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Fernando José Pereira Alves Abelha

Outcome in surgical critical care patients

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Outcome in surgical critical care patients

Dissertação de candidatura ao grau de Doutor apresentada à
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V. Abelha FJ, Botelho M, Fernandes V, Barros H. Outcome and quality of life of patients with acute kidney injury after major surgery. Nefrología 2009; 29(5):404-414.

VI. Abelha FJ, Botelho M, Fernandes V, Barros H. Outcome and quality of life 6 months after aorto-bifemoral bypass surgery. BMC Cardiovasc Disord 2010,10:15.

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Contents:

List of original publications 1

Introduction 3

Aims 11

Papers 15

I. Quality of life before surgical ICU admission 17

II. Quality of life after carotid endarterectomy 27

III. Predictors of major postoperative cardiac complications in a surgical ICU 39

IV. Determinants of postoperative acute kidney injury 49

V. Outcome and quality of life of patients with acute kidney injury after major surgery 61

VI. Outcome and quality of life 6 months after aorto-bifemoral bypass surgery 75

VII. Outcome after postoperative major cardiac events 87

General discussion 107

Results and Conclusions 117

Abstract 129

Resumo 133

List of Original Publications

This doctoral dissertation is based on the following seven papers.

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Introduction

The concept of the intensive care follow-up clinic has developed recently, and is commonly run on multidisciplinary lines. Intensive care has an almost unique objective, that of discharging surviving patients into the care of referring colleagues who undertake subsequent inpatient and outpatient care.
Several studies have suggested that patients who survive intensive care are at a higher risk of death than control cohorts for many years [1-3]
Five years after an Intensive Care Unit admission, survivors are reported to have an increased risk of death compared to the general population on an age and sex matched basis [4]. Survival curves for Intensive Care Unit survivors only run parallel to the general population for 2–3 years after hospital discharge.
The outcomes measured in critically ill patients can be categorized as being related to mortality or morbidity, and the primary objectives of health care should be to reduce these conditions so as to maintain and or improve functional capacity and quality of life.

For a particular patient it is difficult to predict mortality and functional outcome after hospitalization in intensive care. The diagnosis of admission may not be the only one implicated in the variability of mortality and mortality prediction usually understood as the severity of acute illness has been measured by severity of disease scores [5-6] taking into account not only the diagnostic categories for admission, but also changes in physiological variables and age. But if mortality can be well predicted by severity of disease scores, not all functional outcomes after hospitalization are explained by this score, by co-morbidities, or age during hospital care in intensive therapy.

It is becoming clear that intensive care patients continue to experience both physical (e.g. neuropathy, reduced mobility, and breathlessness [7-8]), and psychological problems (e.g. anxiety, depression and post-traumatic stress [9-12]) for some time after discharge from Intensive Care Unit. Patients are often unable to perform simple tasks because of physical exhaustion after a period of critical illness. A variety of aspects of physical status may contribute to impairment of functional capacity, which could have a major impact on quality of life.
The consequences of a period of critical illness can be seen in various organs and systems including nutritional disorders, neuropathy (axonal neuropathy occurring in

Intensive Care Unit patients), alterations in the respiratory and cardiac systems, sexual dysfunction, impaired neuropsychological outcomes (delirium, affective disorders, stress disorders, disorders of cognitive function) and social and family consequences [4].

Baseline function defined as the ability to care for one's self and live independently has been considered too as a prognostic factor in how patients fare in their physical abilities after they leave an Intensive care [13-14].

Survival analysis alone is a crude estimator of outcome and therefore it cannot justify on its own the great investment made in critical care facilities today [15]. Thus, measurements of patient health status, or quality of life have become important end-points in many clinical studies [16-17].

Quality of life is constituted by the sum of values themselves difficult to assess, such as cognitive, affective, and spiritual capacity of a person, and submitted to social, psychological, cultural, familial, relational, and individual factors [18]. The quality of life applied to health, or Health Related Quality of Life, takes into account not all dimensions of the quality of life, but those that can be changed by the disease or its treatment.

A assessment of health status and of quality of life are subjective and therefore difficult to measure, and unreliable compared to the objective physical examination and laboratory data addressed in severity of disease scores. Outcome involving quality of life is patient focused and denotes interest in the patient's perspectives in evaluating health status. By other way retrospective assessment of quality of life is always influenced by the critical illness, and the premorbid quality of life is experienced as falsely high in that a present poor status may lead to overrating preadmission quality of life [19].

Evaluating Health Related Quality of Life in survivors of critical care leads to multiple reflection, such as global care, public health, psychological consequences of ICU treatment, and medical ethics [18].

The research on quality of life outcomes in patients who require intensive care has been diverse. Some studies have examined quality of life after Intensive Care stay whereas others compared quality of life before with quality of life after admission to a critical care unit. Pre-admission quality of life varies considerably depending on the patient’s disease, and is usually said to be good in acutely ill patients and very poor in chronically ill patients, in an acute phase. There may be a relationship between quality of life and hospital mortality, with a higher mortality rate among patients with a worse quality of life.

Patients who were discharged after Intensive Care Unit stays generally experienced fairly good quality of life [20-21] and as been reported [21-22] that most survivors post-critical care were satisfied with their quality of life although when compared with the general population their scores were worse [23-24].
In a systematic review several studies are quoted investigating associations of patient age, severity of illness, admission type, gender, or ICU length of stay with quality of life in Intensive Care Unit survivors. In the same study authors have found that compared with the general population, critical care survivors have lower quality of life for all domains at baseline and at 6 months to 14 years after discharge and that quality of life improves with over time after discharge, but this improvement is not uniform across domains. Pre-existing disease seems to be the most important factor overall for long-term Health Related Quality of Life after a critical illness and a period of critical care [25].

Reasons for being admitted in Intensive Care Units are different among critical care patients and these differences are likely to result in different expectations regarding their health. Therefore, when measuring outcomes we should take into account the possibility that outcomes will vary by admission diagnostic category. It is important to understand Health Related Quality of Life according to specific Intensive Care Unit populations in order to assess the impact of specific interventions in these patients.
Examining post-hospital non-fatal outcomes may enable us to understand the needs and problems of Intensive Care Unit survivors particularly in the surgical Intensive Care Unit patients. Patients scheduled for surgery are of particular interest due to individual risk of surgical procedure which may affect outcome.
Admissions to Intensive Care Unit are not homogeneous, and generalizing findings to all Intensive Care Unit admissions may be misleading since such sample may be representative only of a global surgical population.
It may be important to study the impact on recovery from critical illness in a more homogeneous group of patients: patients submitted to a single type of surgery or patients that developed major complication after surgery [26].
Postoperative recovery is a complex process in which various outcomes can be measured: physiological end-points, adverse events, and change in psychological status [27].

Patients undergoing major elective or urgent surgery are at high risk of death and at risk of developing significant morbidity. Amongst the patients who survive, many suffer major complications with different degrees of morbidity and subsequent impairment of

general health and quality of life [28].The study of outcome after a singular surgery may help in understanding the needs of survivors and may help planning of postoperative period with a better knowledge about circumstances in which the patients may be more vulnerable.

Previous studies of recovery after surgery and anesthesia have focused primarily on physiological consequences, as well as on the incidences of adverse events, usually including data on major morbidity and mortality.

Postoperative morbidity is a major concern with regard to health care management, and negatively affects the cost of care, quality of life and survival [25, 29-30]. In this regard the study of outcome after surgery may also be viewed as the study of major complications after surgery.

The majority of deaths occur in older patients who undergo major surgery and who have severe coexisting disease but as well in those patients that develop complications. Knowing that major complications have serious impact in mortality, length of Intensive care stay and in quality of life may help the promotion of medical strategies in order to prevent their occurrence and avoid the full impact whenever they happen to occur.

Setting

Research questions in this project were studied in patients admitted to a Surgical Intensive Care Unit and to intensive care beds of Post Anesthesia Care Unit of Hospital São João, Porto, Portugal.

Patient demographics, functional capacity, perioperative and postoperative covariates and co morbidities, severity of illness, Intensive Care Unit and hospital length of stay, hospital and Intensive Care Unit mortality rates were recorded during patients' hospitalization.

Patients' quality of life before Intensive Care Unit admission was studied using a validated Quality of Life instrument that fulfills all of the criteria for application to critically ill patients at the moment of Intensive Care Unit admission [31].

Assessment of functional capacity was evaluated with Katz's Index of Independence in Activities of Daily Living [32] and Lawton Instrumental Activities of Daily Living Scale [33].

The Portuguese validated version of Short Form-36 [34-35] was used to assess quality of life at 6 month follow-up.

Studied postoperative complications were Acute Kidney Injury and Major Cardiac Events according to criteria and definitions widely approved and validated [36-37].

The Institutional Review Board of the Hospital de São João approved the studies.

Written consent was obtained from the patients or members of their families.

Other details on methods and data analysis are described in each paper and therefore will not be repeated here.

Aims

The aims of the present studies were to assess outcome, and study their determinants and predictors in patients admitted to Intensive Care Unit after surgery.

1. To analyze quality of life of patients before admission to a surgical Intensive Care Unit and to study its relationship to outcome and to the baseline characteristics of the patients.

2. To evaluate quality of life and independence in Activities of Daily Living in patients submitted to endarterectomy carotid and to identify its determinants.

3. To identify predictors of major postoperative cardiac complications.

4. To evaluate the incidence and determinants of postoperative Acute Kidney Injury after major noncardiac surgery in patients with previously normal renal function.

5. To evaluate outcome and quality of life in patients that develops Acute Kidney Injury after major surgery.

6. To evaluate outcome after Aorto-bifemoral Bypass surgery and to study its determinants.

7. To evaluate outcome after postoperative occurrence of Major Cardiac Events.

Papers

Quality of life before surgical ICU admission

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Research article

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Quality of life before surgical ICU admission

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Abstract

Background: Examining the quality of life (QOL) of patients before ICU admission will allow outcome variables to be compared and analyzed in relation to it. The objective of this study was to analyze QOL of patients before admission to a surgical ICU and to study its relationship to outcome and to the baseline characteristics of the patients.

Methods: All adult patients consecutively admitted to the surgical ICU between November 2004 and April 2005, who underwent non-cardiac surgery, were enrolled in this observational and prospective study. The following patient characteristics were recorded: age, gender, body mass index, ASA physical status, type and magnitude of surgical procedure, length of stay (LOS), in ICU and in hospital, mortality, Simplified Acute Physiology Score II (SAPS), history of co-morbidities and quality of life survey score (QOLSS). The relationships between QOLSS and ICU variables and outcome were evaluated. The relationship between the total QOLSS and each variable or outcome was assessed by multiple linear regression.

Results: One hundred eighty seven patients completed the study. The preadmission QOLSS of the patients studied was 4.43 ± 4.90; 28% of patients had a normal quality of life (0 points), 38% had between 1 and 5 points (considered mild deterioration), 21% had between 6 and 10 points (moderate deterioration), 10% had between 11 and 15 points (considered major deterioration) and 3% had more than 15 points (severe limitation of quality of life). A worse preadmission QOLSS was associated with higher SAPS II scores, with older patients (age> 65 years) and with ASA physical status (ASA III/IV). Total QOLSS was significantly worse in elderly patients and in patients with co-morbidities and in patients more severely ill at ICU admission. Patients who died in the ICU and in hospital had worse QOLSS scores compared to those who survived. However, no statistical differences in QOLSS were found in relation to longer ICU stays (ICU LOS).

Conclusion: Preadmission QOL correlates with age and severity of illness. Patients with co-morbidities and those who died during ICU or hospital stay had worse QOLSS scores.

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Background

The primary purpose of treatment in Intensive Care is to provide sufficient care to save lives and reduce morbidity in survivors. Improving functional capacity and quality of life should be the desired standards to achieve.

Although severity of illness has been found to be associated with greater length of stay in an ICU (LOS) and with ICU resource use [1-3], quality of life appears to be an important consideration for evaluating treatment benefits and resource allocation.

Studies of the quality of life in critically ill patients tend to focus on the results after discharge and very few have examined the situation before admission. Severity of illness and the presence of co-morbidities are parameters used to stratify patients on admission but the quality of life of these patients is seldom evaluated. The reasons are that quality of life has been considered an outcome not an evaluation parameter, and it is difficult to assess quality of life before admission. In a systematic literature review of quality of life in adult survivors of critical illnesses [4], only five studies [5-9] measured pre-admission QOL domains.

Rivera-Fernandèz et al. [10,11] validated an instrument to measure quality of life in critically ill patients at the moment of ICU admission. They verified that previous quality of life influenced quality of life after discharge and hospital mortality. This questionnaire fulfills all the criteria for application to critically ill patients on admission to an ICU [12] and has been used in other studies [13-16]. The study of quality of life before admission to ICU allows previous and subsequent situations to be compared with other variables measured on admission and during ICU stay that may be related to outcome.

The aim of the present study is to analyze QOL of patients before admission to a surgical ICU and to study its relationship to outcome and to the baseline characteristics of the patients.

Methods

The study protocol was approved by our institutional review board and written consent was obtained from the patients or members of their families. The study was conducted in a surgical ICU that admits non-cardiac surgery patients for elective or emergency surgery. The criteria for ICU admission followed the guidelines of the Society for Critical Care Medicine[17]. All consecutive patients, admitted to the ICU between November 2004 and April 2005, were eligible for the study. Exclusion criteria were: age <18 years and death within the first 6 hours after admission. Patients readmitted during the study period were enrolled in relation to the time of their first admission.

The following clinical variables were recorded on admission to the ICU: age, sex, body weight and height, ASA physical status, emergency or scheduled surgery, magnitude of surgical procedure classified as major (surgery in which body cavities or major vessels are exposed to ambient temperature e.g. major abdominal, thoracic, vascular, or thoracic spine surgery with instrumentation, or hip arthroplasty), medium (surgery in which body cavities are exposed to a lesser degree e.g. appendectomy) or minor (superficial surgery). The ICU and in-hospital LOS and mortality were also recorded for all patients, and SAPS II was calculated using standard methods [18].

Any history of ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, renal insufficiency, diabetes or hyperlipidemia was recorded. The presence of coexisting conditions was assessed using the secondary diagnoses of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Diabetes mellitus was considered if previously diagnosed or if the patient received treatment with an oral hypoglycemic agent during hospitalization. Adapting a classification scheme developed by Lee and colleagues [19], we calculated a Revised Cardiac Risk Index (RCRI) score for each patient, assigning one point for each of the following risk factors: high-risk surgery, ischemic heart disease, cerebrovascular disease, renal insufficiency and diabetes mellitus. According to Lee, high-risk surgery includes all intrathoracic, intraperitoneal and suprainguinal vascular procedures.

Data about LOS in the hospital and hospital mortality were collected during the patient's stay in the hospital.

To assess QOL, a questionnaire specifically constructed and validated by Rivera-Fernandèz for critically ill patients was used [10]. It comprises 15 items grouped into three subscales: basic physiological activities (subscale 1, four items, score range 0–9 points), normal daily activities (subscale 2, eight items, score range 0–15 points), and emotional state (subscale 3, three items, score range 0–5 points). Subscale 1 explores oral communication, food intake and sphincter control; subscale 2 explores tolerance of effort, mobility, movements of precision, capacity for dressing, work or activities appropriate to age, and social relationships; and subscale 3 explores vitality, subjective well-being and feelings. The questionnaire was administered by trained physicians on admission or during the days following admission and was answered either by the patient or, if the patient was unable to respond, by a family member with full knowledge of the patient's situation. The questionnaire explores the baseline QOL situation

during the 2 months before its administration. Each item is weighed and results are expressed as a profile or a score. A score of 0 points signifies normality and the score increases as QOL worsens, ranging from 0 (normality) to 29 (worst score) (additional file 1).

Statistical methods

The data are expressed as mean ± sd. To compare two means we used Student's *t*-test. To compare more than two means we used analysis of variance (ANOVA). Multivariate analysis was performed by multiple linear regression, using QOLSS as the dependent variable and the "stepwise" method for selecting variables. The results are expressed as the coefficients of the equations and the values of the multiple regression coefficients at each step. The level of significance was 0.05 (two sided) for all statistical tests. SPSS for Windows version 13.0 (SPSS, Chicago, IL) was used to analyze the data.

Results

One hundred and ninety patients were admitted to the ICU between November 2004 and April 2005. The QOL questionnaire was not completed for 3 patients because they could not express themselves and no close family member was available. The questionnaire was answered either by the patient (82%) or by a family member (18%). A total of 187 patients entered the study, and their demographic and clinical characteristics are presented in table 1. Sixty-seven percent were male, the mean (minimum-maximum) age was 65 years (23–88), mean SAPS II was 25.4 ± 15.2 (range 2–82) and mean LOS was 4.6 ± 8.1 days. Eleven (5.9%) patients died in the ICU and 4 (2.1%) patients died in the ward after ICU discharge.

The preadmission QOLSS of the patients studied was 4.43 ± 4.90. Women had higher scores (4.69 ± 4.61) than men (4.31 ± 5.05) but the differences were not significant. Older patients (5.82 ± 5.40) had higher scores than younger patients (3.03 ± 3.89) and these differences were statistically significant. Table 2 shows the QOLSS values by age and gender.

For subscale 1 the score was 0.35 ± 1.06, for subscale 2 the score was 3.01 ± 3.52 and for subscale 3 the score was 1.08 ± 1.26.

The percentage of people showing normality for each subscale was: 85% for subscale 1 (basic physiological activities), 71% for subscale 2 (normal daily activities) and 48% for subscale 3 (emotional state). For QOLSS, 52 patients (28%) had 0 points or normal quality of life, 38% had between 1 and 5 points (considered mild deterioration), 21% had between 6 and 10 points (considered moderate deterioration), 10% had between 11 and 15 points (considered major deterioration) and 3% had more than 15 points (considered severe limitation of quality of life).

Table 3 shows the mean ± SD for each QOLSS variable. Total QOLSS was significantly worse in elderly patients and in those with hypertension, cerebrovascular disease, renal insufficiency or who were more severely ill as measured by SAPS and ASA. Patients who died in the ICU and in hospital had worse QOLSS scores compared to those who survived. However, no statistical differences in QOLSS were found in relation to longer ICU stays (ICU LOS).

Table 4 shows the multivariate analysis with linear regression, estimating the coefficients of the linear equation with the independent variables involved (age, ASA, SAPS II, mortality in ICU and in hospital, RCRI risk factors age and history of hypertension) entered by the stepwise method. This analysis shows that worse preadmission QOLSS was associated with higher SAPS II scores, older patients (age> 65 years) and worse ASA physical status (ASA III/IV). Those variables were associated in the regression model when QOLSS was the dependent variable.

Discussion

In this study, 52% of patients had a normal quality of life before admission and only 13% had major to severe limitation. Statistically significant differences were observed in preadmission QOLSS with respect to age and severity of illness according to SAPS II scores and ASA physical status: a worse preadmission QOL was observed in older and more severely ill patients. Compared to the survivors, the patients who died in the ICU or in hospital had significantly higher QOLSS scores. These scores were significantly different in patients with co-morbidities such as hypertension, history of cerebrovascular disease and renal insufficiency. QOLSS was not significantly different in patients who stayed longer in the ICU.

As reported by others [11,16,20], the worsening of QOL with increasing age may reflect more limited physical faculties among elderly patients. The impact of age on QOL after ICU has been described by a number of investigators [8,21,22] with reference to worse QOL in older patients. However, the relationship between QOL and age is less clear than it might seem, since our results show that QOL is worse among older patients before ICU admission. This may indicate that QOLSS should be always adjusted for age.

Severity of illness scores could be seen as a determinant of QOL, as in other studies using APACHE III [6,11] or APACHE II [23], and may reflect the impact of acute physiological derangements on admission; so they are indirect

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Table 1: Demographics and clinical characteristics of admitted patients (n = 187)

Variable	mean ± SD or median and range or number/total number
Age	Median 65, mean 62.4 ± 14.2 (range, 23 – 88)
< 65/≥ 65	94/93
Male/Female (n/%)	125(66.8)/62 (33.2)
Body mass index (Kg/m2)	25.62 ± 6.0 (range, 12.4 – 54.4)
ASA Physical status	
I	17 (9.1)
II	66 (35.3)
III	86 (46.0)
IV	18 (9.6)
Emergency surgery	39 (21.0)
Magnitude of surgery	
Minor	27 (14.4)
Medium	77 (41.2)
Major	83 (44.4)
General anesthesia	155 (82.9)
Regional anesthesia	14 (7.5)
Combined anesthesia	18 (9.6)
Duration of anesthesia (min.)	258 ± 143 (range 60–840)
≤ 180 min.	45 (24.1)
> 180 min.	142 (75.9)
Hypertension	85 (45.5)
Hyperlipidemia	28 (15.0)
High-risk surgery	76 (40.6)
Ischemic heart disease	37 (19.8)
History of congestive heart disease	27 (14.4)
History of cerebrovascular disease	20 (10.7)
Insulin therapy for diabetes	11 (5.9)
Preoperative serum creatinine > 2.0 mg/dl	13 (7.0)
Revised cardiac risk index	
0	62 (33.2)
1	84 (44.9)
2	27 (14.4)
3	10 (5.3)
≥ 4	4 (2.1)
QOL total score	4.43 ± 4.90
Subscale I	0.35 ± 1.06
Subscale II	3.01 ± 3.52
Subscale III	1.08 ± 1.26
Score of Acute Physiologic system (SAPS II)	25.4 ± 15.2 (range 2–82)
Length of ICU stay (days)	4.6 ± 8.1 (range, 0.4 – 63)
< 7 days	159 (85)
≥ 7 days	28 [35]
Length of hospital stay (days)	median 18; percentile 25, 9; percentile 75, 33 range 1–211
Any major cardiac complication	
Ventricular fibrillation/cardiac ar rest	1 (0.5)
Acute Myocardial Infarction	9 (4.8)
Pulmonary edema	4 (2.1)
Mortality in the ICU	11 (5.90)
Mortality in the Hospital	15 (8.0)

ASA, American Society of Anesthesiologists; ICU, Intensive Care Unit; QOL, Quality of life

indicators of co-morbidities (chronic disease accounts for severity scores) and age itself.

Patients with high severity of illness had significant co-morbidity and a poor baseline status, which seemed to be major contributors to the QOLSS [24]. In support of previous studies [14,25], QOL measurement is needed as a control for pre-existing impairment because it is difficult to determine whether QOL decrements at follow-up reflect the impact of critical illness or simply a lower baseline QOL. A possible explanation for this finding is that patients who already have an impaired QOL may have a

BMC Surgery 2007, **7**:23 http://www.biomedcentral.com/1471-2482/7/23

Table 2: Mean ± SD and sample size for QOLSS at admission by gender and age (< 65 years and ≥ 65 years)

	Gender			
	Female (n = 62)		**Male** (n = 125)	
	<65 years (n = 26)	≥ 65 Years (n = 36)	<65 years (n = 68)	≥ 65 Years (n = 57)
QOLSS	2.56 ± 2.52	6.17 ± 5.15	3.22 ± 4.31	5.59 ± 5.59

QOLSS, Quality of life survey score

reduced physiological (or psychological) reserve and be less able to tolerate the insult of serious illness and an ICU stay [20,26].

ASA physical status, a universal indicator in surgical patients, correlated independently with QOL. The ASA score, a preoperative evaluation used routinely for every patient, was never intended to be a perioperative risk score, but all large-scale studies have suggested that a high ASA score is one of the best predictors of postoperative morbidity [27,28]. This indicator itself depends on a more generic classification of the presence of disease, and in itself indicates the presence of co-morbidities.

As in other studies [11,29-31], we found no correlation between QOLSS and LOS, nor did patients who stayed longer in the ICU have significantly higher QOLSS values.

The patients who died in the ICU or in hospital had worse QOLSS on admission, confirming the importance of adequate QOL assessment on admission to allow a better study of the impact of critical illness and scheduled treatment. [11,32,33]. Also this was not our main objective these results are in agreement with the work of Hofhuis et al. that concluded that QOL before ICU admission can be used as a predictor of mortality [33].

Prior health status according to the patient's diagnosis confers different risks and probably a different ICU outcome. Therefore background variables, particularly age and previous health status, should always be taken into account when assessing outcome.

But, most of all our objectives were not to identify patients to whom surgery should be denied. Our aim was to understand outcome in surgical patients and to better understand how co morbidities or previous QOL influence post operative outcome. This should be considered important in planning post operative care to these patients and that can only be achieved if we understand the needs of these patients.

We used a validated quality of life questionnaire [10] to measure this complex and multidimensional concept that includes different facets such as functional capacity, physiological functions and subjective aspects. This questionnaire can be applied to all types of critical care patients and can be completed rapidly and easily by the patient or a close family member. It is valid as a follow-up study after discharge from the ICU but also during admission, allowing the patient's previous status to be better understood and current situations to be differentiated. A valuable feature of the survey is that it can be completed by a surrogate, given that many critical patients are sedated or in tracheal intubation and unable to respond. The questionnaire was specifically designed for use in the ICU, where patients are frequently unable to respond directly, and it has demonstrated high patient/family member reproducibility. Relatives' opinions about the quality of life of a critically ill patient have also been used to estimate the baseline QOL [34].

There are several limitations to our study including the potential bias inherent in the questionnaire and the conditions of its use. Only surgical patients were admitted and no diagnostic risk index was used to stratify their disease risk more precisely. Another limitation is that information would ideally be completed before admission to avoid bias in recall of health status, potentially overestimating the degree of baseline function. Pre-hospital information was not available with our study design. Although our sample size of 187 patients was adequate for the correlations performed, it was not sufficient to perform subset analyses of surgical ICU populations.

Admissions to ICU are not homogeneous, and generalizing these findings to all ICU admissions may be misleading since our results represent only a surgical population. The population studied mainly comprised patients undergoing scheduled surgery, probably already having a reduced QOL, and surgery was performed in an attempt to improve their QOL and survival. These patients are usually subjected to careful pre-surgery screening to determine the likelihood of success, and all these premises must be considered in analysing these results.

Our objective was not to identify patients to whom surgery should be denied or postponed and we did not pretend to use QOLSS as an indicator of final outcome. We wanted to understand how previous QOL influence post operative outcome. With this purpose the pre-admission QOLSS proved to be an important QOL assessment tool

BMC Surgery 2007, **7**:23 http://www.biomedcentral.com/1471-2482/7/23

Table 3: Mean ± SD for QOLSS for each variable

Variable	QOLSS mean ± SD	p
Age (years)		**<0.001**
< 65 [35]	3.03 ± 3.89	
≥ 65 [35]	5.82 ± 5.40	
Gender		0.621
Female [35]	4.67 ± 4.60	
Male (125)	4.31 ± 5.05	
BMI		
BMI ≥ 30 (162)	4.13 ± 3.51	0.739
BMI< 30 [35]	4.48 ± 5.09	
ASA Physical status		**0.001**
I/II (83)	3.08 ± 3.93	
III/IV [35]	5.49 ± 5.31	
Type of surgery		0.104
Emergency surgery (39)	5.68 ± 6.63	
Routine surgery (148)	4.11 ± 4.31	
Magnitude of surgery		0.864
Minor/Medium [35]	4.38 ± 4.27	
Major (83)	4.51 ± 5.62	
Hypertension		**0.004**
Yes (81)	5,58 ± 5,44	
Not [35]	3.49 ± 4.19	
Hyperlipidemia		0.471
Yes [35]	4.55 ± 5.10	
No (159)	3.82 ± 3.65	
High-risk surgery		0.991
Yes (76)	4.43 ± 5.07	
No (111)	4.44 ± 4.80	
Ischemic heart disease		0.676
Yes (37)	4.13 ± 3.72	
No (150)	4.51 ± 5.17	
History of congestive heart disease		0.103
Yes [35]	5,85 ± 4.37	
No (160)	4,18 ± 4.96	
History of cerebrovascular disease		**0.011**
Yes (20)	4.11 ± 4.62	
No (167)	7.05 ± 6.26	
Insulin therapy for diabetes		0.990
Yes (11)	4.44 ± 4.98	
No (176)	4.46 ± 3.62	
Preoperative serum creatinine > 2 mg/dl		**0.012**
Yes (13)	4.18 ± 4.69	
No (174)	7.69 ± 6.38	
RCRI		
≥ 2 (41)	6.07 ± 5.08	**0.014**
< 2 (146)	3.95 ± 4.76	
SAPS II		**0.000**
<25 (102)	6.44 ± 3.94	
>25 (85)	3.12 ± 5.53	
Postoperative AMI		0.483
Yes [35]	5.56 ± 4.33	
No (179)	4.38 ± 4.93	
Length of ICU stay (days)*		0.094
< 7 days (157)	4.18 ± 4.67	
≥ 7 days [35]	5.89 ± 5.89	
Mortality in Hospital		0.016
No (172)	4.17 ± 4.84	
Yes [35]	7.33 ± 4.72	
Mortality in ICU		**0.047**
No (176)	4.25 ± 4.82	
Yes (11)	7.27 ± 5.50	

BMI, Body mass index; ASA, American Society of Anesthesiologists; RCRI, Revised cardiac risk index; SAPS II, Simplified Acute Physiology Score; AMI, Acute myocardial infarction; ICU, Intensive Care Unit

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Table 4: Multivariate analysis by stepwise method between QOLSS and variables included in table 3 that had statistical significance.

Variable	B	ST Error	p
SAPS II	1.786	0.589	0.003
Age (>65 years)	1.839	0.702	0.010
ASA (III/IV)	1.743	0.700	0.014

ASA, American Society of Anesthesiologists; SAPS II, Simplified Acute Physiology Score. Adjusted for age, ASA, SAPS II, mortality in ICU and in hospital, RCRI risk factors r = 0.391 and r^2 = 0.153 for this model

and it appears sensible enough to incorporate in clinical practice to be used for the assessment of HRQOL.

Conclusion

In conclusion, measurement of QOL before ICU hospitalization in our study appears to correlate with severity of illness, co-morbidities and age, and consequently with outcome.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

FA participated in conception, design, acquisition of the data, analysis of the data, statistical analysis, critical revision of the manuscript and supervision.

CS participated in analysis of the data, statistical analyses and drafting of the manuscript.

HB has been involved in drafting the manuscript, analysis of the data and revising it critically for important content.

All authors read and approved the final manuscript.

Additional material

Additional file 1

appendix 1. Quality of life questionnaire.
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Quality of life after carotid endarterectomy

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Quality of life after carotid endarterectomy

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Abstract

Background: Most studies documenting beneficial outcomes after carotid endarterectomy (CE) are limited to mortality and morbidity rates, costs, and length of hospital stay (LOS). Few have examined the dependency of patients and how they perceive their own health changes after surgery. The aim of the present study was to evaluate quality of life and independence in activities of daily living (ADL) and to study its determinants.

Methods: Sixty-three patients admitted in the Post Anaesthesia Care Unit (PACU) after CE were eligible for this 14-month follow-up study. Patients were contacted 6 months after discharge to complete a Short Form-36 questionnaire (SF-36) and to have their dependency in ADL evaluated.

Results: Among 59 hospital survivors at 6 months follow-up, 43 completed the questionnaires. Sixty-three percent reported that their general level of health was better on the day they answered the questionnaire than 12 months earlier. Patients had worse SF-36 scores for all domains except bodily pain than a general urban population, and comparison with a group of patients 6 months after surgical ICU discharge showed no differences. Six months after PACU discharge, the Lawton Instrumental Activities of ADL Scale and the Katz Index of ADL demonstrated higher dependency scores (5.9 ± 2.2 versus 4.3 ± 2.4 and 0.3 ± 0.8 versus 0.6 ± 0.9, $p < 0.001$ and $p = 0.047$). Sixty-five percent and 33% were dependent in at least one activity in instrumental and personal ADL, respectively. Patients dependent in at least one ADL task had higher Revised Cardiac Risk Index (RCRI) scores (1.0 versus 1.5, $p = 0.017$). After controlling for multiple comparisons, no significant differences were found.

Conclusion: Patients undergoing CE have improved self-perception of quality of life despite being more dependent. Almost all their scores are worse than those in an urban population. We could identify no predictors of greater dependency in ADL tasks six months after PACU discharge.

Background

Patients with symptomatic carotid stenosis derive substantial benefit from carotid endarterectomy (CE) and this benefit is thought to be long-lasting [1-3]. CE reduces symptoms and stroke risk in patients with high-grade carotid artery stenosis [4,5]; patients with high grade asymptomatic disease also benefit [6]. Although some studies have documented beneficial outcomes after this procedure, most reports are limited to mortality and morbidity rates, costs and length of hospital stay (LOS) [7,8]. Few studies have examined dependency in Activities of Daily Living (ADL), quality of life, or patients' views of

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their own health status after CE [9-12]. Indeed, little is known about the extent and impact of these changes on the long-term outcomes for patients.

In this study we review the characteristics of patients undergoing CE, and study quality of life and dependency in ADL 6 months after surgery.

We also consider risk stratification for this particular procedure [13]. Patients were stratified according to cardiac risk factors [14] that are regarded by some authors as predictors of mortality and hospital LOS, but to the best of our knowledge have never been proposed as predictors of health-related quality of life or dependency in ADL.

Several questionnaires have been validated to study Health-Related Quality of Life (HRQOL) [15-19], mostly multi-item scales. Some of these provide a total score as well as subscales giving information on particular aspects such as mobility. The Short-Form General Health Survey (SF-36) was developed during the Medical Outcomes Study to measure generic health concepts that are relevant across age, disease and treatment groups [20]. It is a self-completed questionnaire covering all aspects of HRQOL, it shows good reliability and validity [20,21], and it has been used for various groups of patients including post-discharge Intensive Care Unit (ICU) patients and those subjected to CE [9].

The ability to care for oneself and live independently is considered a measure of functional outcome after hospitalization [22]. Functional status refers to the level of involvement in activities and is often used as a synonym for performance in ADL[23]. ADL appraisal scales consider functional and instrumental activities. The ability of patients to handle these activities has been assessed by generic or disease-specific tests. Katz's ADL Scale [23] and the Lawton Instrumental ADL [24] have been used for critical care survivors.

The aim of the present study was to evaluate quality of life and autonomy in ADL in patients undergoing CE and to identify its determinants.

Methods

All patients who underwent CE at our institution and were consecutively admitted to the Post Anesthesia Care Unit (PACU) during a period of 14 months beginning in March 2006 were eligible for the study.

All patients had a carotid artery stenosis of ≥ 65%. Their previous neurological evaluations are summarized in Table 1, which summarizes patient characteristics and outcomes. All patients underwent the operation on a single side only and no patient was enrolled twice.

Table 1: Patient characteristics and outcomes (n = 63)

Variable	
Age in years, median (P25–75)	70 (60–75)
Age group, n (%)	
≥ 65 years	43 (68)
< 65 years	20 (32)
Sex, n (%)	
Male	48 (76)
Female	15 (24)
Body Mass Index in Kg/m^2, median (P25–P75)	25 (24–28)
General anesthesia/Regional anesthesia, n. (%)	24 (38)/39 (62)
Duration of anesthesia (min.) median (P25–P75)	160 (140–180)
Temperature at admission on PACU, mean ± sd	35.8 ± 0.81
Troponin I at admission, mean ± sd	0.027 ± 0.22
Hypertension, n (%)	60 (95)
Hyperlipidemia, n (%)	53 (84)
Ischemic heart disease, n (%)	41 (65)
Congestive heart disease, n (%)	5 (8)
Cerebrovascular disease, n (%)	34 (54)
Insulin therapy for diabetes, n (%)	3 (5)
Preoperative serum creatinine > 2 mg/dl	1 (2)
Total RCRI, mean ± sd	1.35 ± 0.85
High-risk patients, n (%)	14 (22.2)
Neurological evaluation	
Asymptomatic	13 (21)
Severe bilateral carotid disease	19 (30)
Amaurosis	4 (6)
Transient ischaemic attack	15 (24)
Stroke with full recovery	6 (10)
Stroke with residual deficit	13 (21)
Katz scale, mean ± sd	0.22 ± 0.72
Dependency in I-ADL, n (%)	7 (11)
Lawton I-ADL scale, mean ± sd	6.1 ± 1.9
Dependency in P-ADL, n (%)	14 (22)
SAPS II, median (P25–75)	16 (12–21)
APACHE II, median (P25–75)	7 (6–10)
PACU length of stay (hours), median (P25–75)	21 (16–22)
Hospital length of stay (days), median (P25–75)	5 (4–7)
Mortality in PACU, n (%)	0 (0)
Mortality in hospital, n (%)	3 (4.8)

RCRI, Revised Cardiac Risk Index I-ADL, Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living; SAPS II, Simplified Acute Physiology Score, PACU, Post Anesthesia Care Unit; P25 and P75 are the 25th and 75th percentiles.

The following variables were recorded on admission to the PACU: age, gender, body mass index, preadmission co morbidities (specifically ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, renal insufficiency, diabetes and hyperlipidemia) duration of anesthesia, type of anesthesia, core temperature and blood troponin I blood level. The ICU and in-hospital LOS and mortality were recorded for all patients. Simplified Acute Physiology Score II (SAPS II) [25] and Acute Physiology & Chronic Health Evaluation II (APACHE II) [26] were calculated using standard methods.

Adapting a classification scheme developed by Lee and colleagues, we calculated the Revised Cardiac Risk Index (RCRI) score, assigning one point for each of the following risk factors: high-risk surgery, ischemic heart disease, cerebrovascular disease (defined as history of transient ischemic attack or history of cerebrovascular accident), renal insufficiency and diabetes mellitus. Patients were classified as "high-risk" or "low-risk" as described by Boules et al. [13]. "High-risk" patients were defined as those with at least 1 of the following: myocardial infarction (MI) or exacerbation of congestive heart failure (CHF) within 4 weeks before CE; unstable angina; steroid-dependent chronic obstructive pulmonary disease; prior ipsilateral CE, neck dissection or irradiation; high carotid bifurcation, as identified angiographically (at the C2 level or higher) or intraoperatively by the surgeon; and those undergoing combined cardiac-carotid procedures. MI was defined as an event resulting in elevation of cardiac enzymes or electrocardiographic changes. High-risk patients with CHF included those with ejection fraction less than 30% or New York Heart Association class III or IV symptoms requiring hospitalization.

Functional capacity before surgery was evaluated in terms of the patient's ability to handle personal and instrumental ADL within the first 24 hours after PACU admission. All eligible consenting patients were interviewed directly by a trained investigator. When the patient was unable to respond, the questionnaire was completed by a close family member living in the same household as the patient. This evaluation was repeated along with the SF-36 questionnaire six months after PACU discharge.

Medical Outcome Survey Short-Form 36 (SF-36)

HRQOL was assessed by the SF-36 [21]. The survey contains 36 questions that evaluate eight health domains considered to be important for patient well-being and health status. These domains reflect physical health, mental health, and the impact of health on daily functioning. The eight multiple-item domains encompass physical functioning (ten items), social functioning (two items), role limitations caused by physical problems (four items), role limitations caused by emotional problems (three items), mental health (five items), energy and vitality (four items), pain (two items) and general perception of health (five items). There is one further unscaled item relating to self-reported changes in the respondent's health status during the past year. For each item, scores are coded, summed and transformed to a scale from 0 (worst possible health state measured by the questionnaire) to 100 (best possible health state). Scores can be aggregated to measures representing a physical health summary scale (consisting of physical functioning, physical role, pain and general health) and a mental health summary scale (vitality, social functioning, emotional role and mental health) [15].

The answers to the question about self-reported changes in health status ("compared to one year ago, how you would rate your health in general now?") were dichotomized as: better, about the same or worse than one year ago.

To minimize distress to the next of kin, each patient's records were checked on the hospital information system after 6 months to ascertain whether he or she was still alive. A copy of a formal letter was sent to all known survivors accompanied by a return envelope and a validated Portuguese SF-36 self-report form [27,28]. This version has been validated for the population of the city of Porto from which the subjects of this report were drawn [29]. Scores were compared with normal values for the population.

Values were compared with urban population normal values and with those collected during another study in a general surgical population admitted to an ICU located in the same demographic area [30].

Activities of Daily Living (ADL)

The questionnaire used to assess dependency was based on the Katz Index of Independence in ADL [22] and Lawton Instrumental ADL scale. The Lawton IADL scale is an easily to administer assessment instrument that provides self-reported information about the functional skills necessary for living in the community. Deficits in the instrumental Lawton scale were scored and a summary score ranging from 0 (low function, dependent) to 7 (high function, independent) was obtained. The Katz ADL scale assesses basic personal activities of daily living and ranks adequacy of performance in six functions. Dependency in each personal activity was evaluated and a summary score ranging from 0 (independence in all activities) to 6 (dependency in all activities) was obtained. The personal ADL (P-ADL) considered were bathing, dressing, going to the toilet, transferring from bed to chair, continence and feeding. The instrumental ADL (I-ADL) considered were cleaning, food shopping, public transportation and cooking. Answers were categorized into two groups: able or unable to perform each activity and group of activities. Four categories were possible: (a) I-ADL and P-ADL independent, (b) I-ADL dependent but P-ADL independent, (c) P-ADL dependent but I-ADL independent and (d) both P-ADL and I-ADL dependent. Patients were considered dependent if they were dependent in at least one I-ADL or P-ADL activity.

BMC Cardiovascular Disorders 2008, **8**:33 http://www.biomedcentral.com/1471-2261/8/33

The study protocol was approved by our institutional review board and written consent was obtained from all patients or members of their families.

Statistical methods

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables between two groups of subjects; chi-square or Fischer's exact test were used to compare proportions between two groups of subjects.

We used a significance level of 0.05 (two sided) for almost all statistical tests except when multiple comparisons were made. In such cases we controlled the values for multiple comparisons to reduce the risk of type II error. SPSS for Windows version 13.0 (SPSS, Chicago, IL) was used to analyze the data.

A t test for independent groups was used for comparison to population means.

The CE population and the general population were compared using a paired t test. Every patient in the CE population was paired prospectively with a demographically matched patient from the control population.

Results

During the study period, 63 patients were admitted to the PACU. The mean patient age was 70 years (range 44–84), with most CEs performed on males (76%). Median SAPS II was 16 (range 7–65), median APACHE II was 7 (range 2–22) and median LOS in hospital was 5 days. Patient characteristics and outcomes are summarized in Table 1.

There were no perioperative deaths, and morbidity was limited to 1 acute myocardial infarction and 3 thrombotic strokes.

Three patients died in hospital and one died before the 6-month evaluation (6.3% mortality rate at the time of evaluation). Of the remaining 59 patients, 14 (24%) did not answer the questionnaires at 6 months follow-up but were known to be alive. The characteristics and outcomes of patients who completed the study are presented in Table 2.

Table 2: Comparison of characteristics and outcomes between respondents and non-respondents

Variable	Respondents (n = 43)	Non-respondents (n = 16)	p value
Age in years, median (P25–75)	68 (60–75)	71 (59–77)	0.585[b]
Sex, n (%)			0.589[a]
Male	33 (77)	12 (75)	
Female	10(23)	4 (25)	
BMI (Kg/m^2), median (P25–P75)	26 (24–28)	25 (24–29)	0.809[b]
Duration of anesthesia (min.) median (P25–P75)	150 (120–180)	178 (150–206)	0.286[b]
General anesthesia/Regional anesthesia	16/27	6/10	0.606[a]
Total RCRI, median (P25–P75)	1 (1–2)	2 (1–2)	0.173[b]
Temperature at admission	35.77 ± 0.85	36.08 ± 0.67	0.276[b]
Troponin I at admission	0.02 ± 0.02	0.03 ± 0.03	0.278[b]
High-risk patients, n (%)	8 (19)	5 (31)	0.241[a]
Hypertension, n (%)	41 (95)	15 (94)	0.620[a]
Ischemic heart disease, n (%)	28 (65)	10(63)	0.595[a]
Congestive heart disease, n (%)	3 (7)	1(6)	0.705[a]
Cerebrovascular disease, n (%)	19 (44)	13(81)	0.011[a]
Insulin therapy for diabetes, n (%)	1 (2)	1(6)	0.472[a]
Preoperative serum creatinine > 2 mg/dl, n (%)	1(2)	0 (0)	0.729[a]
Hyperlipidemia, n (%)	36(84)	13(81)	0.549[a]
Dependency in I-ADL, n (%)	5 (12)	1(6)	0.477[a]
Dependency in P-ADL, n (%)	11(26)	3(19)	0.431[a]
Previous Katz, mean (SD)	0.26 ± 0.82	0.13 ± 0.5	0.548[b]
Previous Lawton, mean (SD)	5.91 ± 2.20	6.50 ± 1.16	0.493[b]
SAPS II, median (P25–75)	17 (12 – 20)	16 (12 – 22)	0.986[b]
APACHE II, median (P25–P75)	7 (6–9)	8 (6–11)	0.945[b]
Hours of ICU length of stay, median (P25–75)	20 (16–22)	20 (16–22)	0.797[b]
Days of hospital length of stay, median (P25–P75)	5 (4–7)	6 (5–8)	0.150[b]

[a] Pearson χ^2. [b] Mann-Whitney test.
There were no significant differences after controlling for multiple comparisons
BMI, Body Mass Index; RCRI, Revised Cardiac Risk Index; I-ADL, Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living; SAPS II, Simplified Acute Physiology Score, PACU, Post Anesthesia Care Unit; P25 and P75 are the 25th and 75th percentiles.

BMC Cardiovascular Disorders 2008, **8**:33 http://www.biomedcentral.com/1471-2261/8/33

Participating patients (response rate 76%) more frequently had histories of cerebrovascular disease (defined by Lee et al. for RCRI [14] as history of transient ischemic attack or of cerebrovascular accident) and there were no statistical significant differences between participants and non-participants regarding the other variables studied (Table 2).

Functional capacity and ADL

Six months after discharge from ICU, 65% of the patients were dependent in at least one activity in instrumental ADL and 33% in at least one personal ADL (Table 3).

Dependency in P-ADL was significantly more frequent after surgery and scores on the Katz and Lawton scales were significantly different, indicating more dependency in ADL after surgery.

The only variable with $p < 0.05$ on the Pearson χ^2 and Mann-Whitney tests was the RCRI score. This result was no longer significant after application of Bonferroni's correction for multiple comparisons (Table 4).

Quality of Life Measures

Overall, 63% stated that their level of health in general was better on the day they completed the SF-36 while 11% considered it to be worse than previously (6 months before PACU discharge). There was no statistically significant relationship between the patients' baseline characteristics and a worse self-reported general level of health.

Compared to normal values for the urban population of Porto, the SF-36 subscores of all patients were worse on all domains except bodily pain (Table 5). Compared to the mean values for non-cardiac surgical patients from the same urban area 6 months after ICU discharge [30], no differences were observed on any domain (Table 6).

Discussion

Carotid endarterectomy is performed to prevent stroke and its complications, namely death or a decrease in quality of life [4,31]. Evidence supports that this procedure is the standard treatment of severe carotid stenosis being a safe and effective procedure in the general population. In a recent study of Ballotta et al. among 348 patients with a complete follow-up after CE, the 5- and 10-year risk of death was 3.7% and 14.3%, respectively [32].

Vriens et al. reported that CE does not disrupt quality of life [33]. The assessment of quality of life represents an important means of examining how disability or cognitive impairment impacts upon a patient's day-to-day life. The combination of cognitive function and quality of life data could provide a more global impression of the impact of the surgery on patients. The effect of CE on cognitive function is controversial [34]. Many studies demonstrate subtle cognitive changes as revealed by neuropsychological testing. Several studies have demonstrated improvement [35,36] whereas others show no change[37,38], and still others demonstrate a decline [39,40] in postoperative neuropsychological performance. Diversity of the patient population, variability of the surgical technique, differences in neuropsychological tests, and varying follow-up periods are all factors contributing to the difficulty in obtaining consistent results among studies. Adding to the complexity, many groups report significant decline in some cognitive domains and significant improvements in others [39].

With the present study we have examined the impact of CE on quality of life and independence in activities of daily living. To study the impact of the procedure in quality of life we have used the self evaluated health transition item of SF-36 questionnaire. This item is not used in scoring the scales and has been shown to be useful in estimating average change in health status during the year prior to its administration [41]. Measuring changes in health status and as reported by Dardik A [12] we found an improved subjective perception of quality of life after CE among the patients who completed the study. Other studies on patients after ICU discharge have reported similar findings using different tools [30,42]. Because self-perception of health may reflect anticipation of future health after a surgical procedure, it is not surprising that these patients, who view themselves as chronically ill, have scores identical to those of other chronically ill patients

Table 3: Dependency and self-reported changes in health in general, 6 months after PACU discharge (n = 38)

Variable	Before surgery	6 months after EC	P
ADL			
Personal			
Katz scale	0.26 ± 0.82	0.56 ± 0.94	**0.047**
Dependency in P-ADL, n (%)	5 (12)	14 (33)	0.186
Instrumental			
Lawton scale	5.91 ± 2.20	4.28 2.43	**< 0.001**
Dependency in I-ADL, n (%)	11 (26)	28 (65)	0.164

I-ADL, Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living

BMC Cardiovascular Disorders 2008, **8**:33 http://www.biomedcentral.com/1471-2261/8/33

Table 4: Comparisons for patients with dependency in ADL 6 months after EC

Variable	ADL Dependency		P
	No (n = 15)	Yes (n = 28)	
Age, median	67	70	0.365[b]
Gender, n(%)			0.231[a]
Female	2 (13)	8 (29)	
Male	13 (87)	20 (71)	
BMI, median	25.7	25.7	0.908[b]
Duration of anesthesia (min.), median	150	180	0.057[a]
T ype of anesthesia, n(%)			0.239[a]
General	4 (27)	12 (43)	
Local	11 (73)	16 (57)	
High-risk patients, n (%)	2 (13)	6 (21)	0.417[a]
Temperature at admission	35.6	36.0	0.474[b]
Troponin I at admission	0.001	0.002	0.178[b]
Hypertension, n(%)	14 (93)	27 (96)	0.581[a]
Hyperlipidemia, n(%)	12 (80)	24 (86)	0.468[a]
Ischemic heart disease, n(%)	7 (47)	21 (75)	0.065[a]
Congestive heart disease	0	3 (11)	0.265[a]
Cerebrovascular disease	5 (33)	14 (50)	0.235[a]
Insulin therapy for diabetes	1 (7)	0	0.349[a]
Preoperative serum creatinine > 2 mg/dl	0	1 (4)	0.651[a]
RCRI score, median	1.0	1.5	0.017[b]
SAPS II, median	15.0	17.0	0.239[b]
APACHE II, median	7.0	7.0	0.301[b]
Length of PACU stay (hours), median	19.0	20.0	0.768[b]
Length of Hospital stay (days), median	5.0	5.0	0.326[b]

[a] Pearson χ^2. [b] Mann-Whitney test.
There were no significant differences after controlling for multiple comparisons
BMI, Body mass index; RCRI, Revised Cardiac Risk Index; SAPS II, Simplified Acute Physiology Score; APACHE II, Acute Physiology and Chronic Health Evaluation; PACU, Post Anesthesia Care Unit;

subjected to surgical procedures and admitted to an ICU (27). Comparisons with a general (taken as "control") population are difficult to interpret because patients subjected to CE generally perceive themselves as chronically ill. Thus, our finding that quality of life was worse in our patients than in the general population was not totally unexpected. ICU patients with similar demographic characteristics from the same urban area seemed more appropriate for establishing comparisons with our patients. This was done and the results were similar to those of Dardik et al. [12], who compared the SF-36 subscores of 50 patients against the population normal values for both healthy and chronically ill subjects in the same age range. They found that the mean postoperative physical function subscores were similar to those of the chronically ill population, whereas the emotional subscores were similar to the mean values of the healthy population.

The patients in our study had higher degrees of dependency in instrumental and personal ADL after surgery,

Table 5: SF-36 after CE and in a general population

Variable	6 months after CE	General population	p
SF-36 domains, mean ± sd			
Physical function	52.0 ± 25.9	75.4 ± 23.6	< 0.001[a]
Role physical	50.3 ± 34.7	76.7 ± 26.1	< 0.001[a]
Bodily pain	60.9 ± 27.8	65.7 ± 26.2	0.11[a]
General health perception	46.8 ± 25.7	59.5 ± 19.8	< 0.001[a]
Vitality	35.0 ± 14.9	57.2 ± 21.1	< 0.001[a]
Social functioning	57.6 ± 26.9	76.0 ± 24.1	< 0.001[a]
Role emotional	53.1 ± 34.3	76.9 ± 25.8	< 0.001[a]
Mental health	50.9 ± 17.2	66.1 ± 22.8	< 0.001[a]

[a] paired t test
SF-36, Short-form 36; CE, carotid endarterectomy
Sd, standart deviation

BMC Cardiovascular Disorders 2008, **8**:33 http://www.biomedcentral.com/1471-2261/8/33

Table 6: SF-36 after CE and in a surgical population

Variable	6 months after CE	ICU surgical patients	p
SF-36 domains, mean ± sd			
Physical function	52.0 ± 25.9	54.1 ± 29.0	0.329[a]
Role physical	50.3 ± 34.7	45.2 ± 33.8	0.183[a]
Bodily pain	60.9 ± 27.8	57.7 ± 29.8	0.258[a]
General health perception	46.8 ± 25.7	44.5 ± 26.6	0.301[a]
Vitality	35.0 ± 14.9	34.7 ± 17.0	0.457[a]
Social functioning	57.6 ± 26.9	60.2 ± 28.7	0.291[a]
Role emotional	53.1 ± 34.3	50.1 ± 34.2	0.299[a]
Mental health	50.9 ± 17.2	48.6 ± 22.3	0.261[a]

[a] paired t test
SF-36, Short-form 36; CE, carotid endarterectomy
Sd, standart deviation

which was not entirely unexpected in view of the extent of comorbidities and the natural history of their atherosclerotic disease. It seems paradoxical that these patients, despite being more dependent, stated that their quality of life was better than before surgery. We think this could also be explained by their expectation of better health when they agreed to surgical intervention.

Trudel et al. concluded that quality of life seemed more markedly affected by cardiovascular and neurological problems. In our study, total RCRI was the only determinant of dependency six months after EC. We did not consider this to be strong enough for true statistical significance because the difference was not consistent after the data were controlled for multiple comparisons.

Trudel and coworkers [43] found that only 20% of patients after CE met the criteria for normal functional capacity. These results are somewhat worse than our findings, although the methods used to classify dependency were different and the study was written more than 20 years ago when surgical skills and procedures for CE were less developed.

The overall characteristics of non-respondents were similar to those of participants and the only observed difference was the incidence of cerebrovascular disease, which was higher in the participants. It must be emphasized that poor quality of life or high incidence of psychological disturbance at the time of the follow-up survey may have contributed to non-response to the questionnaire, constituting a possible limitation of this study [44,45].

This study has several limitations. The small sample size may limit the ability to document real differences among our subgroups of patients. We did not apply the SF-36 questionnaire before surgery so it was not possible to compare quality of life of patients before and after surgery as in the study by Lloyd [10]. Nevertheless, we used the SF-36 question about self-reported changes in health status ("compared to one year ago, how would you rate your health in general now?") to conclude that the level of health in general was better for most patients on the day they completed the SF-36 than before surgery.

Table 4 shows p values < 0.05 in the statistical tests for differences in ADL independence, but when these data where controlled for multiple comparisons to reduce the risk that they were due to chance, they showed no statistical significance. So these results were considered not strong enough to infer a real difference.

Conclusion

In summary, this study supports the conclusion that patients subjected to carotid endarterectomy perceive their quality of life as improved six months after surgery although they are more dependent in ADL activities.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

All people listed as authors contributed to the preparation of the manuscript and no person or persons other than the authors listed have contributed significantly to its preparation.

Each listed author participated in the work to the extent that they could all publicly defend its content. They all read the manuscript before its submission for publication and are prepared to sign a statement stating they had read the manuscript and agree to its publication.

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Predictors of major postoperative cardiac complications in a surgical ICU

Predictors of Major Postoperative Cardiac Complications in a Surgical ICU [23]

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ABSTRACT

Introduction: Cardiovascular complications are associated with increased mortality and morbidity during the postoperative period, resulting in longer hospital stay and higher treatment costs.
Objectives: The aim of this study was to identify predictors of major postoperative cardiac complications.
Methods: 187 patients undergoing noncardiac surgery, admitted to a surgical intensive care unit (ICU) between November 2004 and April 2005. Variables recorded were age, gender, American Society of Anesthesiologists (ASA) physical status, type and magnitude of surgery, mortality, ICU and hospital length of stay (LOS), Simplified Acute Physiology Score II (SAPS II), cardiac troponin I (cTnI) at postoperative day 0, 1, 2 and 3, history of hypertension, hyperlipidemia, Revised Cardiac Risk Index (RCRI) score, major cardiac events (MCE): acute myocardial infarction (AMI), pulmonary edema (PE), ventricular fibrillation (VF) or primary cardiac arrest (PCA). Correlations between variables and MCE were made by univariate analysis by simple logistic regression with odds ratio (OR) and 95% confidence interval (95% CI).
Results: Total of 14 MCE: 9 AMI, 1 VF, 4 PE. Significant risk factors for MCE were high-risk surgery (OR 8.26, 95% CI 1.76-38.85, p=0.008), RCRI ≥2 (OR 4.0, 95% CI 1.22-13.16, p=0.022), admission cTnI (OR 1.46, 95% CI 1.07-1.99, p=0.018); day 1 cTnI (OR 1.75, 95% CI 1.27-2.41, p=0.001); day 2 cTnI (OR 2.23, 95% CI 1.24-3.98, p=0.007), SAPS II (OR 1.08, 95% CI 1.04-1.12, p<0.001). Patients with MCE had longer ICU LOS (19.1±19.3 days against 3.4±4.9) (OR 1.15,

RESUMO

Preditores de complicações cardíacas *major* numa UCI cirúrgica

Introdução: As complicações cardiovasculares associam-se a maior mortalidade e morbilidade durante o período pós-operatório, resultando em maior tempo de internamento e maiores custos relacionados com o tratamento.
Objectivos: O objectivo deste estudo foi identificar preditores de complicações cardíacas *major* no pós-operatório.
Métodos: 187 doentes submetidos a cirurgia não cardíaca, admitidos numa Unidade de Cuidados Intensivos (UCI) cirúrgica entre Novembro de 2004 e Abril de 2005. Foram registadas as seguintes variáveis: idade, género, estado físico ASA, tipo e magnitude da cirurgia, mortalidade, tempo de internamento (TI) na UCI e no Hospital, o Simplified Acute Physiology Score II (SAPSII), Troponina cardíaca I (cTnI) nos dias 0, 1, 2 e 3 do pós-operatório, história de hipertensão, dislipidemia, o Revised Cardiac Risk Index (RCRI), ocorrência de eventos cardíacos *major* (ECM): enfarte agudo do miocárdio (EAM), edema pulmonar (EP), fibrilhação ventricular (FV) ou paragem cardíaca primária (PCP). Foi efectuada correlação entre as variáveis e a ocorrência de MCE com análise univariável através de regressão logística simples com o cálculo de um *odds ratio* (OR) e de um intervalo de confiança a 95% (95%CI).
Resultados: Total de 14 ECM: 9 EAM, 1 FV ,4 EP. Factores de risco significativos para ECM foram cirurgia de alto risco (OR 8.26, 95%CI 1.76-38.85, p=0.008), RCRI≥2 (OR 4.0, 95%CI 1.22-13.16, p=0.022), cTnI na admissão (OR 1.46, 95%CI 1.07-1.99,

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Rev Port Cardiol
Vol. 27 Março 08 / March 08

95% CI 1.08-1.22, p<0.001) and higher ICU mortality (21.4% versus 4.6%) (OR 5.63, 95% CI 1.31-24.23, p=0.02) in the ICU. Conclusions: High-risk surgery, RCRI ≥2, cTnI levels and SAPS II were predictors of postoperative MCE. Patients with MCE had longer ICU stay and higher mortality rate.

Key words
Intensive care; Perioperative care; Outcome; Major cardiac events; Cardiovascular monitoring

p=0.018); cTnI no dia 1 do pós-operatório (OR 1.75, 95%CI 1.27-2.41, p=0.001) ; cTnI no dia 2 (OR 2.23, 95%CI 1.24-3.98, p=0.007), SAPSII (OR 1.08, 95%CI 1.04-1.12, p<0.001). Doentes com ECM tiveram maiores TI na UCI (19.1±19.3 dias *versus* 3.4±4.9) (OR 1.15, 95%CI 1.08-1.22, p<0.001) e maior mortalidade na UCI (21.4% *versus* 4.6%) (OR 5.63, 95%CI 1.31-24.23, p=0.02 e na UCI. *Conclusões:* Cirurgia de alto risco, RCRI≥2, níveis de CTnI e SAPSII foram preditores de ECM pós operatórios. Os doentes que tiveram MCE tiveram maiores tempos de estadia na UCI e maiores taxas de mortalidade.

Palavras-Chave
Cuidados intensivos; Cuidados perioperativos; Resultados; Eventos cardíacos *major*; Monitorização cardiovascular

INTRODUCTION

Advances in treating diseases and improving patients' quality of life have led to an increasing number of noncardiac surgical procedures in recent decades [1]. Tachycardia and hypertension resulting from surgical stress, pain, interruption of beta-blocker therapy, or the use of sympathomimetic drugs all increase myocardial oxygen demand. Decreased supply may be the result of hypotension, vasospasm, anemia or hypoxia. All these factors may be associated with significant cardiac morbidity and mortality, raising the incidence of acute myocardial infarction (AMI) and death among unselected adults from less than 0.5% in non-surgical patients to 3-8% in patients undergoing vascular surgery [1, 2] and 1-5% in unselected patients undergoing noncardiac surgery [3].

The high prevalence of cardiac disease in the population has major implications in the postoperative setting, such as cardiac death, myocardial infarction, myocardial ischemia, congestive heart failure, and arrhythmias.

These events are associated with increased mortality and morbidity and result in longer hospital stay and substantially higher treatment costs [4].

In studies that examined the incidence of myocardial ischemia throughout the entire perioperative period, postoperative myocardial ischemia was consistently found to occur more often than preoperative and intraoperative ischemia [5].

In the early postoperative period, cardiac events may occur without symptoms or distinctive electrocardiography changes and may go unrecognized, so accurate assessment of perioperative cardiac risk can guide prophylactic treatment, perioperative management, location and intensity of postoperative care and early detection of cardiac complications.

There are perioperative studies focusing on patients with or at risk of cardiac disease [5, 6], but few on unselected patients undergoing all types of noncardiac surgery [2]. Lee et al. evaluated 4315 patients aged ≥50 years with expected postoperative length of stay (LOS) ≥2 days but excluded patients undergoing emergent surgery.

The aim of this study was to identify major cardiac complications after noncardiac surgery in all unselected patients undergoing elective and emergent noncardiac surgery and predictors of worse outcome.

METHODS

All patients who underwent noncardiac surgery admitted to the surgical ICU at Hospital de São João between November 2004 and April 2005 were eligible for the study.

After informed consent was obtained to the full study protocol, previously approved by the hospital's ethics committee, the following data were obtained: age, gender, American Society of Anesthesiologists (ASA) physical status, and type and magnitude of surgical procedure. Using the classification scheme developed by Lee and colleagues to predict cardiac risk, we calculated a Revised Cardiac Risk Index (RCRI) score for each patient, assigning one point for each of the following risk factors: high-risk surgery (thoracic, abdominal, or pelvic vascular eg., aorta, renal, mesenteric), history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine >2.0 mg/dl [2].

Functional status was assessed according to the patients' capacity to climb stairs, do their own housework and perform regular exercise.

All medication taken by the patients related to cardiovascular disease was recorded.

Surgery-specific cardiac risk was classified according to the ACC/AHA perioperative practice guidelines [7], stratified into three categories: low risk procedures (endoscopic and superficial procedures, cataract surgery and breast surgery), intermediate risk procedures (intraperitoneal and intrathoracic surgery, carotid endarterectomy, head and neck surgery, orthopedic surgery and prostate surgery) and high-risk procedures (emergency surgery, particularly in the elderly; aortic and other major vascular surgery; peripheral vascular surgery; and anticipated prolonged procedures associated with large fluid shifts and/or blood loss).

Acute myocardial infarction, pulmonary edema, ventricular fibrillation or primary cardiac arrest, and complete heart block were recorded during ICU stay and considered to be major cardiac events (MCE).

Acute myocardial infarction was diagnosed according to the criteria of the European Society of Cardiology/American College of Cardiology [8] considering the following two criteria sufficient to diagnose an acute, evolving or recent myocardial infarction: (i) a typical increase and gradual decrease in troponin I (cTnI) concentrations or more rapid increase and decrease in creatine kinase-MB concentration in combination with at least one of the following: (a) typical ischemic symptoms, (b) development of pathological Q-waves on ECG, (c) ECG changes indicative of myocardial ischemia (ST-segment elevation or depression), and (d) coronary artery intervention; and (ii) pathological findings of acute myocardial infarction.

In all patients postoperative samples of creatine kinase-MB (CK-MB) and cTnI were collected immediately after arriving in the ICU and for 3 consecutive postoperative days.

Twelve-lead ECG was performed in all patients on arrival and on the next three days and whenever symptoms of myocardial events occurred.

Continuous acquisition of ECG leads II and V was performed in all patients to monitor and diagnose possible arrhythmias.

After discharge to the infirmary any MCE that occurred were reported to the physician in the ICU.

ICU and in-hospital LOS and mortality were also recorded for all patients, and the Simplified Acute Physiology Score II (SAPS II) was calculated using the standard method [9].

The data were stored and analyzed using SPSS (SPSS Inc, Chicago, Illinois). Descriptive data were presented as mean and standard deviation (SD) for continuous variables after confirming that they followed a normal distribution.

Assessment of the relation between each variable and major cardiac event was made by univariate analysis performed by simple logistic regression with odds ratio (OR) and 95% confidence interval (95% CI), using a significance level of 5%.

Outcomes were compared between patients with and without MCE by analyzing LOS and mortality rate in the ICU.

RESULTS

The patients' primary characteristics are shown in *Table I*. One hundred and eighty-seven patients were studied, mean age 62 years (median: 65 years; range: 23-88), 67% male. The majority of patients (56%) were ASA class III or IV, and mainly underwent elective surgery. More than 40% were major surgeries. Forty-one patients (22%) had an RCRI score of two or more. The three main factors that contributed to RCRI were high-risk surgery, history of ischemic heart disease and congestive heart disease.

Rev Port Cardiol
Vol. 27 Março 08 / March 08

Table I
Characteristics of the study population (n=187)

Age, years (mean ± SD)	62.4±14.2
Median age, years	65
Age <65 years, n (%)	94 (50.3)
Age ≥65 years, n (%)	93 (49.7)
Male gender, n (%)	125 (67)
ASA physical status, n (%)	
I	17 (9.1)
II	66 (35.3)
III	86 (46.0)
IV	18 (9.6)
Scheduled surgery, n (%)	148 (79)
Magnitude of surgery, n (%)	
Minor	37 (19.8)
Medium	64 (34.2)
Major	86 (46.0)
Type of anesthesia, n (%)	
General	155 (82.9)
Regional	14 (7.5)
Combined	18 (9.6)
Duration of surgery, minutes (mean ± SD)	258±143
≤180 minutes, n (%)	45 (24.1)
>180 minutes, n (%)	142 (75.9)
Hypertension, n (%)	85 (45.5)
Hyperlipidemia, n (%)	28 (15.0)
Revised Cardiac Risk Index criteria, n	
High-risk surgery	76
Ischemic heart disease	37
History of congestive heart disease	27
History of cerebrovascular disease	20
Insulin therapy for diabetes	11
Preoperative serum creatinine >2.0 mg/dl	13
Revised Cardiac Risk Index, n	
0	62 (33.2)
1	84 (44.9)
2	27 (14.4)
3	10 (5.4)
> 4	4 (2.1)

ASA: American Society of Anesthesiologists

Table II shows that 15 patients died in hospital, eleven of whom died in the ICU. Fourteen patients had major cardiac complications. These patients had higher mortality rates (21.4% versus 4.6%) and longer ICU stay (19.1±19.3 days versus 3.4±4.9) compared to patients without MCE.

The MCE were 1 ventricular fibrillation, 9 acute myocardial infarctions and 4 pulmonary edema.

Patients who suffered MCE were mainly men, undergoing elective major surgery under general anesthesia (*Table III*). Approximately 60% had a history of hypertension and almost all underwent high-risk surgery according to the RCRI. Four patients who had cardiac events died in hospital.

In univariate analysis, high-risk surgery

Table II
Postoperative outcome

ICU length of stay, days (mean ± SD)	4.6±8.1
with MCE	19.1±19.3
without MCE	3.4±4.9
Hospital length of stay, days (mean ± SD)	27.5±30.2
ICU mortality, n (%)	11 (5.9)
with MCE	3 (21.4)
without MCE	8 (4.6)
In-hospital mortality, n (%)	15 (8.0)
cTnI on admission, µg/l	0.24±1.08
cTnI on postoperative day 1, µg/l	0.49±1.73
cTnI on postoperative day 2, µg/l	1.61±7.16
cTnI on postoperative day 3, µg/l	1.21±3.35
SAPS II	25.4±15.2
MCE in the ICU, n (%)	14 (7)
Ventricular fibrillation/cardiac arrest	1
Acute myocardial infarction	9
Pulmonary edema	4

ICU: Intensive care unit; MCE: Major cardiac events; cTnI: Cardiac troponin I; SAPS II: Simplified Acute Physiology Score II

Table III
Characteristics of population with MCE

Age, years (mean ± SD)	66.8±9.7
Male/female, n	10 / 4
ASA physical status, n	
I	0
II	3
III	8
IV	3
Emergency/elective surgery, n	6/8
Magnitude of surgery, n	
Minor	1
Medium	6
Major	7
Type of anesthesia, n	
General	9
Regional	2
Combined	2
Duration of surgery, minutes (mean ± SD)	302±126
Hypertension, n	8
Hyperlipidemia, n	2
RCRI criteria, n	
High-risk surgery	12
Ischemic heart disease	5
History of congestive heart disease	3
History of cerebrovascular disease	1
Insulin therapy for diabetes	1
Preoperative serum creatinine >2.0 mg/dl	2
Revised Cardiac Risk Index, n	
0	0
1	1
2	5
3	5
> 4	2
ICU length of stay, days (mean ± SD)	19.1±19.3
Hospital length of stay (mean ± SD)	58.0±56.7
ICU mortality, n (%)	3 (21.4)
In-hospital mortality, n (%)	4 (28.6)

ASA: American Society of Anesthesiologists; ICU: Intensive Care Unit; RCRI: Revised Cardiac Risk Index

Table IV
Univariate analysis of predictors and outcome for patients with MCE

	OR	CI	p
High-risk surgery	8.26	1.76-38.85	0.008
>2 Factors of RCRI	4.0	1.22-13.16	0.022
cTnI on admission	1.46	1.07-1.99	0.018
On postoperative day 1	1.75	1.27-2.41	0.001
On postoperative day 2	2.23	1.24-3.98	0.007
SAPS II	1.08	1.04-1.12	<0.001
ICU length of stay	1.15	1.08- 1.22	<0.001
ICU mortality	5.63	1.31- 24.23	0.02

ICU: Intensive care unit; MCE: Major cardiac events; cTnI: Cardiac troponin I; SAPS II: Simplified Acute Physiology Score II

according to the ACC/AHA criteria was the most significant determinant of adverse cardiac events in the postoperative setting (*Table IV*). The subgroup of patients undergoing high-risk surgery had a more than 8-fold increase in the risk of postoperative cardiac events compared to those without such surgical risk. Other important determinants of postoperative cardiac complications were the existence of ≥2 RCRI risk factors, high cTnI values and high SAPS II.

In univariate analysis, patients with MCE had a significantly greater risk for longer ICU LOS (1.15-fold) and for higher mortality (5.63-fold) (*Table IV*).

In the present study, ASA physical status, history of hypertension, hyperlipidemia and intake of beta-blockers did not increase the risk for cardiac complications.

DISCUSSION

This study evaluated the occurrence of major cardiac complications after all types and magnitudes of noncardiac surgery, enrolling patients with all types of clinical risk.

The low incidence (7%) of serious postoperative cardiac events in our study was similar to that observed in other studies by Mangano (3%) [11] and Lee (2%) [2].

As in other studies [11], myocardial ischemia was the primary cause of postoperative cardiac events. Of all 14 MCE, nine (9/187; 4.8%) were acute myocardial infarctions diagnosed from enzymatic and ECG changes. In other studies the reported incidence of postoperative myocardial infarction varied between 1.4 and 38% [12].

Apart from two patients who had chest pain, no other signs or symptoms were present that made the physician suspect an AMI. If no measurement of cardiac enzymes or electrocardiogram had been performed in these patients, 77% (7/9) of the AMI would have been unrecognized.

In a survey evaluating all prospective cohort studies of patients undergoing nonvascular surgeries only 14% of patients experiencing a postoperative AMI had chest pain and only 53% had clinical signs or symptoms compatible with AMI [13]. The vast majority (more than 90%) of postoperative episodes of myocardial ischemia are silent [14]. The large proportion of clinically unrecognized AMI is related to the fact that most AMI occur during the early postoperative period [15], a time of heavy sedation which may blunt pain perception. Patients may be unable to communicate due to the need for mechanical ventilation and in the context of surgery there may be a more common potential explanation for the signs and symptoms experienced by the patients.

Most ischemic episodes tend to start at the end of surgery and during emergence from anesthesia [16]. This is characterized by increased heart rate, arterial pressure, sympathetic tone and procoagulant activity [17]. Intraoperative hemodynamic parameters were not considered in our study as a risk factor for postoperative complications, this probably being a limitation of our investigation.

Four patients experienced acute PE in the postoperative period, corresponding to 2% (4/187) of the study population. Other studies have concluded that the risk of postoperative pulmonary edema may be as high as 7.6%, the greatest risk being in the first 36 hours after surgery [18].

Of the total number of patients who died,

Rev Port Cardiol
Vol. 27 Março 08 / March 08

26% had cardiac complications in the postoperative period (4/15; 26%). In studies that examined postoperative cardiac death, the authors attributed the cause of death to AMI in 66% of cases and to arrhythmia or heart failure in 34% [13]. Postoperative myocardial ischemia appears to be the best predictor of in-hospital and long-term morbidity and mortality [3, 5]. In a study by Khuri et al the authors also concluded that postoperative complications were more important than preoperative patient risk and intraoperative factors in determining survival after major surgery [10].

Unlike other studies [2, 19] that focus mainly on high-risk noncardiac surgery, this study analyzed patients who underwent all types and magnitudes of noncardiac surgery, enabling analysis of the variable of magnitude of surgery as a possible predictor of adverse cardiac events. High-risk surgery classified according to the ACC/AHA perioperative practice guidelines [7] appeared in this study as an independent risk factor for postoperative major cardiac events, being associated with an eight-fold greater risk of postoperative cardiac complications (*Table IV*). This suggests that magnitude of surgery is an important determinant of adverse outcome.

Although the values are not comparable, the reported cardiac risk for high-risk surgery according to the ACC/AHA guidelines is often greater than 5% [7]. Major surgery generates a strong systemic inflammatory response that leads to an increase in oxygen requirement in the postoperative period [20]. Most patients can meet the increased oxygen demand by increasing cardiac output; however there remains a group who may not have the physiologic reserve to increase cardiac output, and are thus at higher risk of complications after surgery.

Having two or more points on the RCRI increased the probability of an adverse cardiac event by four times. In a different analysis, Lee et al. estimated the risk of MCE at 2.4% in patients with two risk factors [5]. In our study the RCRI score was mainly due to high-risk surgery, history of ischemic heart disease and history of congestive heart failure, present in the study population in 41, 20 and 14% of cases respectively. High-risk surgery appears as a major contributor to the RCRI and as the strongest determinant of adverse cardiac events in the postoperative period. It should be noted that magnitude of surgery as an independent variable was classified according to the ACC/AHA perioperative practice guidelines [7], which are different from the classification of high-risk surgery as part of the RCRI score adopted by Lee et al., and therefore the results should be interpreted differently. In the future it would be interesting to apply Lee's high-risk surgery classification throughout the study and to observe the independent strength of this variable. This conflict in classification could perhaps be considered a limitation in our study.

The contribution of heart failure to the RCRI is consistent with previous studies that consider heart failure to be an important risk factor for postoperative cardiac complications [21].

In our study, although cTnI was part of the diagnostic criteria of AMI, high cTnI values were independently associated with an approximately twofold increase in risk of cardiac events. In an article by Devereaux et al. reviewing six studies assessing the prognostic value of cTnI, the authors concluded that "troponin measurement proved to be a statistically significant independent predictor of intermediate and long-term outcomes (i.e., mortality and major cardiac events)" [22]. In a study by Croal et al. the authors concluded that after accounting for the complexity of the surgery and other potential confounding factors, cTnI levels at 24 hours are independent predictors of outcome [23]. Rene et al. studied the significance of moderate elevations of serum cTnI in a surgical ICU and concluded that a moderate elevation below the threshold required to diagnose myocardial injury was associated with a higher mortality rate and longer hospital and ICU stay [24].

According to Devereaux et al. [22] a reasonable threshold would be to obtain cTnI levels and ECG for patients with established atherosclerotic disease, such as coronary artery disease and peripheral vascular disease, who are undergoing surgery requiring hospital admission.

In the population studied, the occurrence of MCE was considered a risk factor for higher mortality and longer ICU stay, and therefore worse outcome. This reinforces the importance of identifying myocardial injury because it can be associated with subsequent cardiac events that carry a significant population burden of disease [25]. Similarly, in a recent publication Venkataraman et al. [26] noted that perioperative

cardiac events contributed significantly to morbidity and mortality.

The lack of evidence for the effectiveness of beta-blocker therapy in significantly reducing perioperative cardiac events in our study may be related to the small number of patients taking this medication, the low incidence of MCE encountered and the differences in the cardiac risk of the patients enrolled.

Differences in absolute magnitude of benefit can be ascribed in part to the cardiac risks of the population, as demonstrated by Poldermans et al., who found greater benefit of beta-blocker therapy among high-risk patients [27], and results from Boersma et al. [19], who suggested that beta-blocker therapy provided little additional benefit in patients with no clinical risk factors. Mangano et al. [11] found no difference in in-hospital cardiac mortality or outcome in patients taking perioperative beta-blockers.

There was no relation between the choice of anaesthetic technique and the risk of cardiac events. Studies of neuroaxial versus general anesthesia suggest that the neuroaxial technique carries a lower risk for postoperative cardiac complications, although this finding remains controversial [28]. All anaesthetic techniques and drugs have known cardiac effects and the choice of anesthesia should be left to the anesthesia team considering each situation.

Adequate postoperative analgesia may influence the occurrence of MCE due to the effect of pain on the cardiovascular system. This variable was not evaluated in our study and could be the subject of further investigation.

CONCLUSION

Our analysis of the 187 patients studied who underwent all types and magnitudes of noncardiac surgery demonstrated that high-risk surgery, RCRI ≥2, and high cTnI and SAPS II values were the most important clinical determinants of a major cardiac event in the postoperative period. The two strongest determinants, high-risk surgery and RCRI, can be easily assessed before surgery and used for preoperative risk stratification, possibly changing patients' risk and influencing outcome.

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Rev Port Cardiol
Vol. 27 Março 08 / March 08

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Determinants of postoperative acute kidney injury

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Research

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Determinants of postoperative acute kidney injury

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Abstract

Introduction Development of acute kidney injury (AKI) during the perioperative period is associated with increases in morbidity and mortality. Our aim was to evaluate the incidence and determinants of postoperative AKI after major noncardiac surgery in patients with previously normal renal function.

Methods This retrospective cohort study was carried out in the multidisciplinary Post-Anaesthesia Care Unit (PACU) with five intensive care beds. The study population consisted of 1166 patients with no previous renal insufficiency who were admitted to these intensive care unit (ICU) beds over 2 years. After admission patients were followed for the development of AKI, defined as proposed by The Acute Kidney Injury Network (increment of serum creatinine [greater than or equal to] 0.3 mg/dL or 50% from baseline within 48 hours or urine output < 0.5 mL/kg/hr for > 6 hours despite fluid resuscitation when applicable). Patient preoperative characteristics, intraoperative management and outcome were evaluated for associations with acute kidney injury using an univariate and multiple logistic regression model.

Results A total of 1597 patients were admitted to the PACU and of these, 1166 met the inclusion criteria. Eighty-seven patients (7.5%) met AKI criteria. Univariate analysis identified age, American Society of Anesthesiologists (ASA) physical status, emergency surgery, high risk surgery, ischemic heart disease, congestive heart disease and Revised Cardiac Risk Index (RCRI) score as independent preoperative determinants for AKI in the postoperative period. Multivariate analysis identified ASA physical status, RCRI score, high risk surgery and congestive heart disease as preoperative determinants for AKI in the postoperative period. Patients that developed AKI had higher Simplified Acute Physiology Score (SAPS) II and Acute Physiology and Chronic Health Evaluation (APACHE) II, higher PACU length of stay (LOS), higher PACU mortality, higher hospital mortality and higher mortality at 6 months follow-up. AKI was an independent risk factor for hospital mortality (OR 3.12, 95% CI 1.41 to 6.93, $P = 0.005$).

Conclusions This study shows that age, emergency and high risk surgery, ischemic heart disease, congestive heart disease, ASA physical status and RCRI score were considered risk factors for the development of AKI, in patients needing intensive care after surgery. AKI has serious impact on PACU length of stay and mortality. AKI was an independent risk factor for hospital mortality.

Introduction

Acute kidney injury (AKI) is commonly seen in the perioperative period and in the intensive care unit (ICU). It is associated with a prolonged hospital stay and high morbidity and mortality [1-6].

Acute renal failure is a complex disorder that occurs in a variety of settings with clinical manifestations ranging from a minimal elevation in serum creatinine to anuric renal failure.

To date, there is no universally accepted definition for acute kidney dysfunction. Varying terms, including *acute renal failure*, *renal insufficiency*, *kidney injury*, and *renal impairment*, and various definitions (e.g. percent or absolute increments of creatinine, or decrements of urine output) have been used in previous publications. Furthermore the term acute kidney injury has been put forth as the preferred nomenclature to replace acute renal failure with the understanding that the

AKI: acute kidney injury; AKIN: Acute Kidney Injury Network; APACHE II: Acute Physiology and Chronic Health Evaluation; ASA-PS: American Society of Anesthesiologists physical status; BMI: body mass index; CI: confidence interval; ICU: intensive care unit; LOS: length of stay; OR: odds ratio; PACU: post anesthesia care unit; RCRI: Revised Cardiac Risk Index; RIFLE: Risk, Injury, Failure, Loss and End-stage kidney disease; SAPS: Simplified Acute Physiology Score; Scr: serum creatinine.

spectrum of AKI is broad and includes different degrees of severity.

We used the definition of AKI proposed by the Acute Kidney Injury Network (AKIN) that was formed to facilitate the development and execution of initiatives to ensure the best outcomes for patients with AKI [7]. As an initial step the AKIN group proposed the term acute kidney injury to reflect the entire spectrum of acute renal failure and developed interim diagnostic and staging criteria for AKI. The diagnostic criteria require a 0.3 mg/dL or 50% or higher change in serum creatinine (Scr) from baseline or a reduction on urine output of less than 0.5 ml/kg/hr over a six-hour interval, within a 48-hour period, following adequate volume resuscitation. These criteria were based on accumulating evidence that even small alterations in Scr are associated with severe consequences [2,4,8-10].

AKI occurs in approximately 1 to 5% of all hospitalized patients and is increasingly prevalent [1,11]. It is devastating to both patients and anesthesiologists, when patients with no evidence of renal dysfunction preoperatively develop AKI after surgery. Various studies have been published determining AKI incidence in specific patient populations: hospitalized patients [12], ICU patients [13,14], after cardiac surgery [15,16], patients with sepsis, and patients on renal replacement therapy [17,18].

Although predictors of postoperative acute renal failure after noncardiac surgery in patients with previously normal renal function had been studied previously [1], little is known about AKI predictors using the AKIN criteria.

The purpose of our study was to evaluate the incidence and determinants of the development of AKI in the immediate postoperative period in patients with previous normal renal function.

Materials and methods

The Institutional Review Board of the Hospital de São João approved the study and waived the requirement for informed consent for the retrospective review of medical records. This retrospective cohort study was carried out at the Hospital São João, a 1124-bed community teaching hospital in Porto, Portugal, in the multidisciplinary post-anesthesia care unit (PACU). The PACU includes a surgical ICU with five beds in which surgical critically ill patients are admitted and closely monitored and treated.

All postoperative patients admitted to the surgical ICU area of the PACU, aged 18 years or more, who underwent scheduled or emergency noncardiac surgery between 1 March 2006 and 1 March 2008 with an overnight admission and more than 12 hours of PACU stay were eligible for the study. Patients were included only if a preoperative Scr within 30 days of the operative data was available. Patients readmitted during the study period were enrolled in relation to the time of their first admission. The PACU admits all surgical patients, with the exception of cardiothoracic patients.

Exclusion criteria were pre-existing renal dysfunction requiring renal replacement therapy or a preoperative Scr higher than 1.6 mg/dL for men and 1.4 mg/dL for women. Preoperative Scr values were defined as the most recent Scr (mg/dL) measured within 30 days of the surgery.

The primary outcome was development of AKI during PACU stay.

Patients were classified as having AKI if they had an increment of Scr of 0.3 mg/dL or higher or 50% or more increase within any 48-hour interval and/or an episode of less than 0.5 mL/kg/hr urine output for more than six hours despite fluid challenge of 500 mL or more normal saline, when appropriate.

The following variables were recorded on admission to the PACU: age, gender, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS), preadmission comorbilities (specifically ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, diabetes, hyperlipidemia), duration of anesthesia, type of anesthesia, core temperature, and troponin I blood levels.

Intraoperative data recorded for each case included administration of crystalloids, colloids, erythrocytes, and fresh frozen plasma.

Intraoperative and PACU data were collected as well as hospital length of stay (LOS). Mortality was recorded for all patients. The Acute Physiology and Chronic Health Evaluation (APACHE) II [19] and the Simplified Acute Physiology Score (SAPS) II [20] were calculated using standard methods.

Adapting a classification scheme developed by Lee and colleagues [21], we calculated the Revised Cardiac Risk Index (RCRI) score, assigning one point for each of the following risk factors: high-risk surgery (defined as intraperitoneal, intrathoracic, or suprainguinal vascular procedures), ischemic heart disease, congestive heart failure, cerebrovascular disease (defined as history of transient ischemic attack or history of cerebrovascular accident), and diabetes mellitus requiring insulin therapy.

Patients' demographics, and intraoperative and postoperative data were collected.

Physiologic data were recorded using customized data entry forms. Included was Scr that was recorded for each day and for PACU admission. These data were also recorded 24 hours

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before meeting criteria for AKI, at the time of AKI, 24 hours after AKI, and 48 hours or longer after AKI.

PACU and hospital LOS were also recorded. For mortality we have registered PACU mortality, hospital mortality, and mortality at six months after PACU discharge.

Statistical analysis

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables; Chi-squared or Fisher's exact test were used to compare proportions between two groups of subjects.

To evaluate the determinants of postoperative AKI and to identify independent predictors of hospital mortality univariate analysis were performed using simple binary logistic regression with an odds ratio (OR) and 95% confidence interval (CI) with the following independent variables: age, gender, BMI, ASA-PS, type of surgery, comorbidities, RCRI score, type of anaesthesia, intraoperative fluid administration, troponin I blood levels at admission, length of anaesthesia, and temperature at admission (and AKI for mortality model). To reduce the risk of a type II error we have controlled the significance level for multiple comparisons applying the Bonferroni's correction for multiple comparisons (test-wise significance level divided by the number of tests performed). All variables were deemed to be significant if $P \leq 0.002$.

Multiple regression binary logistic with forward conditional elimination was used to examine covariate effects of each factor on AKI and to identify independent predictors of hospital mortality. In these models covariates with a univariate $P \leq 0.002$ in the respective univariate analysis were entered (applying the Bonferroni's correction for multiple comparisons).

Data were analyzed using SPSS for Windows version 16.0 (SPSS, Chicago, IL, USA).

Results

A total of 1597 patients were admitted to the PACU during the study period and 1166 patients met the inclusion criteria and were followed for the development of AKI after PACU admission. One-hundred and twenty-one patients were excluded because they had abnormal renal function preoperatively (defined as Scr higher than 1.6 mg/dL for men and 1.4 mg/dL for women); 196 were excluded because they stayed less than 12 hours and did not had an overnight admission in the PACU; 52 were excluded because they were less than 18 years of age; 44 were admitted more than once to the PACU and therefore excluded; 12 were excluded because they were not surgical patients; and 6 had no preoperative Scr measurement and were excluded.

The remaining 1166 were followed for the development of AKI after PACU admission. Eighty-seven (7.5%) developed AKI. The characteristics of patients with and without AKI are summarized in Table 1. Patients with AKI were older (median age 68 versus 64 years, $P = 0.002$), had lower BMI (median 24 versus 25, $P = 0.020$), were more likely to have been submitted for general anesthesia (85% versus 80%, $P = 0.004$), had higher troponin I at admission (0.18 ± 0.52 versus 0.06 ± 0.29, $P = 0.011$), were more likely to have been submitted to emergency surgery (33% versus 19%, $P = 0.001$) or high risk surgery (72% versus 43%, $P < 0.001$), had more frequently ischemic heart disease (38% versus 23%, $P = 0.001$) and congestive heart disease (46% versus 18%, $P < 0.001$), were more likely to be ASA-PS IV/V (22% versus 5%, $P < 0.001$)and have RCRI scores of more than 2 (74% versus 62%, $P < 0.001$), and had higher volume of intraoperative fluids administered (3.0 ± 2.3 versus 2.6 ± 1.7, $P = 0.021$ for crystalloids; 0.3 ± 0.5 versus 0.2 ± 0.4, $P = 0.014$ for colloids; 1.2 ± 2.6 versus 0.7 ± 1.5, $P = 0.003$ for units of erythrocytes; 0.6 ± 1.5 versus 0.2 ± 1.0, $P = 0.004$ for units of fresh frozen plasma).

Table 2 shows the severity of disease scores and outcome for patients with and without AKI. Patients with AKI were more severely ill (median SAPS II 29 versus 18, $P < 0.001$ and median APACHE II 12 versus 7, $P < 0.001$), and stayed longer in the PACU (median LOS 38 versus 25, $P < 0.001$). For the six months follow-up we obtained the postoperative vital status of all patients. The unadjusted mortality rate at six months follow-up of patients with AKI was 36%, nearly four times the mortality rate of those without AKI (36% versus 10%, $P < 0.001$). The increased mortality observed among patients with AKI was even greater for hospital mortality (26%, versus 3%, $P < 0.001$), and PACU mortality (17% versus 1%, $P < 0.001$).

Univariate analysis for determinants of AKI and their relevant *P*-values are summarized in Table 3. Univariate analysis identified the following independent predictors for development of AKI in the immediate postoperative period ($P \leq 0.002$): age (OR 1.03, 95% CI 1.01 to 1.04, $P = 0.002$), emergency surgery (OR 2.17, 95% CI 1.36 to 3.49, $P = 0.001$), ASA-PS (OR 5.41, 95% CI 3.03 to 9.65, $P < 0.001$ for ASA-PS IV/V patients), high-risk surgery (OR 3.47, 95% CI 2.13 to 5.63, $P < 0.001$), ischemic heart disease (OR 2.07, 95% CI 1.31 to 3.26, $P = 0.002$), congestive heart disease (OR 3.91, 95% CI 2.49 to 6.12, $P < 0.001$), and RCRI score (OR 3.30, 95% CI 2.12 to 5.14, $P < 0.001$ for RCRI > 2).

Univariate analysis for severity of disease, LOS, and mortality are summarized in table 4. Severity of disease scores SAPS II and APACHE II were significantly higher in AKI patients (OR 1.08, 95% CI 1.06 to 1.10, $P < 0.001$ and OR 1.18, 95% CI 1.14 to 1.23, $P < 0.001$ respectively). The perioperative onset of AKI in patients with previously normal renal function was associated with significantly increased in PACU LOS (OR

Table 1

Patient characteristics and outcomes

Variable	All patients (n = 1166)	AKI (n = 87)	Non AKI n = 1079	*P*
Age in years, median (IQR)	64 (53 to 73)	68 (57 to 76)	64 (53 to 73)	0.002
Age group, n (%)				0.003
≥65 years	581 (50)	56 (64)	525 (49)	
< 65 years	585 (50)	31 (36)	554 (51)	
Sex, n (%)				0.470
Male	761 (65)	56 (64)	705 (65)	
Female	405 (35)	31 (36)	374 (35)	
ASA physical status				< 0.001
I/II/III	1094 (94)	68 (78)	1026 (95)	
IV/V	72 (6)	19 (22)	53 (5)	
Body mass index in Kg/m^2, median (IQR)	25 (22 to 28)	24 (22 to 27)	25 (22 to 28)	0.020
General anesthesia, n. (%)	940 (81)	72 (85)	868 (80)	0.004
Duration of anesthesia (min.) median (IQR)	210 (150 to 300)	200 (125 to 300)	210 (150 to 300)	0.772
Temperature at admission on PACU, mean ± sd	35.23 ± 1.31	35.04 ± 1.70	35.25 ± 1.27	0.251
Troponin I at admission, mean ± sd	0.07 ± 0.32	0.18 ± 0.52	0.06 ± 0.29	0.011
Hypertension, n (%)	565 (49)	40 (46)	525 (49)	0.356
Hyperlipidemia, n (%)	338 (29)	24 (28)	314 (29)	0.438
Emergency surgery	231 (20)	29 (33)	202 (19)	0.001
High-risk surgery, n (%)	528 (45)	63 (72)	465 (43)	< 0.001
Ischemic heart disease, n (%)	279 (24)	33 (38)	246 (23)	0.001
Congestive heart disease, n (%)	233 (20)	40 (46)	193 (18)	< 0.001
Cerebrovascular disease, n (%)	170 (15)	12 (11)	158 (15)	0.490
Insulin therapy for diabetes, n (%)	104 (9)	9 (10)	95 (9)	0.370
Total RCRI				< 0.001
≤2	437 (38)	54 (62)	833 (77)	
> 2	729 (63)	33 (28)	246 (23)	
Intraoperative fluid volume				
Chrystaloids (L) (IQR)	2.6 ± 1.8 (1.2 to 3.5)	3.0 ± 2.3 (1.5 to 3.6)	2.6 ± 1.7 (1.2 to 3.4)	0.021
Colloids (L) (IQR)	0.2 ± 0.4 (0 to 0.5)	0.3 ± 0.5 (0 to 0.5)	0.2 ± 0.4 (0 to 0.5)	0.014
Erythrocytes (Units) (IQR)	0.7 ± 1.6 (0 to 1)	1.2 ± 2.6 (0 to 2)	0.7 ± 1.5 (0 to 1)	0.003
Fresh frozen plasma (Units) (IQR)	0.3 ± 1.0 (0 to 0)	0.6 ± 1.5 (0 to 0)	0.2 ± 1.0 (0 to 0)	0.004

AKI = acute kidney injury; ASA = American Society of anesthesiologists, IQR = interquartile range; PACU = post anesthesia care unit; RCRI = Revised Cardiac Risk Index; SD = standard deviation.

1.14, 95% CI 1.06 to 1.21, $P < 0.001$), higher PACU mortality (OR 27.89, 95% CI 11.45 to 67.96, $P < 0.001$), higher hospital mortality (OR 14.00, 95% CI 7.60 to 25.79, $P < 0.001$) and higher mortality at six months follow-up (OR 5.25, 95% CI 3.24 to 8.51, $P < 0.001$).

Multiple regression logistic analysis was used to examine covariate effects of each factor on AKI (Table 5). This regression model included all variables with statistical significance in the univariate analysis made for determinants of AKI development. This analysis showed that significant risk factors for AKI were ASA-PS (OR 3.94, 95% CI 2.07 to 7.51, $P < 0.001$, for ASA-

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Table 2

Severity of disease scores, PACU and hospital length of stay, and mortality

Variable	All patients (n = 1166)	AKI (n = 87)	Non AKI (n = 1079)	*P*
SAPS II, median (IQR)	18 (12 to 25)	29 (20 to 45)	18 (12 to 24)	< 0.001
APACHE II, median (IQR)	8 (5 to 11)	12 (8 to 17)	7 (5 to 10)	< 0.001
PACU length of stay (hours), median (IQR)	25 (21 to 46)	38 (22 to 72)	25 (21 to 44)	< 0.001
Hospital length of stay (days), median (IQR)	13 (7 to 28)	16 (8 to 32)	13 (7 to 28)	0.793
Mortality in PACU, n (%)	23 (2.0)	17 (17.2)	8 (0.7)	< 0.001
Mortality in hospital, n (%)	50 (4.3)	23 (26.4)	27 (2.5)	< 0.001
Mortality at six months follow-up, n (%)	134 (11.5)	31 (35.6)	103 (9.5)	< 0.001

AKI = acute kidney injury; APACHE II = Acute Physiology and Chronic Health Evaluation; IQR = interquartile range; PACU = post anesthesia care unit; SAPS II = Simplified Acute Physiology Score.

PS IV/V patients), RCRI (OR 2.45, 95% CI 1.52 to 3.96, $P < 0.001$ for RCRI > 2), high-risk surgery (OR 3.34, 95% CI 2.02 to 5.33, $P < 0.001$), and congestive heart disease (OR 2.34, 95% CI 1.42 to 3.88, $P = 0.001$).

Multiple logistic regression analyses was used to examine covariate effects of each factor on hospital mortality (Table 6). The regression model included all variables with statistical significance in the univariate analysis for determinants of hospital mortality. This analysis showed that AKI was an independent risk factors for hospital mortality (OR 3.12, 95% CI 1.41 to 6.93, $P = 0.005$) after adjustment for age, ASA-PS, high-risk surgery, congestive heart failure, emergency surgery, SAPS II, APACHE II, PACU LOS, RCRI, and AKI. Other independent predictors of hospital mortality were ASA-PS (OR 5.17, 95% CI 2.38 to 11.21, $P < 0.001$, for ASA-PS IV/V patients), high-risk surgery (OR 2.15, 95% CI 1.02 to 4.53, $P = 0.043$), congestive heart disease (OR 2.90, 95% CI 1.45 to 5.76, $P = 0.002$), and SAPS II (OR 1.06, 95% CI 1.03 to 1.08, $P < 0.001$).

Discussion

We report the incidence of postoperative AKI among patients with normal preoperative renal function to be 7.5%. This incidence is consistent with that reported among general hospitalized patients, ranging from 1 to 5% [1]; although, in other studies, the incidence of postoperative acute renal failure varies from 1.1 to 17% [1] depending on the definition of acute renal failure [22]. Acute renal failure remains a medical problem with a daunting outcome: even the best centres typically report mortalities of 50 to 80% [23]. Recent epidemiologic studies demonstrate the wide variation in etiologies and risk factors [24,25].

Unfortunately, acute renal failure is often unrecognized as definitions for the disease range from quantitative and qualitative alterations in Scr to alterations in urine output and dialysis requirement. The lack of a universally recognized definition of ARF has posed a significant limitation contributing to the lack of clinical success. Recognizing the need for uniform standards, the Acute Dialysis Quality Initiative group in 2002 proposed consensus recommendations of the Risk, Injury, Failure, Loss and End-stage kidney disease (RIFLE) criteria for the definition and staging of acute renal failure [10]. The wide interest sparked by the publication of these criteria demonstrated the additional need for multidisciplinary collaborative efforts for clinical and translational research in this area. Consequently, the AKIN was formed to facilitate the development and execution of initiatives to ensure the best outcomes for patients with AKI. As an initial step the AKIN group proposed the term acute kidney injury to reflect the entire spectrum of acute renal failure and developed interim diagnostic and staging criteria for AKI. The diagnostic criteria require a 0.3 mg/dL or a 50% or higher change in Scr from baseline or a reduction in urine output of less than 0.5 ml/kg/hr over a six-hour interval, within a 48-hour period, following adequate volume resuscitation. These criteria were based on accumulating evidence that even small alterations in Scr are associated with severe consequences [2,10,26] and the RIFLE stage correlated with adverse events [27]. Validation of these concepts was now provided by the study of Barrantes and colleagues [13] in a consecutive cohort of patients admitted to a general medical ICU. The overall incidence of AKI in this cohort is much higher (25.4 to 44.6%) than described in our current study.

Postoperative AKI remains a leading cause of morbidity, mortality, prolonged hospital stay, and increased hospital cost. In this study, we have attempted to correlate and predict factors (preoperative, intraoperative, and early postoperative) predisposing to AKI. By doing so, one might be able to predict those at high risk and interventional measures might be planned in advance to improve outcome after such a complication, achieving a better outcome and a more efficient use of hospital and intensive care resources.

Table 3

Univariate analysis for determinants of renal dysfunction

Variable	AKI/non AKI	Odds ratio (95% CI)	*P*
	n = 87/n = 1079		
Age	66.9 ± 13.2/61.5 ± 15.5	1.03 (1.01 to 1.04)	0.002
≥65 years	56 (64)/525 (49)	1.91 (1.21 to 3.00)	0.005
< 65 years	31 (36)/554(51)	1	
Gender		0.96 (0.61 to 1.51)	0.855
Female	31 (36)/374 (35)		
Male	56 (64)/705 (65)		
Body mass index, median	24.0 ± 4.3/25.6 ± 5.8	0.94 (0.89 to 1.00)	0.019
Duration of anesthesia (min.)	233 ± 140/230 ± 113	1.00 (0.99 to 1.00)	0.772
General/Combined anesthesia, n. (%)	72 (85)/868 (80)	4.59 (1.43 to 14.71)	0.010
Emergency surgery	29 (33)/202 (19)	2.17 (1.36 to 3.49)	0.001
ASA physical status			
II/III	68(78)/1026 (95)	1	
IV/V	19 (22)/53 (5)	5.41 (3.03 to 9.65)	< 0.001
Temperature at admission	35.1 ± 1.8/35.2 ± 1.3	0.91 (0.78 to 1.07)	0.251
Troponin at admission	0.20 ± 0.57/0.06 ± 0.29	1.81 (0.95 to 3.44)	0.070
Hypertension	40(46)/525 (49)	0.90 (0.58 to 1.39)	0.631
Hyperlipidemia	24 (28)/314(29)	0.93 (0.57 to 1.50)	0.765
High-risk surgery	63 (72)/465 (43)	3.47 (2.13 to 5.63)	< 0.001
Ischemic heart disease	33 (38)/246 (23)	2.07 (1.31 to 3.26)	0.002
Congestive heart disease	40 (46)/193 (18)	3.91 (2.49 to 6.12)	< 0.001
Cerebrovascular disease	12(14)/158 (15)	0.93 (0.50 to 1.76)	0.829
Insulin therapy for diabetes	9 (10)/95 (9)	1.20 (0.58 to 2.46)	0.628
RCRI			
≤2	54 (62)/833 (77)	1	
> 2	33 (38)/246 (23)	3.30 (2.12 to 5.14)	< 0.001
Intraoperative fluid volume			
Crystalloids (L)	3.0 ± 2.3/2.6 ± 1.7	1.14 (1.02 to 1.28)	0.024
Colloids (L)	0.3 ± 0.5/0.2 ± 0.4	1.76 (1.11 to 2.78)	0.016
Erythrocytes (Units)	1.2 ± 2.6/0.7 ± 1.5	1.15 (1.04 to 1.27)	0.005
Fresh frozen plasma (Units)	0.6 ± 1.5/0.2 ± 1.0	1.22 (1.04 to 1.42)	0.012

AKI = acute kidney injury; ASA = American Society of Anesthesiologists; CI = confidence interval; RCRI = Revised Cardiac Risk Index

We intentionally excluded patients with documented preoperatively raised Scr in order to predict AKI among patients with preoperatively normal renal function, as dictated by a Scr less than 1.6 mg/dL for men and 1.4 mg/dL for women.

There have been a variety of predictive models developed to stratify risk in patients undergoing cardiac surgery [3,28] and there is an important recently published study addressing renal dysfunction after noncardiac surgery [1]. These studies identified the incidence and risk factors for postoperative acute renal failure after surgery using acute renal failure definitions that are more strict and less sensitive for renal insufficiency than those used in our study for AKI. Most predictors or determinants we have found in our study are consistent with

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Table 4

Univariate analysis for severity of disease, length of stay, and mortality

Variable	AKI/non AKI	Odds ratio (95% CI)	*P*
	n = 87/n = 1079		
SAPS II	33.3 ± 18.7/18.9 ± 10.3	1.08 (1.06 to 1.10)	< 0.001
APACHE II	13.0 ± 6.8/8.0 ± 4.3	1.18 (1.14 to 1.23)	< 0.001
PACU stay (days)	2.8 ± 3.4/1.8 ± 2.1	1.14 (1.06 to 1.21)	< 0.001
Hospital stay (days)	25 ± 27/24 ± 32	1.00 (0.99 to 1.01)	0.793
Mortality in the PACU	17 (17)/8 (1)	27.89 (11.45 to 67.96)	< 0.001
Mortality in the hospital	23 (26)/27 (3)	14.00 (7.60 to 25.79)	< 0.001
Mortality at 6 months	31 (36)/103 (10)	5.25 (3.24 to 8.51)	< 0.001

AKI = acute kidney injury; APACHE II = Acute Physiology and Chronic Health Evaluation; CI = confidence interval; PACU = post anesthesia care unit; SAPS = Simplified Acute Physiology Score.

those described in these studies: emergent surgery, advanced age, peripheral vascular occlusive disease, and high-risk surgery.

In his study with similar objectives but with different methodology Kheterpal and colleagues [1] found seven independent preoperative predictors for the development of acute renal failure after noncardiac surgery in patients with previously normal renal function and four of these predictors were similarly found in our study: age, emergency surgery, high-risk surgery, and ischemic heart disease. Beyond these we also found congestive heart disease, ASA-PS, and higher RCRI scores as risk factors for the development of AKI.

The ASA-PS score, a preoperative evaluation used routinely for every patient, was never intended to be a perioperative risk score, but all large-scale studies have suggested that a high ASA-PS score is one of the best predictors of postoperative morbidity [29,30]. This indicator itself depends on a more generic classification of the presence of disease, and in itself indicates the presence of comorbidities. ASA-PS classification is a strong prognostic predictor for the development of postoperative medical complications for patients in a perioperative setting and in fact in our study, we found that increasingly severe systemic disease (higher ASA-PS level) is a determinant of AKI.

Table 5

Multivariate analysis to evaluate covariate effects on AKI development

Variable	Beta	Adjusted OR	p
ASA physical status	1.371	3.94 (2.07 to 7.51)	< 0.001
RCRI	0.896	2.45 (1.52 to 3.96)	< 0.001
High-risk-surgery	1.206	3.34 (2.02 to 5.53)	< 0.001
Congestive Heart disease	0.851	2.34 (1.42 to 3.88)	0.001

AKI = acute kidney injury; ASA = American Society of Anesthesiologists; RCRI = Revised Cardiac Risk Index.

The RCRI is a prediction tool for major cardiac complications after noncardiac surgery [21,31]. It was developed for the prediction of cardiac risk based on six independent prognostic factors: high-risk surgery, ischemic heart disease, congestive heart disease, history of cerebrovascular disease, insulin therapy for diabetes, and preoperative Scr higher than 2.0 mg/dL. RCRI score is based on predictors, which independently have a significant association with cardiovascular events. This is probably the reason why RCRI score is a predictor of AKI in immediate postoperative period and the meaning of that could be that patients with pre-existing cardiovascular disease have an increased perioperative risk of developing AKI in postoperative period. In the present study, we found that RCRI score was an independent predictor for development of AKI as well as some of the factors included in it, showing that they were independent predictors for AKI.

In fact, to assume that both cardiac and renal complications are based on ischemic injury to sensitive organs may be a plausible explanation for RCRI as an index. Even some of the individualized risk factors that compose it appears as a risk factor for postoperative renal failure.

We noted congestive heart failure to be an independent predictor for hospital-acquired AKI as stated by Drawz and colleagues [32] and that in an ICU population of the study of Barrantes and colleagues [13] patients with congestive heart failure were more likely to develop AKI.

Acute renal injury without the need for renal replacement therapy is associated with increased mortality in critically ill patients and in postoperative cardiac and noncardiac surgery

Table 6

Multivariate regression analysis for predictors of in-hospital mortality

Variable	Simple OR	*P*	Adjusted* OR (95% CI)	*P*[a]
Age group, n (%)				
≥65 years	2.69	0.002		
< 65 years	1			
ASA physical status				
I/II/III	1		1	
IV/V	15.12	< 0.001	5.17 (2.38 to 11.21)	< 0.001
Temperature	0.71	< 0.001		
Emergency surgery	4.05	< 0.001		
High-risk surgery	3.26	< 0.001	2.15 (1.02 to 4.53)	0.043
Congestive heart disease	6.75	< 0.001	2.90 (1.45 to 5.76)	0.002
SAPS II	1.09	< 0.001	1.06 (1.03 to 1.08)	< 0.001
APACHE II	1.27	< 0.001		
PACU LOS (days)	1.19	< 0.001		
AKI	14.00	< 0.001	3.12 (1.41 to 6.93)	0.005

[a]Logistic regression analysis with stepwise forward method was used with an entry criterion of $P < 0.05$ and a removal criterion of $P > 0.1$.
*Adjusted to age, ASA physical status, high-risk surgery, congestive heart failure, emergency surgery, SAPS II, APACHE II, PACU LOS, and AKI.
AKI = acute kidney injury; APACHE II = Acute Physiology and Chronic Health Evaluation; ASA = American Society of Anesthesiologists; CI = confidence interval; LOS = length of stay; OR = odds ratio; PACU = post anesthesia care unit; SAPS = Simplified Acute Physiology Score.

[1,13,33,34]. Similarly our data suggest a relation between AKI and increased postoperative mortality after noncardiac surgery; this increased mortality rate was observed in the PACU, in the hospital, and at six months after PACU discharge.

Mortality of patients with acute renal failure is high. In the study by Barrantes and colleagues [13], the authors demonstrated that critical care patients meeting the definition for AKI similar to the definition used in our study, had a hospital mortality of 46% and that these patients were three times more likely to die during hospitalization. Our hospital mortality were lower (27%) but AKI patients were 13 times more likely to die during hospitalization and 26 times more likely to die during PACU stay.

In our study patients with AKI had significantly higher hospital mortality than patients without AKI. Even when controlled for other variables with a multiple variable regression analysis, AKI remains an independent risk factor for hospital mortality. This is consistent with previous data [1,6,35].

The study by Chertow and colleagues [2] first demonstrated that a change of Scr 0.3 mg/dL or more at any time during hospitalization was associated with increased mortality. Our study, using the same definition for AKI used in the study by Barrantes and colleagues [13], not only supports that such small changes in creatinine are associated with meaningful differences in outcome but also that acute increments of 0.3 mg/dL in a 48-hour period predict mortality.

As in the previous focused study by Barrantes and colleagues [13], patients with AKI had a longer duration of PACU stay.

We should note some limitations to our analysis. First, our study was retrospective in nature; we were unable to identify and analyse all potential confounding factors. The data were collected as part of the delivered clinical cares. As a result, the data reflect the electronic medical record, and no additional detail is available. Documentation of urine output, the use of vasoactive substances and hemodynamic stability during surgery was less reliable. In our analysis we could only quantify volume of intraoperative fluid administration and we were unable to address the complete role of intravenous hydration in AKI because several data elements involved in the quantification of resuscitation volume were not accurately collected in the medical records. This might be an important aspect of pathophysiology for AKI development and could not be included in our analysis.

In the study we do not analyse time points for AKI development and we did not make exclusion criteria to prevent the admission of patients with late development of AKI. With this approach we could have considered AKI that could have been due to complications other than surgery. We did not assess other potential consequential effects of AKI and the studied

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outcomes (mortality and LOS) may not necessarily capture all relevant consequences of AKI. The mortality data are based on all-cause mortality and no additional detail regarding the cause of death are available for review. This may limit the ability to interpret our data on mortality.

Conclusions

Using the interim consensus definition of AKI we could predict meaningful clinical outcomes and were able to identify risk factors for the development of AKI in patients needing intensive care after surgery.

Key messages

- AKI is commonly seen in the postoperative period after major surgery. In our study 7.5% of patients developed AKI after surgery.
- Age, emergency surgery, ASA-PS, high-risk surgery, ischemic heart disease, congestive heart disease, and total RCRI score were considered independent predictors for the development of AKI.
- Patients that developed AKI stayed longer in the PACU.
- The perioperative onset of AKI was associated with significantly increased PACU LOS and higher mortality rates at the hospital and at six months follow-up.
- AKI was an independent risk factor for hospital mortality.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

FA participated in conception, design, acquisition of the data, analysis of the data, statistical analysis, critical revision of the manuscript, and supervision. MB and VF participated in conception, design, acquisition of the data, analysis of the data, and critical revision of the manuscript. HB was involved in drafting the manuscript, analysis of the data, and revising it critically for important content. All authors read and approved the final manuscript.

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Outcome and quality of life of patients with acute kidney injury after major surgery

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Outcome and quality of life of patients with acute kidney injury after major surgery

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RESUMEN

Antecedentes: En pacientes posoperatorios críticamente enfermos que desarrollan insuficiencia renal aguda (IRA), es importante centrarse en la supervivencia y la calidad de vida una vez que se haya obtenido el alta. El objetivo del estudio era evaluar el resultado y la calidad de vida de los pacientes que desarrollan IRA tras haber experimentado una cirugía mayor. **Métodos:** este estudio retrospectivo se llevó a cabo en una Unidad de Recuperación Posanestésica (URPA), con cinco camas de cuidado intensivo, durante 2 años. Se hizo un seguimiento de los pacientes para detectar el desarrollo de IRA, evaluando las características preoperatorias, la gestión de la operación y el resultado. Seis meses después de recibir el alta se contactó con estos pacientes para realizar un cuestionario SF-36 y para evaluar su grado de dependencia en actividades de la vida diaria (AVD). Para comparar proporciones entre grupos, se utilizó el test de Chi-cuadrado o test exacto de Fischer. Para realizar comparaciones se usó un test T y un test T para datos emparejados para grupos independientes. **Resultados:** De los 1597 pacientes ingresados en la URPA, 1.200 cumplían con el criterio de inclusión. Ciento catorce pacientes (9,6%) cumplían el criterio de IRA. Los pacientes con IRA padecían la enfermedad con un nivel de gravedad mayor, y su estancia en la URPA fue más prolongada. Durante una revisión realizada pasados 6 meses de los 71 supervivientes, 50 realizaron los cuestionarios. El 52% de los pacientes opinaron que su estado de salud el día del cuestionario era mejor que 12 meses antes. Los pacientes que cumplían con los criterios de IRA posquirúrgica obtuvieron una puntuación más negativa en los cuestionarios SF-36 en las áreas de funciones físicas, rol físico y rol emocional. Seis meses después de recibir el alta de la URPA, los pacientes que cumplían con los criterios de IRA eran más dependientes en lo que se refiere a las AVD instrumentales, pero no a las AVD personales. **Conclusiones:** los pacientes que desarrollaron IRA mejoraron su percepción de su calidad de vida, a pesar de tener una mayor dependencia en las tareas de la AVD. En las áreas de funciones físicas y rol físico, obtuvieron una puntuación más negativa que los pacientes en la URPA que no habían desarrollado IRA.

Palabras clave: Anestesia. Insuficiencia renal aguda. Actividades de la vida diaria. Calidad de vida.

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ABSTRACT

Background: *In postoperative critically-ill patients who develop Acute Kidney Injury (AKI) it is important to focus on survival and quality of life beyond hospital discharge. The aim of the study was to evaluate outcome and quality of life in patients that develop AKI after major surgery.* ***Methods:*** *This retrospective study was carried out in a Post-Anaesthesia Care Unit with five intensive care beds during 2 years. Patients were followed for the development of AKI. Preoperative characteristics, intra-operative management and outcome were evaluated. Six months after discharge, these patients were contacted to complete a Short Form-36 questionnaire (SF-36) and to have their dependency in Activities of Daily Living (ADL) evaluated. Chi-square or Fischer's exact test were used to compare proportions between groups. A "t test" and a paired "t test" for independent groups was used for comparisons.* ***Results:*** *Of 1597 patients admitted to the PACU, 1200 patients met the inclusion criteria. One hundred–fourteen patients (9.6%) met AKI criteria. Patients with AKI were more severely ill, stayed longer at the PACU. Among 71 hospital survivors at 6 months follow-up, 50 completed the questionnaires. Fifty-two percent of patients reported that their general level of health was better on the day they answered the questionnaire than 12 months earlier. Patients that met AKI criteria after surgery had worse SF-36 scores for physical function, role physical and role emotional domains. Six months after PACU discharge, patients that met AKI criteria were more dependent in Instrumental-ADL but not in Personal-ADL.* ***Conclusions:*** *Patients that develop AKI improved self-perception of quality of life despite having high rate of dependency in ADL tasks. For physical function and role physical domains they had worse scores than PACU patients that did not develop AKI.*

Key words: *Anaesthesia. Acute Kidney Injury. Activities of daily living. Quality of Life.*

INTRODUCTION

Acute kidney injury (AKI) is commonly seen in the perioperative period and in the Intensive Care Unit (ICU). It

is associated with a prolonged hospital stay and high morbidity and mortality[1-5].

To date, there is no universally accepted definition for acute kidney dysfunction. Varying terms, including *acute renal failure*, *renal insufficiency*, *kidney injury*, and *renal impairment*, and various definitions (e.g., percent or absolute increments of creatinine, or decrements of urine output) have been used in previous publications. Furthermore the term acute kidney injury has been put forth as the preferred nomenclature to replace acute renal failure with the understanding that the spectrum of AKI is broad and includes different degrees of severity.

We used the proposed definition by the Acute Kidney Injury Network (AKIN) that was formed to facilitate the development and execution of initiatives to ensure the best outcomes for patients with acute kidney injury[6,7]. These criteria were based on accumulating evidence that even small alterations in serum creatinine are associated with severe consequences[2,8-10].

Acute Kidney Injury occurs in approximately 1-5% of all hospitalized patients and is increasingly prevalent[1,11] and is known to be an independent predictor of poor in-hospital outcome[1,2,12].

It is devastating to both patients and anaesthesiologists, when patients with no evidence of renal dysfunction preoperatively, develop AKI after surgery. Various studies have been published determining AKI incidence in specific patient populations: hospitalized patients[13], ICU patients[14,15], after cardiac surgery[16,17] patients with sepsis and patients on renal replacement therapy[18,19].

We conducted a study in patients that met AKI criteria after major surgery to evaluate outcome and quality of life. In order to accomplish these tasks we tried to evaluate the long-term health status, incorporating measures of quality of life, functional status and hospital discharge location that are now recognized as significant markers of morbidity in survivors of critical illness[20,21].

The long-term quality of life and functional status for survivors of critical illness specifically characterized by severe Acute Renal Failure have been described in various studies [22-27].

Several questionnaires have been validated to study Health-Related Quality of Life (HRQOL)[28-32], mostly multi-item scales. The Short-Form General Health Survey (SF-36) was developed during the Medical Outcomes Study to measure generic health concepts that are relevant across age, disease and treatment groups[33]. It is a self-completed questionnaire covering all aspects of HRQOL, it shows good reliability and validity[33,34], and it has been used for various groups of patients including post-discharge Intensive Care Unit (ICU).

The ability to care for oneself and live independently is considered a measure of functional outcome after hospitalization[35]. Functional status refers to the level of involvement in activities and is often used as a synonym for performance in ADL[36]. ADL appraisal scales consider functional and instrumental activities. The ability of patients to handle these activities has been assessed by generic or disease-specific tests. Katz's ADL Scale[36] and the Lawton Instrumental ADL[37] have been used for critical care survivors.

The aim of the present study was to evaluate outcome, quality of life and autonomy in ADL in patients that develop AKI after major surgery and to identify its determinants.

METHODS

The Institutional Review Board approved the study and waived the requirement for informed consent for the retrospective review of medical records. This retrospective cohort study was carried out in the multidisciplinary Post-Anaesthesia Care Unit with five intensive care beds, at the Hospital São João, an 1100-bed community teaching hospital in Porto, Portugal.

Patient population

All postoperative patients admitted to the PACU, aged 18 years or more, who underwent scheduled or emergency surgery between 1 March 2006 and 1 March 2008 with an overnight admission and more than 12 hours of PACU stay were eligible to the study. Patients readmitted during the study period were enrolled in relation to the time of their first admission. Excluded were patients submitted to cardiac or pulmonary surgery.

The PACU admits all surgical patients, with the exception of cardiothoracic.

Patients with abnormal renal function preoperatively (defined as creatinine blood levels higher than 2.0 mg/dL) were excluded.

Primary outcome

The primary outcome was the development of AKI during PACU stay.

Patients were classified as having AKI criteria according to the definition proposed by the Acute Kidney Injury Network[7] if they had an increment of Scr $\geq$0.3 mg/dL or $\geq$50% increase within any 48 hr interval and/or an episode of <0.5 mL/kg/hr urine output for >6 hrs despite fluid challenge of $\geq$500 mL of normal saline, when appropriate.

Covariates

The following variables were recorded on admission to the PACU: age, gender, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS)[38], emergency or scheduled surgery, preadmission comorbilities (specifically ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, renal insufficiency, diabetes, hyperlipidemia) and duration and type of anesthesia. Intraoperative and PACU data were collected as well as hospital length of stay (LOS). Mortality was recorded for all patients. The Acute Physiology and Chronic Health Evaluation (APACHE) II[39] and the Simplified Acute Physiology Score II (SAPS II)[40] were calculated using standard methods except that they were modified to excluded creatinine increments and the number and types of organ failures.

Adapting a classification scheme developed by Lee and colleagues[41], we calculated the Revised Cardiac Risk Index (RCRI), assigning one point for each of the following risk factors: high-risk surgery, ischemic heart disease, cerebrovascular disease (defined as history of transient ischemic attack or history of cerebrovascular accident) and diabetes mellitus requiring insulin therapy.

Physiologic data were recorded using customized data entry forms. Included was Serum Creatinine (Scr) that was recorded for each day and for PACU admission and at least every patient had two Scr determinations. These data were also recorded 24 hours before meeting criteria for AKI, at the time of AKI, 24 hours after AKI, and ≥48 hours after AKI.

We've also recorded PACU and hospital LOS. For mortality we have recorded PACU mortality, hospital mortality and mortality at 6 months after PACU discharge.

Functional capacity

Functional capacity before surgery was evaluated within the first 24 hours after PACU admission in terms of the patient's ability to handle personal and instrumental ADL. All eligible consenting patients were interviewed directly by a trained investigator. When the patient was unable to respond, the questionnaire was completed by a close family member living in the same household as the patient. This evaluation was repeated along with the SF-36 questionnaire six months after PACU discharge.

Quality of life

HRQOL was assessed by the SF-36[34]. The survey contains 36 questions that evaluate eight health domains considered to be important for patient well-being and health status. These domains reflect physical health, mental health, and the impact of health on daily functioning. The eight multiple-item domains encompass physical functioning (ten items), social functioning (two items), role limitations caused by physical problems (four items), role limitations caused by emotional problems (three items), mental health (five items), energy and vitality (four items), pain (two items) and general perception of health (five items). There is one further unscaled item relating to self-reported changes in the respondent's health status during the past year. For each item, scores are coded, summed and transformed to a scale from 0 (worst possible health state measured by the questionnaire) to 100 (best possible health state). Scores can be aggregated to measures representing a physical health summary scale (consisting of physical functioning, physical role, pain and general health) and a mental health summary scale (vitality, social functioning, emotional role and mental health)[28].

The answers to the question about self-reported changes in health status ("compared to one year ago, how you would rate your health in general now?") were dichotomized as: better, about the same or worse than one year ago.

To minimize distress to the next of kin, each patient's records were checked on the hospital information system after 6 months to ascertain whether he or she was still alive. A copy of a formal letter was sent to all known survivors accompanied by a return envelope and a validated Portuguese SF-36 self-report form[42,43]. This version has been validated for the population of the city of Porto from which the subjects of this report were drawn[44].

Scores for all domains obtained for patients that developed AKI were compared with this published[40] urban population values obtained for population of Porto.

We also compared scores in all SF-36 domains obtained for AKI patients with scores obtained for PACU patients that didn't develop AKI after surgery.

The questionnaire used to assess dependency was based on the Katz Index of Independence in ADL[22] and Lawton Instrumental ADL scale. The Lawton Instrumental ADL scale is an easily to administer assessment instrument that provides self-reported information about the functional skills necessary for living in the community. Deficits in the instrumental Lawton scale were scored and a summary score ranging from 0 (low function, dependent) to 7 (high function, independent) was obtained. The Katz ADL scale assesses basic personal activities of daily living and ranks adequacy of performance in six functions. Dependency in each personal activity was evaluated and a summary score ranging from 0 (independence in all activities) to 6 (dependency in all activities) was obtained. The personal ADL (P-ADL) considered were bathing, dressing, going to the toilet, transferring from bed to chair, continence and feeding. The

instrumental ADL (I-ADL) considered were cleaning, food shopping, public transportation and cooking. Answers were categorized into two groups: able or unable to perform each activity and group of activities. Patients were considered dependent if they were dependent in at least one I-ADL or P-ADL activity.

Outcome measures

Considered outcome endpoints were: 1) Functional capacity and ADL. Patients were considered dependent if they were dependent in at least one I-ADL or P-ADL activities. 2) Quality of life. Quality of life was evaluated at 6 months after PACU discharge. 3) Mortality. Patients were considered survivors if they were alive 6 months after PACU discharge.

Statistical methods

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables between two groups of subjects; chi-square or Fischer's exact test were used to compare proportions between two groups of subjects.

We used a significance level of 0.05 (two sided) for all statistical tests except when multiple comparisons were made. In such cases we controlled the values for multiple comparisons to reduce the risk of type II error and the entry criterion of $P \leq 0.001$ was used.

A "t test" for independent groups was used for comparison to population means. The SF-36 scores for AKI population were compared with the general population using a paired "t test". Every patient in the AKI population was paired prospectively with a demographically matched patient from the control population.

To evaluate the determinants of mortality and dependency in at least one ADL we have used a multiple logistic regression analysis with an entry criterion of $P \leq 0.001$ and independent variables: age, gender, BMI, ASA-PS, type and magnitude of surgery, co-morbidities and RCRI score, type of anaesthesia, intra-operative fluid administration and length of anaesthesia, temperature at admission to the PACU, Troponin I at admission, PACU LOS, SAPS II scores, APACHE II scores and PACU and hospital LOS.

SPSS for Windows version 16.0 (SPSS, Chicago, IL) was used to analyze the data.

RESULTS

A total of 1597 patients were admitted to the PACU during the study period and 1200 patients met the inclusion criteria and were followed for the development of AKI after PACU admission. Eighty patients were excluded because they had abnormal renal function preoperatively (defined as Scr higher than 2.0 mg/dL), 196 stayed less than 12 hours and did not had an overnight admission, 52 because they had less than 18 years and 44 were admitted more than once to the PACU, 13 were admitted after pulmonary surgery and 12 were not surgical patients.

One-hundred fourteen patients (9.6%) developed AKI. The characteristics of patients with and without AKI are summarized in table 1. Patients with AKI were older (median age 68 versus 64 years, $p < 0.001$), had higher ASA physical status (26% versus 5%, $p < 0.001$), were more likely to have been submitted to general anesthesia (85% versus 80%, $p = 0.005$), had higher Troponin I at admission (0.18 ± 0.52 versus 0.06 ± 0.29, $p = 0.016$) were more likely to have been submitted to emergency surgery (34% versus 19%, $p < 0.001$) and high risk surgery (70% versus 43%, $p < 0.001$), had more frequently ischemic heart disease (37% versus 23%, $p = 0.001$) and congestive heart disease (47% versus 18%, $p < 0.001$), had higher RCRI scores (1.76 ± 1.05 versus 1.07 ± 0.98, $p < 0.001$) and had higher volume of intraoperative fluids administered (3.0 ± 2.3 versus 2.6 ± 1.7, $p = 0.014$ for litres of crystalloids; 0.3 ± 0.5 versus 0.2 ± 0.4, $p = 0.004$ for litres of colloids; 1.1 ± 2.4 versus 0.7 ± 1.5, $p = 0.005$ for units of erythrocytes; 0.5 ± 1.4 versus 0.2 ± 1.0, $p = 0.012$ for units of fresh frozen plasma).

Table 2 shows the severity of disease scores and outcome for patients with and without AKI. Patients with AKI were more severely ill (median SAPS II 31 versus 18, $p < 0.001$ and median APACHE II 12 versus 7, $p < 0.001$), stayed longer at the PACU (median LOS 33 hours versus 20 hours, $p < 0.001$). The unadjusted mortality rate at 6 months follow-up of patients with AKI was 38%, nearly 4 times the mortality rate of those without AKI (38% versus 10%, $p < 0.001$). The increased mortality observed among patients with AKI was even greater for hospital mortality (26%, versus 3%, $p < 0.001$) and PACU mortality (18% versus 1%, $p < 0.001$).

Table 3 presents the characteristics of PACU patients according to mortality at 6 months follow-up study. Patients with postoperative AKI criteria that have died until 6 months follow-up had higher scores of ASA-PS (81% versus 63% were ASA IV or V patients) and higher severity of disease scores (45 ± 19 versus 28 ± 14 for mean SAPS II scores and 18 ± 7 versus 11 ± 5 for mean APACHE II scores with $p < 0.001$ for both scores) and had lower temperatures at admission to the PACU ($34.3\ ^{\circ}C \pm 2.0$ versus $35.5\ ^{\circ}C \pm 1.3\ ^{\circ}C$, $p < 0.001$).

Median PACU length of stay were higher in patients that met AKI criteria compared with those without AKI criteria (37 hours versus 24 hours, $p < 0.001$).

Twenty patients (18%) died during PACU stay, ten died before hospital discharge and thirteen died before follow-up at 6 months.

Table 1. Patient characteristics and outcomes

Variable	All patients (n = 1200)	AKI (n = 114)	Non AKI n = 1086	p
Age in years, median (P25-75)	64 (54-74)	68 (57-76)	64 (53-73)	<0.001
Age group, n (%)				0.0064
≥65 years	601 (50)	71 (62)	528 (49)	
<65 years	599 (50)	43 (38)	558 (51)	
Sex, n (%)				0.490
Male	785 (65)	74 (65)	711 (66)	
Female	415 (35)	40 (35)	375 (34)	
ASA physical status				<0.001
I/II/III	1117 (93)	83 (74)	1038 (95)	
IV/V	83 (7)	30 (26)	53 (5)	
Body Mass Index in Kg/m², median (P25-P75)	25 (22-28)	24 (22-27)	25 (22-28)	0.355
General anesthesia, n. (%)	966 (81)	97 (85)	869 (80)	0.005
Duration of anesthesia (min.) median (P25-P75)	210 (150-300)	200 (125-300)	210 (150-300)	0.782
Temperature at admission on PACU, mean ± sd	35.23 ± 1.31	35.04 ± 1.70	35.25 ± 1.27	0.114
Troponin I at admission, mean ± sd	0.07 ± 0.32	0.18 ± 0.52	0.06 ± 0.29	0.016
Hypertension, n (%)	582 (49)	54 (47)	528 (49)	0.439
Hyperlipidemia, n (%)	347 (29)	32 (28)	315 (29)	0.465
Emergency surgery	241 (20)	39 (34)	202 (19)	<0.001
High-risk surgery, n (%)	549 (46)	80 (70)	469 (43)	<0.001
Ischemic heart disease, n (%)	289 (24)	42 (37)	247 (23)	0.001
Congestive heart disease, n (%)	246 (21)	53 (47)	193 (18)	<0.001
Cerebrovascular disease, n (%)	172 (14)	13 (11)	159 (15)	0.215
Insulin therapy for diabetes, n (%)	108 (9)	13 (11)	95 (9)	0.216
Total RCRI, mean ± sd	1.14 ± 1.00	1.76 ± 1.05	1.07 ± 0.98	<0.001
Intraoperative fluid volume				
Chrystaloids (L) (P25-P75)	2.6 ± 1.8 (1.2-3.5)	3.0 ± 2.3 (1.5-3.6)	2.6 ± 1.7 (1.2-3.4)	0.014
Colloids (L) (P25-P75)	0.2 ± 0.4 (0-0.5)	0.3 ± 0.5 (0– 0.5)	0.2 ± 0.4 (0– 0.5)	0.004
Erythrocytes (Units) (P25-P75)	0.7 ± 1.6 (0-1)	1.1 ± 2.4 (0-2)	0.7 ± 1.5 (0-1)	0.005
Fresh frozen plasma (Units) (P25-P75)	0.3 ± 1.0 (0-0)	0.5 ± 1.4 (0-0)	0.2 ± 1.0 (0-0)	0.012

AKI: Acute Kidney Injury; ASA: American Society of anesthesiologists; RCRI: Revised Cardiac Risk; PACU: Post Anesthesia Care Unit; P25 and P75 are the 25th and 75th percentiles.

Table 2. Severity of disease scores, PACU and Hospital Length of stay and Mortality

Variable	All patients (n = 1200)	AKI (n = 114)	Non AKI n = 1086	p
SAPS II, median (P25-75)	18 (12-26)	31 (23-45)	18 (12-24)	<0.001
APACHE II, median (P25-75)	8 (5-11)	12 (8-17)	7 (5-10)	<0.001
PACU length of stay (hours), median (P25-75)	25 (21-46)	37 (24-73)	24 (20-44)	<0.001
Hospital length of stay (days), median (P25-75)	14 (7-28)	17 (7-33)	13 (7-28)	0.587
Mortality in PACU, n (%)	28 (2.3)	20 (18)	8 (1)	<0.001
Mortality in hospital, n (%)	57 (4.8)	30 (26)	27 (3)	<0.001
Mortality at 6 months follow-up, n (%)	146 (12.2)	43 (38)	103 (10)	<0.001

AKI: Acute Kidney Injury; SAPS II: Simplified Acute Physiology Score; APACHE II: Acute Physiology and Chronic Health Evaluation; PACU: Post Anesthesia Care Unit.

Table 3. Characteristics of patients according to mortality at 6 months follow-up

Variable	Deaths (n = 43)	Alive (n = 71)	P
Age in years	64.2 ± 12.5	71.3 ± 13.4	0.005
Age group, n (%)			0.029
≥65 years	32 (74)	39 (55)	
<65 years	11 (26)	32 (45)	
Sex, n (%)		0.147	
Male	31 (672)	43 (61)	
Female	12 (28)	28 (39)	
ASA physical status			**0.001**
I/II/III	8(19)	26 (37)	
IV/V	35 (81)	45 (63)	
Body Mass Index in Kg/m²	25.6 ± 5.8	23.4 ± 4.7	0.074
General anesthesia, n. (%)	39 (91)	58 (82)	0.593
Duration of anesthesia (min)	218 ± 136	242 ± 151	0.390
Temperature at admission on PACU	**34.3 ± 2.0**	**35.5 ± 1.3**	**<0.001**
Troponin I at admission	1.00 ± 0.10	0.23 ± 0.66	0.424
Hypertension, n (%)	22 (51)	32 (45)	0.331
Hyperlipidemia, n (%)	12 (28)	20 (28)	0.576
Emergency surgery	**20 (47)**	**19 (27)**	**0.047**
High-risk surgery, n (%)	35 (81)	45 (63)	0.032
Ischemic heart disease, n (%)	16 (37)	26 (37)	0.553
Congestive heart disease, n (%)	25 (58)	28 (39)	0.040
Cerebrovascular disease, n (%)	7 (16)	6 (9)	0.166
Insulin therapy for diabetes, n (%)	4 (9)	9 (13)	0.411
Total RCRI, mean ± sd	1.98 ± 1.04	1.63 ± 1.05	0.091
Intraoperative fluid volume			
Chrystaloids (L.)	3.1 ± 2.2	2.9 ± 2.3	0.671
Colloids (L.)	0.4 ± 0.6	0.3 ± 0.4	0.127
Erythrocytes (Unit)	1.1 ± 3.0	1.1 ± 1.9	0.994
Fresh frozen plasma (Unit)	0.5 ± 1.5	0.5 ± 1.4	0.987
Katz scale, mean ± sd	0.98 ± 2.03	0.42 ± 1.44	0.092
Dependency in I-ADL, n (%)	10 (23)	6 (9)	0.028
Lawton I-ADL scale, mean ± sd	4.9 ± 2.8	5.8 ± 2.3	0.055
Dependency in P-ADL, n (%)	18 (42)	18 (25)	0.052
SAPS II, mean ± sd	**45 ± 19**	**28 ± 14**	**<0.001**
APACHE II, mean ± sd	**18 ± 7**	**11 ± 5**	**<0.001**
PACU length of stay (hours), mean ± sd	63 ± 82	89 ± 119	0.167
Hospital length of stay (days), mean ± sd	21 ± 127	30 ± 32	0.177

AKI: Acute Kidney Injury; ASA: American Society of anesthesiologists; RCRI: Revised Cardiac Risk; PACU: Post Anesthesia Care Unit; P25; SAPS II: Simplified Acute Physiology Score; APACHE II: Acute Physiology and Chronic Health Evaluation; I-ADL: Instrumental Activities of Daily Living; P-IADL: Personal Activities of Daily Living and P75 are the 25th and 75th percentiles.

Of the remaining 71 patients, 21 (30%) did not answer the questionnaires at 6 months follow-up but were known to be alive.

Response rate to the questionnaires was 70%. There were no significant differences in background and ICU variables between respondents and non-respondents.

FUNCTIONAL CAPACITY AND ADL

Focusing in patients that met AKI criteria, six months after discharge from ICU, 78% were dependent in at least one activity in I-ADL and 34% in at least one P-ADL (table 4).

In these patients, dependency in I-ADL was significantly more frequent after surgery and Lawton scales were lower, indicating more dependency, after surgery. Dependency in P-ADL was not different after surgery but Katz scales were higher, indicating more dependency, 6 months after PACU discharge.

In the univariate analysis patients that met AKI criteria and had dependency in at least one ADL were older than those that were not dependent (OR 9.0, 95%CI 1.69 - 47.84, p = 0.010); there were no more differences in all other studied variables.

QUALITY OF LIFE MEASURES

Fifty-two percent of patients that met AKI criteria stated that their level of health in general was better on the day they completed the SF-36 questionnaire, while 36% considered it to be worse than previously (6 months before PACU discharge). In this group of patients there was no statistically significant relationship between the different studied variables and a worse self -reported general level of health.

Compared to values observed for the urban population of Porto, the SF-36 sub scores of all patients that developed AKI criteria were worse for all domains (table 5).

Patients that met AKI criteria had worse SF-36 scores for physical function, role physical, general health perception and role emotional domains when compared to PACU patients that didn't met AKI criteria (table 6).

DISCUSSION

This is the first study to examine whether the Acute Kidney Injury Network's interim consensus definition for AKI is associated with clinically meaningful outcomes in a cohort consisting of 2 years admissions of intensive care patients to a PACU.

Table 4. Dependency and self-reported changes in health in general, 6 months after PACU discharge for patients that met AKI criteria (n = 50)

Variable	Before surgery	6 months follow-up	P
ADL			
Personal			
Katz scale	0.38 ± 1.35	1.02 ± 1.77	**0.043**
Dependency in P-ADL, n (%)	4 (8)	17 (34)	0.580
Instrumental			
Lawton scale	5.98 ± 2.19	3.74 ± 2.53	**<0.001**
Dependency in I-ADL, n (%)	11 (22)	39 (78)	0.045

I-ADL: Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living.

Table 5. SF-36, 6 months after PACU discharge for patients that develop AKI and for general population

Variable	6 months after discharge (n = 50)	General population	P
SF-36 domains, mean ± sd			
Physical function	43.8 ± 33.3	75.4 ± 23.6	<0.001[a]
Role physical	**38.0 ± 31.3**	76.7 ± 26.1	<0.001[a]
Bodily pain	52.1 ± 31.9	65.7 ± 26.2	<0.001[a]
General health perception	**39.8 ± 28.0**	59.5 ± 19.8	<0.001[a]
Vitality	30.8 ± 15.5	57.2 ± 21.1	<0.001[a]
Social functioning	54.8 ± 32.4	76.0 ± 24.1	<0.001[a]
Role emotional	**40.2 ± 33.7**	76.9 ± 25.8	<0.001[a]
Mental health	48.6 ± 22.9	66.1 ± 22.8	<0.001[a]

[a] Paired t test. SF-36: Short-form 36; AKI: Acute Kidney Injury. Sd: standart deviation.

Table 6. SF-36 6 months after PACU discharge

Variable	AKI (n = 50)	Non-AKI (n = 737)	P
SF-36 domains, mean ± sd			
Physical function	43.8 ± 33.3	**55.2± 30.5**	**0.013[a]**
Role physical	**38.0 ± 31.3**	**48.2 ± 34.0**	**0.044[a]**
Bodily pain	52.1 ± 31.9	58.1 ± 29.4	0.170[a]
General health perception	**39.8 ± 28.0**	**48.0 ± 26.8**	**0.040[a]**
Vitality	30.8 ± 15.5	35.4 ± 16.4	0.056[a]
Social functioning	54.8 ± 32.4	59.1 ± 29.8	0.329[a]
Role emotional	**40.2 ± 33.7**	**52.5 ± 34.4**	**0.015[a]**
Mental health	48.6 ± 22.9	50.4 ± 22.8	0.388[a]

[a] Paired t test. SF-36: Short-form 36; AKI: Acute Kidney Injury. Sd: standart deviation.

In our study patients that met AKI criteria were 9 times as likely to die during hospitalization and almost 4 times as likely to die at 6 months after discharge. These patients that met AKI criteria stayed longer at PACU and were more severely ill. These associations were expected and previous studies that examined the impact of acute renal failure in intensive care population documented increased mortality and prolonged length of stay using AKI criteria[14] or other definitions for acute renal failure[7,13]. These associations were also encountered after cardiac surgery[17].

Not surprisingly, that patients that died and met AKI criteria had higher severity of disease scores and more co morbidities as can be supposed by higher ASA-PS. What is interesting is that temperature at admission was a determinant of mortality 6 months after PACU discharge. In a study about predictors of core hypothermia after surgery, Kongsayreepong et al.[45] found that although core hypothermia on arrival tended to be a significant predictor of mortality the sample size may not have been large enough to prove this and the authors themselves published a study were this correlation could not be met[46].

Acute kidney injury (AKI) is a heterogeneous syndrome encompassing a broad spectrum of insults and changes in function that occur acutely to the kidneys[47]. This syndrome is increasingly encountered in sick hospitalized patients, in particular those admitted to intensive care[12,48,49]. The development of AKI undoubtedly has important implications on both short- and long-term morbidity and mortality[50].

The 2005 AKIN consensus definition was chosen understanding that kidney dysfunction is a continuum of disease, and in order to study it most broadly, the initial interim diagnosis should be as sensitive as possible. The definition for AKI was not intended to be final. Rather, it was proposed with the presumption that it would be tested and refined based on scientific data. Our data indicate that the AKI definition is an excellent beginning. Using only an increase in Scr ≥0.3 mg/dL within 48 hrs as the sole criterion for AKI has the added advantage of not requiring measurement of hourly urine output, a task not routinely done outside an ICU. Using these criteria Barrantes et al.[14] (in a critically ill population) and Tian et al.[10] (in a medical wards population) concluded that AKI was associated with poor outcomes.

The study by Chertow et al.[2] first demonstrated that a change of Scr ≥0.3 mg/dL any time during hospitalization was associated with increased mortality. Our data support not only that such small changes of creatinine are associated with meaningful differences in outcome but also that acute increments ≥0.3 mg/dL predict outcomes. This clinically practical definition of AKI benefits from its simplicity and robust association with patient outcomes and therefore may be most appropriate for future epidemiologic and therapeutic studies.

With the present study we have examined the impact of the development of AKI after surgery on quality of life and independence in activities of daily living.

The patients in our study had higher degrees of dependency in instrumental ADL after surgery and they have scores indicating more dependency in Katz and Lawton scales. Our results indicate that 6 months after PACU discharge, in patients that met AKI criteria after surgery, 78% were dependent in at least one ADL activity and when we compare this degree of dependency with the previous status we saw that they are significantly more dependent.

These results are somehow worst that those reported by Maynard SE et al.[22] in their study about quality of life in patients requiring renal replacement therapy that concluded that "almost half of patients became dependent in at least one ADL".

It seems paradoxical that these patients, despite being more dependent, stated that their quality of life was better than

before surgery. We think this could also be explained by their expectation of better health when they agreed to surgical intervention.

To study the impact of the procedure in quality of life we have used the self evaluated health transition item of SF-36 questionnaire. This item is not used in scoring the scales and has been shown to be useful in estimating average change in health status during the year prior to its administration[51].

Measuring changes in health status we found an improved subjective perception of quality of life 6 months after PACU discharge in patients that met AKI criteria, among the patients who completed the study. Other studies on patients after ICU discharge have reported similar findings using different tools[52,53] and Gopal et al.[54] have reported the same finding in patients with renal failure treated with renal replacement therapy. Because self-perception of health may reflect anticipation of future health after a surgical procedure, it is not surprising that these patients have similar scores to other patients subjected to surgical procedures and admitted to the PACU. Comparisons with a general (taken as "control") population are difficult to interpret because our patients were all submitted to a surgical procedure and after surgery met AKI criteria. Thus, our finding that quality of life was worse in these patients than in the general population was not totally unexpected. The comparison to other PACU patients with similar demographic characteristics and from the same urban area seemed more appropriate for establishing comparisons with ours. We found that AKI patients had lower scores for physical domains and they also had a worst general health perception and role emotional.

This study has several limitations. The small sample size may limit the ability to document real differences among our subgroups of patients.

Because of the retrospective nature of this study we could not ascertain the therapeutic responses to the development of AKI and there were no gold standard for fluid challenge and we presume that practitioners may have varied considerably in their approach.

The outcomes we selected – mortality, length of PACU stay, quality of life and dependency in ADL activities – may not necessarily capture all relevant consequences of AKI and we did not know how frequent was the development of chronic kidney disease and the future need for replacement renal therapy.

We did not apply the SF-36 questionnaire before surgery so it was not possible to compare quality of life of patients before and after surgery. Nevertheless, we used the SF-36 question about self-reported changes in health status ("compared to one year ago, how would you rate your health in general, now?") to conclude that the level of health in general was better for most patients on the day they completed the SF-36 than before surgery.

In summary, this study supports the interim consensus definition of AKI is clinically valid, in that it independently predicts meaningful clinical outcomes and that patients perceive their quality of life as improved six months after surgery, although they are more dependent in ADL activities.

COMPETING INTERESTS

The authors did not use funds for the research and have no conflicts of interest.

AUTHORS' CONTRIBUTIONS

All people listed as authors contributed to the preparation of the manuscript and no person or persons other than the authors listed have contributed significantly to its preparation.

Each listed author participated in the work to the extent that they could all publicly defend its content. They all read the manuscript before its submission for publication and are prepared to sign a statement stating they had read the manuscript and agree to its publication.

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Outcome and quality of life 6 months after aorto-bifemoral bypass surgery

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

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RESEARCH ARTICLE Open Access

Outcome and quality of life after aorto-bifemoral bypass surgery

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Abstract

Background: Aorto-bifemoral bypass (AFB) is commonly performed to treat aorto-iliac disease and a durable long-term outcome is achieved. Most studies documenting beneficial outcomes after AFB have been limited to mortality and morbidity rates, costs and length of hospital stay (LOS). Few studies have examined the dependency of patients and how their perception of their own health changes after surgery. The aim of the present study was to evaluate outcome after AFB and to study its determinants.

Methods: This retrospective study was carried out in the multidisciplinary Post-Anaesthesia Care Unit (PACU) with five intensive care beds. Out of 1597 intensive care patients admitted to the PACU, 75 were submitted to infrarenal AFB and admitted to these intensive care unit (ICU) beds over 2 years. Preoperative characteristics and outcome were evaluated by comparing occlusive disease with aneurysmatic disease patients. Six months after discharge, the patients were contacted to complete a Short Form-36 questionnaire (SF-36) and to have their dependency in Activities of Daily Living (ADL) evaluated. Patient's characteristics and postoperative follow-up data were compared using Mann-Whitney U test, t test for independent groups, chi-square or Fisher's exact test. Patient preoperative characteristics were evaluated for associations with mortality using a multiple logistic regression analysis.

Results: The mortality rate was 12% at six months. Multivariate analysis identified congestive heart disease and APACHE II as independent determinants for mortality. Patients submitted to AFB for occlusive disease had worse SF-36 scores in role physical and general health perception. Patients submitted to AFB had worse SF-36 scores for all domains than a comparable urban population and had similar scores to other PACU patients. Sixty-six percent and 23% of patients were dependent in at least one activity in instrumental and personal ADL, respectively, but 64% reported having better general health.

Conclusion: This study shows that congestive heart disease and APACHE II were risk factors for mortality after AFB surgery. Survivors who have undergone AFB perceive an improved quality of life although they are more dependent in ADL tasks and have worse scores in almost all SF-36 than the population to which they belong.

Background

Although some studies have documented beneficial outcome after aorto-bifemoral bypass (AFB) surgery, most have been limited to mortality and morbidity rates, cost and length of hospital stay (LOS) [1,2]. Few studies have examined the dependency of these patients and how they perceive changes in their own health after this procedure, and little is known about the extent and impact of these changes on patient outcome.

In this study we review the characteristics of patients undergoing AFB, studying outcomes up to six months after the procedure, when dependency on Activities of Daily Living (ADL) and health related quality of life were evaluated. For this study we considered patients who were submitted to scheduled or emergent surgery for either an abdominal aortic aneurysm or arterial occlusive disease.

We considered the stratification of patients according to cardiac risk factors [3] which some authors regard as predictors of mortality or LOS.

Several questionnaires have been validated for the study of Health Related Quality of Life [4-8]. Most of the measures that have been used are multi-item scales; that is, they comprise several questions or items. Some multiple-item scales provide a total score as well as

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Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

generating subscales that provide information on particular aspects such as mobility. The Short-Form General Health Survey (SF-36) was developed during the Medical Outcomes Study (MOS) to measure general health concepts relevant across age, disease and treatment groups [9]. It is a self-completed questionnaire covering all aspects of Health Related Quality of Life (HRQOL). It is a valid instrument for measuring HRQOL. It has been used for post-discharge ICU patients and for studying groups with other diseases; it shows good reliability and validity [9,10]. This questionnaire was culturally adapted to Portuguese and validated in a study by Ferreira[11,12].

Low functional status puts patients at higher risk. Patients with only minor or no clinical predictors but with poor functional capacity are recommended to undergo noninvasive testing prior to this surgery. The ability to care for oneself and live independently has been considered a measure of functional outcome after hospitalization [13]. Functional status refers to the level of involvement in activities and is often used as a synonym for performance in ADL [14]. ADL appraisal scales consider functional and instrumental activities. A patient's ability to handle these activities has been assessed by generic or disease-specific measures of physical functional status. Katz's Activities of Daily Living Scale[14] and the Lawton Instrumental Activities of Daily Living [15] have been investigated in critical care survivors.

The determination of functional outcome and the identification of predictors of survival and functional recovery after AFB may be fundamental for evaluating the needs of these patients and promoting proper treatment.

The aim of the present study was to evaluate quality of life and independence in activities of daily living in patients submitted to AFB surgery.

Methods

The Institutional Review Board of the Hospital de São João approved the study protocol and written consent was obtained from the patients or members of their families.

This retrospective cohort study was carried out in the multidisciplinary Post-Anaesthesia Care Unit (PACU) at the Hospital São João, an 1124-bed community teaching hospital in Porto, Portugal, over a period of two years beginning in March 2006. Included in the PACU was a Surgical Intensive Care Unit with five beds to which critically ill surgical patients are admitted and are closely monitored and treated.

All consecutive postoperative patients admitted to the surgical ICU area of the PACU, who were submitted electively for aorto-bifemoral bypass surgery for either infrarenal abdominal aortic aneurysm or arterial occlusive disease, were enrolled. Patients who were readmitted during the study period were included only on the first admission.

Patients were excluded from the study if the procedure was performed to treat a symptomatic or ruptured abdominal aortic aneurysm or if cross-clamping above the renal arteries was required.

The following clinical variables were recorded on admission to the ICU: age, sex, body weight and height and ASA physical status. At admission, the core temperature was registered using a tympanic thermometer and a sample of blood was taken to measure troponin I. The ICU and in-hospital LOS and mortality were also recorded for all patients, and the Score of Simplified Acute Physiology Score (SAPS) II [16] and Acute Physiology & Chronic Health Evaluation (APACHE) II [17] were calculated using standard methods.

Specifically, preadmission comorbidities, any history of ischaemic heart disease, congestive heart disease, cerebrovascular disease, hypertension, renal insufficiency, diabetes or hyperlipidaemia were recorded. The presence of coexisting conditions was assessed using the secondary diagnoses of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). Adapting a classification scheme developed by Lee and colleagues [3], we calculated a Revised Cardiac Risk Index (RCRI) score for each patient, assigning one point for each of the following risk factors (defined as in the original description made by Lee et al.): high-risk surgery, ischaemic heart disease, congestive heart disease, cerebrovascular disease, renal insufficiency and diabetes mellitus.

Functional capacity

Functional capacity before surgery was evaluated by the ability to handle personal and instrumental ADL, assessed by a questionnaire that evaluates the functional independence of the individual in performing personal activities of daily living (P-ADL) and instrumental activities of daily living (I-ADL). This evaluation was completed again at six months after PACU discharge; on the same occasion, the patients completed a questionnaire on Health-Related Quality of Life.

Medical Outcome Survey Short-Form 36 (SF-36)

Health-related quality of life was assessed by the Medical Outcomes Study Short-form Health Survey (SF-36) [10]. This contains 36 questions that evaluate eight health domains considered to be important for patient well-being and health status. These domains reflect physical health, mental health, and the impact of health on daily functioning. The eight multiple-item domains encompass physical functioning (ten items), social functioning (two

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

items), role limitations caused by physical problems (four items), role limitations caused by emotional problems (three items), mental health (five items), energy and vitality (four items), pain (two items) and general perception of health (five items). There is one further unscaled item that addresses self-reported changes in the respondent's health status during the past year. For each item, scores are coded, summed and transformed to a scale from 0 (worst possible health state measured by the questionnaire) to 100 (best possible health state). Scores can be aggregated to measures representing a physical health summary scale (consisting of physical functioning, physical role, pain and general health) and a mental health summary scale (vitality, social functioning, emotional role and mental health) [4].

The answers to the question in SF-36 about self-reported changes in health status ("compared to one year ago, how you would rate your health in general now?") were dichotomized as better, about the same or worse than one year ago.

To minimize distress to the next of kin, each patient's records were checked on the hospital information system after six months to ascertain whether he or she was still alive. A copy of a formal letter was sent to all known survivors accompanied by a return envelope and a validated Portuguese SF-36 self-report form [11,12]. This version of the SF-36 has been validated for the study population in the Porto region from which the subjects of this report were drawn [18]. Scores for all domains obtained for patients after AFB were compared with the published [18] values for this urban population.

We also compared the scores on all SF-36 domains for patients after AFB surgery with scores obtained for other PACU patients who were not submitted to AFB surgery.

Activities of Daily Living (ADL)

The personal ADL considered were bathing, dressing, going to the toilet, transferring from bed to chair, continence and feeding. The instrumental ADL considered were cleaning, food shopping, public transportation and cooking. This questionnaire was based on Katz' Index of Independence in ADL [19] and Lawton IADL [15] scales. Answers were also categorized into two groups, able or unable to perform each activity or group of activities. Patients were classified by their ability to perform physical and psychosocial ADL and four categories were possible: (a) I-ADL and P-ADL independent, (b) I-ADL dependent but P-ADL independent, (c) P-ADL dependent but I-ADL independent and (d) both P-ADL and I-ADL dependent.

Outcome

The outcome endpoints considered were: (1) Functional capacity and ADL - patients were considered dependent whether they were dependent in at least one I-ADL or P-ADL activity; (2) Quality of life - quality of life was evaluated at six months after PACU discharge; (3) Mortality - patients were considered survivors if they were alive six months after PACU discharge.

Statistical methods

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables between two groups of subjects; chi-square or Fisher's exact test was used to compare proportions between two groups of subjects.

To identify independent predictors of mortality univariate analysis was performed using simple binary logistic regression with an odds ratio (OR) and 95% confidence interval (CI) with the following independent variables: type of surgery, age, gender, BMI, ASA-PS, troponin I blood levels and temperature at admission to the PACU, comorbidities, RCRI score, duration of anaesthesia, and severity of disease scores (APACHE II and SAPS II). All variables were deemed to be significant if $P < 0.05$.

Multiple regression binary logistic with forward conditional elimination was used to examine covariates and to identify independent predictors of mortality. In this model covariates with a univariate $p \leq 0.05$ in the univariate analysis were entered.

The Mann-Whitney U test and "t test" for independent groups were used to compare population means.

SPSS for Windows version 16.0 (SPSS, Chicago, IL) was used to analyze the data.

Results

During the study period there were 1597 admissions in the PACU and 75 patients met the inclusion criteria. The characteristics of all patients enrolled in the study are given in Table 1.

Ninety-seven percent were male. The median age was 64 years (minimum 41, maximum 80), median SAPS II was 18 (range 7-69) median APACHE II was 9 (range 4-25) and median LOS in the PACU was 44 hours. Seven patients (9%) died during hospital stay.

Forty-eight patients had complex aorto-iliac occlusive disease and surgery was performed on 27 patients to treat aortic aneurysm.

Compared to those who had ABF surgery because of occlusive aortic disease, patients submitted to ABF surgery for correction of abdominal aortic aneurysm were older (median 70 versus 59 years, $P < 0.001$), had higher BMI (median 26 versus 23, $P = 0.004$), had lower temperature (median 34.2 versus 34.8, P = 0.029) and higher troponin I at admission to the PACU (median 0.04 versus 0.01, P = 0.029) and were more severely ill (median SAPS II 23 versus 15, $P = 0.002$ and median APACHE II 11 versus 9, $P = 0.012$).

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

Table 1 Patient characteristics and outcome

Variable	AFB (n = 75)	ANE (n = 27)	AOD (n = 48)	P
Age in years, median (IQR)	**64 (57-72)**	**70 (64-75)**	**59(53-68)**	**<0.001[c]**
Age group, n (%)				**0.001[a]**
≥ 65 years	36 (48)	20 (74)	16 (33)	
< 65 years	39 (52)	7 (26)	32 (67)	
Sex, n (%)				0.406[b]
Male	73 (97)	27(100)	46 (96)	
Female	2 (3)	0 (0)	2 (4)	
ASA physical status				0.174[b]
I/II	26 (35)	7 (26)	19 (40)	
III/IV	49 (65)	20 (74)	29 (60)	
Body Mass Index in Kg/m^2, median (IQR)	**24 (21-27)**	**26 (24-31)**	**23 (21-26)**	**0.004[c]**
Duration of anaesthesia (min.), median (IQR)	300 (270-360)	300 (270-360)	300(264-357)	0.519[c]
Temperature at PACU admission, median (IQR)	**34.5 (33.4-35.9)**	**34.2 (32.5-35.1)**	**34.8 (33.9-36.0)**	**0.029[c]**
Troponin I at PACU admission, median (IQR)	**0.09 (0.01-0.04)**	**0.04 (0.01-0.16)**	**0.01 (0.01-0.04)**	**0.029[c]**
Hypertension, n (%)	55 (73)	23 (85)	32 (67)	0.068[b]
Hyperlipidemia, n (%)	37 (49)	16 (59)	21 (44)	0.197[a]
High-risk surgery, n (%)	75 (100)	27 (100)	48 (100)	-
Ischaemic heart disease, n (%)	32 (43)	11 (41)	21 (44)	0.800[a]
Congestive heart disease, n (%)	19 (25)	6 (22)	13 (27)	0.431[b]
Cerebrovascular disease, n (%)	7 (9)	1 (4)	6 (13)	0.204[b]
Renal insufficiency	3 (4)	1(4)	2 (4)	0.707[b]
Insulin therapy for diabetes, n (%)	3 (4)	1(4)	2 (4)	0.707[b]
Total RCRI				0.440[a]
≤ 2	35(47)	11 (41)	24 (50)	
Katz scale, median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)	0.459[c]
Dependency in I-ADL, n (%)	1 (1)	0 (0)	1 (2)	0.646[b]
Lawton I-ADL, median (IQR)	7 (7-7)	7 (7-7)	7 (7-7)	0.241[c]
Dependency in P-ADL, n (%)	6 (8)	1 (4)	5 (10)	0.290[b]
SAPS II, median (P25-75)	**18 (13-27)**	**23 (18-33)**	**15 (12-22)**	**0.002[c]**
APACHE II, median (IQR)	**9 (7-13)**	**11 (8-15)**	**9 (6-11)**	**0.012[c]**
PACU length of stay (hours), median (IQR)	44 (36-68)	43 (21-102)	44 (40-68)	0.603[c]
Hospital length of stay (days), median (IQR)	11 (8-28)	11 (8-24)	11 (8-30)	0.475[c]
Mortality in PACU, n (%)	3 (4)	0 (0)	3 (6)	0.256[b]
Mortality in hospital, n (%)	7 (9)	2 (7)	5 (10)	0.507[b]
Mortality at 6 months follow-up	9 (12)	4 (14)	5 (10)	0.414[b]

[a] Pearson χ^2, [b] Fisher's exact test, [c]Mann-Whitney U test, IQR, interquartile range

AFB, aorto-bifemoral bypass surgery; ANE, aneurysmatic disease; AOD, aortic occlusive disease

RCRI, Revised Cardiac Risk Index I-ADL, Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living; SAPS II, Simplified Acute Physiology Score, APACHE II Acute Physiology & Chronic Health Evaluation PACU, Post Anaesthesia Care Unit; IQR, interquartile range

Sixty-eight patients were discharged from hospital; two died before the six-month evaluation (12% global mortality at the time of evaluation). Of the remaining 66 patients, 16 (24%) did not answer the questionnaires at six months follow-up but were known to be alive.

The characteristics of all patients who were still alive at six-month follow-up are presented in Table 2. Of these 50 participants, 98% were male and the median age was 64 years, median SAPS II was 18, median APACHE II was 9 and median PACU LOS was 43 hours. There were no statistically significant differences between participants and non-participating patients in respect of the variables studied.

Mortality

Patients submitted to ABF because of aortic occlusive disease had higher mortality rates at the PACU (6% versus 0%) and during hospital stay (10% versus 7%), but had lower mortality rates (10% versus 14%) at six months follow-up. However, these differences were not statistically significant.

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

Table 2 Comparison of characteristics between respondents and non-respondents

Variable	Respondents (n = 50)	Non-respondents (n = 16)	P value
Type of surgery			0.407[b]
AFB for Aneurysmatic disease	19 (37)	4 (29)	
AFB for occlusive disease	31 (63)	12 (71)	
Age in years, median (IQR)	64 (56 - 70)	61 (55 - 70)	0.884[c]
Sex, n (%)			0.452[b]
Male	48 (98)	16 (94)	
Female	1 (2)	1 (6)	
BMI (Kg/m^2), median (IQR)	23 (20 - 24)	25 (22 - 27)	0.393[c]
Duration of anaesthesia (min.), median (IQR)	300 (270 - 336)	300 (240 - 360)	0.729[c]
Temperature at admission, median (IQR)	34.5 (33.2 - 35.6)	34.5 (33.3 - 36.0)	0.084[c]
ASA Physical status			0.481[a]
I/II	18 (37)	7 (41)	
III/IV	31 (63)	10 (59)	
Troponin at admission, median (IQR)	0.04 (0.01 - 0.04)	0.01 (0.01 - 0.05)	0.780[b]
Total RCRI			0.442[a]
≤ 2	26 (53)	8 (47)	
>2	23 (47)	9 (53)	
Hypertension n.(%)	36 (74)	13 (77)	0.541[b]
Hyperlipidemia, n (%)	22 (45)	11 (65)	0.130[b]
Ischaemic heart disease	23 (47)	6 (35)	0.293[b]
History of congestive heart disease	11 (22)	2 (12)	0.283[b]
History of cerebrovascular disease	1 (2)	2 (11)	0.050[b]
Insulin therapy for diabetes	3 (6)	0(0)	0.403[b]
Renal insufficiency	1 (2)	0 (0)	0.742[b]
Dependency in P-ADL	1 (2)	0 (0)	0.817[b]
Dependency in I-ADL	6 (12)	0 (0)	0.279[b]
Previous Katz, median (IQR)	0 (0 - 0)	0 (0 - 0)	0.636[c]
Previous Lawton, median (IQR)	7 (7 - 7)	7 (7 - 7)	0.226[c]
SAPS II, median (IQR)	18 (13 - 24)	15 (12 - 23)	0.643[c]
APACHE II, median (IQR)	9 (7 - 13)	8 (5 - 11)	0.121[b]
Hours of ICU length of stay, median (IQR)	43 (23 - 68)	44 (40 - 56)	0.467[c]
Days of hospital length of stay, median (IQR)	11 (8 - 20)	15 (8 - 32)	0.210[c]

[a] Pearson χ^2, [b] Fisher's exact test, [c]Mann-Whitney U test, IQR, interquartile range

AFB, aorto-bifemoral bypass surgery; BMI, Body Mass Index; RCRI, Revised Cardiac Risk Index; I-ADL, Instrumental Activities of Daily Living; P-ADL, Personal Activities of Daily Living; SAPS II, Simplified Acute Physiology Score; APACHE II Acute Physiology & Chronic Health Evaluation PACU; PACU, Post Anaesthesia Care Unit.

Univariate analysis identified the following independent predictors for mortality at 6 months follow-up (Table 3): age (OR 1.15, 95% CI 1.03 to 1.28, P = 0.015), congestive heart disease (OR 8.15, 95% CI 1.80 to 37.01, P = 0.007), renal insufficiency (OR 18.57, 95% CI 1.49 to 231.7, P = 0.023) and RCRI score (OR 8.50, 95% CI 1.01 to 71.83, P = 0.049 for RCRI > 2), SAPS II (OR 1.09, 95% CI 1.04-1.14, p = 0.001) and APACHE II (OR 1.51, 95% CI 1.17-1.83, p = 0.001).

Multiple logistic regression analysis with forward conditional elimination was used to examine covariate effects of each factor on mortality (Table 4). The regression model included all variables with statistical significance in the univariate analysis for determinants of mortality. This analysis showed that independent risk factors for hospital mortality, after adjustment for age, congestive heart disease, renal insufficiency, RCRI, SAPS II and APACHE II were congestive heart disease (OR 9.86, 95% CI 1.48 to 65.55, P = 0.018), and APACHE II (OR 1.40, 95% CI 1.11 to 1.76, P = 0.005).

Functional capacity and ADL

Six months after discharge from the PACU, 62% and 20% of patients, respectively, were dependent in at least one activity in instrumental and personal ADL (Table 5).

Scores on the Katz and Lawton scales were significantly different after surgery, indicating more

Abelha *et al. BMC Cardiovascular Disorders* 2010, **10**:15
http://www.biomedcentral.com/1471-2261/10/15

Table 3 Univariate analysis for determinants of mortality after aorto-bifemoral bypasses surgery

Variable	nonsurvivors/survivors n = 9 n = 66	Odds ratio (95% CI)	P
Type of AFB surgery			
for Aneurysmatic disease	4 (44)/23 (35)	1.50 (0.36 - 6.12)	0.575
for occlusive disease	5 (56)/43 (65)	1	
Age	**73 (67-76)/55 (62-70)**	**1.15 (1.03 - 1.28)**	**0.015**
Gender		-	0.999
Female	0 (0)/2 (3)		
Male	9 (100)/64 (97)		
BMI, median	20 (21-29)/24 (21-26)	0.96 (0.74 - 1.24)	0.733
Duration of anaesthesia (min.)	333(330-450)/300 (264-357)	1.01 (1.00 - 1.01)	0.117
ASA Physical status			
I/II	1 (11)/25(38)	1	
III/IV	8 (89)/41(62)	4.88 (0.58 - 41.36)	0.146
Temperature at admission	34.3(34.0-35.1)/34.5(33.3-35.9)	0.96 (0.61 - 1.50)	0.848
Troponin at admission	0.01(0.01-0.05)/0.02(0.01-0.04)	0.001 (0 - 3500)	0,656
Hypertension	6(67)/49 (74)	0.63 (0.16 - 3.09)	0.631
Hyperlipidemia	4 (44)/33(50)	0.80 (0.20 - 3.25)	0.755
Ischaemic heart disease	3 (33)/29(44)	0.64 (0.15 - 2.77)	0.549
Congestive heart disease	**6 (67)/13 (20)**	**8.15 (1.80 - 37.01)**	**0.007**
Cerebrovascular disease	2 (22)/5(8)	3.49 (0.57 - 21.45)	0.178
Insulin therapy for diabetes	0 (0)/3 (5)	-	0.999
Renal insufficiency	**2 (22)/1 (2)**	**18.57 (1.49 - 231.7)**	**0.023**
RCRI			
≤ 2	1(11)/34 (52)	1	
>2	8 (89)/32 (49)	8.50 (1.01 - 71.83)	0.049
Previous score in Katz scale	0/0	-	0.999
Previous score in Lawton scale	7 (7-7)/7(4-7)	0.76 (0.48-1.18)	0.215
SAPS II, median	**33 (19-60)/18 (13-23)**	**1.09 (1.04 - 1.14)**	**0.001**
APACHE II	**13 (15-25)/8 (6-11)**	**1.51 (1.17 - 1.83)**	**0.001**
Length of PACU stay (hours)	93 (45-140)/44 (34-66)	1.01 (1.00 - 1.02)	0.066
Length of Hospital stay (days)	9 (8-32)/11(8-27)	1.00 (0.98 - 1.02)	0.990

AFB, aorto-bifemoral bypass surgery; BMI, Body mass index; ASA, American Society of anesthesiologists, COPD, Chronic obstructive pulmonary disease; RCRI, Revised cardiac risk index; PACU, Post Anaesthesia Care Unit, SAPS, Simplified Acute Physiology Score; APACHE II Acute Physiology & Chronic Health Evaluation

Table 4 Multivariate regression analysis for predictors of mortality.

Variable	Simple OR	p	Adjusted* OR (95% CI)	p*
Age	1.15	0.015		
Renal insufficiency	18.57	0.023		
Congestive heart disease	8.15	0.007	9.86 (1.48 - 65.55)	0.018
RCRI				
≤ 2	1			
>2	8.50	0.049		
SAPS II	1.09	0.001		
APACHE II	1.51	0.001	1.40 (1.11 - 1.76)	0.005

[a] Logistic regression analysis with stepwise forward method was used with an entry criterion of $p < 0.05$ and a removal criterion of $p > 0.1$.

SAPS, Simplified Acute Physiology Score; APACHE II, Acute Physiology and Chronic health Evaluation.

*Adjusted to age, renal insufficiency, congestive heart disease, RCRI, SAPS II and APACHE II.

Table 5 Dependency and self reported changes in health in general 6 months after PACU discharge (n = 50)

Variable	Before surgery (n = 50)	6 months after AFB (n = 50)	P
Personal activities of daily living			
Katz scale	0	0	**0.040**
Dependency in P-ADL, n (%)	1 (2)	10 (20)	0.796
Instrumental activities of daily living			
Lawton scale	**7.0 (7.0-7.0)**	**5.0 (3.8-7.0)**	**<0.001**
Dependency in I-ADL, n (%)	6 (12)	31 (62)	0.271

AFB, aorto-bifemoral bypass surgery; I-ADL, Instrumental Activities of Daily Living;

P-ADL, Personal Activities of Daily Living

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

dependency. There were no differences in percentage of dependency for ADL-I and ADL-P.

Quality of Life Measures

Overall, 64% stated that their health in general was better on the day of testing and 8% considered it to be worse at that time than previously (six months before PACU discharge). There were no statistically significant differences between patients' baseline characteristics and worse self-reported general level of health.

Patients submitted to AFB because of occlusive disease had worse SF-36 scores for role physical (median 43.8 versus 75.0) and for general health perception (median 42.0 versus 50.0) than patients with aneurysmatic disease (Table 6).

Compared to values obtained from the general urban population of Porto, the SF-36 sub-scores of all patients submitted to AFB were worse in all domains (Table 7).

Patients submitted to AFB did not differ in any of the SF-36 domains from other PACU patients who were not submitted to AFB (Table 8).

Discussion

AFB surgery is a current treatment for two types of complex disease: aorto-iliac occlusive and abdominal aortic aneurysms. This surgery is performed to improve long-term survival and to preserve function.

In the present study we found that independent predictors of mortality before six months after AFB surgery were higher APACHE II scores on admission to the PACU and congestive heart disease.

In a study published by Thomas S. Huber et al. [20], the authors studied aortic reconstructions performed for aneurismal or occlusive disease. They found that multiple systemic organ failure (MSOF) was a leading cause of death and admitted that patient age, APACHE II, and a diagnosis of sepsis at the time of ICU admission had previously been identified as risk factors for the development of MSOF. In that study the mortality rate did not vary with the indication for aortic reconstruction (aneurismal disease, 6.3%; occlusive disease, 5.7%; combined aneurismal/occlusive, 8.3%). In that study they also concluded that history of congestive heart disease was a predictor for mortality and the other predictors were patient age, low ejection fraction, duration of operative time, and performance of additional procedures.

Concerning only aortic occlusive disease, Morris-Stiff et al. [21] found a 30-day mortality of 10.4%, with a 1-year patient and graft survival of 80%; for open elective treatment of aneurismal disease but most large series describe hospital mortality rates of 3 to 6%[22,23] although the existence of pre-existing comorbidities were associated with higher mortality rates.

Table 6 SF-36 6 months after AFB

Variable	Aneurysmatic disease	occlusive disease	p
SF-36 domains			
physical function	70.0 (40.0-75.0)	50.0 (20.0-70.0)	0.094[a]
role physical	75.0 (37.5-81.3)	43.8 (18.8-75.0)	0.047[a]
bodily pain	62.0 (51.0-84.0)	51.0 (41.0-74.0)	0.160[a]
general health perception	50.0 (35.0-77.0)	42.0 (20.0-55.0)	0.048[a]
Vitality	37.5 (20.8-58.3)	29.2 (20.8-41.7)	0.213[a]
social functioning	62.5 (37.5-87.5)	50.0 (37.5-75.0)	0.338[a]
role emotional	50.0 (33.3-100)	50.0 (25.0-75.0)	0.308[a]
mental health	52.0 (32.0-80.0)	48.0 (32.0-68.0)	0.378[a]

[a] Mann-Whitney U test

SF-36, Short-form 36; AFB, aorto-bifemoral bypass surgery

Table 7 SF-36 after AFB and population SF-36 means

Variable	After AFB (n = 50)	urban population (n = 1326)	p
SF-36 domains	mean ± sd	mean ± sd	
physical function	52.5 ± 27.5	75.4 ± 23.6	<0.001[a]
role physical	52.4 ± 32.9	76.7 ± 26.1	<0.001[a]
bodily pain	56.9 ± 26.1	65.7 ± 26.2	0.019[a]
general health perception	46.9 ± 25.1	59.5 ± 19.8	<0.001[a]
Vitality	34.8 ± 16.8	57.2 ± 21.1	<0.001[a]
social functioning	59.0 ± 26.5	76.0 ± 24.1	<0.001[a]
role emotional	54.0 ± 33.7	76.9 ± 25.8	<0.001[a]
mental health	49.7 ± 23.8	66.1 ± 22.8	<0.001[a]

[a] t test for independent groups

SF-36, Short-form 36; AFB, aorto-bifemoral bypass surgery

Table 8 Results of SF-36 administration compared to results in surgical patients 6 months after PACU discharge

Variable	after AFB (n = 50)	after other PACU surgical patients (n = 737)	p
SF-36 domains			
physical function	55.0 (30.0-71.3)	55.0 (25.0-80.0)	0.811[a]
role physical	50.0 (29.7-81.3)	43.8 (18.8-75.0)	0.225[a]
bodily pain	52.0 (41.0-74.0)	52.0 (32.0-80.0)	0.984[a]
general health perception	45.0 (30.0-65.5)	45.0 (25.0-67.0)	0.863[a]
vitality	31.3 (20.8-42.7)	33.3 (20.8-45.8)	0.896[a]
social functioning	62.5 (37.587.5)	62.5 (37.5-87.5)	0.728[a]
role emotional	50.0 (25.0-83.3)	50.0 (25.0-83.3)	0.485[a]
mental health	48.0 (32.0-68.0)	52.0 (32.0-68.0)	0.854[a]

[a] Mann-Whitney U test

SF-36, Short-form 36; AFB, aorto-bifemoral bypass surgery

Abelha et al. BMC Cardiovascular Disorders 2010, 10:15
http://www.biomedcentral.com/1471-2261/10/15

In the univariate analysis we identified six risk factors for mortality after AFB: Age, renal insufficiency, congestive heart disease, RCRI, SAPS II and APACHE II.

In the study of Dimick et al. [24] the authors also identified age of 65 years or older as a risk factor for mortality after AFB and Teufelsbauer et al. [25] found five independent predictors for mortality after open surgical repair of infrarenal aortic aneurysms. Two of these predictors were similarly found in our univariate analises: age and renal dysfunction. Beyond these they also found type of operation, pulmonary dysfunction and diabetes.

Our results differ from those of Wolters et al. [26], who studied ASA physical status, APACHE-II, and operative severity score for enumeration of mortality and morbidity (POSSUM) classification and SAPS, and concluded that none of the systems analyzed separately was useful for determining morbidity and mortality in patients after aorto-iliac surgery.

We evaluated health related quality of life six months after discharge from the PACU according to the American College of Surgeons and the American Society of Vascular Surgery, both of which have promoted the use of SF-36 in the surgical population [27,28]; this questionnaire has been validated for patients with vascular diseases [29].

In the present study we examined the effect of AFB surgery on quality of life and independence in activities of daily living. To study the impact of the procedure on quality of life we used the self-evaluated health transition item of the SF-36 questionnaire. This item is not used in scoring the scales but has been shown to be useful for estimating average change in health status over the year prior to its administration [30].

Although patients submitted to AFB because of occlusive disease were younger than those submitted to AFB because of aneurysmatic disease, they had lower SF-36 scores in two domains: role physical and general health perception. As role physical refers to the extent to which a respondent's performance of roles in daily activities is impeded by their physical state of health, and individual general health perception is measured by ratings such as excellent, very good, good, fair or poor, these differences may reflect the burden of dependency and the perception of a chronic disease.

Comparisons with a general (taken as "control") population are difficult to interpret because patients subjected to AFB generally perceive themselves as chronically ill. Thus, our finding that quality of life was worse in our patients than in the general population was not unexpected. A comparison with other PACU surgical patients with similar demographic characteristics from the same urban area seemed more appropriate for establishing comparisons with AFB patients, and the results, which showed no differences, are comprehensible.

The patients in our study had higher degrees of dependency in instrumental and personal ADL after surgery, which was not entirely unexpected in view of the extent of comorbidities and the natural history of their disease. It seems paradoxical that these patients, despite being more dependent, stated that their quality of life was better than before surgery. We think this could be explained by their expectation that surgical intervention would promote better health.

The limitations of this study include its retrospective nature, the relatively small number of patients and the fact that the patient population in the study is inhomogeneous. We have included patients submitted to ABF surgery done for aneurysmal aorto-iliac disease and patients with occlusive arterial disease. The first group of patients are asymptomatic and the procedure is prophylactic in its nature but in the second group ABF surgery is directed towards improvement of the arterial blood supply to the lower extremities, thereby improving the signs and symptoms. This may have influenced differences in the quality of life during the postoperative 6 month period between these two groups of patients.

Another limitation is that we did not apply the SF-36 questionnaire before surgery so it was not possible to compare quality of life of patients before and after surgery, as in the prospective study by Aljabri et al. [31] on patients after abdominal aortic aneurysm repair. Nevertheless, we used the SF-36 question about self-reported changes in health status ("compared to one year ago, how would you rate your health in general now?") to conclude that general health was better for most patients on the day they completed the SF-36 than before surgery.

Conclusion

This study shows that congestive heart disease and APACHE II were considered risk factors for mortality at six months follow-up. Survivors who have undergone AFB perceive an improved quality of life although they are more dependent in ADL tasks and have worse scores in almost all SF-36 than the population to which they belong.

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Authors' contributions

All people listed as authors contributed to the preparation of the manuscript and no person or persons other than the authors listed have contributed significantly to its preparation.

Each listed author participated in the work to the extent that they could all publicly defend its content. They all read the manuscript before its submission for publication and are prepared to sign a statement stating they had read the manuscript and agree to its publication.

Competing interests
The authors declare that they have no competing interests.

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Outcome after Postoperative Major Cardiac Events

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SCIENTIFIC ARTICLE

Quality of Life and Mortality Assessment in Patients with Major Cardiac Events in the Postoperative Period

Fernando José Abelha [1], Miguela Botelho [2], Vera Fernandes [2], Henrique Barros [3]

Summary: Abelha FJ, Botelho M, Fernandes V, Barros H – Quality of Life and Mortality Assessment in Patients with Major Cardiac Events in the Postoperative Period.

Background and objectives: Cardiovascular complications in the postoperative period are associated with high mortality and morbidity. Few studies have assessed the degree of dependence in these patients and their perception of health. The objective of this study was to assess the mortality and the quality of life in patients who developed major cardiac events (MCE) in the postoperative period.

Method: Retrospective study carried out in a Surgical Intensive Care Unit (SICU), between March 2006 and March 2008. The patients were assessed regarding the occurrence of CE. Six months after the hospital discharge, the Short-Form-36 (SF-36) questionnaire was filled out and dependence was assessed in relation to activities of daily living (ADL). The comparisons between independent groups of patients were carried out using Student's t test. The comparison between each variable and the occurrence of CE was carried out by logistic regression and included all patients.

Results: Of the 1,280 patients that met the inclusion criteria, 26 (2%) developed MCE. The univariate analysis identified as independent determinants for the development of major cardiac events: ASA physical status, hypertension, ischemic heart disease, congestive heart disease and score of the Revised Cardiac Risk Index (RCRI). The six-month mortality after the SICU discharge was 35%. Of the 17 surviving patients, 13 completed the questionnaires. Thirty-one percent of them reported that their general health was better on the day they answered the questionnaire, when compared to 12 months before. Sixty-nine percent of the patients were dependent in instrumental ADL e 15% in personal ADL.

Conclusions: The development of MCE has a significant impact on the duration of hospital stay and mortality rates. Six months after the discharge from the SICU, more than 50% of the patients were dependent in at least one instrumental ADL.

Keywords: COMPLICATIONS: morbidity, mortality, postoperative; SURGERY, Cardiac: quality of life.

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INTRODUCTION

The high prevalence of cardiac disease in the population has major implications in the postoperative setting, and the risk of adverse cardiac events can be significant for patients undergoing major surgery. For instance, cardiac death, myocardial infarction, myocardial ischemia, congestive heart failure and arrhythmias are associated with increased mortality and morbidity and result in longer hospital stay and substantially higher treatment costs [1]. In the early postoperative period, cardiac events may occur without symptoms or distinctive electrocardiographic changes and may go unrecognized, so accurate assessment of perioperative cardiac risk can guide prophylactic treatment, perioperative management, location and intensity of postoperative care and early detection of cardiac complications.

Some perioperative studies have focused on patients with or at risk of cardiac disease [2,3], but few on unselected patients subjected to all types of non-cardiac surgery [4]. Lee et al. [5] evaluated 4,315 patients aged 50 years with expected postoperative length of stay equal or higher than 2 days, but excluded patients undergoing emergency surgery.

Few studies have examined the dependency of these patients and their perceptions of their own health. Several questionnaires have been validated for the study of Health Related Quality of Life (HRQOL) [6-10]. Most of the measures used are multi-item scales; that is, they are made up of several questions or items. Some multiple-item scales provide a total score as well as generating subscales that provide information on particular aspects such as mobility. The Short-Form General Health Survey (SF-36) was developed during the Medical Outcomes Study (MOS) to measure generic health concepts relevant across age, disease and treatment groups [11]. It is a valid instrument for measuring HRQOL that has been used for post-discharge ICU patients and in the study of groups with other diseases; it shows good reliability and validity [11,12]. This questionnaire has been culturally adapted to Portuguese and validated in a study by Ferreira [13,14].

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Low functional status puts patients at higher risk. Patients with no or only minor clinical predictors but with poor functional capacity are recommended to undergo noninvasive testing prior to surgery. The ability to care for oneself and live independently is considered a measure of functional outcome after hospitalization[15]. Functional status refers to the level of involvement in activities and is often used as a synonym for performance in Activities of Daily Living (ADL) [16]. ADL appraisal scales consider functional and instrumental activities. The ability of patients to handle these activities has been assessed by generic or disease-specific tests. Katz's ADL Scale [16] and the Lawton Instrumental ADL [17] have been used for critical care survivors.

The aim of the present study was to evaluate outcome, quality of life and autonomy in ADL in patients who develop major cardiac events (MCE) after major surgery.

METHODS

This retrospective cohort study was conducted at a multidisciplinary Post-Anesthesia Care Unit (PACU). Included in the PACU is a Surgical Intensive Care Unit (SICU) with five beds, in which critically ill surgical patients are admitted and closely monitored and treated.

All postoperative patients admitted to the SICU area of the PACU, aged 18 years or over, who underwent scheduled or emergency surgery between 1 March 2006 and 1 March 2008 with an overnight admission and more than 12 h of PACU stay were eligible for inclusion in the study. Patients readmitted during the study period were enrolled in relation to the time of their first admission. Patients subjected to cardiac or pulmonary surgery were excluded.

The following variables were recorded on admission to the PACU: age, gender, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS) [18], emergency or scheduled surgery, preadmission comorbidities (specifically ischemic heart disease, congestive heart failure, cerebrovascular disease, hypertension, renal insufficiency, diabetes, hyperlipidemia), duration and type of anesthesia, core temperature and blood troponin I levels. Intraoperative data recorded for each case included administration of crystalloids, colloids, erythrocytes and fresh frozen plasma.

Postoperative cardiac troponin I (cTnI) and the occurrence of major cardiac events (MCE) were recorded. Intraoperative and PACU data were collected as well as hospital length of stay (LOS). Mortality was recorded for all patients. The Acute Physiology and Chronic Health Evaluation (APACHE) II [19] and the Simplified Acute Physiology Score II (SAPS II) [20] were calculated using standard methods. Six months after discharge, patients were contacted to complete a Short Form-36 questionnaire (SF-36) and to have their dependency in activities of daily living (ADL) evaluated.

Using a classification scheme developed by Lee and colleagues to predict cardiac risk, we calculated a Revised Cardiac Risk Index (RCRI) score for each patient, assigning one point for each of the following risk factors: high risk surgery (thoracic, abdominal, or pelvic vascular e.g. aorta, renal, mesenteric), history of ischemic heart disease, history of congestive heart failure, history of cerebrovascular disease, preoperative treatment with insulin, and preoperative serum creatinine > 2.0 $mg.dL^{-1}$ [5].

Acute myocardial infarction, pulmonary edema, ventricular fibrillation or primary cardiac arrest and complete heart block were recorded during PACU stay and considered to be Major Cardiac Events (MCE).

Acute myocardial infarction was diagnosed according to the criteria of the European Society of Cardiology/American College of Cardiology [21], considering the following two criteria sufficient for diagnosis of acute, evolving or recent myocardial infarction: (i) a typical increase and gradual decrease in cTnI concentrations or more rapid increase and decrease in creatine kinase-MB concentration in combination with at least one of the following: (a) typical ischemic symptoms, (b) development of pathological Q waves in ECG, (c) ECG changes indicative of myocardial ischemia (ST segment elevation or depression), and (d) coronary artery intervention; and (ii) pathological findings of an acute myocardial infarction.

Immediately after arriving postoperatively in the ICU and every day during their stay in PACU, samples for creatine kinase-MB (CK-MB) and cTnI were collected from all patients. Samples were collected and twelve-lead ECG was performed whenever symptoms of myocardial events occurred.

All patients had continuous acquisition of leads II and V ECG to monitor and diagnose possible arrhythmias.

We also recorded PACU and hospital LOS. For mortality, we recorded PACU mortality, hospital mortality and mortality at six months after PACU discharge.

Functional capacity before surgery was evaluated in terms of the patient's ability to handle personal and instrumental ADL within the first 24 h after PACU admission. All eligible consenting patients were interviewed directly by a trained investigator. When the patient was unable to respond, the questionnaire was completed by a close family member living in the same household as the patient.

Health Related Quality Of Life (HRQOL) was assessed by the SF-36 [12]. The survey contains 36 questions that evaluate eight health domains considered to be important for patient well-being and health status. These domains reflect physical health, mental health, and the impact of health on daily functioning. The eight multiple-item domains encompass physical functioning (ten items), social functioning (two items), role limitations caused by physical problems (four items), role limitations caused by emotional problems (three items), mental health (five items), energy and vitality (four items), pain (two items) and general perception of health (five items). There is one further unscaled item relating to self-reported changes in the respondent's health status during the past year. For each item, scores are coded, summed and transformed to a scale from 0 (worst possible health state measured by the questionnaire) to 100 (best possible health state). Scores can be aggregated to measures representing a physical health summary scale (consisting of physical functioning, physical role, pain

and general health) and a mental health summary scale (vitality, social functioning, emotional role and mental health) [6].

The answers to the question about self-reported changes in health status ("compared to one year ago, how would you rate your health in general now?") were categorized as: better, about the same or worse than one year ago.

To minimize distress to the next of kin, each patient's records were checked on the hospital information system after six months to ascertain whether he or she was still alive. A copy of a formal letter was sent to all known survivors accompanied by a return envelope and a validated Portuguese SF-36 self-report form [13,14]. This version had been validated for the population of the city of Porto from which the subjects of this report were drawn [22]. Scores for all domains obtained for patients who developed MCE were compared with the published urban population values for Porto [17].

We also compared the scores in all SF-36 domains obtained for MCE patients with those obtained for PACU patients who did not develop MCE after surgery.

The questionnaire used to assess dependency was based on the Katz Index of Independence in ADL [22] and Lawton Instrumental ADL scale. The Lawton Instrumental ADL scale is an easily administered assessment instrument that provides self-reported information about the functional skills necessary for living in the community. Deficits in the instrumental Lawton scale were scored and a summary score ranging from 0 (low function, dependent) to 7 (high function, independent) was obtained. The Katz ADL scale assesses basic personal activities of daily living and ranks adequacy of performance in six functions. Dependency in each personal activity was evaluated and a summary score ranging from 0 (independence in all activities) to 6 (dependency in all activities) was obtained. The personal ADL (P-ADL) considered were bathing, dressing, going to the toilet, transferring from bed to chair, continence and feeding. The instrumental ADL (I-ADL) considered were cleaning, food shopping, public transportation and cooking. Answers were categorized into two groups: able or unable to perform each activity and group of activities. Patients were considered dependent if they were dependent in at least one I-ADL or P-ADL.

The outcome endpoints considered were: (1) Functional capacity and ADL. Patients were considered dependent if they were dependent in at least one I-ADL or P-ADL. (2) Quality of life. Quality of life was evaluated at six months after PACU discharge. (3) Mortality. Patients were considered survivors if they were alive six months after PACU discharge.

Descriptive analyses of variables were used to summarize data and the Mann-Whitney U test was used to compare continuous variables between groups of subjects; chi-square or Fischer's Exact test were used to compare proportions between two groups of subjects.

To evaluate the determinants of postoperative MCE and to identify independent predictors of hospital mortality, univariate analyses was performed using simple binary logistic regression with an odds ratio (OR) and its 95% Confidence Interval (CI) with the following independent variables: age, gender, BMI, ASA-PS, type of surgery, comorbidities, RCRI score, type of anesthesia, intraoperative fluid administration, blood troponin I levels at admission, length of anesthesia and temperature at admission (and MCE for mortality model). To prevent the inflation of type I error we controlled the significance level for multiple comparisons by applying Bonferroni's correction (test-wise significance level divided by the number of tests performed). All variables were deemed significant if $p \leq 0.001$.

Multiple regression binary logistics with forward conditional elimination were used to examine covariate effects for each factor in order to identify independent predictors of hospital mortality. In these models, covariates with $p \leq 0.001$ in the respective univariate analysis were entered (applying Bonferroni's correction for multiple comparisons).

A *t* test for independent groups was used to compare population means. The SF-36 scores for the MCE population were compared with the urban population of Porto using a *t* test.

SPSS for Windows version 16.0 (SPSS, Chicago, IL) was used to analyze the data.

RESULTS

There were 1,597 adult PACU admissions during the study period and 1,280 patients met the inclusion criteria and were followed for the development of MCE after admission. One hundred and ninety-six patients were excluded because they stayed less than 12 h and were not admitted overnight, 52 because they were less than 18 years old, and 44 because they were admitted more than once to the PACU; 13 were admitted after pulmonary surgery and 12 were not surgical patients.

Twenty-six patients (2%) developed MCE during their PACU stay. The MCE cases comprised 19 acute myocardial infarctions, five cardiac arrests/ventricular fibrillation and two pulmonary edemas.

The characteristics of patients admitted to the PACU, and a comparison between the patients who did and did not develop MCE, are summarized in Table I. Patients who developed MCE were older (median age 72 versus 65 years, $p < 0.025$), more likely to be ASA-PS IV/V (27% versus 8%, $p = 0.004$) and had RCRI scores > 2 (73% versus 30%, $p < 0.001$), had higher troponin I levels at admission (0.59 ± 1.36 versus 0.05 ± 0.10, $p < 0.001$), more frequently had hypertension (89% versus 48%, $p < 0.001$) and hyperlipidemia (50% versus 28%, $p = 0.018$), were more likely to have been subjected to high-risk surgery (73% versus 46%, $p = 0.005$), more frequently had ischemic heart disease (69% versus 24%, $p < 0.001$) and congestive heart disease (77% versus 20%, $p < 0.001$) and had received higher volumes of fluids intraoperatively (2.0 ± 3.2 versus 0.7 ± 1.6, $p < 0.001$, for erythrocyte packed units, and 0.8 ± 2.1 versus 0.3 ± 1.1, $p = 0.016$ for units of fresh frozen plasma).

Table II presents data on the severity of disease scores and outcomes. Patients who developed MCE were more severely ill (median SAPS II 30 versus 18, $p < 0.001$ and median APACHE II 14 versus 8, $p < 0.001$) and stayed longer in the PACU (median LOS 84 h versus 20 h, $p < 0.001$). The unadjusted mortality rate at six months follow-up for patients who developed MCE was nearly three times greater than for patients

Table I – Patient Characteristics and Outcomes

Variable	All patients (n = 1,280)	MCE (n = 6)	No MCE (1,254)	p value
Age in years *	65 (54 – 74)	72 (57 – 78)	65 (54 – 74)	0.025[b]
Age group **				0.018[a]
≥ 65 years	655 (51)	19 (73)	636 (51)	
< 65 years	625 (49)	7 (27)	618 (49)	
Sex **				0.263[a]
Male	834 (65)	19 (73)	815 (65)	
Female	446 (35)	7 (27)	439 (35)	
Physical status **				0.004[a]
ASA I / II / III	1,174 (92)	19 (73)	1,155 (92)	
ASA IV / V	106 (8)	7 (27)	99(8)	
Body mass index (kg.m^{-2}) *	25 (22 – 28)	26 (24 – 29)	25 (22 – 28)	0.071[b]
General / Combined anesthesia **	1107 (87)	23 (89)	1184 (86)	
Duration of anesthesia (min) *	200 (150 – 300)	240 (128 – 360)	200 (150 – 300)	0.284[b]
Temperature at admission on PACU ***	35.22 ± 1.31	35.14 ± 1.28	35.22 ± 1.31	0.089[b]
Troponin I at admission ***	0.07 ± 0.31	0.59 ± 1.36	0.05 ± 0.10	< 0.001[b]
Hypertension **	628 (49)	23 (89)	605 (48)	< 0.001[a]
Hyperlipidemia **	371 (29)	13 (50)	358 (28)	0.018[a]
Non-elective surgery **	276 (22)	8 (31)	268 (21)	0.178[a]
High-risk surgery **	594 (46)	19 (73)	575 (46)	0.005[a]
Ischemic heart disease **	322 (25)	18 (69)	304 (24)	< 0.001[a]
Congestive heart disease **	275 (22)	20 (77)	255 (20)	< 0.001[a]
Chronic renal failure **	80 (6)	2 (8)	78 (6)	0.491[a]
Cerebrovascular disease **	179 (14)	6 (23)	173 (14)	0.144[a]
Insulin therapy for diabetes **	127 (10)	4 (15)	123 (10)	0.253[a]
RCRI				<0.001[a]
≤ 2	881 (69)	7 (27)	874 (70)	
> 2	399 (31)	19 (73)	380 (30)	
Intraoperative fluid volume				
Crystalloids (L) #	2.6 ± 1.8 (1.2 – 3.4)	3.2 ± 2.9 (1.2 -3.9)	2.6 ± 1.7 (1.2 -3.4)	0.102[b]
Colloids (L) *	0.2 ± 0.4 (0 – 0.5)	0.3 ± 0.5 (0 – 0.5)	0.2 ± 0.4 (0 – 0.5)	0.389[b]
Erythrocytes (unit) #	0.8 ± 1.7 (0 – 1)	2.0 ± 3.2 (0 – 3)	0.7 ± 1.6 (0 – 1)	< 0.001[b]
Fresh frozen plasma (unit) #	0.3 ± 1.1 (0 – 0)	0.8 ± 2.1 (0 – 0)	0.3 ± 1.1 (0 – 0)	0.016[b]
Katz scale ***	0.33 ± 1.21	0.42 ± 1.41	0.33 ± 1.21	0.729[b]
Dependency in I-ADL **	101 (8)	2 (8)	99 (8)	0.664[a]
Lawton I-ADL scale ***	5.95 ± 2.20	5.50 ± 2.52	5.96 ± 2.19	0.307[b]
Dependency in P-ADL **	250 (20)	4 (15)	246 (20)	0.192[a]

[a] Pearson χ^2 or Fisher's exact test; [b] Mann-Whitney U test.
* – median (P25-75); ** – n (%); *** – mean ± sd; # – (P25 – P75) – are the 25th and 75th percentiles.
MCE – Major Cardiac Events; RCRI – revised cardiac risk index; I-ADL – instrumental activities of daily living; P-ADL – personal activities of daily living; PACU – post anesthesia care unit.

Table II – Severity of Disease Scores, PACU and Hospital Length of Stay and Mortality

Variable	All patients (n = 1,280)	MCE (n = 26)	No MCE (1,254)	p value [b]
SAPS II *	18 (13 – 27)	30 (23 – 42)	18 (12 – 27)	< 0.001
APACHE II *	8 (5 – 11)	14 (11 – 15)	8 (5 – 11)	< 0.001
PACU length of stay (hours) *	25 (21 – 46)	80 (38 – 170)	25 (21 – 45)	< 0.001
Hospital length of stay (days) *	14 (7 – 29)	26 (13 – 39)	14 (7 – 28)	0.108
Mortality in PACU **	33 (3)	3 (12)	30 (2)	0.027
Mortality in hospital **	72 (6)	6 (23)	66 (5)	0.002
Mortality at 6 months follow-up **	176 (14)	9 (35)	167 (13)	0.005

* – median (P25-75); ** – , n (%); [b] – Mann-Whitney U test
MCE – major cardiac events; SAPS II – Simplified Acute Physiology Score; APACHE II – Acute Physiology and Chronic Health Evaluation; PACU – Post Anesthesia Care Unit; P25 and P75 are the 25th and 75th percentiles.

without MCE (35% versus 13%, p = 0.005). The difference was even greater for hospital mortality (23%, versus 5%, p = 0.002) and PACU mortality (12% versus 2%, p = 0.027).

Univariate analyses for determinants of MCE and their relevant p-values are summarized in Table III. The following independent predictors for development of MCE in the immediate postoperative period were identified (p ≤ 0.001): ASA-PS (OR 4.30, 95% CI 1.76-10.47, p = 0.001 for ASA-PS IV/V patients), hypertension (OR 8.22, 95% CI 2.46-27.53, p = 0.001), ischemic heart disease (OR 7.03, 95% CI 3.03-16.33, p < 0.001,

congestive heart disease (OR 13.06, 95% CI 5.19-32.85, p < 0.001) and RCRI score (OR 6.24, 95% CI 2.60 – 14.97, p < 0.001 for RCRI > 2).

Univariate analysis for severity of disease, LOS and mortality are summarized in Table IV. Severity of disease scores SAPS II and APACHE II were significantly higher in patients who developed MCE (OR 1.05, 95% CI 1.03-1.07, p < 0.001 and OR 1.14, 95% CI 1.08-1.21, p < 0.001 respectively). The perioperative occurrence of MCE was associated with significantly greater PACU LOS (OR 1.21, 95% CI 1.10-1.31, p < 0.001), higher hospital mortality (OR 5.40, 95% CI 2.10-13.90, p < 0.001 and higher mortality at six months follow-up (OR 3.45, 95% CI 1.51-7.86, p = 0.003).

Multiple logistic regression analyses were used to examine the covariate effects of each factor in hospital mortality (Table V). The regression model included all variables with statistical significance in the univariate analysis for determinants of hospital mortality. This analysis showed that the development of MCE after surgery was a risk factor for hospital mortality (OR 5.40, p < 0.001). After adjustment for age, ASA-PS, temperature at admission, high-risk surgery, congestive heart failure, emergency surgery, SAPS II, APACHE II, PACU LOS and RCRI, the independent predictors of hospital mortality were ASA-PS (OR 3.94, 95% CI 2.03-7.66, p < 0.001, for ASA-PS IV/V patients), high-risk surgery (OR 2.31, 95% CI 1.22-4.39, p = 0.011), RCRI (OR 3.83, 95% CI 2.11-6.94, p < 0.001 for RCRI > 2) and APACHE II (OR 1.22, 95% CI 1.16-1.29, p < 0.001).

Three patients (12%) died during PACU stay, six (23%) died before hospital discharge and nine (35%) died before follow-up at six months. Of the remaining 17 patients, four (24%) did not answer the questionnaires at six months follow-up but were known to be alive.

For the patients who developed MCE the response rate was 76% (13 out 17 survivors at six months follow-up) and there were no statistically significant differences between participants and non-participants regarding any of the variables studied. For patients who did not develop MCE the response rate was 68% (737 out of 1078 survivors at six months follow-up).

Functional Capacity and ADL

Six months after discharge from PACU, 69% of the patients were dependent in at least one activity in instrumental ADL and 15% in at least one personal ADL (Table VI). There was no difference in the Katz scale after surgery but dependency

Table III – Univariate Analysis for Determinants of Major Cardiac Events

Variable	MCE (n = 26)	non MCE (n = 1,254)	Odds ratio (95% CI)	p value
Age *	68.5 ± 12.1	62.3 ± 15.3	1.00 (1.00 – 1.06)	0.040
≥ 65 years	19 (73)	636 (51)	2.64 (1.10 – 6.32)	0.030
<65 years	7 (27)	618 (49)	1	
Gender**				
Female	7 (27)	439 (35)	1	
Male	19 (73)	815 (65)	1.46 (0.61 – 3.51)	0.394
Body mass index (kg.m^{-2})*	27.1 ± 5.3	25.4 ± 5.8	1.04 (0.99 – 1.10)	0.146
Duration of anesthesia (min)*	270 ± 168	226 ± 117	1.00 (0.99 – 1.01)	0.073
General /Combined anesthesia**	23 (89)	1,184 (86)	2.98 (0.65 -13.63)	0.021
Emergency surgery**	8 (31)	268 (21)	1.64 (0.70 – 3.80)	0.253
Physical status**				
ASA II / III	19 (73)	1155 (92)	1	
ASA IV / V	7 (27)	99 (8)	4.30 (1.76 – 10.47)	0.001
Temperature at admission*	35.1 ± 1.8	35.2 ± 1.3	0.96 (0.72 – 1.28)	0.756
Troponin at admission*	0.59 ± 1.36	0.05 ± 0.10	25.56 (3.25 – 200.78)	0.002
Hypertension**	23(89)	605 (48)	8.22 (2.46 – 27.53)	0.001
Hyperlipidemia**	13 (50)	358 (28)	2.50 (1.15 – 5.45)	0.021
High-risk surgery**	19 (73)	575 (46)	3.21 (1.34 – 7.68)	0.009
Ischemic heart disease**	18 (69)	304 (24)	7.03 (3.03 – 16.33)	< 0.001
Congestive heart disease**	20 (77)	255 (20)	13.06 (5.19 – 32.85)	< 0.001
Chronic renal failure**	2 (8)	78 (6)	1.26 (0.29 – 5.41)	0.759
Cerebrovascular disease**	6 (23)	173 (14)	0.88 (0.74 – 4.73)	0.184
Insulin therapy for diabetes**	4 (15)	123 (10)	1.67 (0.57 – 4.93)	0.352
RCRI, n (%)				
≤ 2	7 (27)	874 (70)	1	
> 2	19 (73)	380 (30)	6.24 (2.60 – 14.97)	< 0.001
Intraoperative fluid volume*				
Crystalloids (L)	3.2 ± 2.9	2.6 ± 1.7	1.16 (0.97 – 1.39)	0.103
Colloids (L)	0.3 ± 0.5	0.2 ± 0.4	1.59 (0.68 – 3.75)	0.286
Erythrocytes (units)	2.0 ± 3.2	0.9 ± 1.6	1.23 (1.08 – 1.39)	0.002
Fresh frozen plasma (units)	0.8 ± 2.1	0.3 ± 1.1	1.23 (1.19 – 1.48)	0.031

* – mean ± sd; ** – n (%)
MCE – major cardiac events; RCRI – revised cardiac risk index.

Table IV – Univariate Analysis for Severity of Disease, Length of Stay and Mortality

Variable	MCE (n = 26)	non MCE (n = 1,254)	Odds ratio (95% CI)	p Value
SAPS II*	33.6 ± 16.2	21.1 ± 12.7	1.05 (1.03 – 1.07)	< 0.001
APACHE II*	13.8 ± 5.5	8.7 ± 5.0	1.14 (1.08 – 1.21)	< 0.001
PACU stay (days)*	4.6 ± 3.6	1.8 ± 2.1	1.21 (1.10 – 1.31)	< 0.001
Hospital stay (days)*	25 ± 27	24 ± 32	1.01 (0.99 – 1.02)	0.115
Mortality in the PACU**	3 (12)	30 (2)	5.32 (1.52 – 18.70)	0.009
Mortality in the hospital**	6 (23)	66 (5)	5.40 (2.10 – 13.90)	< 0.001
Mortality at 6 months**	9 (35)	167 (13)	3.45 (1.51 – 7.86)	0.003

* – mean ± sd; ** – n (%)
MCE, Major Cardiac Events; SAPS II, Simplified Acute Physiology Score; APACHE II, Acute Physiology and Chronic Health Evaluation; PACU, Post Anesthesia Care Unit; CI, Confidence Interval.

Table V – Multivariate Regression Analysis for Predictors of In-Hospital Mortality

Variable	Simple OR	p	Adjusted * OR (95% CI)	p [a]
Age	1.04	< 0.001	–	
Physical status				
ASA I / II / III	1		1	
ASA IV / V	13.16	< 0.001	3.94 (2.03 – 7.66)	< 0.001
Temperature	0.70	< 0.001		
High-risk surgery	3.44	< 0.001	2.31 (1.22 – 4.39)	0.011
Ischemic heart disease	2.24	< 0.001	–	
Congestive heart disease	5.86	0.001	–	
Emergency surgery	4.29	< 0.001	–	
MCE	5.40	< 0.001	–	
RCRI (> 2)	5.19	< 0.001	3.83 (2.11 – 6.94)	< 0.001
SAPS II	1.09	< 0.001	–	
APACHE II	1.29	< 0.001	1.22 (1.16 – 1.29)	< 0.001
PACU LOS (days)	1.18	< 0.001	–	

[a] Logistic regression analysis with stepwise forward method was used with an entry criterion of $p < 0.05$ and a removal criterion of $p > 0.1$.
MCE – major cardiac events; PACU – post anesthesia care unit; LOS – length of stay; SAPS – Simplified Acute Physiology Score; APACHE II – Acute Physiology and Chronic Health Evaluation; RCRI – Revised Cardiac Risk Index; OR – Odds Ratio; CI, Confidence Interval.
*Adjusted for age, ASA physical status, High-risk surgery, Ischemic heart disease, Congestive heart failure, Emergency surgery, MCE, SAPS II, APACHE II and PACU LOS.

Table VI – Dependency and Self-Reported Changes in Health in General, Six Months after Post Anesthesia Care Unit Discharge (n = 13)

Activities of daily living	Before surgery	6 months after PACU discharge	p value
Personal activities of daily living			
Katz scale *	0.0 ± 0.0	0.54 ± 1.66	0.266
Dependency in P-ADL **	0 (0)	2 (15)	0.018
Instrumental activities of daily living			
Lawton scale *	7.0 ± 1.7	5.0 ± 2.9	0.003
Dependency in I-ADL **	3 (23)	9 (69)	0.294

* – mean±sd; ** – n (%).

in at least one P-ADL was higher six months after PACU discharge. The Lawton scale score was significantly lower after surgery, indicating greater dependency, but the percentages of dependency in at least one I-ADL were not different.

Quality of Life Measures

Overall, 31% stated that their level of health in general was better on the day they completed the SF-36 questionnaire than 12 months earlier, while 31% considered it to be worse (six months before PACU discharge).

Compared to values observed for the urban population of Porto, the SF-36 sub-scores of all patients who developed MCE were worse in all domains except bodily pain and mental health (Table VII).

Patients who developed MCE did not differ in any of the SF-36 domains from the other PACU patients who did not have MCE (Table VIII).

Table VII – F-36 after Major Cardiac Event and in a General Population

SF-36 domains	6 months after MCE	General population	p value[a]
Physical function	61.5 ± 33.0	75.4 ± 23.6	0.035
Role physical	51.4 ± 32.5	76.7 ± 26.1	< 0.001
Bodily pain	52.3 ± 29.7	65.7 ± 26.2	0.067
General health perception	38.8 ± 18.3	59.5 ± 19.8	< 0.001
Vitality	32.7 ± 17.1	57.2 ± 21.1	< 0.001
Social functioning	60.6 ± 27.4	76.0 ± 24.1	0.021
Role emotional	48.7 ± 32.6	76.9 ± 25.8	< 0.001
Mental health	61.2 ± 41.6	66.1 ± 22.8	0.445

Values expressed as Mean ± Standard deviation; [a] – *t* test
SF-36, Short-form 36.

Table VIII – SF-36 after Major Cardiac Event and in a Surgical Population

SF-36 domains	6 months after MCE (n = 13)	PACU surgical patients (n = 737)	p value[a]
Physical function	61.5 ± 33.0	53.4 ± 31.3	0.352
Role physical	51.4 ± 32.5	46.2 ± 34.3	0.583
Bodily pain	52.3 ± 29.7	57.0 ± 29.8	0.580
General health perception	38.8 ± 18.3	46.4 ± 27.6	0.319
Vitality	32.7 ± 17.1	34.5 ± 16.6	0.705
Social functioning	60.6 ± 27.4	57.4 ± 30.6	0.709
Role emotional	48.7 ± 32.6	50.4 ± 34.8	0.867
Mental health	61.2 ± 41.6	50.1 ± 22.1	0.081

Values expressed as Mean ± Standard deviation; [a] – *t* test
SF-36, Short-form 36; PACU – Post Anesthesia Care Unit.

DISCUSSION

This study evaluated the occurrence of major cardiac complications after all types and magnitudes of noncardiac surgery, enrolling patients with all types of clinical risk.

The differential risk associated with various surgical procedures has been well recognized and different operations are associated with different cardiac risks [23]. We excluded patients submitted to cardiac or pulmonary surgery because the predicted incidence of MCE for these patients is higher [24] and because at our hospital they are admitted to other ICU.

The low incidence (2%) of serious postoperative cardiac events in our study was similar to that observed by Mangano (3%) [25] and Lee (2%) [5].

Postoperative MCE remains a leading cause of morbidity, mortality, prolonged hospital stay and increased hospital cost. In this study, we attempted to correlate and predict factors (preoperative, intraoperative and early postoperative) predisposing to MCE. The findings may enable us to predict those at high risk, so interventional measures might be planned in advance to improve outcome following such a complication, achieving a better outcome and a more efficient use of hospital and intensive care resources.

We have measured postoperative Troponin I levels for every patient although the role of the troponins for the evaluation of patients after non cardiac surgery remains unclear. Measurement of troponin I facilitates the recognition of myocardial damage but the Guidelines of the American College of Cardiology and American Heart Association for evaluating cardiac risk for noncardiac surgery do not recommend their routine measurement [26].

As determinants for the occurrence of MCE this study identified five independent risk factors: ASA-PS, hypertension, ischemic heart disease, congestive heart failure and RCRI.

The ASA-PS score, a preoperative evaluation used routinely for every patient, was never intended as a perioperative risk score, but all large-scale studies have suggested that a high ASA-PS score is one of the best predictors of postoperative morbidity [27,28]. This indicator depends on a more generic classification of diseases that may be present, and in itself indicates the presence of comorbidities. ASA-PS classification is a strong predictor of the development of postoperative medical complications for patients in a perioperative setting.

The RCRI is a tool for predicting major cardiac complications after noncardiac surgery [29,30]. It was developed to predict cardiac risk on the basis of six independent prognostic factors: high risk surgery, ischemic heart disease, congestive heart disease, history of cerebrovascular disease, insulin therapy for diabetes and preoperative serum creatinine > 2.0 $mgdL^{-1}$. The RCRI score is based on predictors that are independently and significantly associated with cardiovascular events. A high score means that patients with pre-existing cardiovascular disease have an increased perioperative risk of developing MCE in postoperative period. The present study corroborated the finding by Lee et al. [5] confirmed by others [31] that the presence of two or more of the RCRI factors identified patients with increased risk for cardiac complications. In our study, RCRI was an independent predictor for development of MCE, and so were some of the factors

included in the index such as ischemic heart disease and congestive heart failure. The contribution of heart failure to the RCRI [5] is consistent with previous studies that showed heart failure to be an important risk factor for postoperative cardiac complications [32]. Heart failure has been identified in several studies as associated with a poorer outcome when noncardiac surgery is performed and it is associated with a substantially increased risk during noncardiac surgery [33].

Although hypertension is common, and treatment has been shown to be associated with decreased rates of death due to stroke and congestive heart disease, the Guidelines of the American College of Cardiology and American Heart Association for evaluating cardiac risk for noncardiac surgery [23] considered hypertension a minor predictor, a recognized marker for cardiovascular disease that has not been proven to increase perioperative risk independently. In our study, however, hypertension appears as an independent risk factor for MCE, conflicting with numerous studies that have shown hypertension not to be independent risk factor for perioperative cardiovascular complications [33-35].

In the population studied, the occurrence of an MCE was considered a risk factor for higher mortality and longer PACU stay, and therefore worse outcome. This reinforces the importance of identifying myocardial injury because it can be associated with subsequent cardiac events that carry a significant burden to the patient [36]. Similarly, Venkataraman et al. [37] recently showed that perioperative cardiac events contributed significantly to morbidity and mortality.

In this study, patients with postoperative MCE had significantly higher hospital mortality than patients without MCE. Patients with MCE had a hospital mortality of 23%, nearly five times the mortality rate of those without.

We examined the impact of the occurrence of MCE on quality of life and independence in activities of daily living. To study the impact on quality of life we used the self-evaluated health transition item in the SF-36 questionnaire. This item is not used in scoring the scales but has been shown to be useful for estimating average change in health status during the year prior to administration of the questionnaire [38]. Only 31% of patients with postoperative MCE stated that their quality of life was better than before surgery, indicating that only a few of the patients who developed MCE had an improved subjective perception of quality of life after surgery.

Comparisons with a general population (taken as "control") are difficult to interpret because this population was not adjusted for age or comorbidities and because surgical patients who develop MCE may view themselves as chronically ill. Thus, our finding that quality of life was worse in almost all domains in MCE patients than in the general population was not totally unexpected. PACU patients from the same urban area with similar demographic characteristics seemed more appropriate for comparison with MCE patients; for this comparison we found no differences between the two populations in any of the SF-36 domains.

The patients in our study showed higher degrees of dependency in instrumental and personal ADL after surgery. These results may be influenced by the presence of comorbidities and concurrent diseases, and as implied by the higher SAPS II and longer PACU LOS among the MCE patients this could reflect the burden still imposed by the acute changes in these patients even six months after PACU discharge.

This study has several limitations. We did not apply the SF-36 questionnaire before surgery so it was not possible to compare the quality of life of patients before and after surgery as in the study by Lloyd [39]. Nevertheless, we used the SF-36 question about self-reported changes in health status ("compared to one year ago, how would you rate your health in general now?") to infer that the level of health in general was better for most patients on the day they completed the SF-36 than before surgery.

In summary, this study supports the conclusion that ASA-PS, hypertension, ischemic heart disease, congestive heart failure and RCRI are determinants of MCE after major noncardiac surgery. The occurrence of MCE after surgery is a risk factor for mortality and patients who developed MCE had higher mortality rates and higher PACU LOS.

Only 31% of patients who survived after surgery showed a subjective positive perception of HRQOL six months after discharge from the PACU.

Patients who developed MCE did not differ in any SF-36 domain from PACU patients who did not.

Six months after PACU discharge, a substantial number of patients were dependent in at least one activity in personal or instrumental ADL. This may be seen as an indicator of prolonged convalescence in this group of patients.

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ARTIGO CIENTÍFICO

Avaliação da Qualidade de Vida e Mortalidade em Pacientes com Eventos Cardíacos Graves no Pós-Operatório

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Resumo: Abelha FJ, Botelho M, Fernandes V, Barros H – Avaliação da Qualidade de Vida e Mortalidade em Pacientes com Eventos Cardíacos Graves no Pós-Operatório.

Justificativa e objetivos: Complicações cardiovasculares no pós-operatório associam-se a elevadas mortalidade e morbidade. Poucos estudos avaliaram o grau de dependência desses doentes e a percepção da sua saúde. O objetivo deste trabalho foi avaliar a mortalidade e a qualidade de vida em doentes que desenvolveram eventos cardíacos graves (EC) no pós-operatório.

Método: Estudo retrospectivo numa Unidade de Tratamento Intensivo Cirúrgica (UTI-Cirúrgica), entre março de 2006 e março de 2008. Os doentes foram avaliados quanto à ocorrência de EC. Seis meses após a alta, foi preenchido o questionário Short-Form-36 (SF-36) e avaliada a dependência nas atividades da vida diária (AVD). As comparações entre grupos independentes de doentes foram efetuadas com teste t de Student. A comparação entre cada variável e a ocorrência de EC foi efetuada por regressão logística envolvendo todos os doentes.

Resultados: Dos 1.280 doentes que apresentaram critérios de inclusão, 26 (2%) desenvolveram EC. A análise univariada identificou como determinantes independentes para o desenvolvimento de EC: estado físico ASA, hipertensão arterial, doença cardíaca isquêmica, doença cardíaca congestiva e escore do Índice de Risco Cardíaco Revisado. A mortalidade seis meses após alta da UTI-Cirúrgica foi de 35%. Dos 17 sobreviventes aos seis meses, 13 completaram os questionários. Trinta e um por cento referiram que sua saúde em geral era melhor no dia em que responderam ao questionário do que 12 meses antes. Sessenta e nove por cento dos doentes estavam dependentes nas AVD instrumentais e 15%, nas AVD pessoais.

Conclusões: O desenvolvimento de EC tem sério impacto no tempo de hospitalização e nas taxas de mortalidade. Seis meses após a alta da UTI-Cirúrgica, mais de metade dos doentes estavam dependentes em pelo menos uma AVD instrumental.

Unitermos: CIRURGIA, não Cardíaca: qualidade de vida, eventos cardíacos; COMPLICAÇÕES: morbidade, mortalidade, pós-operatória

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INTRODUÇÃO

A alta prevalência de doença cardíaca na população tem grandes implicações no pós-operatório e o risco de eventos cardíacos graves pode ser significante para pacientes submetidos a grandes cirurgias. Por exemplo, morte cardíaca, infarto do miocárdio, isquemia miocárdica, insuficiência cardíaca congestiva e disritmias estão associadas a aumento da mortalidade e morbidade e resultam em tempos mais longos de internação e custos substancialmente mais elevados de tratamento [1]. No início do período pós-operatório, os eventos cardíacos podem ocorrer sem sintomas ou alterações eletrocardiográficas características que podem não ser reconhecidas; desta forma, uma avaliação cuidadosa do risco cardíaco perioperatório pode orientar o tratamento profilático, manuseio perioperatório, local e intensidade dos cuidados pós-operatórios e detecção precoce de complicações cardíacas.

Alguns estudos perioperatórios concentraram-se em pacientes com ou em risco de doença cardíaca [2,3], mas poucos (estudos) em pacientes não selecionados submetidos a todos os tipos de cirurgias não cardíacas [4]. Lee e col. [5] avaliaram 4.315 pacientes com 50 anos, com permanência pós-operatória estimada superior ou igual a 2 dias, mas excluíram pacientes submetidos a cirurgias de emergência.

Poucos estudos examinaram a dependência desses pacientes e a percepção de sua própria saúde. Diversos questionários foram validados para o estudo da qualidade de vida (QV) [6-10]. A maioria das medidas usadas são escalas multi-item, isto é, consistiam em diversas questões ou itens. Algumas escalas multi-item fornecem um escore total, bem como geram subescalas que fornecem informações sobre aspectos particulares, como a mobilidade. O questionário SF-36 foi desenvolvido durante o estudo *Medical Outcomes Study* (MOS) para medir conceitos genéricos de saúde relevantes para as diversas idades, doenças e grupos de tratamento [11]. É um instrumento válido para medir a QVRS, que tem sido utilizada para os pacientes pós-alta da UTI e nos estudos de grupos com outras doenças; o questionário mostra boa confiabilidade e validade [11,12]. Este questionário foi culturalmente adaptado para o português e validado no estudo de Ferreira [13,14].

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Um baixo estado funcional coloca os pacientes em risco mais elevado. Pacientes com nenhum ou apenas preditores clínicos menores, mas com baixa capacidade funcional são indicados para testes não invasivos antes da cirurgia. A capacidade do autocuidado e de viver com independência é considerada uma medida de resultado funcional após a hospitalização [15]. O estado funcional refere-se ao nível de envolvimento em atividades, e frequentemente é usado como sinônimo de desempenho das atividades da vida diária (AVD) [16]. As escalas de avaliação das AVD consideram as atividades funcionais e instrumentais. A capacidade do paciente para desempenhar essas atividades foi avaliada através de testes genéricos ou doença-específicos. A Escala de AVD de Katz [16] e a Escala de Atividades Instrumentais de Vida Diária (AVD-I) de Lawton [17] foram usadas em sobreviventes de cuidados intensivos.

O objetivo do presente estudo foi avaliar os resultados, qualidade de vida e autonomia nas AVD em pacientes que desenvolveram eventos cardíacos graves (EC) no pós-operatório.

MÉTODOS

Este estudo retrospectivo de coorte foi realizado em uma Unidade de Cuidados Pós-Anestésicos – Recuperação Pós-Anestésica (UCPA/RPA). Incluída na UCPA/RPA está uma Unidade de Terapia Intensiva Cirúrgica (UTI-Cirúrgica) com cinco leitos, nos quais pacientes graves são admitidos, monitorados de perto e tratados.

Todos os pacientes pós-operatórios admitidos na UTI-Cirúrgica da UCPA/RPA, com 18 anos ou mais, submetidos a cirurgias de emergência ou planejadas entre 11 de março de 2006 e 1º de março de 2008, que tiveram pelo menos uma noite de internamento e mais de 12 horas de permanência na UCPA/RPA e foram elegíveis para inclusão no estudo. Pacientes readmitidos durante o período do estudo foram registrados considerando-se tempo da sua primeira admissão. Pacientes submetidos a cirurgias cardíacas ou pulmonares foram excluídos.

As seguintes variáveis foram registradas na admissão na UCPA/RPA: idade, sexo, índice de massa corporal (IMC), estado físico da *American Society of Anesthesiologists* (ASA) [18], cirurgia de emergência ou planejada, comorbidades pré-hospitalização (especificamente doença isquêmica cardíaca, insuficiência cardíaca congestiva, doença cerebrovascular, hipertensão, insuficiência renal, diabetes, hiperlipidemia), duração e tipo de anestesia, temperatura corporal e níveis séricos de troponina I. Os dados intraoperatórios registrados para cada caso incluíram a administração de cristaloides, coloides, eritrócitos e plasma fresco congelado.

A troponina I cardíaca (TnI-c) pós-operatória e a ocorrência de eventos cardíacos graves (EC) foram registradas. Dados intraoperatórios e da UCPA/RPA foram coletados, bem como o tempo de permanência hospitalar (TPH). A mortalidade foi registrada para todos os pacientes. Os escores das escalas *Acute Physiology And Chronic Health Evaluation* (APACHE) II [19] e *Simplified Acute Physiology Score* II (SAPS II) [20] foram calculados através de métodos-padrão. Seis meses após a alta, os pacientes foram contatados para completar o questionário SF-36 e avaliar sua dependência nas atividades da vida diária (AVD).

Utilizando um esquema de classificação desenvolvido por Lee e col. para predizer o risco cardíaco, calculamos o Índice de Risco Cardíaco Revisado (IRCR) para cada paciente, assinalando um ponto para cada um dos seguintes fatores de risco: cirurgia de alto risco (torácica, abdominal ou pélvica vascular, ex., aorta, renal, mesentérica), histórico de doença isquêmica cardíaca, histórico de insuficiência cardíaca congestiva, histórico de doença cerebrovascular, tratamento pré-operatório com insulina e creatinina sérica > 2,0 $mg.dL^{-1}$ [5].

O infarto agudo do miocárdio, edema pulmonar, fribrilação ventricular ou parada cardíaca primária e bloqueio cardíaco completo foram registrados durante a permanência na UCPA/RPA e considerados eventos cardíacos graves (EC).

O infarto agudo do miocárdio foi diagnosticado de acordo com os critérios da Sociedade Europeia de Cardiologia/Colégio Americano de Cardiologia [21], considerando os dois seguintes critérios, suficientes para o diagnóstico do infarto agudo em evolução ou recente: (i) um aumento típico e redução gradual nas concentrações de TnI-c, ou repentino aumento e diminuição dos níveis de creatina quinase-MB em combinação com pelo menos um dos seguintes: (a) sintomas isquêmicos típicos, (b) desenvolvimento de ondas Q patológicas no ECG, (c) alterações no ECG indicativas de isquemia miocárdica (supra ou infradesnivelamento do segmento ST) e, (d) intervenção arterial coronariana; e (ii) achados patológicos de infarto agudo do miocárdio.

Imediatamente após a chegada do pós-operatório na UTI e durante toda a permanência na UCPA/RPA, amostras de creatina quinase-MB (CK-MB) e TnI-c foram coletadas de todos os pacientes. Amostras foram coletadas e um ECG de doze derivações foi realizado sempre que houvesse sintomas de eventos miocárdicos. Em todos os pacientes, as derivações II e V no ECG foram registradas de forma contínua para monitorar e diagnosticar possíveis disritmias.

Registramos, também, o tempo de permanência (TP) na UCPA/RPA e no hospital. Com relação à mortalidade, registramos a mortalidade na UCPA/RPA, no hospital e a mortalidade 6 meses após a alta da UCPA/RPA.

A capacidade funcional antes da cirurgia foi avaliada com relação à habilidade do paciente para executar atividades diárias (AVD) pessoais e instrumentais durante as primeiras 24 horas após a admissão na UCPA/RPA. Todos os pacientes elegíveis que consentiram em participar foram entrevistados diretamente por um pesquisador treinado. Quando o paciente era incapaz de responder, o questionário foi finalizado por um membro da família que vivia na mesma casa do paciente. A qualidade de vida relacionada com a saúde (QVRS) foi avaliada por meio do questionário SF-36 [12]. A pesquisa contém 36 questões que avaliam oito domínios da saúde considerados importantes para o bem-estar e saúde do paciente. Estes domínios refletem a saúde física, saúde mental e o impacto da saúde na funcionalidade diária. Os oito domínios de múltiplos itens compreendem capacidade funcional (dez itens), aspectos sociais (dois itens), aspectos físicos (quatro itens), aspectos emocionais (três itens), saúde mental (cinco itens), vitalidade (quatro itens), dor (dois itens) e estado geral de saúde (cinco itens). Há mais um item

fora da escala relacionado com mudanças autorreportadas na condição de saúde do inquirido durante o ano anterior. Para cada item, os escores são codificados, somados e transformados em uma escala de 0 (pior estado de saúde possível medido pelo questionário) a 100 (melhor estado de saúde possível). Os escores podem ser agregados às medidas representando a escala resumida de saúde física (consistindo em funcionalidade física, papel físico, dor e saúde geral) e uma escala resumida de saúde mental (vitalidade, funcionalidade social, papel emocional e saúde mental) [6].

As respostas às questões sobre as mudanças autorreportadas na saúde ("comparada há um ano, como você classificaria a sua saúde em geral agora?") foram caracterizadas como: melhor, mais ou menos, a mesma coisa ou pior do que no ano passado.

Para minimizar a angústia dos parentes próximos, o registro dos pacientes foi verificado no sistema de informações do hospital após seis meses, para verificar se os mesmos ainda estavam vivos. Uma cópia de uma carta formal foi enviada a todos os sobreviventes conhecidos acompanhada por um envelope de retorno e um formulário validado em Português do questionário SF-36 [13,14]. Esta versão foi validada para a população da cidade do Porto, onde os participantes deste trabalho vivem [22]. Os escores para todos os domínios obtidos para pacientes que desenvolveram EC foram comparados com os valores publicados para a população da cidade do Porto [17].

Comparamos, também, os escores em todos os domínios do SF-36 obtidos para os pacientes com EC com aqueles coletados dos pacientes da UCPA/RPA que não desenvolveram EC após a cirurgia.

O questionário usado para avaliar a dependência baseou-se na Escala de Atividades de Vida Diária (AVD) de Katz[22] e a Escala de Atividades Instrumentais de Vida Diária (AIVD) de Lawton. A escala AIVD de Lawton é um instrumento de fácil administração que fornece informações autorrelatadas sobre as habilidades funcionais necessárias à vida em comunidade. Déficits na escala AIVD de Lawton foram registrados, sendo obtido um escore resumido variando de 0 (baixa funcionalidade, dependente) a 7 (alta funcionalidade, independente). A escala AVD de Katz avalia as atividades básicas pessoais da vida diária e ranqueia a adequação do desempenho em seis funções. A dependência em cada atividade pessoal foi avaliada e um resumo que variava de 0 (independência para todas as atividades) a 6 (dependência para todas as atividades) foi obtido. As atividades pessoais da vida diária (AVD-P) consideradas foram: tomar banho, vestir-se, ir ao banheiro, transferência da cama para a cadeira, continência e alimentar-se. As atividades instrumentais da vida diária (AVD-I) consideradas foram: fazer limpeza, comprar comida, usar transporte público e cozinhar. As respostas foram categorizadas em dois grupos: capaz ou incapaz de executar cada atividade e grupo de atividades. Os pacientes foram considerados dependentes se fossem dependentes em pelo menos uma AVD-I ou AVD-P.

Os desfechos (*endpoints*) considerados foram: (1) Capacidade funcional e AVD. Os pacientes eram considerados dependentes se fossem dependentes em pelo menos uma AVD-I ou AVD-P. (2) Qualidade de Vida. A Qualidade de vida foi avaliada seis meses após a alta da UCPA/RPA. (3) Mortalidade. Os pacientes foram considerados sobreviventes se estivessem vivos seis meses após a alta da UCPA/RPA.

A análise descritiva das variáveis foi utilizada para resumir os dados e o Teste U de Mann-Whitney foi usado para comparar variáveis continuas entre grupos de indivíduos; o teste de Qui-quadrado ou teste Exato de Fisher foi usado para comparar proporções entre dois grupos de indivíduos. Para avaliar os determinantes de EC pós-operatórios e para identificar preditores independentes de mortalidade hospitalar, análises univariadas foram realizadas usando regressão logística binária simples com um *odds ratio* (OR) e seu intervalo de confiança de 95% com as seguintes variáveis independentes: idade, sexo, IMC, EF-ASA, tipo de cirurgia, comorbidades, escore do IRCR, tipo de anestesia, administração intraoperatória de fluidos, níveis séricos de Troponina I na admissão, duração da anestesia e temperatura na admissão (e EC para o modelo de mortalidade). Para evitar a inflação do erro tipo I, controlamos o nível de significância para comparações múltiplas aplicando a correção de Bonferroni (nível de significância "test-wise" dividido pelo número de testes executados). Todas as variáveis foram consideradas significantes quando $p \leq 0,001$.

A regressão logística binária múltipla com eliminação *conditional forward* foi usada para examinar os efeitos das covariadas para cada fator a fim de identificar preditores independentes de mortalidade hospitalar. Nesses modelos, as covariadas com $p \leq 0,001$ na respectiva análise univariada foram introduzidas (aplicando a correção de Bonferroni para comparações múltiplas).

Um teste *t* para grupos independentes foi usado para comparar médias populacionais. Os escores do questionário SF-36 para a população com EC foram comparados com a população urbana da cidade do Porto usando um teste *t*.

O pacote de *software* estatístico SPSS para Windows versão 16.0 (SPSS, Chicago, IL) foi usado para analisar os dados.

RESULTADOS

Um total de 1.597 indivíduos adultos foram admitidos na UCPA/RPA durante o período do estudo e 1.280 pacientes preencheram os critérios de inclusão e foram observados para o desenvolvimento de EC após a admissão. Foram excluídos 196 pacientes porque permaneceram menos de 12 horas e não passaram uma noite na UCPA/RPA, 52 porque tinham menos de 18 anos e 44 por que foram admitidos mais de uma vez à UCPA/RPA; 13 foram admitidos após cirurgia pulmonar e 12 não eram pacientes cirúrgicos.

Vinte e seis (2%) desenvolveram EC durante a estadia na UCPA/RPA. Os casos de EC consistiram em 19 infartos agudos do miocárdio, 5 paradas cardíacas/fibrilação ventricular e dois edemas pulmonares. As características de pacientes admitidos na UCPA/RPA e uma comparação entre os pacientes que desenvolveram e não desenvolveram EC são apresentadas na Tabela I. Os pacientes que desenvolveram EC eram mais velhos (mediana da idade 72 *vs.* 65 anos,

Tabela I – Características dos Pacientes e Resultados

Variável	Todos os pacientes (n = 1.280)	EC (n = 6)	Sem EC (1.254)	Valor de p
Idade em anos *	65 (54 – 74)	72 (57 – 78)	65 (54 – 74)	0,025 [b]
Faixa etária **				0,018 [a]
≥ 65 anos	655 (51)	19 (73)	636 (51)	
< 65 anos	625 (49)	7 (27)	618 (49)	
Sexo **				0,263 [a]
Masculino	834 (65)	19 (73)	815 (65)	
Feminino	446 (35)	7 (27)	439 (35)	
Estado físico **				0,004 [a]
ASA I / II / III	1.174 (92)	19 (73)	1.155 (92)	
ASA IV / V	106 (8)	7 (27)	99(8)	
Índice de massa corporal (kg.m^{-2}) *	25 (22 – 28)	26 (24 – 29)	25 (22 – 28)	0,071 [b]
Anestesia Geral / Combinada **	1107 (87)	23 (89)	1184 (86)	
Duração da anestesia (min) *	200 (150 – 300)	240 (128 – 360)	200 (150 – 300)	0,284 [b]
Temperatura à admissão na UCPA/RPA ***	35,22 ± 1,31	35,14 ± 1,28	35,22 ± 1,31	0,089 [b]
Troponina I à admissão ***	0,07 ± 0,31	0,59 ± 1,36	0,05 ± 0,10	< 0,001 [b]
Hipertensão **	628 (49)	23 (89)	605 (48)	< 0,001 [a]
Hiperlipidemia **	371 (29)	13 (50)	358 (28)	0,018 [a]
Cirurgia não eletiva **	276 (22)	8 (31)	268 (21)	0,178 [a]
Cirurgia de alto risco **	594 (46)	19 (73)	575 (46)	0,005 [a]
Doença cardíaca isquêmica**	322 (25)	18 (69)	304 (24)	< 0,001 [a]
Doença cardíaca congestiva **	275 (22)	20 (77)	255 (20)	< 0,001 [a]
Insuficiência renal crônica **	80 (6)	2 (8)	78 (6)	0,491 [a]
Doença cerebrovascular **	179 (14)	6 (23)	173 (14)	0,144[a]
Terapia insulínica para diabetes **	127 (10)	4 (15)	123 (10)	0,253[a]
IRCR				< 0,001[a]
≤ 2	881 (69)	7 (27)	874 (70)	
> 2	399 (31)	19 (73)	380 (30)	
Volume fluido intraoperatório				
Cristaloides (L) #	2,6 ± 1,8 (1,2 – 3,4)	3,2 ± 2,9 (1,2 -3,9)	2,6 ± 1,7 (1,2 -3,4)	0,102 [b]
Coloides (L) *	0,2 ± 0,4 (0 – 0,5)	0,3 ± 0,5 (0 – 0,5)	0,2 ± 0,4 (0 – 0,5)	0,389 [b]
Eritrócitos (unid.) #	0,8 ± 1,7 (0 – 1)	2,0 ± 3,2 (0 – 3)	0,7 ± 1,6 (0 – 1)	< 0,001 [b]
Plasma fresco congelado (unid.) #	0,3 ± 1,1 (0 – 0)	0,8 ± 2,1 (0 – 0)	0,3 ± 1,1 (0 – 0)	0,016 [b]
Escala de Katz ***	0,33 ± 1,21	0,42 ± 1,41	0,33 ± 1,21	0,729 [b]
Dependência nas AVD-I **	101 (8)	2 (8)	99 (8)	0,664 [a]
Escala de Lawton AVD-I ***	5,95 ± 2,20	5,50 ± 2,52	5,96 ± 2,19	0,307[b]
Dependência nas AVD-P **	250 (20)	4 (15)	246 (20)	0,192 [a]

[a] Teste de Pearson χ^2 ou teste Exato de Fisher; [b] Teste U de Mann-Whitney.
* – mediana (P25-75); ** – n (%); *** – média ± dp; # – (P25 – P75) – são os percentis 25 e 75.
EC – Eventos Cardíacos Graves; IRCR – Índice de risco cardíaco revisado; AVD-I: atividades instrumentais da vida diária; AVD-P – atividades pessoais da vida diária; UCPA/RPA – unidade de cuidados pós-anestesia – Recuperação Pós-Anestésica.

p < 0,025), tinham maior probabilidade de apresentar estado físico ASA IV/V (27% *versus* 8%, p = 0,004), apresentavam escores IRCR > 2 (73% *versus* 30%, p < 0,001), apresentavam níveis mais altos de troponina I na admissão (0,59 ± 1,36 *versus* 0,05 ± 0,10, p < 0,001), mais frequentemente apresentavam hipertensão (89% *versus* 48%, p < 0,001) e hiperlipidemia (50% *versus* 28%, p = 0,018), tinham maior probabilidade de se submeter à cirurgia de alto risco (73% *versus* 46%, p = 0,005), mais frequentemente apresentavam doença cardíaca isquêmica (69% *versus* 24%, p < 0,001) e doença cardíaca congestiva (77% *versus* 20%, p < 0,001) e tinham recebido um volume maior de fluidos intraoperatórios (2,0 ± 3,2 *versus* 0,7 ± 1,6, p < 0,001, para unidades de eritrócitos e 0,8 ± 2,1 *versus* 0,3 ± 1,1, p = 0,016 para unidades de plasma fresco congelado).

A Tabela II apresenta dados sobre a gravidade dos escores das doenças e desfechos. Os pacientes que desenvolveram EC estavam mais gravemente doentes (média de SAPS II 30 *versus* 18, p < 0,001 e mediana APACHE II 14 *versus* 8, p < 0.001) e permaneceram mais tempo na UCPA/RPA (mediana 84 h *versus* 20 h, p < 0,001). A taxa de mortalidade não ajustada no seguimento de 6 meses para pacientes que desenvolveram EC foi quase três vezes maior do que para pacientes sem EC (35% *versus* 13%, p = 0,005). A diferença foi ainda maior com relação à mortalidade hospitalar (23%, *versus* 5%, p = 0,002) e mortalidade na UCPA/RPA (12% *versus* 2%, p = 0,027).

A análise univariada para determinantes de EC e seus valores de P relevantes estão resumidos na Tabela III. Os seguintes preditores independentes para o desenvolvimento de EC no período imediato pós-operatório foram identificados (p ≤ 0,001): EF-ASA (OR 4,30, IC95% 1,76-10,47, p = 0,001 para pacientes com EF-ASA IV/V), hipertensão (OR 8,22, IC95% 2,46-27,53, p = 0,001), doença cardíaca isquêmica (OR 7,03, IC95% 3,03-16,33, p < 0,001, doença cardíaca congestiva (OR 13,06, IC95% 5,19-32,85, p < 0,001) e es-

Tabela II – Gravidade dos Escores de Doenças, UCPA/RPA e Duração da Hospitalização e Mortalidade

Variável	Todos os pacientes (n = 1.280)	EC (n = 26)	Sem EC (1.254)	valor de p [b]
SAPS II *	18 (13 – 27)	30 (23 – 42)	18 (12 – 27)	< 0,001
APACHE II *	8 (5 – 11)	14 (11 – 15)	8 (5 – 11)	< 0,001
Permanência na UCPA/RPA (horas) *	25 (21 – 46)	80 (38 – 170)	25 (21 – 45)	< 0,001
Duração da hospitalização (dias) *	14 (7 – 29)	26 (13 – 39)	14 (7 – 28)	0,108
Mortalidade na UCPA/RPA **	33 (3)	3 (12)	30 (2)	0,027
Mortalidade hospitalar **	72 (6)	6 (23)	66 (5)	0,002
Mortalidade após 6 meses de acompanhamento **	176 (14)	9 (35)	167 (13)	0,005

* – mediana (P25-75); ** – , n (%); [b] – Teste U de Mann-Whitney
EC – Eventos Cardíacos Graves; SAPS II – Simplified Acute Physiology Score; APACHE II – Acute Physiology and Chronic Health Evaluation; UCPA/RPA – unidade de cuidados pós-anestesia – Recuperação Pós-Anestésica; P25 e P75 são os percentis 25 e 75.

Tabela III – Análise Univariada para Determinantes de Eventos Cardíacos Graves

Variável	EC (n = 26)	Sem EC (n = 1.254)	Odds ratio (IC95%)	valor de p
Idade *	68,5 ± 12,1	62,3 ± 15,3	1,00 (1,00 – 1,06)	0,040
≥ 65 anos	19 (73)	636 (51)	2,64 (1,10 – 6,32)	0,030
<65 anos	7 (27)	618 (49)	1	
Sexo **				
Feminino	7 (27)	439 (35)	1	
Masculino	19 (73)	815 (65)	1,46 (0,61 – 3,51)	0,394
Índice de Massa Corporal ($kg.m^{-2}$) *	27,1 ± 5,3	25,4 ± 5,8	1,04 (0,99 – 1,10)	0,146
Duração da anestesia (min) *	270 ± 168	226 ± 117	1,00 (0,99 – 1,01)	0,073
Anestesia Geral /Combinada **	23 (89)	1.184 (86)	2,98 (0,65 -13,63)	0,021
Cirurgia de Emergência **	8 (31)	268 (21)	1,64 (0,70 – 3,80)	0,253
Estado Físico **				
ASA II / III	19 (73)	1.155 (92)	1	
ASA IV / V	7 (27)	99 (8)	4,30 (1,76 – 10,47)	0,001
Temperatura à admissão *	35,1 ± 1,8	35,2 ± 1,3	0,96 (0,72 – 1,28)	0,756
Troponina à admissão *	0,59 ± 1,36	0,05 ± 0,10	25,56 (3,25 – 200,78)	0,002
Hipertensão **	23(89)	605 (48)	8,22 (2,46 – 27,53)	0,001
Hiperlipidemia **	13 (50)	358 (28)	2,50 (1,15 – 5,45)	0,021
Cirurgia de alto risco **	19 (73)	575 (46)	3,21 (1,34 – 7,68)	0,009
Doença cardíaca isquêmica **	18 (69)	304 (24)	7,03 (3,03 – 16,33)	< 0,001
Doença cardíaca congestiva **	20 (77)	255 (20)	13,06 (5,19 – 32,85)	< 0,001
Insuficiência renal crônica **	2 (8)	78 (6)	1,26 (0,29 – 5,41)	0,759
Doença cerebrovascular **	6 (23)	173 (14)	0,88 (0,74 – 4,73)	0,184
Terapia insulínica para diabetes **	4 (15)	123 (10)	1,67 (0,57 – 4,93)	0,352
IRCR, n (%)				
≤ 2	7 (27)	874 (70)	1	
> 2	19 (73)	380 (30)	6,24 (2,60 – 14,97)	< 0,001
Volume fluido Intraoperatório *				
Cristaloides (L)	3,2 ± 2,9	2,6 ± 1,7	1,16 (0,97 – 1,39)	0,103
Coloides (L)	0,3 ± 0,5	0,2 ± 0,4	1,59 (0,68 – 3,75)	0,286
Eritrócitos (unid.)	2,0 ± 3,2	0,9 ± 1,6	1,23 (1,08 – 1,39)	0,002
Plasma fresco congelado (unid.)	0,8 ± 2,1	0,3 ± 1,1	1,23 (1,19 – 1,48)	0,031

* – média ± dp; ** – n (%)
EC – eventos cardíacos graves; IRCR – índice de risco cardíaco revisado; IC – intervalo de confiança.

core IRCR (OR 6,24, IC95% 2,60 – 14,97, p < 0,001 para IRCR > 2).

A análise univariada para gravidade da doença, tempo de permanência e mortalidade é mostrada na Tabela IV. Os escores de gravidade da doença SAPS II e APACHE II eram significativamente mais altos em pacientes que desenvolveram EC (OR 1,05, IC95% 1,03-1,07, p < 0,001 e OR 1,14, IC95% 1,08-1,21, p < 0,001 respectivamente). A ocorrência perioperatória de EC estava associada a tempo de permanência significativamente mais longo na UCPA/RPA (OR 1,21, IC95% 1,10-1,31, p < 0,001), mortalidade hospitalar mais alta (OR 5,40, IC95% 2,10-13,90, p < 0,001 e maior mortalidade de seis meses de seguimento (OR 3,45, IC95% 1,51-7,86, p = 0,003).

As análises de regressão logística múltipla foram utilizadas para examinar os efeitos das covariadas de cada fator na mortalidade hospitalar (Tabela V). O modelo de regressão incluiu todas as variáveis com significância estatística na análise univariada para determinantes de mortalidade hospitalar. Essa análise mostrou que o desenvolvimento de EC após a cirurgia foi um fator de risco para mortalidade hospitalar (OR 5,40, p < 0,001). Após ajuste para idade, EF-ASA, temperatura na admissão, cirurgia de alto risco, insuficiência cardíaca congestiva, cirurgia de emergência, SAPS II, APACHE II, tempo de permanência na UCPA/RPA e IRCR, os preditores independentes de mortalidade hospitalar foram EF-ASA (OR 3,94, IC95% 2,03-7,66, p < 0,001, para pacientes com EF-ASA IV/V), cirurgia de

Tabela IV – Análise Univariada para Gravidade da Doença, Duração da Hospitalização e Mortalidade

Variável	EC (n = 26)	Sem EC (n = 1.254)	Odds ratio (IC95%)	Valor de p
SAPS II *	33,6 ± 16,2	21,1 ± 12,7	1,05 (1,03 – 1,07)	< 0,001
APACHE II *	13,8 ± 5,5	8,7 ± 5,0	1,14 (1,08 – 1,21)	< 0,001
Permanência na UCPA/RPA (dias) *	4,6 ± 3,6	1,8 ± 2,1	1,21 (1,10 – 1,31)	< 0,001
Hospitalização (dias) *	25 ± 27	24 ± 32	1,01 (0,99 – 1,02)	0,115
Mortalidade na UCPA/RPA **	3 (12)	30 (2)	5,32 (1,52 – 18,70)	0,009
Mortalidade hospitalar **	6 (23)	66 (5)	5,40 (2,10 – 13,90)	< 0,001
Mortalidade de 6 meses **	9 (35)	167 (13)	3,45 (1,51 – 7,86)	0,003

* – média ± dp; ** – n (%)
EC, Eventos Cardíacos Graves; SAPS II, Simplified Acute Physiology Score; APACHE II, Acute Physiology and Chronic Health Evaluation; UCPA/RPA, Unidade de Cuidados Pós-Anestesia – Recuperação Pós-Anestésica; IC, Intervalo de Confiança.

Tabela V – Análise de Regressão Multivariada para Preditores de Mortalidade Hospitalar

Variável	OR Simples	p	* OR Ajustado (IC95%)	p [a]
Idade	1,04	< 0,001	–	
Estado Físico				
ASA I / II / III	1		1	
ASA IV / V	13,16	< 0,001	3,94 (2,03 – 7,66)	< 0,001
Temperatura	0,70	< 0,001		
Cirurgia de alto risco	3,44	< 0,001	2,31 (1,22 – 4,39)	0,011
Doença cardíaca isquêmica	2,24	< 0,001	–	
Doença cardíaca congestiva	5,86	0,001	–	
Cirurgia de Emergência	4,29	< 0,001	–	
EC	5,40	< 0,001	–	
IRCR (> 2)	5,19	< 0,001	3,83 (2,11 – 6,94)	< 0,001
SAPS II	1,09	< 0,001	–	
APACHE II	1,29	< 0,001	1,22 (1,16 – 1,29)	< 0,001
Permanência na UCPA/RPA (dias)	1,18	< 0,001	–	

[a] Análise de regressão logística com método *stepwise forward* foi usada com critério de entrada de p < 0,05 e um critério de remoção de p > 0,1.
EC – eventos cardíacos graves; UCPA/RPA – Unidade de Cuidados Pós-Anestesia – Recuperação Pós-Anestésica; SAPS – Simplified Acute Physiology Score; APACHE II – Acute Physiology and Chronic Health Evaluation; IRCR – Índice de Risco Cardíaco Revisado; OR – Odds Ratio; IC, Intervalo de Confiança.
*Ajustado por idade, estado físico ASA, cirurgia de alto risco, doença cardíaca isquêmica, insuficiência cardíaca congestiva, cirurgia de emergência, EC, SAPS II, APACHE II and permanência na UCPA/RPA.

alto risco (OR 2,31, IC95% 1,22-4,39, p = 0,011), IRCR (OR 3,83, IC95% 2,11-6,94, p < 0,001 para IRCR > 2) e escore APACHE II (OR 1,22, IC95% 1,16-1,29, p < 0,001).

Três pacientes (12%) morreram durante a permanência UCPA/RPA, 6 (23%) morreram antes da alta hospitalar e 9 (35%) morreram antes do seguimento de 6 meses. Dos 17 pacientes remanescentes, 4 (24%) não responderam aos questionários no seguimento de 6 meses, mas se sabia que estavam vivos.

Para os pacientes que desenvolveram EC, a taxa de resposta foi de 76% (13 de 17 sobreviventes no seguimento de 6 meses) e não houve diferença estatisticamente significante entre participantes e não participantes com relação a qualquer das variáveis estudadas. Para pacientes que não desenvolveram EC, a taxa de resposta foi de 68% (737 de 1.078 sobreviventes no seguimento de 6 meses).

Capacidade funcional e AVD

Seis meses após a alta da UCPA/RPA, 69% dos pacientes eram dependentes em pelo menos uma AVD instrumental e 15% em pelo menos 1 AVD pessoal (Tabela VI). Não houve diferença na escala de Katz após a cirurgia, mas dependência em pelo menos uma AVD-P foi maior seis meses depois da alta da UCPA/RPA. O escore da escala de Lawton foi significantemente mais baixo após a cirurgia, indicando maior dependência, mas as porcentagens de dependência em pelo menos uma AVD-I não foram diferentes.

Medidas de qualidade de vida

Em geral, 31% dos pacientes declararam que sua saúde em geral estava melhor no dia em que completaram o questionário SF-36 do que 12 meses antes, enquanto 31% consideravam sua saúde pior (seis meses antes da alta da UCPA/RPA). Comparados aos valores observados para a população urbana da cidade do Porto, os subescores do questionário SF-36 de todos os pacientes que desenvolveram EC foram piores em todos os domínios, exceto dor corporal e saúde mental (Tabela VII). Pacientes que desenvolveram EC não diferiram em nenhum dos domínios do questionário SF-36 de outros pacientes que permaneceram na UCPA/RPA, mas não tiveram EC (Tabela VIII).

Tabela VI – Dependência e Alterações Autorrelatadas na Saúde em Geral, 6 Meses após a Alta da Unidade de Cuidados Pós-Anestesia – Recuperação Pós-Anestésica (UCPA/RPA) (n = 13)

Atividades da vida diária	Antes da cirurgia	6 meses após alta da UCPA/RPA	Valor de p
Atividades Pessoais da vida diária			
Escala Katz *	0,0 ± 0,0	0,54 ± 1,66	0,266
Dependência nas AVD-P **	0 (0)	2 (15)	0,018
Atividades Instrumentais da vida diária			
Escala Lawton *	7,0 ± 1,7	5,0 ± 2,9	0,003
Dependência na AVD-I **	3 (23)	9 (69)	0,294

* – média ± dp; ** – n (%).

Tabela VII – F-36 após Eventos Cardíacos Graves e na População em Geral

Domínios SF-36	6 meses após EC	População em Geral	Valor de p [a]
Capacidade funcional	61,5 ± 33,0	75,4 ± 23,6	0,035
Aspectos físicos	51,4 ± 32,5	76,7 ± 26,1	< 0,001
Dor	52,3 ± 29,7	65,7 ± 26,2	0,067
Estado geral de saúde	38,8 ± 18,3	59,5 ± 19,8	< 0,001
Vitalidade	32,7 ± 17,1	57,2 ± 21,1	< 0,001
Aspectos sociais	60,6 ± 27,4	76,0 ± 24,1	0,021
Aspectos emocionais	48,7 ± 32,6	76,9 ± 25,8	< 0,001
Saúde Mental	61,2 ± 41,6	66,1 ± 22,8	0,445

Valores expressos como médias ± desvios-padrão; [a] – teste *t*
SF-36, Questionário *Short-form* 36.

Tabela VIII – SF-36 após Eventos Cardíacos Graves e em uma População Cirúrgica

Domínios SF-36	6 meses após EC (n = 13)	Pacientes cirúrgicos UCPA/RPA (n = 737)	Valor de p [a]
Capacidade funcional	61,5 ± 33,0	53,4 ± 31,3	0,352
Aspectos físicos	51,4 ± 32,5	46,2 ± 34,3	0,583
Dor	52,3 ± 29,7	57,0 ± 29,8	0,580
Estado geral de saúde	38,8 ± 18,3	46,4 ± 27,6	0,319
Vitalidade	32,7 ± 17,1	34,5 ± 16,6	0,705
Aspectos sociais	60,6 ± 27,4	57,4 ± 30,6	0,709
Aspectos emocionais	48,7 ± 32,6	50,4 ± 34,8	0,867
Saúde Mental	61,2 ± 41,6	50,1 ± 22,1	0,081

Valores expressos como médias ± desvios-padrão; [a] – teste *t*
SF-36, Questionário *Short-form* 36; UCPA/RPA – Unidade de Cuidados Pós-Anestesia – Recuperação Pós-Anestésica.

DISCUSSÃO

Este estudo avaliou a ocorrência de complicações cardíacas maiores após todos os tipos e as magnitudes de cirurgias não cardíacas, incluindo pacientes risco clínico diversificado.

O risco diferencial associado a vários procedimentos cirúrgicos tem sido reconhecido e diferentes cirurgias são associadas a diferentes riscos cardiacos [23]. Pacientes submetidos à cirurgia cardíaca ou pulmonar foram excluídos porque a incidência prevista de EC nesses pacientes é mais alta [24] e porque em nosso hospital são admitidos em outra UTI. A baixa incidência (2%) de eventos cardíacos graves pós-operatórios em nosso estudo foi similar à observada por Mangano (3%) [25] e Lee (2%) [5]. EC pós-operatórios permanecem a maior causa de morbidade, mortalidade, hospitalização prolongada e aumento de custos hospitalares. Nesse estudo, tentamos correlacionar e predizer fatores (pré-operatórios, intraoperatórios e pós-operatórios imediatos) que pudessem predispor à EC. Os achados permitem predizer quais pacientes apresentam alto risco, de forma que medidas de intervenção possam ser planejadas antecipadamente para melhorar o desfecho após tais complicações, dessa forma atingindo melhor resultado e um uso mais eficiente dos recursos de terapia intensiva e hospitalar.

Medimos os níveis pós-operatórios de Troponina I em todos os pacientes, embora o papel da troponina na avaliação de pacientes após cirurgia não cardíaca ainda não tenha sido esclarecido. A medida da Troponina I facilita o reconhecimento de dano miocárdico, mas as Diretrizes do *American College of Cardiology* e da *American Heart Association* para a avaliação de risco cardíaco para cirurgia não cardíaca não recomendam sua medida de rotina [26]. Como determinantes para a ocorrência de EC, este estudo identificou cinco fatores de risco independentes: EF-ASA, hipertensão, doença cardíaca isquêmica, insuficiência cardíaca congestiva e IRCR.

O uso do escore EF-ASA, uma avaliação utilizada rotineiramente para todos os pacientes, nunca foi pretendido para ser escore de risco, mas todos os estudos de larga escala têm sugerido que um alto escore EF-ASA é um dos melhores preditores de morbidade pós-operatória [27,29]. Esse indicador depende de uma classificação mais genérica de doenças que podem estar presentes e por si só indica a presença de comorbidades. A classificação EF-ASA é um forte preditor do desenvolvimento de complicações médicas pós-operatórias para pacientes em um ambiente perioperatório.

O IRCR é uma ferramenta para predizer complicações cardíacas maiores após cirurgia não cardíaca [29,30]. Ele foi desen-

volvido para predizer risco cardíaco com base em seis fatores prognósticos independentes: cirurgia de alto risco, doença cardíaca isquêmica, doença cardíaca congestiva, histórico de doença cerebrovascular, terapia insulínica para diabetes e níveis pré-operatórios de creatinina sérica > 2.0 mg.dL^{-1}. O escore do IRCR baseia-se em preditores que são independentes e significativamente associados a eventos cardiovasculares. Um escore alto significa que pacientes com doença cardiovascular preexistente apresentam um risco perioperatório aumentado de desenvolver EC no período pós-operatório. O presente estudo corroborou os achados de Lee e col. [5], confirmados por outros [31], de que a presença de dois ou mais fatores do IRCR identificaram pacientes com risco aumentado de complicações cardíacas. Em nosso estudo, o IRCR foi um preditor independente para o desenvolvimento de EC e da mesma forma foram alguns dos fatores incluídos no índice, tais como doença cardíaca isquêmica e insuficiência cardíaca congestiva. A contribuição da insuficiência cardíaca ao IRCR[5] é consistente com estudos anteriores, que demonstraram que a insuficiência cardíaca é um importante fator de risco para complicações cardíacas pós-operatórias [32]. A insuficiência cardíaca tem sido identificada em vários estudos como estando associada a um pior desfecho quando uma cirurgia não cardíaca é realizada e está associada a um aumento de risco substancial durante a cirurgia não cardíaca [33].

Embora a hipertensão seja comum e seu tratamento tenha sido associado a uma diminuição das taxas de morte devido a AVC e doença cardíaca congestiva, as Diretrizes do *American College of Cardiology* e *American Heart Association* para a avaliação de risco cardíaco em cirurgia não cardíaca [23] consideraram a hipertensão um preditor menor, um marcador reconhecido para doença cardiovascular, embora não se tenha provado que aumente o risco perioperatório de forma independente. Em nosso estudo, entretanto, a hipertensão aparece como um fator de risco independente para EC, em conflito com numerosos estudos que demonstraram que a hipertensão não é um fator de risco independente para complicações cardiovasculares perioperatórias [33-35].

Na população estudada, a ocorrência de EC foi considerada um fator de risco para maior mortalidade e permanência mais longa na UCPA/RPA e, portanto, pior desfecho. Isso reforça a importância de identificar a lesão miocárdica, pois a mesma pode estar associada a eventos cardíacos subsequentes que trazem uma carga significativa ao paciente [36]. De forma similar, Venkataraman e col. [37] recentemente demonstraram que eventos cardíacos peroperatório contribuíram significativamente para a morbidade e a mortalidade.

Nesse estudo, pacientes com EC pós-operatórios apresentaram mortalidade hospitalar significativamente mais alta do que pacientes sem EC. Pacientes com EC tiveram uma mortalidade hospitalar de 23%, quase 5 vezes a taxa de mortalidade dos pacientes sem EC.

Examinamos o impacto da ocorrência de EC na qualidade de vida e independência nas atividades da vida diária. Para estudar o impacto na qualidade de vida, utilizamos o item de transição de saúde autoavaliado no questionário SF-36. Esse item não é usado para o escore das escalas, mas tem-se mostrado útil na estimativa da mudança no estado de saúde durante o ano anterior à administração do questionário [38]. Somente 31% dos pacientes com EC declarou que sua qualidade de vida era melhor do que antes de cirurgia, indicando que apenas alguns dos pacientes que desenvolveram EC apresentavam uma percepção subjetiva melhorada da qualidade de vida após a cirurgia. Comparações com a população em geral (utilizada como "controle") são difíceis de interpretar porque essa população não foi ajustada para idade ou comorbidades e porque pacientes cirúrgicos que desenvolvem EC podem ver a si mesmos como sendo doentes crônicos. Assim, nosso achado de que a qualidade de vida era pior em quase todos os domínios em pacientes com EC quando comparados com a população em geral não foi totalmente inesperado. Pacientes admitidos na UCPA/RPA da mesma área urbana, com características demográficas similares, pareciam mais apropriados para comparação com pacientes com EC; não encontramos diferenças nessa comparação entre as duas populações em qualquer dos domínios do questionário SF-36.

Os pacientes em nosso estudo mostraram graus mais altos de dependência em AVD instrumental e pessoal após a cirurgia. Esses resultados podem ter sido influenciados pela presença de comorbidades e doenças concomitantes e, como sugerido pelo escore SAPS II mais alto e permanência mais longa na UCPA/RPA entre os pacientes com EC, isso poderia refletir a carga ainda imposta pelas alterações agudas nesses pacientes mesmo 6 meses depois da alta da UCPA/RPA.

Esse estudo tem várias limitações. Não aplicamos o questionário SF-36 antes da cirurgia, de forma que não foi possível comparar a qualidade de vida dos pacientes antes e depois da cirurgia, como no estudo de Lloyd [39]. Entretanto, utilizamos a questão do SF-36 sobre alterações no estado de saúde ("comparada a um ano atrás, como você classificaria a sua saúde em geral agora?") para inferir que o nível de saúde em geral era melhor para a maioria dos pacientes no dia em que completaram o SF-36 do que antes da cirurgia.

Em resumo, o presente estudo permite a conclusão de que o EF-ASA, hipertensão, doença cardíaca isquêmica, insuficiência cardíaca congestiva e IRCR são determinantes de EC após cirurgia não cardíaca maior. A ocorrência de EC após a cirurgia é um fator de risco de mortalidade e pacientes que desenvolveram EC apresentavam maiores taxas de mortalidade e permanência na UCPA/RPA mais longa.

Apenas 31% dos pacientes que sobreviveram após a cirurgia mostraram uma percepção subjetiva positiva da QVRS seis meses após a alta da UCPA/RPA.

Os pacientes que desenvolveram EC não diferiram em nenhum domínio do SF-36 dos pacientes da UCPA/RPA que não desenvolveram eventos.

Seis meses após a alta da UCPA/RPA, um número significante de pacientes era dependente em pelo menos uma AVD pessoal ou instrumental. Isso pode ser visto como um indicador de convalescência prolongada nesse grupo de pacientes.

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Resumen: Abelha FJ, Botelho M, Fernandes V, Barros H - Evaluación de la Calidad de Vida y de la Mortalidad en Pacientes con Eventos Cardíacos Mayores en el Postoperatorio.

Justificativa y objetivos: Las complicaciones cardiovasculares en el postoperatorio están asociadas a los elevados niveles de mortalidad y morbilidad. Pocos estudios evaluaron el grado de dependencia de esos enfermos y la percepción de su salud. El objetivo de este trabajo fue el de evaluar la mortalidad y la calidad de vida en enfermos que desarrollaron eventos cardíacos mayores (EC) en el postoperatorio.

Método: Estudio retrospectivo en una Unidad de Cuidados Intensivos Quirúrgica (UCI-Quirúrgica), entre marzo de 2006 y marzo de 2008. Los enfermos fueron evaluados respecto de la existencia de EC. Seis meses después del alta, se rellenó el cuestionario Short-Form-36 (SF-36) y se evaluó la dependencia de las actividades de la vida diaria (AVD). Las comparaciones entre los grupos independientes de enfermos fueron efectuadas con el test t. La comparación entre cada variable y la incidencia de EC, fue efectuada por regresión logística involucrando a todos los enfermos.

Resultados: De los 1280 enfermos que presentaron criterios de inclusión, 26 (2%) desarrollaron EC. El análisis univariado identificó como determinantes independientes para el desarrollo de EC: estado físico ASA, hipertensión, enfermedad cardíaca isquémica, enfermedad cardíaca congestiva y puntuación del Índice de Riesgo Cardíaco Revisado. La mortalidad seis meses después del alta de la UCI-Quirúrgica fue de un 35%. De los 17 sobrevivientes a los seis meses, 13 completaron los cuestionarios. Treinta y un por ciento declararon que su salud era mejor en general el día que respondieron el cuestionario que 12 meses antes de rellenarlo. Sesenta y nueve por ciento de los enfermos eran dependientes en las AVD instrumentales y un 15% en las AVD personales.

Conclusiones: El desarrollo de EC tiene un serio impacto en el tiempo de ingreso y en las tasas de mortalidad. Seis meses después del alta de la UCI-Quirúrgica, más de la mitad de los enfermos eran dependientes en por los menos una AVD instrumental.

General Discussion

Quality of life before surgical Intensive Care Unit admission

The study of patients' quality of life before Intensive Care Unit admission allows previous and subsequent occurrences to be compared and analyzed in relation to other variables.

The study of quality of life in critically ill patients tends to focus on the results after discharge, and very few studies have examined the situation before admission [38] and its importance in the surgical context in relation to outcome.

Rivera-Fernandèz et al. [39] used an instrument to measure quality of life in critically ill patients at the moment of Intensive Care Unit admission. They verified that previous quality of life influenced mortality but also quality of life after discharge assuming an important role in understanding outcome.

Mortality

The study of outcome in critical care patients has been primarily focused on hospital survival and the resource utilization adjusted according to the severity of illness. In recent decades, intensive care medicine has moved into a highly specific discipline covering several field [40]. Intensive Care Unit case fatality rates strongly depend on the severity of illness of the individual in the patient population being analysed. Across Intensive Care Units, 6.4 to 40% of critically ill patients died, despite appropriate intensive care treatment [41-42].

Predicting mortality is one of the greatest challenges to intensive care physicians. The ability to predict this outcome may influence the triage of patients, the medical therapy, and many other aspects of intensive care. Physicians tend to balance the potential benefits of a procedure by associating it with the physical condition of the patient at risk, which is commonly defined by indices using markers of cardiac, respiratory, and neurological disease, with additional physiological and laboratorial parameters. These allow calculation of risk indices that produce a predicted outcome [36, 43]. The main tools available for mortality prediction are severity scores and published outcomes data but all of them have still significant weaknesses and limitations. Many outcome prediction systems have been developed for Intensive Care Unit patients [6, 44-46] that are now used routinely, measuring the severity of illness using mortality prediction models. Their performances have been well studied in large international data-sets [47]. Results have been controversial, conflicting, and, most importantly, have fallen short of making accurate clinical predictions expected in today's perioperative environment [48].

When considering surgical patients, we can address that high-risk surgical population accounts for the majority of postoperative complications and deaths and that reports from the National Confidential Enquiry into Perioperative Deaths [49] describe advanced age, comorbid disease, major and urgent surgery as the key characteristics of these high-risk patient .

Reduce mortality following major surgery remains a significant challenge for surgical intensive care units. Since 1994, the National Surgical Quality Improvement Program [9] has become a tool for the study of outcomes in surgery; it reports that the majority of deaths occur in older patients who undergo major surgery and who have severe coexisting disease. Its prospectively collected database contains preoperative, intraoperative, and outcomes information on major surgery and have identified preoperative predictors of mortality and mortality after major surgery in a variety of surgeries. With data on this Program it has been also possible to conclude that events in the postoperative period are more important than preoperative patient risk factors in determining the survival after major surgery [29].

Major complications after surgery

The stress response to every surgical procedure initiates a predictable cascade of physiologic and metabolic events by direct activation of the sympathetic and parasympathetic nervous system, with increased circulation of catecholamine and changes in body core temperature, pain and anxiety. The result is tachycardia and hypertension, aggravated by perioperative fluid shifts. Surgery can also induce a hypercoagulable state because of changes in the balance between the pro-thrombotic and fibrinolytic activity [50].

The severity of the stress response may depend directly on the extent and duration of surgery, but the stress induced may also lead to myocardial ischemia, pulmonary insufficiency and hyperglycemia, which may be determinants of survival in the postoperative period.

The predicted risk of postoperative complications in individual patients is currently primarily based on the presence of co morbidities.

To reduce mortality following major surgery remains a significant challenge for surgical intensive care units. The majority of deaths occur in older patients who undergo major surgery and who have severe co-existing disease, but they also occur in patients that develop complications.

Complications after surgery occurring in major systems, namely pulmonary, cardiovascular, neurological and renal, may have a profound impact on outcome, and some may be viewed as risk factors for mortality and for a longer stay in the Intensive Care Unit [36, 51]. The study of these complications is related to outcome when considering mortality and length of stay in the hospital and in the Intensive Care Unit but they can also impair the quality of life.

Among postoperative complications, Acute Kidney Injury remains a leading cause of morbidity, mortality, prolonged hospital stay, and increased hospital costs [52]. It is possible to correlate and predict factors (preoperative, intra operative, and early postoperative) predisposing to Acute Kidney Injury [53]. By doing so, one might be able to predict those at high risk and interventional measures might be planned in advance to improve the outcome after such a complication, resulting in a more efficient use of hospital and intensive care resources. To date, there is no universally accepted definition for acute kidney dysfunction. Varying terms, including *acute renal failure*, *renal insufficiency*, *kidney injury*, and *renal impairment*, and various definitions (e.g., percent or absolute increments of creatinine, or decrements of urine output) have been used in previous publications. Furthermore the term Acute Kidney Injury has been put forth as the preferred nomenclature to replace acute renal failure with the understanding that the spectrum of Acute Kidney Injury is broad and includes different degrees of severity.

The proposed definition by the Acute Kidney Injury Network [37] was formed to facilitate the development and execution of initiatives to ensure the best outcomes for patients with Acute Kidney Injury and intensive care resources.

It is important to understand that Acute Kidney Injury not only contributes to worse outcome but is also a consequence of severity of disease.

The high prevalence of cardiac disease in the population has major implications in the postoperative setting and in patients undergoing major surgery, the risk of cardiac adverse events can be significant. Such is the case of cardiac death, myocardial infarction, myocardial ischemia, congestive heart failure, and arrhythmias that are important causes of morbidity with major non cardiac procedures. Postoperative Major Cardiac Events remains a leading cause of morbidity, mortality, prolonged hospital stay and increased hospital cost [36]. It is possible to correlate and predict factors (preoperative, intraoperative and early postoperative) predisposing to Major Cardiac Events. In doing so, we may be able to predict patients at high risk and can thus take preventive measures that can improve the outcome after these complications and achieve a more efficient use of hospital resources.

Length of stay

The length of stay in Intensive Care Unit is often used as a surrogate for patient morbidity and features in cost analysis studies. Results showed that Intensive Care Unit cost per day and per patient is remarkably consistent across most diagnoses [54], and therefore, the length of stay in Intensive Care Unit has also been used as a measure of resource utilization in the Intensive Care Unit [42, 55]. Despite refinements in perioperative management, prolonged intensive care unit stay remains associated with a poor outcome and increased costs [56-58]. Factors that predispose toward prolonged stay in Intensive Care Unit after surgery have been widely studied and are associated with poor patient outcome and increased costs [59-61].

Although the length of stay in Intensive Care can reflect discharge policies, variable practice patterns and bed management [62], a prolonged Intensive Care Unit stay can adversely affect prognosis by increasing the risk of complications such as infection and possibly, mortality [63]. It can also impact upon bed availability and may result in cancellation of elective surgeries, leading to longer waiting times and ward residence before Intensive Care Unit admission.

The likely length of stay in Intensive Care Unit of a patient may also influence therapeutic decisions. Several recent studies indicate that therapeutic strategies with an impact on patient outcome may only affect patients with longer Intensive Care Unit stays [64-65].

Numerous severity scores have been employed in surgical patients to estimate mortality and few attempts have been made to identify patients at risk for a prolonged stay in the ICU.

Functional Capacity

Although severity of illness is associated with an increased length of stay in Intensive Care Unit and use of resources [66-67], the functional status for survivors of critical illness appears to be an important consideration when evaluating treatment benefits and resource allocation.

The patient's ability to resume their normal activities after surgery is an important indicator of success of surgery and anesthesia. It is therefore important to assess the quality of recovery after surgery and anesthesia from the patient's perspective, and to adequately identify patient-based outcomes important to the overall recovery process.

The ability to care for oneself and live independently is considered a measure of functional outcome after hospitalization [68]. Functional status refers to the level of involvement in activities and is often used as a synonym for performance in Activities of

Daily Living [32]. Activities of Daily Living appraisal scales consider functional and instrumental activities. The ability of patients to handle these activities has been assessed by generic or disease-specific tests like the Katz's Activities of Daily Living Scale [32] and the Lawton Instrumental Activities of Daily Living [33] that have been used to study critical care survivors.

Quality of life

For complete evaluation of the benefits of an intervention, it is essential to have data about the impact on the patient, in terms of their general health status and health related quality of life. These terms refer to experiences associated with the disease, such as pain, fatigue and functional disability, and also to the broader aspects of patient's physical well-being, emotional and social conditions as well as other associated variables, such as social and familiar relationships, employment and financial status [69-70].

The study of the quality of life outcome became an issue of increasing interest due to its probable relevance in reducing healthcare expenditures and resource utilization [71].

In the intensive care units survival alone is a poor estimate of the standards of treatment and quality of life of patients after discharge. Due to the characteristics of critical care it is important to understand and have information about follow-up of patients after discharge from Intensive Care Unit incorporating the feedback of the impact of disease itself and therapeutic measures on morbidity in long-term survivors. Patients scheduled for elective surgery are of particular interest due to the individual risk of surgical procedures which may affect outcome.

As stated by Dowdy and colleagues in a systematic review [72] it is important to understand quality of life in specific Intensive Care Unit subpopulations. Indeed surgical population may be classified in even more specific population providing us with an opportunity to assess the impact of a specific intervention.

Quality of life outcomes and surveys studying health status are useful to include in randomised trials [69, 73-75]. Regardless of whether the results agree with the primary outcomes or not, such data could be important and should be systematically collected and reported.

Many measurements have been suggested [15, 76-79] and the use of questionnaires has raised considerable enthusiasm by providing the patients' perspective about their own outcome. Using different criteria, several questionnaires have been developed to measure specific dimensions of quality of life [76-82].

Generic measures are broadly applicable and can therefore be used across different patient populations. They include several questionnaires, mostly multi-item scales, that have been validated to study Health-Related Quality of Life [20, 39, 80, 83]. One such instrument is the Medical Outcome Survey Short Form-36 developed in the United States in the early 1990s to which excellent psychometric properties have been attributed and used previously both in post Intensive Care Unit discharge populations and disease groups with good reliability and validity [80, 82, 84-85]. The Short-Form General Health Survey was developed during the Medical Outcomes Study to measure generic health concepts that are relevant across age, disease and treatment groups [86]. It is a self-completed questionnaire covering all aspects of Health Related Quality of Life, it shows good reliability and validity and it has been used for various groups of patients including post-discharge Intensive Care Unit.

The appropriate time for the assessment of quality of life following ICU discharge has not been established. Cross-sectional studies of quality of life in critically ill patients have been performed at 1 month, 3 months, 6 months and 12 months after ICU discharge [23]. What investigators expect when assessing quality of life in follow-up patients is to chosen the correct time to minimize drop-outs and the probability of measuring impact of acute illness. Previous studies suggest that health problems leading to ICU admission after 6 months are due to chronic underlying conditions, or to new and unrelated health problems commonly encountered in an elderly population [87-88].

Ethical issues

Institutional Review Boards are currently asked to assure that research protocols approved by them are conducted regarding ethical knowledge. The logistics and practicalities of this mandate provide ways to minimize intrusiveness and maximize effectiveness. Research in the Intensive Care Unit not only tests current ethical theories, it also places specific and unique demands on researchers [89] and requires a level of critical thinking, and knowledge of ethics.

When studying outcome several ethical questions concern investigators: obtaining informed consent, the possibility of obtaining data from a family proxy as a surrogate of a patient that is not capable of answering questions and what is the accuracy of data obtained that way.

Even when the informed consent is obtained in the most optimal conditions for ICU research, its ethical value remains questionable. Obtaining data from members of the families is consistent with Chenaud C et al [90] that concluded in a recently published paper that patients are willing to decide on their own participation in a study, but if they

lose their capacity to decide for themselves they would agree to delegate the decision to a relative in the great majority of cases.

Contributing to the debate of how well relatives evaluate patients quality of life and give adequate response to questionnaires concerning quality of life, a study by Capuzzo M [91] concluded that the relatives give global scores which can be regarded as acceptable substitutes for those given by patients.

Limitations of the studies

The small sample size in some studies may have limited the ability to document real differences among subgroups of patients.

Because of the retrospective nature of some of the studies the therapeutic responses to the development of complications could not be ascertain.

The data were collected as part of the delivered clinical care. As a result, they reflect the electronic medical record, and no additional details are available.

Some of the outcomes selected – mortality, length of Post Anesthesia Care Unit stay, quality of life and dependency in Activities of Daily Living - may not necessarily capture all relevant consequences of postoperative complications and it was not known how frequent the development of important co morbidities was as a result of the complications studied.

The major limitation of studies about quality of life was the fact that the Short-Form-36 was not applied before surgery making impossible to compare quality of life of patients before and after surgery. Nevertheless, the Short-Form-36 question about self-reported changes in health status (“compared to one year ago, how would you rate your health in general, now?”) was used to make comparisons on the level of health in general.

Results and Conclusions

We aimed to assess outcome and study their determinants and predictors in patients admitted to Intensive Care Unit after surgery.
We have designed several studies to study postoperative surgical patients admitted to Intensive Care Unit to measure the impact of the surgical procedure and postoperative complications in outcome considered as mortality, length of stay, functional capacity and quality of life.

With our investigation we may better know the needs of survivors from intensive care after surgery. Concluding that major complications have serious impact in mortality, length of Intensive care stay and in quality of life may promote medical strategies in order to prevent their occurrence and to avoid their full impact whenever they happen to occur. We have evidence and are aware of the degree of dependency after critical care treatment in surgical patients. That may promote a better planning of postoperative period directed to patients knowing their needs for support and their vulnerabilities.

The study of strategies introduced in order to prevent complications may be studied in further investigations to ascertain that they are adequate in reducing mortality and dependency improving their quality of life.

Quality of life before surgical ICU admission

Fifty-two percent of patients had a normal quality of life before admission to the Surgical Intensive Care Unit and 13% had considered major deterioration to severe limitations of quality of life.

In surgical patients admitted to surgical Intensive Care Unit, measurement of quality of life before Intensive care admission correlate with the severity of illness, age and presence of comorbidities.

Patients with co-morbidities and those who died during Intensive Care Unit or hospital stay had worse scores in the Quality of Life Survey Scoring, measuring the quality of life before intensive care admission.

Quality of life after carotid endarterectomy

Mortality rate at 6 months follow-up was 6.3%.

Patients submitted to Carotid Endarterectomy had an improved self-perception of quality of life six months after surgery (63% reported having better general health) despite being more dependent in activities of daily living.

Six months after intensive care discharge, 65% of the patients were dependent in at least one activity in Instrumental Activities of Daily Living and 33% in at least one Personal Activity of Daily Living.

The scores of these patients were worse than those in an urban population in almost all of the Short-Form-36 domains.

Predictors of major postoperative cardiac complications in a surgical ICU

Seven percent of patients admitted to the surgical Intensive Care Unit, after all types and magnitudes of noncardiac surgery had Major Cardiac Events.

We could identify high-risk surgery, Revised Cardiac Risk Index, serum Troponin I and severity of disease scores as predictors of the occurrence of postoperative Major Cardiac Events.

Patients that develop postoperative Major Cardiac Events had a longer Intensive Care Unit stay (19.1± 19.3 days versus 3.4 ± 4.9, $p<0.001$) and a higher mortality rate (21.4% versus 4.6%, $p=0.02$).

Determinants of postoperative acute kidney injury

Using the interim consensus definition of Acute Kidney Injury we could predict meaningful clinical outcomes and were able to identify risk factors for the development of Acute Kidney Injury in patients requiring intensive care after surgery.

Acute Kidney Injury occurred in 7.5% of patients admitted to intensive care in postoperative period after major surgery.

In patients requiring intensive care after surgery, age, emergency and high risk surgery, ischemic heart disease, congestive heart disease, the American Society of Anesthesiologists physical status and the Revised Cardiac Risk Index score were considered risk factors for the development of Acute Kidney Injury.

Acute Kidney Injury had a serious impact on Post Anesthesia Care Unit length of stay (median in hours, 38 versus 25, $p<0.001$) and mortality (17% versus 8%, $p<0.001$ at Post Anesthesia Care Unit and 35.6% versus 9.5%, $p<0.001$, at 6 months follow-up).

Acute Kidney Injury was an independent risk factor for hospital mortality.

Outcome and quality of life of patients with acute kidney injury after major surgery

The unadjusted mortality rate at 6 months follow-up of patients with Acute Kidney Injury was 38%, nearly 4 times the mortality rate of those without Acute Kidney Injury (38% versus 10%, $p<0.001$).

Fifty-two percent of patients reported that their general level of health was better on the day they answered the questionnaire than 12 months earlier.

Six months after discharge from Intensive Care Unit, 78% of the patients were dependent in at least one activity in Instrumental Activities of Daily Living and 34% in at least one Personal Activity of Daily Living. At this time, patients that met Acute Kidney Injury criteria were more dependent in Instrumental Activities of Daily Living.

For physical function and role physical domains of Short-Form-36, they had worse scores compared with those for patients that did not develop Acute Kidney Injury in Post Anesthesia Care Unit.

Outcome and quality of life after Aorto-bifemoral bypass surgery

After Aorto-bifemoral Bypass surgery, the mortality rate was 12% at 6 months follow-up.

Congestive heart disease and severity of disease scores were considered risk factors for mortality.

Survivors who have been submitted to Aorto-bifemoral Bypass surgery, six months after Intensive Care discharge perceived an improved quality of life (64% reported having better general health) although they were more dependent in Activities of Daily Living tasks (Sixty-six percent and 23% of patients were dependent in at least one activity in instrumental and personal Activities of Daily Living, respectively).

After Aorto-bifemoral Bypass surgery patients had worse scores in almost all Short-Form-36 domains compared with scores obtained in the population to which they belong and had similar scores to other Post Anesthesia Care Unit patients.

Outcome after postoperative major cardiac events

In a two year period, 2% of patients admitted to the intensive care beds of the Post Anesthesia Care Unit developed Major Cardiac Events.

The development of Major Cardiac Events in the Post Anesthesia Care Unit there was a risk factor for mortality at hospital (23% versus 5%, $p>0.001$) and at 6 months follow-up (35% versus 13%, $p=0.003$); these patients stayed longer in the Post Anesthesia Care Unit 4.6 ± 3.6 versus 1.8 ± 2.1, $p<0.001$).

Thirty one percent of patients who survived after surgery showed subjective positive perception of Health Related Quality of life, six months after discharge from the Post Anesthesia Care Unit.

Patients who developed Major Cardiac Events had similar scores in all of the Short-Form-36 domains compared with other Post Anesthesia Care Unit patients.

Six months after Post Anesthesia Care Unit discharge, 69% and 15% of patients were dependent in at least one activity in instrumental and personal Activities of Daily Living, respectively.

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Abstract

In addition to mortality and length of stay, the study of quality of life has increasingly been claimed as an essential outcome after intensive care. It is important to understand quality of life in terms of specific Intensive Care Unit populations in order to assess the impact of specific interventions on these patients. Complications after surgery occurring in major systems, namely the cardiovascular and renal systems, may have a profound impact on outcome, may be viewed as risk factors for mortality and for a longer stay in the Intensive Care Unit and they may impose impairment in quality of life. Reasons for being admitted in Intensive Care Units are different among critical care patients and these differences are likely to result in different expectations regarding their health.

We aimed to assess outcome, and study their determinants and predictors in surgical patients admitted to an Intensive Care Unit.

In summary we found that preadmission quality of life correlates with age and severity of illness after Intensive Care Unit admission. Patients with co-morbidities and those who died during Intensive Care Unit or hospital stay had worse quality of life before admission to Intensive Care Unit. After surgery, patients submitted to Carotid Endarterectomy and Aorto-bifemoral Bypass surgery and those that developed Acute Kidney Injury have an improved self-perception of quality of life despite being more dependent in activities of daily living and almost all their Short-Form-36 scores in the different domains were worse than those in an urban population. The occurrence of postoperative Acute Kidney Injury or Major Cardiac Events has a marked effect on Intensive Care Unit length of stay and on mortality. Type of surgery, Revised Cardiac Risk Index, severity of disease scores and serum Troponin I were predictors of postoperative occurrence of Major Cardiac Events. Age, type and magnitude of surgery, ischemic heart disease, congestive heart disease, American Society of Anesthesiologists physical status and Revised Cardiac Risk Index were considered risk factors for the development of Acute Kidney Injury, in patients requiring intensive care after surgery. Acute Kidney Injury was an independent risk factor for hospital mortality.

Resumo

Para além da mortalidade, e do tempo de estadia, o estudo da qualidade de vida tem sido cada vez mais reconhecido como um resultado essencial após internamento em cuidados intensivos. É importante compreender a qualidade de vida em termos de populações específicas em cuidados intensivos, para poder avaliar o impacto de intervenções específicas sobre estes doentes. As complicações após a cirurgia, ocorrendo nos principais órgãos e sistemas, nomeadamente o cardiovascular e renal, podem ter um impacto profundo nos resultados e alguns podem ser vistos como fatores de risco de mortalidade e de maior tempo de internamento em cuidados intensivos mas também podem impor um agravamento da qualidade de vida.

Existem várias razões para admissão em cuidados intensivos entre os doentes críticos e essas diferenças provavelmente resultam em diferentes expectativas em relação ao seu estado de saúde.

Os nossos objetivos foram a avaliação dos resultados e o estudo dos seus determinantes e preditores em doentes cirúrgicos admitidos em cuidados intensivos.

A qualidade de vida antes da admissão nos cuidados intensivos correlacionou-se com a idade e a gravidade da doença após a admissão. Os doentes com comorbilidades e aqueles que morreram durante a estadia na unidade de cuidados intensivos ou no hospital tinham pior qualidade de vida antes da admissão em Cuidados Intensivos. Os doentes submetidos a endarterectomia carotídea e a bypass aorto bifemoral e aqueles que desenvolveram Lesão Renal Aguda no pós-operatório melhoraram a sua perceção da qualidade de vida, apesar de ficarem mais dependentes após a cirurgia e de quase todas as suas pontuações, nos diferentes domínios do Short-Form-36, serem piores do que as pontuações obtidas por uma população urbana. A ocorrência de Eventos Cardíacos Graves ou de Lesão Renal Aguda após a cirurgia teve um efeito importante sobre o tempo de duração da estadia nos cuidados intensivos e sobre a mortalidade. O tipo de cirurgia, o Revised Cardiac Risk Index, a gravidade da doença e os valores séricos de Troponina I foram preditores da ocorrência pós-operatória de eventos cardíacos graves. Em doentes que necessitaram de cuidados intensivos após a cirurgia, a idade, o tipo e a magnitude da cirurgia, doença cardíaca congestiva, doença cardíaca isquémica, o estado físico da American Society of Anestesthesiologists e a pontuação de Revised Cardiac Risk Index foram considerados fatores de risco para o desenvolvimento de Lesão Renal Aguda. A Lesão Renal Aguda foi um fator de risco independente para mortalidade hospitalar.