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# **Monitoring delirium in the intensive care unit: Diagnostic accuracy of the CAM-ICU tool when performed by certified nursing assistants – A prospective multicenter study**

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## **Keywords:**

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## ABSTRACT

### ***Background:***

Monitoring delirium in critically ill patients is recognized as a major challenge. Although involving certified nursing assistants could be a valuable help in this field, such strategy has never been formally investigated.

### ***Objectives:***

Following theoretical training, we conducted a prospective multicenter study assessing the diagnostic accuracy of a CAM-ICU delirium screening strategy performed by CNAs in clinical settings, compared to parallel blinded evaluations conducted by nurses and **physicians.**

### ***Methods:***

From October 2020 to June 2022, adult intensive care patients admitted in three French University teaching hospitals with Richmond Agitation Sedation Scale  $\geq 2$  were independently assessed for delirium by the three members of the care team (clinical nursing assistant, nurse and physician) using CAM-ICU in a random order. Physician's assessment **served as the reference standard for comparisons.**

### ***Findings:***

We analyzed results from 268 triplets of CAM-ICU assessments performed sequentially on 203 patients. Prevalence of delirium was 22%. Compared to physician's assessments, clinical nursing assistants demonstrated a sensitivity (Se) of 88% CI95% [80–96] and a specificity (Sp) of 95% [92–98] in detecting delirium. There was no significant difference in the performance of clinical nursing assistants and nurses (Se = 90 % [82–97] p = 0.77, Sp = 98 % [95–100] p = 0.19). We observed high agreement between results obtained by physicians and clinical nursing assistants ( $\kappa = 0.82$ ) and clinical nursing assistants performance remained **consistent in the subgroups at higher risk of delirium.**

### ***Conclusion:***

Evaluation of the CAM-ICU by clinical nursing assistants is feasible and should be seen as an opportunity to increase routine monitoring of delirium in intensive care patients. *Implication for Clinical Practice:* Delirium is a severe and underestimated complication of intensive care unit stay. This study results demonstrate the great performance of trained clinical nursing assistants in detecting delirium using the CAM-ICU. Further research is needed to define the most effective role for clinical nursing assistants in the routine management of delirium in intensive care patients.

# Introduction

Delirium is a severe cognitive dysfunction characterized by an acute and fluctuating disturbance in attention and awareness. Delirium is frequent in the intensive care unit (ICU) settings with one-third of patients being affected (Salluh et al., 2015). Yet, ICU delirium remains largely underestimated in clinical practice (Spronk et al., 2009). Three subtypes of delirium have been described based on patients level of agitation: hyperactive, hypoactive or mixed delirium (Pandharipande et al., 2007). Although hypoactive delirium is more frequent and is associated with a poorer prognosis, it is less frequently detected in ICUs (Krewulak et al., 2018; Pun and Ely, 2007).

The importance of using validated tools for routine delirium monitoring is widely emphasized in international guidelines (Barr et al., 2013; Devlin et al., 2018). The two currently recommended tools for this purpose are the Confusion Assessment Method for the ICU (CAM-ICU) (Ely et al., 2001), and the Intensive Care Delirium Screening Checklist (ICDSC) (Bergeron et al., 2001). However, in 2020, a French national survey informed that delirium monitoring remained suboptimal, with only 31% of ICU healthcare professionals conducting any form of monitoring and less than half of them reporting doing so on a daily basis (Alaterre et al., 2022).

In recent years, several interprofessional ICU teams developed protocols that aimed at improving adherence to delirium monitoring guidelines (Marino et al., 2015; Radtke et al., 2012; Trogrlic et al., 2020; Sutton-Smith, 2020) which have been shown to reduce mortality (Luetz et al., 2016). Yet, these protocols focused only on critical care physicians and nurses since screening tools have been validated for use by them exclusively (Ely et al., 2001; Ho et al., 2020).

In France, ICU teams also include Certified Nursing Assistants (CNAs). CNAs are working in pairs with nurses under their supervision. They collaborate in a complementary manner, each with distinct responsibilities. Registered nurses undergo a rigorous 3-year state-qualified training program and are authorized to perform technical procedures and administer prescribed care and medications. On the other hand, CNAs complete a comprehensive 12-month theoretical and practical training course that focuses on essential tasks such as recording vital signs, providing a comfortable environment, ensuring optimal sleeping conditions, and assisting patients with daily hygiene and oral feeding. They thus daily spend privileged time alongside patients and their families. Additionally, CNAs can receive specialized training to deliver specific nursing care within their scope of practice. For these reasons, many ICU professionals in France would now like to involve CNAs in the delirium monitoring process (Alaterre et al., 2022). Yet, such strategy has never to date been formally investigated. Thus, we conducted a prospective multicenter study that aimed to investigate the diagnostic accuracy of delirium screening performed by trained CNAs using the CAM-ICU tool in clinical practice.

# Methods

## *Study design*

We conducted a prospective multicenter study in the general ICUs of three French teaching hospitals, comprising a total of 42 ICU beds. These included the 12-bed medical-surgical ICU of la Pitié-Salpêtrière hospital (Paris, France), the 14-bed medical-surgical ICU of Montpellier hospital (France) and the 16-bed medical-surgical ICU of Clermont-Ferrand hospital (France). All three ICUs were affiliated with Universities and provided care to a diverse patient population including both medical and postoperative cases. The staffing ratios in these ICUs were as follows: one nurse for every two patients, one CNA for every four patients, and one physician for every six patients.

From June to October 2020, we implemented educational sessions designed to raise delirium awareness and train caregivers to the CAM-ICU screening tool. Both CNAs and nurses were invited to participate in these sessions that were scheduled days and nights over several days so that they could participate regardless of their day-or-night shift. Each session started with a theoretical lecture on ICU delirium. This lecture was followed by an in-depth presentation of the 2014 updated version of the CAM-ICU tool (Chanques et al., 2018). Finally, clinical cases retrieved from the French version of the Vanderbilt University training manual were proposed to allow for practical training (Chanques et al., 2017). Residents and attending physicians received specific training in a similar manner, and each new member of the care team was offered the full training.

After training-phase, from October 2020 and June 2022, all consecutive ICU patients with inclusion criteria and without exclusion criteria were screened for enrollment in the trial. Inclusion criteria were an age over 18 and a RASS score greater than or equal to  $\square$  2. Exclusion criteria were an inability to communicate verbally (deaf, mutism, non-French-speaking), pregnancy, legal protection measure (guardianship, curatorship, or protective supervision), unavailability of the care team during the 3-hour time slot, and patient opposition. Patients' inclusion was considered whenever the three team-members (CNA, nurse and physician) required for the process were available.

We used a randomized process with sealed envelopes to decide of the assessment order. Once order defined, each team member successively assessed patient for delirium using the 2014-updated version of the CAM-ICU (Chanques et al., 2018). The CAM-ICU tool assesses four features: (1) the acute onset of mental status changes or fluctuating course, (2) inattention, (3) altered levels of consciousness, and (4) disorganized thinking. A positive CAM-ICU assessment requires the presence of features 1 and 2, in addition to either feature 3 or 4. Consequently, it is not essential to assess all four features to obtain the binary outcome: positive (indicating delirium is present) or negative (indicating delirium is absent). (See CAM-ICU Flowsheet in Supplementary Material S1). All assessments were performed blindly and independently one from another within three hours and without treatments changes (sedation, analgesia, ventilation). Each patient could be assessed several times over the study period, up to once a day.

### ***Ethical considerations and regulatory issues***

This study did not imply any risk or constraint or affect the standard patient management. The CAM-ICU is a validated tool (Ely et al., 2001; Chanques et al., 2018) that has been shown to be effective and safe, including in France (Chanques et al., 2017). The assessment performed by ICU was defined as the reference, and other results obtained did not affect patient care. Thus, according to the French law (Toulouse et al., 2020), we obtained approval from the French Institutional Review Board “Comité d’Éthique de la Recherche en Anesthésie-Réanimation” (CERAR,) under the reference IRB000102542020-221. Patient’s non-opposition was obtained before discharge (Toulouse et al., 2020).

All data were anonymized and integrated into a REDcap® form, in accordance with the French CNIL MR-004 methodology and registered in the AP-HP processing register under reference 20210125190126.

### ***Data collection***

For each patient screened, we obtained a triplet of CAM-ICU assessments (CNA/Nurse/Physician).

For each assessment, we collected the overall CAM-ICU result (positive or negative), the number of CAM-ICU features used to (1 to 4) and the time required to conclude (from the start of the assessment to the elicitation of the result).

For each inclusion, we collected from the informatic medical record 1/ patients’ baseline characteristics (*age, gender, admission criteria, and SAPS2 score*); 2/ patients’ characteristics at the time of the assessment (*vital parameters, RASS score, visual analog pain scales, respiratory support type, sedation, analgesia, anxiolysis modalities, and vasopressor support*) and 3/ patients in-hospital outcomes (*in-ICU and in-hospital length of stay, length under mechanical ventilation, length with vasopressors and continuous renal replacement therapy (CRRT), and mortality*). Finally, we collected information to describe healthcare professional involved in the evaluation process (*age, gender and ICU experience*).

### ***Data management and evaluation criteria***

The physician’s assessment was defined as the reference standard for comparisons. The physician, as defined in this study, could be either the resident physician or the attending physician in charge of the patient.

The result of the CAM-ICU is binary: it is “positive” = delirium is present or “negative” = delirium is absent. We compared the results obtained respectively by CNAs and by nurses with results of physicians. We thus obtained the rates of True Positives (TP), False Positives (FP), True Negatives (TN), and False Negatives (FN) for the two comparisons, CNAs/Physician and Nurses/Physicians, respectively.

Diagnostic accuracy was determined based on the computed Sensitivity ( $Se = TP/(TP + FN)$ ), Specificity ( $Sp = TN/(TN + FP)$ ), Positive Predictive Value ( $PPV = TP/(TP + FP)$ ) and

Negative Predictive Value ( $NPV = TN/(TN + FN)$ ) (Altman and Bland, 1994a,c). Sensitivity was defined as the primary endpoint. We also obtained ROC curves and areas under the curve (AUC) (Altman and Bland, 1994b). Subgroup analysis were planned for patients older than 65-year-old, mechanically ventilated, and RASS score  $< 0$ .

Agreement between physicians, CNAs and nurses was determined using a Cohen's Kappa Coefficient ( $\kappa$ ) (Cohen, 1960). Agreements were rated as follow: 0.41–0.60 indicating moderate agreement, 0.61–0.80 as substantial, and 0.81–1 as almost perfect agreement (Landis and Koch, 1977).

For each category of healthcare professionals, the ease of use of the CAM-ICU was assessed by measuring the time required for assessment, the number of features required to conclude (1–4) and frequency of use of each CAM-ICU feature.

### ***Sample size calculation***

According to a recent meta-analysis, CAM-ICU sensitivity when used by physicians or nurses is 84% (Chen et al., 2021). We assumed that performance of the CNAs would be identical. With an expected precision of 10%, we aimed to demonstrate that the lower limit of the 95% confidence interval (CI) for CNAs' delirium screening sensitivity would be 74% or higher. Assuming an incidence rate of 20% for delirium (Berger et al., 2020), a sample of 258 CNAs' CAM-ICU assessments was required to ensure power. To account for a 5% risk of post-hoc exclusions and missing data, a total sample size of 270 triplets of CAM-ICU assessment was planned. The study was not powered for subgroup analyses.

### ***Statistical analysis***

Quantitative variables are presented as median [and 25th; 75th percentiles] or mean (and standard deviation) depending on their distribution. Categorical variables are presented as numbers (and relative percentages). Comparison between categorial variables were conducted using chi-squared tests. For each quantitative variables, normality was assessed by a Shapiro-Wilk test and comparisons were made using Student's *t*-test for paired data, or the Wilcoxon signed ranks test according to the distribution. Missing data in the duration assessments were treated with median imputation. AUCs were compared using a DeLong non-parametric test AUC and kappas using Z-tests (DeLong et al., 1988). The "R" software v4.0.2 (R-project.org, the R foundation for statistical Computing, Vienna, Austria) was used to perform analyses. All analyses were two-sided, and a p-value of  $< 0.05$  was used to define statistical significance.

## Results

Between October 2020 and June 2022, we included 203 patients corresponding to 270 triplets of CAM-ICU assessments. After exclusion of 2 triplets (*1 performed in the presence of a non-inclusion criterion, the other with incomplete reference physician assessment*), 268 triplets of CAM-ICU assessments were analyzed (154 in Paris, 85 in Clermont-Ferrand and 31 in Montpellier, See Appendix S2). A total of 22.0% (n = 59/ 268) CAM-ICUs were positive according to the physician assessments. When considering only the first positive CAM-ICU assessment, 23.6% (n = 48/203) patients presented with at least one episode of delirium over the study period.

### *Patients and caregivers characteristics*

In terms of patient characteristics, the median age was 65 years [55–72] and the study included mostly men with a gender ratio of 1/2 (71/132). Patients presented with a median SAPS2 score of 39 [29–52]. More than half of them required mechanical ventilation (56%) and catecholaminergic support (61%). Detailed demographics, and clinical characteristics collected before each of the 270 assessments, are summarized in Tables 1 and 2. The physicians, nurses and nursing assistants involved in this study were predominantly women caregivers, and the level of experience in the unit varied across these different professions. Demographics of the healthcare professionals who conducted the 268 assessments are detailed in Table 3. The time required by the three categories of caregivers to complete CAM-ICU assessments as well as the time elapsed between each assessment are presented in Table 4.

### *Diagnostic accuracy*

In this study, CNAs reported 62 positive and 206 negative CAM-ICU assessments with the sensitivity being 88% [95% Confidence Interval: 80–96%], the specificity being 95% [92–98%], the PPV being 84% [75–93%] and the NPV being 97% [94–99%] (See Flowchart in Supplementary Material S2).

In the meantime, nurses' sensitivity was 90% [82–97%], with Sp of 98% [95–100%], PPV of 91% [84–99%] and NPV = 97% [94–99%].

There was no significant difference between CNAs' and nurses' performance either when comparing sensitivity ( $p = 0.77$ ), specificity ( $p = 0.188$ ), PPV ( $p = 0.213$ ) or NVP ( $p = 0.751$ ).

Areas Under the ROC curve (AUC) were 0.92 and 0.94 respectively for CNAs and nurses ( $p = 0.40$ ).

### *Agreement*

Cohen's Kappa coefficient indicated “almost-perfect” agreement both between CNAs and physicians ( $\kappa=0.82$  [0.74–0.90]) and between physicians and nurses ( $\kappa=0.88$  [0.81–0.95]), with no significant difference between these two values ( $p = 0.09$ ). Comparisons between CNAs and nurses indicated a “strong” agreement ( $\kappa=0.78$  [0.70–0.87]).



**Table 1**  
Study population.

Number of patients (n)		203
Number of CAM-ICU assessments assessments per patient, median [IQR]		1 [1; 1]
Age (years), mean (SD)		62 (14)
Sex, n(%)	Male	132 (65)
	Female	71 (35)
Weight (kg), median [IQR]		80 [69; 97]
Size (cm), median [IQR]		171 [165; 178]
Relevant medical history, n (%)	Chronic ethylism	39 (19)
	Active smoking	45 (22)
	Active drug abuse	4 (2)
	Benzodiazepine treatment	28 (14)
	Psychotropic medication	17 (8)
	Chronic pain	15 (7)
Admission type, n(%)	Medical	108 (53)
	Elective surgery	45 (22)
	Non-elective surgery	50 (25)
Admission criteria, n(%)	Post-operative care	63 (31)
	Sepsis/Septic choc	37 (18,2)
	Non-Sars-Cov-2 Acute respiratory failure	28 (13,8)
	Sars-Cov-2 induced ARDS	27 (13,3)
	Hemorrhagic shock	11 (5,4)
	Polytraumatism	10 (4,9)
	Acute fluid and electrolyte disorders	7 (3,4)
	Acute heart failure	5 (2,5)
	Cardiac arrest	4 (2)
	Coma	3 (1,5)
	Acute liver failure	3 (1,5)
	Hypovolemic shock	2 (1)
	Pulmonary embolism	1 (0,5)
	Other cause	2 (1)
SAPS2 score, median [IQR]		39 [29; 52]
ICU ressources involved, n (%)	Mechanical ventilation	113 (56)
	Sedation	100 (49)
	Catecholamine support	124 (61)
	Renal replacement therapy	25 (12)
ICU LOS (days), median [IQR]		9 [5; 20]
Alive at ICU-discharge, n (%)		192 (95)

Characteristics of the 203 patients who were at least once triply-screened for delirium using CAM-ICU over the study period (203 patients underwent a total of 268 triplets of assessments). Values are expressed as mean (Standard Deviation), median [InterQuartile Range], or actual (%). Abbreviations: LOS = Length Of Stay; IQR = interquartile range; SD = standard deviation; SAPS2: Simplified Acute Physiology Score; ARDS = Acute Respiratory Distress Syndrome.

**Table 2**

Patients characteristics at the time of the CAM-ICU assessment.

Number of assessments		268
Status at time of assessment, median [IQR]	Days in ICU	6 [3; 17]
	Days under mechanical ventilation	2 [0; 9]
	Days of sedation	1 [0; 6]
	Days of catecholaminergic support	2 [0; 5]
	Days requiring CRRT	0 [0; 0]
Ventilation status, n(%)	No oxygen therapy	66 (25)
	Standard oxygen therapy	88 (33)
	High Flow oxygen Therapy	45 (17)
	Non-invasive mechanical ventilation	7 (3)
	Invasive mechanical ventilation	60 (22)
	ECMO	2 (1)
Ongoing sedative treatments, n(%)	Propofol	3 (1)
	Midazolam	2 (2)
	Dexmedetomidine	23 (9)
	None	234 (88)
Ongoing morphinic treatments, n(%)	Sufentanyl	15 (6)
	Remifentanyl	43 (16)
	Other	53 (20)
	None	157 (59)
Catecholamines, n(%)	Yes	30 (11)
	No	238 (89)
Vital parameters, mean (SD)	Pulse oxygen saturation (%)	96 (6)
	Respiratory rate (per minute)	22 (8)
	Mean arterial pressure (mmHg)	88 (15)
	Heart rate (bpm)	90 (16)
RASS score, n(%)	+4	0 (0)
	+3	1 (1)
	+2	7 (3)
	+1	10 (4)
	0	209 (78)
	-1	35 (13)
	-2	6 (2)

Clinical characteristics collected right before the beginning of the first evaluation for each of the 268 triplets of CAM-ICU assessments. Values are expressed as mean (Standard Deviation), median [InterQuartile Range], or actual (%). Abbreviations: CRRT: Continuous Renal Replacement Therapy; SD = standard deviation; SAPS2 = simple acute physiology score; IQR = Interquartile Range; RASS = Richmond Agitation and Sedation Scale; mmHg = millimeters of mercury; bpm = beats per minute.

**Table 3**  
Demographics of study caregivers.

		Physicians	Nurses	Nursing assistants
Age (years), mean (SD)*		28 (4)	30 (7)	42 (10)
Sex, n (%)	Male	124 (46)	71 (26)	94 (35)
	Female	144 (54)	197 (74)	172 (65)
Experience in the unit, n (%)	< 1 year	231 (87)	92 (35)	29 (11)
	1 à 3 years	30 (11)	67 (25)	44 (17)
	3 à 5 years	0 (0)	49 (18)	13 (5)
	> 5 years	5 (2)	58 (21)	178 (67)
Running CAM-ICU order, n (%)	1	117 (44)	73 (27)	77 (29)
	2	67 (25)	108 (40)	93 (35)
	3	84 (31)	87 (32)	98 (36)

Characteristics of the critical caregivers involved in each of the 268 triplets of CAM-ICU assessments (A single caregiver may be responsible for multiple assessments). Values are expressed as mean (standard deviation) or actual (%). \*Age data are presented as complete. Abbreviation: SD = Standard deviation.

**Table 4**  
Duration of CAM-ICU assessments and time interval between assessments.

<b>A. Duration of assessments</b>	
Physicians' assessments duration (minutes), median [IQR]	2 [1; 4]
Nurse's assessments (minutes), median [IQR]	3 [1; 4]
Nursing assistant's assessments (minutes), median [IQR]*	4 [2; 5]
<b>B. Time interval between the three CAM-ICU assessments</b>	
Time interval between the beginning of the first and the end of the third assessment (minutes), median [IQR]	37 [24; 64]
Time interval between the end of the first and the beginning of the second assessment (minutes), median [IQR]	11 [5; 26]
Time interval between the end of the second and the beginning of the third assessment (minutes), median [IQR]	10 [5; 24]

A. Median time required for each category of caregiver (physician/nurse/nursing assistant) to complete a CAM-ICU assessment across the 268 study evaluations (\*n = 4 missing values were imputed with medians). B. Median time recorded between the three assessments of the CAM-ICU triplet, each being performed sequentially and independently in a random order by the physician, nurse and nursing assistant in charge of the patient, across the 268 study evaluations. Values are expressed as median (IQR). Abbreviation: IQR = Inter-Quartile Range.

### ***Subgroup analysis***

CNAs' diagnostic performances remained similar either for patients older than 65 years-old, patients requiring mechanical ventilation and patients with a RASS score of  $\leq 1$  or  $\leq 2$  (Table 5).

The median duration of the CAM-ICU assessment was 4 min [IQR 2; 5] for CNAs, 2 min [1; 4] for physicians, and 3 min [1; 4] for nurses. The time required by CNAs was significantly longer than for the other caregivers. ( $p < 0.001$ ). (Fig. 1).

### ***Ease of CAM-ICU use***

The final CAM-ICU result was obtained after assessing the first feature alone in 28%, 15% and 11% cases for CNAs, nurses and physicians, respectively (Fig. 2). Over 268 assessments, the feature #4 was assessed by CNAs in 69 cases (26%) compared to 42 cases (16%) for nurses ( $p = 0.12$ ) and 30 cases (11%) for physicians ( $p < 0.001$ ). Notably, in 40 out of the 69 cases where CNAs assessed Feature #4, they did so even though delirium could have confirmed or denied earlier in the algorithm.

## **Discussion**

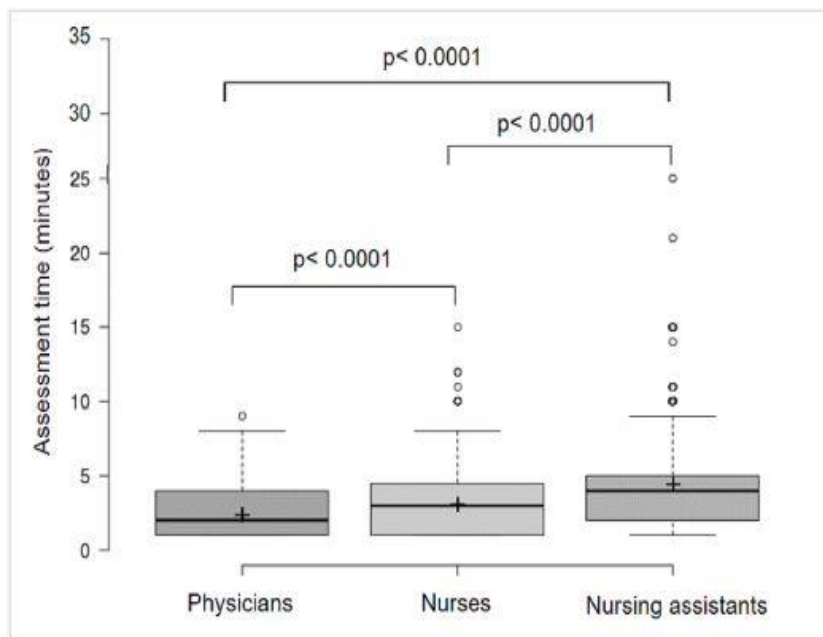
This study is included in a comprehensive approach to improving delirium monitoring and management in the ICU. As part of this initiative, all ICU staff, including CNAs, received training in delirium care. Our findings demonstrate that trained CNAs had great performance for detecting delirium using the CAM-ICU tool, achieving a sensitivity of 88% and a specificity of 95% compared to physicians, with an agreement level approaching perfection. Furthermore, despite slightly lower ("strong") level of agreement, CNAs performed similarly to nurses, and their performance was maintained in subgroups at higher risk for delirium. These results suggest that integrating CNAs into routine ICU delirium monitoring process would be a reasonable approach. However, CNAs required more time to conduct CAM-ICU assessments than nurses and physicians and tended to rely on a greater number of features for reaching conclusions. This suggests that additional training may be necessary to optimize their skills and reduce the time required for CAM-ICU assessments.

In this study, 23.6% of patients presented at least one episode of delirium, which is consistent with literature (Berger et al., 2020; Salluh et al., 2015). Our results are also in line with those reported in CAM-ICU validation studies involving research nurses (Chanques et al., 2018; Ely et al., 2001). CNAs could even perform slightly better than bedside nurses if compared to Vasilevskis et al. results (Vasilevskis et al., 2011).

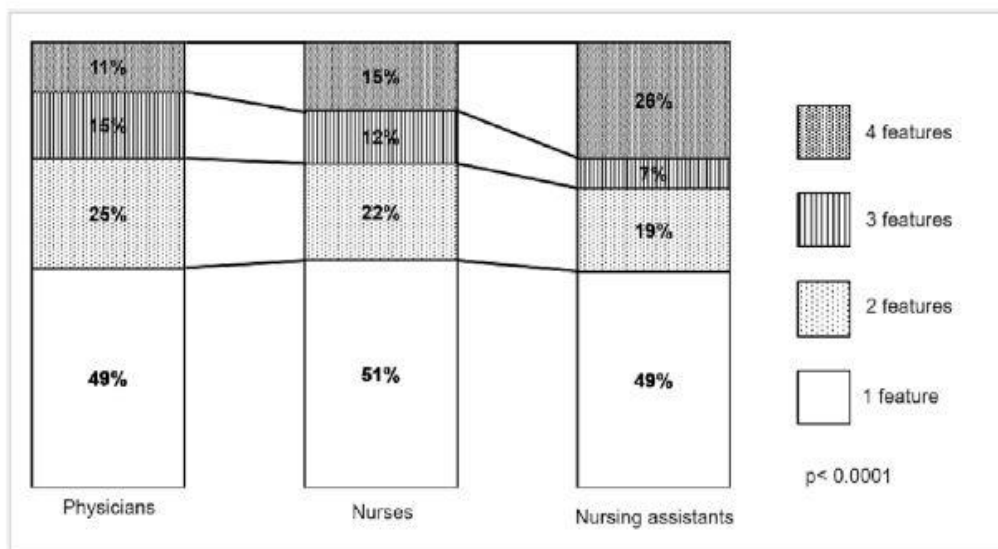
**Table 5**  
Certified Nursing Assistants' subgroup performance analysis.

	Sensitivity(%) [IC95]	Specificity(%) [IC95]	PPV(%) [IC95]	NPV(%) [IC95]	AUC	Kappa Cohen
>65 year-old (n = 136)	91% [82-100]	95% [91-99]	86% [75-98]	97% [94-100]	0.91	0.85
Mechanical ventilation (n = 67)	81% [66-96]	95% [88-99]	91% [78-100]	89% [79-98]	0.88	0.77
RASS score < 0 (n = 42)	93% [83-100]	100% [100-100]	100% [100-100]	88% [73-100]	0.96	0.90

Nursing assistants' performances determined by analyzing 136 CAM-ICU assessments performed in patients over 65 years old, 67 CAM-ICU assessments performed in mechanically ventilated patients, and 42 CAM-ICU assessments performed in patients with a negative RASS score. The results obtained by the medical team were defined as the reference standard for all comparisons. Operational parameters are presented along with their 95% confidence intervals.



**Fig. 1.** CAM-ICU assessment durations. Boxplot graphical representations of the duration required by the three members of the ICU care team (Physician, Nurse, and Nursing Assistant) to complete CAM-ICU assessment. The upper edge border of the box represents the 75th percentile and the lower edge represents the 25th percentile. The vertical length of the box represents the interquartile range and the central horizontal line represents the median. The upper moustache extends from the top edge to the largest value at 1.5 times the interquartile range. The lower moustache extends from the bottom edge to the smallest value at 1.5 times the interquartile range. Extreme values, shown as isolated points *o*, are the values beyond the moustaches. Pairwise comparisons were made by the Wilcoxon signed ranks test ( $n = 4$  missing values were imputed with medians). A  $p$ -value of  $< 0.05$  is set to define statistical significance.



**Fig. 2.** Details of the use of the 4 CAM-ICU features by physicians, nurses and nursing assistants. Graphical representation of the distribution (in percent) of the number of CAM-ICU features needed by each category of caregiver to conclude over 268 assessments.

Delirium monitoring is a critical aspect of the “ICU liberation Bundle” or “ABCDEF bundle” (Marra et al., 2017) which has a dose-dependent association with patients outcomes (Pun et al., 2019). However, despite significant progress, the mortality rate associated with ICU delirium has not decreased over the last 30 years (Aung Thein et al., 2020) and a significant discrepancy persists between guidelines and daily care (Alaterre et al., 2022; Morandi et al., 2017). The main barriers to implementing routine delirium monitoring strategies seem to be a lack of knowledge about delirium and monitoring tools, poor collaboration among ICU caregivers, and concerns about workload (Alaterre et al., 2022; Trogrlić et al., 2017).

Several teams demonstrated the positive impact of educational sessions for nurses. For example, didactic teaching has been reported to improve their confidence in their ability to monitor and manage ICU delirium (Riekerk et al., 2009; Marino et al., 2015; Smith et al., 2017; Sutton-Smith, 2020; Tan et al., 2019). Nevertheless, nurses, like physicians, have a large variety of responsibilities and tasks to attend. To follow guidelines, multiprofessional collaboration has been encouraged to such an extent that some teams have suggested involving families in delirium monitoring (Fiest et al., 2020; Krewulak et al., 2018).

CNAs expertise has been recognized in recent publications (“Value of the Nursing Assistant in Palliative Care,” 2019; Rivosecchi et al., 2016; Costa et al., 2018). In France, CNAs are fundamental part of the ICU care team, as they provide close support to patients and their families by ensuring a comfortable environment, optimal sleeping conditions, daily hygiene, and feeding. They can also play a central role in the non-pharmacological prevention of delirium (Rivosecchi et al., 2016). Previous studies have reported that involving CNAs in delirium monitoring is associated with improved compliance with the ABCDEF bundle (Costa et al., 2018). Thus, CNAs appears to be in a relevant position to provide early alerts if a patient experiences delirium in ICU. In the present study, it is noteworthy to observe that CNAs constituted a stable population of caregivers with considerable experience in the current ICU. Indeed, CNAs tend to have longer job tenures compared to nurses, who typically change department after an average of 2 years, and residents, who rotate to different ICU units every 6 months. The highly promising results we achieved can undoubtedly be attributed to the valuable seniority and experience of CNAs.

This prospective multicenter study is the first to investigate the integration of CNAs into ICU delirium monitoring process and to report their performance in detecting delirium using the CAM-ICU tool. The patients included were from three very general ICUs, encompassing a broad diversity in admission criteria, age, sedation intensity and respiratory assistance modalities, which strengthens the external validity of the results. The randomized, blinded measurement process avoids measurement bias in which CNAs or nurses might have mimicked physician results. The allocated three-hour time frame for the diverse CAM-ICU assessments appears to be reasonable.

## **Limitations**

This study does have some limitations worth noting. First, the need to have three ICU caregivers simultaneously available slowed inclusions, and the COVID-19 crisis further extended this problem.

Second, we defined the CAM-ICU result obtained by ICU physicians as reference for comparisons, and did not involve other specific research staff or neuropsychological experts using an operationalized approach to DSM-V criteria (Vasilevskis et al., 2011; Chanques et al., 2018). However, the CAM-ICU stands out as a validated tool that has undergone rigorous validation against DSM criteria (Ely et al., 2001). It is widely accepted for use by both research investigators (Chanques et al., 2018) and trained bedside caregivers (Vasilevskis et al., 2011). Our choice was motivated by its alignment with international guidelines (Barr et al., 2013; Devlin et al., 2018) and by its strong congruence with our clinical practice. CAM-ICU monitoring was already an integral part of our physicians' daily clinical examination, and they received additional training specifically for this study (Smith et al., 2017). Nonetheless, it is important to consider that there might be instances where ICU physicians may miss or misinterpret delirium symptoms, leading to inaccurate assessments (Oxenbøll-Collet et al., 2018), and this must be considered when interpreting our results.

Third, patients with a RASS score less than or equal to  $\leq 3$  were excluded, so we cannot draw conclusions on the diagnostic performance of CNAs for this category of patients (Brummel and Ely, 2014; Haenggi et al., 2013).

Finally, monitoring delirium without implementing concrete management strategy may seem outdated. A positive diagnosis should lead to investigations and treatments, and we will now have to develop a multiprofessional management algorithm that include screening, etiologic diagnosis and treatment. At the end of the day, this algorithm could allow each caregiver to find their place and measure the value of their work.

## **Conclusion**

Improving delirium management is a major challenge for all ICU caregivers. This study results demonstrate the great performance of trained CNAs in detecting delirium using the CAM-ICU. Further research is needed to define the most effective role for CNAs in the routine management of delirium in the ICU.

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## **CRedit authorship contribution statement Alaterre Camille:**

Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Validation. **Fazilleau Claire:** Conceptualization, Methodology, Project administration, Validation. **Cayot-Constantin Sophie:** Investigation, Validation. **Chanques Gerald:** Investigation, Validation. **Kacer Samia:** Project administration, Validation. **Constantin Jean-Michel:** Conceptualization, Methodology, Supervision, Writing – review & editing, Validation. **James Arthur:** Methodology, Data curation, Formal analysis, Writing – review & editing, Validation.

## **Declaration of Competing Interest**

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: JM-C reports personal fees and non-financial support from Drager, GE Healthcare, Sedana Medical, Baxter, and AOP Health; personal fees from Fisher and Paykel Healthcare, GSK, Guilead, Orion, Philips Medical, and Fresenius Medical Care; and non-financial support from LFB and Bird Corporation, outside of the submitted work.

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