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A Comparative Study To Determine The Sensitivity And Specificity Of Cam-Icu And Icdsc As Screening Tools For ICU Delirium

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Abstract

Background

Delirium is a frequent and serious complication among critically ill patients, associated with increased morbidity and mortality. Early and accurate detection using validated screening tools is essential in intensive care unit (ICU) settings. The Confusion Assessment Method for the ICU (CAM-ICU) and the Intensive Care Delirium Screening Checklist (ICDSC) are widely used instruments, but their relative diagnostic performance varies across clinical contexts. This study aimed to compare the sensitivity and specificity of CAM-ICU and ICDSC for delirium detection using DSM-5 criteria as the reference standard.

Materials and Methods

This prospective observational study was conducted in a mixed medical–surgical ICU and included 100 adult patients admitted for more than 24 hours. Delirium assessment was performed using CAM-ICU and ICDSC by trained ICU personnel, blinded to the psychiatrist's diagnosis. Delirium diagnosis based on DSM-5 criteria served as the gold standard. Baseline demographics, illness severity scores (APACHE II and SOFA), and clinical outcomes were recorded. Diagnostic accuracy measures and agreement between tools were analyzed.

Results

The mean age of the study population was 58.6 ± 16.2 years, with male predominance (62%). Delirium-positive patients were older and had significantly higher APACHE II and SOFA scores. CAM-ICU showed higher specificity (97.0%), positive predictive value(92.9%), and diagnostic odds ratio (98.7), whereas ICDSC demonstrated slightly higher sensitivity (82.4%) and negative predictive value(90.3%). Both tools exhibited good overall diagnostic accuracy and discriminatory ability. Agreement analysis revealed substantial concordance (κ = 0.64). Delirium-positive patients had significantly longer ICU and hospital stays, higher mortality, and prolonged mechanical ventilation.

Conclusion

Both CAM-ICU and ICDSC are reliable screening tools for ICU delirium. CAM-ICU offers higher specificity, while ICDSC provides greater sensitivity. Tool selection should be guided by clinical priorities and ICU workflow to optimize delirium detection and patient outcomes.

Keywords: Delirium, Intensive Care Unit, CAM-ICU, ICDSC, DSM-5, Diagnostic Accuracy

Introduction

Delirium is a common and serious neuropsychiatric syndrome encountered in critically ill patients, particularly in the intensive care unit (ICU). It is defined by an acute onset of fluctuating disturbances

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in attention, cognition, and level of awareness, often accompanied by perceptual abnormalities and disorganized thinking [1]. In the ICU setting, delirium represents acute brain dysfunction rather than a transient or benign condition and is associated with significant clinical and prognostic implications [2]. Numerous studies have demonstrated that ICU delirium is linked with prolonged mechanical ventilation, increased ICU and hospital length of stay, higher healthcare costs, long-term cognitive impairment, and increased mortality [3].

Despite its high prevalence and serious consequences, delirium remains underrecognized and undertreated in ICU settings. The fluctuating nature of symptoms, overlap with sedation effects, and reliance on subjective clinical judgment contribute to underdiagnosis. Studies have shown that clinical impression alone can miss more than half of delirium cases, highlighting the need for structured and systematic screening [4].

The reported incidence of ICU delirium varies widely, ranging from 20% to 80%, depending on patient population, illness severity, and diagnostic methodology. The prevalence is particularly high among mechanically ventilated patients, often exceeding 70%, while non-ventilated patients also demonstrate substantial rates. Advanced age, baseline cognitive impairment, sepsis, multi-organ dysfunction, and prolonged exposure to sedatives and analgesics are well-established risk factors. Hypoactive delirium, characterized by lethargy and reduced responsiveness, is the most common subtype but is frequently overlooked and is associated with poorer outcomes compared to hyperactive delirium [5].

The pathophysiology of delirium is complex and multifactorial. Proposed mechanisms include neuroinflammation, impaired cerebral perfusion, neurotransmitter imbalance, and disruption of the sleep–wake cycle. Systemic inflammatory states such as sepsis compromise the blood–brain barrier, leading to neuronal dysfunction and injury. Neurotransmitter disturbances, particularly cholinergic deficiency and dopaminergic excess, are central to delirium development, with additional involvement of serotonin, GABA, and glutamate pathways. ICU-related environmental factors such as noise, sleep deprivation, immobility, and sensory overload further increase susceptibility [6].

Delirium has important short- and long-term consequences. Acutely, it increases the risk of self-extubation, catheter removal, aspiration, infections, and other ICU complications. It significantly prolongs ICU and hospital stay and increases healthcare costs. Delirium is also an independent predictor of mortality, with affected patients experiencing a two- to three-fold increase in death rates compared with non-delirious patients. Long-term outcomes include persistent cognitive impairment, increased risk of dementia, reduced functional independence, and diminished quality of life [7-8]. Consequently, delirium has been described as a form of "organ dysfunction of the brain" requiring systematic monitoring and management [9].

Given the limitations of clinical judgment alone, international guidelines recommend routine delirium screening using validated tools [5,20]. Early detection enables timely interventions such as optimization of sedation and analgesia, correction of metabolic abnormalities, early mobilization, and environmental modifications. Among available instruments, the Confusion Assessment Method for the ICU (CAM-ICU) and the Intensive Care Delirium Screening Checklist (ICDSC) are the most widely validated and commonly used [6].

CAM-ICU offers rapid point-in-time assessment with high specificity, while ICDSC, based on longitudinal observation, may provide greater sensitivity, particularly for hypoactive delirium. However, diagnostic performance varies across settings and populations [16,18]. Most comparative evidence originates from high-income countries, with limited data from resource-constrained settings where ICU practices differ [9].

Therefore, the present study was undertaken to compare the sensitivity and specificity of CAM-ICU and ICDSC as screening tools for ICU delirium in a real-world clinical setting, with the aim of identifying the most appropriate instrument for routine use.

Materials and Methods

This prospective observational cohort study was conducted in a mixed medical–surgical intensive care unit at Santosh Hospital, Ghaziabad. The study included adult patients admitted to the ICU during the study period. A sample size of 100 patients was

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calculated based on comparison of sensitivities of CAM-ICU (43%) and ICDSC (64%) for delirium detection, assuming 80% power, a 5% alpha error, and a 15% non-response rate, with reference values derived from prior comparative studies.

Patients aged 18 years or older who stayed in the ICU for more than 24 hours, were able to respond to basic questions, and had reliable medical history available were included. Patients with pre-existing dementia or severe cognitive impairment, known psychotic illness, significant language barriers, substance intoxication, participation in another interventional study, or those receiving end-of-life or palliative care were excluded.

The study was conducted after approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants or their legally authorized surrogates. Confidentiality was maintained by anonymizing all collected data.

Data were collected twice daily throughout each patient's ICU stay using standardized proformas. Baseline demographic and clinical information, including age, sex, comorbidities, and primary diagnosis at ICU admission, was recorded. Delirium diagnosis was established by a psychiatrist using the DSM-5 criteria, which served as the gold standard. The psychiatrist remained blinded to the results of both screening tools. Delirium screening was performed independently twice daily by trained doctors and nurses using both the Confusion Assessment Method for the ICU (CAM-ICU) and the Intensive Care Delirium Screening Checklist (ICDSC). Each assessor completed the evaluations individually without knowledge of the other assessor's findings, thereby maintaining independent assessments and minimizing observer bias. Inter-rater reliability between doctors and nurses was evaluated in a subset of patients using independently completed assessments.

CAM-ICU positivity was defined by the presence of acute onset or fluctuating course and inattention along with either altered level of consciousness or disorganized thinking. The ICDSC consisted of eight items scored over a nursing shift, with a score of ≥4 considered diagnostic of delirium. The Richmond Agitation-Sedation Scale (RASS) was used concurrently to assess the level of sedation and agitation at the time of screening.

Data were entered into Microsoft Excel and analyzed using STATA software. Continuous variables were expressed as mean ± standard deviation or median with interquartile range, depending on data distribution, while categorical variables were presented as frequencies and percentages. Group comparisons were performed using the unpaired t-test or Mann–Whitney U test for continuous variables and Chi-square or Fisher's exact test for categorical variables, as appropriate. A p-value of <0.05 was considered statistically significant.

Results –

The baseline demographic and clinical characteristics of the study population are summarized, showing a mean age of 58.6 ± 16.2 years with male predominance (62%). Patients positive for delirium by both CAM-ICU and ICDSC were significantly older and had higher APACHE II and SOFA scores on day 1 and day 3, indicating greater illness severity. There was no significant difference in gender distribution or primary diagnostic categories between delirium-positive and negative groups, reflecting a heterogeneous ICU population. [**Table 1]**

The diagnostic performance of CAM-ICU and ICDSC was evaluated against DSM-5 criteria. CAM-ICU demonstrated a higher specificity (97.0%), positive predictive value(92.9%), and diagnostic odds ratio (98.7), whereas ICDSC demonstrated slightly higher sensitivity (82.4%) and negative predictive value(90.3%). Overall diagnostic accuracy and AUC-ROC values were high for both tools, indicating good discriminatory ability. [**Table 2]**

Agreement analysis between CAM-ICU and ICDSC showed that both tools concurrently identified delirium in 26 patients and were concordantly negative in 60 patients. The Cohen's kappa coefficient of 0.64 indicated substantial agreement, with an overall agreement rate of 86%, supporting reasonable consistency between the two screening instruments. [**Table 3]**

Clinical outcomes differed significantly based on delirium status. Delirium-positive patients identified by either CAM-ICU or ICDSC had longer ICU and hospital stays, higher ICU and hospital mortality, and prolonged duration of mechanical ventilation compared to delirium-negative patients, highlighting

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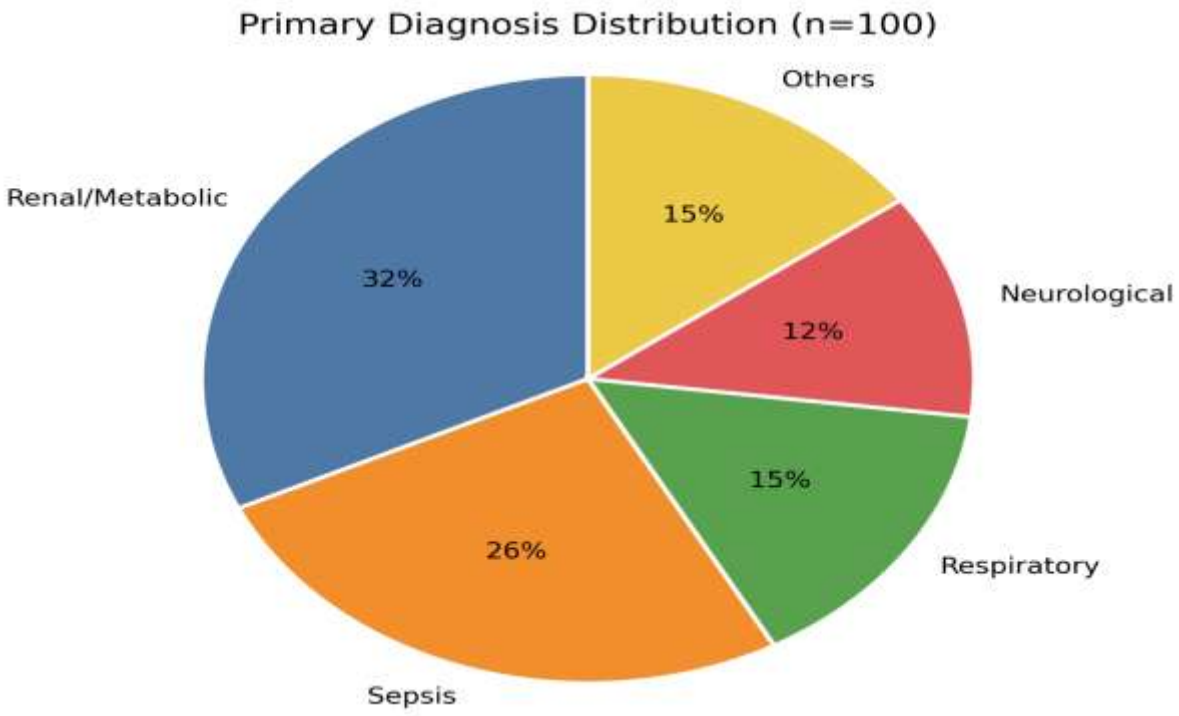
the adverse prognostic impact of ICU delirium. [**Table 4]**

Subgroup analysis demonstrated that delirium prevalence and screening tool sensitivity increased with advancing age, higher APACHE II scores, mechanical ventilation, and sedation. CAM-ICU consistently maintained higher specificity across all subgroups, while ICDSC showed higher sensitivity but lower specificity in severely ill and sedated patients, indicating differential strengths of the two tools depending on clinical context. [**Table 5]**

Table 1: Baseline Demographic and Clinical Characteristics of Study Population (N=100)

Characteristic	Total (N=100)	CAM-ICU +ve (n=28)	CAM-ICU -ve (n=72)	P-value	ICDSC +ve (n=38)	ICDSC -ve (n=62)	P-value
Age (years), mean ± SD	58.6 ± 16.2	64.8 ± 15.3	56.1 ± 16.0	0.012*	63.2 ± 14.8	55.7 ± 16.5	
Male, n (%)	62 (62.0)	18 (64.3)	44 (61.1)	0.542	25 (65.8)	37 (59.7)	
Female, n (%)	38 (38.0)	10 (35.7)	28 (38.9)		13 (34.2)	25 (40.3)	
APACHE II Score, mean ± SD	15.8 ± 7.9	18.4 ± 8.2	14.7 ± 7.5	0.031*	17.9 ± 8.1	14.5 ± 7.6	0.028*
SOFA Score D1, mean ± SD	3.8 ± 2.1	4.9 ± 2.3	3.3 ± 1.8	0.001*	4.6 ± 2.2	3.3 ± 1.9	0.003*
SOFA Score D3, mean ± SD	2.7 ± 2.8	3.8 ± 3.2	2.2 ± 2.5	0.009*	3.5 ± 3.0	2.2 ± 2.6	0.019*



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**Statistically significant (p<0.05); CAM-ICU: Confusion Assessment Method for ICU; ICDSC: Intensive Care Delirium Screening Checklist; APACHE: Acute Physiology and Chronic Health Evaluation; SOFA: Sequential Organ Failure Assessment*

Table 2: Diagnostic Performance of CAM-ICU and ICDSC Against DSM-5 Criteria (N=100)

Parameter	CAM-ICU	ICDSC (cutoff ≥4)	P-value
True Positive	26	28	-
False Positive	2	10	-
True Negative	64	56	-
False Negative	8	6	-
Sensitivity, % (95% CI)	76.5 (59.8-88.2)	82.4 (66.5-92.5)	0.312
Specificity, % (95% CI)	97.0 (89.6-99.6)	84.8 (74.3-92.1)	0.018*
PPV, % (95% CI)	92.9 (76.5-99.1)	73.7 (57.8-85.8)	0.042*
NPV, % (95% CI)	88.9 (79.3-95.1)	90.3 (80.1-96.4)	0.672
Diagnostic Accuracy, %	90.0	84.0	0.183
DOR (95% CI)	98.7 (20.5-475.3)	24.3 (8.1-72.8)	0.021*
AUC-ROC	0.868	0.836	0.241

**Statistically significant (p<0.05); PPV: Positive Predictive Value; NPV: Negative Predictive Value; DOR: Diagnostic Odds Ratio; AUC-ROC: Area Under Receiver Operating Characteristic Curve; CI: Confidence Interval; Reference standard: DSM-5 criteria (34 positive, 66 negative)*

Table 3: Agreement Between CAM-ICU and ICDSC for Delirium Detection (N=100)

	CAM-ICU Positive	CAM-ICU Negative	Total
ICDSC Positive (≥4)	26	12	38
ICDSC Negative (<4)	2	60	62
Total	28	72	100

Cohen's Kappa Coefficient: 0.64 (95% CI: 0.49-0.79) indicating substantial agreement; Overall Agreement: 86.0%; p<0.001

Table 4: Clinical Outcomes Based on Delirium Status (N=100)

Outcome	Total (N=100)	CAM-ICU +ve (n=28)	CAM-ICU -ve (n=72)	P-value	ICDSC +ve (n=38)	ICDSC -ve (n=62)	P-value
ICU Stay (days), mean ± SD	6.8 ± 4.2	8.9 ± 5.1	5.9 ± 3.6	0.003*	8.2 ± 4.8	5.9 ± 3.7	0.009*

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Hospital Stay (days), mean ± SD	12.6 ± 7.8	16.4 ± 9.2	11.1 ± 6.7	0.002*	15.3 ± 8.6	10.8 ± 6.9	0.005*
ICU Mortality, n (%)	8 (8.0)	5 (17.9)	3 (4.2)	0.021*	6 (15.8)	2 (3.2)	0.028*
MV Duration (days)† mean ± SD	4.8 ± 3.2	6.2 ± 3.8	3.9 ± 2.7	0.018*	5.7 ± 3.5	4.1 ± 2.9	0.042*

**Statistically significant ($p<0.05$); †Among 42 mechanically ventilated patients; MV: Mechanical Ventilation; SD: Standard Deviation*

Table 5: Diagnostic Performance of CAM-ICU and ICDSC Across Clinical Subgroups

Subgroup	N	CAM-ICU Sens %	CAM-ICU Spec %	ICDSC Sens %	ICDSC Spec %
Age (years)					
18-40	18	66.7	100.0	66.7	86.7
41-60	38	72.7	96.3	81.8	85.2
61-75	32	78.6	94.4	85.7	83.3
>75	12	83.3	100.0	83.3	83.3
APACHE II Score					
<15	48	66.7	97.2	75.0	88.9
15-24	38	81.3	95.5	87.5	81.8
≥25	14	83.3	100.0	83.3	75.0
Mechanical Ventilation					
Yes	42	80.0	96.2	85.7	80.8
No	58	73.3	97.6	80.0	87.8
Sedation Status					
Sedated	38	83.3	95.2	88.9	81.0
Non-sedated	62	71.4	98.0	77.8	87.2

Discussion

The present study evaluated and compared the diagnostic performance of the Confusion Assessment Method for the ICU (CAM-ICU) and the Intensive Care Delirium Screening Checklist (ICDSC) against DSM-5 criteria among 100 critically ill patients. The mean age of the cohort was 58.6 ± 16.2 years, reflecting the typical demographic profile of ICU admissions. Advancing age is a well-recognized risk factor for delirium, and our findings are consistent

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with previous reports that demonstrate higher delirium prevalence among older patients [10]. Patients who screened positive for delirium by either tool were older, reinforcing age as a key predisposing factor.

Male predominance (62%) observed in this study is in line with patterns reported in mixed medical–surgical ICUs. Importantly, both CAM-ICU and ICDSC demonstrated comparable diagnostic performance across genders, suggesting that neither tool is influenced by sex-related bias. Baseline illness severity, as reflected by APACHE II and SOFA scores, was significantly higher among delirium-positive patients. This finding supports earlier evidence indicating that increasing illness severity is associated with a higher risk of delirium and underscores the importance of routine screening in critically ill populations [10].

The heterogeneous distribution of admission diagnoses—including renal/metabolic disorders, sepsis, respiratory illnesses, neurological conditions, postoperative status, trauma, and cardiovascular diseases—reflects real-world ICU practice and strengthens the generalizability of our findings. Notably, sepsis constituted a substantial proportion of admissions, consistent with prior studies identifying sepsis as an independent risk factor for delirium [11]. The absence of significant diagnostic bias across screening tool outcomes suggests that both CAM-ICU and ICDSC perform reliably across varied clinical contexts.

Comorbidities such as hypertension, diabetes mellitus, ischemic heart disease, chronic obstructive pulmonary disease, and chronic kidney disease were prevalent in our cohort. The presence of cerebrovascular disease and COPD is particularly relevant, as these conditions have been associated with increased vulnerability to delirium [11]. Complex comorbidity profiles may further complicate delirium recognition, highlighting the need for structured screening rather than reliance on clinical judgment alone [12].

When compared against DSM-5 criteria, CAM-ICU demonstrated a sensitivity of 76.5% and a specificity of 97.0%, with an overall diagnostic accuracy of 90%. These findings are consistent with prior validation studies, though sensitivity in our cohort was higher than that reported by van Eijk et al. [13]. Differences in patient characteristics, assessor training, sedation practices, and timing of assessments may explain this variation. Importantly, the high specificity observed for CAM-ICU minimizes false positives, which is clinically advantageous in avoiding unnecessary interventions. Similar diagnostic performance has been reported in mechanically ventilated patients, supporting CAM-ICU's robustness across ICU subgroups [65,66]. Previous work has also shown that CAM-ICU can be reliably administered by non-psychiatric ICU staff following appropriate training [14-15], a finding reinforced by our results.

The ICDSC demonstrated higher sensitivity (82.4%) but lower specificity (84.8%) compared with CAM-ICU. While this higher sensitivity may improve detection rates—particularly for hypoactive delirium—it also resulted in a higher false-positive rate. Similar trade-offs between sensitivity and specificity have been noted in earlier comparative studies [13]. The longitudinal nature of ICDSC assessment may enhance sensitivity but can increase the likelihood of overdiagnosis, which may have implications for resource utilization and patient management. Nonetheless, in settings where minimizing missed delirium cases is prioritized, higher sensitivity may be desirable [16].

Direct comparison revealed that CAM-ICU outperformed ICDSC in specificity, positive predictive value, and overall diagnostic accuracy, whereas ICDSC showed marginally superior sensitivity and negative predictive value. Both tools demonstrated good discriminatory ability, with area under the ROC curve values exceeding 0.8. Agreement analysis revealed substantial concordance between the two instruments (kappa = 0.64), indicating reasonable consistency despite methodological differences. This level of agreement supports the utility of either tool in routine ICU practice, particularly when structured screening is otherwise absent [13,15].

Subgroup analyses showed that delirium prevalence and screening tool sensitivity increased with advancing age and illness severity. CAM-ICU maintained high specificity across age and severity strata, while ICDSC showed more variability. Importantly, neither tool demonstrated gender-related performance differences. These findings suggest that both instruments remain applicable across diverse patient subgroups, including elderly and severely ill patients [67,68].

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Use of mechanical ventilation, sedatives, antipsychotics, opioids, and physical restraints was more common among delirium-positive patients. This reflects both the contribution of these interventions to delirium development and the management challenges posed by delirious patients. Prior studies have highlighted the bidirectional relationship between delirium and sedative exposure, as well as increased risks of adverse events such as device removal [11]. Both CAM-ICU and ICDSC demonstrated improved sensitivity among mechanically ventilated patients, consistent with prior validation studies [17,18].

Patients with delirium experienced longer ICU and hospital stays, prolonged mechanical ventilation, and higher mortality. Those positive by both screening tools exhibited the poorest outcomes, while patients negative by both tools had the most favorable course. These findings align with extensive literature documenting delirium as a marker of poor prognosis in critically ill patients [17,19]. The gradient of outcomes observed across agreement categories suggests that concordant positive screening results may identify a particularly high-risk subgroup.

Overall, this study reinforces the clinical importance of systematic delirium screening in the ICU. While CAM-ICU offers higher specificity and efficiency, ICDSC provides greater sensitivity through longitudinal assessment. The choice of tool should be guided by institutional priorities, staffing patterns, and patient population. Accurate delirium detection remains a critical first step toward implementing preventive and therapeutic strategies that may mitigate adverse outcomes [15,17].

Conclusion

The present study demonstrated that both CAM-ICU and ICDSC are reliable and valid screening tools for the detection of ICU delirium when compared with DSM-5 criteria. CAM-ICU showed superior specificity and overall diagnostic accuracy, making it more suitable for definitive bedside diagnosis, while ICDSC exhibited marginally higher sensitivity, particularly in patients with greater illness severity. Delirium was strongly associated with older age, higher APACHE II and SOFA scores, increased use of sedatives and mechanical ventilation, and poorer clinical outcomes. Routine implementation of structured delirium screening using validated tools can facilitate early detection, timely intervention, and potentially improve outcomes in critically ill patients.

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