CARDIOVASCULAR

Relation of the Sequential Organ Failure Assessment Score to Morbidity and Mortality After Cardiac Surgery

Tommi Pätilä, MD, Sinikka Kukkonen, MD, PhD, Antti Vento, MD, PhD, Ville Pettilä, MD, PhD, and Raili Suojaranta-Ylinen, MD, PhD

Departments of Cardiothoracic Surgery and Anesthesiology and Intensive Care Medicine, Helsinki University Meilahti Hospital, Helsinki, Finland

Background. **Organ dysfunction evaluation using Sequential Organ Failure Assessment (SOFA) has been shown to predict mortality and morbidity in adult cardiac surgical patients with prolonged recovery. The purpose of this study was to evaluate the utility of SOFA in prediction of mortality and morbidity in a cohort of heterogeneous consecutive adult cardiac surgical patients.**

Methods. **A prospective study of 857 consecutive patients entering in a single cardiac postoperative intensive care unit was assigned during the year 2004. The European System for Cardiac Operative Risk Evaluation (EuroSCORE) of each patient was assessed preoperatively. SOFA was calculated daily until intensive care unit discharge or for a maximum of 7 days. SOFA change between the first and the third postoperative day, maximum SOFA during the first 3 days, and maximal SOFA were calculated. Length of intensive care unit stay and 30-day mortality were assessed.**

Results. **Maximum SOFA during the first 3 days and maximal SOFA-predicted 30-day mortality (area under the curve, 0.763 and 0.779, respectively) also correlated with the length of intensive care unit stay ($p < 0.001$ and $p < 0.001$, respectively). The EuroSCORE predicted both mortality and intensive care unit stay ($p < 0.0001$ and $p < 0.0001$). The correlation coefficient between the EuroSCORE and maximum SOFA during the first 3 days or maximal SOFA was low ($r = 0.34$ and 0.33, respectively, $p < 0.0001$ and $p = 0.0001$).**

Conclusions. **The SOFA score is an independent predictor of mortality and length of stay in cardiac surgical patients. The SOFA score is associated with mortality and morbidity even when assessed in the early postoperative period after adult cardiac surgery.**

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Postoperative scoring of cardiac surgical patients in the intensive care unit (ICU) is necessary for the measurement of morbidity. The measurement of morbidity is more sensitive than mortality in the evaluation of new treatment modalities, cost/benefit, or the quality and management of the ICU. It also holds possibilities for the comparison of results of institutions or surgeons. Risk-adjusted morbidity differences between surgeons' performances might differ much more than mortality rates and also have economic aspects.

When preoperative risk algorithms are widely used and accepted in the practice of cardiac surgery, postoperative scoring would give another time point for patient evaluation, if assessed as an aid for clinical decision-making. After the operation, certain factors affecting the patient might be downgraded and new issues raised. The question to be asked at this time might be whether to continue ICU care. Many of the available ICU outcome prediction models ignore changes in patient status [1–3], which is the strength of the Sequential Organ Failure Assessment (SOFA) scoring system.

The SOFA system was created in a consensus meeting of the European Society of Intensive Care Medicine in 1994 and further revised in 1996. The SOFA is a six-organ dysfunction/failure score measuring multiple organ failure daily. Each organ is graded from 0 (normal) to 4 (the most abnormal), providing a daily score of 0 to 24 points (Table 1). The objective in the development of the SOFA was to create a simple, reliable, and continuous score easily obtained in every institution [4].

Although SOFA was developed primarily to describe and quantify organ function, it has been demonstrated in several studies to predict mortality and morbidity of critically ill patients [5–9]. Reports on the SOFA scoring system in cardiac surgical patient population have been sparse. The study by Ceriani and colleagues [10] included patients with an ICU stay of 4 days or more. SOFA scores of adult cardiac surgical population with uneventful recovery have not been published [10–12].

A lack of well validated, widely accepted postoperative ICU outcome prediction score for cardiac surgical patients is evident. Our aim was to examine the utility of the SOFA scoring system in the postoperative evaluation of

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Address correspondence to Dr Pätilä, Department of Cardiothoracic Surgery, University of Helsinki Meilahti Hospital, PO Box 340, FIN-00029 HUS, Helsinki, Finland; e-mail: tommi.patila@hus.fi.

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Table 1. The Sequential Organ Failure Assessment (SOFA) Score

	SOFA Score				
	0	1	2	3	4
Respiration					
Pao_2/Fio_2	>400	≤400	≤300	≤200[a]	≤100[a]
Coagulation					
Platelets × $10^3/\mu L$	>150	≤150	≤100	≤50	≤20
Liver Bilirubin mg/dL (μmol/L)	<1.2 (20–32)	1.2–1.9 (20–32)	2.0–5.9 (33–101)	6.0–11.9 (102–204)	>12.0 (>204)
Cardiovascular[b]					
Hypotension	No hypotension	MAP <70 mm Hg	Dop ≤5, or dob any dose[c]	Dop >5, epi ≤0.1, or norepi ≤0.1[c]	Dop >15, epi >0.1, or norepi >0.1[c]
Central nervous system					
Glasgow Coma Scale	15	13–14	10–12	6–9	<6
Renal creatinine mg/dL (μmol/L) or urine output mL/d	<1.2 (<110)	1.2–1.9 (110–170)	2.0–3.4 (171–299)	3.5–4.9 (300–440) or <500	>5 (>440) <200

[a] Values are with respiratory support. [b] Adrenergic agents administered for at least 1 h. [c] Dosages are in μg/(kg · min).

dop = dopamine; epi = epinefrine; MAP = mean arterial pressure; norepi = norepinefrine.

cardiac surgical patients. We calculated associated European System for Cardiac Operative Risk Evaluation (EuroSCORE) values in the same population to enable comparison with the SOFA scores. The EuroSCORE has been well documented to predict morbidity and mortality after cardiac surgery in Europe and in North America [13–17]. We also evaluated the association of postoperative SOFA with preoperative EuroSCORE and sought to determine whether this later assessment would have impact in the prediction of morbidity and mortality.

Material and Methods

Study Population

Between January 1, 2004 and December 31, 2004, 902 patients underwent cardiac surgery or surgery of the great intrathoracic vessels in the University of Helsinki Meilahti Hospital. The study included all of the 855 cardiac surgical patients admitted in the 14-bed postcardiac surgery ICU. Excluded were transplantation patients and patients transferred into other ICUs after operation. From the postcardiac surgery ICU, patients were transferred directly to the surgical ward; no intermediate care unit was available. Approval for the study was given by the local ethics committee, which waived the need for informed consent.

Data Collection and Measurements

EuroSCORE data of each patient were collected preoperatively. Risk factors included in the EuroSCORE model were age, female gender, chronic pulmonary disease, extracardiac arteriopathy, neurologic dysfunction, previous cardiac surgery, increased serum creatinine level, active endocarditis, critical preoperative state, unstable angina, decreased left ventricular function, recent myocardial infarction, pulmonary hypertension, emergent surgery, cardiac operation other than isolated coronary artery bypass grafting, surgery on the thoracic aorta, and postinfarct septal rupture [13]. Patients' demographic, laboratory, and clinical data were collected in the ICU.

The SOFA score (Table 1) was calculated every 24 hours until discharge or for a maximum of 7 days. In the calculation of the score, the worst values for a given day for each variable were included. The assumed Glasgow Coma Score values were used in sedated patients until proven otherwise. A value of 3 was used for the renal score in patients with continuous venovenous hemofiltration started in an indication of relatively low urine output and massive fluid load.

The maximum SOFA (maxSOFA) score was determined as the highest SOFA value during the ICU stay, Δ-SOFA31 was calculated by subtracting lowest SOFA value from highest SOFA value during the first 3 days. Patients discharged from the ICU before day 3 were included in the Δ-SOFA31 calculations. MaxSOFA3d was

Table 2. Surgical Procedures

Procedure	N
CABG	407
CABG (off-pump)	117
AVR	81
MV procedure	49
Composite graft	35
Rec thoracic aorta	27
CABG + AVR	70
CABG + MV procedure	19
Double valve procedure	13
Tricuspidal valve procedure	7
Others	30
Total	855

AVR = aortic valve replacement; CABG = Coronary bypass surgery; MV = mitral valve.