A pragmatic study of the predictive values of the Morse falls score

FRANCES HEALEY, TERRY P. HAINES

1NHS England, London, UK
2School of Physiotherapy, Monash University, Melbourne, Victoria, Australia

Address correspondence to: F. Healey. Tel: +44 300 311 22 33. Email: frances.healey@nhs.net

Abstract

Background: inpatient falls are an important safety challenge, with around half causing physical injuries that compromise the recovery of older, frailer patients. Falls risk scores are in widespread use, but validation studies of their predictive values are few.

Objectives: to assess the predictive values of the Morse falls score (MFS) in an acute general hospital.

Methods: age, admitting speciality, MFS, and any falls in the subsequent 7 days were collected in April 2011 through case note review and incident reporting systems.

Results: a total of 467 inpatients were included in the study; 51% were aged 75+ years; 56% had an MFS ≥25; 23% had an MFS ≥55; 28 fell. An MFS ≥25 was not significantly better than chance in the total sample or in any subgroups considered (YI: −0.01 to 0.15). An MFS ≥55 was significantly better than chance for the total sample (YI: 0.39), patients ≥75 years (YI: 0.31) and geriatrician-led wards (YI 0.37), although either sensitivity or specificity fell below 70% in each of these groups. Other subgroups did not demonstrate significantly better accuracy than chance, but may have been affected by type II error.

Conclusions: using MFS ≥25 cannot be clinically justified, while using MFS ≥55 would be contingent on an effective intervention that was ethically acceptable to withhold from the patients with an MFS < 55, despite >40% of falls occurring in that group. Given similar limitations of alternative falls risk scores, hospitals should consider directly assessing and acting on individual patients’ specific modifiable risk factors for falls.

Keywords: falls prevention, risk score, accidental injury, older people

Introduction

Falls predominantly affect and harm older, frailer people who currently account for the highest proportion of patients in general hospitals [1]. Reported rates of falls across the whole hospital population typically range from three to five falls per 1,000 bed days [2], representing >250,000 falls each year in English hospitals [3] and over 1 million falls in hospitals in the USA [2]. Falls can have serious consequences; 30–51% of falls in hospitals result in some injury, with fractures occurring in 1–3% [2]. People who are hospital inpatients when they fall and fracture have poor outcomes [4] and, if they survive, greatly extended lengths of stay [5]. Even falls with minor or no injury can cause anxiety and distress to patients, their families and hospital staff, creating a downward spiral where fear of falling leads to reduced mobility and increased dependency. Falls can also lead to litigation [6]. For all these reasons, prevention of falls is an important patient safety challenge for hospitals internationally.

Resources available to prevent falls (both staff time and equipment) are limited, and as most patients do not fall during their hospital stay, there has been understandable interest in scores that aim to identify patients who are likely to fall. Their predictive qualities can be validated through studies in which the falls risk score and any subsequent falls are recorded in order to calculate sensitivity, specificity and other predictive values (Table 2). Although many types of falls risk scores are in clinical use [7], few have been subjected to any validation, and very few to multiple
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The Morse falls score (MFS) [22] was originally developed across acute wards, rehabilitation wards and nursing homes in Canada. Six variables (history of falling, secondary diagnosis, ambulatory aid, intravenous infusion, gait/transferring and mental status) were assigned scores ranging from zero to 25 points. While the original authors suggest that the threshold should be varied locally, it has been commonly adopted in formats where 0–20 indicates no or low risk, ≥25 indicates at least medium risk and ≥45, 50 or 55 indicates high risk [23].

Six prospective validation studies of the MFS [24–29] have been published (Table 1), in differing patient populations, with average patient age ranging from 55 to 84 years, fallers ranging from around one in a hundred to one in three patients, and settings ranging from cardiology to rehabilitation. Only one study [29] encompassed a whole acute hospital population, and this found good sensitivity (88.3%) but weak specificity (48.3%) for an MFS ≥25 and good specificity (91.2%) but weak sensitivity (55%) for an MFS ≥50. Oliver et al. [8] note that high sensitivity can be achieved at the cost of low specificity or vice versa, and suggest that to be clinically useful a falls risk prediction score should combine at least 70% sensitivity and 70% specificity; none of the MFS validation studies reached these values.

Haines et al. [10] in a systematic review and meta-analysis of three prospective evaluations [24–26] with sufficient data (total n = 1,543 patients), calculated a Youden Index (YI) of 0.20 (95%CI = 0.14–0.26) for the MFS. Whilst this is only moderately greater than might be expected by chance, the MFS remains one of the most widely used scores [23], perhaps because it is one of only two falls risk scores which have been subjected to external validations in >1,000 hospital patients [8–12, 30].

Haines et al. [10] also noted that the heterogeneity of settings was reflected in heterogeneity of results, indicating the predictive values of any falls risk score will vary with the population in which it is used. Given the nature of the inpatient population has changed substantially since the MFS was developed in the 1980s, when most patients were aged under 65 years and a minority of patients had a secondary diagnosis, gait or mobility problems, or cognitive deficits [22], this study aimed to calculate its predictive values in a current hospital population.

In any assessment of tool’s predictive values, a potential confounder is that interventions may have been applied on the basis of the score, and that, therefore, low predictive values actually indicate successful falls prevention. This study took advantage of a situation where this was unlikely; an acute general hospital had introduced the MFS and intentional rounding [31] 9 months prior to this study, but had seen no subsequent reduction in falls or injurious falls, indicating that this intervention had no effect on falls.1 The hospital had ~650 beds and provided a comprehensive range of acute secondary care to a mixed urban and rural catchment population in the North of England, with ~65,000 inpatient admissions annually and an average length of stay of 3.4 days.

Methods

The study was assessed as service evaluation not requiring formal ethics committee approval.

Current inpatient records were surveyed by the hospital’s audit team in April 2011 to extract the most recently completed MFS, patient age, ward speciality, and any falls recorded in the case notes or reported as incidents in the subsequent 7 days, and entered into spreadsheets for analysis. Patients in critical care areas and obstetric and paediatric units were excluded.

The predictive accuracy of the MFS was examined using sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) statistics (Table 2). Total predictive value (TPV) was examined using the YI. Confidence intervals (95%) for the YI were calculated using a bootstrap resampling approach involving 2,000 bootstrap replications of the data set [32]. Analyses using MFS ≥25 and ≥55 were pre-planned, as were subgroup analyses for patients aged < or ≥75 years and patients within or outside geriatrician-led wards.

Results

Of the 467 patients surveyed, 51% were ≥75 years, and 35% were on geriatrician-led wards, indicating patients with complex multipathology (Table 3). A total of 116 patients were excluded from analysis due to no recent and complete MFS.

An MFS ≥25 was not significantly better than random chance in any of the subgroups considered, or for the

1The MFS was introduced after education provided to ward managers who cascaded this to registered nurses, who were asked to complete the MFS on admission and recalculate it at least weekly, and provide intentional rounding to all patients with an MFS ≥25. In the 9 months before (October 2009 to June 2010) 1943 falls were reported (63% injurious) and in the 9 months after (July 2010 to March 2011) 1926 falls were reported (61% injurious).
Table 1. Published prospective validations of the Morse falls score\(^a\)

<table>
<thead>
<tr>
<th>Study</th>
<th>Population type</th>
<th>Number of patients included</th>
<th>Number of fallers</th>
<th>Mean age</th>
<th>Cut-off point</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>TPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. McCollam</td>
<td>Medical cardiology ward (\times 1) in USA</td>
<td>458</td>
<td>23</td>
<td>—</td>
<td>69 years</td>
<td>95.7</td>
<td>54.0</td>
<td>9.9</td>
<td>99.6</td>
<td>0.50</td>
</tr>
<tr>
<td>B. Eagle et al.</td>
<td>Rehabilitation ward (\times 1) and acute geriatric ward (\times 1) in Canada</td>
<td>98</td>
<td>29</td>
<td>—</td>
<td>69 years</td>
<td>72</td>
<td>51</td>
<td>9.9</td>
<td>99.6</td>
<td>0.50</td>
</tr>
<tr>
<td>C. O’Connell and Myers</td>
<td>Aged care wards (\times 2) in Australia</td>
<td>1,059</td>
<td>166</td>
<td>84 years</td>
<td>70 years</td>
<td>45.7</td>
<td>13.9</td>
<td>12.8</td>
<td>94.9</td>
<td>0.621</td>
</tr>
<tr>
<td>D. Schwendimann et al.</td>
<td>Medical wards (\times 2) in Switzerland</td>
<td>386</td>
<td>47</td>
<td>70 years</td>
<td>25</td>
<td>91.5</td>
<td>65.8</td>
<td>23.2</td>
<td>99.7</td>
<td>0.527</td>
</tr>
<tr>
<td>E. Schwendimann et al.</td>
<td>Medical wards (\times 2) in Switzerland</td>
<td>386</td>
<td>47</td>
<td>70 years</td>
<td>55</td>
<td>74.5</td>
<td>—</td>
<td>—</td>
<td>1.9</td>
<td>0.701</td>
</tr>
<tr>
<td>F. Haines et al.</td>
<td>Meta-analysis of [24–26]</td>
<td>1,543</td>
<td>242</td>
<td>—</td>
<td>70 years</td>
<td>93</td>
<td>83</td>
<td>1.9</td>
<td>99.7</td>
<td>0.20</td>
</tr>
<tr>
<td>G. Chow et al.</td>
<td>Rehabilitation wards in China (\times 3)</td>
<td>954</td>
<td>N/K</td>
<td>70 years</td>
<td>45</td>
<td>83</td>
<td>48.3</td>
<td>6.4</td>
<td>99.5</td>
<td>—</td>
</tr>
<tr>
<td>H. Kim et al.</td>
<td>Acute hospital in Singapore including medical, oncology, gynaecology, surgery and orthopaedics</td>
<td>5,489</td>
<td>—</td>
<td>55 years</td>
<td>25</td>
<td>88.3</td>
<td>91.2</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>I. Kim et al.</td>
<td>Acute hospital in Singapore including medical, oncology, gynaecology, surgery and orthopaedics</td>
<td>5,489</td>
<td>—</td>
<td>55 years</td>
<td>50</td>
<td>55</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

\(^a\)Utilising additional calculations from systematic reviews [8–11] where not provide by original authors. Note that Morse et al. [22] is not included in this table, as although both two retrospective and one prospective validation study of the MFS are described in the paper, the retrospective study is based on a fixed sample of fallers and non-fallers, rather than the normal distribution of fallers and non-fallers within the population, while the prospective study does not provide sufficient data to calculate predictive values; 107 of 2,689 patients were fallers overall, but the number of fallers (as opposed to number of falls) in the high-risk group is not described.
Table 2. The validity of falls risk scores

If a sample of patients is assessed using a falls risk score, and then observed to see if they subsequently fall, a matrix can be generated:

<table>
<thead>
<tr>
<th>Predicted to fall</th>
<th>Actually fell</th>
<th>Did not fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted to fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not predicted to fall</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Using this matrix, the following predictive qualities can be calculated:

- Sensitivity (true positive) = A / (A + C) (proportion of patients who fell who had been predicted to fall)
- Specificity (true negative) = D / (B + D) (proportion of patients who did not fall who had been predicted not to fall)
- Positive predictive value (PPV) = A / (A + B) (proportion of patients predicted to fall who fell)
- Negative predictive value (NPV) = D / (C + D) (proportion of patients predicted not to fall who did not fall)

The combined predictive qualities of a falls risk score can be expressed as a summary statistic of total predictive value (TPV). The Youden Index (YI) and area under the curve (AUC) of receiver operating characteristic curves [42] can be used to give statistical and graphical representation of the TPV of falls risk scores. For the YI and AUC, perfect TPV is represented by a score of 1.0 and no greater TPV than might be expected by chance is represented by a score of zero.

Table 3. Summarised results

<table>
<thead>
<tr>
<th>Subgroups by age</th>
<th>Subgroups by specialty</th>
<th>All patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients aged ≤75 years</td>
<td>Patients aged 75 years or over</td>
<td>Patients not on geriatrician-led wards</td>
</tr>
<tr>
<td>Number of patients surveyed (%)</td>
<td>227 (49)</td>
<td>240 (51)</td>
</tr>
<tr>
<td>Number of patients with a fall in subsequent 7 days</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Mean age (years)</td>
<td>57.0</td>
<td>84.8</td>
</tr>
<tr>
<td>Cut-off point 55 or above</td>
<td>17 (10)</td>
<td>64 (34)</td>
</tr>
<tr>
<td>Number of patients scoring 55–125 or more (%)</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>50.0</td>
<td>60.0</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>90.5</td>
<td>70.5</td>
</tr>
<tr>
<td>PPV (%)</td>
<td>11.8</td>
<td>23.4</td>
</tr>
<tr>
<td>NPV (%)</td>
<td>98.6</td>
<td>92.1</td>
</tr>
<tr>
<td>Youden index (95% CIs)</td>
<td>0.41 (−0.14, 0.95)</td>
<td>0.31 (0.10, 0.51)</td>
</tr>
<tr>
<td>P-values</td>
<td>0.146</td>
<td>0.004</td>
</tr>
<tr>
<td>Cut-off point 25 or above</td>
<td>61 (38)</td>
<td>135 (71)</td>
</tr>
<tr>
<td>Number of patients scoring 25–125 or more (%)</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Sensitivity (%)</td>
<td>50.0</td>
<td>72.0</td>
</tr>
<tr>
<td>Specificity (%)</td>
<td>62.7</td>
<td>29.3</td>
</tr>
<tr>
<td>PPV (%)</td>
<td>3.3</td>
<td>13.3</td>
</tr>
<tr>
<td>NPV (%)</td>
<td>98.0</td>
<td>87.4</td>
</tr>
<tr>
<td>TPV (Youden) + 95% CIs</td>
<td>0.13 (−0.42, 0.67)</td>
<td>0.01 (−0.18, 0.21)</td>
</tr>
<tr>
<td>P-values</td>
<td>0.651</td>
<td>0.806</td>
</tr>
<tr>
<td>Low risk and excluded patients</td>
<td>101 (62)</td>
<td>54 (29)</td>
</tr>
<tr>
<td>Number of patients scoring 0–20 or more (%)</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Number of patients scoring 0–20 and with a fall in subsequent 7 days</td>
<td>65</td>
<td>51</td>
</tr>
<tr>
<td>Number of excluded patients (no completed and correctly totalled score within past 7 days)</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

*The P-value represents the probability that the accuracy of the instrument is better than random chance based upon bootstrap resampling of the trial data.*
overall sample; the point estimates for the YI ranged from 
-0.01 to 0.15 and P-values from 0.115 to 0.896.

An MFS ≥55 was significantly better than random chance at predicting patients who would fall in the 
following 7 days for patients aged ≥75 years (YI point estimate 0.31, P < 0.004), patients on geriatrician-led wards (YI 
point estimate 0.37, P < 0.001) and for the total sample (YI 
point estimate 0.39, P < 0.000), although either sensitivity 
or specificity fell below 70% in each of these groups.

Subgroups of those aged <75 years or on wards without 
routine geriatrician input did not demonstrate significantly 
better accuracy than random chance, but the number of 
falls in these subgroups was low, indicating potential for a 
type II statistical error.

Discussion and implications for clinical practice

Despite the widespread adoption of the MFS internationally 
for more than 20 years, this study was only the second to 
assess its predictive values in a whole hospital population, 
and the first carried out in a hospital typical of developed 
nations with ageing populations.

The study relied on the MFS as calculated by ward 
nurses. This may result in lower accuracy than in trials 
where research nurses calculated the MFS but is likely to 
make the results more generalizable to clinical practice. 
Previous studies have expected the MFS on admission to 
predict falls at any point in the subsequent hospital stay. 
This is problematic for statistical analysis (since patients 
with shorter stays are less exposed to the opportunity of 
falling) and problematic clinically, since the patient's MFS 
could be expected to vary considerably during an acute ad-
mission episode. Because of these considerations, and 
because local policy in the study hospital required updating 
of the MFS on at least a weekly basis, the study used a 
window of 7 days post-score in which the predictive values 
of the MFS were assessed. Daily recalculation of the MFS 
may have produced better predictive values, but the addi-
tional amount of staff time would need to be justified 
by the potential for such frequent scoring to support the 
more effective targeting of interventions.

The study asserted falls through reported incidents 
and scrutiny of case notes. A combination of these two 
resources can be expected to identify 93% of all falls, [34] 
which is an acceptable level of completeness, although less 
than the ‘gold standard’ of research trial ascertainment 
through case note review, incident reports and regular ques-
tioning of staff and patients.

The study was affected by missing data, with 116 
patients whose score had not been completed or updated 
within the past 7 days, or had been incorrectly totalled. 
This rate is likely to have been similar to those in research 
studies, where an MFS was collected only on the weekday 
subsequent to admission [29], given the turnover of 
patients in acute hospitals. It is impossible to assess if in-
cluding these patients would have changed the predictive 
values of the score, but given only one fall occurred in the 
excluded group, it appears unlikely they were typical 
patients, and may reflect nursing judgement that the patient 
was not at risk of falls and therefore completing the MFS 
was unnecessary; nursing judgement has been found to 
have similar predictive values to risk scores in the previous 
meta-analysis [10].

Despite these limitations, the results indicate that an 
MFS ≥25, commonly used in clinical practice to target falls 
prevention interventions, has predictive values no greater 
than would be expected by chance, whether applied to the 
whole hospital population or in subgroups of patients aged 
over or <75 years, or within or outside geriatrician-led 
wards. Any use of the MFS should therefore be restricted 
to ≥55 as this appeared to generate more statistically satis-
factory results for the sample of all patients. However, 
using an MFS ≥55 designated 23% of patients as high risk, 
and sensitivity was less than satisfactory, with only 58.6% 
of fallers identified, while 41.4% of fallers were not. An 
MFS ≥ 55 generated a PPV of 21.0%, indicating that one 
in five people classified as high-risk fell during the follow-
ning week, while four out of five did not. The subgroup ana-
lyses suggested that an MFS ≥55 remained statistically 
significant in patient populations most vulnerable to falling 
—those aged ≥75 years or on geriatrician-led wards—but 
again with either sensitivity or specificity <70%. In the sub-
groups of patients aged <75 years or not on geriatrician-led 
wards, there was no evidence that an MFS ≥55 was any 
better at predicting falls than would be expected by chance, 
although the small number of falls make a type II error 
likely.

The fundamental purpose of a falls risk score is to 
promote an efficient use of limited resources in a clinical 
environment. Thus even though an MFS ≥55 was significantly 
better than random chance at predicting fallers, the econom-
ic efficiency and clinical utility of applying this threshold also 
needs to be considered. The use of falls scores could be jus-
tified where they enhance the economic efficiency of deliver-
ing a specific falls prevention intervention (of proven 
efficacy) or where it is necessary for pragmatic reasons to 
target a limited falls prevention resource to the patients who 
need it most. Given the predictive values discussed above, 
the economic benefit of using the MFS ≥55 would depend 
on a scenario where there was an intervention that could be 
delivered to 23% patients, but where it was both economi-
cally necessary and ethically acceptable to withhold that inter-
vention from the remaining patients, despite this group 
containing over 40% of fallers. Detecting the minority of 
potential fallers in younger patients is a clinical challenge, 
and therefore the lack of evidence that the MFS predicts fallers 
any more accurately than chance in the subgroups of patients 
aged <75 years or outside geriatrician-led wards makes using 
an MFS ≥55 across a whole hospital population problematic.

These disappointing results are not confined to the 
MFS, with other scores having similar or weaker predictive 
values [10]. This study therefore adds to the increasing 
body of evidence that no falls risk scores have clinically
acceptable predictive values across all wards of an acute hospital [8–12].

So is further research to develop falls risk scores with better predictive values required? The assumption that some form of risk score is an essential component of hospital falls prevention has been challenged by many commentators [2, 7, 35, 36], who suggest a research focus on predictive tools may have been an unnecessary distraction from the issue of preventing falls, as the number of studies aimed at predicting hospital fallers so that ‘something can be done’ [8–12] vastly exceeds the number of studies that explore what that ‘something’ might be [37]. It can be argued that older inpatients are so vulnerable to falling no first stage screening through a risk score is required [38], and that some successful falls prevention programmes in hospital settings have been delivered without the use of any risk score [2, 37, 39]. Despite the relatively limited evidence base for falls prevention in hospitals [37], multifactorial assessment and intervention by nursing, medical and therapy staff on the individual risk factors which are common in the inpatient population [40, 41] and have potential for modification or for better management, including medication that increases falls risk, impaired gait, balance and mobility, delirium, dementia, incontinence, orthostatic hypotension and other cardiovascular causes of falls (an approach sometimes expressed as ‘don’t count risk factors – do something about them’ [35]) appears a more fruitful approach to protecting patients vulnerable to falling in hospital than risk scoring.

**Key points**

- Using an MFS with a threshold of ≥25 is unlikely to identify patients at risk of falling any better than random chance and so cannot be clinically justified.
- Using an MFS with a threshold of ≥55 is statistically satisfactory but may not be clinically useful given low sensitivity and lack of statistical significance in patients aged <75 years and outside geriatrician-led wards.
- Hospitals should review their current practice, and consider directly assessing for and acting on specific individual risk factors for falls which can be modified or better managed.

**Acknowledgements**

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**Conflicts of interest**

None declared.

**Supplementary data**

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

**References**

The very long list of references supporting this review has meant that only the most important are listed here and are represented by bold type throughout the text. The full list of references is available in Supplementary data in *Age and Ageing* online.

Predictors of mortality in men and women aged 90 and older: a nine-year follow-up study in the Vitality 90+ study

K. Tiainen1*, Tiina Luukkaala1,2, Antti Hervonen1, Marja Jylhä1

1Gerontology Research Center and School of Health Sciences, University of Tampere, Finland
2Science Center, Pirkanmaa Hospital District, Tampere, Finland

*Address correspondence to: K. Tiainen. Tel: (+35) 840 190 1648; Fax: (+35) 833 551 6057; Email: kristina.tiainen@uta.fi

Abstract

Background: Information about the predictors of mortality among the oldest-old is limited. Also possible gender differences are poorly known.

Objective: To examine the predictors of mortality among individuals aged 90 and older, focusing on differences between men and women. We also analysed gender differences in survival at different levels of mobility and activities in daily living (ADL).

Design: this 9-year follow-up study is part of the Vitality 90+ study, a population-based study of people aged 90 and older.

Subjects: all inhabitants aged 90 and older in the area of Tampere, Finland were contacted, irrespective of health or