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ORIGINAL PAPER

THE VALIDATION OF THE CZECH VERSION OF THE DELIRIUM OBSERVATION SCALE AND THE NURSING DELIRIUM SCREENING SCALE FOR DELIRIUM SCREENING IN PATIENTS WITH LOCOMOTIVE APPARATUS TRAUMA

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Abstract

Aim: To validate the Czech version of the Delirium Observation Scale and the Nursing Delirium Screening Scale as screening instruments for detecting of delirium in a traumatology department. *Design:* A prospective cohort study. *Methods:* The study included 400 patients hospitalized in the traumatology department, University Hospital, Olomouc. The receiver operating characteristics analysis, sensitivity and specificity values and positive and negative predictive values for the screening delirium symptoms were calculated. *Results:* The average duration of delirium was 2.78 days. The Delirium Observation Scale (DOS) screening instrument produced the best predictive validity values (sensitivity 97.6%, specificity 96.2%), followed by the Nursing Delirium Screening Scale (Nu-DESC) (sensitivity 92.7%, specificity 96.5%). Both screening instruments have comparable psychometric properties as well as features in the area of the already mentioned feasibility. The largest differences between the psychometric features of the screening instruments were detected in the Nu-DESC instrument in the area of sensitivity. *Conclusion:* The benefit of the research lies in obtaining the predictive validity values for the DOS and Nu-DESC screening instruments in patients with locomotive apparatus trauma, having had surgical or conservative treatment. Our results may support a systematic and evidence-based implementation of the screening instruments for detecting of delirium in a clinical setting.

Keywords: delirium, Delirium Observation Scale, nurse, Nursing Delirium Screening Scale, predictive validity, traumatology.

Introduction

The Diagnostic and Statistical Manual of Mental Disorders (DSM-V) published by the American Psychiatric Association (American Psychiatric Association, 2013) defines *delirium* as a condition with a disturbance in consciousness and cognitive changes with acute onset. It also includes changes in consciousness throughout the day, poor attention and vigilance and evidence that the disturbances are a direct physiological consequence of another medical condition. Scientific literature also provides several other definitions of delirium. Some authors (e.g., Agar et al., 2012) define delirium as: … "a brain dysfunction with acute manifestation of confusion affecting the nursing care provided to hospitalized patients, presenting with sudden changes in cognitive functions with adverse progress." Authors also agree that delirium is a frequent complication not only in elderly patients hospitalized in standard wards but also in post-surgical patients hospitalized in surgical wards and intensive care units (Balková & Tomagová, 2018; Godfrey et al., 2013; Van de Steeg et al., 2014).

In the last decade, there have been an increasing number of studies analysing the incidence of delirium in various surgical patient populations. The results of delirium incidence significantly differ depending on the studied patient population, the type of care, and the ICD-10 diagnostic chapter, or study design. In Schubert et al. (2018) delirium is a complication that is rather well described in cardiac surgery and the intensive care setting. The prevalence and clinical consequences of delirium are, however, less studied in many other disciplines. In a one-year Swiss cohort study, Schubert et al. (2018) confirmed that the highest prevalence (36.2%–40.5%) of delirium was observed at cardiac surgery, neurosurgery, and traumatology. The Dutch authors Koster et al. (2009) specifically focused on the incidence of delirium in cardiac surgical patients. They discovered that the incidence of delirium in the cardiac surgical department in the Netherlands was 21%, with

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an average duration of delirium of 2.5 days. A higher incidence of delirium in patients hospitalized at a cardiosurgical ward was demonstrated in the research by Swedish authors, Lingehall et al. (2013). They detected a delirium incidence in 59% of patients who developed delirium during the first and fourth days. German authors Radtke et al. (2010), observed a delirium incidence at a surgical ward in Germany in 19% of patients. These patients experienced an onset of delirium during the first six days after admission. Another German study (Luetz et al., 2010) showed a delirium incidence in post-surgical patients up to 40%. Data from a Finnish study by Poikajarvi et al. (2017) showed a delirium incidence in patients at a surgical ward of 14.6%. The delirium develops within one hour or up to several days, while the intensity of the symptoms varies during the day (Ambler, 2009). A study by Franco et al. (2001) from the United States showed a delirium incidence of 11.4% in patients who were hospitalized at a surgical ward.

Moreover, scientific literature shows that onethird of delirium episodes (30%–40%) could have been prevented but that more than half is not detected. The condition gets serious over a short period of time and worsens during the day (Inouye et al., 1990). Van Velthuijsen et al. (2016) even demonstrated that up to 75% of delirium cases remains undetected or poorly diagnosed. One of the main reasons behind failing delirium diagnostics is the absence of a high quality, standardized, and quick measuring tool that could be used by general nurses during daily care (Bellelli et al., 2014; Schuurmans et al., 2003; Wong et al., 2010).

Ambler (2009) has emphasised that "delirium is always a syndrome". Delirium in patients hospitalized in surgical wards is often linked to many complications and severe consequences, such as frequent falls (off the bed), fractures, aggression and excessive noise, and infections due to pulled catheters by patients in delirium (Franco et al., 2001). Other complications include prolonged hospital stays, increase healthcare costs, increase risk of dementia and nursing home placement, impaired ability to return to everyday life, and long-term deterioration of cognitive and functional characteristics, with cognitive function impairment possibly lasting up to one year. In the most severe cases, the condition may be fatal. Higher mortality has been observed within 12 months of discharge (Eeles et al., 2010; Inouye, 2006). Post-surgical patients are far more susceptible to post-op complications, such as: respiratory insufficiency and, instability of tissues and skeleton, which results in a higher probability of surgical wound revision (Bucerius et al., 2006).

Delirium is frequently confused with depression and dementia, or not enough attention is paid to delirium, as it is considered to be a normal behaviour especially in elderly patients. In addition, it is a rather disturbing finding that nurses lack knowledge of delirium. However, nurses are in a position where they can be the first ones to detect changes in a patients' behaviour, as they are in frequent contact with them (Koster et al., 2009). In the last two decades, several screening measuring instruments usable in everyday nursing have been developed for observation-based delirium screening (Detroyer et al., 2014). Delirium screening, along with adequate medication, allows one to prevent the already mentioned complications. Screening instruments have been developed for better assessment and detection of delirium. Therefore, it is necessary to use validated and reliable screening tools or the detection of delirium. The ability to identify patients with delirium may help reduce any negative outcomes (Adamis et al., 2010; Balková & Tomagová, 2018; De et al., 2017; Grover & Kate, 2012; Jorgensen et al., 2017; Van Velthuijsen et al., 2016; Wong et al., 2010). The Delirium Observation Scale (DOS) and the Nursing Delirium Screening Scale (Nu-DESC) are the most frequently used screening instruments for detecting of delirium (Detroyer et al., 2014; Gavinski et al., 2016; Jorgensen et al., 2017; Koster et al., 2009; Numan et al., 2017).

Aim

The aim of this study was to validate the Czech version of the DOS and the Nu-DESC as screening instruments for detecting of delirium in a traumatology department in the Czech Republic.

Methods

Design

A prospective cohort study.

Sample

The study sample comprised of patients hospitalized in the standard traumatology department meeting the following inclusion criteria:

a) patients older than 18, speaking Czech or Slovak;
b) patients hospitalized for a locomotive apparatus trauma.

Exclusion criteria were as follows:

a) paediatric patient;
b) patient with any degree of dementia;
c) patient with head or brain trauma.

A total of 400 patients met the inclusion criteria. The size of the pattern was determined after consultation with statistics.

Data collection

The data collection period extended from August 2018 to August 2019. Prior to data collection, research team trained nurses working in the traumatology department and participating in the study. The training concerning the correct administration of the instruments was done in groups. The general nurses were trained how to administer the measuring instruments and how to assess them. The training consisted of verbal presentations and examples. Subsequently, a testing study with 20 patients was carried out at the traumatology clinic.

The patients were informed of the purpose of the research. Every time the information was collected from a patient a personal information form was completed (age, sex, education, social situation, total length of hospital stay). Patients who met the respective criteria were subsequently subject to the assessment using the DOS and Nu-DESC screening instruments. This assessment was done once during the first 24 hours after admission. The instruments were scored three times in 24 hours after patient's admission and then only when a patient had signs of delirium, the instruments were administered three times in 24 hours. The subsequent assessment depended on the incidence of delirium. If a patient manifested signs of delirium, the DOS and Nu-DESC measuring instruments were administered. In the traumatology department of the University Hospital in Olomouc, the delirium occurred within 72 hours after admission at the latest. For this reason, a second assessment was done in patients who had not manifested signs of delirium on day three or the day of discharge. Patients with signs of delirium were administered the instruments three times in 24 hours (morning, day, and night shifts). The delirium was actually diagnosed by the Confusion Assessment Method (CAM) tool, considered to be the reference standard in scientific literature. Diagnosing delirium using this measuring tool was carried out by a qualified nurse with a master's degree and experiences with a delirium management guideline.

The data were stored in a lockable cabinet with only the research author having access. This method of storing the data was chosen in order to safeguard the data anonymisation.

Delirium Observation Scale

The DOS measuring instrument was developed by the team of Schuurmans et al. (2003) and for the first time it was tested in a clinical geriatric setting and in patients with femoral neck fractures. Originally, a 25-item scale was later reduced to 13-item scale. The DOS administration takes about 5 minutes and it does not require any training. Just like Nu-DESC this tool was developed for general nurses (Koster et al., 2009). This measuring instrument assesses whether the patient: 1) dozes during conversation or activities; 2) is easily distracted by stimuli from the environment; 3) maintains attention to conversation or action; 4) does not finish a question or an answer; 5) gives answers that do not fit the question; 6) reacts slowly to instructions; 7) thinks to be somewhere else; 8) knows which part of the day it is; 9) remembers recent events; 10) is picking, disorderly, restless; 11) pulls IV tubes, feeding tubes, catheters, etc.; 12) is easily or suddenly emotional; and 13) sees / hears things which are not there. Items are scored with a 0 and 1, with 0 given if the sign is absent and 1 given if the sign is present sometimes or always. For items 3, 8, and 9, the scoring logic is reversed (0 – sometimes, always; 1 – never). For each shift, the total score is calculated based on the number of circled answers. By summing up the total scores for each shift, the rater receives a total score for the day. The final DOS scale score is calculated by taking the total score for the day and dividing it by 3. If the final score for 24 hours is < 3, the patient does not suffer from delirium. If the final score for 24 hours is ≥ 3, the patient is probably delirious (Schuurmans et al., 2003). The sensitivity of the DOS measuring instrument was 62.2% and the specificity was 98.4% (Numan et al., 2017). The area under the Receiver Operating Characteristics (ROC) curve was 0.98 (Koster et al., 2009).

Nursing Delirium Screening Scale

The Nu-DESC measuring instrument is a five-item tool designed specifically for nurses. Its administration takes 3 minutes and no training is required (Gaudreau et al., 2005; Van Velthuijsen et al., 2016). Nu-DESC assesses: 1) orientation; 2) behaviour; 3) communication; 4) hallucinations; and 5) psychomotor retardation of a patient. Symptoms are scored on a scale from 0 to 2, depending on the presence / absence and intensity of the symptoms, and the individual scores are summed up to obtain the total score for one shift. Nu-DESC score > 2 identifies the presence of delirium in 86% of the cases. The sensitivity of this tool is between 65.6% and 97.65%, and the specificity was between 83% and 94.9%. The highest value for the area under the ROC curve was 0.99 (Lingehall et al., 2013; Luetz et al., 2010; Poikajärvi et al., 2017; Radtke et al., 2010).

Confusion Assessment Method

The CAM is one of the most widely used diagnostic instruments for clinical and research purposes, with proven psychometric properties. It was developed by Inouye et al. (1990) based on the DSM-III for the purpose of enabling nonpsychiatric trained clinicians to identify delirium. The CAM instrument assesses the presence, severity, and fluctuation of 9 delirium features: acute onset, inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbances, psychomotor agitation or retardation, and altered sleep-wake cycle (Inouye et al., 1990). A diagnosis of delirium according to the CAM requires the presence of features 1 and, 2, and either 3 or 4. The CAM demonstrated sensitivities from 94%–100%, specificities from 90%–95%, positive predictive accuracy of 91%–94%, negative predictive accuracy of 90%–100%, interrater reliability ranging from 0.81–1.00; and convergent agreement with other mental status tests including the Mini-Mental State Examination (MMSE) (Folstein et al., 1975; Inouye et al., 1990). Administration of the CAM typically takes 5–10 minutes and is informed by a brief, formal cognitive assessment. Robust adherence to the processes described in the training manual is recommended to optimise diagnostic accuracy (Wong et al., 2010).

Linguistic validation of the DOS and Nu-DESC

After the authors had given their consent to carry out the research, a two-phase linguistic validation of all screening measuring instruments was launched. In the first phase two independent native speakers translated the instruments from English into Czech. The review and reconciliation process of the first version produced a first draft of the measuring instruments in Czech. In the second phase two English native speakers translated the text back into English. A team consisting of a researcher, nurse specialized in surgery, neurology and palliative care and assistant professors from the faculty was invited to study the screening measuring instrument versions and reached a consensus regarding their versions. These final versions were tested in twenty patients hospitalized in the traumatology department due to a locomotive apparatus trauma to determine whether the general nurses understand all of the items in both screening measuring instruments.

Data analysis

The statistical analysis was done with IBM SPSS Statistics software, version 22. The primary set was analysed with descriptive statistics – number of respondents, percentages, mean, standard deviation, and minimum and maximum.

To determine the predictors of delirium, the forward stepwise regression was applied. The chi-square test, Fisher's exact test and Mann-Whitney U test were also used to compare the groups.

The ROC analysis was used to determine the optimum cut-off value for the DOS and Nu-DESC score for delirium incidence prediction. Sensitivity and specificity values, positive predictive value (PPV), and negative predictive value (NPV) for the delirium incidence prediction, including 95% confidentiality intervals, were calculated for the obtained cut-off values. The significance level for all statistical tests was 0.05.

Results

Subject characteristics

The sample included 400 respondents, the majority of who were men – 221 (55.3%). There were 179 women (44.8%). The average age was 54.2 years. The median age of respondents with delirium was 78.5 years. 359 (89.8%) of the respondents didn't live alone (lived in a family) and 41 (10.3%) of the respondents lived alone. The education structure was as follows: university level 30 respondents (7.5%), secondary education 177 respondents (44.3%), vocational school 171 respondents (42.8%) and only primary level education 22 respondents (5.5%). A surgical treatment with total anaesthesia during their hospitalization was given to 303 respondents (75.8%), out of which 59.8% of the respondents presented with delirium. 3.0% of the respondents underwent a surgical treatment with spinal anaesthesia. These patients manifested delirium in 10 cases (12.2%). The study included 4 respondents (1%) who underwent surgical treatment under local anaesthesia (socalled nerve block). None of these patients had signs of delirium. There were 81 (20.3%) respondents undergoing conservative treatment, out of which 23 (28%) manifested delirium. Other characteristics related to the risk factors of chronic diseases were as follows: 115 respondents (28.8%) suffered from hypertensive disease, out of which signs of delirium were observed in 51 of them (62.2%); 21 respondents (5.3%) suffered from a coronary artery disease, out of which signs of delirium were observed in 14 of them (17.1%); diabetes mellitus was diagnosed in 43 respondents (10.8%), out of which signs of delirium were observed in 19 of them (23.2%). Other chronic diseases were diagnosed less.

Table 1 summarizes the study sample characteristics and potential risk factors for delirium development (differences in occurrence of these characteristics between delirious and non-delirious group).

Table 1 The characteristics of the patients enrolled in the study

Variable		Entire sample n (%)	Delirious group (CAM+)* n (%)	Non-delirious group (CAM-)* n (%)	p-value**
Sex	men	221 (55.3)	29 (35.4)	192 (60.4)	< 0.0001
	women	179 (44.8)	53 (64.6)	126 (39.6)	
Education	primary	22 (5.5)	20 (24.4)	2 (0.6)	< 0.0001
	vocational	171 (42.8)	53 (64.6)	118 (37.1)	
	secondary	177 (44.3)	5 (6.1)	172 (54.1)	
	university	30 (7.5)	4 (4.9)	26 (8.2)	
Social status	lives alone	41 (10.3)	33 (40.2)	8 (2.5)	< 0.0001
	lives with somebody	359 (89.8)	49 (59.8)	310 (97.5)	
Anaesthesia	general	303 (75.8)	49 (59.8)	254 (79.9)	< 0.0001
	local (block)	4 (1.0)	0 (0.0)	4 (1.3)	
	local sa	12 (3.0)	10 (12.2)	2 (0.6)	
	no anaesthesia	81 (20.3)	23 (28.0)	58 (18.2)	
Smoking		47 (11.8)	17 (20.7)	30 (9.4)	0.005
Hypertensive disease		115 (28.8)	51 (62.2)	64 (20.1)	< 0.0001
Coronary artery disease		21 (5.3)	14 (17.1)	7 (2.2)	< 0.0001
Diabetes mellitus		43 (10.8)	19 (23.2)	24 (7.5)	< 0.0001
Chronic renal insufficiency		6 (1.5)	4 (4.9)	2 (0.6)	0.018
Asthma bronchiale		2 (0.5)	1 (1.2)	1 (0.3)	0.368
Chronic venous insufficiency		1 (0.3)	1 (1.2)	0 (0.0)	0.205
Chronic obstructive pulmonary disease		6 (1.5)	4 (4.9)	2 (0.6)	0.018
Furosemide in chronic medication		10 (2.5)	6 (7.3)	4 (1.3)	0.007
Mobility impairments		382 (95.5)	79 (96.3)	303 (95.3)	1.000
Physical restraint		239 (59.8)	68 (82.9)	171 (53.8)	< 0.0001
Urinary catheterisation		140 (35.0)	68 (82.9)	72 (22.6)	< 0.0001
Sensory impairments		69 (17.3)	49 (59.8)	20 (6.3)	< 0.0001
Pain		393 (98.3)	81 (98.8)	312 (98.1)	1.000
Infection		15 (3.8)	6 (7.3)	9 (2.8)	0.094
Fever		5 (1.3)	4 (4.9)	1 (0.3)	0.007
Sodium imbalance (hyper / hyponatremia)		16 (4.0)	14 (17.1)	2 (0.6)	< 0.0001
Potassium imbalance (hyper / hypokalemia)		26 (6.5)	20 (24.4)	6 (1.9)	< 0.0001
Fatigue		47 (11.8)	33 (40.2)	14 (4.4)	< 0.0001

*n – number; CAM – Confusion Assessment Method; *The presence of three out of four of these signs is required to make a diagnosis of delirium, i.e. to assess the patient as CAM+; **Chi-square statistic and Fisher's exact tests were used for comparison of groups*

Delirium incidence

Delirium was observed in 82 respondents (20.5%) out of the total number of 400. The delirium duration in patients was calculated to be 2.78 days. Results show that the average hospitalization length for patients with observed delirium was 9.4 days, while in patients without observed delirium it was 6.2 days.

Risk factors for delirium development

A delirious state assessed by the CAM was most frequent in patients with local SA anaesthesia, a history of smoking, sensory impairment, and comorbidity (sodium or potassium imbalance, hypertensive disease, cardiac illness, pulmonary or renal disease, diabetes mellitus), as well as with chronic medication with furosemide, with urinary catheterisation, occurrence of pain, fever, or fatigue (Table 1).

In the delirious group in comparison with the non-delirious group, there was a significantly larger number of women (64% versus 40%; $p < 0.0001$), and patients living alone (40% versus 2.5%; $p < 0.0001$).

Significantly higher values of DOS score at admission, and Nu-DESC score at admission, DOS score during delirium, and Nu-DESC score during delirium were found in the group of patients with delirium symptoms (Table 2). There were only three variables that had the predictive value for the delirium (Table 3). The stepwise regression analysis confirmed a total DOS score during the first assessment, patient age, and smoking as significant predictors of delirium development.

Cut-off point

Our DOS score cut-off value was 0.5. It means that if a patient gets at least 1 point out of the total unadjusted score in the DOS questionnaire, delirium incidence may be predicted. If the Nu-DESC score cut-off value is 0.5, it means that if a patient gets at least 1 point out of the total score in the Nu-DESC questionnaire, delirium incidence may be predicted.

Predictive validity of DOS and Nu-DESC

The DOS measuring instrument with the 0.5 cut-off point achieved the following values: sensitivity 97.6%, specificity 96.2%, positive predictive value 87% and negative predictive value 99.4%. The area under the ROC curve was 0.984.

The Nu-DESC measuring instrument with the 0.5 cut-off point achieved the following values: sensitivity 92.7%, specificity 96.5%, positive predictive value 87.4%, negative predictive value 98.1%. The area under the ROC curve was 0.959. The descriptive characteristics and psychometric properties of the screening instruments are shown in Tables 2 and, 4 and Graph 1.

Table 2 DOS score, Nu-DESC and CAM score during the first and the second assessment

		mean	SD	median	min.	max.	p-value
DOS							
during the first assessment	non-delirious group (CAM^-)	0.03	0.21	0.00	0.00	2.67	< 0.0001
(24 hours after admission)	delirious group (CAM^+)*	2.61	1.49	2.33	0.00	9.33	
Nu-DESC							
during the first assessment	non-delirious group (CAM^-)	0.06	0.40	0.0	0.0	6	< 0.0001
(24 hours after admission)	delirious group (CAM^+)*	4.27	3.23	3.5	0.0	20	
DOS							
during the second assessment (72 hours after	non-delirious group (CAM^-)	0.04	0.42	0.00	0.00	7.00	< 0.0001
admission or during discharge)	delirious group (CAM^+)*	6.47	2.58	6.50	1.33	12.00	
Nu-DESC							
during the second assessment (72 hours after	non-delirious group (CAM^-)	1.23	3.92	0.0	0.0	19	< 0.0001
admission or during discharge)	delirious group (CAM^+)*	7.98	7.76	8.0	0.0	30	

*DOS – Delirium Observation Scale; Nu-DESC – Nursing Delirium Screening Scale; CAM – Confusion Assessment Method; *The presence of three out of four of these signs is required to make a diagnosis of delirium, i.e. to assess the patient as CAM+; min. – minimum value; max. – maximum value; SD – standard deviation; p < 0.05 Mann-Whitney U test*

Table 3 The stepwise regression and significant predictors of delirium development

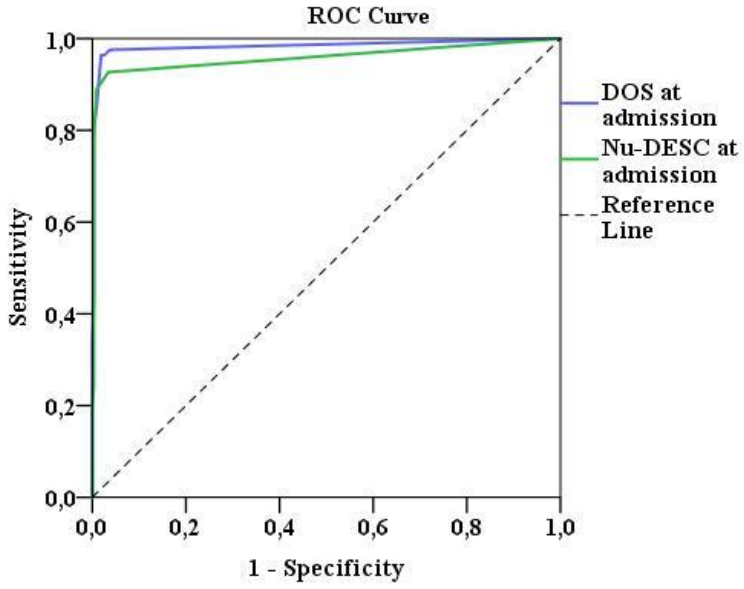
			95 % Confindence interval	
	p-value	Odds ratio	Lower limit	Upper limit
DOS total score during the first assessment (24 hours after admission)	< 0.0001	3.350	2.394	4.69
Age	0.004	1.073	1.023	1.13
Smoking	0.004	13.119	2.245	76.66

p < 0.05 Mann-Whitney U test

Table 4 Psychometric properties of the DOS and the Nu-DESC

Scale	Cut-off point	Sensitivity	Specificity	PPV	NPV	ROC	min.	SD	max.
DOS during delirium	0.5	97.6%	96.2%	87.0%	99.4%	0.984	1.35	2.87	12
Nu-DESC during delirium	0.5	92.7%	96.5%	87.4%	98.1%	0.959	2.60	5.36	30

DOS – Delirium Observation Scale; Nu-DESC – Nursing Delirium Screening Scale; PPV – positive predictive value; NPV – negative predictive value; ROC – Receiver Operating Characteristics; min. – minimum value; max. – maximum value; SD – standard deviation



Graph 1 Area under the ROC curve of the DOS and Nu-DESC screening measuring tools

Discussion

The presented study focuses specifically on the predictive validity of two selected tools for the early detection of delirium – DOS and Nu-DESC – in patients with a locomotive apparatus trauma. These tools may be administered by a nurse as part of the routine screening examination of a patient. Previous research tested the predictive validity of both tools only in patients in post-surgical periods in general (Radtke et al., 2010). However, the predictive validity of both tools has not been studied in a specific population of post-trauma patients. Therefore, this is the first study analysing their psychometric properties in patients admitted to a standard traumatology department for a locomotive apparatus trauma.

Delirium is a frequent problem in post-traumatic or post-surgical patients. In a cohort one-year study Schubert et al. (2018) observed a delirium incidence in up to 36.7% of the patients admitted to the traumatology department. They linked the specified prevalence to the ICD diagnostic chapters. Under the XIX chapter ("injury / poisoning / external causes") they observed delirium in 38.3% of the patients. Pandharipande et al. (2008) diagnosed delirium in 7 out of 10 patients in surgical / traumatology intensive care units. Simultaneously, in compliance with all the newest data about benzodiazepines, they confirmed that taking midazolam is an independent and potentially modifiable predictive factor of delirium onset in patients in surgical / traumatology intensive care units. In our study, delirium was observed in 82 (20.50%) out of 400 patients admitted to a standard traumatology department. The incidence is lower since these patients were not admitted to an intensive care unit where a higher incidence of delirium is expected. De et al. (2017) regard the delirium in Intensive Care Unit (ICU) s to be a different entity from delirium in other clinical settings. They argue that there are specifics in terms of the severity of diseases, invasive treatment strategies, frequent intravenous sedation, etc.

Management of delirium requires selecting and using a suitable screening instrument. Early detection of delirium influences potential clinical (mortality, cognitive function disorder, motor functions, etc.) and economic (hospitalization length, costs of treatment, nursing hours) consequences of delirium. The CAM instrument is perceived as the "gold standard" for assessing delirium. However, this tool is primarily designed to diagnose delirium, not to predict it or screen for it (De et al., 2017; Van Velthuijsen et al., 2016). Van Velthuijsen et al. (2016) emphasizes that CAM requires the patient to be observed but also his cognitive capabilities to be tested, and thus it is much more time-consuming compared to DOS and Nu-DESC. For these reasons, CAM requires the staff to be trained and thus it is more suitable as a diagnostic tool for doctors than for a routine informative screening exam by a nurse. Feasibility of DOS and Nu-DESC for administration by a nurse is also confirmed by review studies (De et al., 2017; Grover & Kate, 2012; Van Velthuijsen et al., 2016).

All patients admitted to a standard ward with apparent symptoms (disorientation, agitation, etc.) or patients ≥ 65 years old should be regularly monitored by a nurse once or more times per shift over the course of at least 3 days, using the DOS (Schubert et al., 2018) or Nu-DESC screening instruments. Their use facilitates the early detection of delirium according to the Diagnostic and Statistical Manual – IV criteria. According to the analysis of reviewed studies, Nu-DESC may be seen as the most tested tool, with nurses acting as the raters (it has been tested in 7 research studies in total). The Nu-DESC score has been developed based on the Confusion Rating Scale (Williams et al., 1988). However, the respective measuring instrument was not developed based on the DSM-IV criteria. Adding the fifth item (psychomotor retardation) completed the development of the Nu-DESC screening measuring instrument (Radtke et al., 2010). Three items of the measuring instrument (inappropriate behaviour, communication, and illusions / hallucinations) are not directly linked to the DSM-IV criteria. On the other hand, DOS fully corresponds with the DSM-IV criteria. Radtke et al. (2010) compared the psychomotor properties of both tools in patients admitted to the recovery room. The authors observed higher sensitivity of Nu-DESC compared to DOS, while they thought that the psychomotor retardation criterion was one of the most important criteria explaining the higher sensitivity. Therefore, Nu-DESC may be used as a sensitive instrument for detecting the widespread form of delirium (hypoactive delirium) in various clinical settings.

This study proved the efficiency, effectivity, and simple administration of both screening measuring instruments for delirium prediction. Our study showed higher sensitivity values for DOS. Sensitivity for Nu-DESC was 89% (80.2%–94.9%). These values are equal to the cut-off 2 recommended by the authors of the measuring instrument (Schuurmans et al., 2003). Sensitivity for the research carried out by Radtke et al. (2010) was 97.65%. However, the study sample included only 88 respondents. In subsequent studies the sensitivity was only between 65.6 and 85.7% (Lingehall et al., 2013; Luetz et al., 2010; Poikajärvi et al., 2017). In our study, the Nu-DESC instrument had a specificity of 91.9% (97.3%–99.8%), which is a value almost comparable with another study with a specificity around 92.3% (Radtke et al., 2010). Nevertheless, not all specificity values of Nu-DESC exceeded 90% (Luetz et al. 2010; Poikajärvi et al., 2017). However, the study by Lingehall et al. (2013) showed the highest specificity of this screening measuring instrument, namely 94.9%. The obtained sensitivity of our research for the DOS instrument was 95.1% (87.9%–98.7%) for the cut-off score 3. However, for the DOS instrument the values were rather lower, which was demonstrated by the study by Koster et al. (2009) with the sensitivity value of only 25.0%, and by Numan et al. (2017) with the value of 62.2%. The DOS screening measuring instrument demonstrated a high sensitivity (97%), but the studies were not conducted in surgical-type wards (Jorgensen et al., 2017). The specificity of DOS in our study was 98.1% (95.9%–99.3%) and it was almost the same as the specificity achieved in research done by Numan et al. (2017). For the already mentioned study the specificity was 98.4%. Only one study presented positive and negative predictive values for the Nu-DESC, namely PPV = 5.4% and NPV = 78.4 (Pokajärvi et al., 2017). PPV and NPV for DOS were specified in three studies. These values oscillated for PPV from 53% to 95.8% and for NPV from 81.8% to 99%. The predictive values in our research for the Nu-DESC screening measuring instrument were PPV 96.1% and NPV 97.2%, while for DOS PPV was 92.9% and NPV 98.7%. In our research study the ROC value at the cut-off score was 0.959 for Nu-DESC and 0.984 for DOS. Only two studies presented the ROC value for a screening measuring instrument. The highest value of 0.99 was shown in the study by Radtke et al. (2010). For the DOS screening measuring instrument, the ROC value was calculated only in the study by Koster et al. (2009), equalling 0.85. It proves that DOS, as well as Nu-DESC, is able to identify a patient at risk of delirium among patients with locomotive apparatus trauma under the Czech healthcare system conditions and that there are opportunities to use them in actual clinical settings. The psychometric properties show different values due to not completely equal study sample sizes. The sample sizes varied from 88 to 167 respondents and the studies were from 3 to 20 months long; some studies did not specify their length (Koster et al., 2009; Lingehall et al., 2013; Luetz et al., 2010; Numan et al., 2017; Poikajärvi et al., 2017; Radtke et al., 2010). In critically ill patients the delirium is independently linked to higher mortality. The results of the studies demonstrate that the post-surgical delirium significantly affects cognitive functions. The effects may be manifested as early ones, but they may also influence the patients over a longer period of time. Educational interventions and the use of screening measuring instruments allow one to better prevent cognitive function impairment. The results also map out how much a general nurse uses the screening measuring instruments – a total of 82% of nurses used a screening measuring instrument to predict delirium. In 62% of cases

the nurse used the measuring instrument correctly (Luetz et al., 2010). The varying values of psychometric properties may also result from the fact that not all raters were nurses. And the differences in professions of the raters might be just one of the reasons making the outcomes of the studies complicated. The approaches may be different depending if the rater is a psychiatrist or a nurse who is in permanent contact with the patient and is the first one to detect the primary symptoms of delirium. As a limitation of the studies, the authors also mention the fact that the research was carried out by trained researchers but not by the nurses providing care to the patients. In the study by Luetz et al. (2010), the limitation arose from the uncertainty of the researchers when assessing the patients' condition with Nu-DESC. All raters in our study were general nurses. In some cases, information about the duration of the research was not provided, which may affect the research results. It especially applies to studies using the DOS screening measuring instrument (Koster et al., 2009; Numan et al., 2017).

Based on the results of our research, we would recommend predicting delirium in patients with locomotive apparatus trauma using the DOS measuring instrument. Although this screening measuring instrument contains more items (13) than the Nu-DESC measuring instrument (5), it captures the reactions of a patient typical of hypoactive and hyperactive delirium symptoms. The items clearly reflect the behaviour and symptoms of the patient and are explicit for nurses who work with patients.

Limitation of study

The study has several limitations that could affect the quality of the results. One of them is the fact that the study was conducted at only one study site. In addition, clinical injury severity and critical illness scoring systems were not used. Another limitation lies in confirming the delirium only with CAM administered by a nurse and not according to DSM-5 criteria assessed by a doctor. Patients with any degree of dementia and head or brain trauma have a higher risk of becoming delirious. However, these patients were excluded from the study to obtain a more homogenous sample. Another limitation was the frequency of the assessment using the DOS and Nu-DESC screening instruments. The instruments were not used every day (three times daily) until three days after patient's admission to reflect the fluctuating character of delirium.

Conclusion

Based on the psychometric property analysis of the respective tools, the DOS screening instrument demonstrated better values of predictive validity (sensitivity 97.6%, specificity 96.2%). The Nu-DESC screening measuring instrument showed higher predictive validity values for specificity (96.5%) and PPV (87.4%). Other predictive validity values were lower but with only minimum differences. DOS and Nu-DESC are screening measuring instruments administered by a nurse that may be widely used in clinical practice. Total DOS score during the first assessment, patient age, and smoking were confirmed as the significant predictors of delirium development.

Routine administration of the DOS and the Nu-DESC may affect impending delirium, which may be life-threatening for hospitalized patients even in modern times. Since the assessment and diagnostics of delirium is not a standard procedure in a Czech clinical setting, the study is very significant for general nurses providing care to patients with locomotive apparatus trauma (traumatology, orthopaedics, surgery).

Conclusions or recommendations or implications for practice

Based on the obtained results of this study nurses should improve their skills and apply procedures in this area that could prevent delirium and related complications.

Ethical aspects and conflict of interest

Prior to the actual research, we obtained consent from the management of the Teaching Hospital in Olomouc and consent from the management of the traumatology clinic at the same institution. Subsequently we also obtained a positive opinion of the Ethics Committee for the Teaching Hospital in Olomouc. The authors of the selected instruments for DOS Schurmmans et al., for Nu-DESC Gaudreau et al., and for CAM Inouye provided us with written consent to use the respective measuring tools. All patients were asked for their informed consent. There were no conflicts of interest.

The research has been approved by the Ethics Committee of the Teaching Hospital in Olomouc on 12 March 2018 under ref. number 25/18.

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Author contributions

Conception and design (BŠ), data analysis and interpretation (HMK, LŠ, EG) manuscript draft (BŠ), critical revision of the manuscript (BŠ, HMK, LŠ, EG), final approval of the manuscript (BŠ).

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