Mortality Predictors in the Oldest-Old in an Acute Geriatric Ward

Sari Tal MD

Department of Geriatrics, Kaplan Medical Center, Rehovot, affiliated with Hebrew University of Jerusalem, Israel

ABSTRACT **Background:** Hospitalization is an inherently serious event in the oldest-old, as the risk of complications associated with it increases exponentially with age and can lead to death. Despite the size of the problem, few studies have been dedicated to determining mortality predictors among hospitalized older patients, particularly among the oldest-old.

Objectives: To examine in-hospital mortality predictors in the oldest-old adults hospitalized in an acute geriatric ward.

Methods: We retrospectively surveyed electronic hospital health records of 977 elderly patients, aged ≥ 90 years, admitted between January 2007 and December 2010 from the emergency department to the acute geriatrics department. We compared the characteristics of the patients who survived to those who died during the hospital stay.

Results: The patients mean age was 93.4 years. In-hospital mortality rate was about 11.6%. Mortality predictors were female sex, on-admission pneumonia, co-morbid congestive heart failure and cerebrovascular accident, high troponin I levels, lower levels of albumin, and higher level of urea ($P = 0.032$, $P < 0.0001$, $P = 0.0015$, $P = 0.0049$, $P = 0.0503$, $P < 0.0001$ and $P < 0.0001$, respectively). Consumption of ≥ 5 drugs and the number of hospitalizations in the last year were inversely associated with death ($P = 0.0145$ and $P < 0.0001$, respectively).

Conclusions: Careful evaluation of mortality predictors might be useful for therapeutic planning and identification of potential inpatients for specific interventions. Awareness of in-hospital mortality predictors might contribute to reducing in-hospital death.

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KEY WORDS: acute geriatric ward, co-morbidities, mortality predictors, oldest-old inpatients

The oldest-old population is globally rapidly growing [1,2], leading to an increasing number of acute hospitalizations [3,4]. However, this segment of population is generally excluded from most studies [1]. Hospitalization is an inherently serious event in the oldest-old as the risk of complications associated with it increases exponentially with age, which in the case of risk of functional decline, affects more than 60% of patients hospitalized in this age group and can lead to death [3,5]. The mortality rate during hospital stay in elderly adults is double that of young people [2]. Data taken from studies conducted on very old patients revealed that mortality varied between 13.3% and 22.8% for acute patients admitted to internal wards [3,5].

There are well-established mortality risk factors, such as hypertension, hypercholesterolaemia, increased body mass index, heart disease, and cancer. In addition, in various hospital populations, abnormally high or low values of serum sodium, glucose, peripheral white cell counts, and blood urea have been shown to correlate with adverse outcomes [2]. Prognostic information collected during the hospital stay may be useful in the definition of care objectives and in deciding on therapy [6]. Despite the size of the problem, few studies have attempted to determine mortality predictors among hospitalized older patients, particularly among the oldest-old [1]. We examined mortality predictors in the oldest-old adults (aged ≥ 90 years of age) hospitalized in an acute geriatric ward.

PATIENTS AND METHODS

We retrospectively surveyed electronic hospital health records of 977 elderly patients, aged ≥ 90 years, admitted between January 2007 and December 2010 from the emergency department to the acute geriatrics department at Kaplan Medical Center (a large community-based general hospital) in Rehovot, Israel.

The recorded data included patient demographics (e.g., age, sex, hospitalization date, stay duration, readmissions number, and death), medical diagnoses, laboratory results, medications taken, and clinical outcomes. We retrieved the following data: admission diagnoses as well as co-morbidities, including dementia, pneumonia, ischemic heart disease (IHD), congestive heart failure (CHF), cerebrovascular accident (CVA), chronic renal failure (CRF), chronic obstructive pulmonary disease (COPD), anemia, malignancy, and falls. The drug types we retrieved were: statins, calcium blockers, β-blockers, angiotensin-converting enzyme (ACE) inhibitors, anti-depressants, benzodiazepines, neuroleptics, aspirin and diuretics. Data on functional and cognitive status were also recorded. For each patient, Charlson Comorbidity Index (CCI) score and age-adjusted CCI scores [7,8] were calculated. We compared the characteristics of

the patients who survived to those who died during their hospital stay. The study was approved by the institutional ethics committee of the Kaplan Medical Center, Rehovot, Israel.

STATISTICAL ANALYSIS

Statistical analysis was performed using JMP 14.0 software (SAS Institute Inc., Cary, NC, USA). Patients who survived were compared to those who died during the hospital stay for categorical and continuous characteristics, and univariate significance was established by chi-square tests and by *t*-tests, respectively. Variables with univariate significance of 0.10 or less were used for a stepwise logistic regression model using $\alpha = 0.10$ to enter the model and $\alpha = 0.05$ to leave the model. After using this criterion, the association between the remaining variables and in-hospital death were used in a multiple logistic regression model. Results are presented as odds ratio (OR) with 95% confidence interval (95%CI) and significance from the possibility OR=1.

RESULTS

Characteristics of the 977 patients (62% females) are presented in Table 1. Their mean age was 93.4 ± 3.0 years. In-hospital mortality rate was approximately 11.6% (n=113). The most common causes for admission were urinary tract infection (UTI), 18.6%, pneumonia (15%), or COPD exacerbation (10%). Approximately 60% of the patients had low serum albumin; 64% (n=626) consumed ≥ 5 drugs.

During hospitalization, a marginally significant higher mortality rate was found among females than males. The significant causes of in-hospital mortality were CCI score and age-adjusted CCI score, fully dependent functional status, on-admission diagnosis of pneumonia, co-morbid CVA, CHF, dementia, diuretics consumption, and laboratory results, both as categorical and as continuous variables (low albumin, low cholesterol, high urea, high creatinine, high troponin I and high vitamin B12) as well as lower hemoglobin level, as a continuous variable only. Compared to patients who died, a higher proportion of patients who survived had a greater number of hospitalizations in the last year, presented with COPD exacerbation, and consumed ≥ 5 drugs, and consumed aspirin, statins, or benzodiazepines.

Multiple logistic regression analysis [Table 2] found that the independent variables (higher level of urea, lower level of albumin, on-admission pneumonia, co-morbid CHF and co-morbid CVA, female sex, and high troponin I) were found to be in-hospital mortality predictors (in descending order of importance). Consumption of ≥ 5 drugs and the number of hospitalizations in the last year were inversely associated with in-hospital death. The significant mortality predictors found in the study explain 28% of the possible predictors for in-hospital mortality.

DISCUSSION

In-hospital admission and mortality of older patients is high globally [2]. Various factors influence the prognosis of older patients admitted to hospital. Hospitalization for medical illnesses is considered to be a risk factor for death among older people because it provokes adverse effects on health. Our study focuses on the oldest-old inpatients aged ≥ 90 years of age. In-hospital mortality rate was about 11.6%, quite similar to some of the findings other studies in the nonagenarian population in internal medicine departments and geriatric acute units [1,3].

There are, generally, scarce data along the wide range of ages, which characterize the third part of life. In many studies, old age is considered homogeneous and starts at ≥ 65 years of age [9]. Some studies found that, independent of the type of disease diagnosed on admission, the in-hospital mortality rate among nonagenarian patients was much higher than that among patients 65–90 years of age [1] and could be as much as twice higher [3]. In our study, no difference in age was found between patients who died and those who survived, correspondingly to some studies [5,9] and contrasting others [2,3,10]. We suppose that patient age is not related to mortality because we dealt with a very limited age group: oldest-old.

We found that female sex was associated with higher mortality risk by about 70% than in men, quite similarly to the findings of Hwang et al. [2] in patients aged 75–105 in contrast to other studies [3,6,9], in which male sex was correlated with higher mortality. However, Rozzini and co-authors [9], after examining gender differences according to various age strata, argued that sex differences were less evident in patients 80–89 years old and almost absent in those ≥ 90 years of age.

Patients admitted for pneumonia were at risk about three times higher for mortality during hospitalization. Although age by itself has not always been associated with a worse prognosis in the older adults hospitalized with community acquired pneumonia (CAP), a fatal event subsequent to CAP is often more probable in persons ≥ 65 years [11]. The efforts of geriatric medicine with regard to patients with pneumonia should be focused on reducing mortality, length of hospital stay, and costs.

A higher proportion of patients with on-admission co-morbid CHF but not admitted for CHF, died during hospitalization, and those patients were at about twice higher risk for in-hospital death. Any acute disease may occasionally lead to exacerbation of chronic conditions [2], such as CHF, of which the patient is presenting. The clinician must be aware of possible exacerbations of co-morbid diseases, which may occur during hospitalization, and try to prevent consequent outcomes.

We found that patients with co-morbid CVA were at higher risk for in-hospital death. These results are comparable to the finding of Ponzetto and colleagues [6]. We presumed that those patients frequently presented with functional and cognitive impairments, which may have contributed to their risk of death.

Table 1. Univariate analysis of selected patient characteristics by mortality (N = 977)

Characteristic	Died n=113	Survived n=864	*P* value
Age, years (mean ± SD)	93.37 ± 3.02	93.13 ± 3.06	0.4262
Female sex, n (%)	79 (13)	525 (87)	0.0598
Male sex, n (%)	34 (9.4)	329 (90.6)	
Length of hospital stay, days (mean ± SD)	6.566 ± 4.36	6.567 ± 3.50	0.9983
Number of hospitalizations in the last month, mean ± SD	1.13 ± 0.39	1.11 ± 0.33	0.5046
Number of hospitalizations in the last year, mean ± SD	1.65 ± 1.03	2.59 ± 1.80	< 0.0001
Number of co-morbidities, mean ± SD	6.42 ± 2.05	6.28 ± 2.06	0.4931
Charlson Comorbidity Index score, mean ± SD	4.08 ± 2.41	3.37 ± 1.99	0.0033
Age-adjusted Charlson Comorbidity Index, score (mean ± SD)	9.08 ± 2.41	8.37 ± 1.99	0.0030
Functional status (n=795), n (%)			
Independent	2 (2.27)	86 (12.6)	0.0035
Fully dependent	45 (51.14)	261 (36.92)	
Frail	41 (46.59)	360 (50.92)	
Admission diagnosis, n (%)			
Pneumonia	41 (36.3)	109 (12.6)	< 0.0001
UTI	26 (23.0)	156 (18.1)	0.2034
COPD exacerbation	4 (3.5)	96 (11.1)	0.0125
CHF	8 (7.1)	82 (9.5)	0.4046
IHD	7 (6.2)	62 (7.2)	0.7018
Co-morbidities, n (%)			
CVA	36 (31.9)	197 (22.8)	0.0336
Diabetes mellitus	19 (16.8)	211 (24.4)	0.0731
CRF	42 (37.2)	254 (29.4)	0.0910
CHF	36 (31.9)	192 (22.2)	0.0228
IHD	57 (50.4)	463 (53.6)	0.5286
COPD	16 (14.2)	162 (18.8)	0.2345
Dementia	80 (70.8)	454 (52.5)	0.0002
Drugs, n (%)			
≥ 5	63 (55.8)	563 (65.2)	0.0499
Aspirin	46 (40.7)	477 (55.2)	0.0037
Diuretics	58 (51.3)	356 (41.2)	0.0406
Benzodiazepines	31 (27.4)	325 (37.6)	0.0344
Statins	12 (10.6)	169 (19.6)	0.0214
Laboratory tests			
Albumin, mg/dl, mean ± SD	2.91 ± 0.54	3.33 ± 0.44	< 0.0001
Low Albumin, n (%)	82 (72.6)	501 (58.0)	0.0030
Cholesterol, mg/dl, mean ± SD	146.50 ± 48.91	161.46 ± 39.11	0.0022
Low cholesterol, n (%)	70 (61.9)	377 (43.6)	0.0002
Urea, mg/dl, mean ± SD	98.26 ± 49.65	62.44 ± 35.97	< 0.0001
High urea, n (%)	97 (85.8)	579 (67.0)	< 0.0001
Creatinine, mg/dl, mean ± SD	1.6 ± 0.98	1.21 ± 0.72	0.0001
High creatinine, n (%)	57 (50.4)	331 (38.3)	0.0132
High troponin I, n (%)	13 (11.5)	46 (5.3)	0.0095
Vitamin B12, pmol/L, mean ± SD	534.58 ± 302.69	436.30 ± 253.41	0.0012
High vitamin B12, n (%)	25 (22.1)	117 (13.5)	0.0149
Low vitamin B12, n (%)	7 (6.2)	102 (11.8)	0.0748
Hemoglobin, g/dl, mean ± SD	11.22 ± 1.99	11.66 ± 1.84	0.0183
Sodium, mg/dl), mean ± SD	139.12 ± 5.45	137.8 ± 5.24	0.0018

low vitamin B12 < 200 pmol/L, high vitamin B12 > 666 pmol/L, low albumin < 3.5, low cholesterol < 150 g/dl, high troponin I > 15.6 pg/ml
CHF = congestive heart failure, COPD = chronic obstructive pulmonary disease, CRF = chronic renal failure, CVA = cerebrovascular accident, IHD = ischemic heart disease, SD = standard deviation, UTI = urinary tract infection

Table 2. Risk factors for in-hospital mortality by multiple logistic regression analysis

Parameter	Odds ratio	95% confidence interval	*P* value
Urea	1.014	1.010–1.020	< 0.0001
Albumin	0.262	0.163–0.419	< 0.0001
Number of hospitalizations in the last year	0.604	0.485–0.753	< 0.0001
Admitted for pneumonia	2.932	1.769–4.859	< 0.0001
Co-morbid CHF	2.391	1.408–4.062	0.0015
Co-morbid CVA	2.096	1.261–3.484	0.0049
Drugs ≥ 5	0.543	0.333–0.887	0.0145
Female sex	1.711	1.037–2.823	0.0320
High troponin I	2.228	1.028–4.828	0.0503

R2 = 28%
CHF = congestive heart failure, CVA = cerebrovascular accident

Older people are prescribed a greater number of medications, which may be inappropriate and fuel the cycle of co-morbidity, disability, hospitalization, nursing home placement, and mortality [12]. Some studies found ≥ 5 drugs consumption to be associated with in-hospital death [4,13]. However, in Socorro et al. [5] found no difference between patients who died during hospitalization and those who survived and the number of drugs prescribed. In our study, a higher percentage of patients who took ≥ 5 drugs survived, probably because we dealt with a limited age group of oldest-old patients who presented with multiple co-morbidities and who needed a higher number of necessary drugs; whereas, most studies had dealt with a whole group of elderly patients aged ≥ 65 years of age. We can speculate that some younger older adults are prescribed a greater number of medications, of which part may be unnecessary or inappropriate.

We found that patients with higher levels of urea were at higher risk for in-hospital death, like those of previous studies [6,14]. The association between urea and mortality may be explained by the direct negative effects of renal dysfunction on multiple organ systems or may reflect generalized decreased tissue perfusion [6].

Patients with a higher level of albumin were at lower risk of mortality during hospitalization, corresponding to other studies [1,11,15]. Serum albumin plays a vital physiologic role in health maintenance for many organs. Hypoalbuminemia in a medical ward usually reflects disease severity and has prognostic implications [1,16]. Hypoalbuminemia may help to identify a high-risk group of geriatric patients who could be targeted for more careful and closer follow-up for an extended period of time.

Patients with high troponin I were at about twice higher risk for mortality during hospitalization than survivors. Elevated troponin concentrations are associated with increasing age. Lee et al. [17] found that age and admission co-morbidity were the strongest independent factors related to elevated troponin concentrations. Cardiac troponin is a sensitive and a specific marker of myocardial injury [18]. Although elevated cardiac troponins are specific for indicating damage to the myocardium, they are not specific for the etiology of the injury. As such, many acute and chronic pathological conditions are associated with elevated cardiac troponins [17]. Cardiac troponin has prognostic implications in many primary non-cardiac illnesses [18].

LIMITATIONS

Our study has all the disadvantages of a retrospective observational study. We did not have all the details that may have influenced in-hospital mortality because they were not found in the electronic data for the patients. Consequently, the significant independent variables (female sex, on-admission diagnosis of pneumonia, low albumin or high troponin I, and co-morbid CHF or CVA) comprised only part of the in-hospital mortality predictors. Some other unknown variables might explain the remainder.

Our study strength lies in the relatively large size of the population. The study focused on in-hospital mortality predictors in the oldest-old patients in acute geriatric ward, whose proportion in the geriatric population is recently significantly increasing.

CONCLUSIONS

Mortality in the oldest-old in-patients hospitalized in acute geriatric ward was associated with some admission diagnoses, laboratory tests, and co-morbidities. Careful evaluation mortality predictors might be useful for therapeutic planning and identification of potential inpatients for specific interventions. Therefore, such factors should be actively examined and considered in the decision-making process. Awareness of in-hospital mortality predictors might contribute to reducing in-hospital death. Accurate evaluation of mortality predictors in this age group may be more challenging and require variables that were not included in our study. Future research is warranted.

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Correspondence

Dr. S. Tal
Dept. of Geriatrics, Kaplan Medical Center, Rehovot 76100, Israel
Phone: (972-8) 944-1573
Fax: (972-8) 944-1767
email: sari@tal.name

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Capsule

Clinical outcomes associated with SARS-CoV-2 Omicron (B.1.1.529) variant and BA.1/BA.1.1 or BA.2 subvariant infection in Southern California

Epidemiologic surveillance has revealed decoupling of coronavirus disease 2019 (COVID-19) hospitalizations and deaths from case counts after emergence of the Omicron (B.1.1.529) severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) variant globally. However, assessment of the relative severity of the Omicron variant infections presents challenges because of differential acquired immune protection against Omicron and prior variants and because longer-term changes have occurred in testing and healthcare practices. **Lewnard** and co-authors showed that Omicron variant infections were associated with substantially reduced risk of progression to severe clinical outcomes relative to time-matched Delta (B.1.617.2) variant infections within a large, integrated healthcare system in Southern California. Adjusted hazard ratios (aHRs) for any hospital admission, symptomatic hospital admission, intensive care unit admission, mechanical ventilation, and death comparing individuals with Omicron versus Delta variant infection were 0.59 (95% confidence interval [95%CI] 0.51–0.69), 0.59 (95%CI 0.51–0.68), 0.50 (95%CI 0.29–0.87), 0.36 (95%CI 0.18–0.72), and 0.21 (95%CI 0.10–0.44), respectively. This reduced severity could not be explained by differential history of prior infection among individuals with Omicron or Delta variant infection and was starkest among individuals not previously vaccinated against COVID-19 (aHR 0.40 [95%CI 0.33–0.49] for any hospital admission and 0.14 [95%CI 0.07–0.28] for death). Infections with the Omicron BA.2 subvariant were not associated with differential risk of severe outcomes in comparison to BA.1/BA.1.1 subvariant infections. Lower risk of severe clinical outcomes among individuals with Omicron variant infection should inform public health response amid establishment of the Omicron variant as the dominant SARS-CoV-2 lineage globally.

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