Analysis of predictive factors for hospitalization outcomes in older patients: the Geriatric Risk Assessment and Care Evaluation (GRACE) study protocol by the *Azienda Ospedaliera San Giovanni-Addolorata* (AOSGA) and the Italian Society of Hospital and Community Geriatrics (SIGOT)

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Abstract

Acute care hospitalization for older people is a major issue in terms of mortality, loss of functional independence, and reduced quality of life.

The Geriatric Comprehensive Assessment may be crucial in promoting predictive models of hospitalization outcomes, including clinical, functional, and socio-demographic factors.

The Geriatric Risk Assessment and Care Evaluation (GRACE) Study, a collaborative effort between the *Azienda Ospedaliera San Giovanni Addolorata* (AOSGA) and the Italian Society of Hospital and Community Geriatrics, is an observational, retrospective cohort study. It focuses on patients consecutively admitted to the acute geriatric care unit of AOSGA. The primary objective of the GRACE study is to identify factors that may predict in-hospital mortality. Secondary objectives include analyzing factors influencing the length of hospital stay and discharge setting. This paper details the study's rationale and methodology and provides a brief overview of existing evidence regarding hospitalization outcomes in older adults.

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Introduction

The aging population presents a significant challenge for healthcare systems worldwide.[1] Older adults constitute a large proportion of hospital admissions, contributing to increased clinical complexity due to multimorbidity, polypharmacy, and functional and cognitive decline.[2] Observational studies have estimated a 35% rise in multimorbidity rates among hospitalized patients over the past 15 years,[3] with a consistent association between potentially inappropriate prescriptions and increased readmission rates.[4,5]

Acute care hospitalizations have a detrimental impact on health outcomes for older patients, elevating the risks of functional decline, as well as short- and long-term mortality, and reducing the likelihood of discharge to home.[6,7]

In this context, predictive models of adverse hospital outcomes for geriatric patients have been developed, often incorporating a multidimensional approach through the Comprehensive Geriatric Assessment (CGA).[8-10] Retrospective studies have demonstrated that in-hospital mortality, length of stay (LOS), functional decline, discharge to non-home settings, and early readmissions are strongly influenced by clinical, functional, and socio-demographic factors.[11-14]

Understanding these predictive factors is essential to improving the quality of care, optimizing resource allocation, and developing targeted preventive strategies. In response, the *Azienda Ospedaliera San Giovanni Addolorata*, in collaboration with the Italian Society of Hospital and Community Geriatrics, initiated the Geriatric Risk

Assessment and Care Evaluation (GRACE) study protocol. This study aims to provide real-world evidence on this vulnerable population. In this paper, we describe the methodological approach and objectives of the GRACE study in the context of current evidence in geriatric acute care.

Study aims

The GRACE study aims to identify key indicators of hospitalization outcomes in older patients admitted to the acute care for elders (ACE) unit in Italy.

Materials and Methods

Study design and data source

The GRACE study is a retrospective observational cohort study involving patients consecutively admitted to the ACE unit of the *Azienda Ospedaliera San Giovanni Addolorata* in Rome, Italy. The study adheres to the principles outlined in the 1964 Helsinki Declaration and its later amendments. Ethics Committee approval was not required, as the study involves secondary analysis of anonymized data. Authorization from hospital administration was obtained to extract clinical data from the AREAS application into a single encrypted electronic database.

Data collection and study measures

Clinical data from admission to discharge were extracted from the medical and nursing electronic health records in the AREAS application. Data collection spans from November 1, 2022, to December 31, 2024, and includes seven categories: i) socio-demographic variables – age, sex, residence, and cohabitation status; ii) department of origin – emergency department or other hospital wards and the LOS in the previous setting; iii) laboratory and vital parameters – hemoglobin, C-reactive protein, creatinine, albumin, systolic blood pressure, pulse rate, level of consciousness or new confusion, temperature, and oxygen saturation; iv) CGA – conducted within the first 2 days of hospitalization, including the Multidimensional Prognostic Index (MPI); v) Blaylock Risk Assessment Screening Score (BRASS) at admission; vi) diagnosis-related group (DRG) – International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM), a medical coding classification for diagnoses and procedures;[15] vii) outcomes – in-hospital mortality, LOS, and discharge destination.

Comprehensive Geriatric Assessment

The MPI is a validated tool for predicting mortality in hospitalized older adults.[16] It is calculated using the following eight domains. i) activities of daily living (ADL):[17] assessment of basic daily tasks such as dressing, bathing, and toileting; ii) instrumental activities of daily living:[18] cognitive and physical evaluation of demanding tasks, including medication management and meal preparation; iii) cognitive status: assessed using the 10-item Short Portable Mental Status Questionnaire;[19] iv) comorbidity: evaluated with the Cumulative Illness Rating Scale,[20] which scores the severity of illnesses across 14 systems; v) nutritional status: assessed with the Mini Nutritional Assessment Short-Form, designed for rapid screening of undernutrition and malnutrition;[21,22] vi) risk of pressure sores: evaluated using the Exton-Smith Scale;[23] vii) polypharmacy: number of drugs taken during the first two days of hospitalization; viii) cohabitation status: categorized as living with family, institutionalized, or living alone.

The MPI score ranges from 0 to 1, with risk categories of mortality at 6 and 12 months of follow-up defined as low (≤0.33), moderate (0.34-0.66), and severe (>0.66).[16] Moreover, the MPI score is used to identify hospitalized older subjects with prolonged LOS,[24,25] who are less likely to be discharged at home,[26] or re-hospitalized within 1 year from discharge.[9]

Blaylock Risk Assessment Screening Score

The BRASS index is recorded within 24 hours of hospitalization to identify patients at risk of prolonged LOS or complex discharge.[27,28] It comprises 10 domains and scores from 0 (lowest risk) to 30 (highest risk).

Outcomes

The primary endpoint was in-hospital mortality. The date of death has been extracted along with the first five main diagnoses of *exitus* and diagnostic/therapeutic interventions by the DRG form.

The secondary endpoint was LOS as the number of days from the date of admission to the date of discharge or death, discharge destination, and type of discharge (home, rehabilitation, long-term care, or other settings).

Analytical approach and statistical analysis

Given the study's retrospective design, no formal sample size calculation was performed, and all eligible patients were included. The statistical analysis was carried out in two steps.

1. Descriptive analysis: continuous variables were reported as mean (standard deviation); categorical variables were reported as frequencies and percentages; chi-square test (categorical variables) and *t*-test or Mann-Whitney U test (continuous variables) were used for group comparisons.
2. Statistical methods for addressing etiological and prognostic hypotheses: the Kaplan-Meier curves and Cox proportional hazards models were used for time-to-event outcomes, and the logistic regression was used for dichotomous outcomes.

Results and Discussion

Hospitalization is a major issue for older persons, increasing the risk of mortality, loss of functional independence, and reduced quality of life.

The coexistence of acute clinical conditions, characterized by sudden and rapid health deterioration that compromises survival and functionality, and chronic diseases, which progress more slowly, represents the most common scenario among hospitalized older patients. Additionally, intrinsic and environmental factors make older people susceptible to complications during the hospital stay, often not directly related to the primary acute illness for which they were hospitalized.[29-31] In keeping up with previous studies, the cohort of patients admitted to our ACE unit is characterized by advanced age, severe comorbidity burden, polypharmacy, physical and cognitive impairment, with frequent need for transition of care settings at discharge (Table 1). In this context, the GRACE study focuses on three main adverse outcomes of hospitalization in older people: in-hospital mortality, LOS, and discharge to settings other than home.

As far as in-hospital mortality rates, studies on older populations have demonstrated wide variability, ranging from 4-5% to 10% and reaching up to 22% in nonagenarians.[32-35]

Cumulative evidence showed the predictive role of physical performance assessed by ADL dependence and slower gait speed, on

health outcomes such as in-hospital mortality and nursing home admission.[36-38]

An Italian multicenter study on older hospitalized patients reported that the admission profile of patients who died during the stay was characterized by the increased need for medical and nursing care due to dependence on ADLs, increased risk of developing pressure sores, and discharge problems.[39]

Similarly, a study on hospitalized nonagenarian patients found a strong correlation between in-hospital mortality and factors such as functional and cognitive decline, pressure sores, permanent urinary catheters, and nasogastric tube/percutaneous gastrostomy.[34]

Functional impairment at hospital admission is generally recognized as an independent predictor of mortality, likely reflecting the severity and interplay of multiple illnesses.[40] However, functional decline may also precede hospitalization; indeed, the disability of the prehospital phase is the effect of the acute disease on functional status in vulnerable patients and a potential predictor of frailty with prognostic relevance.[41] In this context, a multidimensional assessment, including functional status at hospital admission, is also crucial to identifying risk factors for short-term mortality and hospital-acquired disabilities (HAD).[42]

Concerning laboratory values, several studies found that albumin and anemia represent predictors of in-hospital mortality because of the correlation with both malnutrition and disease severity.[43-45] Furthermore, plasmatic creatinine increase was associated with mortality, reflecting the negative effects of renal dysfunction on multiple organ systems.[46]

Among chronic comorbidities, chronic heart failure, which is one of the main causes of hospitalization in the older population, and other cardiovascular diseases were associated with a higher risk of in-hospital mortality and HAD, possibly due to their direct connection to functional and cognitive impairment.[14,47-50] In addition, it is known that the combination of several chronic diseases leads to a higher mortality rate than a single disease, and the number of comorbidities is associated with frailty, increasing the risk of long hospital stay and readmissions.[51-54]

The LOS represents a crucial indicator for evaluating the efficiency and effectiveness of healthcare systems. However, there are growing concerns about the safety and appropriateness of reducing LOS in frail older individuals. Shortened hospital stays and early discharges may create a vicious cycle of readmissions, functional decline, institutionalization, and mortality.[31] Conversely, several studies have reported an association between extended hospital stay and an increased risk of readmission, likely due to the clinical and social complexity that influences both LOS and subsequent readmission risk.[55]

Predictive models for hospital outcomes, such as prolonged LOS, could improve both the quality of care and discharge planning for frail older populations. For instance, Costa *et al.* developed a multivariable regression model in which factors such as the Barthel Index, polypharmacy, diabetes, and difficulties with chewing or swallowing at admission were strong predictors of adverse outcomes, including prolonged LOS, in-hospital death, and 30-day readmissions.[11] Similarly, other authors analyzed a large cohort of older patients admitted to medical and surgical wards and identified increased risks of prolonged LOS associated with acute infections (*e.g.*, urinary tract infections), pneumonia, acute stroke, and reduced discharge home likelihood.[8,56]

Conflicting evidence on the appropriate LOS and timing of discharge highlights the need for further debate. Moreover, as strongly related to LOS, post-discharge settings significantly affect prognosis, healthcare and social costs, and overall quality of life of the frail older population.

There is solid evidence that institutionalization is linked to frailty and HAD, both of which worsen medium- and long-term outcomes, increasing the risks of hospital readmissions and mortality.[57-59] It has been estimated that the reduction in life expectancy in older persons transferred to nursing homes amounts to 47 months, reduced to 41 months when considering the severity of chronic disease.[60] It is, therefore, essential to reflect on the nursing care effect, encouraging the discharge to home with enhanced home care services along the continuum of care.[61]

Table 1. General characteristics of the study population.

N (patients)	1688
Age (years), mean (SD)	85.4 (7.1)
Age range (years), %	
65-74	8.7
75-84	32.1
85-94	51.1
>95	8.1
Sex (female), %	58.1
Department of origin, %	
Emergency department	98
Others*	2
Length of stay (days), mean (SD)	15.8 (13.3)
Discharge outcome, n (%)	
Death	11.3
Home	44.0
Home-based program	20.3
Long term care	11.8
Nursing home	12.6
CIRS_CI, mean (SD)	4.4 (2.4)
MPI, n (patients)	1353
MPI index, mean (SD)	0.59 (0.20)
MPI class, %	
Low (<0.34)	14.1
Moderate (0.34-0.66)	43.1
High risk (>0.66)	42.8
Cognitive impairment (SPMSQ), %	
Low	47.5
Moderate	23.3
Severe	29.3
Drugs range at admission, n (%)	
<3	19.1
4-6	41.0
>6	39.8

SD, standard deviation; CIRS_CI, Cumulative Illness Rating Scale-Comorbidity Index; MPI, Multidimensional Prognostic Index; SPMSQ, Short Portable Mental Status Questionnaire. *Other hospital wards.

Conclusions

Acute care hospitalization, although commonly appropriate and necessary, is a stressful and potentially dangerous event for older people, leading to clinical complications with prognostic relevance.

Identifying possible predictors of hospitalization outcomes might be useful in the definition of care objectives, therapeutic planning, and elaborating effective preventive hospital strategies and correct transitions to the post-hospital settings.

The awareness of such clinical, functional, and socio-demographic factors at admission might contribute to enhancing geriatric medicine efforts in implementing quality of care and quality of life for older patients during the hospital stay.

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