Rev Bras Anestesiol
2010; 60: 6: 593-602

Influence of Central Venous Oxygen Saturation on In-hospital Mortality of Surgical Patients

João Manoel Silva Junior, TSA [1], Amanda Maria Ribas Rosa Oliveira [2], Sandra Zucchi de Morais [3], Luciana Sales de Araújo [3], Luiz Gustavo F Victoria, TSA [4], Lauro Yoiti Marubayashi [5]

Summary: Silva Junior JM, Oliveira AMRR, Morais SZ, Araújo LS, Victoria LGF, Marubayashi LY – Influence of Central Venous Oxygen Saturation on In-hospital Mortality of Surgical Patients.

Background and objectives: Low central venous oxygen saturation ($ScvO_2$) indicates an imbalance between cellular oxygen supply and consumption and, consequently, worse prognosis for critical patients. However, it is not clear what the value of this marker in surgical patients. The objective of the present study was to evaluate whether low perioperative $ScvO_2$ determines a worse prognosis.

Methods: This is a 6-month observational study carried on in a tertiary hospital. Patients who needed to be in the intensive care unit (ICU) postoperatively, with age ≥ 18 years, who underwent large surgeries, were included. Patients who underwent palliative surgeries and those with severe heart failure were excluded. Levels of $ScvO_2$ were measured before the surgery, during the procedure, and after the surgery in the ICU.

Results: Sixty-six patients were included in this study, but 25.8% of them did not survive. Mean $ScvO_2$ levels were higher intraoperatively, 84.7 ± 8.3%, than preoperatively and in the ICU, 74.1 ± 7.6% and 76.0 ± 10.5% (p = 0.0001), respectively. However, only preoperative $SvcO_2$ levels of non-surviving patients were significantly lower than those who survived. By logistic regression, preoperative $ScvO_2$, OR = 0.85 (95% CI 0.74-0.98) (p = 0.02), was an independent factor of in-hospital mortality. Patients with preoperative $ScvO_2$ < 70% had greater need of intraoperative blood transfusion (80.0% versus 37.0%, p = 0.001) and volume replacement, 8,000.0 (6,500.0-9,225.0) mL versus 6,000.0 (4,500.0-8,500.0) mL (p = 0.04), with greater chances of postoperative complications (75% versus 45.7%, p = 0.02) and longer time in the ICU, 4.0 (20.0-5.0) days versus 3.0 (1.7-4.0) days (p = 0.02).

Conclusions: Intraoperative $ScvO_2$ levels are higher than those both in the pre- and postoperative period. However, low preoperative $ScvO_2$ determines worse prognosis.

Keywords: COMPLICATIONS: mortality; OXYGEN: consumption, blood levels; RISK: factors.

[Rev Bras Anestesiol 2010;60(6): 593-602]

INTRODUCTION

It is estimated that 234 million large surgeries are performed each year [1]. Complications after large surgeries represent causes of morbidity and mortality. High risk surgical patients represent 15% of all procedures, but more than 80% of deaths [2,3].

The data confirms that unfavorable outcomes after high risk surgeries represent a global problem [4-6]. Even in patients who survive hospitalization, complications remain an important determinant of a short survival time [6]. Therefore, it is essential to look for tools to improve the outcome of patients undergoing large surgeries.

Several reports indicate that poor outcomes after large surgeries are strongly associated with imbalances in oxygen delivery related to hindered microvascular flow [7,8]. The use of fluids and inotropic drugs increases the oxygen delivery and it can reduce the incidence of complications [9,10].

Several studies in the literature describe changes in perioperative central ($ScvO_2$) and mixed (SvO_2) oxygen saturation[11] and in patients with severe sepsis [12], which have led to the use of venous saturation as a therapeutic target in surgical patients. However, the complex physiology of venous oxygen saturation in surgical patients is poorly understood. Detailed understanding of those principles is essential for the safety and effective application of $ScvO_2$ in clinical practice. Recently, two studies [13,14] with surgical patients demonstrated the impact of low intraoperative venous saturation on complications, but not on mortality.

The objective of this study was to evaluate intraoperative $ScvO_2$ as risk factor for complications and death in surgical patients admitted to the ICU.

METHODS

After approval by the Ethics and Research Commission, this study was carried on in a tertiary hospital. This is an observational study whose inclusion criteria were patients ages ≥ 18 years who underwent surgeries, needed intraoperative central venous catheter, and required postoperative admission to the ICU.

Received from the CET/SBA of Hospital do Servidor Público Estadual (HSPE), SP, Brazil.

1. Anesthesiologist, Coordinator of the Surgical Critical Care Unit, Coresponsible for the CET/SBA of HSPE; Physician in Charge of the Scientific Area of the Critical Care Unit of HSPE
2. Critical Care Physician, Intensive Care Unit of HSPE
3. Resident of HSPE
4. Anesthesiologist, Physician in Charge of the Anesthesiology Residency Program of HSPE
5. Anesthesiologist, Director of the Cooperativa Médica de Anestesiologistas de São Paulo of HSPE

Submitted on April 18, 2010.
Approved on June 28, 2010.

Correspondence to:
Dr. João Manoel Silva Júnior
Rua Pedro de Toledo, 1800 - 6º andar
Vila Clementino
04039-901 – São Paulo, SP
E-mail: joao.s@globo.com

Patients who underwent palliative surgeries, with low life expectancy, liver failure (Child B or C), functional class IV heart failure or ejection fraction lower than 30% on echocardiogram, and those who did not agree to participate were excluded.

The primary outcome of this study was hospital mortality according to venous saturation. Thus, every patient was followed-up until hospital discharge. The secondary outcome was the evaluation of intraoperative complications, such as the intraoperative need of blood transfusion, volume replacement, and vasopressors and, postoperatively, the presence of organ dysfunction, shock (need of vasoactive drugs for over one hour despite volume resuscitation), worse pulmonary exchange (PaO_2/FiO_2 ratio < 200), renal failure (increase of 50% in creatinine or urine output lower than 400 mL in 24 hours), mental confusion (change in behavior, forgetfulness, or psychomotor agitation), and platelet dysfunction (fall of 30% from baseline levels) up to 24 hours postoperatively. Besides, factors such as infection during the stay in the ICU, length of stay in the ICU, and length of hospitalization were also evaluated.

Initially, patients were divided into two groups: survivors (Group 1) and non-survivors (Group 2). Considering prior studies with $ScvO_2$, the percentage of 70% was adopted as a cutting point to evaluate intra- and postoperative complications.

Intraoperative treatment was determined by the surgical team. Postoperatively, the goal of the intensive care physician was to improve perfusion parameters and he had no knowledge which group the patient belonged to.

At the time of inclusion the scores of the Multiple-Organ Dysfunction Syndrome (MODS) [15], Acute Physiology and Chronic Health Evaluation (APACHE II) [16], and Physiologic and Operative Severity Score for the enUmeration of Mortality and morbidity (POSSUM)[17] were also evaluated using the worse values of the variables of those scores. Besides, before beginning the surgery, after anesthetic induction, at 3 hours of the procedure, upon admission to the ICU, and after 6 postoperative hours arterial and venous blood gases were collected. The central venous catheter was placed at the right atrial outlet, which was confirmed by a chest X-ray.

Initially, demographic, clinical, and physiologic characteristics of the patients are described. For the description of categorical variables, the frequencies were calculated. Quantitative variables were described by using central tendency and dispersion measurements.

The choice of the statistical method used in the evaluation of each variable was based on its distribution pattern. Categorical variables were analyzed by the Chi-square test, and continuous variables by the mean with the Student t test, for normal distribution, and continuous variables with irregular distribution were analyzed by the Mann-Whitney test. Values of $p < 0.05$ (bicaudal) were considered significant. The SPSS 13.0 was used in the analysis of those calculations. Initially, patients in Group 1 were compared to those in Group 2. Afterwards, secondary outcomes were compared starting at a value of $ScvO_2$ equal to 70%, according to prior studies in the literature [12,10].

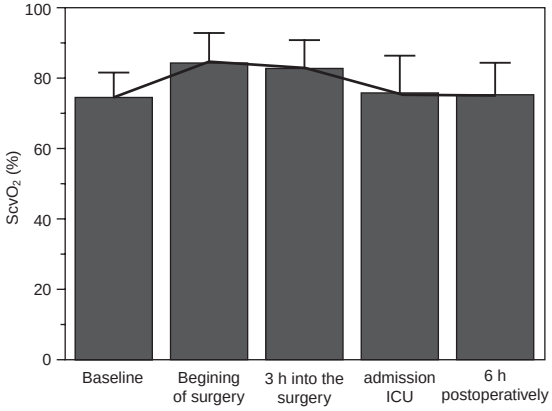
Logistic analysis through stepwise analysis was also done to identify independent risk factors and to control confounding effects (mutually adjusted variables). Variables that presented significant probability (p value) lower than 0.05 in the univariate analysis were considered candidates for the multiple regression model.

RESULTS

From January 1, 2009 to July 1, 2009, 66 patients – 37 males and 29 females – with a mean age of 65.6 years were included in this study. Elective surgeries predominated; they were: gastrointestinal (78.8%), vascular (7.6%), thoracic (4.5%), orthopedic (3.0%), neurologic (3.0%), gynecologic (1.5%), and urologic (1.5%) (Table I).

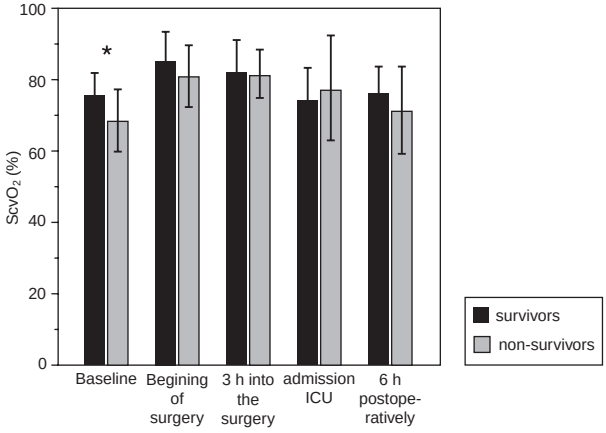
At the time of surgery, 40% of the patients received blood transfusions, 32.5% vasoactive drugs, and an incidence of 54.5% of postoperative complications was observed, of which shock was the most prevalent (45.5%), followed by renal failure (19.7%), platelet dysfunction (19.7%), infection (6.7%), worse oxygenation (10.6%), and confusion (7.6%) (Table II).

Mean $ScvO_2$ values of all patients were higher intraoperatively (84.7 ± 8.3%) than preoperatively and in the ICU (74.1 ± 7.6% and 76.0 ± 8.3% [p = 0.0001], respectively). However, when survivors and non-survivors were compared, only preoperative levels of $ScvO_2$ of non-survivors were significantly lower than those of survivors (Figures 1 and 2).



Bars represent means with standard deviation.

Figure 1 – Mean Postoperative $ScvO_2$ Levels.



Mean levels of $ScvO_2$ and comparison among survivors and non-survivors, *p = 0.001.

Figure 2 – Comparison of $ScvO_2$ in Survivors and Non-survivors.