Different assessment tools for intensive care unit delirium: Which score to use?*

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Objective: **To compare validity and reliability of three instruments for detection and assessment of delirium in intensive care unit (ICU) patients. Delirium in critically ill patients is associated with higher mortality, prolonged duration of ICU stay, and greater healthcare costs. Currently, there are several assessment tools available for detection of delirium, but only a few of these assessment systems are developed specifically to screen for delirium in ICU patients.**

Design: **Prospective cohort study.**

Setting: **ICU at a university hospital.**

Patients: **A total of 156 surgical patients aged ≥60 yrs consecutively admitted to the ICU, with a length of stay of at least 24 hrs.**

Measurements and Main Results: **This study was approved by the institutional ethics committee. Trained staff members performed daily and independently the Confusion Assessment Method for the ICU (CAM-ICU), the Nursing Delirium Screening Scale (Nu-DESC), and the Delirium Detection Score (DDS). These evaluations were compared against the reference standard conducted by a delirium expert (blinded to the study), who used delirium criteria from the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). Of 156 patients, 63 (40%) were identified as delirious by the reference standard during the study. Using the CAM-ICU and the Nu-DESC, we measured comparable sensitivities (CAM-ICU, 81%; Nu-DESC, 83%). The specificity of the CAM-ICU was significantly higher than that of the Nu-DESC (96% vs. 81%, $p < .01$). In contrast, the DDS showed poor sensitivity (30%), whereas the specificity was significantly higher compared with the Nu-DESC (DDS, 91%; Nu-DESC, 81%, $p < .05$). The interrater reliability was "almost perfect" for the CAM-ICU ($\kappa = 0.89$) and "substantial" for DDS and Nu-DESC ($\kappa = 0.79, 0.68$).**

Conclusion: **The CAM-ICU showed the best validity of the evaluated scales to identify delirium in ICU patients. The Nu-DESC might be an alternative tool for detection of ICU delirium. The DDS should not be used as a screening tool. (Crit Care Med 2010; 38:409–418)**

KEY WORDS: delirium; ICU; critical care; detection; screening; algorithms

The reported prevalence of delirium in critically ill patients ranges widely from 11% to 87% (1, 2). This variability relates to a number of methodologic differences, including the assessment instrument being used, level of training provided to delirium evaluators, and patient population studied (e.g., patient age, severity of illness, underlying disease) (3–5). Due to the high prevalence of delirium in the intensive care unit (ICU), the clinical practice guidelines of the Society of Critical Care Medicine recommend routine delirium assessment (6). Although intervention programs have been shown to reduce length of hospitalization and mortality when performed in patients outside of the ICU (7), there is currently a deficit of evidence demonstrating that a systematic assessment of delirium in ICU patients improves outcome (8). The availability of a valid assessment instrument is a key component of any systematic strategy to detect delirium in ICU patients. Devlin and co-workers showed that the use of a validated delirium assessment tool improves the ability of physicians (9) and nurses (10) to identify delirium in medical ICU patients.

Today there are a number of validated instruments available to screen for delirium, but only a few of them are especially designed to evaluate delirium in the critically ill. Devlin and colleagues identified six assessment instruments that have undergone validation in critically ill adults (i.e., Confusion Assessment Method for the ICU [CAM-ICU], Delirium Detection Score [DDS], Intensive Care Delirium Screening Checklist [ICDSC], Cognitive Test for Delirium, Abbreviated Cognitive Test for Delirium, and Neelon and Champagne Confusion Scale) (3). The CAM-ICU (Appendix 1) underwent extensive validation in the ICU setting (2, 11) and is, therefore, one of the delirium scores recommended by international guidelines (6, 12). The DDS (Appendix 2) was modified from the Clinical Institute Withdrawal Assessment for Alcohol, revised scale for the use in ICU patients (13), but was still lacking validation against Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria for delirium (14).

Unfortunately, only a few delirium assessment tools have been translated and published in the German language. These include among a few others the CAM-ICU (15), the DDS (16), the Nursing Delirium Screening Scale (Nu-DESC) (17), and the ICDSC (18, 19). However, at the time our study was conducted, a German transla-

*See also p. 693.

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tion of the ICDSC was not available. So far, the Nu-DESC (Appendix 3) has not been validated for use in ICU patients. The first validation study revealed good test features for the Nu-DESC in patients admitted to the hemato-oncology/internal medicine unit (20) and was particularly included in the current study as it was initially designed to be applied by nursing staff. Implementation into clinical routine might be enhanced by stronger involvement of nursing as opposed to medical staff due to their close around-the-clock care for patients (21, 22).

Although each of these scales has undergone different validation processes, there is no study comparing these scoring systems in the same patients. Therefore, the aim of this study was to compare validity and reliability of the CAM-ICU, the DDS, and the Nu-DESC in critically ill patients.

MATERIALS AND METHODS

Patients. After local ethics committee approval (Approval No. EA2/022/06), we consecutively screened all adult patients for delirium in two ICUs (n = 22 beds and 24 beds) during a 3-month period (February to April 2007).

We only included patients aged ≥60 yrs, newly admitted to the ICU after a surgical procedure, and staying in the ICU for at least 24 hrs. Exclusion criteria were preexisting psychosis, dementia, or depression. Further exclusion criteria were non-German-speaking and inability to communicate due to severe hearing loss or brain injury.

Delirium Assessment Tools. We used the German translation of the CAM-ICU that corresponds to the 2003 version of the CAM-ICU Training Manual (15). DDS and Nu-DESC ratings were performed, using the official published German version of the scores (16, 17). The German translation of the Nu-DESC was performed according to the "Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes (PRO) Measures," which includes preparation, forward translation/reconciliation, back translation, review, harmonization, cognitive debriefing, and validation (23).

Delirium Assessment Procedure. The first delirium assessment was performed on the first postoperative day. Each patient was evaluated for a maximum of 21 days. Otherwise, the patient was evaluated for delirium until ICU discharge. Trained staff members, consisting of trained physicians and registered nurses acting independently of routine clinical patient care in the ICU, performed CAM-ICU, Nu-DESC, and DDS ratings daily and independently. These evaluations were compared against the reference standard conducted by a delirium expert (Board-certified psychiatrist or intensivist, blinded to the study), who used DSM-IV criteria for the diagnosis of delirium. Patients were rated either as delirious or not delirious. Criterion validity was determined by comparing each score with the reference standard (DSM-IV).

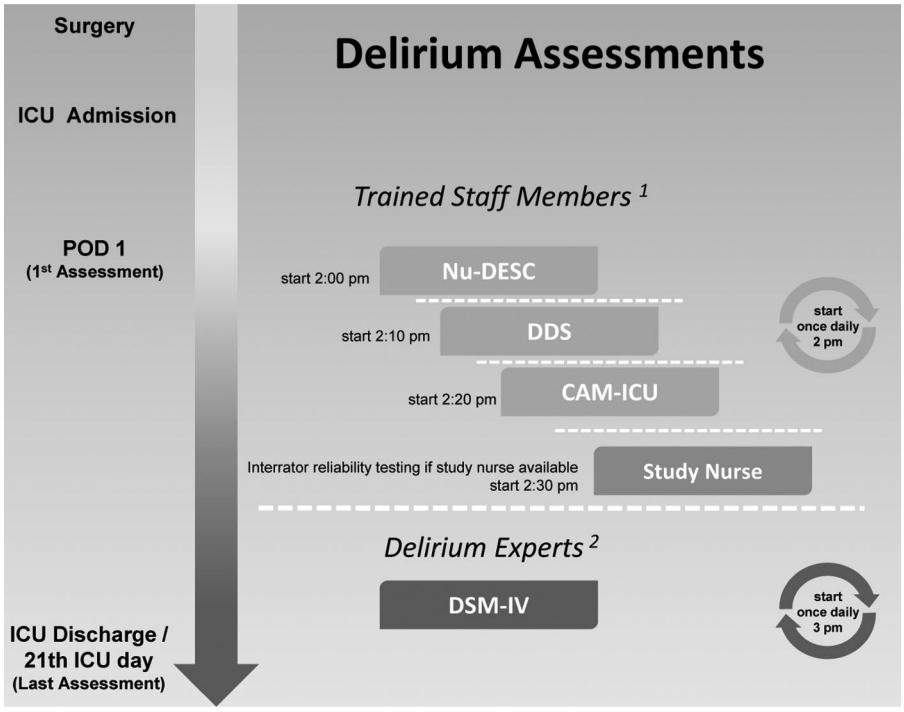

Figure 1. Delirium assessment procedure. *ICU*, intensive care unit; *POD*, postoperative day; *Nu-DESC*, Nursing Delirium Screening Scale; *DDS*, Delirium Detection Score; *CAM-ICU*, Confusion Assessment Method for the ICU; *DSM-IV*, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition.

To minimize bias, the three delirium assessment tools were always performed in a specific order: Every day at 2 PM, the staff members split up into three groups. To be blinded against the results of the other teams, they started testing the patients in a specified sequence 10 mins behind the preceding team. To reduce the influence of the tests on the patients, we ranked the tests depending on how invasive and disturbing the tests were. In our conclusion, we started with the Nu-DESC first, followed by the DDS, and ending with the CAM-ICU. The delirium experts always evaluated the patients finally after all three tests were performed (once daily at 3 PM) (Fig. 1).

As the Richmond Agitation Sedation Scale (RASS) is a component of the CAM-ICU (Feature 4: Altered Level of Consciousness), the assessment implicates measurement of sedation with the RASS. The trained staff members were not able to complete CAM-ICU ratings in patients who had some movement in response to voice but no eye contact (definition of RASS −3). Therefore, the results of CAM-ICU assessments in patients with an RASS of ≤−3 were excluded from data analysis. However, an RASS of ≤[≤−3 during some point of the study period was not exclusion criterion for participating in this study.

Staff Member Training. The program for staff member training consisted of four steps. Step 1: Information about delirium and the scores was provided by means of lectures and handouts, including relevant literature. Furthermore, for each test, a movie was shown, demonstrating the detailed conduct of the respective scores. Step 2: A one-to-one instruction at the patients' bedside was performed. Step 3: During a 1-wk piloting phase, staff members tested the patients on their own. During this period, staff members were able to contact the delirium experts regarding any issues arising with the delirium screening. Step 4: Each trained staff member had to reevaluate five patients who had been pretested by the delirium expert. Different results in delirium assessment between the trained staff members and the delirium expert were discussed until agreement was reached.

Interrater Reliability Testing. The study nurse performed the delirium assessment either with the CAM-ICU, the Nu-DESC, or the DDS. To avoid bias by fluctuating symptoms, retest results later than 1 hr after index testing by the scoring teams were excluded from data analysis. To avoid expectation bias, the study nurse performing retesting was blinded to the prior scoring results and performed only one

type of test with one individual patient at a time (Fig. 1).

Assessment of Subsyndromal Delirium (SSD). The Nu-DESC, as well as the DDS, contains a graded diagnostic scale. To investigate if the Nu-DESC or the DDS has the potential for detecting SSD, we compared outcome measures between the following groups: Nu-DESC = 0 vs. Nu-DESC = 1 and DDS ≤1 vs. DDS = 2–7 (measured on the first postoperative day).

Statistical Analysis. Descriptive statistics were computed for all study variables. Discrete variables are expressed as counts (percentage) and continuous variables as medians with interquartile range. For the discussed clinical parameters, differences between groups were assessed, using Fisher's exact test for frequencies and Mann-Whitney *U* test for continuous variables, respectively. Sensitivities and specificities of the mentioned scores were compared with the help of McNemar's test.

In case of repeated observations from a patient (so-called clustered binary data), particular statistical methods were applied, taking into consideration the relationship between those repeated measures (24). Calculations of sensitivity and specificity (and corresponding tests of comparison) have been conducted with the weighted estimator accordingly (25).

Interrater Agreement for the CAM-ICU, the DDS, and the Nu-DESC were estimated, using the κ measure (26).

Multiple linear regression analyses with duration of ventilation and duration of ICU stay as dependent variables and age, Therapeutic Intervention Scoring System, Acute Physiology and Chronic Health Evaluation II score, Sequential Organ Failure Assessment, and Simplified Acute Physiology Score as exploratory variables were conducted to investigate the potential of detecting SSD by means of DDS and Nu-DESC, respectively. The same procedure was applied with the multiple logistic regression for discharge to home as response. We considered $p < .05$ to be significant. The obtained *p* values are to be understood as exploratory ones; therefore, no multiple adjustments were made. Data were analyzed, using SPSS 13.0 for Windows (Chicago, IL).

RESULTS

Basic Patient Characteristics and Outcome. One hundred fifty-six surgical patients were included in data analysis. The types of surgical interventions are summarized in Table 1. Forty percent (n = 63) of the patients admitted to the ICU for >24 hrs were diagnosed as delirium positive, according to the DSM-IV criteria, during some point of their ICU stay. Basic patient characteristics and outcome data (Table 2) differed significantly between the delirium group (n = 63) and the nondelirium group (n = 93): Patients in the delirium group were significantly older than patients in the nondelirium group. Increased values of Acute Physiology and Chronic Health Evaluation II, Sequential Organ Failure Assessment, Simplified Acute Physiology Score, and Therapeutic Intervention Scoring System-28 were observed in patients developing delirium. Mechanical ventilation, duration of ICU stay, and length of hospital stay were significantly prolonged in delirious patients. Furthermore, in-hospital mortality was significantly increased in the delirium group. The number of delirious patients who were ready for discharge to home at some point during their stay at our university hospital was significantly reduced.

Delirium Assessments on the First Postoperative Day. Measuring ICU delirium on the first postoperative day, we found that the CAM-ICU and the Nu-DESC showed comparable sensitivities (CAM-ICU: 0.81, Nu-DESC: 0.83; $p = .623$). However, the CAM-ICU showed a significant higher specificity compared with the Nu-DESC (CAM-ICU: 0.96; Nu-DESC: 0.81; $p < .0001$). In contrast to this, we observed a poor performance of the DDS considering delirium detection, giving a sensitivity of only 30% and a false-negative rate of 70%. The DDS was significantly less sensitive than the CAM-ICU and the Nu-DESC ($p < .0001$). However, the DDS showed an excellent specificity (91%), indicating 75 of 80 patients rated as not delirious by the reference standard. The specificity of the DDS was significantly higher when compared with the Nu-DESC ($p = .021$) (Tables 3 and 4).

Regarding patients with an RASS <0 on the first postoperative day, the CAM-ICU was the most sensitive and specific assessment tool for delirium detection (sensitivity, 0.85; specificity, 0.96). In patients with an RASS >0, the Nu-DESC revealed the most sensitive screening instrument for delirium detection on the first postoperative day, giving a sensitivity of 75% and a false-negative rate of 25%. Despite this, the specificity evaluating delirium in these patients was slightly higher for the CAM-ICU.

Delirium Assessments During 21 Days. On the 156 participants included in this study, 564 daily assessments were performed during their ICU stay; we conducted 559 CAM-ICU ratings, 547 Nu-DESC ratings, and 547 DDS ratings. Of 564 patient-days, 179 (32%) were classified as delirious by DSM-IV (reference standard). Of the 179 patient-days rated as delirious by the reference standard, 137 were correctly identified, using the CAM-ICU, giving a 79% sensitivity and a 21% false-negative rate. The CAM-ICU in-

Table 1. Reason for intensive care unit admission

Reason for Admission	n (%)
General surgery	61 (39.1)
Gynecologic surgery	14 (09.0)
Otorhinolaryngological surgery[a]	06 (03.8)
Cardiac surgery	39 (25.0)
Trauma surgery[a]	25 (16.0)
Urologic surgery	06 (03.8)
Vascular surgery[a]	03 (01.9)
Oral and maxillofacial surgery[a]	02 (01.3)

[a]There were no cases of intracranial surgery.

Table 2. Basic patient characteristics and outcome in the delirium and the nondelirium groups

Patient Characteristics	No Delirium (n = 93)	Delirium (n = 63)	p^b
Age, yr	67 (64–74)[a]	74 (67–80)[a]	.0003
BMI, kg/m^2	25 (23–28)[a]	25 (23–27)[a]	.8499
Male, %	54	56	.8707
Duration of ICU stay, days	4 (2–8)[a]	11 (6–28)[a]	<.0001
Duration of hospitalization, day	8 (4–21)[a]	21 (9–34)[a]	.0001
Duration of ventilation, hr	3 (0–15)[a]	49 (11–345)[a]	<.0001
APACHE II	16 (13–19)[a]	21 (17–26)[a]	<.0001
SAPS	33 (26–40)[a]	43 (36–50)[a]	<.0001
SOFA	3 (2–5)[a]	5 (4–7)[a]	<.0001
TISS-28	31 (28–35)[a]	36 (30–39)[a]	.0013
Discharge to home (n)	51	18	.0020
In-hospital mortality (n)	4	15	<.0001

BMI, body mass index; ICU, intensive care unit; APACHE, Acute Physiology and Chronic Health Evaluation; SAPS, Simplified Acute Physiology Score; SOFA, Sequential Organ Failure Assessment; TISS-28, Therapeutic Intervention Scoring System.

[a]Values are presented as medians with an interquartile range (25th to 75th) in parentheses; [b]$p < .05$ is considered significant. Inter-group analysis: Mann-Whitney-*U* test, Fisher's exact test and χ^2 test.

Table 3. Sensitivity and specificity of different delirium assessment tools in ICU patients measured on the first postoperative day and during the first 21 days of ICU stay

CAM-ICU n = 151		Nu-DESC n = 154		DDS n = 152	
Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
First postoperative day					
0.81	0.96	0.83	0.81	0.30	0.91
CAM-ICU n = 559		**Nu-DESC n = 547**		**DDS n = 547**	
Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
First 21 days of ICU stay[a]					
0.79	0.97	0.82	0.83	0.25	0.89

ICU, intensive care unit; CAM-ICU, Confusion Assessment Method for the ICU; Nu-DESC, Nursing Delirium Screening Scale; DDS, Delirium Detection Score.

[a]Calculations of sensitivity and specificity have been conducted with the weighted estimator accordingly.

Table 4. Comparing sensitivities and specificities of different delirium assessment tools in ICU patients measured on the first postoperative day and during the first 21 days of ICU stay

Score	Score	Sensitivity (p)	Specificity (p)
First postoperative day[a]			
CAM-ICU[d]	Nu-DESC	.623	<.00001[d]
CAM-ICU[c]	DDS	<.0001[c]	.9
Nu-DESC[c]	DDS[d]	<.0001[c]	.021[d]
First 21 days of ICU stay[b]			
CAM-ICU[d]	Nu-DESC	.423	<.0001[d]
CAM-ICU[c]	DDS[d]	<.0001[c]	.002[d]
Nu-DESC[c]	DDS[d]	<.0001[c]	.031[d]

ICU, intensive care unit; CAM-ICU, Confusion Assessment Method for the ICU; Nu-DESC, Nursing Delirium Screening Scale; DDS, Delirium Detection Score.

[a]Sensitivity and specificity of the mentioned scores were compared with the help of McNemar's test; [b]calculations of sensitivity and specificity (and corresponding tests of comparison) have been conducted with the weighted estimator accordingly; [c]significant higher sensitivity; [d]significant higher specificity.

dicated 368 of 379 rated as not delirious, giving a significant higher specificity (0.97) when compared with the Nu-DESC ($p < .0001$) or the DDS ($p = .002$). The Nu-DESC correctly identified 147 of the 179 patient-days rated as delirious, showing high overall sensitivity of 82% and a false-negative rate of only 18%. The specificity of the Nu-DESC was also satisfactory, giving a false-positive rate of only 17% (311 of 375 patient-days). In contrast, the DDS detected only 42 of 169 patient-days, giving a poor sensitivity of 25% and a false-negative rate of 75%. The DDS showed a specificity of 89% (336 of 378) (Tables 3 and Table 4).

Taking these results into account, we found no significant difference between CAM-ICU and Nu-DESC regarding the sensitivity ($p = .423$). However, the CAM-ICU and the Nu-DESC showed significantly higher sensitivity when compared with the DDS ($p < .0001$).

Interrater Reliability. In the 37 paired observations using the CAM-ICU, overall interrater reliability was "almost perfect" (κ statistics = 0.89) between critical care nurse and trained staff members. Furthermore, we conducted 42 paired observations, using the DDS as well as 37 paired observations for the Nu-DESC. The overall interrater reliability was "substantial" (κ statistics = 0.79 and 0.68, respectively) between nurse and trained staff members for both scores (Table 5) (26).

SSD and Outcome. Duration of mechanical ventilation and duration of ICU stay were significantly prolonged in patients with either Nu-DESC = 1 (compared with patients with Nu-DESC = 0) or DDS = 2–7 (compared with patients with DDS ≤1). The number of patients who were ready for discharge to home at some point during their stay at our university hospital was significantly reduced in patients with either Nu-DESC = 1 (compared with patients with Nu-DESC = 0) or DDS = 2–7 (compared with patients with DDS = ≤1) (Tables 6 and 7).

Table 5. Interrater reliability for the CAM-ICU, the DDS, and the Nu-DESC calculated by κ statistics

Tool	κ	Strength of Agreement[a]
CAM-ICU, n = 37	0.89	Almost perfect
DDS, n = 42	0.79	Substantial
Nu-DESC, n = 37	0.68	Substantial

CAM-ICU, Confusion Assessment Method for the ICU; DDS, Delirium Detection Score; Nu-DESC, Nursing Delirium Screening Scale.

[a]According to Landis and Koch (26).

After univariate testing of the regarded outcomes, we also analyzed the effect of putative SSD (Nu-DESC = 1 or DDS = 2–7) vs. no delirium multivariately. The multiple linear regressions for duration of ICU stay and duration of ventilation revealed no significant results. Furthermore, we analyzed whether putative SSD as tested by Nu-DESC or DDS was an independent risk factor for not being discharged to home (defined as death during hospital stay or referral to other hospitals). Multiple logistic regressions yielded that patients with Nu-DESC = 1 on the first postoperative day experienced significantly worse outcome in terms of death during hospital stay or discharge to further hospital care ($p = .033$).

DISCUSSION

The most important result is that the CAM-ICU was the most valid and reliable assessment tool for the detection of ICU delirium when compared with Nu-DESC and DDS. The Nu-DESC is also valid and reliable to detect delirium in the critically ill, whereas the DDS showed a low sensitivity. We could also demonstrate that validity of the different assessment tools remained constant during daily measurements in the same patients.

Choosing among several scoring tools depends on several issues: validity in former studies, feasibility within the specific context, and appropriateness for the research question. There are only four studies comparing validity of different delirium assessment tools in the same ICU patients. In a prospective cohort study, Plaschke and co-workers (19) assessed

Table 6. SSD and outcome according to Nu-DESC criteria measured on the first postoperative day

Outcome Measure	No Delirium Nu-DESC = 0 (n = 70)	SSD Nu-DESC = 1 (n = 24)	p^b
Duration of ICU stay, day	1 (0–2)[a]	2 (1–7)[a]	.0270[c]
Duration of hospitalization, day	4 (3–13)[a]	7 (3–12)[a]	.2330
Duration of ventilation, hr	0 (0–6)[a]	10 (3–52)[a]	<.0001[c]
Discharge to home, n	48	8	.0020[c]

SSD, subsyndromal delirium; Nu-DESC, Nursing Delirium Screening Scale.

[a]Values are presented as medians with an interquartile range (25th to 75th) in parentheses; [b]$p <$ .05 is considered significant. Intergroup analysis: Mann-Whitney *U* test, Fisher's exact test; [c]significant higher sensitivity.

Table 7. SSD and outcome according to DDS criteria measured on the first postoperative day

Outcome Measure	No Delirium DDS ≤1 (n = 76)	SSD DDS = 2–7 (n = 52)	p^b
Duration of ICU stay [day]	1 (0–3)[a]	2 (1–7)[a]	<.0001[c]
Duration of hospitalization [day]	5 (3–12)[a]	6 (3–19)[a]	.2080
Duration of ventilation [hour]	0 (0–7)[a]	18 (2–76)[a]	<.0001[c]
Discharge to home (n)	43	18	.0150[c]

SSD, subsyndromal delirium; DDS, Delirium Detection Score.

[a]Values are presented as medians with an interquartile range (25th to 75th) in parentheses; [b]$p <$ .05 is considered significant. Intergroup analysis: Mann-Whitney *U* test, Fisher's exact test; [c]significant higher sensitivity.

the agreement between the delirium ratings of the CAM-ICU and the ICDSC in critically ill patients. Both tests were performed independently within 30 mins for 7 days after ICU admission. The authors found a κ coefficient of 0.80, indicating good agreement between both tools. However, the authors did not compare the test results with a gold standard. That is one of the reasons why van Eijk and colleagues(27) performed a comparison between ICDSC and CAM-ICU, including a reference rater using DSM-IV criteria. In this mixed ICU population, the CAM-ICU showed superior sensitivity but lower specificity when compared with the ICDSC (0.64 vs. 0.43).

Translated instruments should undergo a full validation process before use (28). Recently, Morandi and co-workers (29) noted considerable international differences in defining delirium, therefore underpinning the importance of careful cross-cultural adaptation of screening instruments. Furthermore, clinical screening tools are very sensitive to the setting, patient-population, and to the reader application (4, 30). Test characteristics of the CAM as well as CAM-ICU vary considerably in different studies (30); therefore, validation of two screening tools without comparison against a gold standard has to be viewed with caution. The evolving DSM classification itself can be criticized for deficient criterion validity (31, 32). However, for reasons of comparison, it should always be included in a diagnostic accuracy study of delirium screening tools (33).

A second study compared the results of the Neelon and Champagne Confusion Scale in a consecutive sample of 172 nonintubated ICU patients. Criterion validity was determined by comparing the results of the Neelon and Champagne Confusion Scale with the results of the CAM-ICU as the reference assessment tool (34). However, the fact that the same research nurse assessed both scales consecutively could have created an interscale bias.

The results of a further comparison study indicated that the CAM-ICU method is not as sensitive as the standard CAM method in detecting delirium in nonintubated, verbal ICU patients. However, no external reference standard for delirium ratings was used in this study as well (35).

In the present study, 40% of the included patients were diagnosed as delirious, according to the DSM-IV criteria, at some point during their ICU stay. The reported prevalence of delirium in medical and surgical ICUs varies from 11% (1) to >80% (2, 11). Part of the reason for the variance in the reported prevalence of ICU delirium is because some studies look at acquired delirium (36). We only included surgical patients aged ≥60 yrs, staying in the ICU for at least 24 hrs. The age cutoff might be a reason for the high frequency of ICU delirium. Because of different inclusion criteria, it is difficult to compare the respective frequencies resulting from differences in patient characteristics, local sedation practices, the used screening instrument, and its application. However, our reported delirium frequency seems to be comparable with reported delirium occurrences in other studies. Furthermore, we could reproduce previously reported patients' characteristics and outcome measures associated with the occurrence of ICU delirium: older age, increased Acute Physiology and Chronic Health Evaluation score, prolonged duration of ventilation, prolonged ICU and in-hospital stay, as well as increased in-hospital mortality (37–44).

Delirium in critically ill patients is reported to be independently associated with a significantly higher 6-month mortality rate, increased ICU and hospital costs, as well as poor cognitive outcome (45, 46). Recent studies could show that delirium increases the risk for early postoperative cognitive dysfunction (47) as well as long-term cognitive impairment (48). In addition, a previous delirium increased the risk of need for long-term care and had significant effects on subjective and measured cognitive impairment (49). Educational interventions, including the use of a validated delirium assessment instrument, achieved a sevenfold increase in the number of nurses who used the tool (12% vs. 82%) and who used it correctly (8% vs. 62%) (10). The physicians' ability to accurately detect delirium in ICU patients improved significantly after use of a validated delirium score (9). Additionally, delirium-specific multidisciplinary education and nurse-led intervention programs in non-ICU settings have resulted in a decrease in the duration and severity of delirium without advising on any specific pharmacotherapy (7, 50). These data underscore the need for data to support recommendations for delirium assessment in all critically ill patients (6, 51).

In the first validation study of CAM-ICU in 38 ICU patients, the results of CAM-ICU assessments completed by two study nurses and two intensivists were compared with the evaluations of a psychiatrist who based his diagnosis on DSM-IV criteria. CAM-ICU was found to

be highly sensitive, specific, and reliable when compared with the reference standard (2). A further validation study in 111 mechanically ventilated ICU patients found the CAM-ICU to have a high criterion validity that was preserved across all subgroups of patients (11). In our study, we could find comparable results regarding validity and reliability of the CAM-ICU. To avoid repeat-observer bias for patients studied on multiple days, the above-mentioned validation studies used only the first-alert or lethargic comparison evaluation in each patient (2). In our study, we used a new statistical method taking into account the relationship and possible bias between repeated measurements (24). Considering all repeated CAM-ICU ratings over 21 days, we found an unaltered high validity for diagnosing ICU delirium.

The five-item scale of the Nu-DESC includes, in addition to the four items of the Confusion Rating Scale, a fifth item evaluating unusual psychomotor retardation.

In a validation study, Gaudreau and co-workers (20) could demonstrate a sensitivity of 86% and a specificity of 87% when compared with DSM-IV criteria in the oncology inpatient setting. In our study, we validated the Nu-DESC for the ICU and measured almost equal results regarding sensitivity (82%–83%) and specificity (81%–83%). The reason for the Nu-DESC being less specific when compared with the CAM-ICU or the DDS might lie in the fact of detecting patients in the prodromal phase of delirium. As the Nu-DESC does not account for depth of sedation in contrast to the CAM-ICU, this might be a reason for the lower sensitivity of the Nu-DESC. Possibly a patient displays only one or more symptoms without having the full syndrome of delirium (52) and is, therefore, not identified as delirious, using DSM-IV criteria. Recent studies could show that the use of a graded diagnostic scale permits detection of SSD. In older patients with hip fracture, the Memorial Delirium Assessment Scale, a continuous severity measure, was a useful adjunct to the CAM in detecting patients with SSD (53). Patients with SSD had outcomes similar to patients with mild delirium, suggesting that a dichotomous approach (CAM/CAM-ICU) to diagnosis and management of delirium may be inappropriate. Using the ICDSC, Ouimet and colleagues (54) suggested that an entity of SSD does also exist in the critically ill, and that it is associated with clinically important adverse outcome. We were able to show similar results, by defining SSD with a Nu-DESC = 1, which was an independent risk factor for not being discharged to home (defined as death during hospital stay or referral to other hospitals) (p = .033). Identification of patients with such SSD may allow prevention or treatment in patients previously unsuspected as being at higher risk. Using a test detecting SSD may be especially useful in settings in which the caregiver-patient relationship is high and from which patients are discharged to settings with lower staffing levels (55). In contrast to the Nu-DESC and the DDS, the CAM-ICU does not include an ordinal scale for graded symptom identification of delirium. Furthermore, the four items are not counted equally for the test. Therefore, measuring severity of delirium (e.g., SSD) with the CAM-ICU may not be feasible.

The DDS is an eight-item scale modified from the validated Clinical Withdrawal Assessment for Alcohol revised scale and was initially developed for measuring severity of delirium in ICU patients (13). Until now, the DDS was still lacking validation against the DSM-IV criteria for delirium (14). In the present study, results for the DDS, with a cutoff of >7, as used in the study by Otter and colleagues (13), revealed insufficient sensitivity but high specificity in detecting ICU delirium. In order for the DDS to achieve an adequate sensitivity, the cutoff for the DDS was determined with receiver operating characteristic analysis to be >3, using DSM-IV criteria as the gold standard (sensitivity, 0.78; specificity, 0.81). However, in terms of specificity, the CAM-ICU remained superior to both other scores.

We did not systematically record process times. However, feasibility tests before the study indicated that all tests could be completed within an average of 2 mins. This corresponds well with process times recorded by the original authors of either test (2, 20). Furthermore, open qualitative interviews of the scoring teams revealed that CAM-ICU was felt to be more laborious due to its need for compliant patient interaction. As a result, examiners reported that time to complete CAM-ICU ratings varied considerably, depending on the ability of the patients to cooperate. In the CAM-ICU Training Manual, the authors commented that the majority of patients with an RASS of −3 can provide enough data to complete the CAM-ICU (15). However, our scoring team was not able to complete CAM-ICU ratings in patients who showed some movement in response to voice but no eye contact (definition of RASS −3). This was the case especially when performing feature 2 (Inattention) and feature 3 (Disorganized Thinking) of the CAM-ICU worksheet. Therefore, we excluded delirium assessments with the CAM-ICU in patients with an RASS of ≤ -3 from data analysis. Nu-DESC and DDS are mostly independent of active patient interaction; therefore, times were reported to be constant. Contrarily, at times the examiners felt unsure about judging the state of the patient correctly when performing the DDS and the Nu-DESC, whereas when performing the CAM-ICU, they felt more confident due to the simplicity and clarity of the task. Our suspicion that the grading element in DDS and Nu-DESC might threaten reliability receives support by their lower interrater reliability scores.

Devlin and co-workers were encouraged to implement one delirium assessment tool and standardized procedures with written policies and procedures that outline how the tool will be used (3). Therefore, we designed an exemplary algorithm for ICU delirium screening (Fig. 2): According to this algorithm, all patients receive a delirium monitoring with a valid and reliable delirium score for the ICU every 8 hrs. If the patient is scored delirium-positive, a symptom-oriented therapy should be initiated. If the patient is not delirious, scoring should be repeated after 8 hrs. When delirium scoring cannot be performed and/or RASS ≤ -3, the sedation goal should be reevaluated and possibly reduced. In case of agitation or RASS ≥ 1, pain management and adjustment of ventilatory settings should be checked and optimized. If the RASS is ≥ 1 or ≤ -3 the RASS will be reevaluated after 4 hrs. In some circumstances, delirium monitoring may not be possible despite an RASS of ≤ -3; in that case, staff members should exclude other confounders, such as deaf-muteness or the patient not being familiar with the official language. Even though the suggestion to screen for delirium every 8 hrs does not specifically derive from our data, due to the fluctuating nature of delirium symptoms over the period of 1 day (56), delirium assessment should be performed several times a day. For specific intensive care settings, different validated assessment tools might be preferable.

The present study has the following limitations: Due to the lack of a published

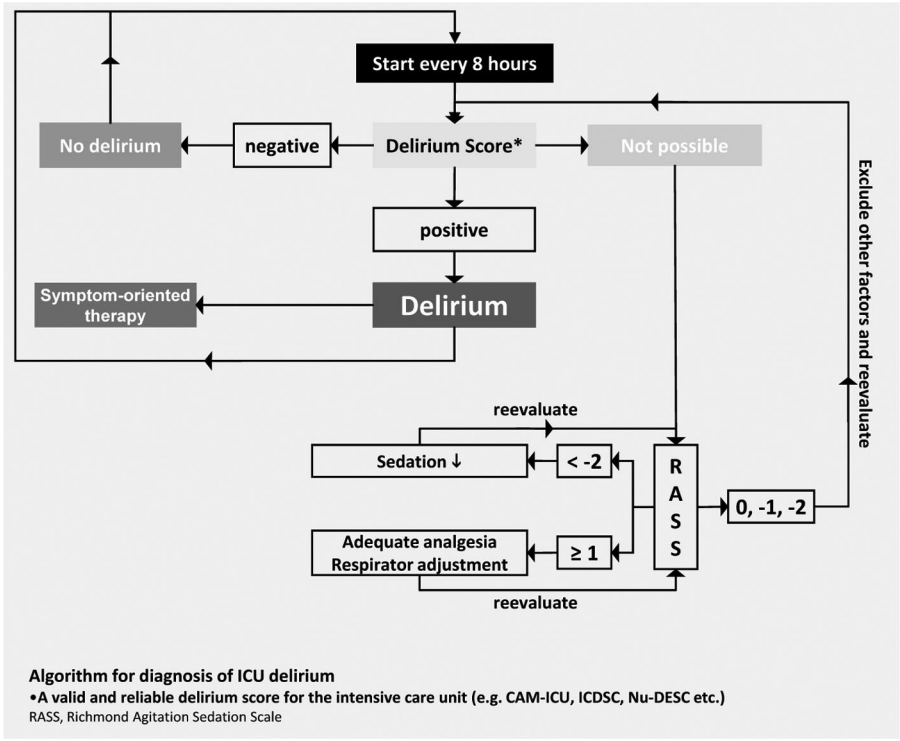

Figure 2. Algorithm for diagnosis of intensive care unit (*ICU*) delirium. *CAM-ICU*, Confusion Assessment Method for the ICU; *IDSC*, Intensive Care Delirium Screening Checklist; *Nu-DESC*, Nursing Delirium Screening Scale.

forward-backward translation at the beginning of the study, we could not include the ICDSC in the study protocol. However, for future studies, the translation process according to international guidelines (23) was completed (18). To minimize bias, the delirium assessments were always performed in the same fixed order starting with the DDS. The CAM-ICU, in particular, requires active cooperation from the patient; as the patient has to solve defined tasks, it shows the highest potential of stimulating or fatiguing the patient. Still, we cannot rule out that one test influenced the results of the subsequent tests. Even though delirium ratings up to 21 days were measured, individual length of ICU stay varied considerably, which could be a source of bias. Additionally, the analysis of interrater reliability is based on relatively small numbers of paired observations. There was only one study nurse performing reliability testing. To ensure the best use of this situation, we roughly aimed for equal numbers of retesting for each scoring system.

To avoid interference with confounders like depression, dementia, and psychosis, we attempted to exclude entities with such potential. Our attempt was to scrutinize tests for their ability to serve in a screening program, not as substitutes for diagnostic tests. Final confirmation of the diagnosis will still rely on expert psychiatric judgment. In turn, dementia, depression, as well as psychosis remain on the list of differential diagnoses. Therefore, including patients with such diagnoses would have raised suspicion about the validity of the results without increasing generalizability. As these differential diagnoses could provide a risk for bias, a subgroup analysis of these patients would be necessary. This would further increase the number of patients needed for the study. Therefore, we aimed for a more homogeneous patient population.

CONCLUSION

The CAM-ICU was the most valid and reliable delirium assessment tool in critically ill patients compared with the Nu-DESC and the DDS. The Nu-DESC might be a good alternative for detecting delirium in critically ill patients due to its high sensitivity and its ability to grade for delirium symptoms. We further conclude that Nu-DESC and, to a lesser degree, DDS convey some potential to detect SSD. However, whether results below cutoff indicate SSD or are actually false-negatives in comparison with the DSM-IV criteria cannot be determined. This seems to be a general problem in dealing with the construct of SSD in nonrandomized designs, as confounding factors might be responsible for the worse outcome.

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Appendix 1. Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)

Feature 1: Acute Onset or Fluctuating Course: Positive if you answer "yes" to either 1A or 1B. Positive / Negative

1A: Is the patient different from his/her baseline mental status? Or **1B:** Has the patient had any fluctuation in mental status in the past 24 hrs as evidenced by fluctuation on a sedation scale (e.g., RASS), GCS, or previous delirium assessment? Yes / No

Feature 2: Inattention: Positive if either score for 2A or 2B is <8. Attempt the ASE letters first. If patient is able to perform this test and the score is clear, record this score and move to Feature 3. If patient is unable to perform this test or the score is unclear, then perform the ASE Pictures. If you perform both tests, use the ASE Pictures' results to score the Feature. Positive / Negative

2A: ASE Letters: Record score (enter NT for not tested). Directions: Say to the patient, *"I am going to read you a series of 10 letters. Whenever you hear the letter "A," indicate by squeezing my hand."* Read letters from the following letter list in a normal tone. **S A V E A H A A R T** Scoring: Errors are counted when patient fails to squeeze on the letter "A" and when the patient squeezes on any letter other than "A." Score (out of 10): _____

2B: ASE Pictures: Record score (enter NT for not tested). Directions are included on the picture packets. Score (out of 10): _____

Feature 3: Disorganized Thinking. Positive if the combined score is <4. Positive / Negative

3A: Yes/No Questions (Use either Set A or Set B, alternate on consecutive days if necessary): Combined Score (3A + 3B): _____ (out of 5)

Set A	Set B
1. Will a stone float on water?	1. Will a leaf float on water?
2. Are there fish in the sea?	2. Are there elephants in the sea?
3. Does one pound weigh more than two pounds?	3. Do two pounds weigh more than one pound?
4. Can you use a hammer to pound a nail?	4. Can you use a hammer to cut wood?

Score ____ (Patient earns 1 point for each correct answer out of 4).

3B: Command. Say to patient: "Hold up this many fingers." (Examiner holds two fingers in front of patient.) "Now do the same thing with the other hand." (Not repeating the number of fingers). *If patient is unable to move both arms, for the second part of the command, ask patient, "Add one more finger."

Score_____ (Patient earns 1 point if able to successfully complete the entire command.)

Feature 4: Altered Level of Consciousness: Positive if the Actual RASS score is anything other than "0" (zero). Positive / Negative

Overall CAM-ICU: (Features 1 and 2 and either Feature 3 or 4). Positive / Negative

Appendix 2. Delirium Detection Score

Symptoms	Points
1 Orientation	
Orientated to time, place and personal identity, able to concentrate	☐ 0
Not sure about time and/or place, not able to concentrate	☐ 1
Not orientated to time and/or place	☐ 4
Not orientated to time, place, and personal identity	☐ 7
2 Hallucinations	
None	☐ 0
Mild hallucinations at times	☐ 1
Permanent mild-to-moderate hallucinations	☐ 4
Permanent severe hallucinations	☐ 7
3 Agitation	
Normal activity	☐ 0
Slightly higher activity	☐ 1
Moderate restlessness	☐ 4
Severe restlessness	☐ 7
4 Anxiety	
No anxiety when resting	☐ 0
Slight anxiety	☐ 1
Moderate anxiety at times	☐ 4
Acute panic attacks	☐ 7
5 Myoclonus/Convulsions	
None	☐ 0
Myoclonus	☐ 1
Convulsions	☐ 7
6 Paroxysmal Sweating	
No sweating	☐ 0
Almost not detectable, only palms	☐ 1
Beads of perspiration on the forehead	☐ 4
Heavy sweating	☐ 7
7 Altered Sleep-Waking Cycle	
None	☐ 0
Mild, patient complaints about problems to sleep	☐ 1
Patient sleeps only with high medication	☐ 4
Patient does not sleep despite medication at night, tired at day time	☐ 7
8 Tremor	
None	☐ 0
Not visible, but can be felt	☐ 1
Moderate tremor (arms stretched out)	☐ 4
Severe tremor (without stretching arms)	☐ 7
Delirium	≥8 ☐
No Delirium	<8 ☐

Appendix 3. Nursing Delirium Screening Scale

	Symptoms	Symptoms Rating
1	Disorientation Verbal or behavioral manifestation of not being oriented to time or place or misperceiving persons in the environment.	☐ 0 ☐ 1 ☐ 2
2	Inappropriate behavior Behavior inappropriate to place and/or for the person; e.g., pulling at catheters or dressings, attempting to get out of bed when that is contraindicated.	☐ 0 ☐ 1 ☐ 2
3	Inappropriate communication Communication inappropriate to place and/or for the person; e.g., incoherence, noncommunicativeness, nonsensical or unintelligible speech.	☐ 0 ☐ 1 ☐ 2
4	Illusions/hallucinations Seeing or hearing things that are not there; distortions of visual objects.	☐ 0 ☐ 1 ☐ 2
5	Psychomotor retardation Delayed responsiveness, few or no spontaneous actions/words; e.g., when the patient is prodded, reaction is deferred, and/or the patient is unarousable.	☐ 0 ☐ 1 ☐ 2
	Delirium	≥2 ☐ yes <2 ☐ no