

Williamson, R., Lauricella, K., Browning, A., Tierney, E., Chen, J., Joseph, S., Sharrock, J., Trauer, T. & Hamilton, B. (2014) Patient factors associated with incidents of aggression in a general inpatient setting. Journal of Clinical Nursing, **23**(7-8), 1144-52.

Winstanley, S. & Whittington, R. (2004) Aggression towards health care staff in a UK general hospital: variation among professions and departments. Journal of Clinical Nursing, **13**(1), 3-10.

Table 1: Sampling per health service

	Cases	Controls	Total
Health Service A – Site 1	46	92	138
Health Service A – Site 2	87	174	261
Health Service A – Site 3	105	210	315
Health Service B	95	190	285
	333	666	999

Table 2: Participant characteristics and outcomes (all patients)

	Cases (n=333)		Controls (n=666)		p*
	n	%	n	%	
Gender – male	240	72.1	344	51.9	<0.001
Type of admission[#]					
• Emergency Mental Health	129	39.3	153	23.4	
• Emergency Medical/Surgical	181	55.2	422	64.4	<0.001
• Elective Mental Health	10	3.0	23	3.5	
• Elective Medical/Surgical	19	5.8	61	9.3	
Compulsory Treatment orders					
• In place at admission	75	22.7	84	12.6	<0.001
• In place on day of exposure Code Grey	85	25.7	75	11.3	<0.001
Admitted with designated observer	20	7.4	5	0.9	<0.001
Mode of arrival to hospital					
• Ambulance	230	85.5	376	88.1	
• Police	60	22.3	47	11.0	<0.001
• CATT	21	7.8	19	4.4	
Discharge destination					
• Home	143	45.8	405	64.2	<0.001
• Other hospital	17	5.4	65	10.3	
• Supported Residential Services	20	6.4	26	4.1	
• Custodial Services	12	3.8	5	0.8	

• Residential Aged Care	86	27.6	90	14.3	
• Subacute Care	24	7.7	33	5.2	
Patient outcomes					
• In-hospital death	11	3.3	8	1.2	0.022
• ≥1 MET call during admission	40	21.1	57	8.6	0.081
• Need for ICU care during admission	2	0.6	10	1.5	0.217

* Chi Square

[#] 15 patients (11 Cases and 4 cases) were emergency admissions for combined mental health and medical / surgical issues; these patients were counted once in each category

Table 3: Triage category and substance affects for emergency department patients (n=228)

	Cases (n=77)		Controls (n=151)		p*
Triage category					
• Category 1 (immediate emergency care)	4	5.2	0	0	
• Category 2 (emergency care <10 minutes)	30	39.0	27	17.9	<0.001
• Category 3 (emergency care <30 minutes)	35	45.5	81	53.6	
• Category 4 (emergency care <60 minutes)	6	7.8	42	27.8	
• Category 5 (emergency care <2 hours)	2	2.6	1	0.7	
Substance affected					
• Alcohol	38	50.0	8	4.9	<0.001
• Drugs	27	36.5	3	1.8	<0.001

* Chi Square

Table 4: Nature of physiological assessments documented in the 12 hours preceding Code Grey

	Documented assessments

Parameter	Cases (n=333)		Controls (n=666)		p*
	n	%	n	%	
Systolic Blood Pressure	244	73.3	573	86.0	<0.001
Respiratory Rate	242	72.7	568	85.3	<0.001
Heart Rate	242	72.7	568	85.3	<0.001
Oxygen Saturation	239	71.8	562	84.4	<0.001
Conscious State (AVPU)	230	69.1	534	80.2	<0.001
Temperature	227	68.2	548	82.3	<0.001
Pain	196	58.9	480	72.1	<0.001
Confusion	137	41.1	57	8.6	<0.001
Work of Breathing	82	24.6	195	29.3	0.121
Skin Colour	53	15.9	130	19.5	0.165
Skin Moisture	50	15.0	119	17.9	0.257

* Chi Square

Table 5: Frequency of physiological assessments documented in the 12 hours preceding Code Grey

Parameter	Number of documented assessments						
	Cases (n=333)			Controls (n=666)			
	n	Mdn	IQR	n	Mdn	IQR	p*
Systolic Blood Pressure	879	2	1 - 3	1853	2	1 - 4	0.017
Heart Rate	873	2	1 - 3	1817	2	1 - 4	0.017
Oxygen Saturation	861	2	1 - 3	1801	2	1 - 4	0.022
Respiratory Rate	857	2	1 - 3	1808	2	1 - 4	0.016
Conscious State (AVPU)	874	1	0 – 3	1643	2	1 - 3	0.008
Temperature	672	1	0 – 3	1581	2	1 - 3	0.001
Pain	558	1	0 – 2	1513	2	0 - 3	<0.001
Confusion	264	0	0 - 2	84	0	0 - 0	<0.001

Work of Breathing	160	0	0	440	0 - 1	0 - 1	0.189
Skin Colour	71	0	N/A	207	0	N/A	0.241
Skin Moisture	71	0	N/A	199	0	N/A	0.357

* Mann-Whitney U

Table 6: Physiological abnormalities in the 12 hours preceding Code Grey

Parameter	Cases (n=333)			Controls (n=666)			
	Patients with documented assessment	Patients with ≥ 1 abnormal measures		Patients with documented assessment	Patients with ≥ 1 abnormal measures		
	n	n	%	n	n	%	p*
Respiratory Rate	242	35	14.5	568	44	7.7	0.003
Oxygen Saturation	239	42	17.6	562	106	18.9	0.667
Heart Rate	243	87	35.8	568	120	21.1	<0.001
Systolic Blood Pressure	244	112	45.9	573	274	47.8	0.615
Conscious State	231	41	17.7	534	35	6.6	<0.001
Temperature	217	10	4.4	548	19	3.5	0.531
Pain	196	59	30.1	480	139	29.0	0.767
Confusion	333	137	41.4	664	57	8.6	<0.001
Work of Breathing	82	4	4.9	195	20	10.2	0.149
Skin Colour	53	3	5.7	130	8	6.2	0.899
Skin Moisture	50	5	10.0	119	4	3.4	0.079

* Chi Square

Table 7: Factors associated with 12 hours preceding a Code Grey activation

	OR	95% CI	p
Confusion	16.508	9.923 - 27.463	<0.001
Police involved in transport to hospital	4.221	1.576 - 11.303	0.004
Abnormal respiratory rate in preceding 12 hours	2.564	1.374 - 4.786	0.003
Male gender	2.345	1.549 - 3.552	<0.001
Abnormal heart rate in preceding 12 hours	1.603	1.024 - 2.509	0.039
Age	0.972	0.962 - 0.983	<0.001
Abnormal conscious state in preceding 12 hours	1.228	0.649 - 2.323	0.528
Emergency mental health admission	1.191	0.579 - 2.449	0.635
Compulsory treatment order in place prior to admission	0.434	0.168 - 1.120	0.084