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Are nonemergent cardiac operations performed during off-time associated with worse outcome?

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ABSTRACT

Background: With the implementation of value-based health care, it is of increasing interest to understand whether performing elective surgeries during off-time impacts surgical outcomes. The objective of this study was to evaluate the impact of start times on nonemergent cardiac operations.

Methods: The institutional Society of Thoracic Surgeons was used to identify all adult nonemergent cardiac operations performed between January 2008 and December 2015 at our institution. "*Off-time*" is defined as either operation "late starts," that is, an incision time after 3 PM and before 7 AM, or procedures occurring during the weekends. Univariate and multivariate logistic regression analyses were performed to examine its impact on in-hospital mortality and major adverse events. Available cost data were directly obtained from the departmental BIOME database.

Results: Of the 3406 cardiac operations included in the study, 2933 (86.1%) were *normal-start* and 473 (13.9%) were *off-time-start* operations. After adjusting for patient and operative characteristics, late operating room start times were not associated with increased in-hospital mortality ($P = 0.28$, confidence interval [CI] 95% = 0.99-1.03), readmissions ($P = 0.21$, CI 95% = 0.99-1.07), or major adverse events ($P = 0.07$, CI 95% = 1.00-1.12). In addition, there was no significant impact on total hospital cost (9.0% increase, $P = 0.07$).

Conclusions: These findings suggest that late operating room start times are not associated with increased mortality or other complications in a tertiary-care academic medical center. Our findings should be considered during operative scheduling to optimize resource distribution and patient care strategies.

Introduction

The "*after-hours*" effect is a well-documented phenomenon that impacts both medical and surgical specialties. On an institutional level, patient handoffs, differences in expertise of hospital staff, and resource deficits in nonbusiness hours ("*off-hours*") can lead to gaps in patient care[1-3] In addition, physiologic limitations such as disturbances in circadian rhythm, physician fatigue, and diurnal variation of technical skills can lead to lapses in medical judgment.[1] Indeed, cardiac

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arrests and myocardial infarctions that occur during *off-hours* have been associated with lower odds of survival to discharge.[2-5] Operations in colorectal, obstetrics, and orthopedics services have similarly been associated with higher risk of mortality and complications during *off-hours*,[3,6-8] an effect not observed in acute surgical services such as transplantation or trauma.[9-11]

Cardiac surgery is resource intensive and requires coordination between multiple teams, making it especially vulnerable to the "*after-hours*" effect. Few have examined the timing of operations and effects of after-hours care in cardiac surgery, with conflicting results. A recent report by Yount *et al.* found significantly worse clinical outcomes and costs with cardiac operations performed during off-hours.[12] However, a study by Tan *et al.* showed equivalent outcomes with operations beginning late in the day and advocated elimination of start time as a potential risk factor for worse outcomes.[14] Therefore, the present study was performed to evaluate whether "*off-hours*" start of nonemergent cardiac operations is associated with inferior outcomes and increased costs. We hypothesized that later start times would be associated with higher rates of mortality and complications.

Methods

Our institution's prospectively maintained Society of Thoracic Surgeons (STS) database was used to identify all adults who underwent cardiac surgery between January 2008 and December 2015. Patients were enrolled in the study through approved waiver of consent. Emergent procedures were defined by their STS status of emergent (patients requiring operative intervention without delay) and emergent salvage (patients requiring cardiopulmonary resuscitation or extracorporeal membrane oxygenation [ECMO] en route to the operating room), whereas nonemergent procedures were defined by STS status of elective (stable days or weeks before surgery) or urgent (operation required during same hospitalization but not immediately). Patients who had emergent or transplant procedures were excluded. Baseline demographics included age, gender, body mass index, preoperative hematocrit, serum creatinine, and left ventricular ejection fraction, among others (Table 1). Collected intraoperative variables included type of operation (valvular, coronary artery bypass graft [CABG], other cardiac, and other noncardiac procedures), operation start time defined as time of skin incision, cardiopulmonary bypass (CPB) times, aortic cross-clamp times, and length of operation defined as the time elapsed between initial skin incision and skin closure. Other cardiac procedures included operations such as ablation for atrial fibrillation, resection of cardiac tumors, aneurysm repair, and so forth. Other noncardiac procedures involved operations such as pulmonary, vascular, or other thoracic procedures not considered the primary cardiac procedure. Postoperative outcomes included the occurrence of major adverse events (MAEs—defined as prolonged respiratory support, postoperative atrial fibrillation, stroke or transient ischemic attack, myocardial infarction, renal failure, surgical site infection, sepsis, and reoperations), hospital length of stay, 30-d readmission, in-hospital mortality, and use of intraoperative or postoperative ECMO or intra-aortic balloon pump. Patient data, including demographics, cardiovascular risk factors, preoperative cardiac status, perioperative data, and postoperative events as defined by STS,[13] were retrieved electronically from the institutional database and supplemented with the hospital's electronic health records.

For the purposes of this study, "*normal-start*" operations were defined as skin incision after 7 AM and before 3 PM on weekdays, whereas "*off-time-start*" operations were defined as skin incision after 3 PM and before 7 AM or procedures occurring anytime during weekends. Univariate and multivariate logistic regressions were performed to examine its impact on hospital mortality and MAEs. Available financial data were obtained from the institutional Biome database and reported in this study as ratios due to institutional policies.

All statistical analysis was performed on R, version 3.2.1 (R Core Team, Vienna, Austraia; 2016). The Student's *t*-test and

Table 1 – Patient demographics and clinical outcomes.

Preoperative characteristics	Off-time start ($n = 473$)	Normal start ($n = 2933$)	*P* value
Age, y	64.3	63.6	0.35
Male, %	63.7	65.3	0.50
BMI, kg/m^2	27.1	27.3	0.76
Hypertension, %	67.0	64.4	0.28
Diabetes, %	33.6	26.2	<0.01
Dyslipidemia, %	54.8	53.7	0.68
Dialysis, %	8.2	6.0	0.10
Liver disease, %	2.3	2.0	0.67
Chronic lung disease, %	15.2	8.0	<0.01
Hematocrit, %	35.8	36.8	<0.01
Creatinine, mg/dL	1.4	1.3	0.05
Ejection fraction, %	50.1	53.8	<0.01

BMI = body mass index.

Table 2 – Operative variables.

Variables	Off-time start ($n = 473$)	Normal start ($n = 2933$)	*P* value
Procedure type			
Valve repair/replacement, %	44.8	55.4	<0.01
CABG, %	38.2	41.5	0.19
Other cardiac, %	33.8	38.9	0.03
Other noncardiac, %	12.2	8.6	0.02
Operative characteristics			
Cardiopulmonary bypass time, min	148.4	162.5	<0.01
Aortic cross-clamp time, min	108.3	120.0	<0.01
Length of operation, min	325.7	346.1	0.45
ECMO, %	0.6	0.2	0.18
IABP, %	1.5	1.6	0.79