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Identification of acute brain failure using electronic medical records

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ABSTRACT

Purpose: Up to 80% of critically ill patients have acute neurologic dysfunction syndromes. We evaluated interrater reliability between the examination by the investigator and the charted assessment by the nurse because the accuracy and reliability of detailed data sets extracted from the electronic medical records represents a keystone for creating EMR-based definitions.
Materials and methods: We conducted a prospective observational study of intensive care unit (ICU) patients to assess the reliability of charted Confusion Assessment Method for the ICU, Glasgow Coma Scale (GSC), Full Outline of Unresponsiveness, and Richmond Agitation Sedation Scale (RASS) scores, and a composite measure of ABF defined as new-onset coma or delirium. Trained investigator blinded to nursing assessments performed the neurologic evaluations that were compared with nursing documentation.
Results: A total of 202 observations were performed in 55 ICU patients. Excellent correlation was noted for GCS and Full Outline of Unresponsiveness scores on Bland-Altman plots (Pearson correlation 0.87 and 0.92, respectively). Correlation for Confusion Assessment Method for the ICU was also high (κ= 0.86; 95% confidence interval [CI], 0.70-1.01). Richmond Agitation Sedation Scale had good agreement when scores were dichotomized as oversedated (less than −2) vs not oversedated, with κ= 0.76 (95% CI, 0.54-0.98). Investigator assessment and nurse charting were highly concordant (κ= 0.84; 95% CI, 0.71-0.99).
Conclusion: Neurologic assessments documented on the EMR are reliable.

1. Introduction

Delirium affects up to 80% of critically ill patients and negatively impacts prognosis [1]. It is associated with both poor short- and long-term outcomes, such as increased length of intensive care unit (ICU) stay, prolonged invasive mechanical ventilation, increased mortality and costs, and long-term cognitive impairment [2–5]. The recently published Society of Critical Care Medicine Pain, Agitation and Delirium guidelines recommend routine monitoring of delirium in adult ICU patients using validated bedside instruments [6].

There are several validated tools to identify delirium, most notably the Confusion Assessment Method ICU (CAM-ICU) [7]. Yet, evaluation of delirium requires assessment of thought content, and therefore, its recognition is confounded in patients with depressed level of consciousness and those who are deeply sedated. As a result, delirium is both overdiagnosed and underdiagnosed [8–11]. Reduced level of consciousness can be reliably defined using the Glasgow Coma Scale (GCS) or the Full Outline of Unresponsiveness (FOUR score), both of which have been extensively validated in the ICU [12,13]. The Richmond Agitation Sedation Score (RASS) can be effectively used to determine the level of sedation. Because brain dysfunction in patients with critical illness can manifest with alterations in the level and content of consciousness, delirium does not encompass the entire spectrum of cerebral disorders in these patients. An end point that includes delirium (ie, alteration in the content of consciousness) and diminished level of consciousness (drowsiness, stupor, or coma) is necessary to capture the spectrum of acute brain failure (ABF).

The widespread adoption of electronic medical records (EMRs) allows for novel research into common conditions using electronic search strategies [14,15]. We hypothesized that ABF and its components could be reliably identified using EMR queries and "big data" research methods. Any sort of EMR query, however, is contingent upon the accuracy of the data being entered into the patient records. Therefore, it was necessary to first validate neurologic assessment documentation before making an electronic search algorithm.

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This is a validation study in which we assessed the accuracy of nurse-determined neurologic scoring (CAM-ICU, GCS, FOUR score, and RASS).

2. Materials and methods

2.1. Subjects

Because some patients had altered mental status, we were waived from obtaining informed consent from subjects but required to obtain a delayed consent from a legally authorized representative. Subjects were recruited from the Mayo Clinic's medical, surgical, cardiac, and trauma ICUs.

2.2. Study population

This study was approved as minimal risk research by the Mayo Clinic Institutional Review Board. Subjects were adult patients (age > 18 years) admitted to the Mayo Clinic medical, cardiac, or surgical ICUs between July and December 2014. Patients admitted with primary neurological disease (eg, stroke, head trauma) were excluded.

2.3. Study methods and personnel

The research team consisted of 2 critical care fellows trained in neurologic assessments (DRR and PKG). The team used standard printed reference cards for each neurologic assessment. While conducting this prospective study and randomizing patients, we preferentially examined patients with abnormal examination so that we can better assess the differences in the abnormal scores between the physician and nurses. Both researchers were assessed for competence by an expert neurocritical care physician (AAR) before the start of the study. An additional researcher (TS) was assigned to alert the clinical researchers when a subject was due for an examination to keep the examiners blinded to the charted values. Thus, 1 researcher would randomly identify patients with normal or abnormal neurologic scores across participating ICUs and instruct another researcher which subjects needed to be examined. The researcher performing the examination was thus blinded to the nurse assessment.

The tools assessed in the present study included GCS, FOUR score, CAM-ICU, and RASS. Glasgow Coma Scale and FOUR scores are measured every 4 hours on every patient. Richmond Agitation Sedation Scale is performed on initiation of sedation and at least hourly until the sedation goal is reached. Confusion Assessment Method ICU is evaluated at least twice daily, and frequency increased if a patient has an acute change in mental status. The increase can be to every 4, 2, or 1 hour. This is specifically ordered by the medical team on a case-by-case basis. All evaluations are performed with the assistance of a computerized scoring guide and charted directly into the EMR. Unit staff was not made aware that research staff would randomly perform prospective neurologic assessments after nursing assessments to minimize Hawthorne effect. The time delay in performing these assessments between nurses and research study fellows was usually around 30 minutes and never exceeded 60 minutes. The results of the prospective examinations were considered the criterion standard and compared to the recorded nursing assessments on the EMR to determine the reliability of the latter.

2.4. Acute brain failure

Our preliminary algorithm for identifying ABF had 3 components; a measurement for confounding sedation (RASS less than −2), a level of consciousness component (GCS or FOUR score less than maximum achievable for that patient, accounting for intubated status), and a thought content component (CAM-ICU positive), as explained in Fig. 1. For this reliability study, we only evaluated interrater reliability between the examination by the investigator and the charted assessment by the nurse. The details are shown in Fig. 1.

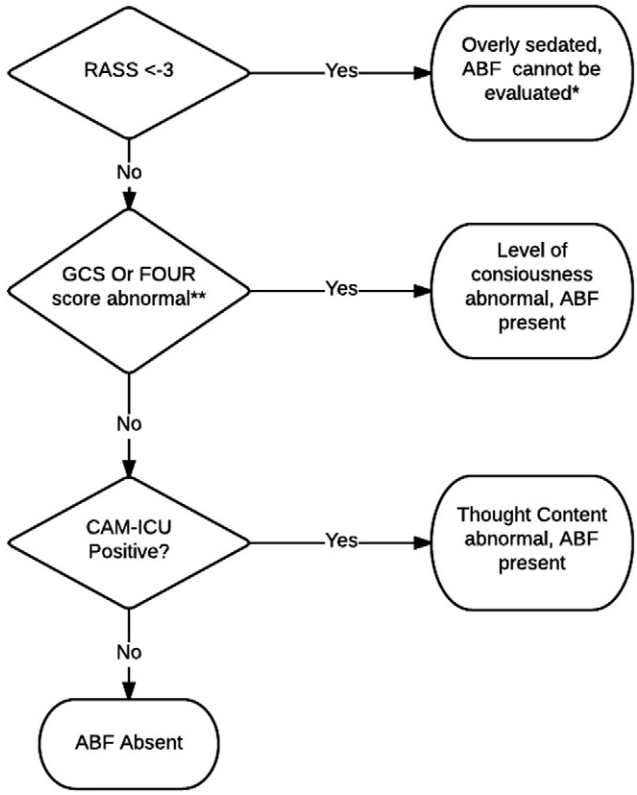

Fig. 1. Acute brain failure identification algorithm. *When data are insufficient to categorize it as ABF, it is scored as "not present." **Abnormal GCS or FOUR score depends on patient status. For intubated patients who cannot be assessed for verbal components, less than 13 FOUR score or less than 12 GCS is abnormal. For all others, GCS less than 15 and FOUR score less than 16 is scored as abnormal.

2.5. Statistical analysis

Bland-Altman plots were used to evaluate the presence of bias and interobserver variability between nursing and researcher assessments on continuous and categorical data [16]. The κ coefficient was used to evaluate interobserver variability for binary data. For binary data, values were dichotomized into "abnormal" vs "not abnormal." The thresholds for "abnormal" were GCS less than 15 for nonintubated patients, GCS less than 11 for intubated patients, FOUR score less than 16 for nonintubated patients, and FOUR score less than 13 for intubated patients. The threshold for coma was GCS equal to or less than 8. Delirium was defined by a positive CAM-ICU. *Deep sedation* was defined as a RASS −3 or lower. Deeply sedated patients could not be further assessed. Acute brain failure was considered present when GCS or FOUR scores were abnormal or the CAM-ICU was positive. Analyses were performed using JMP 10 software (SAS Institute, Inc, Cary, NC).

3. Results

A total of 202 observations were performed in 55 patients. Patient characteristics are shown in Table 1. No patients were lost due to withdrawal of consent. One patient was omitted from analysis because of a drastic change in clinical status between the time of nurse and researcher assessments, which had required administration of large sedative doses. The details are presented in Table 1 and Fig. 2.

3.1. Glasgow Coma Scale score

Glasgow Coma Scale scores were obtained on all 55 patients, and 30 of them had positive ones. Glasgow Coma Scale scores showed a positive Pearson correlation at 0.87, with a mean difference of 0.35