PREDICTIVE VALUE OF THE SLOVAK VERSION OF THE MORSE FALL SCALE AT A UNIVERSITY HOSPITAL
PREDIKČNÁ VALIDITA SLOVENSKEJ VERZIE MORSEOVEJ STUPNICE RIZIKA PÁDU V UNIVERZITNEJ NEMOCNICI

BÓRIKOVÁ Ivana, TOMAGOVÁ Martina, MIERTOVÁ Michaela

Department of Nursing, Jessenius Faculty of Medicine in Martin, Comenius University in Bratislava, Martin, Slovak Republic

ABSTRACT

Objectives: To investigate the predictive value of the Slovak version of the Morse Fall Scale (MFS) in inpatients.

Methods: Prospective cross-sectional study was performed in the selected internal medicine and surgical wards of the university hospital. There were 1,319 inpatients included in the sample (1,288 nonfallers, 31 fallers). The predictive value of the MFS was investigated at different values of cut-off score (from 25 to 55).

Results: The patients were at a mean age on the level of the senior category (mean age 65.50 ± 15.00 years), and the mean fall risk score was high (mean fall risk score 45.11 ± 23.74). The best predictive validity for the high risk of falling by the MFS Slovak version (MFS-SK) was cut-off ≥ 55, when sensitivity was 92.1 %, specificity 71.6 %. The MFS-SK had the best optimal predictive values at cut-off ≥ 55.

Conclusions: There are different factors that influence the selection of the optimal cut-off value, e.g. the size and age of the sample, and the particularities of setting. The value of the optimal cut-off has an impact on the selection of patients with a high risk of falling and the setting of targeted interventions. The predictive validity of the MFS is unstable. Prior to implementing the tool into practice, a prospective validation is necessary in the setting where it will be used. Further validation of the Slovak version also for other departments and patient groups are needed.

Key words: Falls Risk. Hospital. Nursing Assessment. Morse Fall Scale. Predictive Value.

ABSTRAKT

Úvod: Posúdenie rizika pádu je kľúčovým aspektom prevencie pádu. Klinicky použiteľný merací nástroj má mať dobrú predikčnú validitu. Morseovej stupnica rizika pádu (MFS) je často testovaná v akútnej starostlivosti, lebo posudzuje signifikantné rizikové faktory pádu u dospelých pacientov, vrátane seniorov.

Cieľ: Preskúmať predikčnú validitu slovenskej verzie MFS u dospelých hospitalizovaných pacientov.

Súbor a metodika: Prospektívna prierezová štúdia bola realizovaná na vybraných interných a chirurgických oddeleniach univerzitnej nemocnice v roku 2018. V súbore bolo 1 319 hospitalizovaných pacientov (1 288 bez pádu, 31 s pádom). Predikčná validita slovenskej verzie MFS bola preskúmaná na rôznych hodnotách hraničného skóre (od 25 po 55).

Výsledky: Súbor pacientov mal priemerný vek na úrovni seniorskej kategórie (65,50 ± 15,00 rokov), priemerné skóre rizika pádu bolo vysoké (MFS skóre 45,11 ± 23,74). Najlepšia predikčná validita pre vysoké riziko pádu podľa slovenskej verzie MFS (MFS-SK) bola pri hraničnej hodnote ≥ 55, keď senzitivita predstavovala 92,1 % a špecificita 71,6 %.

Záver: Na výber optimálnej hodnoty cut-off majú vplyv rôzne faktory, napr. veľkosť a vek súboru a špecifiká klinického prostredia. Hodnota optimálneho hraničného skóre má vplyv na selekciu pacientov s vysokým rizikom pádu a nastavenie cielených intervencií. Predikčná validita MFS je nestabilná. Pred implementáciou nástroja do praxe je potrebná prospektívna validácia nástroja v prostredí, kde sa bude používať. Potrebná je ďalšia validácia slovenskej verzie MFS aj pre iné oddelenia a pacientske skupiny.

Kľúčové slová: Riziko pádu. Hospitalizácia. Morseovej stupnica rizika pádu. Predikčná validita.

INTRODUCTION

Monitoring of at-risk patients is the integral part of an internal quality assessment system and safety in provided healthcare. Analysis of fall-related injuries reveals several factors that increase the number of falls in hospitals, including a lack of systematic risk assessment of the fall. Due to the multifactor nature, complex interaction and cumulative effect of risk factors, this process is difficult but inevitable. Using a standardized risk assessment methodology helps identify the main risk factors for the fall and focus prevention on correctly identified patients. The outcome of the assessment is the basis for the implementation of targeted, evidence-based preventive interventions that significantly reduce the number of falls (Joint Commission, 2015; Ganz et al., 2013; WHO Global report on falls prevention in older age, 2007).

Patients' falls and their prevention are an issue in Slovak hospitals as well, but the problematic of falls is not given proper attention and is not resolved as a whole. The definition of fall, the methods of assessing the risk of falls, including screening via a valid measuring tool, are absent, and there hasn't been any complex programme how to prevent falls developed, nor at least a national nursing standard. Some risk factors for falls (gender, age, mobility, ambulatory aids, sensory barriers, drug groups) are assessed only after the patient's fall (Methodical

guide, 2014). The analysis of reported falls serves the management of hospitals as a base for setting some routine preventive interventions that are carried out in all patients regardless of the level of risk.

A key component in fall prevention is the identification of risk factors for falls also via a screeening measuring tool which is able to detect several risk factors at the same time, providing it has been tested for predictive validity (Watson et al., 2016; Aranda-Gallardo et al., 2013; Oliver, Healey, 2009). A clinically useful predictive tool should be simple to use, and should have a limited number of items; it should not require specialized assessment, technology or skills, and should be consistent for the target group. Furthermore, it should be based on scientific score testing, with solid inter-rater reliability, and high staff adherence (Oliver, 2008). Since clinical specializations and patient populations may vary, selecting the proper tool requires careful consideration in order to find the best and most suitable for hospital preventative programmes. While there is no gold standard, the Morse Fall Scale (MFS) is one of the most tested and recommended tools for the initial assessment of fall risk in clinical practice. In 1989, J. M. Morse developed and tested the MFS to identify the patients at a high risk of anticipated physiological fall that stands for roughly 78 % of all falls. The development of the MFS was based on the assessment of 100 fallers and 100 randomized controls in the environments of acute care (internal medicine, surgical ward) as well as in those of long-stay geriatric and rehabilitation care. On the basis of long-term testing on physiological and environmental factors, Morse identified six MFS items to be significant risk factors for physiological falls in adult patients, including the seniors (Morse et al., 1989a).

Fall risk screening – including a tool with good predictive validity – is the basis for evidence-based prevention strategies to address a specific risk factor in a correctly identified patient in order to prevent a fall successfully. Several dozen fall risk screening tools have been proposed and tested. Prior to implementing a particular tool into a specific clinical setting, clinically useful predictive values should be considered, combining sensitivity ≥ 70 % and specificity ≥ 70 %. Predictive validity is an important indicator of the diagnostic accuracy of the tool. It includes the selection of an optimal cut-off value as well as the analysis of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), the Youden index (J), receiver operating characteristic curve (ROC) and the area under the ROC curve (AUC) (McKechnie et al., 2016). The predictive validity of the original version at MFS cut-off ≥ 45 had a sensitivity of 78 %, specificity of 83 %, PPV of 10.3 % and NPV of 99.2 % (Morse et al., 1989b). Morse determined the cut-off point of 45 as the lowest for detecting a high risk of falling and the best for analysis. However, she allows for the variability of cut-off values and recommends to test the predictive validity of the MFS for each particular facility at cut-off values from a minimum of 25 to a maximum of 55 (Morse, 2009). There is no consensus on the fall risk assessment, and a general valid measuring tool does not exist (Chapman et al., 2011), therefore, considering the quoted terminus a quo, we decided to test the predictive validity of the MFS in slovak clinical setting. This article aim was to determine the predictive value of the Slovak version of the MFS (MFS-SK) in a sample of adult hospitalized patients in the selected departments of the university hospital.

MATERIAL AND METHODS

Sample and setting

Before the study was intiated, the registered nurses selected from the units listed above (including the hospital nursing management) attended an educational meeting with the study authors. They were provided with both verbal and written information about the aim and organization of the study, as well as the method on data collecting and item scoring in the MFS-SK so that no doubts would arise. These trained nurses admitted patients for hospitalization and filled in the research protocol. Two nursing researchers supervised both the study and the data collection.

The prospective cross-sectional study study comprised the patients who were admitted to the university hospital in the period of its performance (2018), and met the classification criteria: 1. age ≥ 18 years; 2. admission to an internal medicine or a surgical department; 3. length of hospitalization > 48 hours. All the patients enrolled in the study were assessed for the risk of falling within the period of 24 to 48 hours following their admission as part of nursing assessment. In order to know the basic characteristics of the hospitalized patients, the demographic data and a list of selected risk factors

of falling were included in the research protocol, in adition to the MFS-SK fall risk screening.

For the purposes of this study, the authors used the following definition of a fall: An event that results in a person coming to rest inadvertently on the ground or floor or other lower level (WHO, 2018). Falls count as a fall if the person was trying to get out of bed to walk when the fall occurred or if the patient was being transferred from a wheelchair to a bed (Morse, 2009).

The study was performed in 8 internal medicine and 7 surgical units, patients' gender, age and the length of hospitalization were recorded. In literature, some of these data are referred to as the key risk factors of falling. The patients over the age of 65 are at a higher risk of falling, and from the gender's point of view, older women with physical disability and polypharmacotherapy are at a higher risk (Chang, Do 2015). The length of hospitalization exerts an influence upon changes in the patient's health condition and increases the chance of falling (Morse, 2009; Jun et al., 2018). It can generally be said that all patients are at a certain risk of falling during hospitalization, but some health characteristics are associated with a higher risk. Literary sources present various risk factors of falling, among which these belong to the most significant ones: a history of falling, chronic disease (polymorbidity with subsequent polypharmacotherapy), gait and balance disorders, use of a ambulatory aid (Jun et al., 2018). Their presence in the patients' sample was surveyed from their health records; however, they can be quickly assessed through the MFS as well. The MFS is a rating scale for screening fall risk and consists of six items: 1. History of falling, immediate history or within 3 months (no 0, yes 25); 2. Presence of a secondary diagnosis (no 0, yes 15), a secondary diagnosis was coded if the patient had more than one medical diagnosis in the patient's chart; in regard to the associated diagnosis, pharmacotherapy is significant, too, while Morse considers the use of more than one medication group to be polypharmacotherapy; 3. Use of an ambulatory aid (none/bed rest/nurse's assistance 0, crutches/cane/walker 15, furniture for support 30); 4. Intravenous therapy/saline lock (no 0, yes 20); 5. Type of gait (normal/bedrest/wheelchair 0, weak 10, impaired 20); 6. Mental status (oriented to own ability 0, overestimates ability or forgets limitations 15). The final possible score range is between 0 and 125, low fall risk level is rated at ≤ 20, moderate 25–44 and high ≥ 45. Cut-off score ≥ 45 identifies patients with a high fall risk, which then initiates the selection of preventive interventions in order to reduce the fall risk. Staff nurses can use this tool to identify fall risk (Morse, 2009). The Slovak version of the MFS (MFS-SK) was used. Translation into the Slovak language – the MFS-SK version (back translation approach) was performed by two independent translations (by a translator specialized in nursing), from which the final version of the tool was created (Sung et al., 2014).

Data analysis

Statistical analysis was performed using the Statistical Software Package with IBM PASW Statistics version 20.0 for Windows. The characteristics of the sample were analyzed using descriptive statistics (such as frequencies, percentages, and mean and standard deviations) for variable. The predictive validity of the MFS-SK was analyzed using the values of sensitivity, specificity, PPV a NPV, and the total predictive value through J, ROC curve and AUC (CI 95 %) at the MFS-SK cut-off values ≥ 25, ≥ 35, ≥ 45, ≥ 50 and ≥ 55.

RESULTS

The whole sample consisted of 1,319 inpatients (1,288 in the non-fall group, 31 in the fall group). The gender representation was well balanced; the mean age was 65.50 ± 15.00 years (min. 19, max. 97). The mean length of hospitalization was 9.48 ± 6.18 days (min. 2, max. 61), with prevailing patients coming from internal medicine units, aged over 65, and with polypharmacotherapy.

The patients at a high risk of falling (n = 620) predominantly came from the internal medicine units, were female, over the age of 65, with polymorbidity, polypharmacotherapy, gait disorders, and walking aids. Characteristics of the sample are given in Table 1.

31 patients suffered a fall in the course of hospitalization, their mean age was 75.94 ± 10.48 years (min. 48, max. 90), and the mean length of hospitalization was 11.23 ± 6.43 days (min. 2, max. 27). In this sample, 20 patients were predicted for a high risk of falling.

On admission, 262 patients were at a low risk of falling (MFS-SK ≤ 20), 437 patients were at a moderate risk of falling (MFS-SK 25-44), and 620 patients were at a high risk of falling (MFS-SK ≥ 45).

The mean of fall risk score in the sample (n = 1,319) was high (MFS-SK 45.11 ± 23.74, min. 0, max. 125). The patients at a high risk of falling (MFS-SK ≥ 45, n = 620) had even a higher fall risk score (MFS-SK 65.82 ± 15.93, min. 45, max. 125).

The predictive MFS-SK values at different cut-off scores are given in Table 2. Sensitivity had the values ranging from 92.1 % to 100 %, specificity from 22.2 % to 71.6 %, PPV from 13.2 % to 27.8 %, NPV from 98.6 % to 100 %, J from 0.222 to 0.819, and AUC from 0.611 to 0.819. The best predictive validity for the high risk of falling was surveyed at the MFS-SK cut-off ≥ 55, when sensitivity was 92.1 %, specificity 71.6 %, PPV 27.8 %, NPV 98.7 %, J 0.637, ergo the values were most optimal. In addition, the ROC curve with its AUC value of 0.819 in comparison to the MFS-SK ≥ 45 and the reference line (Figure 1) points at a good predictive validity at MFS-SK cut-off ≥ 55.

Table 1 Sample characteristics

Variable		Total sample (n = 1,319)	Sample with high risk of fall MFS-SK ≥ 45 (n = 620)
Unit	Internal	937 (71.0)	375 (60.5)
	Surgical	382 (29.0)	245 (39.5)
Gender	Female	655 (49.7)	350 (56.5)
	Male	664 (50.3)	270 (43.5)
Age (years)	< 65	594 (45.0)	200 (32.3)
	≥ 65	725 (55.0)	420 (67.7)
History of falling	No	1,179 (89.4)	489 (78.9)
	Yes	140 (10.6)	131 (21.1)
Secondary diagnosis/polymorbidity	No	741 (56.2)	285 (46.0)
	Yes	578 (43.8)	335 (54.0)
Polypharmacotherapy	No	612 (46.4)	212 (34.2)
	Yes	707 (53.6)	408 (65.8)
Gait impaired	No	729 (55.3)	118 (19.0)
	Yes	590 (44.7)	502 (81.0)
Ambulatory aids	No	838 (63.5)	216 (34.8)
	Yes	481 (36.5)	404 (65.2)
Fall during hospitalization	No	1,288 (97.7)	600 (96.8)
	Yes	31 (2.3)	20 (3.2)

Table 2 Predictive validity of the MFS-SK cut-off scores (n = 1,319)

Cut-off score	25	35	45	50	55
TP	140	138	131	129	129
FN	0	2	9	11	11
FP	917	874	489	431	335
TN	262	305	690	748	844
Sensitivity	100.0	98.6	93.6	92.1	92.1
Specificity	22.2	25.9	58.5	63.4	71.6
PPV	13.2	13.6	21.1	23.0	27.8
NPV	100.0	99.3	98.7	98.6	98.7
J	0.222	0.244	0.521	0.556	0.637
AUC (95% CI)	0.611 (0.569-0.652)	0.622 (0.581-0.663)	0.760 (0.726-0.794)	0.778 (0.744-0.811)	0.819 (0.787-0.850)

Legend: Cut-off score – the limit point on the numerical fall risk scale which defines the patients with a high or low fall risk; *TP* – true positive, hit; *FN* – false negative, miss; *FP* – false positive, false alarm; *TN* – true negative, correct denial; *Sensitivity* – percentage of patients with falls and who were predicted as high risk (true positive rate, *TPR* = TP/(TP + FN); *Specificity* – percentage of patients who did not fall and were predicted as low risk (false positive rate, FPR = FP/(TN + FP); *PPV* – positive predictive value; percentage of patients identified as "high risk" who fell (PPV = TP/(TP + FP); *NPV* – negative predictive value; percentage of patients identified as "low risk" who did not fall (NPV = TN/(TN + FN); *J* – Youden index = (sensitivity + specificity) – 1; alternative statement as 1 – (false positive + false negative); *AUC* – area under ROC curve; values from 0 to 1; *CI* – confidence intervals

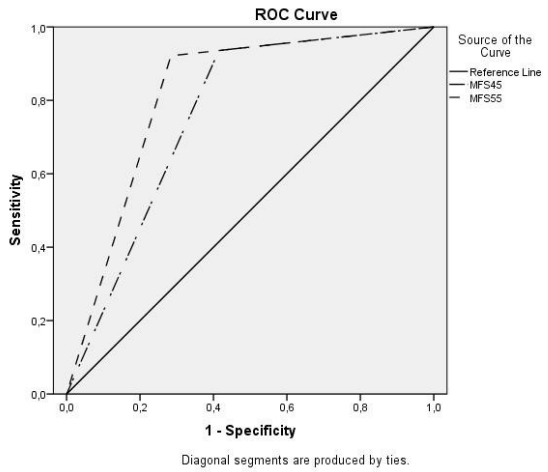

Figure 1 ROC curve with the AUC of the MFS-SK ≥ 55 and MFS-SK ≥ 45. *Legend: ROC curve* – receiver operating characteristic curve; *AUC* – area under the ROC curve; *MFS-SK ≥ 55* – Morse Fall Scale of Slovak version with predictive values at cut-off ≥ 55; *MFS-SK ≥ 45* – Morse Fall Scale of Slovak version with predictive values at cut-off ≥ 45

DISCUSSION

The predictive validity is a key indicator of the clinical applicability of the tool, and should be established prior to its implementation in practice (Baek et al., 2014), even if the validity of the tool does not mean that, even if it predicts the risk, it will really prevent it (Aranda-Gallardo et al., 2013). Diagnostic accuracy of the tool is related to the sensitivity and specificity values. These MFS values have been tested by many authors in an acute care setting in a broad spectrum of adult patients, including the seniors. The values of sensitivity varied from 31 % to 98 %, those of specificity from 8 % to 97 %, PPV from 1.9 % to 69.2 %, NPV from 76 % to 99.7 %, AUC from 0.527 to 0.71, and J from 0.15 to 0.63, depending on the cut-off value tested in the range from a minimum of 25 to a maximum of 120 (Bóriková et al., 2017). The MFS cut-off separates the patients at a low risk of falling and with a need for routine strategies from those ones who are at a high risk of falling and in need of targeted protective strategies (Morse, 2009). An optimal cut-off is where sensitivity and specificity meet at the highest point of curve. When both the cut-off and specificity are high, sensitivity is on the descrease and the patients at risk may escape the notice. At a lower cut-off, sensitivity is higher and more patients could be mistakenly considered to be at a high-risk (Watson et al., 2016). The use of the MFS has its limitations in view of the fact that some low-risk patients fall accidentally, and those ones at a high risk never fall down, which has an impact on the diagnostic accuracy of the tool (Matarese et al., 2015).

Sensitivity and specificity have an inversive relationship; high sensitivity can be reached at the expense of low specificity or vice versa, but a clinically useful predictive score should combine sensitivity ≥ 70 % and specificity ≥ 70 % (Healey, Haines, 2013). In our study, both of the mentioned values were at the highest point and closest to each other at MFS-SK ≥ 55. The testing of national MFS versions should be limited to this cut-off, as this result seems to yield statistically satisfying results for a sample of all patients, which however does not have to be also clinically and economically useful (McKechnie et al., 2016).

When analyzing PPV and NPV along with sensitivity and specificity, the combination of sensitivity and NPV is important. A high sensitivity (MFS-SK ≥ 55 had the value of 92.1 %) represents a high percentage of patients who fell down and were predicted for a high risk. A high NPV (MFS-SK ≥ 55 had the value of 98.7 %) represents all the patients with a low risk prediction, and a high percentage of those ones who did not fall. The high NPV values are likely to be attributed to a large number of patients who did not fall (n = 1,288, 97.7 %). In a large sample with a low number of falls, the values of PPV and NPV may not be a good indicator for predictive validity (Chapman et al., 2011).

The Youden index allows the selection of an optimal cut-off value. The closer to 1 it is, the higher the prediction, and the value of 1 represents a perfect predictive accuracy. It is influenced neither by the prevalence of cases nor by the sample size (Matarese et al., 2015). In our study, J reached the highest value of 0.637 at cut-off ≥ 55, similarly to the study by Baek et al. (2014). The ROC curve analysis provides two main results – diagnostic accuracy of the test and an optimal cut-off value by illustrating the relationship between sensitivity and specificity. The 'cut points' continuous curve allows to select a score that separates the patients at a high risk of falling from those ones at a low risk of falling, which minimizes the consequences of faulty diagnostic decisions. AUC expresses the diagnostic effectiveness of the test; the larger the area, the higher the prediction value of the test. The MFS-SK had the highest AUC of 0.819 at cut-off 55, at which the values of 0.8–0.9 refer to a very

good discriminatory ability of the test (Dušek et al., 2011).

Considering the multifactorial causes of falls, no predictive indicator gives with its value a 100% guarantee that a patient who has been tested positively is actually at a real risk of falling. The outcome can be influenced by various factors (Bóriková et al., 2017), therefore the results of one study do not stand for general validity. Demographic data and fall risk factors in our sample were likely to impact on the results of this study. The mean age of the sample bordered 65 years, in the patients after a fall 75 years, ergo at the levels of the first and the second age limits for the risk of falling (NICE, 2013). Predictive validity at MFS ≥ 55 was tested by several authors (Watson et al., 2016; Sung et al., 2014; Healey, Haines, 2013; Schwendimann et al., 2006) and, similar like we did, they determined the optimal values for sensitivity and specificity at this cut-off. The patients in their sample were at a mean age of 65 to 80, too, and manifested characteristics of a vulnerable senior population. In Morse's original study (Morse et al., 1989b), the majority of the patients (58.8 %) were below 65, and likewise, the presence of risk factors was lower, which established the cut-off for a high risk of falling at MFS ≥ 45.

The low number of patients with a fall (n = 31, 2.3 %) in our study can be explained by the fact that despite any complete preventive programme or a standard having been approved and present in the hospital, the nurses and auxiliary staff of the hospital are educated on the problematics of general prevention of falls and patient's safety. The patients are instructed to follow the prescribed mobility regime, to not to stand up with the i.v. line, to call for the staff, or, as reported by Chow et al. (2007), they themselves, considering their current health state, reduce their mobility because they are worried about falling. In addition to this, a low number of patients with a fall may not represent the entire spectrum of patients.

In the course of the study, we attempted to maintain the methods of the original study by Morse as well as those of the validation studies in other countries. Based on the results, we can state that the MFS-SK testing in the conditions of the particular university hospital demonstrated the optimal predictive values for a high risk of falling at MFS-SK ≥ 55. The demographic and health characteristics of our sample definitely affected the results of this study, therefore the MFS-SK cut-off ≥ 55 for a high risk of falling cannot be recommended as universal for all the patients in internal medicine and surgical wards in the university hospital. Further MFS-SK testing is needed also in younger age groups and in some other specific patients' groups.

It is difficult to predict the risk of falling considering the complexity of risk factors, and the research studies provide the nurses with evidence that can be later implemented into practice. A screening tool for assessing significant risk factors, with a good predictive validity, will help to quickly identify the particular risk factor and to subsequently implement the targeted interventions. The MFS meets the criteria for clinical utility and feasibility in practice, has a small number of items, a clear fall risk scoring, does not require any special technologies or skills, the nurses find it quick and easy, although it should not replace clinical judgment. The benefit of using this tool is also its ability to categorize the protective and preventive interventions, depending on the level of fall risk (Morse, 2009), which makes it easier for the staff to select them. The MFS validation studies yield different results, which contributes to understanding how the various variables influence the fall risk prediction.

This study has several limitations. It was performed only in a single hospital in the selected departments; therefore, the results cannot be generalized for the entire adult in-patient population. The fall risk was a one-off assessment, on patient's admission to hospital, but not done repeatedly as recommended, which could potentially affect the MFS-SK predictive validity values. Despite these limitations, and considering the absence of domestic validation studies, we consider the results of our study to be significant for Slovak nursing practice.

CONCLUSION

Fall risk assessment is an integral and key part of the preventive programmme for identifying fall risk factors and selecting interventions. The MFS belongs to the most commonly used assessment tools in different countries, in a variety of clinical settings. The MFS predictive validity has been tested with different outcomes, depending on the particularities of clinical setting and patient population. Therefore, the MFS validity values are unstable, and so, before its implementation, a prospective validation is needed in that specific environment in which the tool will be used, with the aim to adjust an opti-

mal cut-off for the high risk of falling, so that fall prevention does not require unnecessary staff efforts and does not increase the hospital expenses.

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Ethical recommendations

The Ethics Committee of the University Hospital in Martin approved the Research Protocol. Janice M. Morse gave her approval with the translation and use of the original version of the MFS in the Slovak context. The author declares no conflict of interest. The patients' rights were respected.

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