

## TITLE PAGE

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**Title:** Effect of delirium motoric subtypes on administrative documentation of delirium in the surgical intensive care unit

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**Acknowledgments**

Investigators would like to thank Harlan Sparrow IV, MA (Senior Outcomes Analyst II, Quality, Houston Methodist System) and Bob Smith, MA (Epic Clarity Project Team, Houston Methodist System) for conducting queries of the electronic medical record to provide data for this study. The authors would like to thank Mary Thomas, MSN, RN (Manager, Clinical Documentation Management Program, Houston Methodist Hospital) and Tessie Bautista, CCS, (Health Information Management Manager, Coding and Data Management, AHIMA-Approved ICD-10-CM Trainer, Houston Methodist Hospital) for advising on administrative database and coding process. Investigators would like to thank the Department of Pharmacy at Houston Methodist Hospital for providing administrative, intellectual, and information technology support. Investigators would like to thank the Texas Southern University Undergraduate Research Program for the awarded stipend to Lan N. Bui to support her effort in the study.

## ABSTRACT

**Purpose:** This study compares the proportions of surgical intensive care unit (ICU) patients with delirium detected using the Confusion Assessment Method for the ICU (CAM-ICU) who received administrative documentation for delirium using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes, stratified by delirium motoric subtypes.

**Methods:** This retrospective cohort study was conducted at a surgical ICU from 06/2012 to 05/2013. Delirium was assessed twice daily and was defined as having  $\geq 1$  positive CAM-ICU ratings. Delirious patients were categorized into hyperactive/mixed and hypoactive subtypes using corresponding Richmond Agitation Sedation Scales (RASS). Administrative documentation of delirium was defined as having  $\geq 1$  of 32 unique ICD-9-CM codes. Proportions were compared using Pearson's Chi-square test.

**Results:** Of included patients, 40% (423/1055) were diagnosed with delirium, and 17% (183/1055) had an ICD-9-CM code for delirium. The sensitivity and specificity of ICD-9-CM codes for delirium were 36% and 95%. ICD-9-CM codes for delirium were available for 42% (95% CI 35%-48%; 105/253) of patients with hyperactive/mixed delirium and 27% (95% CI 20%-34%; 46/170) of patients with hypoactive delirium (relative risk = 1.5; 95% CI 1.2-2.0;  $p = 0.002$ ).

**Conclusions:** ICD-9-CM codes yielded a low sensitivity for identifying patients with CAM-ICU positive delirium and were more likely to identify hyperactive/mixed delirium compared with hypoactive delirium.

**KEYWORDS:** Delirium; ICD-9-CM; CAM-ICU; delirium motoric subtypes; surgical ICU

## INTRODUCTION

Delirium is an acute dysfunction of a patient's mental status and is recognized as a major public health issue for critically ill patients [1-4]. Delirium is an independent predictor of mortality, prolonged time on mechanical ventilation, prolonged intensive care unit (ICU) stay, prolonged hospital stay, and prolonged cognitive impairment in critically ill patients [5-10]. Delirium costs the United States health care system 4 to 16 billion dollars annually [11]. The underlying pathophysiology of delirium in the critical ill patients is still poorly understood [7,12,13]. Multiple risk factors are associated with the development of delirium in the ICU including preexisting disorders (dementia, history of hypertension, alcoholism, high severity of illness) and precipitating conditions (coma and benzodiazepine use) [14-17].

When delirium is detected using the validated Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) screening tool, the prevalence of delirium among ICU patients is 23% to 60% [5,6,18]. However, in a retrospective observational cohort study conducted at 71 United States academic medical centers, Swan and colleagues reported that the prevalence of delirium is only 6% (10,034/164,996) among hospitalizations with at least one day in the ICU, using a query set of 21 unique *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes [19]. This prevalence is much lower than what is expected in this critically ill population [20-24]. It is unclear if this discrepancy is due to lack of systematic screening for delirium or if ICD-9-CM codes have a low sensitivity for identifying patients with delirium.

The Richmond Agitation-Sedation Scale (RASS) is a 10-point scale, ranging from (−5) unarousable to (+4) combative, that is used to evaluate level of consciousness in critically ill patients. The RASS can be used in combination with the CAM-ICU to further categorize delirious patients into 3 motoric subtypes: hyperactive, hypoactive, and mixed [18,20,21,23-25]. The prevalence of pure hyperactive delirium (1% -

23%) is much lower than the prevalence of hypoactive (19% - 68%) and mixed subtypes (14% - 55%) [18,20-28]. Compared to patients with hypoactive or mixed motoric delirium subtypes, patients with hyperactive delirium have shorter lengths of hospital stay and decreased in-hospital mortality [22-24,27]. Hyperactive and mixed subtypes are more readily recognized because of their array of symptoms of agitation and combative behaviors, while hypoactive delirium is often overlooked due to a subdued and lethargic presentation [20-24]. We hypothesized that surgical ICU patients with either hyperactive or mixed (hyperactive/mixed) subtypes of delirium would be more likely to receive administrative documentation for delirium compared to patients with hypoactive delirium. The objective of this study is to compare the proportions of patients with hyperactive/mixed delirium that had ICD-9-CM codes for delirium versus those with hypoactive subtype that had ICD-9-CM codes for delirium.

## **METHODS**

### **Study Design and Population**

This retrospective cohort study included patients who were 18 years or older and were admitted to a 24-bed surgical ICU at an 800-bed tertiary academic medical center from 1 June 2012 to 31 May 2013. If a patient was admitted to the hospital multiple times during the enrollment period, only the index hospital admission was included. Although previous research indicated appropriate compliance with delirium screening using the CAM-ICU in this surgical ICU [18], delirium-screening compliance varied in the other ICUs at this hospital. Therefore, patients admitted to ICUs other than the surgical ICU during their hospital admission were excluded. Patient with less than 24 hours of surgical ICU care, who were never assessed for delirium using the CAM-ICU, and who did not have any corresponding RASS scores available at the time of the CAM-ICU assessment were also excluded. The study was reviewed by the Institutional Review Board and was granted a waiver of informed consent.

### **Delirium Screening and Motoric Subtype Classification**

According to the standard practice of our surgical ICU, bedside nurses who received extensive training on the CAM-ICU [18] screened all patients for delirium using the CAM-ICU every 12 hours. The CAM-ICU results were categorized as positive, negative, or unable to assess. Patients met the diagnostic criteria for delirium if they received one or more positive CAM-ICU ratings anytime during the surgical ICU stay [6,5,18]. Patients who screened positive for delirium using the CAM-ICU were further categorized into three motoric subtypes using corresponding RASS scores. If all corresponding RASS scores, recorded at the same time as positive CAM-ICU ratings, were from 1 to 4, the patient was classified as having the hyperactive subtype. If all corresponding RASS scores were from -3 to 0, the patient was classified as having the hypoactive subtype. If a patient had corresponding RASS scores that were both from 1 to 4 and from -3 to 0, the patient was classified as having the mixed subtype. If all corresponding RASS scores were



-4 or -5, the patient was comatose and excluded from delirium subtype categorization [20,21,23-25]. Because of the low prevalence of pure hyperactive patients reported in this surgical ICU [18] and other studies [20-27], patients with hyperactive delirium were combined with patient who had mixed delirium to form the hyperactive/mixed group.

### **ICD-9-CM Codes for Delirium**

There are 7 explicit ICD-9-CM codes that contain the word “delirium” in the code’s description, such as “293.0 drug-induced delirium”. However, there are many implicit ICD-9-CM codes, such as “348.31 metabolic encephalopathy,” that do not contain the word “delirium” in the code’s description [28]. Previous studies have used various combinations of explicit and implicit codes to identify delirium, without clear consensus of codes (Online Resource 1). Therefore, we included all codes that were used in at least two literature sources. Our literature sources included previous studies that aimed to identify delirium using ICD-9-CM codes [18,29-35], the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) [36], and codes provided by our institution’s Health Information Management (HIM) department. Using this method, we selected 32 unique ICD-9-CM codes for delirium: 290.11-290.13, 290.20, 290.3, 290.41-290.43, 290.8, 290.9, 291.0, 292.0-292.2, 292.81, 292.82, 293.0-293.9, 348.30, 348.31, 348.39, 349.82, 780.02, 780.09 and 780.97 (Online Resource 2).

### **Sources of Data**

Demographics, diagnosis codes, procedure codes, length of stay (LOS), and in-hospital mortality data were obtained from the institution’s electronic medical and administrative record. Results of CAM-ICU ratings and RASS scores were extracted from the institution’s electronic medical record by study investigators. The ICD-9-CM codes utilized to detect comorbidities of mechanical ventilation, dialysis, and dementia are listed in Online Resource 3.

Information on admission severity of illness was obtained from the Clinical Database/ Resource Manager at the University Health System Consortium (UHC) [37]. The UHC Clinical Database/ Resource Manager includes patient severity of illness on admission generated from 3M™ All Patient Refined Diagnosis Related Groups software (3M Health Information Systems, Salt Lake City, UT, USA) which uses ICD-9-CM diagnosis and procedural codes present on admission to classify patients into four categories of severity of illness: mild, moderate, major and extreme[38].

### **Study Outcomes**

The primary outcome of this study was to compare the proportions of surgical ICU patients with hyperactive/mixed versus hypoactive delirium who received administrative documentation for delirium using ICD-9-CM codes. The secondary outcome was to describe the performance characteristics of ICD-9-CM codes for detecting delirium compared to the standard reference of one or more positive CAM-ICU ratings.

### **Statistical Analysis**

Descriptive statistics were generated for patients' demographic and clinical characteristics using percentages for nominal data, means ( $\pm$  standard deviation [SD]) and medians (interquartile range [IQR]) for continuous data that were normally distributed and not normally distributed, respectively. Continuous variables were analyzed using unpaired Student's *t* test. Categorical variables were compared using the Pearson's Chi-squared test. To describe the performance characteristics of ICD-9-CM codes for detecting delirium, we calculated sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy using one or more positive CAM-ICU rating as the standard reference. The primary

analysis was conducted using the Pearson's Chi-squared test. Two-sided  $p$  value of 0.05 or lower is used to indicate statistical significance.

It was estimated that 192 CAM-ICU positive patients would provide 80% power using Pearson's Chi-squared test (two-sided 5% significance) to detect a 20% difference in the proportions of patients who would have at least one ICD-9-CM code for delirium based on motoric subtype, assuming that 65% of patients with hyperactive/mixed delirium had at least one ICD-9-CM code for delirium.

Sensitivity analyses were conducted to assess the robustness of results from the primary analysis. In one sensitivity analysis, the diagnostic criterion of delirium was revised to be more rigorous. Two or more positive CAM-ICU ratings during surgical ICU care (instead of one or more) were required for patients to receive a diagnosis of delirium. In a second sensitivity analysis, we employed a multivariable logistic regression model to assess independent predictors of receiving ICD-9-CM codes for delirium. This model included quantity of positive CAM-ICU ratings (1, 2, 3 to 6, 7 to 13 and  $\geq 14$ ), degrees of sedation (light and deep), and degrees of agitation (non-severe and severe). Light sedation was defined as a minimum RASS score of -1 to -3, and deep sedation was defined as a minimum RASS score of -4 or -5. Non-severe agitation was defined as a maximum RASS score of 1, and severe agitation was defined as a maximum RASS score of 2 to 4. Hosmer-Lemeshow goodness of fit test was used to assess model fit and area under receiver operating characteristic (ROC) curve was used to assess discriminatory ability of the logistic regression model. All analyses were performed using Stata version 13 (StataCorp LP, College Station, TX, United States).

## RESULTS

### Study Outcomes

Of 1,960 hospital admissions with surgical ICU care during the one-year screening period, 1,055 unique patients were included (Fig. 1). Delirium was diagnosed using the CAM-ICU in 40.1% ( $n = 423$ ) of patients, and ICD-9-CM code documentation of delirium was present in 17.3% ( $n = 183$ ). Of 423 patients with CAM-ICU positive delirium, 59.8% ( $n = 253$ ) had hyperactive ( $n = 3$ ) or mixed ( $n = 250$ ) subtypes and 40.2% ( $n = 170$ ) had the hypoactive subtype.

Of patients with delirium, ICD-9-CM codes for delirium were present in 42% (95% CI 35%-48%; 105/253) of patients with hyperactive/mixed delirium and 27% (95% CI 20%-34%; 46/170) of patients with hypoactive delirium (relative risk = 1.5; 95% CI 1.2-2.0;  $p = 0.002$ ) (Fig. 2).

One hundred and fifty-one patients diagnosed with delirium using the CAM-ICU (105 hyperactive/mixed and 46 hypoactive) had an ICD-9-CM code for delirium. Thirty one patients had an ICD-9-CM code for delirium but did not have a positive CAM-ICU rating. Compared with a reference standard of  $\geq 1$  CAM-ICU positive rating, this set of 32 ICD9-CM codes for delirium had a sensitivity of 36% and specificity of 95% (Table 1).

Compared to non-delirious patients, delirious patients were older, more likely to have baseline dementia, were more likely to be on mechanical ventilation and dialysis, had longer lengths of stay in the ICU and hospital, and experienced an increased mortality (all,  $p < 0.001$ ) (Table 2). Compared to the hypoactive delirium motoric subtype, patients with hyperactive or mixed motoric subtypes had longer lengths of stay in the ICU and hospital (both,  $p < 0.001$ ), had more CAM-ICU assessments ( $p < 0.001$ ), and were more likely to be on mechanical ventilation ( $p < 0.001$ ) and dialysis ( $p = 0.004$ ).

Only 12 codes out of the set of 32 ICD-9-CM codes for delirium were ever used in administrative data of the included patients (Table 3). Code 348.31 for “metabolic encephalopathy” was the most commonly used code (8.8% [93/1055]) and was the best predictor of delirium (proportion with code; 19% [81/423] of delirious patients versus 1.9% [12/632] of non-delirious patients, odds ratio = 12.2,  $p < 0.001$ ). Among patients with delirium, the “metabolic encephalopathy” appeared to be associated with the hyperactive/mixed motoric subtype (proportion with code; 23.3% [59/253] of hyper/mixed patients versus 12.9% [22/170] of hypoactive patients, odds ratio = 2.0,  $p = 0.08$ ).

### **Sensitivity Analyses**

The sensitivity analysis that modified the diagnostic criterion for delirium to  $\geq 2$  positive CAM-ICU ratings during surgical ICU care supported the primary analysis results. In this sensitivity analysis, ICD-9-CM codes for delirium were present in 44% (95% CI 37%-51%; 99/225) of patients with hyperactive/mixed delirium and 29% (95% CI 21%-38%; 36/124) of patients with hypoactive delirium (relative risk = 1.5; 95% CI 1.1-2.1;  $p = 0.006$ ). The performance characteristics of 32 ICD9-CM codes for identifying delirium using the modified diagnostic criterion yielded a sensitivity of 39% and specificity of 93%.

Using a multivariable logistic regression model that included quantity of positive CAM-ICU ratings, degree of sedation, and degree of agitation, number of positive CAM-ICU ratings and presence of severe agitation were significant independent predictors of having ICD-9-CM codes for delirium. Patients with severe agitation were 1.9 times more likely to receive an ICD-9-CM code for delirium compared to patients without agitation (odds ratio = 1.9 [95% CI 1.1-3.3],  $p = 0.02$ ) (Table 4). This sensitivity analysis confirmed our hypothesis that the presence of agitation (i.e. hyperactive delirium) was associated with increasing chance for patients to receive administrative documentation using ICD-9-CM code for delirium.

## **DISCUSSION**

This is the first study to evaluate the effects of the association between delirium motoric subtypes and ICD-9-CM codes for delirium. Our study reports that patients with hyperactive or mixed delirium are 50% more likely received ICD-9-CM codes for delirium compared to patients with hypoactive delirium.

### **Lack of accurate documentation of delirium with ICD-9-CM codes**

Our study provides evidence that ICD-9-CM codes severely underestimate the prevalence of delirium in surgical ICU patients among patients who are routinely screened with the CAM-ICU screening tool. A prospective validation study conducted by Inouye and colleagues showed a similar finding in general hospitalized patient population. Of 919 hospitalized elderly patients, only 3% (3/919) had an ICD-9-CM code for delirium comparing to 12.5% (115/919) were diagnosed for delirium using Confusion Assessment Method (CAM) [32]. When administrative data is used for ICU delirium research, lack of accurate documentation of delirium with ICD-9-CM codes may lead to biased and low estimates of the delirium prevalence, biased estimates of associations with risk factors, biased estimates of outcomes associated with delirium, and under-recognition of the delirium's significance to public health. To improve the accuracy of administrative data for estimating the prevalence of delirium, we recommend that health information management staff be educated about the availability of the direct cognitive assessment tools such as the CAM-ICU and health care providers should use the direct cognitive assessment tools in addition to their clinical judgment to diagnose and document delirium in the medical record.

### **Mixed subtype delirium and duration of surgical ICU stay**

An interesting finding of this study is the association between delirium motoric subtype and duration of surgical ICU stay. Compared to hypoactive, hyperactive/mixed delirious patients had longer surgical ICU stays ( $11 \pm 12$  versus  $5 \pm 5$  days,  $p < 0.001$ ). However, it is unclear if having a mixed motoric subtype

actually caused a longer LOS or if a longer LOS increased the chances of being classified as the mixed motoric subtype. For example, if a patient only has one positive CAM-ICU rating, then the patient can only be classified as either hyperactive or hypoactive, and cannot not be classified as mixed. This attribute of the classification system introduces a small association between subtype and LOS. Additionally, if a patient remains in delirium for several days with corresponding RASS score  $\leq 0$ , the patient would be classified as hypoactive delirium. However, if the patient has one corresponding RASS score  $> 0$  at any point during the course of delirium, that patient gets reclassified from hypoactive delirium to mixed delirium. This creates a bias by which patients who have initial hypoactive presentation with longer durations of delirium (e.g.  $> 3$  days) are systematically reclassified from hypoactive delirium to mixed delirium. The same reclassification can occur for those who originally present with hyperactive delirium, but this had no impact on our study as patients with hyperactive and mixed delirium were grouped together. To adjust for difference in the duration of delirium, we employed a multivariable logistic regression model to assess the independent predictors of receiving an ICD-9-CM code for delirium. Rather than included the motoric subtype in the model, we included variables denoting the largest degree of sedation (surrogate for hypoactive subtype) and largest degree of agitation (surrogate for hyperactive/mixed subtype). We found that duration of delirium (counts of positive CAM-ICU ratings) and severe agitation were independent predictors of receiving an ICD-9-CM code for delirium, which supported our hypothesis that agitated patients are more likely to receive ICD-9-CM codes for delirium.

### **International Classification of Disease, Tenth revision**

The United States Department of Health and Human Services released an interim final rule that require the use of *International Classification of Disease, Tenth revision, Clinical Modification* (ICD-10-CM) beginning October 1, 2015. The ICD-10-CM codes are more specific, which may impact the accuracy of documenting delirium. There are 33 unique ICD-10-CM codes that contain the word “delirium”, compared

to 7 of ICD-9-CM; and there are 19 ICD-10-CM codes that contain the word “encephalopathy” in their description, compared to 18 of ICD-9-CM. The list of these ICD-10-CM codes and their description are listed in the Online Resource 4. Even though many United States hospitals are adopting the new coding systems, we still believe our study is relevant for 2 reasons: 1) the issues identified in this study may persist after implementation of ICD-10-CM codes and 2) investigators may continue to use ICD-9-CM data for retrospective studies.

### **Strengths**

There were several strengths in our study’s design. First, we conducted a thorough literature review and have identified a list of 32 explicit and implicit ICD-9-CM codes that can reasonably be indicative of delirium. Secondly, patients were actively screened for delirium, as recommended in the 2013 Society of Critical Care Medicine Pain, Agitation, and Delirium (PAD) clinical practice guidelines [28], with the CAM-ICU during surgical ICU care. These strengths allowed us to accurately assess the performance characteristics of ICD-9-CM codes using the validated CAM-ICU as the standard preference.

### **Limitations**

Several limitations must be considered when interpreting the results of this retrospective observational study. This study was conducted in a single ICU at a tertiary hospital, which may have limited the generalizability of our results. Administrative codes were recorded for each hospitalization and do not differentiate delirium that occurred within the surgical ICU from delirium that occurred outside of the ICU. Additionally, delirium screening was not routinely conducted among general medical wards outside of the ICU. Due to these two limitations, we were unable to estimate the true prevalence of delirium during the entire hospitalization, and used the prevalence of delirium during surgical ICU care, where routine CAM-ICU screening occurred, as a surrogate marker.



## **CONCLUSION**

In conclusion, ICD-9-CM codes had a sensitivity of 36% for documenting delirium in surgical ICU patients, and the use of ICD-9-CM codes will likely underestimate the prevalence of delirium. Of patients with delirium detected using the CAM-ICU, ICD-9-CM codes for delirium were present in 42% of patients with hyperactive/mixed delirium and 27% of patients with hypoactive delirium. Patients with hyperactive or mixed delirium subtypes were 50% more likely to receive administrative documentation for delirium using ICD-9-CM codes compared with patients with the hypoactive delirium subtype.

**Compliance with Ethical Standard**

**Funding:** LNB received an intramural grant from Texas Southern University, Houston, Texas, USA supporting her efforts on this study and a travel grant from Texas Society of Critical Care Medicine (SCCM) to present study result at SCCM Congress at Phoenix, Arizona, USA in January 2015. Other authors received no other financial support for the research, authorship, and/or publication of this article.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Ethical Approval:** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study formal consent is not required.

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## FIGURE CAPTIONS & FOOTNOTES

**Fig 1** Flow diagram of patient inclusion

<sup>a</sup>Patients with delirium:  $\geq 1$  positive CAM-ICU ratings during surgical ICU stay; <sup>b</sup> Patients without delirium: no positive CAM-ICU ratings during surgical ICU stay; <sup>c</sup> hyperactive delirium: all corresponding RASS scores, recorded at the same time as positive CAM-ICU ratings, were from 1 to 4; mixed delirium: corresponding RASS scores that were both 1 to 4 and -3 to 0; <sup>d</sup> Hypoactive delirium: all corresponding RASS scores were -3 to 0.

ICU: Intensive care unit; CAM-ICU: Confusion Assessment Method for the ICU; RASS: Richmond Agitation-Sedation Scale

**Fig 2** Proportion of patients with ICD-9-CM documentation of delirium by delirium motoric subtype.

\*Surgical ICU patients with hyperactive or mixed delirium motoric subtypes were more likely to receive ICD-9-CM documentation of delirium compared to patients with the hypoactive delirium motoric subtype (relative risk = 1.5 [95% CI 1.2 to 2.0],  $p = 0.002$ ).

ICD-9-CM: *International Classification of Diseases, Ninth Revision, Clinical Modification*; ICU: Intensive care unit