

# The European Journal of Psychiatry

## Screening time for delirium in dementia patients matters: Validation of the Spanish version of the RADAR scale --Manuscript Draft--

<b>Manuscript Number:</b>	
<b>Article Type:</b>	Original article
<b>Keywords:</b>	Delirium; Dementia; diagnosis; postacute care; elderly; nursing
<b>Corresponding Author:</b>	Esteban Sepulveda Hospital Psiquiatric Universitari Institut Pere Mata Reus, SPAIN
<b>First Author:</b>	Esteban Sepúlveda
<b>Order of Authors:</b>	Esteban Sepúlveda Ester Bermúdez Lourdes Vallinoto Julia Sánchez Paola Saura Pau Piany Eva Viñuelas Marta Ciutat José Palma Imma Grau Elisabet Vilella Philippe Voyer José G. Franco
<b>Abstract:</b>	<p>Background and objectives: Delirium is frequently underdiagnosed, especially in patients with dementia. The Repérage Actif du Delirium Adapté à la Routine (RADAR) scale can be adapted to nursing routines and facilitates delirium screening, but the Spanish version of the scale has not yet been validated. The objective was to validate it and determine the best time of day for its administration. Methods: We assessed all dementia patients admitted to a postacute care centre on one day; patients were independently assessed by nurses using the RADAR scale during the morning and midday shifts and by geriatric physicians with the Delirium Diagnostic Tool-Provisional (DDT-Pro) as a reference standard for the diagnosis of delirium and subsyndromal delirium. We evaluated the test-retest temporal stability of the morning and midday RADAR assessments and the RADAR validity considering each of the two time points. Results: Of the 34 patients with dementia included in the study, 47.1% had delirium, and 83.3% had behavioural, mental or neurological disturbances that made diagnostic assessment difficult. The test-retest temporal stability of the RADAR scale was only moderate, which is consistent with the fact that the diagnostic accuracy of the midday assessment for delirium (79.4%) was better than that of the morning assessment (73.5%). The accuracy of the screening when also considering subsyndromal delirium, accounting for either assessment time, was 79.4%. Conclusion: The RADAR scale is useful for the screening of delirium and subsyndromal delirium by nurses in dementia patients and midday assessments have greater diagnostic validity than morning assessments.</p>
<b>Suggested Reviewers:</b>	Paula Trzepacz Adjunct Clinical Professor of Psychiatry, Indiana University School of Medicine pttrzepacz@outlook.com Expert in the phenomenology and diagnosis of delirium

	<p>Dimitrios Adamis          Psychiatrist, Sligo University Hospital          dimaadamis@yahoo.com          Clinician and researcher with extensive experience in delirium</p>
	<p>Sandeep Grover          Professor, Post Graduate Institute of Medical Education and Research          drsandeepg2002@gmail.com          Researcher in psychiatry, with numerous publications on the phenomenology and diagnosis of delirium.</p>
	<p>Tanya Mailhot          Professeure adjointe, Universite de Montreal          t.maihot@umontreal.ca          Researcher with expertise in elderly care, including the identification and treatment of delirium</p>
<p><b>Opposed Reviewers:</b></p>	

April 10th, 2024

Dr. Guillermo Lahera  
Editor-in-Chief  
European Journal of Psychiatry

Dear Editor

I am pleased to submit the article entitled " Screening time for delirium in dementia patients matters: Validation of the Spanish version of the RADAR scale" for your consideration for publication as an original manuscript.

In this paper we validate the Spanish version of the RADAR scale, which allows the screening of delirium by nursing staff, in a rapid manner at each shift, as a "sixth vital sign". In our case, we evaluated its performance when administered to people with dementia in a post-acute care facility, a population with special characteristics that make it difficult to detect delirium. The centre's geriatricians performed the reference diagnosis of delirium and subsyndromal delirium using the DDT-Pro tool, which has shown good diagnostic validity in previous studies, including one in our own population.

We found that the RADAR allows screening for delirium and subsyndromal delirium with good levels of validity, with better results obtained in the midday assessment than in the morning. Our results are explained by the delirium characteristics and severity in our sample of patients with dementia (that are described in the manuscript), and perhaps also by the especial characteristics of the postacute care work with low ratio of health professionals to patients and high work overload especially at the morning shift.

All authors have access to all data and have approved the final version of the article.

The results of this study have not been submitted to any other journal.

Thank you very much for considering our work and we look forward to your response.

Kind regards,

Esteban Sepúlveda Ramos  
Corresponding author.  
esteban\_sr@hotmail.com

## **Screening time for delirium in dementia patients matters: Validation of the Spanish version of the RADAR scale**

Esteban Sepúlveda<sup>1,2,3,4\*</sup>, Ester Bermúdez<sup>1,2,3</sup>, Lourdes Vallinoto<sup>1</sup>, Julia Sánchez<sup>1</sup>, Paola Saura<sup>1</sup>, Pau Piany<sup>1</sup>, Eva Viñuelas<sup>1</sup>, Marta Ciutat<sup>1</sup>, José Palma<sup>1</sup>, Imma Grau<sup>1</sup>, Elisabet Vilella<sup>1,2,3,4</sup>, Philippe Voyer<sup>5</sup>, José G. Franco<sup>6</sup>.

<sup>1</sup>Hospital Universitari Institut Pere Mata, C/ de l'Insitut Pere Mata, S/N, 43206, Reus, Spain.

<sup>2</sup>Universitat Rovira i Virgili, Carrer de Sant Llorenç, 21, 43201 Reus, Spain,

<sup>3</sup>Institut d'Investigació Sanitària Pere Virgili-CERCA, Reus, Spain.

<sup>4</sup>CIBER de Salud Mental, Instituto de Salud Carlos III, C/ Monforte de Lemos 3-5. Pabellón 11. Planta 0, 28029 Madrid. Spain

<sup>5</sup>Université Laval, Faculté des sciences infirmières, Pavillon Ferdinand Vandry, 1050 Avenue de La Médecine, Québec (Québec), G1V 0A6, Canada.

<sup>6</sup>Grupo de Investigación en Psiquiatría de Enlace (GIPE), Facultad de Medicina, Universidad Pontificia Bolivariana. Campus Laureles de la UPB, Bloque 11, Facultad de Medicina, CP 050031. Medellín, Colombia

\*Correspondence author email: [esteban\\_sr@hotmail.com](mailto:esteban_sr@hotmail.com)

Address: Hospital Universitari Institut Pere Mata, C/ de l'Insitut Pere Mata, S/N, 43206, Reus, Spain

## Screening time for delirium in dementia patients matters: Validation of the Spanish version of the RADAR scale

### ABSTRACT

**Background and objectives:** Delirium is frequently underdiagnosed, especially in patients with dementia. The *Repérage Actif du Delirium Adapté à la Routine* (RADAR) scale can be adapted to nursing routines and facilitates delirium screening, but the Spanish version of the scale has not yet been validated. The objective was to validate it and determine the best time of day for its administration. **Methods:** We assessed all dementia patients admitted to a postacute care centre on one day; patients were independently assessed by nurses using the RADAR scale during the morning and midday shifts and by geriatric physicians with the Delirium Diagnostic Tool-Provisional (DDT-Pro) as a reference standard for the diagnosis of delirium and subsyndromal delirium. We evaluated the test-retest temporal stability of the morning and midday RADAR assessments and the RADAR validity considering each of the two time points. **Results:** Of the 34 patients with dementia included in the study, 47.1% had delirium, and 83.3% had behavioural, mental or neurological disturbances that made diagnostic assessment difficult. The test-retest temporal stability of the RADAR scale was only moderate, which is consistent with the fact that the diagnostic accuracy of the midday assessment for delirium (79.4%) was better than that of the morning assessment (73.5%). The accuracy of the screening when also considering subsyndromal delirium, accounting for either assessment time, was 79.4%. **Conclusion:** The RADAR scale is useful for the screening of delirium and subsyndromal delirium by nurses in dementia patients and midday assessments have greater diagnostic validity than morning assessments.

**Keywords:** delirium, dementia, diagnosis, postacute care, elderly, nursing.

## INTRODUCTION

Delirium is a syndrome with important clinical implications, increasing the risk of cognitive impairment, dementia, institutionalisation and death<sup>1</sup>, as well as increasing economic costs during hospitalisation and postdischarge care<sup>2</sup>. Moreover, delirium is a highly prevalent entity regardless of the clinical setting, with a particularly high risk for those with a previous diagnosis of dementia<sup>3</sup>.

Despite the high prevalence and clinical importance of delirium, up to 90% of delirium cases remain undiagnosed<sup>3,4</sup>. On the other hand<sup>3</sup>, some clinicians tend to diagnose delirium when they identify symptoms of the cognitive core domain (such as inattention and disorientation) and noncore symptoms (affective and psychotic symptoms), paying less attention to symptoms of the other two core domains (circadian cycle and higher-order thinking)<sup>5</sup>. This helps to explain why only some delirium cases are diagnosed and why errors are made in the differentiation of the disorder from other diagnoses that also involve cognitive alterations and psychotic or affective symptomatology, such as dementia.

The detection of delirium in postacute care units is particularly challenging for a diversity of reasons. Although many patients in these facilities are elderly and have dementia, both of which are known risk factors for delirium<sup>6</sup>, clinicians often focus on resolving the specific medical-surgical reasons that led to admission and prioritise the diagnosis of dementia over that of delirium—the opposite tendency of which happens in acute care settings, where priority is given to ruling out delirium instead of dementia. Moreover, as patients in postacute care settings typically have had health problems for some time and many are referred from hospitals or nursing homes, it is difficult to obtain information regarding the onset and evolution of their mental alterations<sup>7,8</sup>. Behavioural and psychological disturbances are also very prevalent in patients with dementia, affecting approximately 90% of people admitted to postacute care centres, further increasing the difficulty in the assessment of possible episodes of delirium<sup>9,10</sup>. Finally, the ratio of doctors and nurses to patients is lower, making mental status assessment just one aspect of many other clinical and administrative responsibilities<sup>11</sup>.

Multiple screening instruments have been developed to facilitate the identification of delirium by healthcare professionals who are not experts in psychopathology<sup>12</sup>. Among these instruments, the four-item Confusion Assessment Method (CAM) algorithm is the most widely used; this algorithm has strengths such as rapid administration but has documented limitations such as poor performance when administered by untrained personnel<sup>13</sup> and low sensitivity despite being administered by experts, especially in patients with dementia<sup>14,15</sup>.

Our team validated two recently developed screening instruments, the 4 A's test (4AT) and the Delirium Diagnostic Tool-Provisional (DDT-Pro), which were administered by geriatricians during routine clinical practice in a postacute health care centre<sup>8</sup>. The three items of the DDT-Pro performed well, including in patients with dementia. Conversely, two of the four 4AT items had limitations in relation to the population

studied, as in the case of the attention item, which showed poor diagnostic performance, probably due to the complexity and multipathology of our patients, and the acute onset and fluctuating course item, probably due to the difficulties in determining the onset and evolution of symptoms in postacute care patients. The three items of the DDT-Pro and their graded severity also allow for the diagnosis of subsyndromal delirium according to the definition of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-5TR)<sup>16</sup>. For these reasons, the DDT-Pro is useful for the diagnosis of delirium in complex populations, including those with baseline dementia admitted to postacute care wards.

Nurses often have close relationships with patients and their families, which gives them a central role in observing and recording changes in patients' mental state. However, they have limited time to perform multiple tasks. Therefore, there is a need for simple screening instruments that are quick to administer and adaptable to nurses' routine activities. The *Repérage Actif du Delirium Adapté à la Routine* (RADAR) scale was designed to be used as a 6th vital sign assessed by nurses during the administration of medication and is based exclusively on patient observation. In the validation of the original version of the RADAR, the sensitivity was 73%, and the specificity was 67% with respect to the diagnosis of delirium according to the DSM-IV<sup>17</sup>. The Spanish version of the RADAR has not been validated.

The aim of this study was to validate the Spanish version of the RADAR for the screening of delirium and subsyndromal delirium in patients with dementia by nursing staff, and to determine the best time of the day for its administration. The scale was administered in the morning and at midday, which allowed us to determine its reliability and validity at each of the two time points and when both administrations were considered together.

## **MATERIALS AND METHODS**

This was a cross-sectional study conducted at the Monterols Postacute Care Centre in Reus (Spain). All the patients who were in the centre at midweek (Wednesday) with a baseline diagnosis of dementia were eligible to be included and assessed on the same day.

### **Procedures**

The study was conducted by the geriatrics, nursing and psychiatry teams of the centre. Three geriatricians administered the DDT-Pro in the morning to the patients assigned to their care (over a period of no more than 4 hours), and nursing staff independently administered the RADAR while administering medication and recording vital signs, both in the morning (between 8:00 and 9:00 h) and at midday (12:30-13:30 h). The RADAR assessment was considered positive for delirium if the answer to any of the three questions about the patient's current status was "yes": 1) at the morning administration, 2) at the midday administration, OR 3) at either time (morning or midday administration). Psychiatrists collected demographic and clinical information and scored the motor items (#7 and #8) of the Delirium Rating Scale-Revised-98 (DRS-

R98) to determine the motor subtype of delirium. The assessments made by each team were conducted independently.

### **Establishing the presence of dementia and comorbidities**

To determine whether patients had dementia, the centre's physicians accessed all available sources, such as electronic health records, neuroimaging results and clinical assessments. The physicians also collected information on the comorbid cause of dementia that led to the need for admission to the unit.

### **Instruments**

Demographical and clinical characteristics were collected and recorded in a standardised way.

The DDT-Pro was the reference standard for the diagnosis of delirium. This tool is based on phenomenological delirium research that led to the description of its three core domains, enables easy assessment by nonpsychiatric health personnel and provides a continuous score that allows for the detection of delirium, with different cut-off scores for both delirium and subsyndromal delirium. Each item is scored on a Likert scale between zero (maximum severity) and three (no disturbance) and contains anchored instructions for the clinical disturbances corresponding to each level of severity, with nine as the maximum possible score and zero as the worst possible score<sup>8,18,19</sup>. Two items are scored by direct patient assessment (comprehension and attention/vigilance), and the third is scored by assessment over the last 12-24 hours using any available means (sleep-wake cycle). The DDT-Pro was validated in the same centre of the current study, with a sensitivity of 77.2% and specificity of 84% for the recommended cut-off score of  $\leq 6$  for delirium and a better sensitivity of 84.8% for the cut-off of  $\leq 7$ , recommended for also identifying patients with subsyndromal delirium.

The RADAR scale (in English, recognising acute delirium as part of your routine) was designed to be used as a 6th vital sign by nurses during medication administration and is based solely on patient observation. In the validation of the original version in Canada, when the scale was "positive" at any of four potential 12-hour medication administration times (i.e., a "yes" answer for any item without differentiating the time of administration: 08:00 h, 12:00 h, 15:00 h OR bedtime), the sensitivity was 73%, and the specificity was 67% for screening delirium diagnosed according to the DSM-IV<sup>17</sup>. The RADAR has two original French and English versions.

The original RADAR questions in English are "When you gave the patient his or her medication...1) Was the patient drowsy? 2) Did the patient have trouble following your instructions? 3) Were the patient's movements slowed?". We performed a simple translation of the scale into Spanish, which was revised and approved by the author and published on the RADAR website ([www.philippevoyer.org/outil-radar](http://www.philippevoyer.org/outil-radar)).

The Charlson Comorbidity Index was used to determine the severity of medical burden and has prognostic value. A score of 1, 2, 3 or 6 is assigned to 19 different clinical conditions. The sum of the individual scores determines the total score, where a value

of 0 to 1 indicates no comorbidity, 2 indicates low comorbidity and  $\geq 3$  high comorbidity<sup>20</sup>.

Regarding the motor items of the DRS-R98, we used Items #7 (motor agitation) and #8 (psychomotor retardation), where a positive score for only Item #7 indicated hyperactive delirium, a positive score for only Item #8 indicated hypoactive delirium, and a positive score for both items indicated mixed delirium; a score of 0 for both items indicated normoactive delirium<sup>21</sup>.

### **Statistical analysis**

The data were analysed in SPSS v. 21 and in a spreadsheet. Although the continuous variables were not normally distributed, are reported with means  $\pm$  standard deviations rather than as mean ranges, and were analysed with the Mann–Whitney U test. Discrete variables are reported as frequencies and percentages and analysed with the chi-square test or Fisher's exact test.

Patients' clinical and demographic variables were compared according to the presence or absence of delirium by the DDT-Pro  $\leq 6$  cut-off. To verify that the DDT-Pro used as a reference standard correctly differentiates delirium cases from nondelirium and to provide a description of the clinical characteristics and severity of delirium in the sample, we compared the frequency of positive cases regardless their severity (scores 0-2) and of moderate-severe cases (scores 0-1) for each of the three items, as well as the total scores of the tool, between the groups with and without delirium.

We used the morning and midday assessments to evaluate the reliability of the RADAR (test-retest temporal stability to assess the impact of the time of administration), considering that the test result was positive for a "yes" response to any question in the morning (test) compared to a "yes" response to any question in the afternoon (retest) for each patient. Kappa coefficients  $>0.4$  indicated moderate concordance,  $>0.6$  indicated substantial concordance, and  $>0.8$  indicated almost perfect concordance.

Regarding the validity of RADAR assessment in the morning, at midday OR in combination, we report the diagnostic accuracy for each scenario (percentage of patients correctly classified) for delirium (cut-off score  $\leq 6$  of the DDT-Pro) and for delirium and subsyndromal delirium (cut-off score  $\leq 7$ ), as well as the sensitivity, specificity, positive and negative predictive values (PPV and NPV) and positive and negative likelihood ratios (LR+ and LR-). All these discriminant measures are presented with 95% confidence intervals (95% CIs).

## **RESULTS**

There were 103 potential patients in the centre the day of the study. Twenty-one of them were excluded: 10 due to communication problems, two because they did not sign the consent form, two because they were not at the centre at the time of assessment, one due to being in a palliative care condition and three for failure to complete the assessment. Of the remaining 82 patients, 34 (41.5%) had dementia and

were therefore included in the study. Of these, 16 (47.1%) had delirium according to the DDT-Pro  $\leq 6$  cut-off.

According to the motor items of the DRS-R98, five (31.3%) patients with delirium had the hyperactive subtype, four (25%) had the hypoactive subtype, three (18.8%) had the mixed subtype, and four (25%) were normoactive.

### Clinical and demographic characteristics

We found no differences in any of the clinical or demographic variables analysed between patients with and without delirium (Table 1). Where the type of dementia was available, the most common was Alzheimer's degenerative dementia, followed by vascular dementia. Among all participants, 15 (83.3%) had behavioural, mental or neurological disturbances complicating the assessment of their mental status.

**Table 1.** Clinical and demographic variables of the 34 patients with dementia, differentiated by the presence or absence of delirium according to a cut-off score  $\leq 6$  on the DDT-Pro. The results are reported as frequencies (percentages) for discrete variables and means  $\pm$  standard deviations for continuous variables.

Variable	NO DELIRIUM (18)	DELIRIUM (16)	Significance
Women	8 (44.4%)	10 (62.5%)	0.292
Age	79.9 $\pm$ 8.5	80.9 $\pm$ 11.5	0.574
Marital Status			
• Single	2 (11.1%)	0	
• Stable partner	5 (27.8%)	7 (43.8%)	0.382
• Separated	3 (16.7%)	4 (25.0%)	
• Widowed	8 (44.4%)	5 (31.3%)	
Charlson Comorbidity Index Score	2.7 $\pm$ 1.5	2.8 $\pm$ 1.42	0.851
Length of stay (days)	539.6 $\pm$ 721.6)	276.6 $\pm$ 439.3	0.224
Dementia subtype			
• Nonspecified	10 (55.6%)	7 (43.8%)	
• Alzheimer	2 (11.1%)	7 (43.8%)	0.148
• Vascular	4 (22.2%)	1 (6.3%)	
• Other	2 (11.1%)	1 (6.3%)	
Associated admission diagnosis			
• Disruptive behaviour	8 (44.4%)	12 (75.0%)	
• Psychiatric diagnosis	4 (22.2%)	2 (12.5%)	0.320
• Fracture	2 (11.1%)	1 (6.3%)	
• Stroke	3 (16.7%)	0	
• Other	1 (5.6%)	1 (6.3%)	
Referral site			
• General hospital	8 (44.4%)	6 (37.5%)	
• Family home	7 (38.9%)	5 (31.3%)	0.681
• Residential resource	1 (5.6%)	3 (18.8%)	
• Acute psychiatric hospital	2 (11.1%)	2 (12.5%)	

### Clinical characteristics of delirium according to the DDT-Pro scores

The mean total DDT-Pro score for patients without delirium was  $8.72 \pm 0.575$ , and that for patients with delirium was  $3.69 \pm 1.922$  ( $p < 0.001$ ).

Table 2 shows the percentage of positivity for each of the three DDT-Pro items and the presence of moderate to severe impairment in patients with and without delirium, where the prevalence of positivity was significantly greater for comprehension and vigilance in delirium patients. Moderate to severe disturbances, including sleep-wake cycle disturbances, were significantly more common in patients with delirium. Notably, all patients with delirium had moderate to severe disturbances in vigilance.

**Table 2.** The frequency of positivity or moderate to severe impairment for each item of the DDT-Pro in 34 patients according to the diagnosis of delirium.

DDT-Pro Item	NO DELIRIUM (18)	DELIRIUM (16)	Significance
<b>Frequency of positivity (range 2-0)</b>			
Comprehension	2 (11.1%)	13 (81.3%)	p<0.001
Vigilance	0 (0%)	16 (100%)	p<0.001
Sleep-wake cycle	2 (11.1%)	6 (37.5%)	P=0.110
<b>Frequency of moderate to severe impairment (range 1-0)</b>			
Comprehension	1 (5.6%)	9 (56.3%)	p=0.002
Vigilance	0 (0%)	16 (100%)	p<0.001
Sleep-wake cycle	0 (0%)	4 (25%)	p=0.039

### Reliability and validity of the RADAR for delirium screening

The test-retest reliability of the RADAR was 0.509 (p=0.002) according to the kappa coefficient.

The diagnostic accuracy for delirium considering both morning and midday assessments was 76.4% (95% CI 58.4-88.6%), with 12 out of 16 patients with delirium being correctly screened. One patient received a score of seven on the DDT-Pro (subsyndromal delirium), and when this patient was included among the cases, the accuracy of the RADAR for subsyndromal delirium or delirium was 79.4% (95% CI 61.6-90.7%), with 13 out of 17 patients correctly screened.

When considering only the morning assessment, the accuracy of the scale was 73.5% for delirium (95% CI 55.4-86.5%), with nine patients correctly screened, and 76.47% (95% CI 58.4-88.6%) for subsyndromal delirium or delirium, with 10 patients correctly screened.

The midday assessment correctly screened 79.4% (95% CI 61.6-90.7%) of the patients with delirium (12 correctly screened) and 76.5% (95% CI 58.4-88.6%) of those with subsyndromal delirium or delirium (12 patients correctly screened).

Table 3 shows all validity indicators of the RADAR, for which it was observed that the sensitivity of the midday assessment was clearly better than that of the morning assessment and similar to that when both assessments were considered. In concordance, the likelihood of a given patient not being delirious when the RADAR is negative (i.e. post-test likelihood for a lower -LR) was higher for the midday.

**Table 3.** Validity of the RADAR for the diagnosis of delirium according to the DDT-Pro. Data are reported for each of the two assessments and for both (Total). Values are

shown with 95% confidence intervals in parentheses for the DDT-Pro cut-off scores  $\leq 6$  (delirium) and  $\leq 7$  (subsyndromal delirium and delirium).

DDT-Pro cut-off scores	Morning		Midday		Total	
	score $\leq 6$	score $\leq 7$	score $\leq 6$	score $\leq 7$	score $\leq 6$	score $\leq 7$
<b>Diagnostic accuracy</b>	73.5% (55.4-86.5)	76.4% (58.4-88.6)	79.4% (61.6-90.7)	76.5% (58.4-88.6)	76.4 (58.4-88.6)	79.4 (61.6-90.7)
<b>Sensitivity</b>	56.3% (30.6-79.3)	58.8% (33.5-80.6)	75.0% (47.4-91.7)	70.6% (44.1-88.6)	75.0% (47.4-91.7)	76.5 (49.8-92.2)
<b>Specificity</b>	88.9% (63.9-98.1)	94.1% (69.2-99.7)	83.3% (57.7-95.6)	82.4% (55.8-95.3)	77.8% (51.9-92.6)	82.4% (55.8-95.3)
<b>PPV</b>	81.8% (47.8-96.8)	90.91% (57.1-99.5)	80.0% (51.4-94.7)	80.0% (51.4-94.7)	75.0% (47.4-91.7)	81.2% (53.7-95.0)
<b>NPV</b>	69.6% (47.0-85.9)	69.6% (47.0-85.9)	79.0% (53.9-93.0)	73.7% (48.6-89.9)	77.8% (51.9-92.6)	77.8 (51.9-92.6)
<b>LR+</b>	5.06 (1.28-20.05)	10.00 (1.43-69.77)	4.50 (1.54-13.13)	4.00 (1.37-11.68)	3.38 (1.36-8.38)	4.33 (1.50-12.51)
<b>LR-</b>	0.49 (0.28-0.88)	0.44 (0.24-0.78)	0.30 (0.13-0.72)	0.36 (0.17-0.77)	0.32 (0.13-0.78)	0.29 (0.12-0.69)

PPV: positive predictive value; NPV: negative predictive value; LR+: positive likelihood ratio, LR-: negative likelihood ratio.

## DISCUSSION

We evaluated the performance of the RADAR which assesses behavioural and interactional disturbances easily identifiable by nursing staff, for screening of delirium and subsyndromal delirium in patients from a postacute care centre with well-known diagnostic difficulties, namely, baseline dementia and a high frequency of neuropsychiatric/behavioural symptoms or sequelae of stroke. The RADAR administered by nursing staff as part of their regular patient care was able to identify patients with delirium or subsyndromal delirium with good diagnostic accuracy, although the time of day at which the scale was administered influenced its screening ability.

The assessment of the onset of delirium symptoms in different care settings is a major diagnostic challenge, as there is often no reliable source of information, which prevents the appropriate use of many screening instruments, such as the CAM<sup>22</sup>, the 4AT<sup>23</sup>, or even the DSM-5-TR criterion B for determining the onset/course of a delirium episode<sup>16</sup>. Moreover, in dementia patients with behavioural disturbances, it is difficult to identify the time of delirium onset. Conversely, the study of postacute care patients shows that the assessment of the symptoms of the three delirium core domains allows the diagnosis of delirium, even though it was not possible to determine the moment of onset in patients with mild cognitive impairment or dementia<sup>24</sup>. In this study, the DDT-Pro differentiated delirium from nondelirium by five score points and the RADAR, which does not ask about the symptom onset or course, also performed well.

Many patients in the current study came from general or psychiatric hospitals or residential facilities (64.7%), for whom the clinical information contained in the referral reports was often brief and limited to the pathological process motivating the

admission, often without specifying symptoms indicative of delirium<sup>8,25</sup>. The frequency of comprehension and vigilance alterations (Table 2) differed between patients with and without delirium, even from its mild presentation. Sleep-wake cycle disturbances were more severe in patients with delirium but were similar to those in controls when they were mild. The high frequency of sleep disturbances in patients with dementia<sup>26</sup>, as in many of the patients in this study, may explain these findings. On the other hand, moderate-severe disturbances in the sleep-wake cycle of our patients with delirium involved more episodes of daytime sleepiness, awakenings with confusion or severe fragmentation with rapid alteration of the 24-hour cycle (DDT-Pro item #3 score 0-1).

The RADAR had good diagnostic validity, both when considering the results of either of the two assessments (morning or midday) and when analysing each assessment separately. However, the midday assessment had better sensitivity values than the morning assessment, which is a key aspect for an instrument such as this one, with a greater number of patients correctly screened. Compared to the use of two daily assessments, the use of only a midday assessment would have little reduction in sensitivity and equal specificity, with less burden of nurses. The test-retest reliability between the morning and midday assessments was moderate.

It is possible that the greater nursing workload in the morning (due to the number of medications and clinical or administrative procedures required) and the particularity that at this time patients are expected to be just waking up, hinder the correct administration of the RADAR items and the assessment of sleepiness, which would alter the scale's screening capacity<sup>11</sup>. Although it is important to assess the presence of delirium during each patient contact, our results suggest that emphasis should be placed on midday assessments. Such a finding could also be related to the moderate-severe sleep-wake cycle disturbances (i.e., more evident over the course of the day) observed in our postacute care patients with delirium and baseline dementia, which would favour the identification of the disorder at midday assessments.

Future work could determine whether the administration of the RADAR during the night shift implies screening difficulties or advantages such as those encountered during the two assessed shifts. Two aspects to consider for the nocturnal administration of the scale are the proximity to bedtime and the number of nursing staff, which is usually lower than that in the daytime.

A previous study in the same healthcare centre indicated that it is important to also consider subsyndromal cases of delirium<sup>8</sup>, which has similar prognostic implications to delirium<sup>27</sup> and whose diagnostic importance is also reflected in the incorporation of specific criteria in the new version of the American Psychiatric Association's DSM-5TR<sup>16</sup>. The RADAR scale allowed us to identify the only patient with subsyndromal symptoms in our sample, although this was determined during the morning assessment. A larger sample size would be helpful to establish whether cases of subsyndromal delirium are also better identified at a specific time of day.

In contrast to what has been suggested in some previous studies reporting a higher prevalence of hypoactive delirium in patients with baseline cognitive impairment<sup>28</sup>, in

our sample, there was a greater percentage of patients with hyperactive delirium. The RADAR scale items were designed to facilitate the identification of patients with hypoactive delirium, which may be more easily missed by healthcare staff<sup>29</sup>; however, although the number of patients did not enable a subgroup analysis, the results of our study suggest good performance of the scale regardless of the motor subtype of delirium.

Although in contrast to most studies of delirium scales, our study considered the time of day when the RADAR scale was administered; one limitation was that we did not administer the scale during the night shift. We found that the midday assessment is very important, but assessments at other times of the day or at night would allow us to identify the few patients not detected at that time. Another limitation of this study is the relatively small number of participants, as we selected a group of patients who represent a challenge for delirium diagnosis and for nurses screening.

In conclusion, when administered by nursing staff the RADAR is useful as a screening tool for delirium and subsyndromal delirium in patients with dementia admitted to postacute care facilities. The performance of the scale is better when administered at midday rather than in the morning, with little change in screening capacity when the two evaluation times are considered together.

It is recommended that the RADAR be administered during each nursing shift according to the availability of professionals and workload, with special emphasis on the midday assessment or preference of this time, and that patients with a positive result be assessed using the DDT-Pro or undergo a psychiatric assessment to proceed with the appropriate treatment. Future studies could provide further information on the usefulness of the RADAR in other clinical settings.

**Ethical considerations:** The study was approved by the Ethics Committee of the *Institut d'Investigació Sanitària Pere i Virgili*. All study participants, if their cognitive capacities allowed, as well as their proxy, provided written informed consent.

**Conflicts of interest:**

Philippe Voyer: author of the original version of the RADAR tool, but no conflicts to declare regarding this study.

José Franco: co-owner of the copyright of the DDT-Pro scale, but does not charge for non-profit use.

All other authors declare no conflicts of interest.

**Funding**

This research has not received specific funding from public sector agencies, the commercial sector or non-profit organisations.

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