Validating with Gold Standard Assessments

Abstract

Aspire Motion Fall Risk Management (AM) is a wearable fall risk assessment tool designed to aid healthcare professionals by providing valuable insights that are not easily detected by visual observation. Fall risk is multifactorial, arising from the complex interplay of intrinsic factors such as balance, gait, coordination, strength, and postural stability, which are critical for maintaining stability.

A study run by a group of physical therapists and nurses assessed 48 inpatients using AM and Berg Balance Scale (BBS), a gold standard for measuring fall risk. AM had a sensitivity (true positive) of 96% and a specificity (true negative) of 80%. The BBS takes 15-20 minutes to administer while AM takes 3-5 minutes. Given AM's high sensitivity, specificity, and time efficiency, it can be a valuable tool to enhance fall risk assessments.

Introduction

Fall risk assessments are critical in inpatient settings, where patients are often at a heightened risk of falling due to factors like medical conditions, medications, decreased mobility, and unfamiliar environments. Proactively identifying those at risk is crucial to prevent injuries and improve patient safety. Many hospitals rely on the Morse Fall Scale (MFS) for this purpose. However, studies have shown that the MFS is often ineffective, providing only a 50% chance of accurately identifying patients at risk of falling.

More comprehensive gold standard assessments, such as the BBS or the Elderly Mobility Scale (EMS), offer a more thorough evaluation but require significant resources and time. Assessments require trained physical therapists or nurses to conduct and can take 15-30 minutes per assessment.

In response to these challenges, Aspire Motion (AM) has emerged as a promising alternative. AM assesses everyday body movements with a single sensor in just 3 to 5 minutes and provides a risk score. The assessments include a short walk, standing balance, and sit-to-stand transitions. The portable setup is simple to operate and requires minimal training making it accessible for administrative personnel to conduct the assessments and reducing the burden on nursing and therapy staff.

Method

The study involved 55 inpatients, of which 7 participants were excluded from the analysis due to their inability to complete the full BBS assessment, leaving 48 patients in the final analysis.

Participants wore the AM sensor, a single Inertial Measurement Unit (IMU) placed on their low back near the L5 vertebra. The AM assessment consisted of the following three tasks:

1. 3m x 2 walk (a short walk to assess mobility)
2. 30-second eyes open feet-together balance (measure static balance)
3. 3 sit-to-stand transitions (performed within 30 seconds to assess functional mobility)

Physical therapists administered both the AM and BBS assessments, while nurses administered the MFS. The AM assessment generated a score ranging from 1 to 100. A threshold of 55 was used to classify patients into two categories: scores above 55 indicated low fall risk, and scores below 55 indicated high fall risk.

For the BBS, a threshold of < 45 was used to identify patients at high fall risk. Finally, for the MFS, a threshold of 45 was used, with scores > 45 indicating high fall risk.

Results

The study involved 48 inpatients, after excluding 7 participants who were unable to complete the BBS assessment. In addition to the AM and BBS assessments, the MFS was conducted for each patient as part of the standard clinical protocol.

The breakdown of results of the 48 participants are shown in the confusion matrix in Table 1.

	Predicted Positive (AM)	Predicted Negative (AM)	Total
Actual Positive (BBS)	22	1	23
Actual Negative (BBS)	5	20	25

Table 1. The comparison between Aspire Motion (AM) and Berg Balance Scale (BBS) for fall risk classification is summarized in the confusion matrix.

From the confusion matrix, key validity parameters were calculated and are summarized in Table 2. The parameters include sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), along with their 95% Confidence Intervals (CI).

Predictive Validity	Value	95% Confidence Interval (CI)
Sensitivity (%)	96%	(0.88, 1.00)
Specificity (%)	80%	(0.63, 0.98)
Positive Predictive Value (PPV)	81%	(0.61, 0.89)
Negative Predictive Value (NPV)	95%	(0.70, 1.00)

Table 2. Validity parameters comparing AM to BBS

A deeper look at the relationship between AM and BBS shows a strong positive correlation. Figure1 plots the AM Score vs. BBS with the regression line (Pearson's correlation coefficient = 0.73).

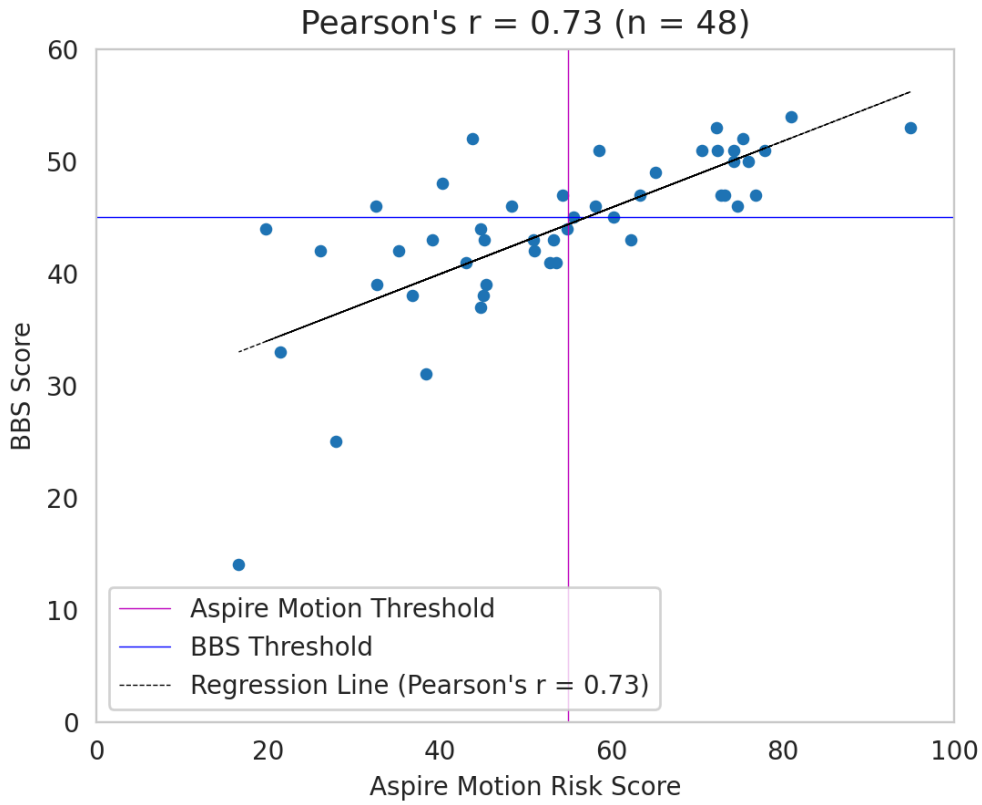

Figure 1. Scatter plot of AM Score vs. Berg Score showing regression line

The AM Score was also converted into a binary classification of "at risk" vs. "not at risk" and compared to the BBS classification. The resulting Receiver Operating Characteristic (ROC) curve, shown in Figure 2, yielded an AUC (Area Under the Curve) of 0.88, indicating that AM has strong discriminatory ability in identifying fall risk when compared to BBS.

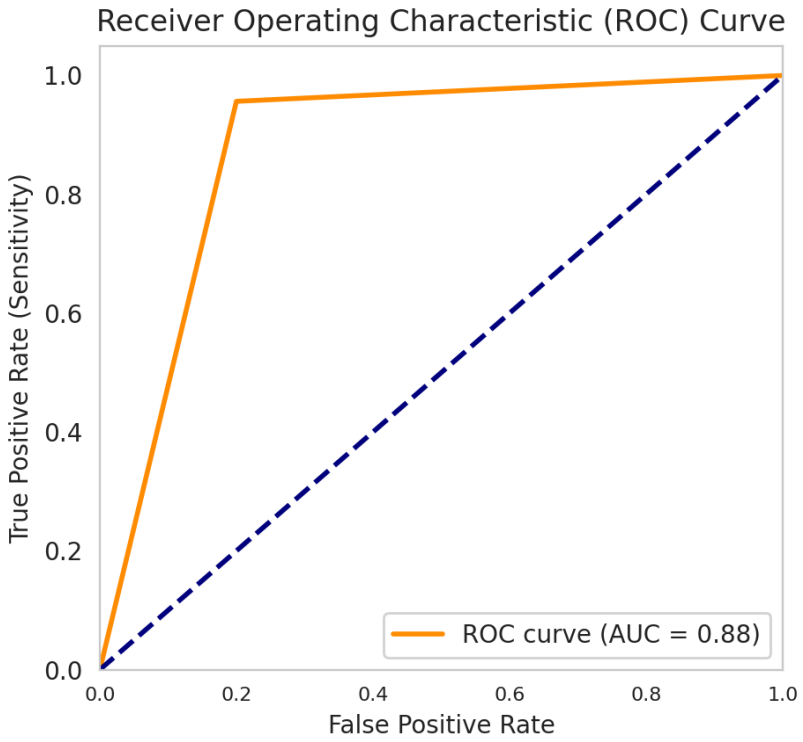

Figure 2. ROC curve of AM risk classification compared to BBS

Although the primary focus of this study was the comparison between the AM and BBS assessments, the MFS was also included as part of standard clinical practice. For comparative purposes, Table 3 presents the validity parameters for BBS vs. MFS, AM vs. MFS, and BBS vs. AM. Figure 3 plots the ROC curve comparing MFS to BBS. As supported by previous studies, the MFS demonstrated lower predictive accuracy than BBS. When compared to the BBS, the MFS produced 13 false positives and had a sensitivity of only 65% and specificity of 48%. The ROC curve resulted in an AUC of 0.48.

Predictive Validity	Berg vs. Morse	AM vs. Morse	Berg vs. AM
Sensitivity (%)	65% (0.40, 0.90)	63% (0.41, 0.84)	96% (0.88, 1.00)
Specificity (%)	48% (0.12, 0.84)	50% (0.30, 0.70)	80% (0.63, 0.98)
Positive Predictive Value (PPV)	53% (0.26, 0.80)	56% (0.38, 0.74)	81% (0.61, 0.89)
Negative Predictive Value (NPV)	60% (0.29, 0.91)	57% (0.38, 0.76)	95% (0.70, 1.00)

Table 3. Validity parameters comparing Aspire Motion and Morse Fall Scale

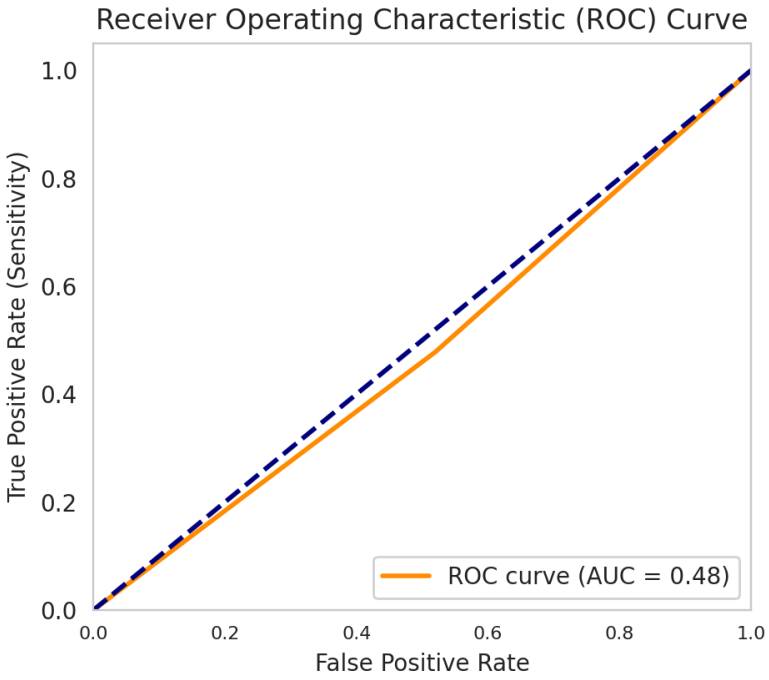

Figure 3. ROC curve of BBS compared to MFS

Discussion

The findings of this study demonstrate that AM is both an efficient and effective alternative to traditional fall risk assessments like the BBS in inpatient settings. AM's high sensitivity (96%) and specificity (80%) suggest that it reliably identifies fall risks with minimal time investment (3-5 minutes) compared to BBS, which can take up to 30 minutes. This time efficiency is crucial in busy hospital settings, where resources and staff time are often limited. Furthermore, the strong Pearson's correlation (0.73) between AM and BBS indicates that the two assessments are closely aligned, providing confidence that AM can be used as a viable option for fall risk assessment.

The AUC value of 0.88 for AM further supports its ability to accurately distinguish between high- and low-risk patients, demonstrating strong discriminatory power. In contrast, the MFS classification of fall risk suggests it performs at a level close to chance, highlighting its limited discriminative ability in this context. Given these results, AM could serve as a valuable complementary tool to the BBS, offering a quicker alternative to identify patients who may require further, more detailed assessments. In addition to its high performance, AM is portable, easy to use, and requires minimal training, allowing non-therapist staff to conduct assessments and thus reducing the workload on physical therapists and nurses.

While this study provides strong evidence of AM’s effectiveness in the inpatient setting, future research should explore its applicability in other clinical contexts, such as outpatient settings or among patients with neurological conditions. Long-term studies will also be essential to evaluate the predictive power of

AM regarding actual falls and patient outcomes. Further validation of AM in diverse populations and clinical settings will help establish its role in routine fall risk assessments across healthcare systems.

The study's findings demonstrate AM as an improved and efficient method for fall risk identification in inpatient populations. The positive correlations observed with AM in comparison to BBS, highlight its potential as a comprehensive tool in fall risk assessment. Future research may explore the integration of AM into broader clinical practice and further assess its impact on patient outcomes.

Conclusion

In conclusion, AM demonstrates a strong correlation to gold standard assessments such as BBS in identifying fall risk patients. These findings position AM as a valuable alternative or complementary tool to the BBS by offering a faster, more accessible means of identifying patients at risk of falling. AM's simplicity and ease of use make it an ideal solution for improving fall risk assessments in clinical settings where time and resources are limited. Further research should explore its application in diverse healthcare environments and evaluate its long-term impact on patient outcomes.