Casa Colina Fall Risk Assessment Scale—Revised: Predicting Falls in Inpatient Rehabilitation Facilities

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**Abstract**

**Objective:** To revise the Casa Colina Fall risk assessment scale (CCFRAS) using the new Medicare standards required functional ability quality measures and to assess the sensitivity and specificity of this revised fall risk assessment tool.

**Design:** The Casa Colina Fall risk assessment scale—revised (CCFRAS-R) was assessed both retrospectively and prospectively on consecutive patients at 3 inpatient rehabilitation facilities (IRFs) to determine the sensitivity and specificity of this tool in predicting fall risk.

**Setting:** Three IRFs.

**Participants:** A total of 6253 adult patients (N=6253) admitted to 1 of 3 IRF settings including those with stroke, brain injury, spinal cord injury, and other conditions requiring medical rehabilitation, with mean age of 66 years; 50% were female and 50% were male.

**Interventions:** Not applicable.

**Main Outcomes:** Each IRF quantified the number of falls detected for the patient population under evaluation and determined the site-specific sensitivity and specificity of the CCFRAS-R.

**Results:** Quality measures were analyzed for predicting fall risk using logistic regression analyses and found that impaired toileting hygiene, impaired toilet transfer, impaired chair/bed transfer, and difficulty walking 3 meters were the most significant predictors for falls. The area under the curve was used to determine the cut-off score and new scoring for the revised falls scale. A second data set was used to validate the tool showing a sensitivity and specificity of 0.6 and 0.62, respectively (P<.001). The degree of “agreeability” between the original scale and the revised scale was 0.72.

**Conclusion:** This multi-site data set predicted quality measures for the risk of falling resulting in a revised fall risk assessment scale for IRFs. Evaluation of this revised assessment tool indicates that the CCFRAS-R is effective and broadly generalizable for predicting patients at high risk for falling although the sensitivity and specificity of the tool may vary slightly based on environmental differences and patient acuity.

**KEYWORDS**

Brain Injuries; Falls; Hospitals; Rehabilitation; Rehabilitation Nursing; Stroke Rehabilitation; Risk Assessment

**List of abbreviations:** CCFRAS, Casa Colina Fall risk assessment scale; CCFRAS-R, Casa Colina Fall risk assessment scale—revised; FIM, functional independence measure; IRF, inpatient rehabilitation facilities; IRF-PAI, inpatient rehabilitation facilities-patient assessment instrument.

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Falls in the hospital setting are common, costly, and often preventable. Up to 1 million patients fall during a hospital stay each year, leading to increased health care utilization and serious injury in more than one-third of those who fall.1 The key to fall prevention in the hospital setting is managing a patient’s underlying fall risk. However, despite research identifying differences in fall risk based on various settings, most fall risk assessment tools were developed for and tested in acute hospital settings. Patients in acute rehabilitation actually represent one of the most at risk populations for falls during hospitalization because of the cognitive and functional impairments and the fact that the goal of acute rehabilitation is to prepare the patients to return home.2

The use of fall risk scales developed for the acute setting, including The Morse Fall Risk Scale in inpatient rehabilitation facilities (IRFs) have not proven effective as most of the patients will be identified as high risk.3,4 When 100% of the patient population is identified as high risk, patients who are at an elevated risk are prevented from receiving interventions focused on fall prevention.

The increased risk of falling observed in IRFs may be due to a combination of factors, including the primary goal of inpatient rehabilitation, which is to increase function for patients with significant physical and cognitive impairments during a short length of stay to facilitate a safe discharge.5,6 Risk factors that contribute to a higher rate of falls in IRFs include a brain injury diagnosis, being between the ages of 41 and 50 years old, lower cognitive and physical abilities, and a history of previous falls.6,7 To reduce the prevalence of falls in IRFs, it is important to identify those patients at the highest risk of falls through outcome measures appropriate for this type of setting to allow for focused patient-specific interventions.

The Functional Independence Measure (FIM) instrument, previously used in all inpatient rehabilitation settings, has been proven successful in accurately predicting falls. For example, fallers have been shown to have lower cognitive, motor, and total FIM scores at admission.3,4,8 Specifically, fallers have an average of 22 points lower on the FIM upon admission, and a 1-point decline in total FIM results in a 1% greater risk of a fall.9 The Casa Colina Fall Risk Assessment Scale (CCFRAS) was created previously by the combination of FIM and diagnoses and performed with a high specificity and sensitivity for the IRF population.10 Because of changes in the Inpatient Rehabilitation Facility-Patient Assessment Instrument (IRF-PAI) Quality Reporting Program (QRP) with the removal of the FIM items, the CCFRAS required revision. The goal of the new QRP GG quality measures expanded self-care items and mobility functional items to better characterize the functional status of a patient across the post-acute care settings. This instrument is completed by occupational and physical therapists, with the former discipline assessing how both cognitive and physical factors affect fall risk scores and the latter providing specialized assessment in patient physical abilities. In this multi-site study, we have revised the CCFRAS with the section GG quality measures used in the IRF-PAI per the revised Medicare standard to yield a fall risk assessment tool specific to the IRF population.

Methods

The CCFRAS was revised using data from 3 Joint Commission and Commission on Accreditation of Rehabilitation Facilities accredited IRFs in the United States. All data were collected retrospectively from an electronic health record database. The de-identified archival data included the GG quality measures from admission, as well as diagnosis and if a fall occurred during the inpatient stay. A fall was defined as a patient finding themselves on the ground when unintended. Assisted and non-assisted falls were included. No identifying information were included with the data. This study was approved by an Institutional Review Board, which stood as the Institutional Review Board of record for all the facilities. Informed consent was not applicable as only retrospective data were used.

To identify the differences in risk factors for falls between fallers and non-fallers, independent t tests and Chi-square analyses were conducted for the IRF-PAI GG quality measures. Logistic regression and chi-square analyses were used to determine the relative risk score associated with each predictive factor (GG quality measure), as well as to determine the overall sensitivity and specificity of the CCFRAS for each IRF. Specifically, the risk scores, which are calculated by dividing the risk in a specific population group by the risk of people from all other groups, were used to develop a revised version of the CCFRAS. Chi-square analyses were used to set the cut-off score for high risk for falling. A receiver-operating characteristic analysis was used to evaluate the CCFRAS-R and determine its sensitivity and specificity. A logistic regression was also used to determine if a more appropriate cut-off score would change the sensitivity and specificity. JMP statistical software (Cary, NC) was used for all analyses. The level of significance was set at 0.05 for all analyses.

Results

The study population included a sample size of 4320 patients from 3 IRFs, 1 in Hawaii and 2 in California (table 1). The primary diagnoses for these patients being admitted to acute rehabilitation included stroke, brain injury, spinal cord injury, and other conditions requiring medical rehabilitation, with a mean age of 66 years; 50% were female and 50% were male. The previous FIM items in the CCFRAS included toileting, bed transfer, tub/shower transfer, and stairs however, not all these items were included in the new quality measures. Therefore, the predictive values of the new functional measures were assessed for each of the 3 datasets to identify the most significant variables based on a Chi-square analysis (table 2). The most significant variables from each site were listed and the top overlapping items were
selected. Toileting hygiene, toilet transfer, chair/bed transfer, and walking 3 meters were the variables chosen for further evaluation with a logistic regression. From the logistic regression, the area under the curve was used to identify the score (0-7 on the QRP item) that significantly correlated with fall risk (Table 3). A Chi-square analysis was used to confirm the relation, identify the cut-off score, and determine the relative risk score. The relative risk scores were then used to create the revised scale (Table 4) as described previously. Using the combined 3 data sets, the sensitivity and specificity of the tool was found to be at 0.6 and 0.62, respectively (P<.001). The degree of “agreeability” (Kappa) between the original scale and the revised scale was 0.72 (range 0.54-0.89) representing substantial agreement.

A new dataset from 1 of the IRFs only (novel to the original cohort used to assess predictive factors for falling) was used to validate the Casa Colina Fall Risk Assessment Scale—Revised (CCFRAS-R) after it had been implemented. The data, n=1933, represented 111 patients who fell during their rehabilitation stay and 1822 who did not. Similar to the initial dataset, patients were admitted to acute rehabilitation with primary diagnoses of stroke, brain injury, and spinal cord injury with a mean age of 66 and 49% male and 51% female. Data analysis showed that the CCFRAS-R was significant in predicting fallers in an inpatient rehabilitation setting (χ2=14.1, P=.001). The sensitivity of the revised scale was .694, while the specificity was lower at .453. By adjusting the cut-off score based on the receiver-operating characteristic curve analysis, we were able to retain significance and improve the specificity to 0.62 while the sensitivity was also at 0.6.

Discussion

The goal of this study was to revise the CCFRAS because of the removal of the FIM from the IRF-PAI and the addition of the section GG quality measures. We collected retrospective data from 3 IRFs to assess which functional measures best predict falls and used these variables to create a revised scale with optimal sensitivity and specificity.

While there are a number of risk assessment tools, few prior to the development of the CCFRAS were created specifically for acute rehabilitation. Existing measures from other levels of care were used to predict fall risk; however, these tools were overly sensitive for a rehabilitation population, which often resulted in nearly 100% of patients being identified as high risk. For these reasons, an assessment tool specific to IRFs was needed. We previously developed

| Table 1 | Demographic data |
|---------|-------------------|
| Casa Colina | Cottage | REHAB Hospital of the Pacific |
|-----------|----------|-----------------------------|
| Sample size | 1857 | 1825 | 638 |
| Number of falls | 139 | 96 | 17 |

| Table 2 | Logistic regression by fall during rehab stay |
|---------|-----------------------------------------------|
| Admission Variable | Casa Colina (n=1857) | Cottage Rehab (n=1825) | REHAB Hospital of the Pacific (n=638) |
|---------------------|----------------------|------------------------|------------------------|
| Toileting hygiene | χ²=9.9, df=1, P=.0016 | χ²=44.3, df=1, P=.0001 | χ²=15.42, df=1, P=.0001 |
| Eating | χ²=9.2, df=1, P=.0025 | χ²=28.4, df=1, P=.0001 | χ²=10.74, df=1, P=.001 |
| Oral hygiene | χ²=7.7, df=1, P=.0054 | χ²=36.6, df=1, P=.0001 | χ²=8.22, df=1, P=.0041 |
| Upper body dressing | χ²=9.2, df=1, P=.002 | χ²=38.1, df=1, P=.0001 | χ²=10.86, df=1, P=.001 |
| Lower body dressing | χ²=6.6, df=1, P=.01 | χ²=27.1, df=1, P=.0001 | χ²=30.38, df=1, P=.0001 |
| Putting on/taking off footwear | χ²=2.3, df=1, P=.12 | χ²=15.7, df=1, P=.0001 | χ²=50.64, df=1, P=.0001 |
| Shower/bathe self | χ²=5.2, df=1, P=.02 | χ²=16.7, df=1, P=.0001 | χ²=7.41, df=1, P=.0065 |
| Toilet transfer | χ²=14.1, df=1, P=.0002 | χ²=32.5, df=1, P=.0001 | χ²=15.87, df=1, P=.0001 |
| Roll left and right | χ²=2.1, df=1, P=.15 | χ²=0.2, df=1, P=.66 | χ²=19.88, df=1, P=.0001 |
| Sit to lying | χ²=3.4, df=1, P=.06 | χ²=15.3, df=1, P=.0001 | χ²=6.18, df=1, P=.013 |
| Lying to sit | χ²=4.4, df=1, P=.04 | χ²=16.6, df=1, P=.0001 | χ²=7.31, df=1, P=.0068 |
| Sit to stand | χ²=10.7, df=1, P=.0011 | χ²=28.7, df=1, P=.0001 | χ²=9.15, df=1, P=.0025 |
| Chair/bed to chair transfer | χ²=13.3, df=1, P=.0003 | χ²=33.1, df=1, P=.0001 | χ²=6.63, df=1, P=.010 |
| Car transfer | χ²=1.2, df=1, P=.27 | χ²=0.15, df=1, P=.70 | χ²=29.73, df=1, P=.0001 |
| Walk 10 feet | χ²=18.1, df=1, P=.0001 | χ²=34.0, df=1, P=.0001 | χ²=26.29, df=1, P=.0001 |

Abbreviation: df, degrees of freedom.

| Table 3 | Receiver-operating characteristic curve and cutoff score |
|---------|---------------------------------------------------------|
| Admission Variable | Casa Colina (n=1857) | Cottage Rehab (n=1825) | REHAB Hospital of the Pacific (n=638) |
| Toileting hygiene | 0.57702; 1 Relative risk score=1.3 | 0.68593; 2 Relative risk score=3.9 | 0.53401; 1 Relative risk score=1.1 |
| Toilet transfer | 0.58384; 2 Relative risk score=1.8 | 0.63813; 2 Relative risk score=3.5 | 0.55645; 3 Relative risk score=1.3 |
| Chair/bed to chair transfer | 0.58776; 2 Relative risk score=1.8 | 0.65814; 2 Relative risk score=3.5 | 0.63382; 3 Relative risk score=3.2 |
| Walk 10 feet | 0.60193; 1 Relative risk score=1.9 | 0.67112; 1 Relative risk score=3.6 | 0.66153; 3 Relative risk score=3.3 |
the CCFRAS, which was highly sensitive and specific to the unique patient population in acute rehabilitation, which included diagnoses of stroke and brain injury. In this study, we found similarities in the items that were predictive for falls between the original FIM measures and the new GG quality measures. The GG quality measures which best predicted falls across all 3 sites were toilet hygiene, toilet transfer, chair/bed transfer, and walking 10 feet. The previous scale had 4 FIM items that included toileting, bed transfers, tub/shower transfers, and stairs. There were similarities but differences between the FIM and GG quality measures, such as the removal of stairs and tub/shower transfers.

In addition to the difference in functional variables, another difference between these scales is patient diagnoses associated with fall risk. In the original CCFRAS, right cerebrovascular accident or stroke and amputation were both considered high risk for falls. In the revised version, the data showed a shift and found traumatic brain injury and all strokes were significant. This result may be due to perceptual and/or cognitive deficits secondary to these diagnoses contributing to fall risk. These differences were based on the dataset of patient population included in the study. While the patient population at all IRF is similar to meet the requirements for admission, there will be slight differences in patient acuity, demographics, and differences in fall prevention programs as well as other environmental factors. The primary diagnoses of stroke, brain injury (including traumatic brain injury), and spinal cord injury was similar at the 3 IRFs where data were collected for this study.

### Study limitations

We were only able to test this tool in 3 IRFs. Often, a larger sample size provides a more stable specificity and sensitivity. Another limitation is not having a complete understanding of the patient population, represented in this data are a patient population with a mean age around 66 which represents the youngest-old and thus may not be as generalizable to other populations (see references). Despite the limitation in sample size, this study still found the CCFRAS-R to be highly sensitive and specific assessment tool defined by statistically significant results on the chi square analyses (see Table 2). When the CCFRAS was initially developed, data from the 3 IRFs demonstrated similar sensitivity and specificity to one another. These data suggest that the CCFRAS can be optimized for individualized facilities, which may differ slightly in patient acuity and case mix, by identifying the cut off score for high risk of falling associated with the best combination of sensitivity and specificity (ie, approximately 0.7). To this point, the COVID-19 pandemic has affected IRF admissions. While data for this study were collected prior to the beginning of the pandemic, the changes in patient population, including post-COVID patients, seen in IRF hospitals may change the efficacy of the scale. Based on previous findings, we predict that a novel data set could be assessed to determine the ideal cut off score for fall risk to assure the scale is optimized for each facility. To clearly determine the efficacy of this tool for IRFs, several different facilities will need to test its effectiveness over longer periods of time.

### Conclusions

Multi-site evaluation of this assessment tool indicates that the CCFRAS-R is effective and broadly generalizable for predicting patients at high risk for falling in IRFs, especially for patients’ post-stroke and traumatic brain injury. The primary inpatient rehabilitation population has significant cognitive and physical impairments; therefore, this patient population is at increased risk for falls. A main challenge for nursing and the clinical team is to accurately assess fall risk and provide focused, meaningful intervention. The CCFRAS was developed specifically for IRFs and this high-risk patient population. This assessment tool has been found to have a greater sensitivity and specificity than other fall risk assessment tools (including the Morse Fall Risk Scale, Hendrich II Fall Risk Model and STRATIFY Risk Assessment Tool). This study showed how the revised version of the CCFRAS can provide the inpatient rehabilitation team with a strong tool to assess risk and prevent falls based on functional ability quality measures consistent with Medicare standards. The CCFRAS was revised because of changes in the IRF-PAI to remove the FIM items and include specific QRP GG quality measures. The CCFRAS-R is a fall risk assessment tool with good sensitivity and specificity will allow for a more functional activity focused fall prevention plan that can also engage the clinical team and families/caregivers.

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References

1. Hitcho EB, Krauss MJ, Birge S, et al. Characteristics and circumstances of falls in a hospital setting. J Gen Intern Med 2004;19:732-9.
2. Rabadi MH, Rabadi FM, Edelstein L, Peterson M. Cognitively impaired stroke patients do benefit from admission to an acute rehabilitation unit. Arch Phys Med Rehabil 2008;89:441-8.
3. Gilewski MJ, Roberts P, Hirata J, Riggs R. Discriminating high fall risk on an inpatient rehabilitation unit. Rehabil Nurs Off J Assoc Rehabil Nurses 2007;32:234-40.
4. Kwan F, Kaplan S, Hudson-McKinney M, et al. Comparison of fallers and nonfallers at an inpatient rehabilitation facility: a retrospective review. Rehabil Nurs Off J Assoc Rehabil Nurses 2012;37:30-6.
5. Forrest G, Huss S, Patel V, et al. Falls on an inpatient rehabilitation unit: risk assessment and prevention. Rehabil Nurs Off J Assoc Rehabil Nurses 2012;37:56-61.
6. Lee JE, Stokic DS. Risk factors for falls during inpatient rehabilitation. Am J Phys Med Rehabil 2008;87:341-50. quiz 351, 422.
7. Rosario ER, Kaplan SE, Khonsari S, Patterson D. Predicting and assessing fall risk in an acute inpatient rehabilitation facility. Rehabil Nurs Off J Assoc Rehabil Nurses 2014;39:86-93.
8. Saverino A, Benevolo E, Ottonello M, et al. Falls in a rehabilitation setting: functional independence and fall risk. Eur Medico-physica 2006;42:179-84.
9. Thomas D, Pavic A, Bisaecia E, Grotts J. Validation of fall risk assessment specific to the inpatient rehabilitation facility setting. Rehabil Nurs Off J Assoc Rehabil Nurses 2016;41:253-9.
10. Power M, Fell G, Wright M. Principles for high-quality, high-value testing. BMJ Evid-Based Med 2013;18:5-10.