A Comparative Study on the Validity of Fall Risk Assessment Scales in Korean Hospitals

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Purpose The purpose of this study was to compare the validity of three fall risk assessment scales including the Morse Fall Scale (MFS), the Bobath Memorial Hospital Fall Risk Assessment Scale (BMFRAS), and the Johns Hopkins Hospital Fall Risk Assessment Tool (JHFRAT).

Methods This study was a prospective validation cohort study in five acute care hospitals in Seoul and Gyeonggi-Do, Korea. In total, 356 patients over the age of 18 years admitted from December 2009 to February 2010 participated. The three fall risk assessment scales listed above were tested for sensitivity, specificity, positive predictive and negative predictive values. A receiver-operating characteristic (ROC) curve was generated to show sensitivities and specificities for predicting falls based on different threshold scores for considering patients at high risk.

Results Based on the mean scores of each scale for falls, the MFS at a cut-off score of 50 had a sensitivity of 78.9%, specificity of 55.8%, positive predictive value of 30.8%, and negative predictive value of 91.4%, which were the highest values among the three fall assessment scales. Areas under the curve of the ROC curves were .761 for the MFS, .715 for the BMFRAS, and .708 for the JHFRAT.

Conclusions Accordingly, of the three fall risk assessment scales, the highest predictive validity for identifying patients at high risk for falls was achieved by the MFS. [Asian Nursing Research 2011; 5(1):28–37]

Key Words accidental falls, risk assessment, sensitivity and specificity, ROC curve

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INTRODUCTION

Falling is one of the adverse events that occur most often in acute care hospitals (Hendrich, Bender, & Nyhuis, 2003) and continues to be a complex challenge that acute care hospitals face. Incidence of falling is also a sensitive nursing quality indicator together with pressure ulcer incidence and pain management (American Nurses Association, 2008). In acute care hospitals, inpatient falls represent the largest category of reported incidents. In the United States, the incidence rate of falls in acute care hospitals is 2–10% of all hospitalized patients (Hendrich, Nyhuis, Kippenbrock, & Soja, 1995), which accounts for 38% of total adverse events (E. A. Kim, Mordiffi, Bee, Devi, & Evans, 2007). In Korea, there is no accurate information available about the incidence rate of falls among hospitalized patients because hospitals are reluctant to release their fall rates. According to one specific hospital incident report, falls occupied 30% of all incident reports (E. K. Kim & Suh, 2002).

Fall-related injuries include fractures and head injuries, as well as postfall anxiety. These can lead to a loss of independence through disability and a fear of falling. The reductions in mobility and independence are often serious enough to result in admission to the hospital or even premature death (Chang et al., 2004; Hendrich et al., 1995). In addition, treatment and investigation for damage from a fall may extend the length of a hospital stay and may cause an additional economic burden for medical costs and also legal consequences (Bergland & Wyller, 2004). Therefore, nurses must assess the fall risk of the patient at the time of hospitalization and implement appropriate nursing interventions to prevent falls. Protecting patients from falls and ensuring a safe environment are fundamental to providing high-quality care.

In order to prevent falls, the most important preventive strategy is to assess patients periodically using a highly predictive fall risk assessment scale (The Joint Commission on Accreditation of Healthcare Organization, 2006). International hospital accreditation bodies such as the Joint Commission and the Australian Council on Healthcare Standards (2006) require applying a scientific, valid, and reliable scale based on research and evidence from patients at the time of the fall risk assessment. In addition, they recommended selecting the appropriate fall risk assessment scales based on the characteristics of patients, workload of nurses, and scale utilization in the hospital.

Many fall risk assessment scales have been suggested, such as the Morse Fall Scale (MFS; Morse, Morse, & Tylko, 1989), St Thomas’s Risk Assessment Tool in Falling Elderly Inpatients (Oliver, Britton, Seed, Martin, & Hopper, 1997), and the Hendrich Fall Risk Model (Hendrich et al., 1995). However, most of these scales were developed for and applied to elderly people or patients in long term care facilities. The results of comparison research for these scales in terms of validity and reliability varied (Vassallo, Stockdale, Sharma, Briggs, & Allen, 2005). Although the Johns Hopkins Hospital Fall Risk Assessment Tool (JHFRAT) was developed with evidence based on adult patients and acute care hospitals, and it is also widely used internationally, compared to the other scales, further studies on the reliability and validity of this scale are still needed (Poe, Cvach, Gartrell, Radzik, & Joy, 2005).

In Korea, many studies have conducted investigate fall risk factors and predictive value of fall risk assessment scales for the elderly and long term care or home care setting (C. G. Kim & Suh, 2002; E. K. Kim, Lee & Eum, 2008; Sung, Kwen, & Kim, 2006). However, only limited studies have addressed the fall risk factors and predictive value of fall risk assessment scales for adults and acute care hospitals. Therefore, it is very difficult to predict the occurrence of fall in adult patients admitted to acute care hospitals. In addition, most of acute care hospitals in Korea use either MFS or Bobath Memorial Hospital Fall Risk Assessment Scale (BMFRAS) which were developed for elderly patients in long term care hospitals and community or home care settings and not much information is available to support validity and reliability of these scales for use in adult patients in an acute care hospital (K. S. Kim et al., 2009).

Due to absence of reliable findings and evidence in nursing research studies, none of researchers and nursing professionals suggested an easy and effective fall risk assessment scale with high value of validity
and reliability for adult patients in acute care hospitals. According to the nursing guidelines for fall prevention developed by K. S. Kim et al. (2009), MFS, the most widely used scale in United States, and the BMFRAS, the most widely used in Korea, were recommended as fall risk assessment scales although the validity of these scales had not been tested on patients in Korean acute care hospitals. Thus further research was suggested to assess the validity of these scales for the patients in acute care hospitals (K. S. Kim et al., 2009).

For this reason, accurate assessment of fall risk factors and implementation of effective nursing interventions for fall prevention are lacking for the patients admitting to acute care hospitals in Korea. Therefore, nursing research studies that provide an important resource to develop the fall prevention nursing strategies including fall risk assessment with valid and reliable scales are needed.

The purposes of this study were to compare the validity of the three fall risk assessment scales and to recommend the most appropriate fall risk assessment scale with a high validity for Korean patients in acute care hospitals.

**METHODS**

**Study design**

This study was a prospective cohort study to determine the best fall risk assessment scale with a high validity for the patients in acute care hospitals.

**Sample and setting**

Korea hospital nurses association recommended hospitals which were selected by convenience sampling and among these hospitals, five agreed to participate in the study. These five hospitals were general teaching hospitals located in Seoul and Gyeonggi-do, Korea and with acute care hospital setting with over 700 licensed beds. In each general hospital, two wards with high fall rates were selected. The fall risks of adult patients aged 18 and over were then rated using the MFS, BMFRAS and JHFRAT; fall events during hospitalization were monitored. In this study, the data from 356 patients were analyzed.

For data collection, nine registered nurses, who understood the purposes of this study and had signed a written agreement participated in the data collection, were recommended by the nursing managers of these five hospitals. Prior to data collection, the researcher trained them on how to use the fall risk assessment scales by explanation and performed a pre-evaluation using three example cases in order to minimize the differences among the data collectors.

**Data collection procedures**

After receiving approval from the Institutional Review Board of Seoul National University in Korea, permission was obtained from the nursing department at the five hospitals where the study was conducted. The researcher provided a verbal and written explanation of the study and obtained the written informed document from patients or patient’s legal guardians prior to enrolling subjects in the study.

The data collection period was from December 2009 to February 2010. Each data collector applied the three fall risk assessment scales to one patient at 10 a.m. once a week, and evaluated the results. Each patient was assessed 4 times over 4 weeks. If the patient had a fall incident or left the hospital, the assessment was terminated.

The definition of fall in this study was a sudden, unintentional change in position causing an individual to land at a lower level, on an object, the floor, the ground or other surfaces. This included slips, trips, falling into other people, being lowered, loss of balance, and legs giving way. This definition was developed based on the definition devised by Tinetti, Baker, Dutcher, Vincent, and Rozett (1997).

Fall events were closely monitored by nurses’ observation, caregivers’ report, and patient’s chart review. If a patient had fallen, the last scores they received for the fall risk were used for the analysis. If the patient had not fallen, the final assessment scores were used.

**MFS**

The MFS developed by Morse (1986) consists of six variables including history of falling (0 and 15 points), secondary disease (0 and 15 points), ambulatory aid
Validity of Three Fall Risk Assessment Scales

Three fall risk assessment scales were evaluated in this study: the Morse Fall Scale (MFS), Bobath Memorial Hospital Fall Risk Assessment Scale (BMFRAS), and Johns Hopkins Hospital Fall Risk Assessment Tool (JHFRAT).

**Bobath Memorial Hospital Fall Risk Assessment Scale (BMFRAS)**
The BMFRAS was developed for elderly hospitalized patients at the Bobath Memorial Hospital in Korea in 2003. It consists of eight items including age (0–3 points), history of falling (0–3 points), gait (0–8 points), cognition (0–8 points), communication (0–3 points), number of risk factors (sleep disturbance, urination problems, diarrhea, visual disturbance, dizziness, depression, agitation, and anxiety) (0–3 points), number of related diseases (stroke, hypertension, hypotension, dementia, parkinsonism, osteoporosis, kidney disease, musculoskeletal disease, and seizure) (0–3 points), and number of medication (antihypertensives, diuretics, digitalis, sedatives, antidepressants, antipsychotics, antiparkinson drugs, and anticonvulsants) (0–3 points) (Korea Hospital Nurses Association, 2005). Total score above 15 points represent a high risk, and it is recommended that patients with total scores above 20 points be monitored intensively.

**Johns Hopkins Hospital Fall Risk Assessment Tool (JHFRAT)**
The JHFRAT was developed by the Johns Hopkins Hospital in 2005, and was supplemented in 2007 with opinions of clinical practice experts. JHFRAT consists of eight main evaluation areas of fall risk factor categories: age (0–3 points), fall history (0–5 points), elimination (0–4 points), medication (0–7 points), patient care equipment (0–3 points), mobility (0–2 points), and cognition (0–4 points). A total score between 6 and 13 points represents an intermediate risk, and a total score above 13 points indicates a high risk. Fall risk assessment is performed during the first eight hours of hospitalization, once a day, and when there is any change in a patient’s condition or risk condition (Poe et al., 2007).

The investigators have received approval for using the tool from its author Stephanie Poe. One researcher translated the tool in English into Korean, and a Korean-English bilingual back-translated this tool, and evaluated the homogeneity of expressions and meanings. After identification of its translation validity, this tool was used.

**RESULTS**

**General characteristics of participants**
The data of 356 patients in total were analyzed, and there were 71 patients with fall incidents (19.9%) and 285 patients who did not experience fall incidents (80.1%). The average age of patients was 62.6, and there were more males (201 patients, 56.5%) than females (155 patients, 43.5%). Between the fall and nonfall group, there was no statistically meaningful difference for age ($p = .812$), gender ($p = .189$),...
operation \((p = .207)\), caregiver \((p = .858)\), or use of restraints \((p = .052)\). There was a statistically meaningful difference in fall risk \((p = .038)\) based on the ward type, intensive care units and surgical wards have higher fall rates than medical wards (Table 1).

**Characteristics of fall events**
Among a total of 356 patients, 71 patients (19.9%) experienced fall events. The place where fall events occurred most frequently was in the patient's room (39 patients, 54.9%), while 11 patients (15.5%) experienced fall events in the bathroom and 11 patients (15.5%) in other areas such as lounges. Regarding the condition of patients after fall event, 43 patients (60.6%) did not have any injuries. There were 23 cases reported to have “slight damage” (32.4%), 2 cases requiring extension of hospitalization (2.8%), and 1 case of transfer to the intensive care unit after fatal damage (1.4%).

**Mean scores of fall risk by each assessment scales**
Table 2 shows the average scores for all patients, the fall group and the nonfall group patients according to the three fall risk assessment scales. There were statistically meaningful differences between the fall and nonfall groups in all fall risk assessment scales \((p < .001)\).

**Validity of fall risk assessment scales**
The investigators applied the average score of each tool calculated from this study and the standard score which distinguishes the high risk group of fall,
regarding cut-off values for analyzing validity of each tool.

For the MFS, the sensitivity was 78.9%, specificity 55.8%, positive predictive value 30.8%, and negative predictive value 91.4% at the cut-off point of 51 points, as the average score calculated in this study. At 51 points as the minimum score for high risk of fall, the sensitivity was 73.2%, specificity 61.1%, positive predictive value 31.9% and negative predictive value 90.2%. For the BMFRAS, the sensitivity was 76.1%, specificity 58.3%, positive predictive value 31.8%, and negative predictive value 90.9% at the cut-off point of 11 points calculated as the average score in the study. At 15 points, which the scale suggested to be within high risk group, the sensitivity, specificity, and positive and negative predictive values were 69.0%, 60.0%, 30.1% and 88.6%, respectively at the cut-off point of 12, which was calculated as the average score in this study. At 14 points, which was classified within the group at high risk of falling by Poe et al. (2007), the sensitivity, specificity, and positive and negative predictive values were 62.0%, 69.5%, 33.6% and 86.0%, respectively (Table 3).

Figure 1 presents the ROC curves and the area under the curves (AUCs) to assess the overall validity of these scales. The value of the AUC for the MFS was .761, for BMFRAS .715, and for JHFRAT .708. Based on the pairwise comparison of ROC curves using MedCalc, there was significant difference between AUC of MFS and JHFRAT (Z = 2.029, p = .043) while the difference between AUC of MFS and BMFRAS was not significant (Z = 1.353, p = .176). Also, there was no significant difference

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<tr>
<td><strong>Mean Scores by Three Fall Risk Assessment Scales</strong></td>
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<table>
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<tr>
<th>Scales</th>
<th>Total Mean ± SD</th>
<th>Fall group Mean ± SD</th>
<th>Nonfall group Mean ± SD</th>
<th>t</th>
<th>p</th>
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<tr>
<td>Morse Fall Scale</td>
<td>49.7 ± 25.2</td>
<td>69.0 ± 24.1</td>
<td>45.0 ± 23.2</td>
<td>7.760</td>
<td>&lt;.001</td>
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<tr>
<td>BMFRAS</td>
<td>10.7 ± 4.8</td>
<td>13.5 ± 4.5</td>
<td>9.9 ± 4.6</td>
<td>5.760</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>JHFRAT</td>
<td>11.6 ± 6.4</td>
<td>15.3 ± 6.0</td>
<td>10.6 ± 6.2</td>
<td>5.769</td>
<td>&lt;.001</td>
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Note. BMFRAS = Bobath Memorial Hospital Fall Risk Assessment Scale; JHFRAT = Johns Hopkins Hospital Fall Risk Assessment Tool.

<table>
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<th>Table 3</th>
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<td><strong>Sensitivity, Specificity, PPV, and NPV by Scales at Each Cut-off Point</strong></td>
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<tr>
<th>Scales</th>
<th>Cut-off point</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
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<tbody>
<tr>
<td>Morse Fall Scale</td>
<td>51</td>
<td>73.2</td>
<td>61.1</td>
<td>31.9</td>
<td>90.2</td>
</tr>
<tr>
<td>BMFRAS</td>
<td>15</td>
<td>38.0</td>
<td>87.4</td>
<td>42.9</td>
<td>85.0</td>
</tr>
<tr>
<td>JHFRAT</td>
<td>14</td>
<td>62.0</td>
<td>69.5</td>
<td>33.6</td>
<td>86.0</td>
</tr>
</tbody>
</table>

Note. PPV = positive predictive value; NPV = negative predictive value; BMFRAS = Bobath Memorial Hospital Fall Risk Assessment Scale; JHFRAT = Johns Hopkins Hospital Fall Risk Assessment Tool.
between areas of JHFRAT and BMFRAS ($Z = 0.217$, $p = .828$).

**DISCUSSION**

Falling is one of the adverse events that occur most often in hospitals; it is very important to identify patients with a high risk of falling in order to prevent fall events. Various fall risk assessment scales have been developed to identify patients with a high risk of falling, and thus it is necessary to identify which is the most easily applicable and appropriate fall risk assessment scale with a high validity value for hospitalized Korean patients.

This study first selected three tools, MFS, BMFRAS and JHFRAT, which are all widely used in hospitals (Korea Hospital Nurses Association, 2005; Poe et al., 2005; Schwendimann, Geest, & Milisen, 2006). In order to suggest the fall risk assessment scale that best suited to hospitalized patients in Korea, four validity criteria were used, sensitivity, specificity, and positive and negative predictive values, which are widely used indices for diagnostic tests or accuracy and validity interpretation of assessment tools (Rao, 2004).

According to these results, among all patients, 71 (19.9%) experienced fall. This rate is significantly higher than 1.6% of elderly patients in Korean hospitals (C. G. Kim & Suh, 2002), and it is also much higher than 3.1% at an urban academic hospital in United States (Fischer, Krauss, Dunagon, & Birge, 2005). In this study, two wards with high fall risk rates per hospital were selected, and data for patients with fall events were collected first. Therefore, a higher fall rate compared to other existing research was shown in this study. For incidents which only happen at a relatively lower rate, such as falling, data collection on a long-term basis is necessary; and this was suggested as a limitation of many studies. Sung et al. (2006) collected fall events first and also collected additional data by focusing on patients who experienced fall events.

Regarding the condition of patients after falling, 43 patients (60.6%) did not have any injuries. However, there were 23 cases reported to have “slight damage” (32.4%), 2 cases requiring extension of hospitalization (2.8%), and 1 case that was transferred to the intensive care unit after fatal injury (1.4%). If fall event occurs, patients can suffer from the additional economic burden of medical costs, extension of hospitalization, and also legal consequences (Hendrich et al., 1995). Therefore, prevention of falls is of utmost importance.

Of the four validity criteria, the sensitivity is the ratio of people who are expected to fall according to the tool score of patients who had fall incidents, and specificity is the ratio of people who are expected not to fall according to the tool score of patients who did not have fall incidents. ROC analysis shows the relationship between sensitivity and specificity by graph according to the continuous change of cut-off (Rosenberg, Joseph, & Barkun 2000). The ideal ROC graph has low a false negative rate at high sensitivity, and the AUC is the possibility that can distinguish accurately the true positive and true negative depending on the tool. In other words, if the AUC is closer to 1, it means that it is a better assessment tool. If the AUC is above .7, we can conclude that the tool has decisive power. If the AUC is below .5, we can regard
the tool as not having decisive power (Rosenberg et al., 2000).

The AUCs of the three fall risk assessment scales were shown .761 for the MFS, .715 for BMFRAS, and .708 for JHFRAT in this study. The AUCs of all three were above .7, and thus showed appropriate decisive power to assess fall risk. The AUC of the MFS was the highest in this study, and higher than .701 reported by Schwendimann et al. (2006).

There is a trade-off between sensitivity and specificity; if we increase sensitivity, then specificity decreases accordingly. Therefore, it is proposed to select an appropriate cut-off according to clinical conditions. The assessment of fall risk is to apply preventive action to patients with a high fall risk and consequently to reduce the possibility of fall risk. It is more effective to apply the scale with a high sensitivity and positive predictive value, which means a low false positive rate.

In this study, the MFS showed the highest sensitivity. When the average score of 50 points was applied as the cut-off, its sensitivity was 78.9%. This was similar to the sensitivity of 80.9% with the cut-off of 50 points reported in the previous study (Schwendimann et al., 2006). In other studies, the sensitivity of MFS was 31% with the cut-off of 45 points (Chow et al., 2007) and 74.5% with the cut-off of 55 points (Schwendimann et al.). It was concluded that MFS with the cut-off of 50 points was able to determine the level of patient’s risk for falls. The BMFRAS showed the lowest sensitivity. When the 15 points that the tool developer suggested as the standard score of high risk groups was used as the cut-off, it showed a very low sensitivity of 38.0% and a positive predictive value of 42.9%. When the average score of 11 points as a cut-off drawn from this study was applied, its sensitivity increased to 76.1% and its positive predictive value decreased to 31.8%.

O’Connell and Myers (2001) used the MFS for preventive intervention, and had no intervention effects. In the study, when 45 points was used as a cut-off, they concluded that the MFS had a low ability to discriminate patients who had a high fall risk. They reported a specificity of 29%, positive predictive value of 18%, and AUC of .621, which were lower than in the present study. For the cut-off, which determines high fall risk with application of the fall risk assessment scale, it is recommended that the score with a high sensitivity and positive predictive value be chosen.

As a whole, considering the AUC and four validity criteria, the MFS showed the most satisfactory results. The MFS consists of six items in total, and BMFRAS and JHFRAT consist of eight items. Although MFS has fewer risk factors, has and thus more points allotted to each question, it is judged to have high validity in determining fall risk for adult hospitalized patients including elderly people.

E. K. Kim et al. (2008) suggested history of falling in a year, orientation ability, dizziness or vertigo, general weakness, urination problems, transfer/mobility difficulty, walking dependency, inpatient status, benzodiazepines, diuretics, and vasodilators during one year to be fall risk factors of hospitalized patients. However, no scales have yet been developed using these items. Four of the items are similar to those in the Morse Fall Scale: history of falling, ambulatory aid, gait and mental status. Based on these results, it is necessary to develop an appropriate fall risk assessment scale, and further investigate reliability and validity of the scale in order to assess fall risk scientifically and effectively in Korea.

Because this study was conducted in medical and surgical nursing units at the five acute care hospitals, it may decrease generalizability of the sample population and the study findings. Therefore, it may not appropriate to use the findings of this study for other settings such as ICUs, pediatric units, and geriatric units which have different environments and categories of patient population.

Incidence of falls is not easy to be predicted in adult patients. Although the risk factors of falls are assessed on a daily basis and continuous close observation and care are provided to the patients with high risk, there are always the chances of falls because of the complex and complicated medical environments. Thus it is very difficult to develop the best fall risk assessment scale with high predictive power and sensitivity.

Most of current available fall risk assessment scales were developed for the elderly population and home
or community environments. In addition, there have not been so many studies comparing and applying these fall risk assessment scales to hospitalized patients (Myers, 2003). Considering that this study was conducted with a purpose of identifying the validity of domestic and international fall risk assessment scales for adult hospitalized patients in Korea. Although there are some limitations to generalizing the results of this study to children and elderly people and different settings, this study can be regarded as meaningful research.

CONCLUSIONS

In order to suggest the most useful fall risk assessment scale with high validity, this study selected three fall risk assessment scales, the Morse Fall Scale, BMFRAS, and JHFRAT, which are the most commonly used in the hospitals in South Korea and the United States. Furthermore, four validity criteria, sensitivity, specificity, and positive and negative predictive value of the scales were analyzed using data on 356 hospitalized patients in acute care hospitals. The results of data analysis showed that the MFS is the most appropriate scale for assessing the fall risk of adult hospitalized patients in Korea. Based on the research results, the investigators propose the following: (a) Using the MFS suggested in this research, additional validity studies applied to various medical environments and patients are needed in Korea. (b) It is necessary to develop revised scales which reflect the diverse medical environments and fall risk factors in Korea, and these scales need to be evaluated for validity and reliability. (c) It is necessary to analyze the validity and reliability of these scales, which consider fall risk characteristics depending on age for groups such as children and elderly patients.

ACKNOWLEDGMENTS

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REFERENCES


Validity of Three Fall Risk Assessment Scales


