

In-hospital Mortality and Low Cardiac Output Syndrome are Similar

After Morning and Afternoon Cardiac Surgeries:

A Retrospective Cohort Study

Supplemental Digital Content

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eTable 1: Sources and definitions of patient and surgical variable and outcomes

Data sources for the variables listed below included: 1) the Society of Thoracic Surgeons (STS) database using version 2.9 definitions (click the following hyperlink for variable definitions: https://www.sts.org/sites/default/files/documents/ACSD_DataSpecificationsV2_9.pdf; 2) Patient electronic medical record; or 3) Cleveland Clinic Perioperative Health Documentation System (PHDS), an institutional perioperative database that captures anesthesia and surgical variables.

Variable	Source
Exclusion criteria	
End-stage renal disease requiring renal replacement therapy	STS version 2.9*
Elevated baseline troponin T	STS version 2.9*
Myocardial infarction within 7 days	STS version 2.9*
Aortic cross-clamp time before 8 AM or after 5 PM	
Emergent surgery	STS version 2.9*
Heart or lung transplantation	STS version 2.9*
Preoperative cardiogenic shock	STS version 2.9* (Indicate if the patient developed cardiogenic shock. Cardiogenic shock is defined as a sustained (>30 min) episode of hypoperfusion evidenced by systolic blood pressure <90 mm Hg and/or, if available, cardiac index <2.2 L/min per square meter determined to be secondary to cardiac dysfunction and/or the requirement for parenteral inotropic or vasopressor agents or mechanical support (e.g., IABP, extracorporeal circulation, VADs) to maintain blood pressure and cardiac index above those specified levels. Note: Transient episodes of hypotension reversed with IV fluid or atropine do not constitute cardiogenic shock. The hemodynamic compromise (with or without extraordinary supportive therapy) must persist for at least 30 min.
Planned ventricular assist device	STS version 2.9*
Demographics	

Age, years	STS version 2.9*
Female	STS version 2.9*
Body mass index (Kg/m²)	STS version 2.9*
Medical History	
Hypertension	STS version 2.9*
Atrial fibrillation or flutter	STS version 2.9*
Coronary artery disease	Medical record: ICD9 Code 414.01
Left Ventricular Dysfunction	
- Normal	STS version 2.9*
- Mild	STS version 2.9*
- Moderate	STS version 2.9*
- Moderate-severe	STS version 2.9*
- Severe	STS version 2.9*
Myocardial infarction	STS version 2.9*
Pulmonary hypertension	Medical record: ICD9 code 416.0
Chronic obstructive pulmonary disease	Elixhauser comorbidity category
Moderate or severe mitral insufficiency	STS version 2.9*
Carotid artery stenosis	STS version 2.9*
Peripheral vascular disease	STS version 2.9*
Diabetes mellitus	STS version 2.9*
Cerebral vascular accident	STS version 2.9*
Preoperative medication	
Aspirin	Electronic medical chart review of preoperative medications using search terms for generic and brand name aspirin
Beta-adrenergic blocking agents	Electronic medical chart review of preoperative medications using search terms for generic and brand name beta-adrenergic blocking agents
Angiotensin Converting Enzyme Inhibitor (ACEI)/Angiotensin Receptor Blocker (ARB)	Electronic medical chart review of preoperative medications using search terms for generic and brand name ACEI and ARB
Statins	Electronic medical chart review of preoperative medications using search terms for generic and brand name statin medications

Diuretics	Electronic medical chart review of preoperative medications using search terms for generic and brand name diuretic medications
Preoperative laboratory measurements	
Hematocrit (%)	STS version 2.9*
Creatinine (mg/dL)	STS version 2.9*
Glucose (mg/dL)	PHDS. Preoperative serum glucose value closest to surgery, but before entrance to operating room
Surgical characteristics	
Year of surgery	PHDS. Anesthesia record for surgery date
Duration of surgery, min	STS version 2.9*
Cardiopulmonary bypass time, min	STS version 2.9*
Aortic cross-clamp time, min	STS version 2.9*
Surgical approach	STS version 2.9*
Median Sternotomy	STS version 2.9*
Mini Sternotomy	STS version 2.9*
Robot-assisted thoracoscopy	STS version 2.9*
Thoracotomy	STS version 2.9*
Reoperative surgery	Electronic medical record using search terms for reoperation, redo, reoperative surgery in preoperative notes
Surgical procedure	
Aortic Valve Replacement	STS version 2.9*
Aortic Valve Replacement + Ascending Aorta Replacement	STS version 2.9*
Aortic Valve Replacement + Coronary Artery Bypass Grafting	STS version 2.9*
Aortic Valve Replacement + Coronary Artery Bypass Grafting + Other	STS version 2.9*
Aortic Valve Replacement + Mitral Valve Replacement/ Repair	STS version 2.9*
Coronary Artery Bypass Grafting	STS version 2.9*
Coronary Artery Bypass Grafting + Mitral Valve Repair	STS version 2.9*
Coronary Artery Bypass Grafting + Mitral Valve Replacement	STS version 2.9*

Mitral Valve Repair	STS version 2.9*
Mitral Valve Replacement	STS version 2.9*
Composite Outcome	
In-hospital mortality	STS version 2.9*
Low cardiac output syndrome (required one or both conditions listed below)	
≥2 inotropic agents at 24-48 hours postoperatively	Use of epinephrine, milrinone, dobutamine, or dopamine (rate ≥ 5 mcg/kg/min) from patient's electronic medical record: Medication administration record (MAR)
Mechanical circulatory support	STS version 2.9*

* for definitions of variables from the Society of Thoracic Surgeons (STS) database (version 2.9), please click the hyperlink below:
https://www.sts.org/sites/default/files/documents/ACSD_DataSpecificationsV2_9.pdf

eTable 2: Perioperative profile of patients who fulfill criteria for Low Cardiac Output Syndrome (N = 263)

	Missing	Summary
Intraoperative Pulmonary Catheter Use		220 (84)
Required 2 or more inotropic agents at end of surgery		263 (100)
Cardiac Index < 2.0 L/min/m ²		
- Intraoperatively	15	181 (73)
- First 6 hours in ICU	169	37 (39)
- During either period	13	190 (76)
Left Ventricular Dysfunction post-cardiopulmonary bypass*	32	135 (58)
Right Ventricular Dysfunction post-cardiopulmonary bypass*	32	154 (67)
RV and/or LV Dysfunction post-cardiopulmonary bypass*	31	188 (81)
RV and/or LV Dysfunction documented in medical record	20	197 (81)
Cardiac Index < 2.0 and/or RV/LV dysfunction		254 (97)
Intraaortic balloon pump use		84 (32)
<i>One or more indicators of cardiac insufficiency/dysfunction/failure/shock[#]</i>		263 (100)

Variables were summarized as N (%)

*Left and right ventricular function was assessed by transesophageal echocardiography post-cardiopulmonary bypass (CPB).

[#]Indicators of cardiac insufficiency/dysfunction/failure/shock include include the requirement for 2 or more inotropic agents and/or need for intraaortic balloon pump with one or more of the following: (i) Cardiac index < 2.0 L/min/m² measured by hemodilution using a pulmonary artery catheter post-CPB or immediately postoperatively, (ii) Left/Right Ventricular dysfunction post-CPB documented by the intraoperative/postoperative echocardiography or medical records, (iii) need for IABP support for cardiac insufficiency/failure, (iv) documentation of postoperative cardiac insufficiency/shock in intensive care unit.

eTable 3: Incidence of the Primary Outcome, a composite of mortality and/or low cardiac output syndrome, by Surgery Start Time.

Surgery Start Time	N	Mortality	Low Cardiac Output Syndrome	Mortality/ Low Cardiac Output Syndrome	Adjusted Odds Ratio (95% CI)	P-Value
6:00 am – 7:29 am	6696	41(0.6)	213(3)	237(4)	Reference	-
7:30 am – 8:29 am	2712	29(1)	112(4)	126(5)	1.20 (0.94, 1.54)	0.151
8:30 am – 9:29 am	236	1(0.4)	13(6)	13(5)	1.08 (0.57, 2.06)	0.812
9:30 am – 10:29 am	142	0(0)	11(8)	11(8)	1.95 (0.95, 3.98)	0.069
10:30 am – 11:29 am	265	3(1)	9(3)	11(4)	1.69 (0.87, 3.27)	0.120
11:30 am – 12:29 pm	936	7(1)	19(2)	22(2)	0.81 (0.50, 1.30)	0.377
12:30 pm – 1:29 pm	1246	4(0.3)	35(3)	37(3)	1.17 (0.80, 1.73)	0.418
1:30 pm – 2:29 pm	760	5(1)	24(3)	27(4)	1.51 (0.96, 2.35)	0.072
2:30 pm – 3:29 pm	306	0(0)	9(3)	9(3)	1.35 (0.64, 2.83)	0.428
3:30 pm – 5:00 pm	45	0(0)	1(2)	1(2)	0.82 (0.10, 6.69)	0.855

Surgery start time are partitioned at half-hour post every full hour, as the first natural wave of surgery started between 6:30 – 7:30.

Incidence is summarized as N (%).

eTable 4: Summary of Postoperative Outcomes as described by the Society of Thoracic Surgeons at <https://pubmed.ncbi.nlm.nih.gov/12822628/>

Postoperative Outcomes	Morning (N = 6859)	Afternoon (N = 2875)	Adjusted Odds Ratio (95% CI)	P-value
Stroke	100 (1.5)	30 (1.0)	1.48 (0.98, 2.24)	0.062
Renal Failure*	45 (0.7)	14 (0.5)	1.39 (0.77, 2.5)	0.270
Prolonged Ventilation (>48 hours)	320 (4.7)	183 (6.4)	0.82 (0.68, 0.99)	0.036
Deep Sternal Wound Infection	2 (0.0)	1 (0.0)	1.54 (0.11, 21.63)	0.750
Reoperation (any cardiac surgery)	144 (2.1)	67 (2.3)	0.92 (0.69, 1.23)	0.575

Incidence was summarized as N (%)

Odds Ratio were calculated for morning vs. afternoon.

*Renal failure is defined as acute postoperative renal insufficiency resulting in one or more of the following: an increase of serum creatinine to more than 2.0; 50% or greater increase in creatinine over base line preoperative value; a new requirement for dialysis