Coronary Artery Bypass Graft Surgery at the University Hospital of the West Indies, Jamaica: Analysis of Clinical Characteristics, Mortality and Length of Hospital Stay

CD McGaw[1], CA Walters[2], RW Irvine[1], MD Scarlett[1], J Blidgen[1], K Ehikhametalor[1], PJ Toppin[1], S Little[1], S Stephenson[1], PS Ramphal[3], HW Spencer[4]

ABSTRACT

Objectives: A detailed analysis of coronary artery bypass graft (CABG) surgical cases performed at the University Hospital of the West Indies (UHWI) has never been conducted. We present the demographic profile, clinical characteristics, and outcome of cases performed during the period March 2010 to March 2016.

Methods: Data from consecutive CABG surgeries performed during the study period were collected prospectively, entered into a computerized database and then analyzed. Outcome measures were 30-day operative mortality, ICU length of stay (ICU LOS) and total postoperative length of stay (PostOp LOS).

Results: Of the 190 patients comprising the study population, 68.9% were males, and mean age (SD) was 61.3 (±10.2) years. The most frequent co-morbidities and risk factors were hypertension (82.1%) and diabetes (55.3%), cigarette smoking (33.7%) and hyperlipidaemia (89%). Left ventricular ejection fraction (LVEF) was found to be grades 1(good), 2(moderate), and 3(poor) in 50%, 44.2%, and 5.8% of patients, respectively. The majority (83%) were diagnosed with triple vessel disease. The crude, unadjusted 30-day mortality rate was 8.4%. Using the Canadian Risk Index Model, the mortality rates were: low risk (0-3), 5.5%; medium risk (4-7), 14.3%; and high risk (≥8), 100%. The median ICU LOS and median postoperative LOS were 3 days (IQR, 2-4), and 8 days (IQR, 6-11), respectively. Logistic regression analysis revealed that grade 2 LVEF and urgent/emergent operations were predictors of mortality, female gender predictive of prolonged ICU LOS, and advanced age and female gender of borderline significance for prolonged PostOp LOS.

Conclusion: This analysis of outcome of CABG cases performed at the UHWI provides an indication of current performance and serves as a benchmark against which future studies may be compared to determine the efficacy of future quality improvement initiatives.

Keywords: Clinical characteristics, coronary artery bypass graft surgery, University Hospital of the West Indies, outcomes

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From: [1]Department of Surgery, Radiology, Anaesthesia and Intensive Care, Faculty of Medical Sciences [2]Health Research Resource Unit, Office of the Dean, Faculty of Medical Sciences, Mona, [3]UWI School of Medicine and Research, Nassau, Bahamas. [4]Dept of Surgery, Radiology, Anaesthesia and Intensive Care, UWI, Mona, Kingston, Jamaica.

Correspondence: Dr CD McGaw, Department of Surgery, Radiology, Anaesthesia and Intensive Care. The University of the West Indies, Mona, Kingston, Jamaica, West Indies
E-mail: cdmcgaw@cwjamaica.com or Clarence.mcgaw@uwimona.edu.jm

INTRODUCTION

Coronary artery bypass graft (CABG) surgery was not available in Jamaica until 1994 when the first CABG was performed at the University Hospital of the West Indies (UHWI) by a visiting cardiac surgeon assisted by local medical personnel (1). Subsequent cases were performed on a limited basis by both local and/or visiting surgical teams until around the turn of the millennium when cases began to be performed regularly and exclusively by local providers. Meanwhile, in the developed world, a demand for public reporting of clinical outcomes data had grown exponentially, attributable to the large number of CABG cases being performed, the relatively high mortality rates associated with cardiac surgery, and the wide variation in outcomes between hospitals and caregivers (2). This pressure for greater transparency in quality of care has not spared healthcare teams in developing countries as they are likewise expected to publish their outcomes data. This study is the first detailed analysis of the demographic profile, clinical characteristics and outcomes in relation to mortality rate and length of hospital stay of CABG cases performed at the UHWI since being performed entirely by local medical personnel. Benchmarking of such outcomes data will enable a comparison of results when future studies are carried out to evaluate the efficacy of current and future quality-of-care improvement initiatives.

SUBJECTS AND METHODS

The UHWI is a 500-bed, tertiary care teaching institution, affiliated with the University of the West Indies, and located in Kingston, the capital city of Jamaica. It is the only institution in Jamaica where adult open heart surgery is performed and, therefore, the data obtained from this study represent the data for the entire country of Jamaica. Only patients who had isolated CABG surgery were included in this study. The data was collected prospectively on consecutive patients who had isolated CABG between March 2010 and March 2016, was subsequently entered into a computerized database (SPSS, version 17), and then analyzed. Approval for the study was granted by the Ethics Committee of the University of the West Indies.

The outcomes of interest were 30-day operative mortality, ICU length of stay (ICU LOS), and postoperative length of stay (PostOp LOS) – including the days in ICU. Mortality is generally considered to be operation-related if it occurred during the same hospitalization or within 30 days after surgery, regardless of venue.

Statistical analyses

Patient characteristics and outcomes were summarized as frequencies and percentages. Length of ICU and hospital stay were reported as mean +/- standard deviation if data distribution did not deviate significantly from normality and median (interquartile range or IQR) if they did. Continuous variables were analyzed using the student's t-test or Mann-Whitney U test and categorical variables analyzed using the chi-square test or Fisher's exact test, as appropriate. Univariate and multi-variate logistic regression models were generated to quantify risk for 30-day mortality, very long ICU LOS (more than 3 days) and very long PostOp LOS (more than 8 days). P-values below 0.05 were considered statistically significant. Stata Version 13.1 statistical package was used for statistical analysis.

Predicted mortality was assessed preoperatively using the Canadian Risk Index (CA) model (3). We chose this model for its simplicity, accuracy and reliability (4). This predictive model utilizes six variables: age, sex, left ventricular function, urgency of surgery, repeat operation and type of surgery (Table 1). The definition of the variables used in this study are identical with those used in the studies conducted by Tu *et al: emergency* surgery is defined as operation required within 24 hours, while *urgent* surgery is surgery recommended in the index hospitalization (3, 4). For this study, '*isolated'* CABG outcomes, one variable (type of surgery) was set to its null value, leaving only 5 variables and their associated risk scores.

RESULTS

Characteristics of participants included in the analyses are shown in Table 2. One hundred and ninety (190) patients underwent isolated, primary CABG surgery during the study period; none were repeat operations. They were predominantly male (68.9%), and ranged in ages between 30 and 84 years, with a mean (SD) of 61.3 (10.2) (Table 2). There was a high incidence of hypertension (82.1%) and diabetes (55.3%), and 51.1% of patients were both hypertensive and diabetic. Left ventricular function - based on ejection fraction as assessed by echocardiography (LVEF) was Grade 2 and Grade 3 in 44.2% and 5.8% of patients, respectively.

Operative and postoperative characteristics

There was an almost equal distribution of elective (53.2%) and urgent (42.6%) operations (Table 3). The median cardiopulmonary bypass (CPB) and cross clamp times were 152 and 83 minutes, respectively. Almost one-half (49.2%) of the patients had a triple vessel bypass procedure, while another 37.4% had quadruple vessel bypass. Median ICU LOS and PostOp LOS were 3 and 8 days, respectively.

Outcomes

The crude overall 30-day mortality rate was 8.4%. When stratified according to CA risk groups, the mortality rates were: low risk (0-3), 5.5%; medium risk (4-7), 14.3%; and high risk (=/>8), 100% (Table 4a). However, note that only 2 of the 190 study patients were categorized as high risk, each with a CA risk score of 8. The lowest risk category of patients, i.e., those with scores of 0-1, had a very low mortality rate of 1.4%. Generally, higher risk scores were associated with higher mortality rates (Table 4b). Patients with no risk factors, i.e., 30 patients, had a 0% mortality rate (Table 4b). Higher risk scores were also predictive of longer ICU and PostOp length of stays (p = .0015 and p = .0023 respectively).

Logistic regression analysis carried out on predictors of 30-day mortality showed an increased risk among: *older age groups* (p = .057); *grade II LVEF* (p = .014) and *grade III LVEF* (p = .351); *urgent* (p = .009) and *emergent* (p = .001) surgery, when compared with younger patients, grade 1 LVEF patients, and elective cases, respectively. There was almost a three-fold increased risk for prolonged ICU LOS among *females* (p = .002). Compared to each reference category, increased risks were seen throughout for prolonged PostOp LOS. Significantly increased risk for 30-day mortality among *urgent* (p = .012) and *emergent* (.005) surgery compared to elective cases was retained in the multivariate model (not shown); as was the three-fold increased risk for prolonged ICU LOS among *females* (p = .002) (Table 5).

DISCUSSION

Despite operating on an older and sicker population, CABG surgery has seen a remarkable improvement in outcome since the high mortality rates associated with the procedure in the initial phase of its history (5). Currently, mortality rates for isolated primary CABG range between 1-3% (6, 7). Although these low mortality rates have been achieved primarily at leading medical centers in the world, they now constitute the ‘gold standard’ or benchmark for outcomes wherever in the world CABG surgery is performed. In an audit carried out by Scarlett et al on all cardiac cases performed at the UHWI up to 2003 an overall mortality rate of 21% was reported for CABG cases. However, the study was retrospective, small volume (91 patients), and used only NYHA score for risk assessment; 72% of cases were NYHA III/IV and accounted for all the mortality.

In this study, the overall (crude) mortality rate of 8.4%, while exceeding the ‘gold standard’, compares favorably with that reported in some developing countries and unfavorably with others (8–11). de Oliveira *et al*, in their study on a Southern Brazilian population undergoing CABG surgery between 2002 and 2010, reported a relatively high overall mortality rate of 12.1% (8). Likewise, Jamaati *et al*., in their study on Iranian patients between 2004 and 2010, reported a mortality rate of 12.2% (9). On the other hand, Saifuddin *et al*, in their study at the Aga Khan University (Pakistan) on 2198 cases performed between 2006 and 2010, reported an overall 30-day mortality of only 2.7% (10). Also, Seethararaman *et al*, in their study conducted between 2003 to 2008 in Trinidad and Tobago (T&T), reported a low mortality rate of 1.2% (11).

The marked disparity in mortality outcomes reported in our study (8.4%) and the T&T study warrants further elucidation, considering the many similarities between both countries - and small populations (Jamaica, 2.7m; T&T, ~1.4m) geographic location (Caribbean Sea), historical background (former British colonies) (12). Three factors which may be contributory towards this disparity are: the volume of cases, the operative technique, and the actual quality of care.

Volume of cases

The Trinidad and Tobago study was comprised of 1082 cases versus 190 cases in our study, both collated over a similar time span. The impact of volume of cases on mortality rate can be significant as many studies have reported an inverse relationship between high volume of cases and mortality rate (13, 14). This phenomenon may be explained by the well-known adage, ‘practice makes perfect’. However, some more recent studies have reported excellent results at many low volume centres, suggesting that an inverse volume-mortality rate relationship is not immutable (15). The message from this study is that concerted and consistent focus on quality can compensate for lower case volumes in determining outcome in CABG surgery. There is yet another means by which difference in volume of cases may skew mortality rates in favour of larger volumes. Marcin et al. explain that outcome measurements and risk adjustment are statistical procedures that rely on large sample sizes to produce risk estimates and outcome interpretations that are trustworthy, *eg* observed outcome rates are less likely to be skewed by outliers in the case of high-volume providers than in the case of low-volume providers (16,17).

Operative technique

In the T&T study, Hariharan *et al* state that the proportion of cases they do off-pump have steadily increased from 50% in 2002 to a current level of 80-85%, and further that, in a previous study, they found the overall mortality rate for off-pump CABG (OPCAB) surgeries during the period 1997 to 2002 was 2.6% compared with 4.6% for OPCAB (11),17). Whether OPCAB confers an early or long-term clinical advantage to conventional CPB remains controversial. Some studies support an advantage for OPCAB while others do not (19,20). In an effort to resolve the conflicting results, Yadava and Kundu carried out a review on many of the seminal studies on the issue, and concluded that the problem lies, not with the technique, but with the surgeon, and that the best technique is that which works best for that particular patient, in the context of his clinical setting and his treating surgeon’s repertoire (21).

Quality of care

In the Trinidad and Tobago study, the surgeries were performed by visiting cardiac teams, mostly from developed countries, assisted by local providers, unlike in Jamaica where they were carried out entirely by local providers. To what extent this translates into differences in quality of care and outcomes is difficult to determine. Evaluation of quality of care is a complex process as quality is a fluid and abstract concept. When assessing quality of care, it is important to consider all pre, peri and post-operative variables (22). Regardless, as important as performance comparisons between institutions may be, of greater import is the need for each institution to identify areas of their respective service which may be amenable to quality-of-care improvement initiatives. To this end, an analysis of structure, process and outcome variables must be carried out according to the method initially presented by Donabedian and later expanded on by Birkmeyer (23, 24). Various studies have confirmed the positive effect of quality improvement programs on mortality and morbidity outcomes for surgical procedures generally and for cardiac surgery, specifically (25, 26).

Our median ICU LOS (3 days) and median PostOp LOS (8 days) were comparable with international standards. Bridgewater et al, in their study utilizing data from 366 hospitals in 29 countries reported a median PostOp LOS after isolated CABG of 7 days, but varies from 4.5 days up to 11 days between countries (7). The median PostOp LOS was 5 days in the UK, and 9 days in France (7).

Limitations

Firstly, our sample size was small relative to other previously published studies. Also, while the CA risk index is simple, accurate and reliable, there is a possibility that other models may provide more precise stratification of risk as the prevalence and importance of certain risk factors may be different in different settings. Future studies comparing different models will be required to satisfy this issue. Regarding mortality rates, other peri-operative factors, e.g., aortic cross-clamp time, and post-surgical quality of care could impact on patient outcome. Likewise, hospital length of stays may be skewed as a result of differing discharge protocols between institutions, *eg* at the UHWI, there is both a mandatory minimum ICU stay of 2 days due to the lack of a well-developed high dependence unit, as well as a tendency to prolong postoperative hospitalization as many patient live in rural environments with inadequate medical and transportation facilities.

CONCLUSION

This study provides the first benchmark for 30-day operative mortality for CABG surgery cases performed at the UHWI exclusively by local medical personnel. Such data are required to provide an indicator of current performance; to assist prospective patients and their physicians in deciding whether to have their CABG surgery at the UHWI or elsewhere; to guide local policy makers in the implementation of quality of care improvement initiatives; and to provide a baseline against which future studies may compare outcomes in order to determine the efficacy of whatever quality of care initiatives are instituted.

ACKNOWLEDGEMENTS

The authors wish to thank the many cardiologists who care for and refer our patients in a timely manner, our cardiopulmonary perfusionists, Dorothy Pinnock and Fitzhugh Forrest, for their expert care during the operations, and Kaodi McGaw for compiling the references using the Mendeley citation manager software.

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Table 1: Canadian Risk Index

Variable	**Risk score**
Age	
Under 65	0
65 – 74	2
75 and older	3
Sex	
Male	0
Female	1
Left ventricular function	
Grade 1 (> 50%)	0
Grade 2 (35 - 50%)	1
Grade 3 (20 - 34%)	2
Grade 4 (<20%)	3
Urgency of surgery	
Elective	0
Urgent	1
Emergency	4
Re-operation **(previous CABG)**	
No	0
Yes	2
Type of Surgery	
CABG only	0
Single valve	2
Complex (plus valve)	3
Maximum score	16

Table 2: Demographic and Preoperative Clinical Characteristics for Patients undergoing Isolated CABG

Characteristic	**n (%)**
Number of patients	190
Demographic	
Male	131 (68.9%)
Age (yrs.):	
mean ± SD	61.3± 10.2
Under 65	114 (60.0%)
65 – 74	57 (30.0%)
75 and over	19 (10.0%)
African race/ ethnicity	139 (73.2%)
Body mass index (kg/m^2):	
Overweight (25.0-29.9)	81 (42.9%)
Obese (30.0-34.9)	12 (7.1) 33 (17.5%)
Very obese (35.0 or more)	13 (6.9%)
Preoperative CV risk factors	
Hypertension	156 (82.1%)
Diabetes Mellitus	105 (55.3%)
Dyslipidaemia	169 (88.9%)
Current smoking	37 (19.5%)
Past Medical History	
Previous CCF	31 (16.3%)
Previous CVA	18 (9.5%)
Previous vascular surgery	7 (3.7%)
Recent MI (<3 months)	98 (52.7%)
Chronic lung disease	17 (8.9%)
Left main trunk stenosis (>50%)	57 (30.0%)
LV EF:	
Grade 1 (>50%)	95 (50.0%)
Grade 2 (35-50%)	84 (44.2%)
Grade 3 (20-34%)	11 (5.8%)
Grade 4 (<20%)	---

Abbreviations: CV = cardiovascular; CCF = congestive cardiac failure; CVA = cerebrovascular accident; MI = myocardial infarction; LVEF = left ventricular ejection fraction

Table 3: Patient's intra- and post-operative characteristics

Characteristic	**n (%)**
Operative priority (acuity):	
Elective	101 (53.2%)
Urgent	81 (42.6%)
Emergent	8 (4.2%)
No. of grafts:	
One	3 (1.6%)
Two	22 (11.8%)
Three	92 (49.2%)
Four or more	70 (37.4%)
CPB bypass time (min.), median (IQR)	152 (132 – 176)
Cross-clamp time (min.), median (IQR)	83 (71 – 99)
ICU LOS (days), median (IQR)	3 (2-4)
PostOp LOS (days), median (IQR)	8 (6 - 11)

CPB = cardiopulmonary bypass; IQR = interquartile range

Table 4a: Mortality rate, ICU LOS and PostOp LOS according to CA risk index groups

Risk Score	**Patients n (%)**	**Mortality n (%)**	**Median ICU LOS d (IQR)**	**Median PostOp LOS d (IQR)**
0 – 3	146 (76.8%)	8 (5.5%)	3 (2 – 4)	7 (6 – 10)
4 – 7	42 (22.1%)	6 (14.3%)	3 (3 – 7)	10 (7 – 17)
8 or more	2 (1.1%)	2 (100.0%)	--- [a]	--- [a]

Only 2 patients in this category
Mortality = 30-day mortality
Abbreviations: ICU LOS = length of stay in the intensive care unit; PostOp LOS = total postoperative length of stay (includes ICU LOS)
d = days; IQR = interquartile ratio

Table 4b: Mortality rates according to CA risk index

Risk Score	Patients n (%)	Mortality n (%)	Median ICU LOS, d (IQR)	Median PostOp LOS d (IQR)
0	30 (15.8%)	0 (0%)	2 (2 – 4)	7.5 (5.5 – 9.5)
1	40 (21.1%)	1 (2.5%)	3 (2 – 4)	7 (5 – 9)
2	42 (22.1%)	4 (9.5%)	3 (2 – 4)	7 (6 – 10)
3	34 (17.9%)	3 (8.8%)	3 (2 – 4)	9 (6 – 13)
4	17 (8.9%)	3 (17.7%)	3 (3 – 7)	10.5 (7 – 17)
5	14 (7.4%)	2 (14.3%)	3.5 (2 - 6)	10 (7 – 17)
6	8 (4.2%)	---	7 (3.5 – 12.5)	11 (7.5 – 45)
7	3 (1.6%)	1 (33.3%)	--- [a]	--- [a]
8	2 (1.1%)	2 (100.0%)	--- [a]	--- [a]

Only 2 patients in this category

Abbreviations: as for previous table

Table 5: Logistic Regression (Univariate) Models for Mortality, ICU LOS and PostOp LOS

Risk Factor	30-day Mortality OR	*p*-value	Prolonged ICU LOS OR	*p*-value	Prolonged PostOp LOS OR	*p*-value
Age, Y						
65 to 74	2.94	0.057	1.07	0.842	1.97	.055
$\geq$75	2.12	0.381	1.47	0.444	2.78	.066
Sex						
Female	0.72	0.586	2.82	0.002	1.92	.055
LVEF						
Grade 2	5.11	0.014	1.71	0.102	1.10	.778
Grade 3	3.07	0.351	2.11	0.248	3.22	.106
Urgency of surgery						
Urgent	7.78	0.009	0.74	0.361	1.60	.144
Emergent	29.7	0.001	2.33	0.285	2.07	.358

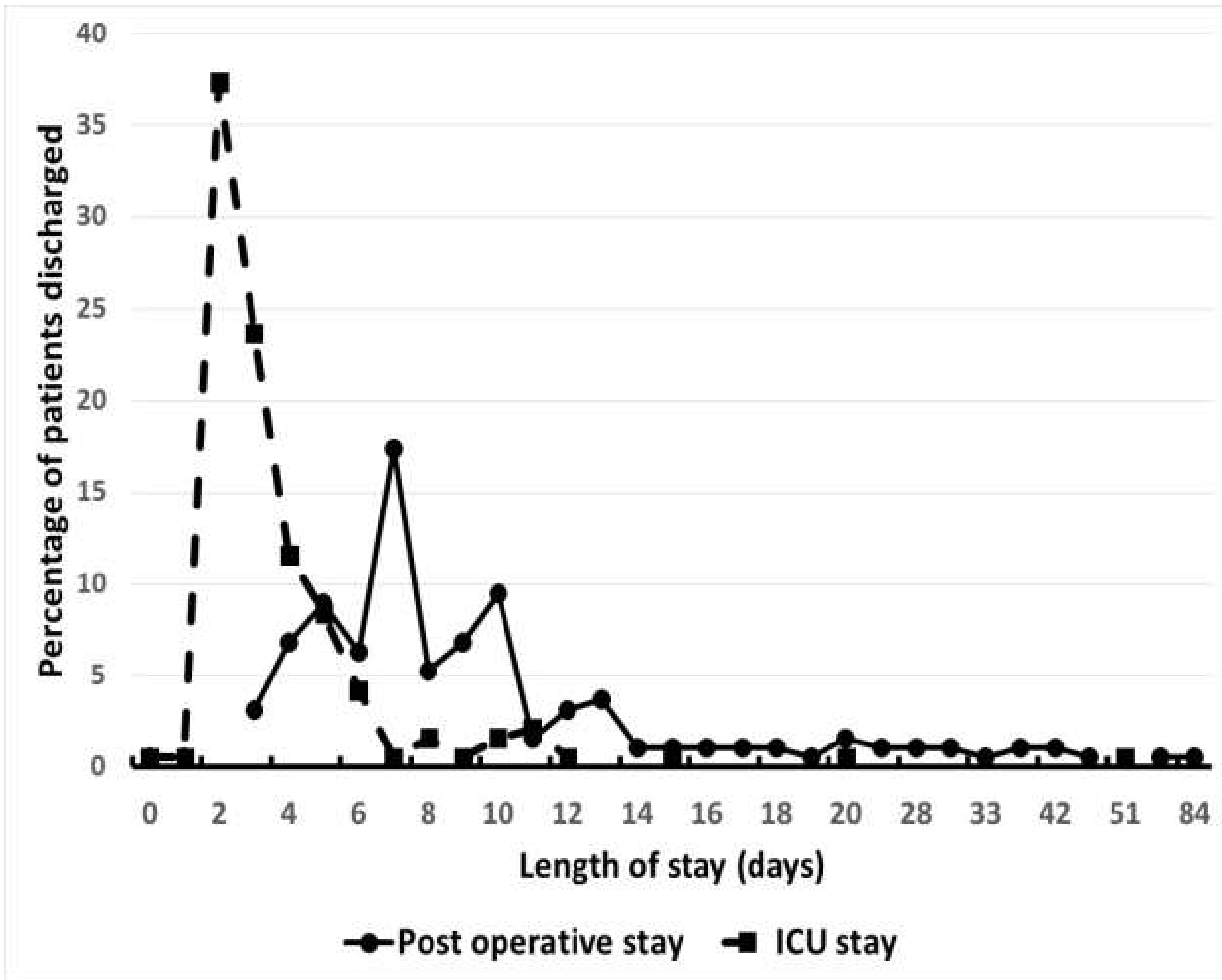

Figure: Distribution of ICU and postoperative length of stay (in days).
Abbreviations: ICU = intensive care unit; Post-operative stay = total postoperative stay (include ICU stay)