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# Prognostic factors in elderly patients admitted in the intensive care unit

*Fatores prognósticos em pacientes idosos admitidos em unidade de terapia intensiva*

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## ABSTRACT

Currently, aging of the population is a widespread global phenomenon. Therefore, the assessment of prognosis in elderly patients is needed. This study aims to identify risk factors in a population of elderly patients admitted in the intensive care unit **Methods**: A prospective study in the intensive care unit of a general tertiary hospital was carried out for five months. Patients with 65 years or more of age, who stayed in the intensive care unit for 24 hours or more were included and those at the-end-of-life, patients readmitted to intensive care unit during the same hospital stay were excluded. **Results:** In this study 199 patients were involved, with a mean age of 75.4±6.8 years, and 58.8% were female. Mortality was 57.3%. The mean APACHE II, SOFA, MODS and Katz index (assessment of daily activities) were respectively 20.0±5.8, 6.8±3.9, 2.4±1.9 and 5.3±1.6. Most patients were postoperative 59.3% and 41.6% were under invasive mechanical ventilation. At regression analysis, the independent determinants of higher mortality were: older age (76.9±6.7 years death versus 73.3±6.5 years discharge, P<0.001, OR=1.08, CI 95% 1.01-1. 16), the Katz index (4.9±1.9 deaths versus 5.7±0.9 discharge, p=0.001, OR=0.66, CI 95% 0.45-0.98), hyperglycemia (158.1±69.0 death versus 139.6±48.5 discharge p=0.041; OR=1.02; CI 95% 1.01-1.03) and need for mechanical ventilation at admission to the intensive care unit (57.0% death versus 20.5% discharge p <0.001, OR=3.57, CI 95% 1.24-10.3).

**Conclusion:** Elderly patients admitted to the intensive care unit that have difficulties in performing daily activities, hyperglycemia and who are under invasive mechanical ventilation had a worse hospital prognosis.

**Keywords:** Elderly; Intensive care units; Prognosis; Risk factors

## INTRODUCTION

Currently aging of the population is a prevailing global phenomenon. In the United States, the fastest growing segment of population includes those aged over 65 years. There, the number of people present in this group increased approximately 1000%, from 3.1 million in 1900 to 35 million in 2000.[1] In Brazil, a recent review of the Brazilian Institute of Geography and Statistics (IBGE) showed that in 2000, 30% of Brazilians were in the age bracket of up to 14 years, while those over 65 years of age accounted for 5% of the population. In a projection for 2050, these two age groups will be equal: each representing 18% of the overall Brazilian

population.[2]

In intensive care units (ICU) of the U.S., the aged represent 42% to 52% of all admissions and almost 60% of all daily ICU charges.[3] Advanced age is associated with increased mortality in these patients.[4] However, studies in specific subgroups of the elderly have shown that mortality can range from 4.3% to 22.1% for patients more that 85 years old, admitted because of surgery, 15% to 25% for neurosurgical causes and 39 to 48% for medical clinical causes.[5,6] Therefore, age is not solely responsible for the lower survival, but also the individual's functional capacity prior to ICU admission and severity of the disease causing admission.[7]

Faced with aging, the body's functional reserves become reduced, with a decline of the cardiovascular, pulmonary and renal functions. In addition, there is a reduction of muscle mass and strength as well as loss of memory. These changes significantly impact the environment of the ICU, where, considering age alone, management of ventilatory and hemodynamic conditions would be difficult.[3]

A practice that has been introduced since 1981 with the publication of the Acute Physiology and Chronic Health Evaluation (APACHE),[8] is the assessment of severity and prognosis of patients admitted to ICU. Prognostic indices such as APACHE are assessment tools related to clinical outcome, laboratory and physiological changes that can orient care while providing parameters for clinical follow-up and patient prognosis.[9]

Since then, several studies have been conducted to obtain the best correlation between the prognostic index and the real outcome of these patients. Many other models and variables have been published and validated. However, little is known neither about the actual correlation of this data in geriatric patients, nor about the impact of cognitive and functional status prior to admission to the ICU.

Considering the need for assessment of prognosis in elderly patients in the ICU the purpose of this study was to identify risk factors in a population of elderly patients admitted to ICU.

## METHODS

After approval by the Ethics and Research Committee a prospective longitudinal study was conducted in general ICU of a tertiary hospital, from December 1, 2006 to April 30, 2007.

Patients aged 65 years or more, with a 24 hours or more stay in the ICU were included in the study. Patients at the end- of- life or at end-stage of chronic or neoplastic disease and those readmitted to ICU during the same hospital stay were excluded, that is to say, only the first admission was considered.

Demographic data of patients admitted and who met the inclusion criteria for this study were collected, also for calculation of prognostic scores, considering the worst results of the last 24 hours prior to inclusion in the study, found in the routine laboratory tests as part of the ICU care. Variables of perfusion, Basic Activities of Daily Living (Katz) index[10,11] and complications of stay , were also collected (Table 1).

**Table 1 – Katz Index (Independence in Activities of Daily Living)[10,11]**

| Activity | Independent |
|---|---|
| 1. Bath | Does not receive help or only help for a part of the body |
| 2. Dress | Pick up clothes and dresses without any help, except for tying shoes |
| 3.Personal hygiene | Goes to the bathroom, uses the bathroom, dresses and returns without any help (may use a cane or walker) |
| 4. Mobility | Manages to lie down in the bed, sit in the chair and get up without help (may use a cane or walker) |
| 5. Continence | Completely controls urine and feces |
| 6. Food | Eats without help (except for cutting meat or buttering) |

The number of points is the sum of "yes". Independence: 6 points; Partial dependence: 4 points; Important dependence: 2 points.

Disease severity was assessed using the Acute Physiology and Chronic Health Evaluation II (APACHE II),[12] Sequential Organ Failure Assessment (SOFA),[13] Multiple Organ Dysfunction Score (MODS)[14] and KATZ [10,11] scores. Patients were followed until discharge or hospital death.

Data were expressed as mean ± standard deviation, median (25-75%) and percentages. Continuous variables with normal distribution were evaluated by parametric method Student's t test and categorical variables by Chi-square test. Patient characteristics and odds ratio (OR) and corresponding confidence intervals (CI) were calculated by stepwise logistic regression analysis to identify independent risk factors and control confusion effects.

Only the significant variables in univariate analysis were submitted to logistic regression. The addition of other variables that are considered important from a clinical point of view (e.g., length of hospital stay before ICU admission) would provide4 the model with many degrees of freedom and collinearities, which make the regression unstable. Thus, only variables with greater statistical power were considered in the model. That is why we decided to maintain in the regression only variables with significance in univariate analysis.

All significance probabilities (p values) presented were of the double-tailed type and values of less than 0.05 were considered statistically significant. Statistical analysis was performed using the SPSS (v13, Chicago, IL).

## RESULTS

A total of 453 patients was admitted to the ICU during this period, 237 patients were older than 65 years, however only 199 patients participated in the study, 9 patients were considered at the-end-of-life , 3 were discharged before 24 hours of ICU and 26 patients readmitted were also excluded. The mean age was 75.4±6.8 years, 58.8% were female. Mortality in the ICU and hospital in this population was respectively 28.1% and 57.3% (Table 2).

At univariate analysis the variables that discriminated in-hospital mortality were age, clinical patients, emergency surgery, APACHE II, SOFA, MODS, Katz index, use of vasopressors, invasive mechanical ventilation, urine output, lower Glasgow score and blood glucose (Table 3).

At logistic regression, considering only the significant variables in univariate analysis, only age, Katz index, blood glucose and use of invasive mechanical ventilation independently discriminated hospital mortality (Table 4).

Regarding ICU mortality, it was noted that besides the Katz index and use of invasive mechanical ventilation, use of vasopressors (OR = 3.12, p = 0.015, CI = 1.24-7.83) and SOFA score (OR = 1. 12, p = 0.047, CI = 1. 04-1.28), were also independent factors of death in the ICU. Furthermore, age and blood glucose did not show the same statistical power when compared to hospital mortality. However, considering the short time of assessment when ICU mortality was analyzed, hospital outcome continued to be the main objective.

**Table 2 – Patient characteristics**

| Variables | Characteristics |
|---|---|
| Age (Years) | 75.4 ± 6.8 |
| Female gender | 58.8 |
| Hospital mortality | 57.3 |
| ICU mortality | 28.1 |
| Weight (Kg) | 71.9±36.1 |
| Height (cm) | 164.7±7.8 |
| APACHE II | 20.0±5.8 |
| SOFA | 6.8±3.9 |
| MODS | 2.4±1.9 |
| KATZ index | 5.3±1.6 |
| Clinical patients | 40.7 |
| Surgical patients | 59.3 |
| Emergency surgery | 38.3 |
| Elective surgery | 61.7 |
| Origin | |
| Surgery center | 59.3 |
| Wards | 29.2 |
| Emergency room | 11.4 |
| Reason for ICU admission | |
| High risk postoperative | 57.3 |
| Respiratory failure | 18.1 |
| Level of consciousness alteration | 9.5 |
| Shock | 5.0 |
| Coronary disease | 3.0 |
| Sepsis | 1.0 |
| Metabolic disorder | 1.0 |
| Pancreatitis | 1.0 |
| Disorder of cardiac rhythm | 0.5 |
| Digestive hemorrhage | 0.5 |
| Others | 3.0 |
| Albumin (g/dl) | 2.5 ± 0.8 |
| Blood glucose(g/dl) | 150.4 ± 12.0 |
| Lactate (mmo/L) | 2.2 ± 0.9 |
| Lower value of Glasgow score | 13.1 ± 3.4 |
| Urinary output (ml) | 1400.0 (775.0-2375.0) |
| Use of vasopressors | 39.1 |
| Invasive mechanical ventilation | 41.6 |
| Days of hospital admission prior to ICU admission | 6.0 (2.0-15.0) |
| ICU days length of stay | 4.0 (2.0-9.0) |
| Hospital days length of stay | 23.0 (13.0-37.0) |

APACHE - Acute Physiology and Chronic Health Evaluation; SOFA - Sequential Organ Failure Assessment; MODS - Multiple Organ Dysfunction Score; ICU- intensive care unit. Results expressed in means ± standard deviation, median (25-75%) or %.

**Table 3- Univariate analysis of survivors and non-survivors**

| Variables | Non-survivors (N=114) | Survivors (N=85) | P value |
|---|---|---|---|
| Age (years) | 76.9±6.7 | 73.3±6.5 | <0.001 |
| Female gender | 59.6 | 57.6 | 0.777 |
| Weight (Kg) | 73.8±46.1 | 69.1±13.2 | 0.420 |
| Height (cm) | 164.8±7.6 | 164.6±8.3 | 0.895 |
| APACHE II | 21.4±6.0 | 18.0±4.9 | <0.001 |
| SOFA | 8.0±3.8 | 5.6±3.6 | <0.001 |
| MODS | 6.3±2.9 | 4.5±2.7 | <0.001 |
| KATZ index | 4.9±1.9 | 5.7±0.9 | 0.001 |
| Clinical patients | 52.6 | 24.7 | <0.001 |
| Surgical patients | 47.4 | 75.3 | <0.001 |
| Emergency surgery | 50.9 | 27.7 | 0.009 |
| Elective surgery | 49.1 | 72.3 | 0.009 |
| Albumin (g/dl) | 2.5±0.9 | 2.6±0.7 | 0.550 |
| Blood glucose (g/dl) | 158.1±69.0 | 139.6±48.5 | 0.041 |
| Lactate (mmo/L) | 3.1±2.2 | 3.1±2.0 | 0.967 |
| Lowest value of Glasgow score | 12.2±3.9 | 14.2±2.0 | <0.001 |
| Urine output (ml) | 1354.0±1181.4 | 2136.2±1179.1 | <0.001 |
| Use of vasopressors | 48.2 | 26.5 | 0.002 |
| Invasive mechanical ventilation | 57.0 | 20.5 | <0.001 |
| Hospital days length of stay | 29.4±22.4 | 28.2±21.9 | 0.701 |
| Days of hospital stay prior to ICU admission | 10.2±11.3 | 9.2±9.9 | 0.489 |

APACHE - Acute Physiology and Chronic Health Evaluation; SOFA - Sequential Organ Failure Assessment; MODS - Multiple Organ Dysfunction Score; ICU– intensive care unit. Results expressed in means ± standard deviation, or %.

**Table 4- Multivariate analysis for independent death factors**

| Variables | P value | OR (CI95%) |
|---|---|---|
| Age | 0.02 | 1.08 (1.01-1.16) |
| APACHE II | 0.76 | 1.02 (0.89-1.18) |
| SOFA | 0.58 | 1.09 (0.8-1.48) |
| MODS | 0.44 | 0.88 (0.64-1.21) |
| KATZ index | 0.04 | 0.66 (0.45-0.98) |
| Clinical patients | 1.00 | 0.00 (0.0-∞) |
| Emergency surgery | 0.34 | 1.72 (0.56-5.33) |
| Glucose | 0.01 | 1.02 (1.01-1.03) |
| Lowest Glasgow value | 0.18 | 0.87 (0.71-1.06) |
| Urinary output | 0.19 | 1.00 (0.99-1.0) |
| Use of vasopressors | 0.29 | 1.98 (0.55-7.12) |
| Invasive mechanical ventilation | 0.02 | 3.57 (1.24-10.3) |

OR - odds ratio; CI95% - confidence interval of 95%; APACHE - Acute Physiology and Chronic Health Evaluation; SOFA - Sequential Organ Failure Assessment; MODS - Multiple Organ Dysfunction Score.

## DISCUSSION

In this study the main risk factors associated with death of the elderly are related to their old age, Katz index, high blood glucose and need for invasive mechanical ventilation upon ICU admission.

In the present study higher hospital mortality was found than in the ICU. Among the elderly, chronic conditions tend to be more pronounced and in this phase, often occur simultaneously. Such conditions usually are not fatal; however they tend to significantly impair the quality of life of older people. In most cases, they may spur what might be called the disabling process, that is to say, the process by which a given condition (acute or chronic) affects the elderly functionality and, consequently, the performance of daily activities.[15] This fact that may have contributed to higher hospital mortality in relation to that in the ICU, therefore, these patients require greater care after discharge from the ICU, which may provide a worse hospital outcome.

Advanced age interferes with the prognosis, as shown in this study, some research shows advanced age as an important independent predictor of mortality.[16,17] Survival in the short term, of patients with more than 65 years of

age is significantly lower than in the younger.[18] Finally, after discharge, deaths occur predominantly during the first three months.[18] As such, aging per se is a risk factor for mortality in the long-term, risk of death increases with the number of comorbidities, poor cognitive function and difficulty in performing routine activities.

Based upon these assumptions, that the assessment of capacity to perform routine activities can affect the evolution of elderly patients, this study showed that assessment of the Katz index was better than other scores to reach a prognosis in this population.

Katz et al. significantly demonstrated that recovery of functional performance of six activities considered basic in the daily life of elderly with disabilities (bathing, dressing, toileting, moving around, being continent and feeding himself) are biological and psychosocial primary functions.[19] Katz and Akpom[20] presented the classification of the Index by the number of functions in which the assessed individual is dependent. The ranking from 0, 1, 2, 3, 4, 5 or 6 reflects in a summarized manner, the number of areas of dependence.[20]

Many theories and measurement tools have been developed such as APACHE, SOFA and MODS, but in this analysis none of them was able to determine in-hospital mortality in the elderly patients. The APACHE II score was developed for the general population in intensive care and for not specific populations, elderly patients are poorly assessed by this score, because it provides high scores for the aged and for patients over 65 years of age the score is practically the same, changing just 01 point above 75 years of age.[12] For this reason, it may poorly evaluate a population over 65 years of age. On the other hand, the SOFA and MODS scores, only assess organ dysfunction and age is not included in these scores, furthermore they were developed for daily assessments, specifying the evolutionary tendency of patients are therefore not able to reach a hospital prognosis with a single assessment,[13,14] especially in an aged population that previously had presented impaired organs.

According to Katz et al., measures that appeared to be clinically reliable did not present the same reliability in their use, due to a vague or poorly defined terminology. Since they are not accurate, the information obtained with these tools is not adequate for prognosis and decision taking about treatment or care to be provided to the elderly.[19]

Moreover, it was observed in this study that in a population of elderly patients occurrence of hyperglycemia also is detrimental, recalling that in the elderly patients there is a high prevalence of sub-clinical arterial disease with potential cardiac and brain damage[21,22] reducing tolerance to hyperglycemia.[23,24]

Hyperglycemia is common in the extensive range of severe illnesses, regardless prior diagnosis of diabetes. This stress hyperglycemia was considered beneficial to ensure glucose supplementation as an energy source for organs that did not require insulin for glucose uptake, including the brain and the immune system. However, it now becomes clear that even a moderate hyperglycemia is related to unfavorable outcomes.[25]

Hyperglycemia has been identified as a risk factor for worse prognosis in many types of clinical observations including severe brain injury,[26] trauma,[27,28] myocardial infarction[29] and stroke.[30] Moderate levels of hyperglycemia occur even after ICU admission and were associated to substantial increase of death during hospital stay.[31]

Furthermore, this study showed that use of invasive mechanical ventilation was an important risk factor for death in this population. In 40 institutions of the United States and 36 from France, the proportion of patients over 65 years of age admitted to the ICU was 48% and 36% respectively.[32,33] In addition, the incidence of respiratory failure increases almost exponentially with increasing age.[34] The incidence of respiratory failure in patients over 65 years of age is two times higher than in the group of patients with 55 and 65 years of age and is three times higher than in younger patients.

Ray et al. evaluated a population of elderly patients with respiratory failure in the emergency wards, just as the present study evaluated in the ICU and found that 29% of the patients needed admission to the ICU within the first 24 hours and mortality rates were higher in other patients. Since, the PaCO2, the creatinine clearance, increased levels of natriuretic peptides and the presence of paradoxical breathing were independent variables associated with death.[35]

Thus, greater importance should be given to elderly patients who have difficulties in daily activities, hyperglycemia and are under invasive mechanical ventilation.

However, there are noteworthy limitations in this study such as an observational study which can provide bias in patient selection, for example, the fact that the vast majority were high risk surgical patients. In addition, the study was conducted in a single hospital, a fact that hinders definitive conclusions on the subject, nevertheless calculations show enough statistical power in the study. In addition, complementary data were missing in the analysis such as previous diseases associated to the cause of ICU admission and specific type of surgeries, however the number of scores involved in the analyses has the power to determine severity of the patients studied.

Thus, further studies with adequate designs are required to confirm the findings of this research.

## CONCLUSION

Follow-up of elderly patients requiring admission to the ICU requires new prognostic models aiming to correcting errors and improve performance of the service, and the Katz index was an important discriminator for poor outcome in this population. Furthermore, hyperglycemia and mechanical ventilation are risky in these patients and must be monitored and reversed as soon as possible.


## RESUMO

**Objetivos:** Atualmente o envelhecimento populacional é proeminente fenômeno mundial. Então, a avaliação do prognóstico em pacientes idosos é necessária, sendo assim o objetivo deste estudo foi identificar fatores de risco em população de pacientes idosos admitidos em unidade de terapia intensiva

**Métodos:** Foi realizado estudo prospectivo, em unidade de terapia intensiva geral de um hospital terciário, durante 5 meses. Pacientes com idade maior ou igual a 65 anos que permaneceram na unidade de terapia intensiva por tempo maior ou igual a 24 horas foram incluídos, pacientes moribundos e aqueles readmitidos na unidade de terapia intensiva durante mesma internação hospitalar foram excluídos.

**Resultados:** Foram envolvidos 199 pacientes com média de idade de 75,4± 6,8 anos, 58,8% do sexo feminino. A mortalidade hospitalar foi 57,3%. A média do APACHE II, SOFA, MODS e KATZ índice (avaliação de atividades diárias) foram respectivamente 20,0±5,8, 6,8±3,9, 2,4±1,9 e 5,3±1,6. A maioria dos pacientes estava no pós-operatório 59,3%, sendo que 41,6% estavam em uso de ventilação mecânica invasiva. Foi determinante independente de maior mortalidade através de análise de regressão: a idade avançada (76,9±6,7 anos óbito versus 73,3±6,5 anos alta; p<0,001; OR=1,08; IC95% 1,01-1,16), o índice KATZ (4,9±1,9 óbito versus 5,7±0,9 alta; p=0,001; OR=0,66; IC95% 0,45-0,98), hiperglicemia (158,1±69,0 óbito versus 139,6±48,5 alta; p=0,041; OR=1,02; IC95% 1,01-1,03) e necessidade de ventilação mecânica na admissão da unidade de terapia intensiva (57,0% óbito versus 20,5% alta; p<0,001; OR=3,57; IC95% 1,24-10,3).

**Conclusão:** Pacientes idosos admitidos na unidade de terapia intensiva que apresentam dificuldades nas atividades diárias, hiperglicemia e uso de ventilação mecânica invasiva apresentam pior prognóstico hospitalar.


**Descritores:** Idoso; Unidades de terapia intensiva; Prognóstico; Fatores de risco

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