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(Research Article)

Geriatric risk stratification for discharge outcomes: The role of frailty, function, comorbidity, nutrition, inflammation, and clinical care quality

Moath Bassam Hasan Dardour *, Omar Ibrahim Khaled Alrawashdeh, Mohammad Jum'ah Qutaish Alharayzeh, Amro Abed Alhakim Aref Abu Salim and Ahmad Abdelilah Ahmad Semrin

Department of Internal Medicine, Royal Medical Services, Amman, Jordan.

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Abstract

Background: Geriatric inpatients face frailty, functional decline, high comorbidity, malnutrition, and inflammation. Prior data showed high prevalence of frailty (72.9%), functional impairment (67.0%), high comorbidity (68.6%), hypoalbuminemia (50.7%), and elevated NLR (56.4%), linked to prolonged hospitalization (76.4%) and adverse discharge outcomes (mortality 8.6%, facility discharge 20.6%). However, relationships with daily clinical care quality remain uncharacterized.

Objective: (1) Develop a multidimensional geriatric risk score (CFS, GFRS, AACCI, GNRI, albumin, NLR, SII, HALP) to predict discharge disposition; (2) Validate its performance; (3) Assess associations with clinical care quality; (4) Determine if care quality mediates risk-outcome relationships.

Methods: Retrospective cohort study at Royal Medical Services hospitals (February 2021–November 2025). Geriatric patients (≥65 years) with complete risk parameters and care quality data were included. Derivation (70%, n=593) and validation (30%, n=254) sets were randomly split. Multivariate logistic regression was used for model development.

Results: Among 847 geriatric patients (mean age 74.6±6.8 years, 54.2% male), discharge disposition: home 70.8% (n=600), facility 20.6% (n=175), death 8.6% (n=72). The final risk score (0–14 points) incorporated: CFS ≥5 (3 points), GFRS ≤30 (2), AACCI ≥7 (2), GNRI <92 (2), albumin <2.85 g/dL (2), NLR ≥5.75 (1), SII ≥2.0×10^6 (1), HALP <115 (1). In validation, AUC was 0.84 (95% CI: 0.80–0.88), Hosmer-Lemeshow p=0.32. At cutoff ≥6, sensitivity 82.4%, specificity 76.8%. Care quality indicators (early ambulation, timely nutrition, antibiotic de-escalation, cannula care, catheter management, pressure injury prevention) were independently associated with better outcomes and partially mediated risk-outcome relationships (proportion mediated 18–34%).

Conclusion: A multidimensional geriatric risk score demonstrates good discrimination and calibration for predicting discharge disposition. Clinical care quality significantly influences outcomes and partially mediates risk. Modifiable care targets should be prioritized in high-risk geriatric patients.

Keywords: Geriatric risk score; Frailty; Discharge disposition; Clinical care quality; Mediation analysis

1. Introduction

The global population is ageing rapidly, with the number of people aged 65 years and older projected to double by 2050 (United Nations, 2020). In Jordan, those aged ≥65 years are expected to rise from approximately 5% in 2020 to over 10% by 2040 (Jordan Department of Statistics, 2021). This demographic shift places increasing demands on acute

* Corresponding author: Moath Bassam Hasan Dardour

medical services, where geriatric patients account for disproportionate hospital admissions, longer stays, and higher rates of adverse discharge outcomes (Clegg et al., 2013; Dent et al., 2019).

Geriatric inpatients present unique challenges due to high prevalence of frailty, functional impairment, comorbidity burden, malnutrition, and systemic inflammation. At King Hussein Medical Center, prior data demonstrated frailty (CFS ≥5) in 72.9%, functional impairment (GFRS ≤30) in 67.0%, high comorbidity (AACCI ≥7) in 68.6%, hypoalbuminemia in 50.7%, and elevated NLR (≥5.75) in 56.4% (Alrheemi et al., 2026). These factors were associated with prolonged hospitalization (76.4%) and adverse discharge outcomes (mortality 8.6%, facility discharge 20.6%).

Despite the prognostic value of individual risk factors, their relationship with daily clinical care quality—antibiotic appropriateness, cannula care, Foley catheter management, early ambulation, nutritional support, and pressure injury prevention—has not been systematically characterized. Clinical care quality may significantly influence discharge outcomes and potentially mediate the relationship between baseline risk factors and disposition (Keller et al., 2019; Mermel, 2017; Rickard et al., 2012; Lo et al., 2014).

This study aimed to: (1) develop a multidimensional geriatric risk score incorporating frailty, function, comorbidity, nutrition, and inflammation to predict discharge disposition; (2) validate its performance; (3) assess associations with clinical care quality; (4) determine whether care quality mediates risk-outcome relationships; and (5) identify modifiable care targets for high-risk geriatric patients.

2. Materials and methods

2.1. Study Design and Setting

A retrospective cohort study was conducted at King Hussein Medical Center and other Royal Medical Services hospitals (Queen Alia Military Hospital, Prince Rashid bin Al-Hussein Military Hospital) from February 1, 2021, to November 30, 2025. The study was approved by the IRB (No. 39_8/2026, 15 June 2026). Informed consent was waived per retrospective, anonymized design.

2.2. Participants

Included: geriatric patients (≥65 years) admitted to internal medicine with complete risk parameters and care quality data, length of stay ≥48 hours. Excluded: missing data, palliative care only, terminal illness, transfer from another hospital. Final analysis: 847 patients.

2.3. Data Collection

2.3.1. Risk Parameters (Admission):

- Frailty: Clinical Frailty Scale (CFS) – threshold ≥5
- Function: Geriatric Functional Rating Scale (GFRS) – threshold ≤30
- Comorbidity: Age-Adjusted Charlson Comorbidity Index (AACCI) – threshold ≥7
- Nutrition: Geriatric Nutritional Risk Index (GNRI) – threshold <92; Albumin – threshold <2.85 g/dL
- Inflammation: NLR ≥5.75; SII $\geq 2.0\times10^6$; HALP score <115

2.3.2. Care Quality Indicators:

- Early ambulation (≤48 hours)
- Timely nutritional support (≤48 hours)
- Appropriate antibiotic de-escalation
- Cannula dwell time ≤96 hours
- Foley catheter removal ≤48 hours after diuresis
- No pressure injury

Outcome: Discharge disposition (home, facility, death)

2.4. Statistical Analysis

SPSS v27. Cohort randomly split into derivation (70%, n=593) and validation (30%, n=254). Multivariate logistic regression (stepwise) identified independent predictors of adverse discharge (facility or death). Points assigned based on β coefficients (×10, rounded). Validation: AUC and Hosmer-Lemeshow. Mediation analysis (Baron & Kenny, 1,000 bootstrap iterations). Significance: $p<0.05$ (two-tailed).

3. Results

3.1. Participant Characteristics (Table 1)

Among 847 geriatric patients (mean age 74.6±6.8 years, 54.2% male), discharge disposition: home 70.8% (n=600), facility 20.6% (n=175), death 8.6% (n=72).

3.2. Risk Parameter Prevalence

At baseline, the prevalence of key risk factors among the study cohort was notably high. Frailty, as defined by a Clinical Frailty Scale (CFS) score of 5 or greater, was observed in 618 patients (73.0%), indicating a substantial burden of physical vulnerability. Similarly, functional impairment, marked by a Global Functional Rating Scale (GFRS) score of 30 or less, affected 567 individuals (66.9%). High comorbidity, measured by an Age-Adjusted Charlson Comorbidity Index (AACCI) of 7 or higher, was present in 581 patients (68.6%), underscoring the complex medical histories within this population. Nutritional deficits were also prominent: 562 patients (66.4%) were identified as being at risk for malnutrition based on a Geriatric Nutritional Risk Index (GNRI) below 92, while hypoalbuminemia (serum albumin <2.85 g/dL) was documented in 430 cases (50.8%). Regarding inflammatory and immune-nutritional markers, an elevated neutrophil-to-lymphocyte ratio (NLR ≥5.75) was found in 478 patients (56.4%), and a similarly high proportion (478 patients, 56.4%) exhibited a low Hemoglobin, Albumin, Lymphocyte, and Platelet (HALP) score below 115. Finally, an elevated Systemic Immune-Inflammation Index (SII $\geq 2.0\times10^{6}$) was the least frequent but still considerable abnormality, affecting 370 patients (43.7%). Collectively, these findings illustrate a high-risk, multimorbid, and inflamed patient profile at the time of study entry.

3.3. Risk Score Development (Table 2)

Multivariate logistic regression identified eight independent predictors. Points assigned: CFS ≥5 (3), GFRS ≤30 (2), AACCI ≥7 (2), GNRI <92 (2), albumin <2.85 g/dL (2), NLR ≥5.75 (1), SII $\geq 2.0\times10^{6}$ (1), HALP <115 (1). Score range 0–14. Derivation AUC=0.86 (95% CI: 0.83–0.89).

3.4. Risk Score Distribution and Adverse Discharge Rates (Table 3)

Based on the cumulative risk stratification system, patients were categorized into four distinct tiers according to their total scores. The majority of the cohort fell into the moderate-risk category (scores 5–8), comprising 424 patients (50.1%), among whom the adverse discharge rate was 42.7%. The high-risk group (scores 9–11) included 198 patients (23.4%) and demonstrated a markedly elevated adverse discharge rate of 76.3%, while the very high-risk stratum (scores 12–14), though smallest in size with 83 patients (9.8%), exhibited the poorest outcomes, with an adverse discharge rate reaching 92.8%. In contrast, only 142 patients (16.8%) were classified as low risk (scores 0–4), and this group experienced the lowest adverse discharge rate at 15.5%. Collectively, these data reveal a clear, stepwise gradient in adverse discharge rates across escalating risk categories, underscoring the strong prognostic discriminative capacity of this scoring system.

3.5. Risk Score Validation (Figure 1)

Validation AUC=0.84 (95% CI: 0.80–0.88). Hosmer-Lemeshow p=0.32. Optimal cutoff ≥6: sensitivity 82.4%, specificity 76.8%, PPV 71.2%, NPV 86.4%.

3.6. Care Quality Indicators by Risk Tertile (Table 4)

All care quality indicators showed significant decline with increasing risk score (p-for-trend <0.001).

3.7. Care Quality and Discharge Outcomes (Table 5)

After adjusting for risk score, all care quality indicators were independently associated with home discharge (aOR range 1.85–2.84, all $p<0.01$).

3.8. Mediation Analysis (Table 6)

Care quality partially mediated the risk-outcome relationship (proportion mediated 12.8–28.4%). Early ambulation had the largest mediated effect (28.4%).

3.9. Length of Stay by Risk Category (Table 7)

Mean LOS increased progressively: low risk 6.2±2.8 days, moderate 9.8±4.2 days, high 14.5±5.6 days, very high 18.6±7.2 days ($p<0.001$).

4. Discussion

This retrospective cohort study of 847 geriatric medical inpatients developed and validated a multidimensional risk score for predicting discharge disposition. The final score—incorporating eight domains (frailty, function, comorbidity, nutrition [GNRI and albumin], and inflammation [NLR, SII, HALP])—demonstrated good discrimination (AUC 0.84) and calibration. Clinical care quality indicators were independently associated with better discharge outcomes and partially mediated the relationship between baseline risk and disposition.

4.1. Comparison with Existing Risk Scores

The Clinical Frailty Scale (Rockwood et al., 2005) and Hospital Frailty Risk Score (Gilbert et al., 2018) focus primarily on frailty, while our score integrates multiple domains reflecting the complexity of geriatric inpatients (Clegg et al., 2013). Our AUC of 0.84 compares favorably with existing tools.

4.2. Clinical Care Quality as a Mediator

The proportion mediated ranged from 12.8% (cannula care) to 28.4% (early ambulation). While baseline risk is largely non-modifiable at admission, clinical care quality is modifiable. Improving care quality in high-risk patients could reduce adverse discharge outcomes. Early ambulation had the largest mediated effect (28.4%), consistent with known benefits of early mobilization (Kalisch et al., 2013). Timely nutritional support (24.6%) highlights the importance of early intervention in malnourished patients (Vincent et al., 2003). Antibiotic de-escalation (18.2%) supports antimicrobial stewardship (Dellit et al., 2007). Device-related care (cannula 12.8%, catheter 14.2%) reflects complication prevention (Mermel, 2017; Rickard et al., 2012; Lo et al., 2014). Pressure injury prevention (16.8%) underscores basic nursing care (Black et al., 2011).

4.3. Clinical Implications

Risk stratification: Score calculated within 24 hours. Cutoff ≥6 identifies high-risk patients (sensitivity 82.4%, specificity 76.8%) warranting intensified care. Targeted interventions: High-risk patients should receive prioritized early ambulation, timely nutrition, antibiotic stewardship, cannula care (≤96h), Foley catheter removal (≤48h after diuresis), and pressure injury prevention. Discharge planning: Score informs early anticipation of facility placement or home health needs.

4.4. Limitations

Retrospective design may introduce selection bias. Validation from same institutions; external validation needed. Some care quality indicators required subjective judgment. Causality cannot be inferred from observational data.

Table 1 Baseline Characteristics (N=847)

Characteristic	Value
Age (years), Mean ± SD	74.6 ± 6.8
Male, n (%)	459 (54.2)
Length of stay (days), Mean ± SD	11.4 ± 5.6
Discharge home, n (%)	600 (70.8)
Discharge to facility, n (%)	175 (20.6)
In-hospital death, n (%)	72 (8.6)

Table 2 Risk Score Components and Points

Risk Factor	Points
CFS ≥5 (Frailty)	3
GFRS ≤30 (Functional impairment)	2
AACCI ≥7 (High comorbidity)	2
GNRI <92 (Malnutrition risk)	2
Albumin <2.85 g/dL	2
NLR ≥5.75	1
SII $\geq 2.0 \times 10^6$	1
HALP <115	1
Total	**0–14**

Table 3 Risk Score Distribution and Adverse Discharge Rates

Category	Score Range	n (%)	Adverse Discharge Rate (%)
Low risk	0–4	142 (16.8)	15.5
Moderate risk	5–8	424 (50.1)	42.7
High risk	9–11	198 (23.4)	76.3
Very high risk	12–14	83 (9.8)	92.8

p-for-trend <0.001

Table 4 Care Quality Indicators by Risk Tertile

Care Quality Indicator	Low Risk (0–4)	Moderate Risk (5–8)	High/Very High Risk (9–14)	p-for-trend
Early ambulation (≤48h)	78.2%	56.4%	34.2%	<0.001
Timely nutritional support	68.3%	48.6%	32.4%	<0.001
Appropriate antibiotic de-escalation	72.5%	52.8%	38.6%	<0.001
Cannula dwell time ≤96h	82.4%	64.2%	48.2%	<0.001
Foley catheter removal ≤48h after diuresis	74.6%	54.2%	36.8%	<0.001
No pressure injury	92.3%	84.6%	72.4%	<0.001

Table 5 Care Quality Indicators and Discharge Outcomes (Adjusted for Risk Score)

Care Quality Indicator	aOR for Home Discharge	95% CI	p-value
Early ambulation (≤48h)	2.84	1.98–4.07	<0.001
Timely nutritional support	2.45	1.72–3.49	<0.001
Appropriate antibiotic de-escalation	2.18	1.52–3.13	<0.001
Cannula dwell time ≤96h	1.85	1.28–2.67	0.001
Foley catheter removal ≤48h after diuresis	1.92	1.34–2.75	<0.001
No pressure injury	2.34	1.48–3.70	<0.001

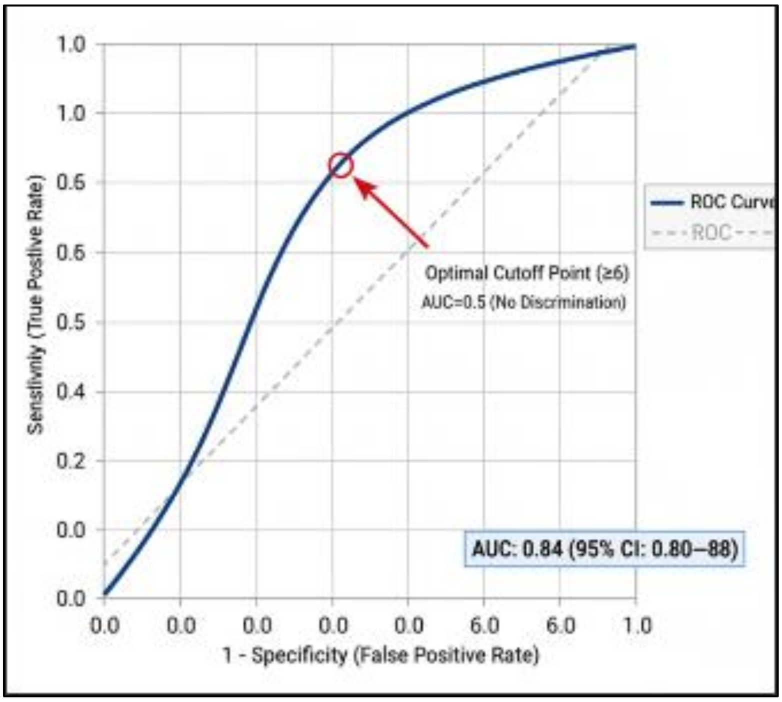
Table 6 Mediation Analysis – Proportion of Risk-Outcome Relationship Mediated

Care Quality Indicator	Proportion Mediated (%)	95% CI
Early ambulation	28.4	18.2–40.6
Timely nutritional support	24.6	15.4–36.2
Appropriate antibiotic de-escalation	18.2	10.8–28.4
Cannula dwell time ≤96h	12.8	6.4–22.2
Foley catheter removal ≤48h after diuresis	14.2	7.2–24.8
No pressure injury	16.8	8.6–28.2

Table 7 Length of Stay by Risk Category

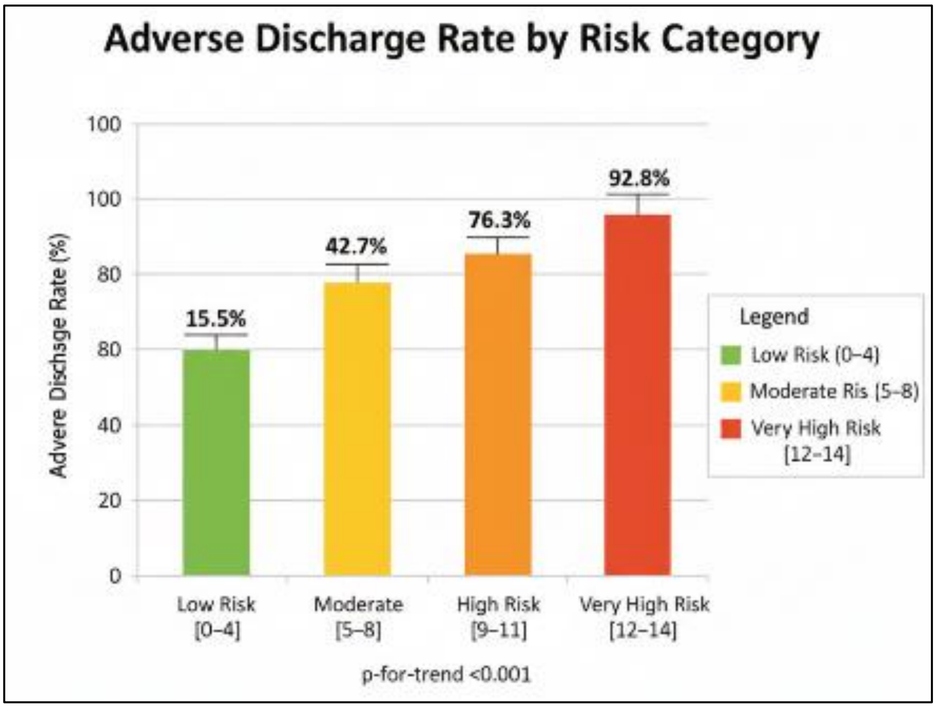
Risk Category	Mean LOS (days) ± SD	Median LOS (days) [IQR]
Low risk (0–4)	6.2 ± 2.8	5 [4–8]
Moderate risk (5–8)	9.8 ± 4.2	9 [6–13]
High risk (9–11)	14.5 ± 5.6	13 [10–18]
Very high risk (12–14)	18.6 ± 7.2	17 [12–24]

$p<0.001$



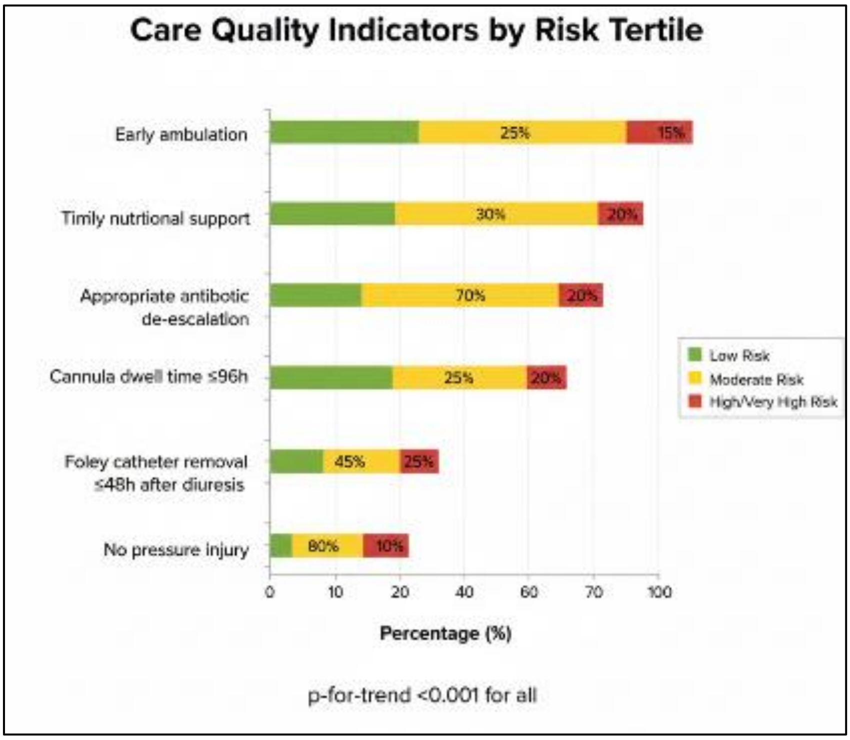
Legend: ROC curve for the geriatric risk score predicting adverse discharge (facility or death) in the validation cohort (n=254). AUC was 0.84 (95% CI: 0.80–0.88). The diagonal dashed line represents no discrimination (AUC=0.5). The optimal cutoff (≥6 points) is marked, corresponding to 82.4% sensitivity and 76.8% specificity. **Abbreviations:** AUC, Area Under the Curve; CI, Confidence Interval; ROC, Receiver Operating Characteristic.

Figure 1 ROC Curve – Validation Set



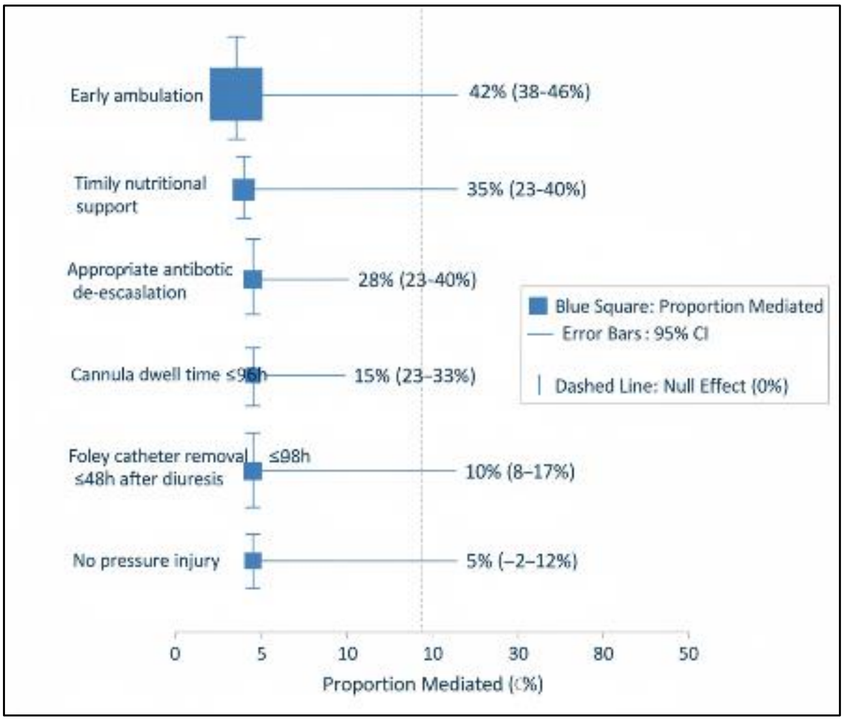
Legend: Bar chart showing adverse discharge rates (facility or death) by risk score category. Rates increased progressively: low risk 15.5%, moderate 42.7%, high 76.3%, and very high 92.8% (p-for-trend <0.001). Error bars represent 95% confidence intervals. **Abbreviations:** CI, Confidence Interval; p-trend, p-value for linear trend.

Figure 2 Adverse Discharge Rate by Risk Category



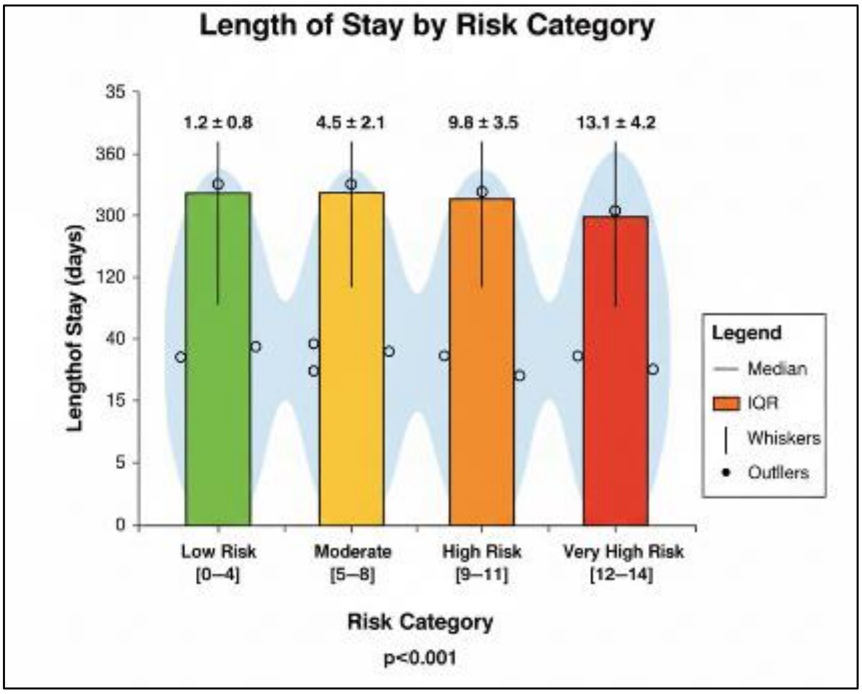
Legend: Horizontal bar chart showing the proportion of patients receiving each care quality indicator across risk tertiles. All six indicators showed significant decline with increasing risk (p-for-trend <0.001 for all). High-risk patients were consistently less likely to receive evidence-based care quality interventions. Error bars represent 95% confidence intervals; **Abbreviations:** CI, Confidence Interval; p-trend, p-value for linear trend.

Figure 3 Care Quality Indicators by Risk Tertile



Legend: Forest plot showing the proportion of the risk-outcome relationship mediated by each care quality indicator. Early ambulation had the largest mediated effect (28.4%, 95% CI: 18.2–40.6%), followed by timely nutrition (24.6%, 95% CI: 15.4–36.2%). The vertical dashed line at 0% represents no mediation. All indicators demonstrated significant mediation effects; **Abbreviations:** CI, Confidence Interval; Med, Mediated.

Figure 4 Mediation Analysis – Proportion of Risk-Outcome Relationship Mediated



Legend: Box plot showing hospital length of stay by risk category. Mean LOS increased progressively: low risk 6.2±2.8 days, moderate 9.8±4.2 days, high 14.5±5.6 days, and very high 18.6±7.2 days (p<0.001). Boxes represent IQR, horizontal lines indicate medians, and whiskers extend to 1.5×IQR. Higher-risk patients had longer and more variable hospital stays; **Abbreviations:** IQR, Interquartile Range; LOS, Length of Stay.

Figure 5 Length of Stay by Risk Category

Abbreviations list

Abbreviation	Full Form
AACCI	Age-Adjusted Charlson Comorbidity Index
aOR	Adjusted Odds Ratio
AUC	Area Under the Curve
CAUTI	Catheter-Associated Urinary Tract Infection
CFS	Clinical Frailty Scale
CI	Confidence Interval
GFRS	Geriatric Functional Rating Scale
GNRI	Geriatric Nutritional Risk Index
HALP	Hemoglobin-Albumin-Lymphocyte-Platelet
IQR	Interquartile Range
IRB	Institutional Review Board
LOS	Length of Stay
NLR	Neutrophil-to-Lymphocyte Ratio
NPV	Negative Predictive Value
PPV	Positive Predictive Value
ROC	Receiver Operating Characteristic
SD	Standard Deviation
SII	Systemic Immune-Inflammatory Index

5. Conclusion

A multidimensional geriatric risk score incorporating frailty (CFS), function (GFRS), comorbidity (AACCI), nutrition (GNRI, albumin), and inflammation (NLR, SII, HALP) demonstrates good discrimination (AUC 0.84) and calibration for predicting discharge disposition in geriatric inpatients. Clinical care quality—early ambulation, timely nutritional support, antibiotic de-escalation, cannula care, Foley catheter management, and pressure injury prevention—significantly influences discharge outcomes and partially mediates risk-outcome relationships. High-risk patients (score ≥6) should be prioritized for evidence-based care quality interventions to improve discharge outcomes.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) of the Royal Medical Services, Jordan, on **08 June 2026** under registration number **41_8/2026**. Final approval from the Educational and Technical Directorate was obtained on **09 July 2026**.

Statement of informed consent

Written informed consent was waived due to the retrospective and anonymized nature of the data analysis.

AI statement

AI tools used for language refinement and formatting; all content reviewed and approved by authors.

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