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Delirium in the intensive care setting: A reevaluation of the validity of the CAM–ICU and ICDSC versus the DSM–IV–TR in determining a diagnosis of delirium as part of the daily clinical routine

SOENKE BOETTGER, M.D.,[1,*] DAVID GARCIA NUÑEZ, M.D.,[1,2,*] RAFAEL MEYER, M.D.,[3] ANDRÉ RICHTER, M.D.,[1] SUSANA FRANCO FERNANDEZ, M.D.,[4] ALAIN RUDIGER, M.D.,[4] MARIA SCHUBERT, R.N., PH.D.,[5] AND JOSEF JENEWEIN, M.D.[1]

[1]Department of Psychiatry and Psychotherapy, University Hospital of Zurich, University of Zurich, Zurich, Switzerland
[2]University Hospital Basel, University of Basel, Basel, Switzerland
[3]Institute for Regenerative Medicine, University of Zurich, Schlieren, Switzerland
[4]Institute of Anaesthesiology, University Hospital Zurich, University of Zurich, Zurich, Switzerland
[5]Inselspital, University Hospital of Bern, Directorate of Nursing/MTT, Bern, Switzerland

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ABSTRACT

Background: In the intensive care setting, delirium is a common occurrence that comes with subsequent adversities. Therefore, several instruments have been developed to screen for and detect delirium. Their validity and psychometric properties, however, remain controversial.

Method: In this prospective cohort study, the Confusion Assessment Method for the Intensive Care Unit (CAM–ICU) and the Intensive Care Delirium Screening Checklist (ICDSC) were evaluated versus the DSM–IV–TR in the diagnosis of delirium with respect to their validity and psychometric properties.

Results: Out of some 289 patients, 210 with matching CAM–ICU, ICDSC, and DSM–IV–TR diagnoses were included. Between the scales, the prevalence of delirium ranged from 23.3% with the CAM–ICU, to 30.5% with the ICDSC, to 43.8% with the DSM–IV–TR criteria. The CAM–ICU showed only moderate concurrent validity (Cohen's $\kappa = 0.44$) and sensitivity (50%), but high specificity (95%). The ICDSC also reached moderate agreement (Cohen's $\kappa = 0.60$) and sensitivity (63%) while being very specific (95%). Between the CAM–ICU and the ICDSC, the concurrent validity was again only moderate (Cohen's $\kappa = 0.56$); however, the ICDSC yielded higher sensitivity and specificity (78 and 83%, respectively).

Significance of Results: In the daily clinical routine, neither the CAM–ICU nor the ICDSC, common tools used in screening and detecting delirium in the intensive care setting, reached sufficient concurrent validity; nor did they outperform the DSM–IV–TR diagnostic criteria with respect to sensitivity or positive prediction, but they were very specific. Thus, the non-prediction by the CAM–ICU or ICDSC did not refute the presence of delirium. Between the CAM–ICU and ICDSC, the ICDSC proved to be the more accurate instrument.

KEYWORDS: Delirium, Intensive care unit, Confusion Assessment Method for Intensive Care Units (CAM–ICU), Intensive Care Delirium Screening Checklist (ICDSC), DSM–IV–TR, Concurrent validity

Address correspondence and reprint requests to: Soenke Boettger, Department of Psychiatry and Psychotherapy, University Hospital of Zurich, University of Zurich, Ramistraase 100, 8091 Zurich, Switzerland. E-mail: soenke.boettger@usz.ch.
*Shared first authorship.

INTRODUCTION

Delirium is a usually transient neuropsychiatric syndrome characterized by an abrupt onset and fluctuating disturbances in consciousness and cognition, as well as problems in a range of noncognitive domains, including disturbances in motor behavior, emotionality, and the sleep/wake cycle, all caused by an underlying etiology (American Psychiatric Association, 2000; Trzepacz et al., 1999).

Delirium is the most common psychiatric syndrome across healthcare settings (Bucht et al., 1999; Inouye et al., 2014). In patients undergoing cardiac surgery, delirium affects up to 70% of patients (Gottesman et al., 2010; Norkiene et al., 2007). With respect to the intensive care setting, this occurrence reaches 80% in patients on mechanical ventilation (Pun & Ely, 2007). Furthermore, delirium often inflicts short-term (Rosen et al., 2002; Santos et al., 2004) and long-term adversities for the patients and the healthcare system (Koster et al., 2009). Among others, these include a prolonged stay on the ICU (Ely et al., 2004; Ouimet et al., 2007), more frequent or prolonged mechanical ventilation (Heymann et al., 2010), and increased rates of morbidity and mortality (Balas et al., 2009; Heymann et al., 2010), and, as long term-consequences, a decline in functionality and cognitive abilities (Bickel et al., 2008) and increased rates of institutionalization (Ouimet et al., 2007).

Several instruments have been developed to improve the screening for and detection of delirium. In the intensive care setting, the Confusion Assessment Method for the ICU (CAM–ICU) (Ely et al., 2001*a*) and the Intensive Care Delirium Screening Checklist (ICDSC) (Devlin et al., 2007) are commonly utilized instruments.

From a review (Gusmao-Flores et al., 2012) including 9 studies assessing delirium with the CAM–ICU with sample sizes ranging from 22 to 181 patients, with delirium rates between 22 and 87%, the sensitivity and specificity of the CAM–ICU ranged from 46.7 to 100% and 71.4 to 100%, respectively. The metaanalysis by Gusmao-Flores et al. (2012) indicates a sensitivity and specificity of 80 and 95.9%, respectively, the accuracy of which was considered excellent.

From this same review, the ICDSC was evaluated in four studies that included 59 to 126 patients. Delirium rates ranged from 16 to 38.6%, and the sensitivity as well as specificity ranged from 42.9–95.7 to 72.6–94.7%, respectively. The metaanalysis indicated a sensitivity and specificity of 74 and 81.9%, respectively, and the accuracy was considered good (Gusmao-Flores et al., 2012). From this review (Gusmao-Flores et al., 2012), the CAM–ICU was considered to be superior to the ICDSC overall.

However, from different studies, the sensitivity of the CAM–ICU and ICDSC were reported at lower rates, ranging from only 18 to 28% for the CAM–ICU and at 47% for the ICDSC (Neufeld et al., 2011; 2013).

Thus, although the CAM–ICU and ICDSC have been evaluated in various settings, some inconsistencies remain, particularly with studies documenting lower sensitivity toward delirium (Neufeld et al., 2013; van Eijk et al., 2009; 2011). Clinical observation actually supports these findings with respect to subsyndromal and milder forms of delirium. In order to confirm this hypothesis, in the following, these scales were evaluated versus the delirium diagnosis of the DSM–IV–TR (American Psychiatric Association, 2000), which was established in a large sample.

METHODS

Patients

All patients in this prospective, descriptive cohort study were recruited at the University Hospital of Zurich, a level one trauma center, with nearly 900 beds and 39,000 admissions yearly. The cardiovascular surgical patients in our study were recruited on a 12-bed intensive care unit between May of 2013 and April of 2015. The inclusion criteria were (1) being an adult, (2) being able to consent, and (3) being under intensive care management for more than 18 hours. The exclusion criteria were; (1) not being able to consent or (2) a history of substance use disorder, aiming to exclude delirium caused by withdrawal.

Procedures

All of our participants were informed of the rationale and procedures of the study, and an initial attempt to obtain written informed consent was made. In those patients unable to provide written consent at that time—either due to more severe delirium, their medical condition and sedation, or frailty—proxy assent from the next of kin or a responsible caregiver was obtained instead. After their medical condition improved, consent from these patients was obtained. Patients were excluded when participation and consent at the initial attempt or after improvement were refused.

The assessment of delirium was performed by four raters trained in the application of the DSM–IV–TR criteria, and interrater reliability was achieved.

The aim of our study was to evaluate the concurrent validity, sensitivity, and specificity, as well as the positive and negative prediction of the CAM–ICU

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and ICDSC, versus the DSM–IV–TR diagnostic criteria.

The baseline assessment included several steps. At first, the patient was interviewed. Second, the presence of delirium was determined according to DSM–IV–TR criteria (American Psychiatric Association, 2000). Third, nurses and doctors specifically trained in the administration of the ICDSC (Devlin et al., 2007) and CAM–ICU (Ely et al., 2001*a*) completed these scales.

If required, the assessment was completed by obtaining collateral information from the nursing and medical-surgical staff, the electronic medical record system (Klinikinformationssystem, KISIM, CisTec AG, Zurich), and family or caregivers.

Measurements

Diagnostic and Statistical Manual, 4th ed., Text Revision (DSM–IV–TR)

The diagnosis of delirium was determined using the DSM–IV–TR (American Psychiatric Association, 2000), including four criteria: (1) disturbance of consciousness (i.e., reduced clarity of awareness of the environment) with reduced ability to focus, sustain, or shift attention; (2) a change in cognition (such as memory deficit, disorientation, language disturbance) or the development of a perceptual disturbance that is not better accounted for by a preexisting, established, or evolving dementia; (3) the disturbance develops over a short period of time (usually hours to days) and tends to fluctuate during the course of the day; and (4) there is evidence from the history, physical examination, and laboratory findings that: (a) the disturbance was caused by the direct physiological consequences of a general medical condition, (b) the symptoms in criterion (a) developed during substance intoxication or during or shortly after a withdrawal syndrome, or (c) the delirium had more than one etiology.

The Confusion Assessment Method for the Intensive Care Unit (CAM–ICU)

The CAM–ICU (Ely et al., 2001*a*) is based on the CAM (Inouye et al., 1990), reflecting the DSM–III–R criteria (American Psychiatric Association, 1987), and designed for patients with limited communication abilities. This scale contains four features with two levels (absent and present): (1) acute onset and fluctuating course, (2) inattention, (3) altered level of consciousness, and (4) disorganized thinking. Feature 1 scores as absent or present; feature 2 includes "recognizing letters" scores as number of errors (more than two scores as present); feature 3 scores the Richmond Agitation Assessment Scale (RASS) other than alert and calm (RASS = 0) as present; and feature 4 includes simple questions and instructions, with a combined number of errors of more than one scored as present. Features 1 plus 2 and either 3 or 4 scored as present indicates presence of delirium. The nonverbal items achieve a lower sensitivity than the verbal items. Interrater reliability ranges from 0.79 to 0.95 (McNicoll et al., 2005).

The Intensive Care Delirium Screening Checklist (ICDSC)

The ICDSC (Devlin et al., 2007) is a screening instrument that includes eight items based on DSM–IV TR criteria specifically designed for the intensive care setting, and it has two score points: absent and present. This scale was designed for patients with limited communication abilities, such as intubated patients. The items include the assessment of (1) consciousness (comatose, soporose, awake, or hypervigilant); (2) orientation; (3) hallucinations or delusions; (4) psychomotor activity; (5) inappropriate speech or mood; (6) attentiveness; (7) sleep/wake cycle disturbances; and (8) fluctuation of symptomatology. The maximum score is 8, and scores of more than 3 indicate the presence of delirium. Each item is rated based on the patient's behavior over the previous 24 hours, and interrater reliability between intensive care staff was considered adequate (Bergeron et al., 2001).

Statistical Analysis

All statistical procedures were conducted using the Statistical Package for Social Sciences (SPSS, v. 22). Descriptive statistics were implemented for characterization of the study sample with respect to their sociodemographic and clinical variables, including a comparison of the included versus excluded patients. The inclusion criterion was performance of the CAM–ICU, ICDSC, and DSM–IV–TR in diagnosis.

In the next step, patients with delirium were compared to those without delirium using the same procedures. For the determination of differences between those with and without delirium, Student's t test was employed for variables on a continuous scale (such as the age of patients). For items on categorical scales (such as the presence of items on the CAM–ICU or ICDSC), Pearson's χ^2 was determined.

The interrater reliability with respect to a DSM–IV–TR diagnosis was determined by its corresponding Fleiss's κ, with perfect agreement defined as >0.80 (DeVellis, 2012).

The concurrent validity of the CAM–ICU and ICDSC was calculated versus the DSM–IV–TR diagnosis of delirium, and, in addition, the validity of the

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CAM–ICU and ICDSC were determined. All scales represented two score levels, indicating the absence or presence of delirium. Cohen's κ was then determined as a measure of concordance. Agreement was defined as moderate (0.41–0.60), substantial (0.61–0.80), or perfect (>0.80) (DeVellis, 2012). Further, the respective sensitivity and specificity, as well as the corresponding positive and negative predictive values (PPV and NPV), were calculated, and their confidence intervals were determined as exact Clopper–Pearson confidence intervals.

The significance level of Cronbach's α was set at $p = 0.05$ for all of the implemented tests.

RESULTS

Characteristics of the Study Sample

Patients were predominately male and on average in their mid-60s. In total, 42% were diagnosed with delirium according to the DSM–IV–TR, versus 23.3% diagnosed with the CAM–ICU and 28.7% with the ICDSC (Table 1).

Characteristics of Included versus Excluded Patients

Excluded patients were not different from included patients. Between those patients included versus those excluded, neither age, gender distribution, nor day of assessment were different. Also, no differences were found with respect to the rates of delirium diagnosis as determined with the ICDSC or DSM–IV–TR (Table 1).

Characteristics of Patients with Delirium versus Those Without

The patients with delirium were older and proportionately more likely to be women, and they were assessed at a later time in their hospitalization (Table 2). In those with delirium as diagnosed by the DSM–IV–TR, the CAM–ICU detected delirium

Table 1. *Sociodemographic and medical variables of all patients assessed, included, and excluded patients*

	All patients ($n = 289$)	Included patients ($n = 210$)	Excluded patients ($n = 79$)	p
Age in years	64.8 (18–91, $SD = 14.7$)	65 (18–91, $SD = 14.6$)	64.3 (19–87, $SD = 14.9$)	0.724 [a]
Gender in %				0.767 [b]
Male	72.6	73.3	70.9	
Female	27.4	26.7	29.1	
Day of assessment	5 (1–31, $SD = 4.8$)	"5.1 (1–31, $SD = 5.1$)"	4.6 (1–18, $SD = 3.8$)	0.346 [a]
DSM–IV–TR diagnosis of delirium in %	42.4	43.8	38	0.423 [b]
CAM–ICU diagnosis of delirium in %	23.3	23.3	–	
CAM–ICU items in %				
1a: acute onset or	–	96.4	–	–
1b: fluctuating course	–	73.9	–	–
2: inattention	–	85.2	–	–
3: altered level of consciousness	–	91.3	–	–
4: disorganized thinking	–	66.7	–	–
ICDSC delirium in %	28.7	30.5	24.1	0.310 [b]
ICDSC items in %				
1: altered level of consciousness	–	23.9	18.7	0.524 [b]
2: inattention	–	43.9	32.6	0.226 [b]
3: disorientation	–	40.3	28.3	0.162 [b]
4: hallucinations, delusions, or psychosis	–	10.1	2.2	0.121 [b]
5: psychomotor agitation or retardation	–	72.7	63	0.264 [b]
6: inappropriate speech or mood	–	32.4	26.1	0.446 [b]
7: sleep/wake cycle disturbance	–	79.9	78.3	0.835 [b]
8: symptom fluctuation	–	48.2	28.3	0.025 [b]
ICDSC total score	2.3 (0–8, $SD = 2.2$)	2.4 (0–8 $SD = 2.3$)	2 (0–7, $SD = 2$)	0.155 [a]

DSM–IV–TR = Diagnostic and Statistical Manual, 4th ed., Text Revision); CAM–ICU = Confusion Assessment Method for the ICU; ICDSC = Intensive Care Delirium Screening Checklist; SD = standard deviation.
[a] Student's t test. [b] Pearson's χ^2.

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Table 2. *Sociodemographic and medical variables of patients with and without delirium*

	Patients with delirium ($n = 92$)	Patients without delirium ($n = 118$)	p
Age in years	68.1 (30–88, $SD = 11.9$)	62.6 (18–91, $SD = 16.1$)	<0.001 [a]
Gender in %			0.046 [b]
Male	67.4	78	
Female	32.6	22	
Day of assessment	6.7 (1–31, $SD = 6.3$)	3.9 (1–21, $SD = 3.6$)	<0.001 [b]
DSM–IV–TR diagnosis of delirium	100	–	
CAM–ICU diagnosis of delirium in %	46.7	5.1	<0.001 [b]
CAM–ICU items in %			–
1a: acute onset or	96.4	–	–
1b: fluctuating course	73.9	–	–
2: inattention	85.2	–	–
3: altered level of consciousness	91.3	–	–
4: disorganized thinking	66.7	–	
ICDSC delirium in %	63	5.1	<0.001 [b]
ICDSC items in %			
1: altered level of consciousness	26.6	8.3	0.008 [b]
2: inattention	68.4	11.7	<0.001 [b]
3: disorientation	59.5	15	<0.001 [b]
4: halluc., delusions or psychosis	15.2	3.3	0.024 [b]
5: psychomotor agit. or retard.	88.6	51.7	<0.001 [b]
6: inappropriate speech or mood	49.4	10	<0.001 [b]
7: sleep/wake cycle disturbance	86.1	71.7	0.054 [b]
8: symptom fluctuation	62	30	<0.001 [b]
ICDSC total score	4.1 (0–8, $SD = 2.1$)	1.1 (0–8, $SD = 1.5$)	<0.001 [a]

DSM–IV–TR = Diagnostic and Statistical Manual, 4th ed., Text Revision; CAM–ICU = Confusion Assessment Method for the ICU; ICDSC = Intensive Care Delirium Screening Checklist; SD = standard deviation.
[a] Student's t test. [b] Pearson's χ^2.

in only every other patient (46.7%). In contrast, the ICDSC detected delirium in two of three (63%). Conversely, both the CAM–ICU and ICDSC had a false positive rate of 5%. All items of the ICDSC scored more frequently in delirious patients when including the trend in item 7. As expected, ICDSC total scores were higher in the presence of delirium.

Interrater Reliability with Respect to DSM–IV–TR Diagnosis

With respect to DSM–IV–TR diagnosis, the overall rating agreement between psychiatrists' assessments of delirium was almost perfect (Cohen's $\kappa = 0.89$, $CI_{95\%} = 0.69–1.1$, $p < 0.001$), and with respect to the presence and absence of delirium perfect (Cohen's $\kappa = 0.97$, $CI_{95\%} = 0.69–1.1$, $p < 0.001$; Cohen's $\kappa = 0.93$, $CI_{95\%} = 0.69–1.1$, $p < 0.001$).

The CAM–ICU and ICDSC versus DSM–IV–TR and CAM–ICU versus ICDSC

The following evaluations of concurrent validity are listed in Table 3 and 4.

1. The CAM–ICU versus DSM–IV–TR

Agreement was moderate between the CAM–ICU and DSM–IV–TR, and half of the cases of delirium

Table 3. *Allocation of the presence and absence of delirium: CAM–ICU and ICDSC versus the DSM–IV–TR diagnosis*

	CAM–ICU delirium			ICDSC delirium		
	Absent	Present	Total	Absent	Present	Total
DSM–IV–TR delirium						
Absent	112	6	118	112	6	118
Present	49	43	92	34	58	92
Total	161	49		146	64	

DSM–IV–TR = Diagnostic and Statistical Manual, 4th ed., Text Revision; CAM–ICU = Confusion Assessment Method for the ICU; ICDSC = Intensive Care Delirium Screening Checklist.

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Table 4. *Agreement, sensitivity and specificity, positive and negative predictive value (NPV and PPV) of CAM–ICU and ICDSC versus the DSM–IV–TR diagnostic criteria*

	κ	p	Sensitivity	$CI_{95\%}$	Specificity	$CI_{95\%}$	PPV	$CI_{95\%}$	NPV	$CI_{95\%}$
DSM–IV–TR and CAM–ICU	0.44	<0.001	46.7	39.3–57.4	94.9	89.3–98.1	87.8	75.2–95.4	69.6	61.8–76.6
DSM–IV–TR and ICDSC	0.60	<0.001	63	52.3–78.9	94.9	89.3–98.1	90.6	80.7–96.5	76.7	69–83.3
CAM–ICU and ICDSC	0.56	<0.001	77.6	63.4–88.2	83.4	77.2–89.2	59.4	46.4–71.5	92.5	86.9–96.2

$CI_{95\%}$ = 95% confidence interval; DSM–IV–TR = Diagnostic and Statistical Manual, 4th ed., Text Revision; CAM–ICU = Confusion Assessment Method for the ICU; ICDSC = Intensive Care Delirium Screening Checklist; PPV = positive predictive value; NPV = negative predictive value.

were not detected, as evidenced by the sensitivity of less than 50%. Conversely, the specificity and PPV nearly reached 95% and the NPV was 70%. Although the CAM–ICU was not a very sensitive instrument, it was very specific, with high predictive values with respect to presence or absence of delirium.

2. The ICDSC versus the DSM–IV–TR

Agreement between the DSM–IV–TR and ICDSC in terms of detection of delirium was also within the moderate range. The ICDSC was able to detect two of three patients with delirium, as evidenced by its sensitivity of 63%. In addition, the ICDSC proved to be a highly specific instrument, with its specificity and PPV exceeding 90% and the NPV reaching nearly 80%. Altogether, the ICDSC proved to be a sensitive and highly specific instrument.

3. The CAM–ICU versus the ICDSC

Finally, the concurrent validity between the CAM–ICU and ICDSC was also only moderate. The sensitivity reached almost 80%, the specificity exceeded 80%, the NPV exceeded 90%, and the PPV reached nearly 60%.

DISCUSSION

Summary of Main Findings

From these findings, the CAM–ICU and ICDSC were found to be useful and very specific instruments within the daily clinical routine in the detection of delirium in an intensive care setting. However, the concurrent validity as well as the sensitivity of these instruments versus the psychiatric assessment and application of DSM–IV–TR criteria was only moderate. Between the CAM–ICU and ICDSC, the latter reached greater accuracy in the diagnosis of delirium versus the DSM–IV–TR. Similarly, the sensitivity of these scales was only moderate to substantial, whereas the specificity was substantial to perfect. The advantage of prediction of delirium with these scales versus the DSM–IV–TR was substantial.

Comparison with the Existing Literature

The findings presented in this study supported previous studies which indicated that both the CAM–ICU and ICDSC did not reach the previously assumed sensitivity. This concern has been raised in two studies that included more than 300 patients (van Eijk et al., 2009; 2011), as well other more recent studies that included almost 200 patients (Neufeld et al., 2011; 2013). The first two studies conducted on medical-surgical and general ICU settings documented

the sensitivity of the CAM–ICU at 46.7 and 64.3%, while reaching a specificity of 98.1 and 88.8%, respectively. The latter studies were conducted on medical oncology and post-anesthesia care units, with documented sensitivities of 18 and 28%, respectively, while specificity remained high.

Similarly, with respect to the ICDSC, two studies documented lower sensitivities toward delirium (43 to 47%) and high specificities (>94%) (Neufeld et al., 2013; van Eijk et al., 2009).

Conversely, a number of studies indicated that both the CAM–ICU and ICDSC are very sensitive and specific instruments. For the CAM–ICU, three studies documented nearly perfect sensitivities (96–100%) (Ely et al., 2001*a*; 2001*b*; Lin et al., 2004), while two other studies (Luetz et al., 2010; Mitasova et al., 2012) documented sensitivities ranging between 79 and 80%. With respect to the specificities of the CAM–ICU, all of these studies exceeded 88%, while reaching perfect specificity.

Although studies evaluating the ICDSC are fewer in number, the sensitivities and specificities usually reached 95% (Bergeron et al., 2001; Gusmao-Flores et al., 2011),

Disagreement Between the CAM–ICU and ICDSC versus the DSM–IV TR

Naturally, the improper administration of the CAM–ICU and ICDSC had to be considered as a potential source of error. However, all personnel administering these tests had been rigorously trained within a standardized, mandatory, hospital-wide program. Thus, this source of error appeared less likely and was therefore excluded. Moreover, overdiagnosis of delirium by expert raters was excluded by the perfect agreement between their assessments. Furthermore, the DSM–IV–TR (American Psychiatric Association, 2000) has been recognized to be more sensitive in detection of delirium, particularly the subsyndromal and milder forms (Laurila et al., 2003). In contrast, the CAM–ICU is based on DSM–III–R criteria (American Psychiatric Association, 1987), which have been recognized to be more restrictive in the diagnosis of delirium (Laurila et al., 2003). Thus, the underlying diagnostic criteria likely contributed to the moderate sensitivity of the CAM–ICU. Similarly, in another study, the original CAM versus the DSM–IV–TR reached only moderate agreement (Meagher et al., 2014). With respect to the sensitivity of the ICDSC, the diagnostic criteria were not responsible since they were the same (DSM–IV–TR). However, the cutoff score for this scale has been debated, and decreasing it from 4 to 3 actually increased the sensitivity (George et al., 2011).

Notwithstanding, with these conflicting results and later reports indicating lower sensitivities, the question remains as to whether the CAM–ICU or ICDSC detect delirium sufficiently when compared with experts' assessments. Most likely, these instruments will suffice in most instances and when implemented as screening instruments will enhance the detection of delirium. However, these instruments are not perfect, and, as our results and parts of the literature suggest, they might not fully suffice in detecting every type of delirium, particularly the subsyndromal and milder forms. Thus, potentially, negative CAM–ICU or ICDSC scores do not necessarily refute the presence of delirium, irrespective of whether it is mild or subsyndromal.

STRENGTHS AND LIMITATIONS OF THE STUDY

This study has several strengths; however, a number of limitations should be noted. Almost 300 patients were prospectively screened and rated for delirium using the CAM–ICU and ICDSC versus the DSM–IV–TR criteria. Eventually, 210 patients with corresponding assessments were included. These patients were not different from those excluded. With respect to diagnosis of delirium with the DSM–IV–TR, interrater agreement was perfect. The limitations included the high prevalence of hypoactive delirium, which was due to the critical care population studied, and the absence of baseline cognitive recording owing to the prospective nature of the study. Thus, preexisting cognitive disorders could not be excluded despite screening the medical record for them. Moreover, our study was cross-sectional, and further longitudinal studies of the concurrent validity of these scales, as well as the impact of unrecognized delirium, are required. Without a doubt, further studies assessing the sensitivity and specificity as well as positive and negative prediction of delirium with the CAM–ICU and ICDSC are called for.

CONCLUSIONS

In summary, neither the CAM–ICU nor ICDSC proved to be highly accurate instruments. Altogether, both instruments reached only moderate agreement and sensitivity, although the ICDSC proved to be somewhat more accurate. Conversely, both instruments proved to be highly specific, and the positive as well as negative prediction of delirium was substantial. Although both these instruments are very useful in an intensive are setting, nondetection by these scales does not necessarily refute the presence of delirium.

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CONFLICTS OF INTEREST

The authors hereby declare that they have no conflicts of interest to declare.

REFERENCES

American Psychiatric Association (1987). *Diagnostic and statistical manual of mental disorders*, 3rd rev. ed. Washington, DC: American Psychiatric Association.

American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders*, 4th ed., Text Revision. Washington, DC: American Psychiatric Association.

Balas, M.C., Happ, M.B., Yang, W., et al. (2009). Outcomes associated with delirium in older patients in surgical ICUs. *Chest*, *135*(1), 18–25. Epub ahead of print Nov 18, 2008. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2963095/.

Bergeron, N., Dubois, M.J., Dumont, M., et al. (2001). Intensive Care Delirium Screening Checklist: Evaluation of a new screening tool. *Intensive Care Medicine*, *27*(5), 859–864.

Bickel, H., Gradinger, R., Kochs, E., et al. (2008). High risk of cognitive and functional decline after postoperative delirium: A three-year prospective study. *Dementia and Geriatric Cognitive Disorders*, *26*(1), 26–31. Epub ahead of print Jun 24.

Bucht, G., Gustafson, Y. & Sandberg, O. (1999). Epidemiology of delirium. *Dementia and Geriatric Cognitive Disorders*, *10*(5), 315–318.

DeVellis, R.F. (2012). *Scale development: Theory and applications*. Los Angeles: Sage Publications, esp. pp. 109–110.

Devlin, J. W., Fong, J.J., Schumaker, G., et al. (2007). Use of a validated delirium assessment tool improves the ability of physicians to identify delirium in medical intensive care unit patients. *Critical Care Medicine*, *35*(12), 2721–2724; quiz 2725.

Ely, E.W., Inouye, S.K., Bernard, G.R., et al. (2001*a*). Delirium in mechanically ventilated patients: Validity and reliability of the confusion assessment method for the intensive care unit (CAM–ICU). *The Journal of the American Medical Association*, *286*(21), 2703–2710. Available from http://jamanetwork.com/journals/jama/fullarticle/194422.

Ely, E.W., Margolin, R., Francis, J., et al. (2001*b*). Evaluation of delirium in critically ill patients: Validation of the Confusion Assessment Method for the Intensive Care Unit (CAM–ICU). *Critical Care Medicine*, *29*(7), 1370–1379.

Ely, E.W., Shintani, A., Truman, B., et al. (2004). Delirium as a predictor of mortality in mechanically ventilated patients in the intensive care unit. *The Journal of the American Medical Association*, *291*(14), 1753–1762. Available from http://jamanetwork.com/journals/jama/fullarticle/198503.

George, C., Nair, J.S., Ebenezer, J.A., et al. (2011). Validation of the Intensive Care Delirium Screening Checklist in nonintubated intensive care unit patients in a resource-poor medical intensive care setting in South India. *Journal of Critical Care*, *26*(2), 138–143. Epub ahead of print Jan 26.

Gottesman, R.F., Grega, M.A., Bailey, M.M., et al. (2010). Delirium after coronary artery bypass graft surgery and late mortality. *Annals of Neurology*, *67*(e), 338–344. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3723404/.

Gusmao-Flores, D., Salluh, J. I., Dal Pizzol, F., et al. (2011). The validity and reliability of the Portuguese versions of three tools used to diagnose delirium in critically ill patients. *Clinics (São Paulo)*, *66*(11), 1917–1922. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3203964/.

Gusmao-Flores, D., Salluh, J.I., Chalhub, R.A., et al. (2012). The confusion assessment method for the intensive care unit (CAM–ICU) and intensive care delirium screening checklist (ICDSC) for the diagnosis of delirium: A systematic review and meta-analysis of clinical studies. *Critical Care*, *16*(4), R115. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3580690/.

Heymann, A., Radtke, F., Schiemann, A., et al. (2010). Delayed treatment of delirium increases mortality rate in intensive care unit patients. *The Journal of International Medical Research*, *38*(5), 1584–1595.

Inouye, S.K., van Dyck, C.H., Alessi, C.A., et al. (1990). Clarifying confusion: The confusion assessment method. A new method for detection of delirium. *Annals of Internal Medicine*, *113*(12), 941–948.

Inouye, S.K., Westendorp, R.G. & Saczynski, J.S. (2014). Delirium in elderly people. *Lancet*, *383*(9920), 911–922. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4120864/.

Koster, S., Hensens, A.G. & van der, P.J. (2009). The long-term cognitive and functional outcomes of postoperative delirium after cardiac surgery. *The Annals of Thoracic Surgery*, *87*(5), 1469–1474.

Laurila, J.V., Pitkala, K.H., Strandberg, T.E., et al. (2003). The impact of different diagnostic criteria on prevalence rates for delirium. *Dementia and Geriatric Cognitive Disorders*, *16*(3), 156–162.

Lin, S. M., Liu, C.Y., Wang, C.H., et al. (2004). The impact of delirium on the survival of mechanically ventilated patients. *Critical Care Medicine*, *32*(22), 2254–2259.

Luetz, A., Heymann, A., Radtke, F.M., et al. (2010). Different assessment tools for intensive care unit delirium: Which score to use? *Critical Care Medicine*, *38*(2), 409–418.

McNicoll, L., Pisani, M.A., Ely, E.W., et al. (2005). Detection of delirium in the intensive care unit: Comparison of confusion assessment method for the intensive care unit with confusion assessment method ratings. *Journal of the American Geriatrics Society*, *53*(3), 495–500.

Meagher, D., O'Regan, N., Ryan, D., et al. (2014). Frequency of delirium and subsyndromal delirium in an adult acute hospital population. *The British Journal of Psychiatry*, *205*, 478–485. Epub ahead of print Oct 30. Available from http://bjp.rcpsych.org/content/205/6/478.long.

Mitasova, A., Kostalova, M., Bednarik, J., et al. (2012). Post-stroke delirium incidence and outcomes: Validation of the Confusion Assessment Method for the Intensive Care Unit (CAM–ICU). *Critical Care Medicine*, *40*(2), 484–490.

Neufeld, K.J., Hayat, M.J., Coughlin, J.M., et al. (2011). Evaluation of two intensive care delirium screening tools for non-critically ill hospitalized patients. *Psychosomatics*, *52*(2), 133–140.

Neufeld, K.J., Leoutsakos, J.S., Sieber, F.E., et al. (2013). Evaluation of two delirium screening tools for detecting post-operative delirium in the elderly. *British Journal of Anaesthesia*, *111*(4), 612–618. Epub ahead of print May 8. Available from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3770063/.

Norkiene, I., Ringaitiene, D., Misiuriene, I., et al. (2007). Incidence and precipitating factors of delirium after coronary artery bypass grafting. *Scandinavian Cardiovascular Journal*, *41*(3), 180–185.

Ouimet, S., Kavanagh, B.P., Gottfried, S.B., et al. (2007). Incidence, risk factors and consequences of ICU delirium. *Intensive Care Medicine*, *33*(1), 66–73. Epub ahead of print Nov 11, 2006.

Pun, B.T. & Ely, E.W. (2007). The importance of diagnosing and managing ICU delirium. *Chest*, *132*(2), 624–636.

Rosen, S.F., Clagett, G.P., Valentine, R.J., et al. (2002). Transient advanced mental impairment: An underappreciated morbidity after aortic surgery. *Journal of Vascular Surgery*, *35*(2), 376–381. Available from http://www.jvascsurg.org/article/S0741-5214(02)57363-8/pdf.

Santos, F.S., Velasco, I.T. & Fraguas, R., Jr. (2004). Risk factors for delirium in the elderly after coronary artery bypass graft surgery. *International Psychogeriatrics*, *16*(2), 175–193.

Trzepacz, P.T., Breitbart, W., Franklin, J., et al. (1999). Practice guideline for the treatment of patients with delirium. American Psychiatric Association. *The American Journal of Psychiatry*, *156*(Suppl. 5), 1–20. Available from http://psychiatryonline.org/pb/assets/raw/sitewide/practice_guidelines/guidelines/delirium.pdf.

van Eijk, M.M., van Marum, R.J., Klijn, I.A., et al. (2009). Comparison of delirium assessment tools in a mixed intensive care unit. *Critical Care Medicine*, *37*(6), 1881–1885.

van Eijk, M.M., van den, B.M., van Marum, R.J., et al. (2011). Routine use of the confusion assessment method for the intensive care unit: A multicenter study. *American Journal of Respiratory and Critical Care Medicine*, *184*(3), 340–344. Epub ahead of print May 11.