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# DIAGNOSTIC ACCURACY OF DELIRIUM ASSESSMENT TOOLS AMONG CRITICALLY ILL INFANT : A SYSTEMATIC REVIEW

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**ABSTRACT**
Delirium is an acute change in neurologic function that can potentially lead to longterm impacts on children's cognitive development and the quality of life. Infants under 12 months are particularly vulnerable because their cognitive and language abilities are not fully developed. Therefore, healthcare professionals need to enhance their knowledge of delirium symptoms, child development stages, and how to identify it in this age group to better detection and management. This study aims to evaluate the diagnostic accuracy of delirium assessment tools, namely the Cornell Assessment of Pediatric Delirium (CAPD), the Preschool Confusion Assessment Method for the ICU (psCAM-ICU), and the Sophia Observation Withdrawal Symptoms Pediatric Delirium (SOSPD), in detecting delirium in critically ill infants. This systematic review follows the PRISMA 2020 guidelines and includes a literature search in PubMed, Scopus, ProQuest, ScienceDirect, and Taylor & Francis from 2013 to 2023. Inclusion criteria consist of observational studies involving infants aged 0-11 months in ICU settings that utilized CAPD, psCAM-ICU, or SOSPD for delirium detection. The quality of the studies was assessed using the JBI Critical Appraisal Checklist for Studies Reporting Diagnostic Test Accuracy. Result : The analysis indicates that the SOSPD tool has a sensitivity ranging from 76.9% to 96.8% and specificity between 92% and 96.4%. The CAPD shows sensitivity from 87% to 94.1% and specificity from 88% to 98%. The psCAM exhibits sensitivity from 75% to 95% and specificity from 81% to 91%. The results demonstrate variability in accuracy depending on the age group and clinical condition of the children. Based on the research findings, psCAM is recommended as the most effective tool for detecting delirium in the infant population due to its ease of use and high accuracy. Early detection of delirium is crucial for enhancing clinical management and improving outcomes in critically ill infants.

Keywords: assessment tools; delirium; critically ill infant; diagnostic accuracy

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## INTRODUCTION

Delirium, a neurocognitive status disorder characterized by acute fluctuations in consciousness and reversible, is a significant concern among critically ill infant patients (Balsalobre et al., 2024). The prevalence of delirium in children admitted to the PICU ranges from 10% to 66% (Semple et al., 2021), with a particularly high rates observed in critically ill infants and children under two years of age with a high prevalence ranging from 8.1 to 64% (Holberg et al., 2021). Therefore, early detection using validated screening tools and appropriate treatment is crucial to prevent complications that can arise from delirium. Typical features of delirium in pediatric patients are irritability, affect lability, agitation, and sleep disturbance. These symptoms will impact the child's emotional well-being and increase the risk of injury (Thom, 2017). Furthermore, the long-term negative effects of recurrent delirium include prolonged ICU stay, increased duration of weaning from mechanical ventilators, higher healthcare cost, increased mortality rates, and reduced quality of life post-recovery (Dechnik & Traube, 2020; Dervan et al., 2022; Salluh et al., 2015; Schiveld and Janssen, 2014; Silver et al., 2020; Zhu et al., 2022). 2022). Traube et al. (2016) found that children with critical conditions who experience delirium have an increased cost of care of up to 85%.

In terms of intensive care settings, such as the Pediatric Intensive Care Unit (PICU), Neonatal Intensive Care Unit (NICU) or other intensive care units early assessment of delirium, is crucial as its condition can affect cognitive function and long-term development. Currently, a number of instruments are available to detect delirium in the pediatric population, namely the Pediatric Confusion Assessment Method for the ICU (pCAM-ICU), Preschool Confusion Assessment Method for the ICU (psCAM-ICU), Pediatric Anesthesia Emergence Delirium (PAED), Cornell Assessment of Pediatric Delirium (CAPD), and Sophia observation withdrawal symptoms pediatric delirium (SOSPD) (Rohmah et al., 2023; Stenkjaer et al., 2023). However, until today, no agreement found on the diagnostic accuracy of each of these instruments in diagnosing delirium in critically ill infants. Therefore, this systematic review aims to evaluate the accuracy of Cornell Assessment of Pediatric Delirium (CAPD), Preschool Confusion Assessment Method for the ICU (psCAM-ICU), and Sophia Observation Withdrawal Symptoms Paediatric Delirium (SOSPD) in detecting delirium of critically ill infants. This study aims to evaluate the diagnostic accuracy of delirium assessment tools, namely the Cornell Assessment of Pediatric Delirium (CAPD), the Preschool Confusion Assessment Method for the ICU (psCAM-ICU), and the Sophia Observation Withdrawal Symptoms Pediatric Delirium (SOSPD), in detecting delirium in critically ill infants.

## METHOD

### Data Sources and Searches

This systematic review employed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) 2020 as a guideline in preparation, and has been registered with PROSPERO with registration number CRD42024627813The researchers explored and searched several databases, namely PubMed, ScienceDirect, Proquest, Scopus, and Taylor & Francis. The search was conducted since October 2024, with the keywords "Critical Pediatric" AND "Sensitivity and Specifity" AND "Pediatric confusion assessment method for the intensive care unit" OR "Preschool confusion assessment method for the intensive care unit" OR "Cornell assessment of pediatric delirium" OR "Pediatric anesthesia emergence delirium scale" OR "Sophia observation withdrawal symptoms pediatric delirium" OR "Vanderbilt assessment for delirium in infants and children". In order to strengthen the findings, an additional manual search focusing on the accuracy of delirium screening instruments in critically ill infants was also conducted.

### Study Selection

The inclusion criteria of this study included: 1) children aged 0-11 months admitted to the intensive care unit; 2) the research subjects screened using pCAM, psCAM, CAPD, PAED, SOSPD or VADIC instruments to detect delirium; 3) outcomes to be assessed including prevalence of delirium, diagnostic accuracy measured in terms of sensitivity, and specificity; and 4) only included studies with observational design, Cohort studies, and case series or case reports. The researchers limited the search results to English-language articles only, with no restrictions on time or research methods.All articles retrieved from the five databases were initially imported into EndNote software, then duplicate articles were subsequently removed. Two researchers (DAR and RN) independently screened the remaining articles based on their titles and abstracts to determine their eligibility. Articles that successfully passed the initial screening were then subjected to a comprehensive review of their full content. In cases where the two researchers disagreed on the inclusion of a particular article, a third researcher was consulted to reach a consensus.

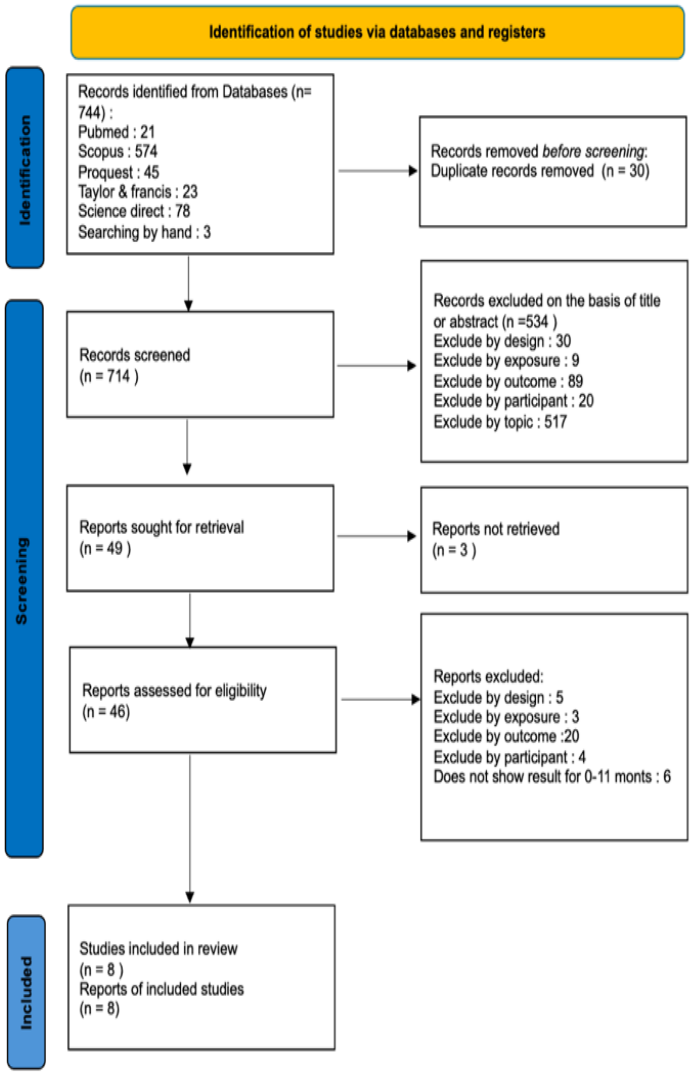
**Data Extraction and Risk of Bias Assessment**

Two researchers (DAR and RN) separately collected information from each study, including respondent characteristics, measurement tools, reference standards, threshold values used, prevalence of delirium, and relevant results to gauge the accuracy of an instrument. Disagreements were resolved through discussion, with the third researcher acting as a mediator to help reach agreement. In assessing the quality of each study, the researchers used the Joanna Briggs Institute (JBI) instrument to evaluate the accuracy of diagnostic test tools. This instrument contains ten question items. Each item was rated with three answer options of Yes, No, and Unclear. Based on this assessment, the researchers determined the feasibility of the study to be included in the analysis, considering the predetermined eligibility criteria. Differences of opinion was then discussed by involving a third researcher as a mediator.

**RESULT**

Study Selection

According to the search results, a total of 741 articles were identified. After removing 30 duplicates articles, 711 articles were excluded because they did not meet the eligibility criteria set by the researchers. This left 46 articles for a comprehensive review, from which five articles met the eligibility criteria. To ensure data saturation, the researcher then conducted a manual search resulting in the addition of three more articles that met the criteria. Consequently, a total of eight articles were included in this systematic review.




Gambar 1. Diagram PRISMA

**Characteristics of the Study**

The articles included in this systematic review were published between 2013 and 2023, covering studies conducted across three continents: Europe, America, and Asia. The total sample of all articles amounted to 1,059 children, ranging in ages from 0 to 18 years. Samples sizes varied, with the smallest number of 49 participants and the largest number involving 300 samples. Almost all studies used a prospective observational study design. Meanwhile, one of the studies applied mixed research methods, combining qualitative and quantitative approaches.Among the eight studies reviewed, three used the SOSPD instrument, three employed the CAPD, and two applied psCAM. The pCAM, PAED, and VADIC were excluded from the analysis as they did not meet the eligibility criteria. All studies referenced DSM-IV or DSM-V depending on the publication year. The SOSPD scale has a sensitivity between 76.9% to 96.8%, and a specificity between 92% to 96.4% (Ista *et al.,* 2017; Stenkjaer *et al.,* 2023; Stenkjaer *et al.,* 2023). In the study conducted by Stenkjaer *et al.,* (2022 and 2023), it was found that the younger the age of the child, the higher the incidence of delirium. This contradicted with the study conducted by Ista e*t al.,* 2017.

The CAPD scale demonstrated a sensitivity ranging from 87% to 94.1%, and a specificity ranging from 98% to 88%. AUC values range from 91.1% to 94%, and inter-rater agreement values of $\kappa$ 84.9% to 94% (Hong *et al.,* 202; Hoshino *et al.,* 2020; Traube *et al.,* 2013). In the premature children group, the CAPD sensitivity value was 92.9%, then 64.6% of specificity, and 87% of AUC. In children <2 years of age, CAPD sensitivity was 100%, specificity 67.7%, and AUC 92%. Meanwhile, in children with developmental disorders, CAPD sensitivity was 96.2%, specificity was 51.2%, and AUC was 86% (Traube *et al.,* 2013). The psCAm scale has a sensitivity of 75% to 95% and a specificity between 81% and 91%, with an inter-rater agreement score of $\kappa$ between 79% to 100% (Canter *et al.,* 2021; Smith *et al.,* 2016). For infants age group <1 month, the sensitivity of psCAM was 100%, and the specificity was 78%. In children aged >1 month, the sensitivity is 90%, and the specificity is 84% (Canter *et al.,* 2021). Meanwhile, in children < 2 years of age psCAm has a sensitivity of 78%, and a specificity of 93% (Smith *et al.,* 2016).

Table 3.

Analysis of Selected Articles

| No. | Author (year), country | Measuring Instrument/ Cut-off/Reference Standard | Characteristics of participants | Three main diagnoses (%) | Risk Factor (P value) | Prevalence of delirium (%) | Sensitivity (95% CI) | Specificity (95% CI) | PPV (95% CI) | NPV (95% CI) | AUC | Interrater reliability | JBI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Stenkjaer *et al.,* (2022) , Denmark | SOSPD/≥ 4/ DSM-V | N= 50, with inclusion criteria:<br>a. Age≥ 4 weeks to 18 years.<br>b. Minimum length of stay of 48 hours<br>c. COMFORT score≥ 11 or RASS -3≥ | - Cardiology (54%)<br>- Respiration (12%)<br>- Surgery (12%) | None | 13/50 (26%), consisting of:<br>0-2 months (0%)<br>3-23 months (38.46)<br>2-5 years (30.77)<br>6-12 years (7.69%)<br>>12 years (23.08%) | 76,9% (46,2-95,0) | 91,9% (78,1-98,3) | 76,9% (52,0-92,1) | 91.9 (80,7-96,9) | None | None | 9/10 yes; 1/10 unclear (Q 8) |

| No. | Author (year), country | Measuring Instrument/ Cut-off/Reference Standard | Characteristics of participants | Three main diagnoses (%) | Risk Factor (P value) | Prevalence of delirium (%) | Sensitivity (95% CI) | Specificity (95% CI) | PPV (95% CI) | NPV (95% CI) | AUC | Interrater reliability | JBI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2. | Stenkjaer *et al.*, (2023), Denmark | SOSPD/≥ 4/ DSM-V | N=141, with inclusion criteria:<br>a. Ages 3 months to 18 years<br>b. Minimum length of stay of 48 hours<br>c. COMFORT score≥ 11 or RASS -3≥ | -Cardiology (52%)<br>-Respiration (11%)<br>-Neurology and surgery (8%) | None | 30/141 (21%), consisting of :<br>-23 months (36.7%)<br>-5 years (3.3%)<br>-12 years (13.3)<br>12 years (20%) | 83,3% (65,3-94,4) | 96,4% (91,0-99,0) | 86,0% (69,9-94,2) | 95,6% (90,7-98,0) | 91% | None | 10/10 yes |
| 3. | Ista *et al.*, (2017), Netherlands | SOSPD/≥ 4/ DSM-IV | N= 146, with inclusion criteria:<br>a. Ages 3 months to 16 years<br>b. Minimum length of stay of 48 hours<br>c. COMFORT SCORE≥ 1 | Respiration (34.93%)<br>Cardiology (17.81%)<br>Neurology (15.75%) | Espiration (0.04)<br>OV (0.02)<br>OS in ICU (<0.0001)<br>Idazolam (0.002)<br>lonidine (<0.001)<br>Morphin (<0.001)<br>Fentanyl (<0.001) | 13/146 (8.90%), consisting of :<br>3-12 years (7.69)<br>1-4 years (38.46%)<br>5-18 years (53.85%) | 96,8% ( 80,4-99,5%) | 92,0% (59,7-98,9%) | None | None | None | ICC = 0.90 (0.76-0.96)<br>$\kappa$ each item :0.46-1.0 | 9/10 yes ; 1/10 unclear (Q 8) |
| 4. | Hoshino *et al.*, (2020), Japan | CAPD/≥ 9/ DSM-V | N= 41, with inclusion criteria:<br>a. Age 0-13 years<br>b. RASS Score≥ -3 | - Cardiology: (73%)<br>- Respiration (17%)<br>- Ventilators (39%) | - Ventilator (<0.01)<br>- PIM II (0.02)<br>- Midazolam (<0.01) | 49/92 assessments (53%) | 90% (79-97%) | 88% (75-96%) | 90% (79-97%) | 91% (80-97%) | 92% | $\kappa$ psychiatrist: 0.91 (0.83-0.99)<br>$\kappa$ Nurse: 0.89 (0.80-0.98)<br>$\kappa$ per item: 0,67 (0,54-0,80)-0,89 (0,80-0,98) | 9/10 yes ; 1/10 unclear (Q 8) |
| 5. | Traube *et al.*, (2013), USA | CAPD/≥ 9/ DSM-IV | N : 111, with inclusion criteria:<br>a. Age 0-21 years<br>b. RASS Score≥ -3 | - Surgery/other (47.75 %)<br>- Respiration (45.05 %)<br>- Infection (34.23 %) | None | 51/111 (45,94%) | Total: 94,1 (83,8-98,8%)<br>Preterm infants: 92,9% (78,9-100%)<br>< 2 years : 100% (100-100%) | Total: 79,2% (73,5-84,9%)<br>Preterm infants: 64,6% (37,6-91,6%)<br>< 2 years: 67,7% (45,9-89,6%) | None | None | Total: 94%<br>Premature babies: 87%<br>< 2 years : 92% | $\kappa$ : 0,94<br>$k$ per item: 0,68-0,78 | 9/10 yes ; 1/10 unclear (Q 8) |
| 6. | Hong *et al.*, (2021), China | CAPD/≥ 9,≥ 10, and≥ 11/ DSM-V | N= 170, with inclusion criteria:<br>a. Post GA<br>b. Ages 1month to 18 years<br>c. Minimum length of stay of | ENT Surgery (45.3%)<br>General surgery (24.1%)<br>Urological surgery (17.1%) | - H: 0,049<br>- W: 0,033<br>- Surgery type: 0,001 | 23/170, consisting of :<br>0-6 months (4.35%)<br>6 months-2 years (30.4%)<br>2-5 years | Cut-off≥ 9: 87,0% (63,5-96,6%)<br>Cut-off≥ 10: 78,3% (55,8-91,7%) | Cut-off≥ 9: 98% (93,7-99,5%)<br>Cut-off≥ 10: 100% (100-100%)<br>Cut- | None | None | None | $\kappa$ Cut-off≥ 9: 0.849<br>$\kappa$ Cut-off≥ 10: 0,862<br>$\kappa$ Cut-off≥ 11: 0.798 | 9/10 yes ; 1/10 no (Q 2) |

| No. | Author (year), country | Measuring Instrument/ Cut-off/Reference Standard | Characteristics of participants | Three main diagnoses (%) | Risk Factor (P value) | Prevalence of delirium (%) | Sensitivity (95% CI) | Specificity (95% CI) | PPV (95% CI) | NPV (95% CI) | AUC | Interrater reliability | JBI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | d. 48 hours RASS Score≥ -3<br>e. Good hearing and vision function | | | (26.1%) >5 years (39.1%) | Cut-off≥ 11: 69.6% (47.0-85.9%) | off≥ 11: 100% (100%-100%) | | | | | |
| 7. | Canter *et al.*, (2021), Spain | ps-CAM/ feature 1 and 2 positive, plus either feature 3 or 4/ DSM-V | N= 49, with inclusion criteria:<br>a. Infants < 6 months of age<br>b. RASS Score≥ -3<br>c. Good hearing and vision function | - PJB (51%)<br>- Respiration (39%)<br>- Cardiomyopathy (6%) | - | 23/49, consisting of : < 1 month (61%) > 1 month (39%) | Total: : 95% (89-100%) < 1 month : 100% (100%-100%) > 1 month: 90% (80%-100%) | Total: : 81% (68-90%) < 1 month :78% (47%-91%) >1 month: 84% (72%-94%) | Total:: 69% (55-79%) < 1 month : 100% (100% - 100%) - >1 month: 71% (53%-87%) | Total: : 97% (94-100%) < 1 month: 67% (43%-81%) > 1 month: 95% (90%-100%) | None | $\kappa$ : 1.0 | 10/ 10 yes |
| 8. | Smith *et al.*, (2016), USA | ps-CAM/ feature 1 and 2 positive, plus either feature 3 or 4/ DSM-V | N= 300, with inclusion criteria:<br>a. Ages 6 months to 5 years<br>b. RASS Score≥ -3<br>c. Good hearing and vision function<br>d. Normal development. | - ARDS (34%)<br>- PJB (31%)<br>- Breathing apparatus (18%) | - | 41/300 (33%) | Total: 75% (72-78) < 2 years : 78% (75-81%) >2 years: 66% (58-74%) | Total: 91 % (90-93%) < 2 years : 93% (95% CI 92-95%) > 2 years: 87% (83-91%) | Total: 84% (81%-87%) < 2 years : 88% (95% CI 86-91%) > 2 years: 71% (95% CI 86-91) | Total: 86% (85%-88%) < 2 years : 86% (85-88%) > 2 years : 84% (80-88%) | None | $\kappa$ = 0,79 | 10/ 10 yes |

## DISCUSSION

This systematic review aimed to determine the accuracy of various delirium screening tools in the infant population. This study analyzed three diagnostic scales to assess delirium in children aged 0-11 months, namely SOSPD, CAPD, and psCAM. All scales commonly showed good accuracy, with varying sensitivity and specificity values. In the preterm infant group, the CAPD showed a very high sensitivity (92.9%), indicating its excellent ability to detect positive cases of delirium. However, the specificity was relatively low (64.6%), reflecting limitations in identifying preterm infants without delirium. Meanwhile, in the group of children under 2 years of age, CAPD has excellent sensitivity (100%), but weak specificity (Traube et al., 2013). On the other hand, the psCAm also has good sensitivity and specificity values in assessing delirium in the infant population. It has a perfect sensitivity value in infants <1 month of age, with a specify was in the moderate category (78%). This score was higher than that of the older age group. Inter-rater agreement was also perfect ($\kappa$=1) (Canter et al., 2021).

In terms of its practicality, psCAM seems to be superior to other instruments as it has fewer items to assess. The items in this instrument are also mostly objective, so it is easy to use and the time required is also relatively shorter (Smith et al., 2015). In contrast, the CPAD has more subjective items with a wide range of categories, making it difficult to distinguish between response categories such as "rarely" and "sometimes" (Flaigle et al., 2016; Ista et al., 2017). The accuracy of delirium assessment is highly dependent on the assessor knowledge.

An in-depth understanding of normal child development and common child behaviors is crucial. In addition, the assessor also needs to have a good knowledge of the symptoms of delirium. Comprehensive training and effective implementation will ensure that assessors can use the delirium screening instrument appropriately and carefully. This screening instrument offers a number of advantages. The observation process becomes more systematic, with the clear and targeted questions. Thus, the risk of errors in assessment can be minimized (Smith et al., 2016; Traube et al., 2013).

Moreover, parental involvement in the assessment process can significantly improve the accuracy of assessment results. As the individuals who are closest to and understand their child the most, parents have in-depth knowledge of the child's behavior. They are able to provide valuable information regarding symptoms of delirium that may be missed by medical personnel, such as changes in attention, cognition, and consciousness (Paterson et al., 2020; Stenkjaer et al., 2022). In the included studies, the prevalence of delirium varied widely. This variation can be caused by several factors, such as the frequency of screening performed in a day. Ista et al., 2017 conducted screening using the SOS-PD instrument only once in 24 hours, while Stenkjer et al., 2022 and 2023 conducted delirium screening every shift using the same instrument and found a greater prevalence of delirium. Delirium refers to a fluid condition, causing children may not exhibit symptoms of delirium at the time of screening (Traube et al., 2017). As a result, if the assessment is conducted only once, there is a chance that some cases of delirium may go undetected. Conversely, by conducting assessments more frequently, it increases the chances of possibly finding cases of fickle delirium (Alvarez et al., 2018; Smith et al., 2016).

The variation in delirium prevalence is influenced by the specific assessment tool employed and the applied diagnostic threshold. Different instruments, such as the pCAM and the SOPD, utilize distinct methodologies and approaches to evaluate delirium. The pCAM, which requires direct patient interaction, may introduce variability in assessment results due to clinician-specific observations and the child's fluctuating condition at the time of assessment. Conversely, the SOPD, which relies on a 4-hour observation window, allows for a more comprehensive assessment of fluctuating delirium symptoms (Stenkjaer et al., 2022; Ista et al., 2017). Although both tools have demonstrated relative consistency in delirium assessment in children, their methodological differences may impact prevalence estimates. Additionally, the selected diagnostic threshold plays a crucial role in delirium detection. A lower threshold increases sensitivity, potentially identifying more cases but also increasing the risk of false positives. Conversely, a higher threshold may reduce false positives but may overlook true cases of delirium (Paterson et al., 2020).

## CONCLUSION

Among the three instruments, the authors recommend the psCAm for use in assessing delirium in the infant population. This recommendation is based on its design specifically for younger children, ease of use, and its validity evidence in detecting delirium in this population. In a busy critical care environment with limited staffing, there is a need for a tool capable of rapidly assessing symptoms of delirium. Moreover, timely detection can aid in more effective management and increase outcomes for critically ill infants.

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