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SCIENTIFIC ARTICLE

The very elderly surgical population in a critically ill scenario: clinical characteristics and outcomes

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Abstract

Background: The elderly population is an especially heterogeneous group of patients with a rising number of surgical interventions being performed in the very elderly patient. The aim of this study was to evaluate the correlation between different age strata and functional status with the surgical outcome of the elderly patient.

Methods: Retrospective cohort study conducted in a Surgical Intensive Care Unit (SICU), between 2006 and 2013. A total of 2331 surgical patients' $\geq$ 65 years old were included. Patients were grouped according to age: Older Elderly Group (OEG: 65–85 years old); Very Elderly Group (VEG > 85 years old). Demographic and perioperative data were recorded. Revised Cardiac Risk Index, APACHE II and SAPS II scores were calculated and postoperative complications were documented. Variables were compared on univariate analysis.

Results: The incidence of the VEG was 5.4%. This group had a higher proportion of non-elective surgery (22.4% vs. 11.2%, $p < 0.001$), higher APACHE II (12.0 vs. 10.0, $p < 0.001$) and SAPS II (26.6 vs. 22.2, $p < 0.001$) scores, higher incidence of organ failure (24.6% vs. 17.6%, $p = 0.048$) and a higher mortality rate during SICU (14.0% vs. 5.2%, $p = 0.026$) and hospital stay (9.3% vs. 5.0%, $p = 0.012$).

Conclusion: We found that very elderly patients represented a significant proportion of patients admitted to the SICU. They had higher severity scores with a higher prevalence of organ failure and were more likely to undergo non-elective surgery. They had worse outcomes in regarding mortality during SICU and hospital stay.

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A população cirúrgica muito idosa em cuidados intensivos: características clínicas e desfechos

Resumo

Introdução: A população idosa envolve um grupo muito heterogêneo de doentes, com um crescente número de doentes muito idosos a serem propostos para cirurgia. O objetivo do presente estudo foi avaliar a relação entre diferentes grupos etários e estados funcionais com os resultados cirúrgicos do doente idoso.

Métodos: Estudo retrospectivo de coorte realizado em uma Unidade de Cuidados Intensivos Cirúrgica (UCIC) que incluiu um total de 2331 doentes cirúrgicos com idade ≥ 65 anos, entre 2006 e 2013. Os doentes foram agrupados de acordo com a idade: doentes idosos (65–85 anos); doentes muito idosos (DMI > 85 anos). Dados demográficos e perioperatórios foram registrados. Índice de Risco Cardíaco Revisto, *scores* de APACHE e SAPS II foram calculados e complicações pós-operatórias, documentadas. As variáveis foram comparadas em análise univariada.

Resultados: A incidência de DMI foi de 5,4%. Este grupo foi mais frequentemente submetido à cirurgia não eletiva (22,4% vs. 11,2%; $p < 0,001$, apresentou *scores* maiores de APACHE II (12,0 vs. 10,0; $p < 0,001$ e SAPS II 26,6 vs. 22,2; $p < 0,001$, maior incidência de insuficiência do órgão 24,6% vs. 17,6%; $p = 0,048$ e uma mortalidade superior na UCIC 14,0% vs. 5,2%; $p = 0,026$ e no hospital 9,3% vs. 5,0%; $p = 0,012$.

Discussão: Os piores resultados nos DMI podem refletir uma maior vulnerabilidade a complicações pós-operatórias, possivelmente relacionadas com múltiplas comorbilidades e uma reserva fisiológica diminuídas.

Conclusão: Os doentes muito idosos representaram uma porção importante dos doentes admitidos na UCIC, tinham *scores* de gravidade mais elevados e maior prevalência de falência orgânica e foram mais frequentemente submetidos a cirurgias não eletivas. Tinham piores resultados relativamente à mortalidade durante a permanência na UCIC e no hospital.

Introduction

The global population is aging. With a better healthcare and an improvement in quality of life, the proportion of older people is gradually increasing, especially in developed countries.[1,2]

Conventionally ''elderly'' has been defined as a chronological age of 65+ years old. For this era, with a life expectancy of 80 years, such a definition of elderly to simply include all people over 65 years might no longer be appropriate, especially in what concern to health issues.[3,4]

In some health studies, elderly patients had been sub divided into different groups: ''young elderly'' for patients aged between 65–75 years, ''older elderly'' between 75–85 years and ''very elderly'' for those > 85 years.[3,5,6] The last group is expected to grow faster than any other category.[6]

Between 2006 and 2014, the number of surgeries for patients > 85 years old increased three times.[3] As life expectancy is continuously rising and older age is associated with a greater prevalence of chronic illnesses and functional decline, there has been an increasing rate of hospitalization and more elderly patients are being submitted to surgical care.[7,8]

Postoperative complications are an important cause of death and admission to Intensive Care Unit (ICU).[9,10] As older age is associated with an increased prevalence of comorbidities, older patients are more prone to suffer morbid events.[2] The mean age of patients admitted to ICU is steadily increasing. In 2010, very old patients were responsible for more than 10% of ICU admissions in developed countries.[1]

Even though age is considered an important independent risk factor for hospital and ICU mortality, there are other factors, such as patients' functional status, that might influence prognosis.[8,11]

For patients admitted to the ICU, there is several risk models used to quantify disease severity and predict outcome. The Acute Physiology and Chronic Health Evaluation (APACHE) II and Simplified Acute Physiology Score (SAPS) II are two of the most commonly used. These scores help stratify the patients' risk and predict prognosis.[12–15]

The elderly population is an especially heterogeneous group. With the very elderly patients representing an important increasing group admitted to the operating room and, consequently, to Surgical Intensive Care Unit (SICU), it is essential to understand how they may differ from the other ''young'' elderly patients, in order to predict and prevent further complications.

Therefore, the aim of this study was to compare surgical outcomes between patients aged > 85 years old and patients aged between 65–85, admitted to SICU after non-cardiac and non-neurological surgeries, discussing the relevance of age and patients' functional status in outcomes.

Methods

After approval from the institutional research ethics committee for health, this retrospective cohort study was conducted at the post-anesthesia care unit of a tertiary hospital. The unit has a five-bed SICU where patients are closely monitored and treated. SICU admissions were determined according to surgical risk, previous health status and the occurrence of adverse events. All patients included were submitted to non-cardiac, non-neurological surgery between January 2006 and July 2013. Exclusion criteria were patients aged < 65 years old, non-surgical patients, readmitted for the same medical reason during the study period and patients with a length of stay at SICU < 12 hours.

Patients were divided into two groups according to their age: the Older Elderly Group (OEG) for patients aged between 65 and 85 years old and the Very Elderly Group (VEG) for those aged > 85 years old.

Demographic and perioperative data were recorded at SICU admission as age, gender, type of surgery (elective or non-elective). An individual cardiac risk profile was scored for each patient using the Revised Cardiac Risk Index (RCRI) developed by Lee et al. The RCRI include the following variables: high risk surgery, history of congestive heart failure, history of ischemic heart disease, history of cerebrovascular disease, diabetes with insulin therapy, and a preoperative serum creatinine > 2.0 mg.dL^{-1}.[16]

Table 1 Univariate analysis of patient's demographics and perioperative data.

Variables	OEG (65–85 years old) n = 2205	VEG (> 85 years old) n = 126	p-value
Gender, n (%)			<0.001[a]
Male	1400 (63.5)	52 (41.3)	
Female	805 (36.5)	74 (58.7)	
Type of admission, n (%)			<0.001[a]
Elective surgery	1942 (88.8)	97 (77.6)	
Non-elective surgery	245 (11.2)	28 (22.4)	
High risk surgery, n (%)	1245 (56.5)	59 (46.8)	0.034[a]
History of ischemic heart disease, n (%)	421 (19.1)	21 (16.7)	0.499[a]
History of congestive heart disease, n (%)	462 (21.0)	45 (35.7)	<0.001[a]
History of cerebrovascular disease, n (%)	412 (18.7)	20 (15.9)	0.430[a]
Preoperative insulin therapy, n (%)	139 (6.3)	7 (5.6)	0.736[a]
Chronic renal failure, n (%)	169 (7.7)	14 (11.1)	0.162[a]
RCRI, n (%)			0.830[a]
≤ 2	1964 (89.1)	113 (89.7)	
> 2	241 (10.9)	13 (10.3)	
Glasgow coma scale, n (%)			0.968[a]
≤ 7	34 (1.5)	2 (1.6)	
> 7	2171 (98.5)	124 (98.4)	
Mechanical ventilation, n (%)	651 (29.5)	32 (25.4)	0.322[a]
Body temperature (°C), median (IQR)	35.7 (34.5–36.0)	35.6 (34.6–36.0)	0.812[b]
Heart rate (beats per min), median (IQR)	85 (70–96)	78 (65–93)	0.589[b]
Systolic pressure (mmHg), median (IQR)	122 (102–145)	121 (99–140)	0.082[b]
Mean arterial pressure (mmHg), median (IQR)	85 (70–96)	78 (65–93)	0.015[b]
Respiratory rate, median (IQR)	14 (12–16)	14 (12–16)	0.621[b]
Haematocrit (%), median (IQR)	33.0 (29.5–36.0)	32.3 (30.0–35.6)	0.281[b]
Serum urea (mg.dL^{-1}), median (IQR)	32 (22–46)	36 (25–50)	0.046[b]
Serum creatinine (mg.L^{-1}), median (IQR)	9.0 (7.0–12.0)	10.0 (7.0–13.0)	0.288[b]
Total bilirubin (mg.L^{-1}), median (IQR)	5.0 (1.0–7.0)	4.0 (1.0–7.0)	0.118[b]
Leucocyte count, median (IQR)	10.4 (7.6–13.4)	10.6 (7.7–13.0)	0.894[b]
Serum sodium (mEq.L^{-1}), median (IQR)	140 (137–142)	139 (137–142)	0.293[b]
Serum potassium (mEq.L^{-1}), median (IQR)	3.8 (3.4–4.1)	3.8 (3.3–4.0)	0.330[b]
FiO$_2$ (%), median (IQR)	0.40 (035–0.40)	0.40 (0.33–0.40)	0.148[b]
pH, median (IQR)	7.4 (7.3–7.4)	7.4 (7.3–7.4)	0.648[b]
PaO$_2$ (mmHg), median (IQR)	100.0 (99.0–109.0)	100.0 (100.0–105.0)	0.695[b]
PaCO$_2$ (mmHg), median (IQR)	40.0 (35.0–45.0)	41.0 (35.7–45.0)	0.096[b]
Serum bicarbonate (mmoL.L^{-1}), median (IQR)	22 (21–24)	22 (21–24)	0.080[b]

FiO$_2$, Fraction of Inspired Oxygen; OEG, Older Elderly Group; PaO$_2$, Partial Pressure Arterial Oxygen; PaCO$_2$, Partial pressure Arterial Carbon Dioxide; RCRI, Revised Cardiac Risk Index; VEG, Very Elderly Group; n, number; IQR, Interquartile range (P25–P75).
[a] Chi-square test.
[b] Mann-Whitney U test.

Table 2 Univariate analysis for Severity of Disease Scoring Systems, Length of stay in SICU, Postoperative complications and Mortality.

Variables	OEG (65–85 years old) n = 2205	VEG (> 85 years old) n = 126	p-values
APACHE II, median (IQR)	10.0 (8.8–13.0)	12.0 (9.0–15.3)	<0.001[b]
SAPS II, median (IQR)	22.2 (17.8–28.9)	26.6 (20.0–33.9)	<0.001[b]
Length of stay in SICU, hours, median (IQR)	20.0 (16.0–41.0)	20.0 (16.0–43.0)	0.898[b]
Organ insufficiency,[c] n (%)	389 (17.6)	31 (24.6)	0.048[a]
MACE, n (%)	74 (3.4)	1 (0.8)	0.079[a]
ARF, n (%)	167 (7.6)	14 (11.1)	0.149[a]
Mortality in SICU, n (%)	120 (5.2)	6 (14.0)	0.026[a]
Mortality in hospital, n (%)	105 (5.0)	21 (9.3)	0.012[a]

APACHE II, Acute Physiology and Chronic Health Evaluation; ARF, Acute Renal Failure; MACE, Major Adverse Cardiac Events; OEG, Older Elderly Group; SAPS II, Simplified Acute Physiology Score II; SICU, Surgical Intensive Care Unit; VEG, Very Elderly Group; n, number; IQR, Interquartile range (P25–P75).
[a] Chi-square test.
[b] Mann-Whitney test.
[c] Organ insufficiency as defined by APACHE II.

Acute Physiology and Chronic Health Evaluation (APACHE) II and Simplified Acute Physiology Score (SAPS) II were calculated as original described. Beyond age and previous health status, both rely also on physiologic measurements, including hemodynamic factors (systolic blood pressure, mean arterial pressure, heart rate, respiratory rate and body temperature); complete blood counts and blood biochemistry (haematocrit, leucocyte count, serum sodium, potassium, bilirubin, urea and creatinine); arterial gases (arterial pH, PaO_2, $PaCO_2$ and serum bicarbonate) and Glasgow Coma Scale, measured during the first 24 hours of SICU admission.[13,14] APACHE II and SAPS II enables stratification of acutely ill patients and performs similarly in predicting the outcomes of patients at SICU.[15] Organ insufficiency was established when there was failure of at least one organ, defined according to APACHE II.[13] Need for postoperative mechanical ventilation and the fraction of inspired oxygen at admission were also documented.

Postoperative complications were also documented as Major Adverse Cardiac Events (MACE): acute myocardial infarction, acute pulmonary oedema, ventricular fibrillation, complete heart block and cardiorespiratory arrest; Acute Renal Failure (ARF): serum creatinine > 2 mg.dL⁻¹, associated with a urinary output lower than 500 mL/day and death during SICU and hospital stay. Length of stay at SICU was also recorded.

Statistical analysis was performed using SPSS version 22.0 software (SPSS Inc., Chicago, Illinois, USA). A descriptive analysis was performed to summarize the collected data. Categorical variables are presented as number and percentage. For continuous variables, after confirmation on the Kolmogorov Smirnov test, data that not followed a normal distribution are presented as median and percentile interval (P25–P75). Variables were compared on univariate analysis: the chi-square or Fischer's exact test for categorical variables; Mann-Whitney U test for continuous variables. Variables were considered significant at values of $p < 0.05$.

Results

A total of 2331 patients met the inclusion criteria. One hundred and twenty six patients (5.4%) were included in the very elderly group (VEG – aged > 85 years old) and 2205 (94.6%) in the older elderly group (OEG – aged between 65–85 years old).

During the study period, we found a total incidence of organ insufficiency of 18.0% (420 patients). ARF happened in 181 (7.8%) and MACE in 75 (3.2%) patients. Six hundred and eighty three patients (29.3%) were mechanically ventilated at SICU admission. We found an incidence of mortality in SICU and also in hospital of 5.4% (126 patients).

Demographic and perioperative data comparing the two groups mentioned above are presented in Table 1.

There was a higher proportion of female patients in the VEG comparing to the younger OEG (58.7% vs. 36.5%, $p < 0.001$). The majority of patients were admitted in the context of an elective surgery, but a higher proportion of the VEG were submitted to a non-elective surgery (22.4% vs. 11.2%, $p < 0.001$). There were no differences in the total score of RCRI when considering a cutoff of 2, but a higher proportion of patients submitted to a high risk surgery was found in the OEG (56.5% vs. 46.8%, $p = 0.034$), conversely VEG showed a higher incidence of history of congestive heart disease (35.7% vs. 21.0%, $p < 0.001$). We did not find any significant difference between groups in respect to physiological, hemodynamic or laboratory variables, other than mean arterial pressure that was lower in the VEG (median 78 vs. 85, $p = 0.015$) and serum urea higher in VEG (median 36 vs. 32, $p = 0.046$). However, disease scoring systems showed differences between the two groups. Table 2 presents data related to APACHE II and SAPS II, length of stay in the SICU and adverse outcomes as organ insufficiency, MACE, ARF and mortality. The VEG showed higher scores at APACHE II (median 12.0 vs. 10.0, $p < 0.001$) and SAPS II (median 26.6 vs. 22.2, $p < 0.001$). There were no differences between groups in respect to mechanical ventilation, in the incidence of MACE, ARF and in the length of stay in SICU. However, VEG

patients had a higher incidence of organ insufficiency (24.6% vs. 17.6%, $p = 0.048$), had a higher mortality rate in SICU (14.0% vs. 5.2%, $p = 0.026$) and during the hospital stay (9.3% vs. 5.0%, $p = 0.012$).

Discussion

With this retrospective cohort study, we evaluated the correlation between different age strata and surgical outcome of the elderly patient. The principal findings of our study were as follows: a) VEG patients represented a significant proportion of patients admitted to the SICU; b) A higher proportion of the VEG patients were submitted to a non-elective surgery; c) VEG patients showed a higher incidence of history of congestive heart disease; d) The VEG patients showed higher severity scores at SICU admission and had a higher incidence of organ insufficiency and e) VEG patients had higher mortality rate in SICU and during the hospital stay.

There are some limitations in this study that should be considered. The retrospective nature of the study with its inherent flaws must be noted. The number of patients in the VEG was small comparing to the younger OEG, which could limit our results. Being a study with a single-center design performed at a university hospital, the results could not be applicable to other centers. Even though we included variables such as type and risk of surgery, we did not include any measure of the patients' frailty status, nor any comorbidities other than those present in RCRI score. However, there are some components of this research that add important information to the study and might overcome these limitations, as the collection of significant quantitative data obtained on the entry of these patients in the ICU.

Elderly patients represent a large fraction of all surgical procedures. Older age is a risk factor for perioperative mortality, but preoperative comorbidity, frailty and invasiveness of the surgical procedure are another important predictors of mortality.[17]

Despite advanced age have been considered an important independent risk factor for adverse outcomes and mortality in critically ill patients, the elderly population is a heterogeneous group, and differences inside this vast group of patients may be expected.[11,18]

In our study, we found an incidence of 5.4% very elderly patients (VEG > 85 years old) admitted to a surgical intensive care unit. The ratio of gender was different between groups with the proportion of women being higher in the VEG population. Women's prolonged life expectancy may explain this gap between groups.[2] The preponderance of female gender among the very elderly has been described in some studies and several countries.[2]

In this study, we observed a higher mortality rate in the VEG, not only in SICU but also in hospital, as was also shown in other previous studies.[1,8] Several efforts have been made to determine if age is a major predictor of ICU outcome for elderly patients. Hamel and contributors concluded that age was independently associated with a worse survival rate in older patients admitted to the ICU, not related to a lesser intensive therapy strategy.[18] While many studies suggest that age is a very important and independent predictor of mortality following ICU admission, with mortality rates rising with age, other studies questioned the importance of age as a major determinant in the outcome of critical diseases, being the prognosis predicted more strongly by severity of illness, length of stay, respiratory insufficiency and prior ICU admission.[11]

Age is probably an important factor that must be associated with illness severity, comorbidities, frailty and functional status prior to ICU admission.[19] Therefore, age is a component of disease scoring systems as APACHE II and SAPS II.[13,14] These systems are regularly used to stratify patient's risk indicating the severity of underlying disease, which is subsequently associated with prognosis and mortality.[20,21] In the present study, VEG patients showed higher scores in APACHE II and SAPS II, which can represent a higher severity of disease and a poorer functional status in this group. Chelluri et al. concluded that APACHE II score was the most important predictor of mortality in the very elderly.[6] Accordingly, Lee et al. observed that postoperative APACHE II score on ICU admission in patients aged > 85 years old was an important prognostic predictor.[3] In a large cohort study in Australia and New Zealand, Bagshaw et al. reported a greater severity of illness in the age strata > 80 years old when compared to younger patients.[8] As for SAPS II, a very recent study found to be an independent prognosis factor for mortality in octogenarians.[22]

The individual risk for adverse events also depends on the burden of comorbidities and other risk factors such as the risk of surgery.[23] RCRI estimates risk of perioperative cardiac complications in non-cardiac surgery. This score is widely adopted since it plays an important role in preoperative stratification.[24] RCRI is acceptable for all ages, so it is reasonable to use it even in the very elderly patients.[23] In a prospective cohort study by Hirano et al., elderly patient's higher RCRI score was related to an increased post-operative morbidity and length of stay in the hospital.[24] In the present study, RCRI scores did not differ between groups, only two variables at this index showed differences: high risk surgery, with a higher proportion in the OEG, and history of congestive heart failure, more frequently in VEG. This probably reflects for the VEG a lesser proposal for higher risk surgeries and a higher prevalence of comorbidities. A recent study in a geriatric cohort suggested that RCRI tends to underrate the real cardiac risk in the elderly and that a new Geriatric-Sensitive Cardiac Risk Index (GSCRI) is a better indicator of cardiac risk in these patients.[25] We did not find differences in the incidence of MACE and ARF, however the incidence of organ insufficiency was higher in VEG. This could be explained by a greater amount of chronic diseases and a reduced individual's organ physiological reserve. Adding the surgical stress and hemodynamic lability this could led more easily to an organ failure and worse outcomes.

The VEG was more often submitted to non-elective surgery comparing to the OEG. Urgent surgery together with a higher prevalence of comorbidities and a worse functional status may all contribute to a lower survival in this group of patients.

In this era, with many more elderly patients undergoing surgery and being admitted to intensive care, this study brings to discussion the differences between chronological and physiological age. Since APACHE II and SAPS II date from 1985 and 1993, with an aging population in the recent

decades, it is important to discuss the way age is incorporated in these scoring systems.

It is necessary to rethink the way we look to the elderly patients, studying the physiological differences and the functional decline that happens in different strata of elderly patients. These differences may explain different consequences on events and outcomes.

Conclusion

We found that very elderly patients represented a significant proportion of patients admitted to the SICU; they had higher severity scores with a higher prevalence of organ failure and were more likely to undergo non-elective surgery. They had worse outcomes regarding mortality during SICU and hospital stay.

Conflicts of interest

The authors declare no conflicts of interest.

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