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Background. **We have found no study conducted outside of the United States on the association between physician volume and patient outcomes after coronary artery bypass graft surgery. The aim of this study is to examine the association between surgeon-hospital coronary artery bypass graft volume and patient outcomes using three-year population-based data on Taiwan.**

Methods. **This study uses the Taiwan National Health Insurance Research Database covering the period 2000 to 2002, with the study sample comprising 9,895 first-time coronary artery bypass graft admissions, treated by 316 surgeons in 46 hospitals.**

Results. **Of the sampled patients, 356 (3.6%) were discharged after death. Those patients treated by low-volume (1–50 cases) surgeons had significantly higher mortality rates than those treated by medium-volume (51–100 cases) surgeons (7.0% vs 3.8%), high-volume (101–150 cases) surgeons (7.0% vs 2.7%), or very-high-volume (≥ 151 cases) surgeons (7.0% vs 3.2%). However, hospital coronary artery bypass graft volume alone is an insufficient predictor of hospital in-patient deaths (p = 0.078). The adjusted odds ratio of hospital in-patient deaths declined with increasing surgeon volume, with the odds of in-patient death for those patients treated by low-volume surgeons being 1.52 times those of medium-volume surgeons, 1.89 times those of high-volume surgeons, and 2.04 times those of very-high-volume surgeons.**

Conclusions. **We conclude that for all coronary artery bypass graft surgeries taking place in Taiwan, the skill and experience of individual surgeons is a more critical factor for patient outcome than either hospital equipment or surgical teams.**

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The past quarter of a century has seen the publication of a substantial number of studies aimed at explaining the association between the volume of patients treated under particular procedures by physicians and hospitals, and subsequent patient outcomes [1, 2]. One particular procedure, coronary artery bypass graft (CABG) surgery, has drawn considerable attention, largely because it is among the most common of all procedures performed within the United States [3, 4]. However, the findings of the prior studies on the relationship between CABG volume and patient outcomes do not seem to have reached any real consensus because some have reported significantly lower mortality rates for hospitals performing higher volumes of CABG operations [4–7], while others have found no significant relationship between hospital CABG volume and mortality rates [8, 9]. As to surgeons, some of the studies have found that mortality rates decreased significantly with increasing CABG volume [3–5], while others have failed to find any significant relationship [10, 11].

Most of the prior studies on the association between CABG volume by healthcare providers and subsequent patient outcomes have been heavily reliant upon statewide samples or subpopulations of patients, and as such, have failed to present unequivocal conclusions. Furthermore, most of these studies were conducted on hospital-level volume alone, with very few seeking to examine the simultaneous contribution to patient outcomes from both hospital and surgeon volumes. The majority of the studies on CABG volume and subsequent patient outcomes have also lacked case-specific measures of either surgeon or hospital volumes within their dataset. All of these issues have hampered the efforts of both clinicians and policymakers alike, to optimize CABG patient outcomes through the simultaneous development of hospital-level and surgeon-level strategies.

Using three-year population-based data on Taiwan, this study sets out to examine the association between surgeon and hospital CABG surgery volume, and subsequent patient outcomes. We have found no other study on CABG volume, and subsequent patient outcomes, to be conducted within any Asian country, and indeed, we also have found no other CABG volume-outcome study outside of the United States.

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Material and Methods

Database

This study uses pooled data for the years 2000, 2001, and 2002 obtained from the National Health Insurance Research Database (NHIRD) published in Taiwan by the National Health Research Institute. The NHIRD covers all in-patient medical benefit claims for the Taiwanese population of over 23 million. The NHIRD database includes a registry of contracted medical facilities, a registry of board-certified surgeons, a monthly claims summary for in-patient claims, and details of in-patient orders and expenditure on prescriptions dispensed at contracted pharmacies.

Study Sample

The study sample was identified from the database by a principal performed operational procedure International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) code 36.10–36.20 (broadly defined as bypass anastomosis for heart revascularization). Of the six million in-patient records within the dataset covering the period of this study, 10,844 hospitalized patients had undergone CABG surgery. In order to limit our study sample to the adult population, all patients aged below 18 years ($n = 15$) were excluded from the dataset. In addition, our study sample was limited to those patients who had undergone first-time CABG surgeries only; ultimately, our study sample comprised 9,895 admissions.

Surgeon and Hospital CABG Volume Groups

Since unique physician and hospital identifiers are available within the NHIRD for each medical claim submitted, this enabled us to identify the same physician, or the same hospital, carrying out one or more CABG surgeries during our three-year study period. Surgeon volume was calculated by counting all claims for principal performed operational procedure ICD-9-CM code 36.10-36.20 submitted in 2000, 2001, or 2002.

In order to permit the comparison of our finding to the experiences of the US, we have used the same volume thresholds as those adopted in the US studies [6, 12]. The sample of 9,895 patients was divided into four surgeon volume groups: 50 or less cases (hereafter referred to as low volume), 51 to 100 cases (medium volume), 101 to 150 cases (high volume), and 151 or greater cases (very high volume), while the three hospital volume groups were 249 or less cases (low volume), 250 to 499 cases (medium volume), and 500 or greater cases (high volume).

Statistical Analysis

The SAS statistical package (SAS Institute, Cary, NC) was used to perform statistical analysis of the data. Global χ^2 analyses were conducted in order to examine the relationship between surgeon CABG volume groups and unadjusted hospital in-patient deaths. After adjusting for surgeon, patient, and hospital characteristics, multivariate logistic regression analyses were also employed to assess the independent association between surgeon CABG volume and hospital in-patient deaths.

Finally, generalized estimated equation (GEE) was also carried out in order to account for any clustering of the sampled patients among particular surgeons. Hospital in-patient deaths were denoted by "1," while live discharges were denoted by "0." We define in-patient deaths as "the death of a patient at any time after operation if the patient does not leave hospital." The primary study outcome was dichotomous, irrespective of whether or not a CABG surgery resulted in hospital in-patient death.

Surgeon characteristics included the surgeon's gender and age (as a surrogate for practice experience). Hospital characteristics included hospital ownership, hospital level, and geographic location. The hospital ownership variable was recorded as one of three types: public hospital, private not-for-profit (NFP), or private for-profit (FP). The hospital level variable classified each hospital as a medical center (with a minimum of 500 beds), a regional hospital (minimum 250 beds), or a district hospital (minimum 20 beds). Hospital level can therefore be used as a proxy for both hospital size and clinical service capabilities. Hospital teaching status was not included within the regressions since all medical centers and regional hospitals in Taiwan are teaching hospitals. In addition, given the relatively small number of cases in private FP hospitals, as well as hospitals located in eastern Taiwan, all of the private NFP and FP hospitals, and those hospitals located in central, southern, and eastern parts of Taiwan, were combined into a single category referred to as "others."

Patient characteristics comprised age, gender, and severity of illness. Since no illness severity index is currently available in Taiwan, we used the Charlson Comorbidity Index (CCI) to quantify preexisting comorbidity. The CCI was developed in 1987 by Charlson and colleagues [13] as a means of classifying comorbid conditions that might affect the risk of death from comorbidity disease, and it has been widely used for risk adjustment in administrative datasets [14].

In addition, after the method proposed by Rathore and colleagues [6], the following ICD-9-CM codes were adjusted: principal diagnosis of myocardial infarction (MI), secondary diagnosis of MI, any other non-MI coronary disease diagnosis, concomitant valve repair, and the use of an internal mammary graft. A two-sided p value of 0.05 or less was considered statistically significant.

Results

Table 1 describes the distribution of the sampled patients by patient, surgeon, and hospital characteristics. Of the 9,895 first-time CABG hospitalizations during the three-year study period, 7,536 (76.2%) were male and 356 (3.6%) were discharged on death. The mean age of the patients was 66.7 years, while that of the attending surgeons was 44.7 years. No sampled patient underwent concomitant valve repair during the study period.

The bivariate analyses of patient, surgeon, and hospital characteristics by discharge status, which are also presented in Table 1, indicate that significant relationships

Table 1. Distribution of CABG Patients in Taiwan, 2000–2002 (n = 9,895)

	Totals		Discharge Status				
			Alive		Deceased		
Variables	No.	%	No.	%	No.	%	*p* Value
Patient gender							
Male	7,536	76.2	7,278	96.6	258	3.4	0.096
Female	2,359	23.8	2,261	95.9	98	4.2	
Patient age							
<65	3,637	36.8	3,560	97.9	77	2.1	<0.001
65–74	3,885	39.3	3,751	96.6	134	3.5	
>74	2,373	24.0	2,228	93.9	145	6.1	
Coronary disease							
MI as primary diagnosis	848	8.6	744	87.7	104	12.3	<0.001
MI as secondary diagnosis	76	0.8	67	88.2	9	11.8	
Other coronary artery disease	8,971	90.7	8,728	97.3	243	2.7	
Diabetes							
Yes	2,970	30.0	2,925	98.5	45	1.5	<0.001
No	6,925	70.0	6,614	95.5	311	4.5	
Hypertension							
Yes	3,861	39.0	3,821	99.0	40	1.0	<0.001
No	6,034	61.0	5,718	94.8	316	5.2	
COPD							
Yes	336	3.4	325	98.5	11	3.3	0.045
No	9,559	96.6	9,208	96.3	351	3.7	
Renal disease							
Yes	807	8.2	742	92.0	65	8.0	<0.001
No	9,088	91.8	8,797	96.8	291	3.2	
Congestive heart failure							
Yes	836	8.5	781	93.4	55	6.6	<0.001
No	9,059	91.5	8,758	96.7	301	3.3	
Peripheral vascular disease							
Yes	78	0.8	78	100	—	—	
No	9,817	99.2	9,461	96.4	356	3.6	
Internal mammary artery grafts							
Yes	4,355	44.0	4,263	97.9	92	2.1	<0.001
No	5,540	56.0	5,276	95.2	264	4.8	
Surgeon gender							
Male	9,605	97.1	9,265	96.5	340	3.5	0.075
Female	290	2.9	274	94.5	16	5.5	
Surgeon age							
<41	4,162	42.1	3,988	95.8	174	4.2	0.003
41–50	3,173	32.1	3,087	97.3	86	2.7	
>51	2,560	25.9	2,464	96.3	96	3.8	
Hospital level							
Medical center	7,192	72.7	6,955	96.7	237	3.3	0.008
Regional hospital	2,703	27.3	2,584	95.6	119	4.4	
Hospital ownership							
Public	3,742	37.8	3,563	95.2	179	4.8	<0.001
Private not-for-profit	5,824	58.9	5,655	97.1	169	2.9	
Private for-profit	329	3.3	321	97.6	8	2.4	
Hospital location							
Northern	5,847	59.1	5,596	95.7	251	4.3	0.001
Central	1,275	12.9	1,237	97.0	38	3.0	
Southern	2,616	26.4	2,553	97.6	63	2.4	
Eastern	157	1.6	153	97.5	4	2.6	

CABG = coronary artery bypass grafting; COPD = chronic obstructive pulmonary disease.

Table 2. Surgeon, Hospital, and Patient Characteristics in Taiwan, by Surgeon CABG Volume Groups, 2000–2002

	Surgeon CABG Volume Group											
	Low (1–50)			Medium (51–100)			High (101–150)			Very High (≥151)		
Variable	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)
Surgeon characteristics[a]												
No. of Surgeons	258			21			16			21		
Mean of surgeon CABG volume			6 (9)			68 (14)			121 (12)			260 (86)
Mean of surgeon age			41.8 (6.4)			39.5 (6.2)			44.0 (9.3)			47.1 (8.1)
Surgeon gender												
Male	242	93.8		21			16			20	95.2	
Female	16	6.2								1	4.8	
Hospital characteristics[b]												
No. of hospitals	27			7			6			6		
Hospital level												
Medical center	9	33.3		2	28.6		3	50.0		4	66.7	
Regional hospital	18	66.7		5	71.4		3	50.0		2	33.3	
Hospital ownership												
Public	7	25.9		3	42.9			1	16.7	2	33.3	
Private (not-for-profit)	15	55.6		2	28.6			5	83.3	4	66.7	
Private (for-profit)	5	18.5		2	28.6							
Hospital location												
Northern	10	37.0		2	28.6			3	50.0	5	83.3	
Central	8	29.6		1	14.3			1	16.7			
Southern	9	33.3		4	57.1			1	16.7			
Eastern								1	16.7	1	16.7	
Patient characteristics[c]												
Total No. of patients	1,072	10.8		1,426	14.4		1,941	19.6		5,456	55.1	
Mean age of patients			67.5 (10.3)			65.6 (10.5)			66.0 (10.0)			67.0 (10.4)
Patient gender												
Male	791	73.8		1,085	76.1		1,431	73.7		4,229	77.5	
Female	281	26.2		341	23.9		510	26.3		1,227	22.5	

[a] Total No. of surgeons = 316. [b] Total No. of hospitals = 46. [c] Total patient sample = 9,895.

CABG = coronary artery bypass grafting.

exist between discharge status and patient age ($p < 0.001$), whether a patient's condition was complicated by MI ($p < 0.001$), diabetes ($p < 0.001$), hypertension ($p < 0.001$), chronic obstructive pulmonary disease ($p = 0.045$), renal disease ($p < 0.001$) or congestive heart failure ($p < 0.001$), use of internal mammary artery grafts ($p < 0.001$), surgeon age ($p = 0.003$), hospital level ($p = 0.008$), ownership ($p < 0.001$), and geographic location ($p < 0.001$).

Patient, surgeon, and hospital characteristics, by surgeon CABG volume group, are summarized in Table 2, which shows that 316 surgeons performed the CABG surgical procedure between 2000 and 2002 at a mean volume per surgeon of 33 operations. Of these, 258 (81.7%) were in the low-volume group with 50 or less operations, while a further 21 (6.7%) were in the medium-volume group with 51 to 100 operations; 16 (5.1%) were in the high-volume group with 101 to 150 operations and 21 (6.7%) were in the very-high-volume group, with 151 or greater operations. The mean age of the patients was similar across all of the groups.

Surgeon, hospital, and patient characteristics, by hospital CABG volume group, are shown in Table 3. A total of 46 hospitals performed CABG operations during the period of this study, at a mean volume per hospital of 236 operations. The vast majority of hospitals (67.4%) fell into the low-volume group; they were also more likely to be regional or private NFP hospitals.

Table 4 provides the crude odds ratio estimates of the likelihood of hospital in-patient death, by surgeon and hospital CABG volume. Patients treated by low-volume surgeons had significantly higher mortality rates than those treated by medium-volume surgeons (7.0% vs 3.8%, $p<0.001$), high-volume surgeons (7.0% vs 2.7%, $p<0.001$), or very-high-volume surgeons (7.0% vs 3.2%, $p<0.001$). However, hospital CABG volume alone is an insufficient predictor of hospital in-patient death.

As shown in Table 5, the adjusted odds ratio of hospital in-patient deaths declined with increasing surgeon volume, with the odds of hospital in-patient death for those patients treated by low-volume surgeons being 1.52 (re-

Table 3. Surgeon, Hospital, and Patient Characteristics in Taiwan, by Hospital CABG Volume Groups, 2000–2002

	Hospital CABG Volume Group								
	Low (1–249)			Medium (250–499)			High (≥500)		
Variable	No.	%	Mean (SD)	No.	%	Mean (SD)	No.	%	Mean (SD)
Surgeon characteristics[a]									
No. of surgeons	103			96			117		
Mean of surgeon age			40.5 (5.5)			43.5 (7.6)			42.2 (6.9)
Surgeon gender									
Male	98	95.2		90	93.7		111	94.9	
Female	5	4.8		6	6.3		6	5.1	
Hospital characteristics[b]									
No. of hospitals	31			7			8		
Mean of hospital CABG volume			55 (53)			370 (44)			698 (227)
Hospital level									
Medical center	5	16.1		7	100.0		6	75.0	
Regional hospital	26	83.9					2	25.0	
Hospital ownership									
Public	7	22.6		2	28.6		4	100.0	
Private (not-for-profit)	17	54.8		5	71.4				
Private (for-profit)	7	22.6							
Hospital location									
Northern	11	35.5		4	57.1		5	62.5	
Central	9	29.0					1	12.5	
Southern	9	29.0		3	42.9		2	25.0	
Eastern	2	6.5							
Patient characteristics[c]									
Total No. of patients	1730			2,584	31.3		5,581		
Mean age of patients			66.6 (10.5)			65.7 (10.2)			67.2 (10.3)
Patient gender									
Male	1,247	72.1		1,915	74.1		4,374	78.4	
Female	483	21.9		669	25.9		1,207	21.6	

[a] Total No. of surgeons = 316. [b] Total No. of hospitals = 46. [c] Total patient sample = 9,895.

CABG = coronary artery bypass grafting.

ciprocal of 0.66) times those of medium-volume surgeons, 1.89 (reciprocal of 0.53) times those of high-volume surgeons, and 2.04 (reciprocal of 0.49) times those of very high-volume surgeons. In this regression model, the C-index value is equal to 0.805.

With the exception of the widening of the confidence intervals, when these results are adjusted for clustering effects by GEE, all of the significant relationships remain. It is also worth noting that higher hospital in-patient deaths occurred among those patients with higher CCI scores, those principally diagnosed with myocardial infarction, and those whose operations had taken place in public hospitals.

Comment

Effective identification of the volume-outcome relationship can help clinicians and policy makers alike to develop effective strategies to improve the quality of CABG surgery. Although there is, as yet, no general consensus on the volume-outcome relationship of CABG operations in the current literature, a considerable number of these studies have reported a significant relationship between high-volume hospitals or surgeons, and better patient outcomes [4–7, 15]. However, all of the prior studies were undertaken within the United States and it remains unclear as to whether the findings can be generalized to other regions or countries.

After adjusting for patient, surgeon, and hospital characteristics, we find that a significant inverse relationship exists between surgeon volume and hospital in-patient deaths; however, this study also finds that hospital volume is not a significant predictor of hospital in-patient deaths after CABG surgery. This finding suggests that in Taiwan the skill or experience of individual surgeons is a more critical factor than hospital equipment or surgical teams in determining patient outcomes after CABG surgery. This finding also comes in light of the conclusions of five earlier studies

Table 4. Crude Odds Ratios for Hospital In-Patient Deaths in Taiwan, by Surgeon and Hospital CABG Volumes, 2000–2002 (n = 9895)

	Discharge Status						
	Alive		Deceased				
Variables	No.	%	No.	%	OR	95% CI	*p* Value
Surgeon CABG volume							
≤50	997	93.0	75	7.0	1.00		
51–100	1,372	96.2	54	3.8	0.52	(0.37–0.75)	<0.001
101–150	1,888	97.3	53	2.7	0.37	(0.26–0.54)	
≥151	5,282	96.8	174	3.2	0.44	(0.33–0.58)	
Hospital CABG volume							
≤249	1667	96.4	63	3.6	1.00		
250–499	2,507	97.0	77	3.0	0.72	(0.51–1.13)	0.078
≥500	5,356	96.0	2254	4.0	1.11	(0.84–1.48)	

CABG = coronary artery bypass grafting; CI = confidence interval; OR = odds ratio.

by Hannan and others [3, 5, 12, 16, 17], which took place in New York State during different time periods. The results of these studies have consistently reported that surgeon volume is a more significant factor than hospital volume in predicting patient outcomes after CABG surgery, and that hospital volume is only marginally related to patient outcomes.

The prior literature in this area proposes three possible hypotheses to explain the inverse volume-outcome relationship [1]. The first of these hypotheses, "practice makes perfect," is based upon the rationale that a larger volume of patients allows providers to develop better skills and expertise in the management of operations or treatment procedures. Therefore, high-volume providers are more likely to achieve better clinical performance due to their greater skills and experience. Under such a hypothesis, there is the likelihood that low-volume surgeons with poor outcomes can improve their clinical performance substantially by increasing their patient volume. However, we must remain cautious here because an increase in the volume of low-volume surgeons may lead to adverse effects, such as incentives being created for low-volume surgeons to lower artificially the threshold for CABG operations [18]. Furthermore, although it is difficult to refute the role that "practice makes perfect" has played in the system of healthcare delivery in Taiwan [19], we are unable to demonstrate through our cross-sectional study whether the volume-outcome relationship observed in this study can be fully explained by such a hypothesis.

The second hypothesis relates to "selective-referral," which suggests that selectively referring physicians or patients leads to the referral to providers of more patients with superior outcomes; thus, these providers would be performing a high volume of CABG procedures. The study of Luft and colleagues [7] confirmed that at least part of the volume-outcome relationship was attributable to physician referral or patient self-referral.

The findings of our study suggest that under this hypothesis, patients or referring physicians will be more inclined to move their patients toward surgeons with better patient outcomes, as opposed to those hospitals with superior reputations. In Taiwan, although physicians work in the same department within one hospital, they may, nevertheless, have graduated from different medical schools or have undertaken their residencies in different hospitals. Therefore, even within the same department, physicians could be practicing a variety of skills or procedures in CABG operations, which could well lead to very different patient outcomes.

"Self-referral" may also be a major factor contributing to the inverse relationship between the patient outcomes and surgeon volumes observed in Taiwan,

Table 5. Adjusted Odds Ratios for Hospital In-Patient Deaths in Taiwan, by Surgeon CABG Volume, 2000–2002 (n = 9895)

Variable	OR	95% CI	*p* Value
Surgeon CABG volume			
≤50	1.00		
51–100	0.66	(0.45–0.96)	0.029
101–150	0.53	(0.36–0.79)	0.002
≥151	0.49	(0.36–0.67)	<0.001
Charlson comorbidity index score			
0	1.00		
1	1.45	(1.09–1.95)	0.012
2	1.58	(1.12–2.23)	0.010
3	0.55	(0.30–1.03)	0.061
4 or more	2.25	(1.34–3.78)	0.002
Surgeon age	1.00	(0.99–1.02)	0.750
Hospital level			
Medical center	0.56	(0.42–0.77)	0.003
Regional hospital	1.00		
Hospital ownership			
Public	1.00		
Others	0.45	(0.34–0.59)	<0.001
Hospital location			
Northern	1.00		
Others	0.38	(0.29–0.50)	<0.001
Patient gender			
Male	0.89	(0.70–1.14)	0.369
Female	1.00		
Patient age			
Coronary disease			
MI as primary diagnosis	3.73	(2.84–4.89)	<0.001
MI as secondary diagnosis	3.22	(1.53–6.77)	0.002
Other coronary artery disease	1.00		
Internal mammary graft			
Yes	0.39	(0.30–0.51)	<0.001
No	1.00		

CABG = coronary artery bypass grafting; CI = confidence interval; MI = myocardial infarction; OR = odds ratio.

particular since, in the absence of a referral system, Taiwanese consumers have the freedom to choose their preferred provider. Physicians with good reputations or superior outcomes will tend to attract a greater number of patients as a result of word-of-mouth recommendations from relatives or friends [20]. However, prior to any policy decisions being derived from this hypothesis, further longitudinal studies will be required to determine whether surgeons with better outcomes in the initial time period would subsequently acquire any greater volume of patients.

The third hypothesis on the inverse relationship between surgeon volume and outcomes is the difference in patient characteristics between low-volume and high-volume providers, particularly with regard to "severity of illness." Although this study has controlled for patient comorbidities, the administrative database used by this study is extremely limited in its ability to account for the differences in severity of coronary diseases among patients. Nevertheless, the studies by Tu and colleagues [21] and Jones and colleagues [22] have demonstrated that a relatively small number of clinical variables are sufficient to enable a fair comparison across hospitals of risk-adjusted mortality rates after CABG surgery. Moreover, the "severity of illness" hypothesis gains no support from the study of Shook and colleagues [23], which found that low-risk patients were more likely be treated by low-volume providers.

In addition to the abovementioned limitations, one additional caveat to this study should be noted. While some of the European countries and some of the states in the US have regulations limiting the number of providers allowed to perform certain procedures, the situation is quite different in Taiwan, with some surgeons having only very small CABG caseloads. Such small caseloads may prohibit meaningful statistical comparisons of the individual surgeons concerned.

Despite these limitations, this study has found that after adjusting for patient, surgeon, and hospital characteristics, an inverse volume-outcome relationship does exist for surgeons in Taiwan, but not for hospitals. Many studies have proposed feasible policy implications such as a regionalized or centralized CABG program, or even selective referral of CABG procedures to low-mortality providers based upon the volume-outcome relationship; however, low volume as an overall indicator of poor quality must be used with considerable caution. It is difficult to deny the existence of low-volume surgeons who provide excellent CABG surgery outcomes and high-volume surgeons who provide poor outcomes; indeed, the casual mechanisms linking volume and outcomes remain unclear. We suggest, therefore, that volume should be used merely as a screening measure in the first instance, while initiating a more thorough, in-depth review of provider performance. We also suggest that investigations should be undertaken to identify the differences in clinical approaches and techniques between high-volume surgeons with excellent outcomes and low-volume surgeons with poor outcomes; the results of such studies could help the latter to improve the quality of their patient care.

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Online Discussion Forum

Each month, we select an article from the *The Annals of Thoracic Surgery* for discussion within the Surgeon's Forum of the CTSNet Discussion Forum Section. The articles chosen rotate among the six dilemma topics covered under the Surgeon's Forum, which include: General Thoracic Surgery, Adult Cardiac Surgery, Pediatric Cardiac Surgery, Cardiac Transplantation, Lung Transplantation, and Aortic and Vascular Surgery.

Once the article selected for discussion is published in the online version of *The Annals*, we will post a notice on the CTSNet home page (**http://www.ctsnet.org**) with a **FREE LINK** to the full-text article. Readers wishing to comment can post their own commentary in the discussion forum for that article, which will be informally moderated by *The Annals* Internet Editor. We encourage all surgeons to participate in this interesting exchange and to avail themselves of the other valuable features of the CTSNet Discussion Forum and Web site.

For March, the article chosen for discussion under the Pediatric Cardiac Dilemma Section of the Discussion forum is:

Genetic Syndromes and Outcome After Surgical Correction of Tetralogy of Fallot

Guido Michielon, MD, Bruno Marino, MD, Roberto Formigari, MD, Gaetano Gargiulo, MD, Fernando Picchio, MD, Maria C. Digilio, MD, Silvia Anaclerio, MD, Gianluca Oricchio, MD, Stephen P. Sanders, MD, and Roberto M. Di Donato, MD

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