Improved detection of delirium, implementation and validation of the CAM-ICU in elderly Emergency Department patients

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Improved detection of delirium, implementation and validation of the CAM-ICU in elderly Emergency Department patients

Evelien K. Van de Meeberg[a], Suzanne Festen[b], Marieke Kwant[a], Rita R. Georg[b], Gerbrand J. Izaks[b] and Jan C. ter Maaten[a]

Objective **To evaluate the effect of routine use of the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) on the diagnosis rate of delirium in elderly Emergency Department (ED) patients and the validity of the CAM-ICU in the ED setting.**

Methods **This was a prospective observational study in a tertiary care academic ED. We compared the diagnosis rate of delirium before implementation of the CAM-ICU, without routine use of a screening tool, with the diagnosis rate after implementation of the CAM-ICU. All consecutive patients aged 70 years or older were enrolled. The diagnosis rate before implementation was based on chart review and after implementation on a positive CAM-ICU score. In a subsample, the presence of delirium was evaluated independently according to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed., text revision (DSM-IV-TR) criteria to assess the validity of the CAM-ICU.**

Results **The total study population included 968 patients: 490 before and 478 after implementation of the CAM-ICU. The two groups were not significantly different in patient characteristics. Before implementation of the CAM-ICU, delirium was diagnosed in 14 patients (3%) and after implementation in 48 patients (10%) ($P < 0.001$). The sensitivity of the CAM-ICU for delirium in the ED setting was 100%, specificity was 98%, positive predictive value was 92%, and negative predictive value was 100%.**

Conclusion **The diagnosis rate of delirium after implementation of the CAM-ICU was three-fold higher than before. The CAM-ICU is a reliable screening tool in the ED, with high sensitivity, specificity, and positive and negative predictive value. *European Journal of Emergency Medicine* 24:411–416 Copyright © 2017 Wolters Kluwer Health, Inc. All rights reserved.**

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Keywords: CAM-ICU, delirium, *Diagnostic and Statistical Manual of Mental Disorders*, Emergency Department, validation

Departments of [a]Emergency Medicine and [b]Geriatrics, University Medical Center Groningen, Groningen, University of Groningen, The Netherlands

Correspondence to Evelien K. Van de Meeberg, Department of Emergency Medicine, University Medical Center Groningen, Hanzeplein 1, 9700 RB Groningen, The Netherlands
Tel: +31 503 616 161; fax: +31 503 611 725;
e-mail: e.k.van.de.meeberg@umcg.nl

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Introduction

Delirium is a major unrecognized problem in the Emergency Department (ED). Previous research shows that around 7 to 20% of elderly ED patients have delirium [1]. With increasing numbers of elderly patients visiting the ED, the prevalence of delirium will only increase over time. In up to 80% of the cases, delirium remains undetected or misdiagnosed by ED physicians [2–8]. This high rate of missed diagnoses might be because of the fluctuating course of delirium or its different psychomotor subtypes [8], leading to misdiagnoses as depression or dementia. Therefore, it is important to screen older patients routinely for delirium in the ED.

In most EDs, delirium is not routinely screened for [9]. However, it is a form of organ failure (acute brain failure) and thus an important sign of severe illness [10]. Especially in the elderly, delirium can even be the first and only sign of illness. Previous research suggests that older patients with delirium have a higher risk for complications and adverse outcomes [11]. They have a higher risk of hospitalization with increased hospital lengths of stay [12,13]. Also short-term and long-term mortality rates are increased in these patients [7,14–16].

To detect delirium, there are several screening methods available, but it is not clear which one is the best to use in the ED. Best evidence supports the use of the Confusion Assessment Method (CAM) for diagnosing delirium in adult in-hospital patients [17]. The Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) has shown an excellent sensitivity, specificity, and interrater reliability for intensive care patients [18–20]. Looking at previous studies of delirium screening in the ED, most of them used the CAM or CAM-ICU. One study showed high sensitivity (95%) and specificity (95%) of the CAM [21]; another showed moderate sensitivity (76%) and high specificity (98%) of the CAM-ICU in older ED patients [22]. We chose to use the CAM-ICU because it is brief and easy to use in a demanding

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environment with high workflow and crowding, such as the ED. To our knowledge, in none of the before mentioned studies was delirium screening performed in the ED 24 h a day, 7 days a week, for a continuous period of time.

The aim of our study was to compare the detection of delirium in older ED patients before and after introducing the CAM-ICU to our ED. In addition, we used the *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed., text revision (DSM-IV-TR) criteria [23] as a reference standard to validate the CAM-ICU for diagnosing delirium in the ED.

Methods

Study design and setting

This prospective observational study was carried out in a tertiary care academic ED with ~34 000 visits per year. The study protocol was approved by the Medical Ethical Committee of our hospital (University Medical Center Groningen). In accordance with the Dutch Medical Research Act, we did not seek written informed consent from participants as all data were collected as part of standard patient care. This procedure was also approved by the Medical Ethical Committee of our hospital (University Medical Center Groningen).

The study was carried out from April up to August 2012, and all consecutive patients aged 70 years or older were enrolled, 24 h a day, 7 days a week. Patients were included by ED nurses or a study investigator (M.K.) if verbal informed consent was obtained from themselves or, if this was not possible, from a family member or carer. The ED nurse or study investigator recorded the inclusion and exclusion criteria and vital signs on a Case Record Form. Exclusion criteria were as follows: (a) previous enrollment in the study, (b) non-Dutch speaking, (c) inability to follow simple commands before or because of an acute illness, (d) need for an emergency intervention, or (e) presence of a hip fracture. The rationale for these enrollment criteria was that (c) the CAM-ICU is not validated for patients with severe dementia; we excluded patients with a history of this disease. Some patients with an acute illness were unable to follow simple commands because of, for example, low Glasgow Coma Scale or hemodynamic instability. (d) Patients who had to undergo emergency interventions were in the ED for very short periods of time. (e) Patients with hip fractures were excluded because they had already enrolled in another study in our hospital.

Diagnosis rate

The diagnosis rate was investigated by means of a pretest–post-test study design. The pretest phase comprised 2 months in which the diagnosis rate before implementation of the CAM-ICU was determined by chart review. The post-test phase comprised 3 months in which the diagnosis rate after introducing the CAM-ICU to our ED was determined using the CAM-ICU and the common CAM-ICU algorithm [18,19]. Inclusion and exclusion criteria were the same throughout the study.

To determine the diagnosis rate before implementation of the CAM-ICU, the medical records of all 490 included patients aged 70 years or older, who visited the ED from April up to May 2012 (2 months), were examined for the diagnosis of delirium or any reference to an acute or a new confusional state or an acute mental status change. This chart review was performed by a single investigator (M.K.).

The diagnosis rate after implementation was based on a positive CAM-ICU score in a study sample that included 478 patients aged 70 years and older who visited the ED from June up to August 2012 (3 months). The CAM-ICU was administered by the study investigator (M.K.), or when the study investigator was absent, by the attending emergency physician or internist. In total, the CAM-ICU was administered by ~16 different doctors. All doctors who were involved in the study were verbally informed about the implementation of the CAM-ICU and watched a CAM-ICU training video before the start of the inclusion period. A positive CAM-ICU was defined as the presence of both (a) an acute onset of mental status changes or a fluctuating coarse and (b) inattention, and either (c) disorganized thinking or (d) an altered level of consciousness [18,19]. Because the inclusion period was relatively short, CAM-ICU training was not repeated during the study.

Validation study

To validate the CAM-ICU for use in the ED, a subsample of patients was also evaluated by an experienced nurse practitioner (R.G.) from the Department of Geriatric Medicine who diagnosed the presence or absence of delirium on the basis of a clinical interview and according to the DSM-IV-TR criteria. In case of doubt, the patient underwent an additional assessment by a geriatrician (S.F., G.I.). The diagnosis according to the DSM-IV-TR criteria was defined as the reference standard. The nurse practitioner evaluated all patients with positive CAM-ICU and every fifth patient with a negative CAM-ICU on weekdays from 8 a.m. till 5 p.m. The nurse practitioner was blinded to the results of the CAM-ICU. The validation was performed in the 3 months after implementation of the CAM-ICU in the ED.

Other variables

Age, sex, blood pressure, heart rate, respiratory rate, peripheral oxygen level, body temperature, and Glasgow Coma Scale were recorded at arrival at the ED. These variables were used to calculate the Rapid Emergency Medicine Score (REMS) as a measure of illness severity [24]. The Charlson Comorbidity Index (CCI) was used as a measure of comorbidity burden [25].

Statistical analyses

All the data mentioned above was collected using a Case Record Form and anonymized before being entered into an SPSS database. Patient characteristics before and after implementation of the CAM-ICU were compared using the Pearson χ^2-test for categorical variables and the independent-samples *t*-test for continuous variables. The diagnosis rate of delirium before and after implementation of the CAM-ICU was also compared using the χ^2-test. The sensitivity and specificity of the CAM-ICU were calculated using the DSM-IV-TR as the reference standard. In all statistical analyses, the *P*-value for statistical significance was set at less than 0.05. The analyses were carried out using IBM SPSS Statistics, version 20 (IBM Corporation, Armonk, New York, USA).

Results

In the period from April 2012 up to August 2012, a total of 9781 patients visited the ED, of whom 1782 patients were aged 70 years or older: 841 patients before implementation of the CAM-ICU and 941 after the implementation.

Of the 841 patients before implementation, a total of 490 patients (58%) were included (Fig. 1). Of these patients, 240 were men (49%) and their mean age was 78.6 ± 6.4 years. Of the 941 patients after implementation, a total of 478 (51%) were included (Fig. 2). Of these patients, 248 were men (51%) and their mean age was 78.5 ± 6.9 years.

Diagnosis rate

Before implementation of the CAM-ICU, 14 patients (3%) were diagnosed with delirium, established through chart review. After implementation, 48 patients (10%) were diagnosed with delirium using the CAM-ICU. This difference in the diagnosis rate was statistically significant ($P < 0.001$, Table 1). The patients who were included before and after implementation of the CAM-ICU were not statistically significantly different with respect to sex ($P = 0.37$), age ($P = 0.85$), REMS ($P = 0.41$), and CCI ($P = 0.21$) (Table 1). We obtained the CCI in 481 patients before and 470 patients after implementation of the CAM-ICU. Complete data to calculate a REMS were obtained in, respectively, 332 and 257 patients.

Validation study

Fifty three patients who had a CAM-ICU score were also evaluated according to the DSM-IV-TR criteria for delirium. Of these, 13 patients had a positive and 40 patients had a negative CAM-ICU (Table 2). In 12 of 13 patients with positive CAM-ICU, the diagnosis was confirmed using the DSM-IV-TR criteria. In all 40 patients with negative CAM-ICU, delirium was absent according to the DSM-IV-TR criteria. Thus, the sensitivity of the CAM-ICU was 100%, the specificity was 98%, the positive predictive value was 92%, and the negative predictive value was 100% (Table 2).

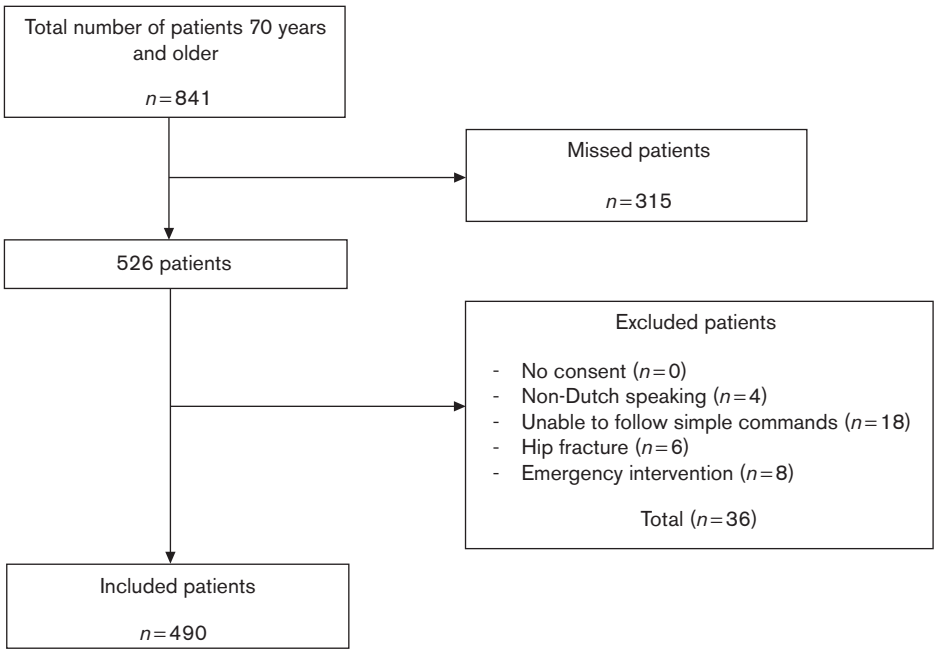
Discussion

This prospective observational study showed a significant increase in the detection of delirium after implementing the CAM-ICU in an ED setting. The diagnosis rate of delirium increased more than three-fold after introducing the CAM-ICU, which could not be ascribed to differences in sex, age, REMS, or CCI. Furthermore, it was found that the CAM-ICU had a high sensitivity and specificity for delirium in ED patients. Therefore, the CAM-ICU is probably not only a valuable tool in the ICU but also in ED settings.

The 10% of older patients with delirium found in our ED, after implementation of the CAM-ICU, corresponded with the previous literature that reported percentages of around 7–20% [1]. Most of these studies used the CAM for delirium screening in the ED [2–7]; only Han and colleagues [8,13,15] used the CAM-ICU, showing a prevalence of around 8–17%. Inclusion and exclusion criteria of the previous literature were broadly similar to ours, but some of the studies included patients aged 65 years and older [2,4,7,8,15] compared with 70 years and older in our study. This could mean that we still missed a percentage of patients with delirium between 65 and 70 years of age. Also, because delirium is a form of organ failure and an important sign of severe illness [10], the prevalence of delirium is likely to be underestimated because of the exclusion of some critically ill patients.

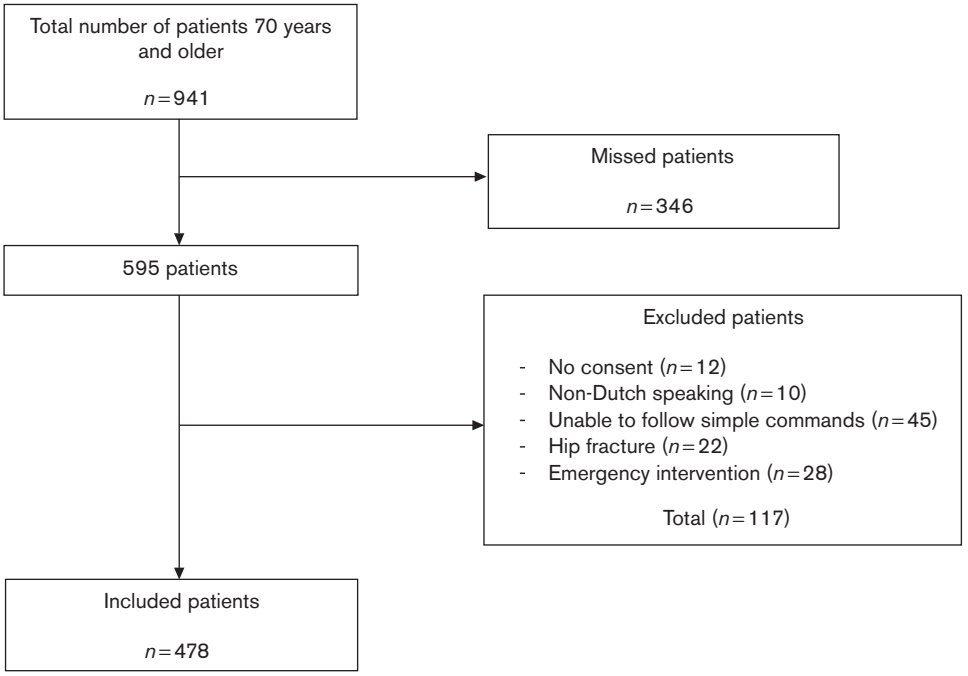
Validating the CAM-ICU for use in the ED, we found high sensitivity (100%) and specificity (98%) when using it as a screening method for delirium. These numbers correspond to previous studies, most of them carried out in the ICU [18–20]. One study validated the CAM-ICU for use in the ED, showing a moderate sensitivity (76%) and high specificity (99%) [22]. This difference in sensitivity may arise from the fact that in both studies, a convenience sample was obtained for validation of the CAM-ICU, which can easily result in a difference in patient characteristics. The validation sample in our study was considerably smaller and older than the validation sample of Han *et al.* [22]. It is also plausible to assume that the setting of the two studies (Nashville, Tennessee vs. Groningen, the Netherlands) differed in several other aspects. For example, compared with the ED population in Groningen, the validation sample in Nashville included a large proportion of patients who were living at home (90%) and had a relatively high level of education (45% college education or higher). The differences in patient characteristics may at least partially explain the difference in the performance of the CAM-ICU in the two studies.

Fig. 1



Inclusion of patients 70 years and older before implementation of the CAM-ICU. CAM-ICU, Confusion Assessment Method for the Intensive Care Unit.

Fig. 2



Inclusion of patients 70 years and older after implementation of the CAM-ICU. CAM-ICU, Confusion Assessment Method for the Intensive Care Unit.

Table 1 Patient characteristics before and after implementation of the CAM-ICU

Characteristics	Before implementation	After implementation	Difference after vs. before implementation	
			95% CI	*P*-value
N	490	478		
Sex [*n* (%)]				0.37
Male	240 (49)	248 (52)		
Female	250 (51)	230 (48)		
Age [mean (SD)] (years)	78.6 (±6.4)	78.5 (±6.9)	−0.9 to 0.8	0.85
CCI[a] [mean (SD)]	1.8 (±1.7)	1.6 (±1.8)	−0.4 to 0.2	0.21
REMS[a] [mean (SD)]	7.6 (±2.0)	7.5 (±2.0)	−0.5 to 0.2	0.41
Systolic BP (mmHg)	139.3±28.3	138.4±26.4	−4.6 to 2.8	0.64
Diastolic BP (mmHg)	73.6±16.5	73.6±15.4	−2.1 to 2.2	0.99
Mean arterial BP	95.5±18.1	95.2±17.0	−2.7 to 2.0	0.77
Heart rate (/min)	83.0±21.4	82.8±21.6	−3.2 to 2.7	0.85
Respiratory rate (/min)	19.1±5.9	17.6±4.9	−2.4 to −0.7	<0.001
Saturation (%)	96.2±3.4	95.9±8.0	−1.1 to 0.5	0.47
Temperature (°C)	36.6±0.95	36.6±0.86	−0.1 to 0.1	0.99
GCS	14.8±0.91	14.8±0.80	−0.1 to 0.1	0.84
Delirium [*n* (%)]	14 (3)	48 (10)		<0.001

BP, blood pressure; CCI, Charlson Comorbidity Index; CI, confidence interval; GCS, Glasgow Coma Scale; REMS, Rapid Emergency Medicine Score.
[a]CCI; $n=481$ before and $n=470$ after implementation, REMS was obtained in, respectively, $n=332$ and $n=257$.

Table 2 Validity of the CAM-ICU

Delirium[a]	Yes	No	Total
CAM-ICU positive[b]	12	1	13
CAM-ICU negative[b]	0	40	40
Total	12	41	53

CAM-ICU, Confusion Assessment Method for the Intensive Care Unit; DSM-IV, *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. criteria.
[a]According to DSM-IV-TR criteria (reference standard).
[b]Sensitivity 100%, specificity 98%, positive predictive value 92%, negative predictive value 100%.

A unique feature of our study was the inclusion of patients 24 h a day, 7 days a week for an uninterrupted period. Only Hustey and colleagues [5,6] also included patients in different shifts using convenience sampling. Because in the ED we provide 24 h care, patient inclusion and delirium screening should be performed accordingly to collect a representative sample of older ED patients. It is possible that the prevalence of delirium differs between shifts, although the prevalence of delirium that we found corresponds with the previous literature.

Limitations

There are some limitations in this study. First, a number of eligible patients were missed in both parts of the study (before implementation of the CAM-ICU 38%; after implementation 37%). This was mainly because of the fact that all patients of 70 years or older for all different specialties had to be screened for inclusion, which resulted in large numbers of patients. If ED visits were short, patients had already left the ED before inclusion. Nevertheless, it is unlikely that the patients who were missed before implementation of the CAM-ICU were different from the patients who were missed after its implementation as the same inclusion criteria were applied throughout the study.

There was a difference in the number of excluded patients before implementation of the CAM-ICU (7%) and after implementation (20%), which possibly introduced selection bias. This was probably because of the fact that in both parts of the study, patients were screened for inclusion by ED nurses, but after implementation of the CAM-ICU, were also seen by a doctor or an investigator for delirium screening. During the CAM-ICU screening, some patients may have been unable to follow simple commands because they were more ill than estimated by the ED nurse. Or they may have had to undergo an emergency intervention that was not foreseen, and therefore had to be excluded. However, patient characteristics were not significantly different in both patient groups.

There is also a possibility that we introduced ascertainment bias by the chart review, underestimating the diagnosis rate before implementation of the CAM-ICU. However, medical records were examined not only for the diagnosis delirium but also for any other reference to a confusional state or mental status change. After introducing the CAM-ICU, there was a small chance of overestimation of the delirium rate because likely, nurses and doctors in the ED were more aware of the problem. However, the diagnosis rate of 10% delirium in older patients in our study was similar to the diagnosis rates that are reported by others [1]. Also, in our validation study, we showed that the number of false-positive cases of delirium was small.

Finally, with respect to the validation of the CAM-ICU in this study, because of limited availability of the research nurse, we included a relatively small convenience sample. In 53 patients, the CAM-ICU was compared with the DSM-IV-TR, of whom 13 had a positive CAM-ICU. This could have increased the performance of the CAM-

ICU. However, the research nurse was blinded to the results of the CAM-ICU.

Conclusion

With increasing numbers of older patients visiting the ED, the prevalence of delirium will increase. Delirium is a sign of more severe illness and patients with delirium have worse outcome during hospital stay as well as during the first year after discharge. Therefore, it is important to systematically screen for delirium in the ED. In our study, we found that, with the use of the CAM-ICU, the detection of delirium in the ED increased three-fold. In addition, we found that screening for delirium with the CAM-ICU in the ED is a reliable method, with high sensitivity and specificity. Additional larger prospective studies are required, but in the meantime, we recommend screening older patients in the ED using the CAM-ICU.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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