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Factors related to mortality in geriatric patients after elective surgery: a retrospective cohort study

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ABSTRACT

Introduction: The increased number of surgery on the elderly is often followed by an increased risk of mortality rate. Identifying the risk factors of surgical death in elderly patients will be mandatory before making a decision. This study aimed to determine mortality-associated factors in older people who underwent inpatient elective surgery.

Methods: This cohort retrospective study analyzed secondary data from the medical records of geriatric patients hospitalized at Dr. Kariadi Hospital Semarang in 2020. Patients aged ≥ 60 years and who have undergone elective surgery were included. Patients with incomplete medical records, who had undergone outpatient surgery, more than one surgery, and emergency surgery, Covid-19, were excluded. A total of 382 patients met the criteria. In this study, independent variables analyzed were age, sex, nutritional status based on body mass index, functional status by Barthel, marital status, residence status, number of comorbidities according to Charlson Comorbidity Index, albumin levels, electrocardiogram (ECG) abnormalities, surgery type, and American Society of Anesthesiologists (ASA) status. The dependent variable was in-hospital mortality. In the logistic regression analysis, we identified the five most significant variables to allow for the prediction of in-hospital mortality.

Results: Residence status ($p= 0.003$), ECG ($p= 0.001$), comorbidity ($p <0.0001$), albumin status ($p< 0.0001$), and ASA status ($p< 0.0001$) were identified as factors that affect postoperative mortality after multivariate analysis.

Conclusion: In this study, mortality-associated factors were living alone, ECG abnormality, comorbidity > 2, hypoalbumin, and ASA > 2.

Keywords: General Surgery, Geriatrics, Mortality, Older people, Elective surgery.

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INTRODUCTION

Older age is a natural period of human life and is the culmination of the life cycle.[1] Their number is expected to double in 2050, thus, this age group becomes the fastest-growing population worldwide.[2] The increase in the older population is a challenge for the medical world, especially for geriatricians and surgeons, because an increasing number of older adults require surgical interventions, especially the very old ones.[3] We looked at a risk assessment of operations commonly used in Indonesia using the American Society of Anesthesiologists (ASA) score. Preoperative evaluation in older patients is more complex than in young ones because of the heterogeneity of these patients and the large number of comorbidities that generally accumulate with old age. Perioperative functional status can be complicated because many older adults have decreased preoperative function because of deconditioning, the presence of aging-related diseases, and cognitive impairment. These conditions make it difficult to adequately assess the patient's ability to respond to specific surgery-related stress.[4] Old age has physiological, pharmacological, psychological, and social challenges that increase the complexity of surgeries.[5] Age appears to be a significant predictor of postoperative outcomes. Story et al reported that the mortality odds ratio doubled with each decade over 70.[6] In older patients planning for surgery, two crucial factors should be considered. First, surgery-requiring diseases of the older population are not identical to those of young adults. The pattern, appearance, and natural history of the disease in the older population are often different, which indicates atypical symptoms and signs. The atypical presentation can result from physiological changes associated with age, physiological reserves lost because of aging, interactions of chronic conditions with acute diseases, and unreported symptoms. Second, the care of older patients is made complicated by chronological age and unequal physiological age. Moreover, aging among older people, so assessing functional status is essential.[7]

Surgical outcomes can be successful or failure. One of the most undesirable surgical failures is mortality. Madalyn G et al. examined the effect of age on the morbidity and mortality of patients undergoing cytoreductive surgery, and they found that the age of 60 years was independently associated with 30-day mortality and severe complications with an odds ratio of 1.6.[8]

With the above background, this study aimed to identify mortality-associated factors in older patients undergoing elective surgery to reduce the mortality rate and assist the patient's family and clinicians in considering surgery.

METHODS

This retrospective cohort study included patients (aged > 60 years) who underwent elective surgery at Dr. Kariadi Hospital Semarang in 2020. Patients who had incomplete data in the medical records; had undergone outpatient surgery (one-day surgery), more than one surgery, or emergency surgery; and were diagnosed with COVID-19 were excluded. To reduce selection bias, we established inclusion and exclusion criteria for the included study subjects.

The independent variables were sex, age, marital status, surgery type, residence status, functional status, ECG status, comorbidity, albumin, nutritional status, and ASA status. The dependent variable is in-hospital mortality. Patient data were taken from electronic medical records.

Sex was determined on the medical record. Age was based on the birth date provided on the medical record. Marital status was also obtained from the medical record, and patients were then classified as married and single. Surgery types were classified as minor or major risk procedures. The residence status was taken as written in the medical record, which was then divided into living alone or living with another person. Functional status was assessed based on the Barthel index and was classified into mild and severe dependence. Comorbidity was defined as the presence of comorbidities and it was calculated based on the Charlson comorbidity index (CCI) and classified into ≤ 2, and >2. Albumin data were obtained from the medical records. Nutritional status was assessed based on the body mass index provided in the medical record. The body mass index was then categorized based on the Asia Pacific guidelines: underweight body mass index <18.5 kg/m^2; normal 18.5-22.9 kg/m^2; overweight 23-24.9 kg/m^2; and obese ≥ 25 kg/m^2. Moreover, we categorized normal weight as normal nutritional status, and underweight, overweight, and obese indicated malnutrition. The ASA status provided in the medical record was then classified into ASA >2 and ASA < 2.

Statistical analysis was conducted using IBM SPSS Statistics for Windows version 25. (IBM Corp., Armonk, NY, USA). Data analysis included descriptive analysis and hypothesis testing. The descriptive analysis was conducted with the univariate analysis. The categorical variables were presented as frequency and percentages. Categorical scaled variables were analyzed with the X^2 test or Fisher's Exact test if there are cells with a frequency of expectation of < 5, and the number is ≥20%. In the bivariate analysis finds, if a free variable had p < of 0.25, then it will be included in the multivariate logistic regression test. To overcome the bias due to confounding in the data analysis phase, confounding was controlled through multivariate analysis.

Logistic regression was used to describe data and explain the relationship among variables. In the multivariate logistic regression test, the backward conditional method was used to produce the best model that can be used for postoperative mortality prediction. We used the receiver operating characteristic (ROC) analysis to determine the accuracy of this combined variable to predict postoperative mortality.

RESULTS

This study involved 382 older adults who underwent elective surgery at Dr. Kariadi Semarang in 2020 and met the selection criteria. Of these patients, 178 died, and 204 survived (control group). The most common reasons for exclusion were an incomplete medical record, surgery performed more than once, and emergency surgery.

Based on Table 1, the variables that had a significant effect on postoperative mortality were residence status, functional status, ECG status, comorbidity, albumin status, and ASA category. Variables in the bivariate analysis with a p-value < 0.25 were entered into the multivariate analysis.

Variables that influence postoperative mortality were residence status, ECG status, comorbidity, albumin status, and ASA category. Comorbidity showed the strongest relationship, whereas ECG status had the weakest relationship. The obtained equation is as follows:

Y = -3.74 + 2.935 (comorbidity) + 2.076 (residence status) + 1.794 (albumin status) + 1.685 (ASA category) + 1.576 (ECG)

The value of the variance inflation factor was shown in table 3 as less than 10, indicating there was no collinearity between the independent variables. The determining factor in this ROC curve is 94.1% (95% CI 91.8 - 96.3).

DISCUSSION

In this study, the sample was dominated by men, (54.5 %; total sample 208). Moreover, the male group recorded the highest mortality rate, but the difference was not significant. When comparing our results to those of previous studies, Smith et al. revealed that men have a greater risk for postoperative mortality. However, in their study, the result obtained was significant, and the possible reason was that they analyzed a large sample of 544,733 and only one type of surgery.[9]

The mortality rate was higher in the very old group (50.7 %) than in the young old group (45.7 %). This further strengthens that age alone is not a predictor of postoperative mortality. This is in line with the finding of Andreas et al., which showed that the relationship between age and mortality in older patients undergoing elective surgery was not significant.[10]

In this study, patients generally have a partner (married; 79.6 %), and the percentage of deceased patients was higher in the married group (46.7 %). This finding is different from the result of Atay et al., which showed that patients without a partner were more likely to experience depression that resulted in decreased general condition and postoperative recovery.[11]

Most of the patients (55.8%) had major surgery. The mortality rate (48.4%) was higher in the major surgery group than in the minor surgery group (44.4 %). However, the difference was not significant. This finding was different from that of the study by Andres, in which major surgery was the most significant independent risk factor for poor outcomes. Andres also considered the blood loss volume when determining the level of surgery.[12] Harris et al. also showed relatively similar research results.[13] They analyzed individuals who underwent non-elective surgery of the hip; thus, non-elective surgery preparation for surgery was shorter.

In this study, 89.3% of the patients lived with other people, either with their families or caregivers. The mortality rate (85.4%) was higher in the group who lived alone. This value is different from that reported by Andres et al. In their study, 33 (26%) lived alone, 24 (18.9%) lived with a partner, 6 (4.7%) lived in a nursing home, and only 7 (5.5%) needed a caregiver before surgery.[10] The lifestyle of the older population and their need for care are interrelated; that is, when a person's functional status deteriorates, an older person living alone may move to an institution or join their adult child's family. Lifestyle changes can be related to a person's life events, such as becoming a widow or changes in household composition. Living alone has been shown to double a person's chances of being accepted into an institution such as a nursing home, compared with living with a partner. The change from a familiar environment to an unfamiliar one can affect the risk of death.[14] In the presence of physical, mental, social, and health changes, older people appear to depend on other residents for support/assistance both economically and socially. Ideally, being near one's family is the best place to spend old age, considering that family is the most potential supporter of survival.[15]

Table 1. Data from the mortality study of elderly patients undergoing elective surgery.

Characteristics	n (%)	Deceased (n=178)	Alive (n=204)	P- value	RR	95% confidence interval	
						Lower	Upper
Sex							
Male	208 (54.5)	99 (47.6%)	109 (52.4%)	0.608	0.95	0.61	1.37
Female	174 (45.5)	79 (45.4%)	95 (54.6%)				
Age							
≥71 years	69 (18.1)	35 (50.7%)	34 (49.3%)	0.448	1.11	0.85	1.44
< 71 years	313 (81.9)	143 (45.7%)	170 (54.3%)				
Marital status							
Widower/widow/ unmarried	78 (20.4)	36 (46.2%)	42 (53.8%)	0.930	0.99	0.76	1.29
Married	304 (79.6)	142 (46.7%)	162 (53.3%)				
Surgery type							
Major risk	213 (55.8)	103 (48.4%)	110 (51.6%)	0.439	1.09	0.87	1.36
Minor risk	169 (44.2)	75 (44.4%)	94 (55.6%)				
Residence status							
Alone	41 (10.7)	35 (85.4%)	6 (14.6%)	0.000*	2.04	1.70	2.43
Together	341 (89.3)	143 (41.9%)	198 (58.1%)				
Functional status							
Dependent	228 (59.7)	134 (58.8%)	94 (41.2%)	0.000*	2.06	1.57	2.70
Independent	154 (40.3)	44 (28.6%)	110 (71.4%)				
ECG status							
Abnormal	71 (18.6)	55 (77.5 %)	16 (22.5 %)	0.000*	1.96	1.63	2.36
Normal	311 (81.4)	123 (39.5%)	188 (60.5%)				
Comorbidity							
CCI >2	188 (49.2)	152 (80.9%)	36 (19.1%)	0.000*	6.03	4.19	8.69
CCI ≤2	194 (50.8)	26 (13.4 %)	168 (86.6%)				
Albumin status							
Hypoalbumin (<3.5 G/dl)	176 (46.1)	134 (76.1%)	42 (23.9%)	0.000*	3.57	2.70	4.69
Normal	206 (53.9)	44 (21.4%)	162 (78.6%)				
Nutritional status							
Malnutrition	193 (50.5)	94 (47.2%)	105 (52.8%)	0.794	1.03	0.830	1.27
Normal	189 (49.5)	84 (45.9%)	99 (54.1%)				
ASA category							
ASA >2	162 (42.4)	123 (75.9%)	39 (24.1%)	0.000*	3.037	2.38	3.88
ASA ≤2	220 (57.6)	55 (25%)	165 (75 %)				

* Significant p-value
Abbreviations: ASA: American Society of Anesthesiologists**; CCI:** Charlson comorbidity index; **ECG:** electrocardiogram**.**

Robards et al. found that moving to a new house was associated with a higher risk of death 1-2 years after moving, even after controlling for health status at the time of moving. The risk of death also depends on the relationship between the caregiver and the older person, as parents who are cared for by a spouse, children, or other relatives have a lower risk than those who received care from unrelated individuals.[16]

Table 2. Multivariate regression analysis.

Variable	Bivariate	Multivariate				
	p-value	β Coefficients	p-value	OR	95 % Confidence interval	
					Lower	Upper
Residence status	0.000	2.076	0.003	7.97	2.02	31.52
Functional status	0.000	- 0.098	0.790	0.91	0.44	1.86
ECG status	0.000	1.576	0.001	4.84	1.92	12.22
Comorbidity	0.000	2.935	0.000	18.82	9.33	37.94
Albumin status	0.000	1.794	0.000	6.01	3.05	11.83
ASA category	0.000	1.685	0.000	5.39	2.70	10.78

Abbreviations: ASA: American Society of Anesthesiologists; **ECG:** electrocardiogram

Table 3. Table of tolerance value and Variation Inflation Factor (VIF).

Model	Collinearity Statistics	
	Tolerance	VIF
Functional status	0.833	1.200
Residence status	0.933	1.072
ECG status	0.924	1.083
Comorbidity	0.707	1.413
Albumin status	0.705	1.418
ASA category	0.767	1.304

Abbreviations: VIF: variance inflation factor.

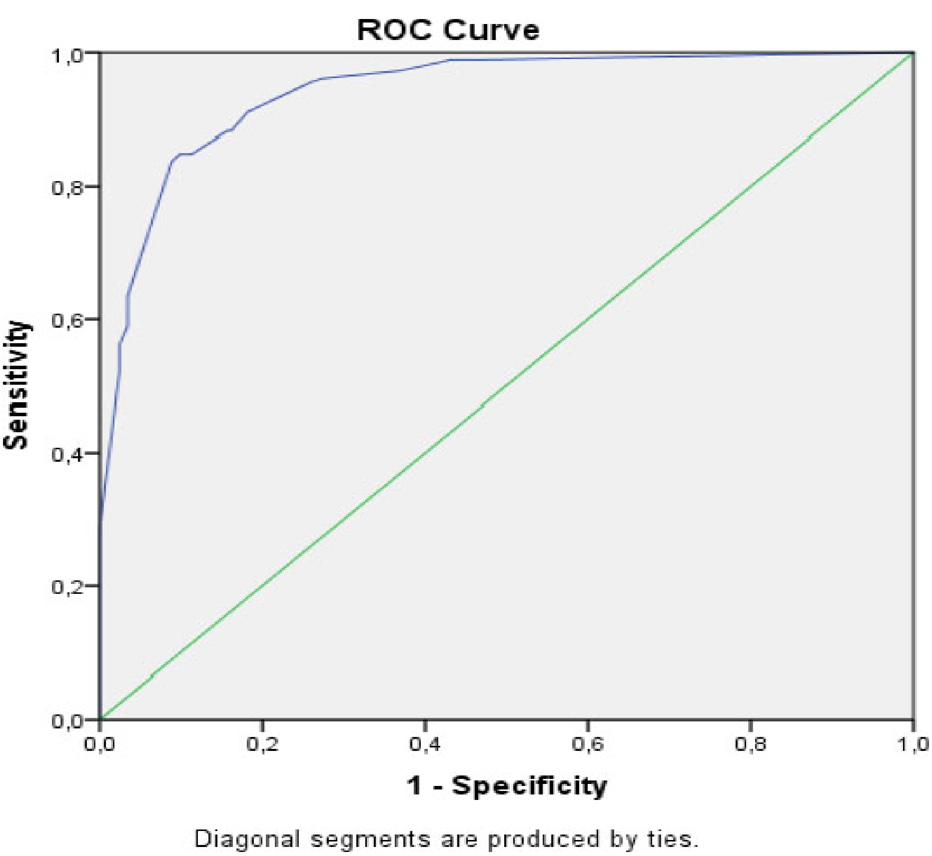

Figure 1. Quality discrimination equation based on the ROC graph.

In this study, the mortality rate (58.8%) was higher in patients with dependent functional status than in those with functional independent status. However, in the multivariate analysis of the dependent functional status, the results were not significant after combination with other involved variables. This is different from the result of Jersey, who reported that mortality increased with the degree of dependence of the patient.[17] Various possible causes include problems in self-care, hygiene, food intake, and patient mobilization.[17,18,19]

The mortality rate was higher in the group with ECG abnormalities, with as many as 55 cases (77.5 %). Goldman showed an increased risk of death due to cardiovascular injury after non-cardiac surgery.[20] Rafiq also showed an increased mortality risk in the older population with ECG abnormalities.[21]

The mortality rate was higher in the group with a CCI>2 (80.9%) than in the group with a CCI score of ≤ 2 (13.4%). Roche's study analyzed 2,448 subjects with hip fractures and found that having three or more medical comorbidities was associated with higher complications and mortality rates.[22] Other studies by Nadal, Wosniack, and Lascano et al. showed the same results on various measures.[16,21,23,24]

In the present study, the mortality rate was higher in patients with low albumin levels s (<3.5 g/dL). This finding is in line with the result of Larsen et al., where low preoperative albumin level has a fatal effect (Rafiq, Sklyar, and Bella, 2017; Harris, Brovman, and Urman, 2019), and the results were similar to those of Mosfeldt and Fisher et al.[23]

In the present study, the majority (47.2%) of the patients had malnutrition. Malnutrition is a problem that often occurs in elderly patients. The causes of malnutrition are often multifactorial and include the biological, physiological, and psychological changes that result from aging.[24] In this study, the mortality rate was higher in the ASA > 2 groups than in the ASA ≤ 2 group. This is in line with the finding of El-Haddadi.[25]

Multivariable logistic regression analysis was used to identify variables associated with in-hospital mortality (Table 2). Of these, comorbidity status, residence status, albumin status, ASA score, and ECG were significantly predictive of in-hospital mortality. This can be explained because increased comorbidity indicates an increased risk of complications and physiological system consequences due to the interaction of morbidity and disease therapy.[26] Living alone was associated with minimal social support which caused stress and contributed to a high disability, poor recovery, and early death.[27]

Low albumin levels were associated with poor recovery after surgery because albumin was a plasma protein required to maintain oncotic pressure, and prevent platelet aggregation.[28] The level of ASA was related to the severity of systemic disease and physical status before surgery.[29] The ECG abnormality reflected a serious active cardiac condition that may affect mortality and it was recommended to perform a 12-lead ECG before surgery.[30] From the similarities obtained, it appears that comorbidity, residence status, albumin status, ASA categories, and ECG had the largest coefficients on the probability of in-hospital mortality in older patients. An interesting point was found in the functional status variables, which in the bivariate analysis were significant ($p<0.0001$) and in the multivariate analysis were not significant. The independent variables were checked with the variance inflation factor; indeed, there was no collinearity between the independent variables. ROC of ≥ 94.1 % means that the combination of the above variables has accuracy in predicting postoperative mortality in 94.1% of the cases, which means it is very accurate.

As regards limitations, this is a retrospective cohort study with limited data completeness. A prospective cohort study is warranted.

CONCLUSION

In this study, factors associated with in-hospital mortality were comorbidities >2, single living status, hypoalbumin, ASA ≥ 2, and ECG abnormality. Moreover, the model combining these variables has an accuracy of >90 % in predicting postoperative mortality.

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CONFLICT OF INTEREST

All authors declare that they have no conflict of interest.

ETHICAL STATEMENT

The study was conducted according to the principles of the Helsinki Declaration, and it was approved by the ethical committee of Dr. Kariadi Hospital Semarang (No.884/EC/KEPK-RSDK/2021).

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AUTHOR CONTRIBUTION

All of the authors contributed equally to this work.

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