NCPD 2.5 contact hrs Nursing Continuing Professional Development

Predicting Falls in Rehabilitation: A Comparison of Three Instruments Including Hester Davis

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Abstract

Purpose: The aim of this study was to evaluate the ability of the Hester Davis Scale (HDS), Section GG, and facility fall risk assessment scores to predict patients who fall during inpatient rehabilitation.

Design: This study was an observational quality improvement project.

Methods: Nurses administered the HDS in parallel to the facility's current fall risk assessment and Section GG of the Centers for Medicare & Medicaid Services Inpatient Rehabilitation Facility Patient Assessment Instrument. Receiver operating characteristic curves were compared in 1,645 patients. Relationships of individual scale items to falls were also assessed.

Results: The HDS (area under the curve [AUC] = .680, 95% CI [.626, .734]), facility fall risk assessment (AUC = .688, 95% CI [.637, .740]), and Section GG scores (AUC = .687, 95% CI [.638, .735]) adequately identified patients who fell. AUCs did not significantly differ between assessments. HDS scores of ≥13, facility scores of ≥14, and Section GG scores of ≤51 resulted in the highest sensitivity/specificity balance.

Conclusions: HDS, facility fall risk assessment, and Section GG scores adequately and similarly identified patients of mixed diagnoses at risk of falling in inpatient rehabilitation.

Clinical Relevance to the Practice of Rehabilitation Nursing: Rehabilitation nurses have several options including the HDS and Section GG to identify patients at greatest risk of falling.

Keywords: Accidental falls; hospitals, rehabilitation; rehabilitation nursing; risk assessment.

Introduction

Falls, particularly those occurring later in life, can have devastating physical and emotional consequences, including brain injury, fractures, and increased fear of moving about at home or in the community (Centers for Disease Control and Prevention, 2021). There have been increased efforts in recent years to reduce falls in hospital settings through improvements in patient education (Heng et al., 2020), the use of movement sensors with alarms (Cortes et al., 2021), video monitoring, and in-person sitters (Quigley et al., 2010). Fall risk assessment tools (Strini et al., 2021) are also used to identify patients at higher risk of falling, allocate resources, and increase staff awareness surrounding patients who are most at risk.

Patients admitted to inpatient rehabilitation facilities (IRFs) have many characteristics that put them at high risk for falling, including cognitive and physical impairments that reduce independence with activities of daily living. There is currently no consensus on the most appropriate fall risk assessment scale for IRFs. Risk assessments developed in acute settings are often too sensitive (Campanini et al., 2018; Rivers et al., 2021) or have limited predictive value when implemented in rehabilitation settings (Fusco-Gessick & Cournan, 2019; Lohse et al., 2021; Salamon et al., 2012; Thomas et al., 2016), potentially because of a greater level of debility among admissions. Ideally, fall risk assessments would be generalizable to a variety of diagnoses and across the continuum of care; however, differences in the types of patients, diagnoses, and degree of disability have made the development of a single instrument challenging.

Several fall risk assessments have been validated in rehabilitation settings, including the Casa Colina Fall Risk Assessment Scale (Kaplan et al., 2020), the Heindrick Fall Risk Model II (Campanini et al., 2018), and the Stroke Assessment of Falls Risk (Breisinger et al., 2014), but

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limitations exist. The Stroke Assessment of Falls Risk was designed for patients with stroke (Breisinger et al., 2014), limiting its generalizability for facilities with diverse diagnoses. The Casa Colina Fall Risk Assessment Scale is based on the Functional Independence Measure (FIM) instrument (Kaplan et al., 2020), which is no longer required by the Centers for Medicare & Medicaid Services (CMS) for rehabilitation facilities in the United States (CMS, 2019b). In addition, the Casa Colina Fall Risk Assessment Scale requires validation in acute care facilities for implementation across settings. The Heindrick Fall Risk Model II shows promise when using higher cutoff values than what is recommended for acute care settings (Campanini et al., 2018) but also requires additional validation.

Although not specifically designed as a fall risk assessment tool, lower scores on the FIM instrument are associated with higher fall risk in rehabilitation settings (Forrest et al., 2013; Fusco-Gessick & Cournan, 2019; Rivers et al., 2021). However, time required to complete the FIM is a practical limitation to identifying patients at higher risk of falling, particularly early in the rehabilitation stay. In addition, the FIM instrument was replaced by Section GG on the CMS Inpatient Rehabilitation Facility Patient Assessment Instrument (IRF-PAI; CMS, 2019b) and is no longer required or used by many facilities.

Given these challenges, our facility implemented a fall risk assessment tool, developed through a retrospective analysis of facility data and interviews with nurses. The facility fall risk assessment tool has served as the primary instrument for predicting patient falls in our facility since 2016, with reasonable accuracy (unpublished data).

In 2021, Epic was adopted as the electronic medical records system for our organization. The Hester Davis Scale (HDS) is included within the Epic system as a fall risk assessment tool. The HDS, originally developed in an acute neuroscience unit, is a reliable and accurate predictor of falls among patients with neurological diagnoses (Hester & Davis, 2013). Research suggests that the HDS may be less reliable in other settings including a large urban hospital (Kaiser et al., 2021) and an epilepsy monitoring unit (Johnson et al., 2023), possibly because of differences in patient characteristics or hospital practices. Little other validation data exist, including the use of the HDS for rehabilitation facilities.

The healthcare organization governing our facility requires hospitals to use the HDS, and implementation was planned with the integration of Epic at our site. As the HDS has not been validated for rehabilitation hospitals, we sought to evaluate the ability of admission scores on the HDS to predict patients at risk of falling prior to replacing our local instrument. In this quality improvement project, nurses concurrently administered the HDS alongside the facility's existing fall risk assessment tool. The ability of admission scores on the HDS to correctly identify patients who fell was evaluated and compared to the facility fall risk instrument. The relationship of individual scale items with patients who fell was also examined.

The relationship of Section GG scores with fall risk has not been established. If Section GG scores are associated with fall risk and can be completed early enough in the rehabilitation stay, it may also be considered as a tool to predict patients at risk of falling, without the additional documentation burden of a specific fall risk assessment scale.

Methods

Procedure

Nurses were instructed to complete the HDS and facility risk assessment within 4 hours of admission to the rehabilitation facility, weekly, and after every fall. Nurses used scores on both fall predictor tools, as well as their best clinical judgment to intervene with video monitoring, bed alarms, chair alarms, and other fall prevention precautions when patients were identified as high risk of falling. Section GG of the CMS IRF-PAI was completed by both nurses and therapists within the first 3 days of admission, as part of routine practice.

Participants

A total of 1,808 patients admitted to a single acute IRF between June 26, 2021, and June 30, 2022, were screened for eligibility. Patients were included in our analysis if they were ≥18 years of age. Four patients less than 18 years of age were excluded, as well as 159 patients with missing or incomplete HDS or facility fall risk assessments, or if the fall risk assessment occurred more than 3 days after admission. Patients admitted multiple times were included more than once if the above criteria were met. A total of 1,645 patient stays were included.

Falls

Falls were identified using the definition of falls provided in Section J of the CMS IRF PAI manual Version 4.0 (CMS, 2022).

Hester Davis Scale

The HDS is a nine-item scale, with scores ranging from 0 to 77 (Hester & Davis, 2013). Scale items include (1) age, (2) history of falls, (3) mobility, (4) medications, (5) mental status, (6) toileting needs, (7) volume/electrolyte status, (8) communication/sensory issues, and (9) behavioral issues. According to authors, scores of 10 or less indicate low fall risk, scores between 11 and 14 indicate moderate fall risk,

and scores greater than 15 indicate high fall risk (Hester & Davis, 2013). The HDS has high interrater reliability ($\kappa = .90$) and internal consistency (Cronbach's alpha = .772; Hester & Davis, 2013).

Facility Fall Risk Assessment Tool

The facility fall risk assessment tool is a nine-item scale, with scores ranging from 7 to 22. Patients with complete quadriplegia are assigned a score of 1, indicating low risk, and additional items are not administered. The additional eight items (and number of points assigned to each item) included in the facility scale are (2) gender (2 = male, 1 = female), (3) diagnosis (4 = neurological, 1 = other), (4) history of falls (3 = yes, 1 = no), (5) awareness of limitations (2 = not aware, forgets limitations; 1 = aware), (6) toileting (3 = requires minimum assist or greater, 1 = independent or requires contact guard), (7) ability to follow instructions (3 = unable, 1 = able), (8) spatial neglect (3 = yes, 1 = no), and (9) hospital unit (2 = cardiac/pulmonary unit, 0 = stroke or brain injury unit).

Section GG

The CMS IRF-PAI Section GG (CMS, 2019a, 2019c) is an assessment of functional independence with seven self-care (Section GG130) and 15 mobility items (Section GG170). Section GG items assess independence with self-care (eating, oral hygiene, toileting hygiene, showering/bathing, upper body dressing, lower body dressing, putting on/taking off footwear) and mobility (sit to lying, lying to sitting on side of bed, sit to stand, chair/bed-to-chair transfers, toilet transfers, car transfers, walking 10 ft, walking 50 ft with two turns, walking 150 ft, 1 step (curb), 4 steps, 12 steps, picking up an object, walking on uneven surfaces). Each item is ranked on a scale of 1–6, with higher numbers indicating greater independence when performing the activity. Reason codes indicating that the activity was not attempted were converted to 1. The total GG score is the sum of all 22 functional assessments, with total scores ranging from 22 to 132. The Section GG Self-Care score is the sum of Section GG130 items, and ranges from 7 to 42. The Section GG Mobility score is the sum of Section GG170 items and ranges from 15 to 90. Good internal consistency (Cronbach's alpha = .95) and interrater reliability of items ($\kappa = .598$–$.762$) have been reported (RTI International, 2018).

Data Analysis

All data were analyzed using SPSS (Version 26; IBM Corporation, 2019). Medians and interquartile ranges were reported for age and Section GG scores. Age and Section GG scores were compared between patients who did and did not fall using Mann–Whitney *U* tests because of the nonparametric distribution of data. Gender and rehabilitation impairment category group were compared using chi-square tests. Correlations between scales were evaluated using Spearman's analysis. The number of falls occurring in 1,000 patient days, the total number of falls occurring during the study period, and the number of patients who fell during the study period were calculated.

Receiver operating characteristic (ROC) curves were generated to evaluate the ability of scores on the HDS, the facility instrument, and Section GG to identify patients who fell. Patients experiencing one or more falls during a single admission were included in this classification. The fall assessment scores obtained on admission were used to generate ROC curves; fall risk assessment scores obtained later in the admission or after a fall were not used in the ROC analysis. Patients with complete quadriplegia were excluded from the ROC analysis of the facility fall risk assessment tool, as these patients are classified as low risk, and additional scale items are not scored. Because higher scores on fall assessment tools and lower scores on Section GG are associated with greater fall risk, the inverse of Section GG scores was taken to compare metrics on the same ROC curve.

Sensitivity was calculated as the proportion of correctly predicted patients who fell (true positives) out of all patients who fell (both true positives and false negatives). Specificity was calculated as the proportion of correctly predicted patients who did not fall out of all patients who did not fall. The Youden's index was calculated to determine the cutoff values with the greatest sensitivity and specificity balance. The Youden's index ranges from 0 to 1 and is equal to Sensitivity + Specificity – 1. A higher Youden's index is considered optimal.

Univariate binomial logistic regression was used to determine the relationship between scores on fall risk assessment items with patients who fell. Multivariable logistic regression was performed to determine the scale items independently associated with patients who fell. In this analysis, all scale items were entered into the model, and nonsignificant items were eliminated through backward subtraction.

Target sample size was estimated at 1,642 using methods described by Hajian-Tilaki (2014). This calculation assumed a fall prevalence of 5% and an alpha of .05. A data collection period of 1 year was estimated for 80% power, required based on historic enrollments. A Bonferroni correction was applied to account for multiple comparisons; the threshold for statistical significance was set to $p < .002$.

Ethical Considerations

This project was reviewed by the St. Peter's Health Partners Institutional Review Board and approved as a quality

Table 1 Patient Demographics

Demographics	Total	Nonfallers	Fallers	*p*
Patients, *n* (%)	1,645	1,545 (93.9)	100 (6.1)	
Age, median (IQR)	71 (60–80)	71 (60–80)	64 (52–77)	<.001
Gender (female), *n* (%)	799 (48.6)	753 (48.8)	46 (46.0)	.607
Gender (male), *n* (%)	844 (51.3)	790 (51.2)	54 (54.0)	
RIC group				
Stroke	488 (29.7)	446 (28.9)	42 (42.0)	<.001
Brain injury	178 (10.8)	153 (9.9)	25 (25.0)	
Spinal cord injury	74 (4.5)	69 (4.5)	5 (5.0)	
Orthopedic	429 (26.1)	416 (26.9)	13 (13.0)	
Neurological	77 (4.7)	74 (4.8)	3 (3.0)	
General	399 (24.3)	387 (25.0)	12 (12.0)	
Assessment scores				
HDS, median (IQR)	11 (9–14)	11 (9–14)	14 (11–17)	<.001
Facility, median (IQR)	13 (12–15)	13 (11–14)	14 (13–16)	<.001
Section GG, median (IQR)	54 (40–66)	54 (41–67)	41 (31–52)	<.001
Self-Care	22 (18–26)	22 (18–26)	18 (13–23)	<.001
Mobility	31 (22–40)	31 (22–41)	24 (20–31)	<.001

Note. IQR = interquartile range; RIC = rehabilitation impairment category; HDS = Hester Davis Scale.

improvement initiative; it was not formally supervised by the St. Peter's Health Partners Institutional Review Board.

Results

Patient Demographics and Characteristics

A total of 1,645 patients admitted for rehabilitation were included. Patients were a median of 71 years of age (IQR: 60–80 years), and 48.6% were female (Table 1). Admissions occurred for a variety of reasons including stroke (488), brain injury (178), spinal cord injury (74), orthopedic (429), neurological (77), or general rehabilitation for other reasons (399) including cardiac, pulmonary, pain, or general debility (Table 1).

Falls occurred at a rate of 4.7 falls per 1,000 patient days. The total number of falls that occurred was 120, and the number of patients who fell was 100 (6.1%). Patients who fell were younger than patients who did not fall (median age of 64 years vs. 71 years, $p < .001$; Table 1) but did not significantly differ in gender. The group of patients who fell had higher rates of stroke (42%) and brain injury (25%) compared to patients who did not fall (28.9% and 9.9%, respectively; $p < .001$; Table 1). Functional independence levels (Section GG scores) were significantly lower among patients who fell (median score of 41 vs. 54, $p < .001$; Table 1). Both Self-Care and Mobility GG subscale scores were also lower in patients who fell ($p < .001$; Table 1).

Hester Davis Scale

The median HDS score for the cohort was 11 (IQR: 9–14; Table 1). Overall, 22.1% of patients were identified as high risk (scores of ≥15), and 55.1% were classified at medium risk or higher (≥11 and ≤14), using cutoffs established by Hester and Davis (2013). The AUC of the HDS was .680 (95% CI [.626, .734], $p < .001$; Table 2). A cutoff score of 11 yielded a sensitivity of .778 and a specificity of .463 (Table 3). A cutoff score of 15 improved specificity (.792) but reduced sensitivity (.424; Table 3). The optimal cutoff was 13 (sensitivity = .636, specificity = .644, Youden's index = .280; Table 3).

Facility Fall Risk Assessment

Scores on the facility fall risk assessment were moderately correlated with HDS scores (Spearman's $\rho = .517$, $p < .001$). The median score on the facility risk assessment was 13 (IQR: 12–15), and 25.8% of patients were identified as high risk using this instrument. The AUC of the facility fall risk assessment was .688 (95% CI [.637, .740], $p < .001$; Table 2) and not significantly different from the HDS ($p = .707$). The highest sensitivity/specificity balance occurred at a cutoff of 14 (sensitivity = .697, specificity = .615, Youden's index = .312; Table 3).

Five patients with quadriplegia were excluded from the ROC of the facility instrument, as the facility assessment is

Table 2 Receiver Operating Characteristics

Assessments	AUC (95% CI)	*p*
Hester Davis	.680 [.626, .734]	<.001
Facility fall risk	.688 [.637, .740]	<.001
Section GG scores	.687 [.638, .735]	<.001
Section GG Self-Care subsection	.681 [.629, .732]	<.001
Section GG Mobility subsection	.666 [.619, .712]	<.001

Note. AUC = area under the curve; CI = confidence interval.

Table 3 Sensitivity and Specificity of Assessments

Assessments	Cutoff Score	Sensitivity	Specificity	Youden's Index	% of Patients ≥ or ≤ Cutoff[a]
Hester Davis	11[b]	.778	.463	.241	55.1
	12	.697	.556	.253	46.0
	13[c]	.636	.644	.280	37.4
	14	.515	.740	.256	27.5
	15[d]	.424	.792	.217	22.1
Facility	13	.818	.422	.241	59.0
	14[e]	.697	.615	.312	40.3
	15[f]	.485	.756	.241	25.8
Section GG	51	.747	.566	.313	45.4[a]
Self-Care	20	.660	.632	.292	38.6[a]
Mobility	28	.690	.595	.285	42.4[a]

[a] For Section GG and GG subsections, this column indicates the % of patients ≤ the cutoff score.
[b] Cutoff for medium risk on Hester Davis Scale (HDS), suggested by Hester & Davis (2013).
[c] Facility optimal cutoff of HDS, based on Youden's index.
[d] Cutoff for high risk on HDS, established by Hester & Davis (2013).
[e] Facility optimal cutoff of facility instrument, based on Youden's index.
[f] Cutoff value of facility instrument used prior to this study.

not completed in these patients, and they are automatically classified as low risk on the facility instrument. The ROC analysis of the facility instrument with these five patients included can be found in Supplementary Table 1, available at http://links.lww.com/RNJ/A41. Of the five patients identified by nurses as having quadriplegia, one patient fell. Of note, this patient was identified as high risk by the HDS.

Section GG

Section GG scores were negatively correlated with HDS scores (Spearman's $\rho = -.455$, $p < .001$). The AUC of the inverted GG scores on admission was .687 (CI [.638, .735], $p < .001$; Table 2) and was not significantly different from the HDS ($p = .833$). The highest sensitivity/specificity balance occurred at the GG score of 51 (sensitivity = .747, specificity = .566, Youden's index = .313; Table 3), which accounted for 45.4% of rehabilitation patients. Section GG Self-Care and Mobility subscale scores were also related to patients who fell (Self-Care AUC = .681, 95% CI [.629, .732]; Mobility AUC = .666, 95% CI [.619, .712]; Table 2). Self-Care scores of ≤20 or Mobility scores of ≤28 yielded the greatest sensitivity/specificity balance (Table 3).

Relationship of Individual Scale Elements to Falls

The relationship of individual HDS item scores in the prediction of falling odds was examined using binomial logistic regression. In a univariate analysis, higher scores on HDS fall history (*OR* = 1.28, 95% CI [1.11, 1.48]), mobility (*OR* = 1.41, 95% CI [1.19, 1.68]), mental status (*OR* = 1.51, 95% CI [1.32, 1.74]), toileting (*OR* = 1.30, 95% CI [1.13, 1.48]), and behavior items (*OR* = 1.27, 95% CI [1.12, 1.43]) were associated with greater odds of falling (Table 4). Medications, volume/electrolyte status, and communication/sensory were not related to falling odds. Surprisingly, higher HDS age categories were associated with lower odds of falling (*OR* = 0.54, 95% CI [0.41, 0.72], $p < .001$; Table 4). In a multivariable analysis, only age (*OR* = 0.51, 95% CI [0.37, 0.69]), fall history (*OR* = 1.30, 95% CI [1.11, 1.51]), and mental status (*OR* = 1.53, 95% CI [1.32, 1.77]) were independent predictors of falling ($p < .001$; Table 4).

Table 4 Binomial Logistic Regression Analysis of Assessment Items Associated With Patients Who Fell

	Odds Ratio	95% CI	*p*
Hester Davis Scale			
Univariate analysis			
Age	0.54	[0.41, 0.72]	<.001
History of falls	1.28	[1.11, 1.48]	.001
Mobility	1.41	[1.19, 1.68]	<.001
Medications	1.14	[0.94, 1.38]	.191
Mental status	1.51	[1.32, 1.74]	<.001
Toileting	1.30	[1.13, 1.48]	<.001
Volume electrolyte status	1.19	[0.96, 1.48]	.117
Communication/sensory	1.19	[1.01, 1.40]	.032
Behavior	1.27	[1.12, 1.43]	<.001
Multivariate analysis			
Age	0.51	[0.37, 0.69]	<.001
History of falls	1.30	[1.11, 1.51]	<.001
Mental status	1.53	[1.32, 1.77]	<.001
Facility Fall Risk			
Univariate analysis			
Gender (male)	1.12	[0.75, 1.68]	.587
Diagnosis (neurological)	2.59	[1.67, 4.01]	<.001
History of falls (yes)	1.76	[1.16, 2.67]	.008
Awareness (not aware/ forgets limits)	3.13	[2.07, 4.73]	<.001
Toileting (min A or more)	2.81	[1.22, 6.50]	.015
Follows instructions (unable)	3.48	[1.95, 6.22]	<.001
Spatial neglect (yes)	2.39	[1.47, 3.88]	<.001
Unit	0.38	[0.23, 0.61]	<.001

Individual items on the facility fall risk assessment were also examined for their ability to predict falls. In a univariate analysis, facility items indicating a neurological diagnosis (*OR* = 2.59, 95% CI [1.67, 4.01]), lack of awareness of limitations (*OR* = 3.13, 95% CI [2.07, 4.73]), inability/unwillingness to follow instructions (*OR* = 3.48, 95% CI [1.95, 6.22]), and spatial neglect (*OR* = 2.39, 95% CI [1.47, 3.88]) were all associated with greater odds of falling (Table 4). Gender, history of falls, and functional independence with toileting were not significantly associated. Unit was negatively related to falling (*OR* = 0.38, 95% CI [0.23, 0.61], $p < .001$; Table 4). In a multivariable analysis, only awareness of limitations was an independent predictor of falling.

Discussion

In this study we found that the HDS, facility fall risk assessment, and Section GG scores were adequate in predicting patients with greater odds of falling at an IRF. At the conclusion of this study, the HDS was adopted to maintain a universal method for assessing fall risk between our organization and other facilities already utilizing the HDS in the Epic platform. Nurses at our facility can see HDS scores of patients admitted from hospitals also using Epic, and the adoption of a single scale makes for an easier transfer of information between facilities.

The HDS was originally developed for a neuroscience population (Hester & Davis, 2013) and has shown reduced accuracy in other settings (Johnson et al., 2023; Kaiser et al., 2021). Cutoff values of ≥15 on the HDS have been proposed to identify patients at high risk of falling (Hester & Davis, 2013). At this facility, this cutoff value had reasonable specificity (.792) but low sensitivity (.424) in identifying patients who fell. More than half of the patients who fell had HDS scores below this cutoff. On the other hand, HDS scores of ≥11 (medium or higher risk) identified more patients who fell but had low specificity (.462). The greatest sensitivity specificity balance was determined to occur at HDS scores of ≥13, according to the Youden's index. The observed sensitivities and specificities were lower than originally reported for the scale (Hester & Davis, 2013). Differences may be attributed to variable patient characteristics and fall prevention efforts at each facility. True accuracy of the instrument is difficult to assess, as successful efforts to prevent falls in high-risk patients reduce sensitivity. It is important for facilities to determine optimal cutoff values, as they may differ based on patient characteristics and fall prevention strategies in place.

Univariate analysis of individual HDS items supported the relationship of several included factors to fall occurrence in a rehabilitation setting. For example, the HDS assessment of mental status was associated with higher odds of falling. This item considers patient orientation, confusion, and noncompliance with instructions. The HDS assessment of behavior was also associated with greater odds of falling. This item also considers the ability or willingness of patients to follow instructions, as well as impulsiveness. Both HDS items are similar to the facility fall risk items assessing "the ability of patients to follow instructions," which was associated with greater odds of falling as well. Patients who do not follow directions may be more likely to attempt transfers or walk before they are safe to do so.

Other HDS items such as toileting were positively related to falls. The HDS toileting item assigns higher fall risk to patients with incontinence as well as increased frequency/urgency. Other studies have documented greater rates of incontinence among patients who fall at rehabilitation facilities as well (Hermann et al., 2018).

Higher scores on the HDS mobility item were also associated with higher odds of falling. This item considers level of independence, assistive device requirements, and the presence of hemi- or paraplegia. Research supports the idea that hemiparesis is more prevalent among patients who fall in rehabilitation (Hermann et al., 2018) and may contribute to the ability of this item to identify patients at greater risk of falling.

There was no relationship observed between medications, volume/electrolyte status, and communication/sensory HDS items with falls. Of note, the original HDS validation paper also saw no relationship between the medications or volume/electrolyte status items to falls (Hester & Davis, 2013). The ability of these items to predict patient falls should be further studied to determine if their inclusion within the HDS is warranted.

Another unexpected finding was the relationship of age with falls. Age is included in the HDS, with older age resulting in a higher rating of risk. Interestingly, in this cohort, older patients had reduced odds of falling compared to younger ones. Although other rehabilitation facilities have observed a positive relationship (Rivers et al., 2021) or no relationship (Forrest & Chen, 2016; Thomas et al., 2016; Wong et al., 2016) between patient age and falls, biphasic relationships between age and fall rates have also been observed. Lee and Stokic (2008) found that rehabilitation patients aged 41–50 years had a higher rate of falls compared to both younger and older patients (Lee & Stokic, 2008). In this specific rehabilitation facility, many of the older patients are recovering from hip fractures. Staff awareness surrounding the negative consequences of falls in this population may contribute to greater fall prevention education and prevention measures, resulting in lower fall occurrence in these patients. Patients recovering from brain injury and spinal cord injury at this facility

are often younger and perhaps more likely to take chances. The relationship with age and falls may be facility specific but may also be important for nurses to consider when assessing fall risk.

Facility Fall Risk Assessment

Scores on the facility fall risk assessment were similar to the HDS in its ability to predict patients who fell, and IRFs may consider this instrument, with the caveat that items such as "unit" are not directly translatable. As unit was inversely related to fall occurrence, removal of this item should not reduce accuracy, but predictive properties, including cutoff values, should be validated. The facility instrument contains several unique items not included in the HDS or Section GG that merit discussion.

"Lack of awareness regarding limitations" was a unique component of the facility instrument and significantly associated with falls. Lack of awareness is common for patients in rehabilitation facilities, particularly for patients who were functioning independently prior to their hospital stay. Many patients with stroke and brain injury experience anosognosia, or lack of awareness surrounding the disability of their hemiparetic limb (Antoniello & Gottesman, 2020; Steward & Kretzmer, 2022; Vidovic et al., 2019). Anosognosia from dementia may also contribute to lack of awareness regarding new physical limitations (Wilson et al., 2016). Byrd et al. (2023) recently reported a high prevalence of anosognosia among patients with stroke in rehabilitation using the Visual-Analogue Test for Anosognosia for motor impairment. Although Byrd et al.'s study did not reveal a significant relationship between anosognosia and falls, the facility assessment of "awareness of limitations" was related to falls in this larger study. Differences in methodology for characterizing lack of awareness and other differing patient characteristics may contribute to results. Further research is necessary to determine the best instruments assessing awareness of limitations and the relationship with falls.

Spatial neglect was also associated with falls in the univariate analysis of the facility instrument. Spatial neglect is not assessed in the HDS or Section GG but is a component of other fall assessments including the Stroke Assessment of Fall Risk (Breisinger et al., 2014). The relationship between spatial neglect and falls has been observed at other rehabilitation facilities (Campbell & Matthews, 2010; Chen et al., 2015; Czernuszenko & Czlonkowska, 2009), and it is important for nurses to be aware of.

Another difference between the HDS and the facility risk assessment relates to assigning risk among patients with quadriplegia. On the HDS, patients with quadriplegia are considered high risk, whereas on the facility assessment, risk is considered low. The reasoning behind assigning low fall risk to patients with quadriplegia is related to the high level of immobility in these patients. Lee and Stokic (2008) found that patients with very low FIM scores were less likely to fall early in the rehabilitation stay, when compared with patients who have the ability to partially mobilize. Patients with some ability to move may attempt to do so before they are ready, in comparison with patients who lack the ability to move at all. Patients with incomplete quadriplegia, who are able to partially mobilize, may be at risk of falling. When evaluating fall risk in patients with quadriplegia, it is important to reevaluate risk as patients gain functional abilities. In this study, one patient with quadriplegia fell, possibly because of improvements in ambulatory function during the rehabilitation stay not reflected by the facility risk scores on admission. Fall risk may change during the rehabilitation stay, and risk should be continuously reassessed.

There were several items on the facility instrument that were not associated with higher fall risk, including gender, history of falls, and toileting. These unexpected findings could result from either a lack of relationship to falls or successful fall prevention efforts for patients with these characteristics at our facility. Unit was associated with fall risk, but in the opposite direction than expected. This underscores the importance of continued reevaluation of instruments, as patient population and facility procedures influencing risk are subject to change. Facilities may utilize the facility assessment but should validate its properties, particularly as some items (e.g., unit) cannot be directly translated.

Finally, lower scores on Section GG of the CMS IRF-PAI were also related to fall occurrence in this study. The ability of Section GG scores to predict patients who fell was similar to the HDS and the facility instrument. Because completion of Section GG is required by CMS within 3 days of admission, facilities already using Section GG may consider the assessment to identify patients at greater risk of falling. At our facility, Section GG scores are determined by both nurses and therapists and are sometimes not completed until the third day of admission. Because the HDS is completed within the first 4 hours of admission at our facility, it was implemented to ensure identification of potential patients at risk of falling as early as possible in the rehabilitation stay. Facilities that score Section GG earlier may consider Section GG, as it was similar to the HDS and the facility instrument in predicting falls. For facilities already administering Section GG, this could reduce documentation burden. It would be interesting to determine if single GG items or the use of additional routinely collected IRF-PAI data elements could improve the prediction of falls during inpatient rehabilitation.

Key Practice Points

- Scores on the HDS, the facility fall risk assessment, and Section GG were adequate predictors of patients at risk of falling in an acute rehabilitation setting.
- Mental status, history of falls, and younger age were independent predictors of falls on the HDS instrument.
- Lack of awareness regarding physical limitations was an independent predictor of falls on the facility instrument.

With the potential exception of patients with very low or no functional independence (Lee & Stokic, 2008), most research indicates that lower levels of independence are associated with greater fall risk using functional independence scales such as the FIM instrument and the Barthel index (Forrest & Chen, 2016; Fusco-Gessick & Cournan, 2019; Hermann et al., 2018; Rivers et al., 2021). The Casa Colina Fall Risk Assessment Scale also includes items assessing functional independence for toileting, bed transfer, tub/shower transfer, and stairs.

Limitations

The results represent the findings of a single rehabilitation facility. Other facilities may see different results when using the HDS, Section GG, and the facility instrument because of differing patient characteristics and fall prevention measures in place. The facility instrument contains items such as "unit," which may be difficult to translate across settings and also requires validation at other facilities.

Patients considered at high risk of falling likely had additional fall prevention measures in place, such as video monitoring. Additional fall prevention measures for patients considered high risk were not controlled for. Sensitivity and specificity of fall risk assessment scales are subject to influence by interventions to prevent falls. Sensitivity is high when patients predicted to fall actually do, and successful fall prevention efforts reduce the accuracy of the instruments.

Fall risk assessment scores occurring within the first 3 days of the patient admission were used to evaluate sensitivity and specificity. Changes to scores that may have occurred later in the stay were not included. Because risk of falling can change during the rehabilitation stay (e.g., as patients become more independent), the actual fall risk assessment score at the time of a fall may be different from the scores used in this analysis. This study did not address frequency of falls; patients were categorized as a person who fell regardless of frequency.

Interrater reliability of the HDS and the facility fall risk assessment was not measured. The HDS has high interrater reliability (.90) according to the initial validation study (Hester & Davis, 2013).

Conclusions

Scores on the HDS, the facility fall risk assessment, and Section GG were adequate in identifying patients who fell in a rehabilitation setting. When developing a fall prevention plan, nurses may use one or more of these tools to identify patients at greater risk of falling. Formal fall risk assessment tools encourage mindfulness toward preventing falls in patients with high-risk characteristics (e.g., ability/willingness to follow directions and awareness of physical limitations). Plans must be individualized to the patient and their personal risk factors, as not all fall prevention strategies are appropriate for each patient and intervention resources are often limited.

Conflicts of Interest

The authors declare no conflict of interest.

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