Sex differences in resource use after on-pump and off-pump coronary artery bypass surgery: A propensity score-matched cohort

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M Maganti, V Rao, RJ Cusimano. Sex differences in resource use after on-pump and off-pump coronary artery bypass surgery: A propensity score-matched cohort. *Can J Cardiol* 2009;25(5):e151-e156.

BACKGROUND: Previous studies have demonstrated that off-pump coronary artery bypass surgery (OPCAB) is associated with less use of hospital resources compared with on-pump coronary artery bypass surgery (ONCAB).

OBJECTIVE: To determine whether there is a sex effect between the two procedures regarding resource utilization.

METHODS: Between 1996 and 2004, 13,522 patients (10,637 men and 2885 women) underwent coronary artery bypass grafting surgery at the Toronto General Hospital (Toronto, Ontario). Among the men, 10,121 patients underwent ONCAB and 516 underwent OPCAB. The female population consisted of 2723 ONCAB and 162 OPCAB patients. Both groups were matched to standard preoperative risk factors. A propensity score macro-matched 471 OPCAB men to 471 ONCAB men, and 148 OPCAB women to 148 ONCAB women.

RESULTS: The mean ($\pm$ SD) postoperative length of stay (7.5 ± 6.5 days versus 6.4 ± 5.5 days; $P < 0.0001$) was significantly higher in ONCAB compared with OPCAB in the male population. The mean length of stay in the intensive care unit and the mean ventilation time was similar between the groups. However, in the female population, there were no differences in mean postoperative length of stay (8 ± 5.9 days versus 8 ± 6 days; $P = 0.4$), mean length of stay in the intensive care unit (43 ± 38 h versus 53 ± 81 h; $P = 0.4$) or mean ventilation time (9.8 ± 9.7 h versus 11 ± 13 h; $P = 0.8$).

CONCLUSION: These results suggest that the benefits of OPCAB in terms of hospital resource use are influenced by sex. The potential beneficial effects are not demonstrated in the female population.

Key Words: Off-pump; On-pump; Outcomes; Sex

Beating heart revascularization gained popularity several years previously as an attractive method to reduce the morbidity and mortality associated with cardiopulmonary bypass surgery (CPB). As technological advances improved the ability of surgeons to reproduce the results of 'off-pump' coronary artery bypass surgery (OPCAB), several clinical trials were initiated to compare the early clinical outcomes of OPCAB with those of standard myocardial revascularization using a CPB circuit (on-pump coronary artery bypass surgery [ONCAB]).

While the majority of observational studies favoured clinical outcomes following OPCAB, these results were not substantiated in subsequent randomized clinical trials. Indeed, a recent meta-analysis (1) suggested very little benefit of OPCAB over conventional ONCAB. Despite these findings, most surgeons continue to believe that OPCAB is beneficial in certain high-risk subgroups. The present

Les différences d'utilisation des ressources selon le sexe après un pontage aortocoronarien à cœur battant ou avec circulation extracorporelle : Une cohorte appariée selon l'indice de propension

HISTORIQUE : Des études antérieures ont démontré que le pontage aortocoronarien avec circulation extracorporelle (PACCE) s'associe à un moindre usage des ressources hospitalières que le pontage aortocoronarien à cœur battant (PACCB).

OBJECTIF : Déterminer si le sexe de l'individu a un effet sur les deux interventions en matière d'utilisation des ressources.

MÉTHODOLOGIE : De 1996 à 2004, 13 522 patients (10 637 hommes et 2 885 femmes) ont subi un pontage aortocoronarien au *Toronto General Hospital* de Toronto, en Ontario. Chez les hommes, 10 121 patients ont subi un PACCB et 516, un PACCE. Au sein de la population de femmes, 2 723 ont subi un PACCB et 162, un PACCE. Les deux groupes ont été appariés selon les facteurs de risque préopératoires standard. Un indice de propension a permis de procéder au macroappariement de 471 hommes ayant subi un PACCE à 471 hommes ayant subi un PACCB, et de 148 femmes ayant subi un PACCE à 148 femmes ayant subi un PACCB.

RÉSULTATS : Au sein de la population d'hommes, la durée ($\pm$ ÉT) moyenne d'hospitalisation postopératoire (7.5 ± 6.5 jours par rapport à 6.4 ± 5.5 jours; $P < 0.0001$) était considérablement plus longue après un PACCB qu'après un PACCE. La durée moyenne d'hospitalisation aux soins intensifs et la durée moyenne de ventilation étaient similaires au sein des deux groupes. Cependant, au sein de la population de femmes, on ne constatait aucune différence de durée moyenne d'hospitalisation postopératoire (8 ± 5.9 jours par rapport à 8 ± 6 jours; $P = 0.4$), de durée moyenne d'hospitalisation aux soins intensifs (43 ± 38 heures par rapport à 53 ± 81 heures; $P = 0.4$) ou de durée moyenne de ventilation (9.8 ± 9.7 heures par rapport à 11 ± 13 heures; $P = 0.8$).

CONCLUSION : Selon ces résultats, les bienfaits du PACCE en matière de ressources hospitalières dépendent du sexe de l'individu. Les effets bénéfiques potentiels ne sont pas reflétés dans la population de femmes.

study examined whether there are sex-specific benefits of OPCAB, particularly with respect to hospital resource use. To adjust for the selected nature of OPCAB patients, a propensity score analysis was performed to match male and female cohorts with standard preoperative demographic characteristics. The present study demonstrates that the potential beneficial effects of OPCAB are not observed in female patients. In contrast, there were significant benefits in resource use for male patients undergoing isolated myocardial revascularization using an off-pump technique.

METHODS

Data source and patient population

Data were collected prospectively on all patients undergoing cardiac surgery at the Toronto General Hospital (Toronto, Ontario)

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Received for publication April 13, 2007. Accepted November 18, 2007

and entered into a computerized database. A retrospective review of the institutional database was conducted to identify patients who underwent coronary artery bypass graft surgery (CABG) between 1996 and 2004. A total of 13,522 patients (10,637 men and 2885 women) underwent CABG. Among the men, 10,121 patients underwent ONCAB and 516 underwent OPCAB. The female population consisted of 2723 ONCAB patients and 162 OPCAB patients. Patients underwent either ONCAB or OPCAB, according to the preference and expertise of the operating surgeons.

Operative technique

The details of routine ONCAB have been previously described (2). Anesthetic induction and perioperative management were similar between ONCAB and OPCAB patients, except for the following important differences. All ONCAB patients received full heparinization to maintain an activated clotting time of longer than 400 s. Following completion of all anastomoses and weaning from CPB, complete reversal of anticoagulation was achieved with the administration of protamine sulphate. In the OPCAB group, partial heparinization was employed, aiming to maintain activated clotting times of longer than 300 s.

As previously described (2), CPB was maintained using sodium nitroprusside, phenylephrine or noradrenaline as required to maintain a mean arterial pressure of greater than 65 mmHg and CPB flows of greater than 2.2 L/min/m². Systemic temperatures were allowed to drift to 32°C and rewarming was initiated before construction of the last distal anastomosis. Myocardial protection strategies varied according to the surgeon, but the vast majority of patients received cold-blood cardioplegia delivered antegrade via the aortic root. Minimal dilution of blood cardioplegia was achieved by using the myocardial protection system (MPS; Quest Medical Inc, USA). All proximal and distal anastomoses were performed under a single crossclamp.

For OPCAB patients, systemic normothermia was maintained and various interventions were performed, as required, to maintain acceptable hemodynamics during cardiac manipulation. All proximal anastomoses were performed on the aortic root with the aid of a partial occluding clamp.

Database variables

Preoperative variables included in the present study included age, sex, body surface area, left ventricular ejection fraction, urgency of operation, New York Heart Association class, recent myocardial infarction (MI), diabetes, dyslipidemia, history of hypertension, peripheral vascular disease (PVD), stroke or transient ischemic attack, congestive heart failure, renal failure, cardiogenic shock, syncope, left main disease, number of diseased vessels, previous angioplasty, previous thrombolysis, CABG redo and any reoperative surgeries. Variables pertaining to intraoperative details include the number of distal grafts, use of left internal mammary artery, use of right internal mammary artery and the number of units of packed red blood cells (RBCs) per patient.

Postoperative variables included hospital resource use, low cardiac output syndrome, reoperation for bleeding, use of inotropes, MI, stroke, atrial fibrillation, pulmonary complications and operative mortality. Operative mortality was defined as any death occurring postoperatively during the same hospital stay. Details of this database have been published elsewhere (3).

Definitions of hospital resource use

Hospital resource use was defined as three different variables: the length of time on a ventilator before postoperative tracheal extubation (VENTHR); the duration of stay in the intensive care unit (ICULOS); and the length of stay after surgery, including ICULOS (POSTLOS).

Statistical analysis

The objective of the analysis was to match OPCAB patients with ONCAB patients stratified by sex. Propensity score-matching methods were used to match patients in the OPCAB and ONCAB groups (4).

All statistical analyses were conducted using SAS version 8.2 software (5). Univariate comparisons were made among the unmatched and matched groups for categorical and continuous variables. Categorical variables were analyzed using χ^2 analyses, Fisher's exact test or McNemar's test for paired data, and were expressed as percentages. Continuous variables with normal distribution were analyzed using Student's *t* test, variables with non-normal distributions were analyzed using Wilcoxon's ranked sum test, and matched pairs of data were analyzed using Wilcoxon's signed rank test. All continuous variables are expressed as mean $\pm$ SD. Median values were also reported when data were skewed or when reporting variables that represented hospital resource use. Among matched populations, multivariate linear regression methods were used to evaluate the possible association of sex and other preoperative characteristics with VENTHR, ICULOS and POSTLOS.

Propensity score matching

The differences in the distribution of preoperative characteristics between the ONCAB and OPCAB groups were eliminated by matching on the propensity score. A propensity score or the predicted probability of receiving OPCAB was calculated from the logistic regression model. All variables that are used for calculating the probability of receiving OPCAB are forced into the logistic model. A list of variables used in the logistic model are provided in Appendix 1. Based on the calculated propensity score, matching between the two groups was achieved through a propensity score-matching algorithm. Among 516 men undergoing OPCAB, 471 (91%) could be matched with ONCAB men (area under the receiver operating characteristic curve 0.787; Hosmer-Lemeshow statistic 0.2). Similarly, 91% of matching was achieved within the female population, in which 148 of 162 OPCAB patients were matched with ONCAB patients (area under the receiver operating characteristic curve 0.805; Hosmer-Lemeshow statistic 0.05).

RESULTS

Unmatched male population

Univariate analysis of the unmatched ONCAB and OPCAB male population revealed that the two groups differed with respect to left ventricular ejection fraction ($P<0.0001$), New York Heart Association class ($P<0.0001$), number of diseased vessels ($P<0.0001$), dyslipidemia ($P=0.01$), body surface area ($P=0.05$) and PVD ($P<0.0001$). There was a significant difference in the number of distal grafts between the two groups. The OPCAB group received 2.8 ± 1.1 grafts compared with 3.7 ± 0.9 grafts for the ONCAB group ($P<0.0001$).

The prevalence of low cardiac output syndrome was higher in ONCAB patients (4.1% versus 2.1%; $P=0.03$). The OPCAB group had a higher rate of reoperation for bleeding postoperatively (4.5% versus 2.5%; $P=0.005$). The ONCAB group had an increased rate of stroke (1.2% versus 0.2%; $P=0.03$) and atrial fibrillation (17% versus 14%; $P=0.04$) postoperatively. No differences in hospital mortality rates were seen between the groups (ONCAB 1.14% versus OPCAB 0.78%; $P=0.4$).

There was no significant difference in the mean ICULOS between groups; 1.9 ± 3.3 days in the ONCAB group versus 1.7 ± 3.5 days in the OPCAB group. However, VENTHR and POSTLOS were significantly higher in the ONCAB group than in the OPCAB group (VENTHR 15 ± 51 h versus 11 ± 52 h [$P=0.003$]; POSTLOS 7.5 ± 5.7 days versus 6.5 ± 5.5 days [$P<0.0001$]).

Matched male population

The preoperative clinical data for the matched male ONCAB and OPCAB groups are presented in Table 1. The matched groups had no significant differences in any of the preoperative characteristics. There was no significant difference in the mean number of CABGs between the two groups. The ONCAB group received 2.9 grafts and the OPCAB group received 2.8 grafts ($P=0.3$). The rate of use of left internal mammary artery grafts was 90% in the OPCAB group and 86% in the ONCAB group ($P=0.04$). No differences were seen in the rate of use of right internal mammary artery grafts or the mean number of units of packed RBCs transfused per patient.

TABLE 1
Distribution of preoperative variables in the matched male population

Variable	ONCAB (%)	OPCAB (%)	P
Patients, n	471	471	
Age, years*	63±10	63±10	0.4
Body surface area, m ² *	1.95±0.2	1.95±0.19	0.9
Diabetes mellitus	32	30	0.4
Hypertension	60	58	0.5
Dyslipidemia	75	77	0.4
Left ventricular ejection fraction			0.2
≥60%	39	43	
<60%	61	57	
Urgency of surgery			0.4
Elective or same hospital	94	93	
Urgent/emergent	6	7	
New York Heart Association class			0.1
I or II	31	36	
III or IV	69	64	
Number of diseased vessels*	2.5±0.7	2.5±0.7	0.3
Congestive heart failure	5.9	6.8	0.6
Peripheral vascular disease	39	37	0.5
COPD	5.1	3.4	0.2
Myocardial infarction	21	19	0.4
Stroke	8.3	8.7	0.8
Renal failure	2.8	1.7	0.3
Cardiogenic shock	0.85	0.42	0.4
Syncope	0	0.64	—
Left main disease	23	24	0.5
Previous angioplasty	8.1	8.5	0.8
Previous thrombolysis	8.3	11	0.14
CABG redo	4	4.3	0.9
Any reoperative surgery	4.3	4.3	1

*Data presented as mean ± SD. CABG Coronary artery bypass graft surgery; COPD Chronic obstructive pulmonary disease; ONCAB On-pump coronary artery bypass surgery; OPCAB Off-pump coronary artery bypass surgery

Figure 1 Mean length of stay in the matched male population. *Data presented as SD; median for respective groups. ICU Intensive care unit; ONCAB On-pump coronary artery bypass surgery; OPCAB Off-pump coronary artery bypass surgery

Postoperatively, the OPCAB group had a higher percentage of re-exploration for bleeding compared with the ONCAB group (4.9%

TABLE 2
Multivariate predictors of intensive care unit length of stay in the matched male population

Variable	Parameter estimate ± SEM	P
Intercept	3.3±0.02	<0.0001
Peripheral vascular disease	0.16±0.04	<0.0001
Congestive heart failure	0.32±0.08	<0.0001
Number of units of red blood cells	0.05±0.005	<0.0001

TABLE 3
Multivariate predictors of prolonged ventilator support in the matched male population

Variable	Parameter estimate ± SEM	P
Intercept	0.86±0.17	<0.0001
OPCAB	-0.1±0.05	0.04
Number of distal grafts	0.07±0.02	0.005
Age	0.01±0.003	<0.0001
Number of units of red blood cells	0.06±0.006	<0.0001
Hypertension	0.15±0.05	0.004
Urgency of surgery	0.3±0.1	0.013
Peripheral vascular disease	0.12±0.05	0.03
Congestive heart failure	0.27±0.007	<0.0001

OPCAB Off-pump coronary artery bypass surgery

TABLE 4
Multivariate predictors of postoperative length of stay in the matched male population

Variable	Parameter estimate ± SEM	P
Intercept	1.86±1.2	0.12
OPCAB	-0.96±0.37	0.01
Previous angioplasty	1.4±0.7	0.04
Number of units of red blood cells	0.33±0.05	<0.0001
Preoperative stroke	3.2±0.8	<0.0001
Congestive heart failure	3.3±0.8	<0.0001
Age	0.07±0.02	<0.0001

OPCAB Off-pump coronary artery bypass surgery

versus 1.5%; $P=0.004$). There were no significant differences in low cardiac output syndrome (3.2% versus 1.9%; $P=0.2$), use of inotropes (33% versus 31%; $P=0.7$), MI (2.1% versus 3.4%; $P=0.3$), stroke (1.3% versus 0.2%; $P=0.6$), renal failure (1.5% versus 0.9%; $P=0.4$), atrial fibrillation (15% versus 18%; $P=0.2$) or hospital mortality (1.1% versus 0.9%; $P=0.7$).

Hospital resource use data for the matched male population are presented in Figure 1. The mean ICULOS was similar between the groups. Although not statistically significant, the OPCAB group showed a trend toward a reduction in ventilator dependence. The mean POSTLOS was significantly lower in the OPCAB group than in the ONCAB group.

A linear regression model was used to evaluate the possible association of ONCAB/OPCAB with ICULOS, VENTHR and POSTLOS, while adjusting for the effects of other preoperative variables. The distribution of ICULOS and hours on a ventilator were positively skewed. Therefore, before multivariate analysis, data on ICULOS and VENTHR were transformed to natural logarithms to stabilize variances (Tables 2 and 3).

Multivariate linear regression showed that ONCAB/OPCAB was not significantly associated with ICULOS. Use of the pump was significantly associated with longer hours of ventilator dependence and longer postoperative length of stay. Parameter estimates, along with standard errors and P values, are detailed in Table 4.

TABLE 5
Distribution of preoperative variables in the matched female population

Variable	ONCAB (%)	OPCAB (%)	P
Patients, n	148	148	
Age, years*	64±12	65±10	0.6
Body surface area, m ² *	1.76±0.2	1.77±0.2	0.5
Diabetes mellitus	41	41	1
Hypertension	68	70	0.7
Dyslipidemia	73	74	0.8
Left ventricular ejection fraction			0.8
≥60%	47	49	
<60%	53	51	
Urgency of surgery			0.2
Elective or same hospital	85	90	
Urgent/emergent	15	10	
New York Heart Association class			0.9
I or II	15	15	
III or IV	85	85	
Number of diseased vessels*	2.4±0.75	2.4±0.77	0.6
Congestive heart failure	13	12	0.7
Peripheral vascular disease	41	41	1
COPD	8.1	4	0.2
Myocardial infarction	16	21	0.11
Stroke	13	12	0.9
Renal failure	0.7	0.7	1
Cardiogenic shock	0.7	0	—
Syncope	3.4	2.7	0.7
Left main disease	20	22	0.6
Previous angioplasty	11	12	0.7
Previous thrombolysis	6.1	8.9	0.3
CABG redo	0	0.7	—
Any reoperative surgery	0.7	0.7	—

*Data presented as mean ± SD. CABG Coronary artery bypass graft surgery; COPD Chronic obstructive pulmonary disease; ONCAB On-pump coronary artery bypass surgery; OPCAB Off-pump coronary artery bypass surgery

Figure 2) Mean length of stay in the matched female population. *Data presented as SD; median for respective groups. ICU Intensive care unit; ONCAB On-pump coronary artery bypass surgery; OPCAB Off-pump coronary artery bypass surgery

Unmatched female population

Univariate comparison of the ONCAB versus OPCAB groups showed that the two groups differed significantly in the number of diseased

TABLE 6
Multivariate predictors of intensive care unit length of stay in the matched female population

Variable	Parameter estimate ± SEM	P
Intercept	3.2±0.04	<0.0001
Chronic obstructive pulmonary disease	0.27±0.13	0.046
Preoperative stroke	0.25±0.09	0.008
Congestive heart failure	0.28±0.01	0.004
Number of units of red blood cells	0.15±0.013	<0.0001

vessels (2.7 versus 2.4; $P<0.0001$), PVD (17% versus 40%; $P<0.0001$) and the number of distal grafts (3.3 versus 2.5; $P<0.0001$). The ONCAB group received 2.3 units of RBCs per patient and the OPCAB group received 1.6 units of RBCs per patient ($P=0.02$). There were no statistically significant differences in postoperative outcomes between the groups.

The mean VENTHR and POSTLOS were significantly higher in the ONCAB group compared with the OPCAB group (VENTHR 18 ± 57 h versus 16 ± 46 h [$P=0.007$]; POSTLOS 8.5 ± 6.9 days versus 8.2 ± 6.8 days [$P=0.007$]). ICULOS was similar between the groups: 2.2 ± 3.2 days in the ONCAB group versus 2.2 ± 3.3 days in the OPCAB group.

Matched female population

The preoperative characteristics of the matched female population are presented in Table 5. The matched groups had no significant differences in any of the preoperative variables. In the matched population, both groups received 2.5 distal grafts ($P=0.9$). The percentage of use of left internal thoracic artery and right internal thoracic artery grafts was also similar between the groups. There was no significant difference in the mean number of units of transfused RBCs between the groups.

Postoperative use of inotropes was higher in the OPCAB group than in the ONCAB group (49% versus 35%; $P=0.01$). Although the re-exploration rate for bleeding showed an increasing trend in the OPCAB group compared with the ONCAB group, it did not reach statistical significance (2.7% versus 0.7%; $P=0.2$). Comparing ONCAB with OPCAB revealed no significant differences in low cardiac output syndrome (2% versus 4.1%; $P=0.3$), MI (1.4% versus 4.1%; $P=0.2$), stroke (2% versus 0%; $P=0.2$), atrial fibrillation (14% versus 19%; $P=0.2$) or hospital mortality (2% versus 0.7%; $P=0.3$).

Figure 2 represents the hospital resource use data in the matched female population. There was no significant difference in the mean ICULOS, VENTHR or POSTLOS between the two groups. The mean values, along with SDs and medians, are depicted in Figure 2.

Data for ICULOS and VENTHR were transformed to natural logarithms before multivariate linear regression analysis. Results of the multivariate analysis revealed that ONCAB/OPCAB was not significantly associated with ICULOS, VENTHR or POSTLOS. Tables 6, 7 and 8 represent significant predictors of ICULOS, VENTHR and POSTLOS, respectively.

DISCUSSION

The present study examined the influence of sex on hospital resource use in a large chronological series of patients undergoing ONCAB or OPCAB over a period of nine years in a university teaching hospital. The retrospective study revealed that the benefits of OPCAB in terms of resource use are clearly demonstrated in a matched male population, but the same is not applicable to a matched female population.

Over the past few years, several studies have examined resource use between ONCAB and OPCAB cohorts. Only three previous studies (6-8) have matched study groups to account for baseline preoperative demographic characteristics. However, these papers did not examine male or female populations individually. Comparisons between ONCAB and OPCAB were performed in

TABLE 7
Multivariate predictors of prolonged ventilator support in the matched female population

Variable	Parameter estimate ± SEM	P
Intercept	1.03±0.22	<0.0001
Chronic obstructive pulmonary disease	0.48±0.16	0.003
Number of distal grafts	0.01±0.04	0.02
Age	0.007±0.003	0.03
Number of units of red blood cells	0.17±0.02	<0.0001

female patients in four previous studies (9-12). Three of these studies (9-11) did not use propensity matching to account for baseline differences in preoperative characteristics. A recent study by Mack et al (12) examined the effect of OPCAB in women after propensity adjusting, but the study focused on operative mortality and morbidity more than resource use.

To the best of our knowledge, the present paper is the first to compare resource use in male and female populations individually, after propensity matching for baseline preoperative differences between the groups.

The hospital resources that we examined were ICULOS, VENTHR and POSTLOS. The first resource that was examined showed no significant differences in ICULOS between the ONCAB and OPCAB groups in either male or female populations. This is in agreement with previous reports (13-15). Other studies (16-18) have reported significant differences in ICULOS between ONCAB and OPCAB groups; however, these have been mostly retrospective, unadjusted observational studies.

The other resource examined was the VENTHR. Although the mean length of ventilator support was higher in the ONCAB male group compared with the OPCAB male group, it did not reach statistical significance by univariate analysis. However, multivariate regression analysis identified the use of the pump to be significantly associated with longer lengths of time on the ventilator. This is in accordance with previous studies (17-19) that reported reduced requirements for mechanical ventilation in OPCAB patients. A recent meta-analysis (20) of 37 randomized trials of OPCAB versus ONCAB also reported shorter VENTHR in OPCAB patients. However, no significant differences were seen between ONCAB and OPCAB women, either univariately or multivariately, for time to extubation. The present data are in agreement with a previous report by Mack et al (12).

The next resource examined was POSTLOS. ONCAB men stayed nearly one day longer in the hospital than OPCAB men. These study results support the findings of previous reports (17-18,21-22) that also demonstrated that ONCAB patients stayed significantly longer in the hospital compared with OPCAB patients. Nevertheless, some studies (14-15) reported no differences in the length of stay between the two operative procedures. In our institutional experience, OPCAB surgery introduced the concept of earlier patient discharge after cardiac surgery. Our anecdotal experience indicates that both OPCAB and ONCAB patients can be discharged in three to four days if that is the goal of both the patient and physician.

In contrast to the differences seen in men, no differences in length of stay were observed between ONCAB and OPCAB women. These results are in accordance with a recent study by Mack et al (12). However, other studies (9-10) that looked at differences among women alone reported shorter lengths of stay in OPCAB patients than in ONCAB patients. Neither of these studies accounted for baseline differences in preoperative characteristics between groups. Those differences in preoperative characteristics may have contributed to the observed differences rather than the use of the pump.

LIMITATIONS

The main limitation of the present study is that it represents a retrospective, single-centre experience. However, propensity score

TABLE 8
Multivariate predictors of postoperative length of stay in the matched female population

Variable	Parameter estimate ± SEM	P
Intercept	5.2±0.44	<0.0001
Diabetes	1.1±0.61	0.04
Chronic obstructive pulmonary disease	4.8±1.2	0.0001
Number of units of red blood cells	1.2±0.12	<0.0001

matching on preoperative characteristics resulted in equivalent risk profiles between the groups. Another limitation is that in the study, OPCAB surgery was performed mostly by a single surgeon, whereas ONCAB was performed by all surgeons at our institution. However, hospital outcomes for ONCAB were similar for all surgeons over the period of the study, suggesting that surgeon-specific variability did not confound our results. Another limitation is the small sample size in the female population compared with the male population.

CONCLUSIONS

The present study provides further evidence that the benefits of OPCAB surgery are not universal and are likely limited to specific patient subgroups. Importantly, after matching patients to adjust for major preoperative risk factors, OPCAB surgery conferred a significant sex-specific benefit to male patients. Unfortunately, the sample size of the present study did not permit a detailed examination of the female cohort to determine whether certain high-risk subgroups of women may benefit from OPCAB technology.

ACKNOWLEDGEMENTS: The authors thank Ms Susan Collins for her excellent data collection and management skills.

APPENDIX 1

Variables used in the logistic model to calculate the probability of receiving off-pump coronary artery bypass surgery

- Age
- Body surface area
- Left ventricular grade (based on left ventricular ejection fraction)
- Coronary artery bypass graft surgery redo
- New York Heart Association class
- Family history
- Diabetes mellitus
- Hypertension
- Dyslipidemia
- Preoperative myocardial infarction
- Angina
- Preoperative stroke
- Peripheral vascular disease
- Congestive heart failure
- Number of diseased arteries
- Total number of distal grafts
- Syncope
- Renal failure

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