Does anesthesiology residency training result in decreasing intraoperative drug cost from a resident's first to second month's experience in adult cardiac anesthesiology?

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Original Article

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Abstract

Background: All physicians bear the responsibility of minimizing cost while providing care that meets or exceeds national quality benchmarks. Intraoperative anesthetic drug costs constitute a small but significant fraction of the total cost in the perioperative period. Previous studies have revealed that anesthesiologists are generally unaware of drug costs. In order to determine if experience and education improve anesthetic drug cost containment, we compared the total anesthetic drug cost per case as residents progressed through their rotations in cardiac anesthesia.

Methods: We considered the total anesthetic drug cost for 202 adult cardiac cases, including coronary artery bypass grafting, mitral valve repair/replacement, and aortic valve repair/replacement. 77 of the cases analyzed were done by residents in their first month of cardiac anesthesia, and 125 were done by residents in their second month of cardiac anesthesia. In the interval between these rotations, residents participate in didactics and other educational activities including a practice management rotation in the CA-3 year where they are exposed to financial topics in healthcare.

Results: The average total drug cost per case for residents in their first month was $193.50; SD= $82.00. The average total cost per case for residents in their second month was $223.30; SD=$96.10. With multivariate analysis considering case type, length of procedure and patient age, the resident training level did not impact the cost in a significant way (p=0.062).

Conclusions: In the multivariate analysis considering case type, length of procedure and patient age, more experienced residents did not have a significantly different total drug cost per case. This finding suggests that didactic educational efforts and implicit modeling over time did not reduce drug costs in the operating room during adult cardiac surgery.

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Introduction

The escalating cost of health care is an issue of great concern for patients, physicians and the government. Despite numerous attempts to curtail growth in spending, the cost of health care continues to rise and is projected to consume 19.3% of the US gross domestic product by 2019 [1]. According to the Organization for Economic Co-operation and Development (OECD) the average health care expenditure per person in the United States is two-and-a-half times greater than the worldwide OECD average and twice as much as the average health care expenditure per person in France, a country which is generally accepted as having very good health care[2]. Spending on pharmaceutical and medical goods in the US is higher than in any other country.

Multiple studies have assessed the cost of coronary artery bypass grafting (CABG) in the US[3-8]. The cost for CABG ranged from $15,600 to $29,120 depending on patient presentation, hospital factors, and patient population characteristics. Approximately 10% of the total expenditure for a CABG operation is consumed by drug cost. Even though intraoperative drug cost constitutes a relatively small fraction of the total cost for cardiac surgery, the sum total of drug cost is significant. Little evidence exists to support cost considerations in determining which medications to use in providing anesthesiology care during cardiac surgery. Cost awareness among anesthesiologists has been notoriously low. In one study questioning anesthesiology staff at various levels of experience regarding the costs of anesthesia care, only 47% of estimated costs of consumables were within 50% of actual cost[9]. Multiple other studies have revealed that anesthesiologists tend to underestimate the cost of expensive drugs while overestimating the cost of inexpensive drugs[10-12]. This lack of knowledge in our profession regarding drug cost may hold profound implications for total drug costs in the operating room.

Drug wastage is a significant contributor to high drug costs in the operating room. For example, in the year 2000, one study documented at least $300 per operating room in wasted drug costs over a two-week period[13]. For phenylephrine alone, the projected wastage per operating room per year was $1,621. Another study reported that the cost of wasted drugs in the operating room constituted nearly 47% of the total cost for drugs issued[14]. The IV anesthetic Propofol and neuromuscular blocking agents were the drugs most commonly wasted. Education regarding drug costs and measures to reduce drug wastage have been shown to be effective[15].

In our Anesthesiology residency program, seven residents per year progress through a four-year training sequence. The anesthesiology residency program requirements mandate practice management education for trainees. At the end of training residents are expected to incorporate considerations of cost awareness and risk-benefit analysis in patient-based care. The practice management program requirements are fulfilled at our facility with a series of didactic conferences, a two-week operating room management rotation, and via implicit modeling from staff physicians. This study proposes to measure the effectiveness of this training on improving intraoperative drug costs during the course of a resident's time in training.

Materials and Methods

Anesthesiology residents are required to complete at least two months of adult cardiac anesthesia care during their three year clinical-anesthesia training sequence. Typically, in our program, the first month occurs during the latter half of the CA-1 year through mid way into the CA-2 year. The second month usually occurs from mid CA-2 year up to the middle of the CA-3 year. In the interval between these rotations, residents are exposed to four practice management didactic sessions and other educational activities including a practice management rotation in the CA-3 year where they are educated on financial topics in healthcare. In addition, residents are continuing to train in our program over this timeline and are thus exposed to staff Anesthesiologists who are incentivized to model cost effective healthcare delivery. The primary endpoint for this study is the average total intraoperative anesthesia drug cost (excluding volatile anesthetics) for residents in their first month versus residents in their second month of adult cardiac anesthesia.

All intraoperative drugs (excluding volatile anesthetics) used by the anesthesiology care team in our 450-bed independent academic medical center flagship hospital are dispensed from an electronic medication-dispensing machine located in the operating room. Following institutional IRB approval, total drug costs for cases done by anesthesia residents in their first or second month of cardiac anesthesia for a twenty-two month period were extracted from the automated medication dispensing system database. Data was obtained on 202 adult cardiac surgery procedures including coronary artery bypass grafting (CABG), mitral valve repair/replacement (MVR), and aortic valve replacement (AVR), which were performed from January 2010 to October 2011. The start time for the data draw was set to coincide with a revision in the practice management educational content provided to our residents. Secondary endpoints considered in this study included patient age, duration of surgery, and type of surgery (CABG vs. Valve surgery).

Statistical Analysis

Because our data was normally distributed, the student's t-test was used to assess the difference in total cost among the dependent variables. To check for any confounding effect on our results, we also performed multivariate analysis, analyzing the impact of resident level, duration of anesthesia, surgical case type and the age of the patient on total drug cost.

All analyses were performed in STATA /IC v. 11 (College Station, TX).

Results

There were 77 cases performed by residents in their first month of cardiac anesthesia and 125 by residents in their second month during this time period. Cases performed as primary by fellows, by CRNAs or by residents in their third month of cardiac anesthesia were excluded from the analysis. For residents in their first month, the average total drug cost was 193.50 with a standard deviation of 82.0. For residents in their second month, the average total drug cost was $223.30 with a standard deviation of 96.1. Utilizing the student's t-test, this difference was statistically significant (P= .025). This difference did not hold under multivariate analysis when accounting for case length, type and the age of the patient involved (see table 3).

We also compared the average anesthetic drug cost for cases shorter than 7 hours with cases longer than 7 hours, and no statistically significant difference in price was found between the two groups. Similarly there was no difference in cost when comparing CABG to valve surgery, or when comparing patients younger than 70 to patients older than 70. Multivariate analysis showed no statistically significant difference for length of case, surgical procedure and age of patient (see table 3).

For 3 selected, high-cost drugs, only dexmedetomidine was used out of proportion to case volume by CA-2 residents (19 vials or 86.4% of usage on 62% of total cases –see table 1). 65% of nicardipine usage and 62% of esmolol usage were by CA-2 residents. Nicardipine contributed the largest amount of total drug cost for all drugs utilized in these cases, accounting for 32% of intraoperative drug expense (see table 4).

Table 1. Characteristics of the data stratified by resident level

Variable	Resident Level 1 (n = 77) **Mean ±SD n(%)†**	Resident Level 2 (n = 125) **Mean ±SD n (%)†**
Patient Age (y)	67.8 ±12.5	65.8±12.1
Total Cost	193.5 ± 82.03	223.3 ± 96.1
Duration of Anesthesia (hours)	7.3 ± 1.9	7.1 ± 1.7
Drug		
Dexmedetomidine (N = 22)	3 (13.6%)	19 (86.4%)
Nicardipine (N = 100)	35 (35%)	65 (65%)
Esmolol (N = 184)	70 (38 %)	114 (62 %)

† number of times the drug was used by resident, percentage was calculated by n/N.

Table 2. Comparisons of total costs

Variable	N	Drug Cost Mean ±SD	(95 % CI)	P-value†
Resident level				
Level 1	77	193.5 ± 82.0	174.9, 212.2	-
Level 2	125	223.3 ± 96.1	206.3,240.3	0.025*
Duration of anesthesia				
≤ 7 hours	139	207.0 ± 95.4	191.0, 223.0	-
> 7hours	63	222.9 ± 83.5	201.9, 244.0	0.225
Medical procedure				
Aortocoronary bypass	115	202.3 ± 87.6	186.2, 218.6	-
Aortic/mitral valve replacement/repair	87	224.7 ± 96.5	204.1, 245.3	0.087
Age group				
≤ 70 years	120	218.1 ± 93.9	201.1, 235.1	
> 70 years	82	202.9 ± 88.7	183.4, 222.4	0.250

*p< 0.05

Table 3. Multivariate analysis – linear regression

Variable§	Coefficient	SE	(95 % CI)	P-value
Resident level	26.4	14.1	-1.4, 54.13	0.062
Duration of anesthesia	17.6	14.2	-10.3, 45.6	0.216
Surgical procedure	18.9	13.7	-8.08, 45.9	0.168
Age group	-7.8	13.8	-35.1, 19.5	0.574
Surgeon	4.2	13.7	-22.8, 31.9	0.758

§resident level 1, anesthesia time ≤ 7 hours, Aortic/mitral valve replacement/repair, age ≤ 70 years-old were coded as reference.
When adjusting for all dependent variables, no statistically difference in total cost was found at 5% level of significance.

Table 4 - Percentage of total cost by drug (Total cost $ 42.820.2)

Drug	Drug Cost (U$)	% total drug cost
Nicardipine (N = 100)	13,714.8	32 %
Esmolol (N = 184)	3,544.4	8%
Dexmedetomidine (N = 22)	1,495.6	3.5%

Discussion

In this study of educational impact on intraoperative drug costs for cardiac anesthesia, multivariate analysis considering case type, length of procedure and patient age, failed to show a significant impact of higher resident experience level on total drug cost per case. This finding suggests that didactic educational efforts and implicit modeling over time did not reduce drug costs in the operating room during adult cardiac surgery.

One explanation for this finding could be that more complex cases may have been assigned to more experienced residents, and that these patients may have required greater pharmacologic support. Though no formal system is in place to regulate the preferential assignments of less complex cases to beginner residents, there is an informal process in place by the clinical directors of our department to assign beginner residents to the less complex of the available cases. Hospital costs for cardiac surgery have already been shown elsewhere to increase with the number and severity of patient comorbidities[16-17]. Still, multivariable analysis that included proxies for case complexity failed to reveal an effect.

We can also speculate cost over the training sequence did not decrease because experienced residents attempted to anticipate the pharmacologic needs for their patients prior to staff consultation. The departmental guidelines for adult cardiac anesthesia contain specific medications that should usually be prepared for adult cardiac cases. In anticipation of individual patient needs, more experienced residents may have strayed outside the guidelines in preparation. This anticipatory dispensing of additional expensive medications may have resulted in higher wastage in cases performed by upper level residents. (unclear)There is no method available to retrospectively determine the extent to which this occurred on these cases.

Our study did not factor in overall case cost or ICU length of stay and thereby provides only a narrow view of drug costs. Fast-track anesthesia is a strategy commonly employed as a measure to reduce overall cost for patients undergoing cardiac surgery. Patients are anesthetized with a goal of extubating in the ICU within a few hours of arrival. Fast track anesthesia has been shown to be safe and cost-effective[18]. With this goal in mind, less expensive, but longer sedating drugs like opioids and benzodiazepines are minimized. Instead, more expensive medications like dexmedetomidine are used for sedation, until the patient is ready for extubation. The intraoperative cost of anesthesia tailored for a fast-track approach may be more expensive, but seems to be cost-effective with regard to the total cost of care, when the post-operative period is included in the analysis[19].

Of the three highest expense drugs analyzed, only dexmedetomidine was used out of proportion to case volume by CA-2 residents. While known to be an expensive drug, nicardipine did contribute out of proportion to total drug cost beyond what was expected (32% -see table 4). This suggests a role for additional methods of improving drug cost going forward, such as requiring expressed staff physician approval prior to utilizing high-cost drugs like nicardipine.

In the face of rising health care costs, all physicians share the responsibility to minimize cost without reducing the quality of patient care. At our facility we strive to do so by reducing intraoperative anesthesia drug costs through education of our resident anesthesiologists. The results of this study did not reveal a decrease in intraoperative drug cost as residents progressed through training at this time. Future strategies will include more explicit education of residents about the costs of specific drugs along with alternative strategies to reduce costs.

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