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Is Physician Anesthesia Cost-Effective?

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One of the most controversial issues in anesthesia is whether nonmedically directed nurse anesthetists are relatively more cost-effective than anesthesiologists in the provision of anesthesia care. We electronically surveyed anesthesia practices throughout the United States to estimate the range in anesthesia professional costs from the payer perspective. Using this survey data on anesthesia reimbursement and published outcomes studies, we developed an *ad hoc* model to estimate the cost-effectiveness of physician-directed anesthesia relative to a nonmedically directed nurse anesthetist model of care from the payer perspective. Cost-effectiveness ratios were defined as the ratio of incremental costs associated with physician anesthesia relative to the estimated incremental life expectancy gains with this model of care (i.e., dollars per year of life saved [$/YLS]). Reference case results suggest that physician anesthesia is cost saving with an estimated incremental cost-effectiveness ratio of −$2,601/YLS for a younger privately insured patient and an estimated cost-effectiveness ratio of −$4,410/YLS for an elderly Medicare insured patient. Cost-effectiveness ratios ranged from −$4,410 to $38,778/YLS in univariate and multivariate sensitivity analyses across payer types. Results were most sensitive to assumed differences in reimbursement (commercial conversion factors) and to mortality rate assumptions by provider type. This analysis offers economic evidence in support of the physician anesthesia model of care.

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Information on the relative cost-effectiveness of health care services can help determine whether a health care service is worth the cost. If a practice change (e.g., introduction of a new medication, technology, or model of care) is associated with better patient outcomes, the relative cost-effectiveness of this change is then determined by whether (and by how much) resource utilization is decreased, increased, or unchanged compared with the baseline practice model. Unfortunately, practice changes that improve patient outcomes often increase net health care expenditures. Policymakers must decide whether these improvements are worth the increased costs. In general, practice changes that achieve improved patient outcomes at a cost-effectiveness ratio of no more than $50,000 to $100,000 per year of life saved (2002 constant dollars) are considered reasonable for adoption because this is the estimated cost-effectiveness of medical interventions payers typically reimburse (1,2).

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One of the most controversial issues in anesthesia is whether nonmedically directed nurses with graduate-level education in anesthesia (nurse anesthetists) are relatively more cost-effective than physicians specializing in anesthesiology (anesthesiologists) in the provision of anesthesia care. Cromwell and Rosenbach (3–5) argue that nurse anesthetists and anesthesiologists are highly substitutable. This is based on surveys of nurse and physician activities, which showed that both groups are engaged in some of the same activities (e.g., preoperative evaluations, regional anesthesia, and invasive monitoring), but at different rates. Cromwell (3) asserts that substitutability is evidenced by the distribution of anesthesia personnel across hospitals and regions. Rosenbach and Cromwell (5) note that, as of 1988, there were no definitive studies showing a difference in outcome between the 2 groups, further supporting the substitutability of nurses for physicians. The fact that nurses are involved in complex surgical procedures is offered as *prima facie* evidence of perceived quality by surgeons and health care facilities.

In purely economic terms, physicians are often claimed to be much more expensive than nurses, based on differences in income. In 1999, Cromwell (3) noted that anesthesiologist net incomes averaged $224,000 per year, compared with $80,000 per year for

0003-2999/04

nurse anesthetists working independently or in anesthesia care teams. Johnstone (6) reported that the hourly fee locum tenens agencies charge for anesthesiologists and nurse anesthetists were $133 and $86/h, respectively. These studies suggest that substituting nurse anesthesia for physician anesthesia would not adversely impact patient outcomes, would decrease health care costs, and, therefore, would be a cost-saving practice change worthy of adoption.

More recent outcomes studies, however, suggest that physician and nurse anesthesia may not be substitutable services because anesthesia delivered by physicians (whether personally performed or medically directing nurses), may result in fewer adverse events compared with nonmedically directed nurse anesthesia (7,8). Furthermore, differences in income and locum tenens agency fees for physician and nurse anesthetists likely do not represent the true costs of providing anesthesia services. Additional information on the total costs associated with anesthesia care by provider type is needed before the adoption of any anesthesia practice changes.

Using survey data on anesthesia reimbursement and published outcomes studies, we developed an *ad hoc* model to estimate the cost-effectiveness of physician-directed anesthesia relative to a nonmedically directed nurse anesthesia model of care from the payer perspective. The purpose of this study was to assess whether the observed improvements in quality of care with physician-directed anesthesia can be obtained at a cost deemed reasonable by societal standards.

Methods

Cost-Effectiveness Analysis

We conducted cost-effectiveness analyses to estimate the incremental cost per year of life saved ($/YLS) associated with physician anesthesia compared with the nurse anesthetist model of care from the private as well as the public payer perspective. Costs (measured in 2002 constant dollars) considered in the model included anesthesia provider costs as well as potential cost savings associated with reduced perioperative morbidity and mortality under the physician treatment model. Effectiveness of physician versus nurse anesthesia is based on observational data assessing mortality and failure to rescue rates by provider type. We undertook extensive sensitivity analyses (univariate, multivariate, and threshold analyses) to assess uncertainty in results.

Model Inputs

Anesthesia Outcomes. Morbidity and mortality associated with anesthesia has decreased markedly over the last 50 yr. In 1954, Beecher and Todd (9) reported an anesthesia-related mortality rate of 1:1,560 anesthetics. In 1989, Eichhorn (10) reported an anesthesia-related mortality rate of 1:151,400 in 757,000 anesthetics delivered from 1976 to 1985. The same study reported that from 1985 to 1988 when monitoring standards (including pulse oximetry) were introduced, no anesthetic-related deaths occurred in >240,000 anesthetics. In 1993, Warner et al. (11) reported similar results, finding no anesthetic deaths in >75,000 anesthetics. The American Society of Anesthesiologists' (ASA) Closed Claims Study has shown significant decreases in malpractice claims brought for death, brain damage, and respiratory system damage (12).

Over the last quarter century, the number of anesthesiologists has tripled (13,14) whereas the numbers of nurse anesthetists has grown by only 75% (3,14). This increase in physician anesthesia may be a contributing factor for observed improvement in anesthesia outcomes (15). A variety of studies and health policy data support this contention. Bechtoldt (16) and Forest (17) documented a decrease in anesthesia-related morbidity and mortality with physician anesthesia compared with nurse anesthesia. In both studies, the best outcomes were seen when anesthesiologists medically directed nurse anesthetists (i.e., the anesthesia care team). Bechtoldt (16) did not offer statistical analysis of his results, but the reported anesthesia-related mortality rate was 26% larger when nurse anesthetists worked without anesthesiologists. Forest's results (17) did not reach statistical significance—perhaps the result of an insufficient sample size. In the study sample of 8593 patients, the standardized mortality ratio and the Bayes-adjusted ratio favored hospitals with anesthesiologists. In 2000, Curling et al. (8) found that anesthesia personally provided by an anesthesiologist for thoracoabdominal aneurysm repair had a smaller mortality rate compared with nurse anesthetists medically directed by anesthesiologists (4.26% versus 15.8%; $P = 0.005$, respectively).

Using anesthesia-related mortality as a metric for quality of care is problematic because determining which perioperative deaths are anesthesia-related requires a subjective determination (9–11,16,17). The subjective nature of and the infrequent incidence of anesthesia-related mortality has made it difficult to study the impact of practice changes on anesthesia outcomes. Other outcomes of care, such as 30-day mortality and failure to rescue rates (i.e., death after an adverse event), have emerged in the literature as more sensitive measures of the quality of hospital care (18). In the context of anesthesia outcomes, 30-day mortality and failure to rescue may be superior metrics in determining differences between practice models, because it is increasingly evident that apparently small

differences in hospital course can lead to significant differences in eventual outcomes. For example, Mangano et al. (19) and Browner et al. (20) have shown that, although perioperative administration of a β-adrenergic-blocker makes no difference in hospital course, it leads to a significant difference in 2-yr mortality rate.

In a more recent study, Silber et al. (7) reviewed the Medicare claim records of 217,440 patients who had elective general and orthopedic surgical procedures. The study examined the outcomes of patients who received anesthesia from nurse anesthetists who were medically directed by anesthesiologists (n = 194,430) and nurse anesthetists supervised by the operative physician (n = 23,010). The results showed that the 30-day mortality, complication, and failure to rescue rates were 4.53%, 47.9%, and 9.32%, respectively, for undirected nurse anesthetists. This compared with 3.41%, 41.2%, and 8.18%, respectively, for nurse anesthetists medically directed by anesthesiologists, P = 0.0001. When the data were adjusted for patient and hospital characteristics, the adjusted odds ratio for 30-day mortality and failure to rescue were larger when care was not directed by anesthesiologists (1.08, $P < 0.04$, and 1.10, $P < 0.01$, respectively).

These results suggest that, for every 400 patients anesthetized by nonmedically directed nurses, 1 additional patient will die within 30 days compared with those anesthetized by physician-directed models of care. These results suggest significantly far more frequent anesthesia-related mortality than has been previously reported. The length of follow-up (i.e., 30-day mortality versus the immediate perioperative period) and differing methods of attributing mortality to anesthesia care (i.e., multivariate analysis versus retrospective chart review) likely contribute to the difference in anesthesia-related mortality reported by Silber et al. (7) and those reported in earlier studies.

The results of Silber et al. (7) are consistent with the results of two recent studies that examined the relationship, if any, between patient outcomes and education level. Needleman et al. (21) reviewed administrative data from 1997 of more than six million patients from 11 states, to examine the relation between the amount of nonanesthesia care provided by registered nurses, licensed practical nurses, and nurses aides at the hospital and patient outcomes. The study showed that a larger proportion of care provided by registered nurses was associated with smaller rates of hospital morbidity and length of stay. In 2002, Silber et al. (22) reviewed 144,883 Medicare claim records of patients who had elective general and orthopedic procedures. The results showed that adjusted odds ratios for 30-day mortality and failure to rescue were larger when anesthesia was delivered by non–board-certified anesthesiologists versus board-certified anesthesiologists. These studies support the results of the study by Silber et al. (7) of nurse anesthetist direction in which better outcomes are seen when care is delivered by those with more education and a more rigorous certification process.

Anesthesia Provider Costs. Although data on income and locum tenens agency fees for physician and nurse anesthetists are available in the literature, neither accurately reflects the true value of the resources used to provide anesthesia services as recommended by current guidelines for cost-effectiveness analyses (23,24). Incomes of anesthesiologists and nurse anesthetists are significantly impacted by practice productivity, patient acuity, other sources of professional income (e.g., consultations, critical care, and pain management services), and various practice models (e.g., physicians and nurses split the professional fee in anesthesia care team practices whereas the entire fee is retained in sole provider practices). Similarly, locum tenens agency fees can vary based on profit margins and local market conditions. Anesthesia reimbursement, which has been based on a relative value system since the 1960s, may offer a closer approximation to the true cost of providing anesthesia services.

Anesthesia reimbursement is a patient-specific reimbursement system that incorporates a predefined number of base units determined by the complexity of the procedure and the length of the procedure (time units). Total reimbursement for an anesthesia procedure is determined by the sum of the base and time units multiplied by a payer-specific monetary conversion factor. In 2002, the national average Medicare anesthesia conversion factor was $16.60 for nurse and physician anesthesia (25). Other public payers have followed suit with some state workers compensation programs, state and federal employee benefit programs, as well as state Medicaid programs reimbursing at the same anesthesia conversion factor rate regardless of provider type (26–29).

The value of private payer nurse and physician anesthesia conversion factors, however, is often shrouded in secrecy, hidden behind fears of antitrust violations. Blue Cross Blue Shield of Michigan and South Dakota, for instance, publicly acknowledge a provider-specific payment scheme (nurse anesthetists at 85% and 75%, respectively, of the physician rate). However, the nominal value of the anesthesia conversion factor is not clearly specified (30,31). Blue Cross Blue Shield in Maryland and Louisiana pay the same conversion factor for nurse and physician anesthesia but the actual amount reimbursed is not publicly available (32,33). In 2001, the ASA reported the results of a survey of 120 anesthesiology practices throughout the United States and found that the average anesthesia private conversion factor for the 3 largest volume commercial payers was $45.76 (34). Nurse anesthetist conversion factor rates, however, were not reported.

Assessment of Provider Reimbursement. To more accurately estimate the range in anesthesia costs from the private payer perspective, we electronically surveyed anesthesia practices throughout the United States in the spring of 2001. A total of 381 surveys were e-mailed to: graduates of the Mayo Clinic anesthesiology residency program ($n = 37$), ASA officers ($n = 5$), directors ($n = 28$), delegates ($n = 123$), members of the ASA committees on Economics ($n = 17$), Government Affairs ($n = 17$), Quality Management ($n = 20$), and Anesthesia Care Team ($n = 15$), academic department chairs ($n = 111$), and practice managers ($n = 8$). The survey asked these clinicians to report on the average commercial physician anesthesia conversion factor (PCCF) and the average commercial anesthesia conversion factor for nonmedically directed nurse anesthetists (NCCF) that they receive from private payers. Practice information was also assessed on the number of anesthetics delivered per year and practice location by state. Those surveyed were assured that the data would be reported only in aggregate for research purposes.

A total of 173 surveys were returned for an overall response rate of 45.4%. No economic or provider data were included in 92 returned surveys. Physician-only data were returned in 57 surveys, from 33 states. Both physician and nursing data were returned in 23 surveys, from 18 states. Reasons for not forwarding data varied. They included lack of access or willingness to share financial data, physician was not engaged in an operative practice, or lack of involvement with the nurse anesthetist model of care.

Survey results indicate that commercial anesthesia conversion factors are similar between anesthesiologists and nurse anesthetists. In fact, practices reported the same commercial conversion factor for physicians and nurses in 20 of 23 returned surveys. Overall, the average PCCF and NCCF were \$49.02 ± \$13.63 and \$47.27 ± \$14.44 per anesthesia unit, respectively ($P = 0.595$).[1] The mean cost difference of \$1.75 in favor of nurse anesthetists is not statistically significant. However, the economic implications of a small difference in reimbursement could be important considering that the average practice surveyed delivered 25,960 ± 15,392 anesthetics per year.

Cost Savings with Reduced Perioperative Morbidity and Mortality. Emerging anesthesia outcomes research suggests that morbidity and mortality rates may be reduced when anesthesia is medically directed by physicians. A complete cost-effectiveness analysis, therefore, must also consider the incremental cost savings associated with reduced perioperative morbidity and mortality under the physician treatment model. It has been well documented that the cost of care for patients incurring adverse outcomes is more expensive than the cost for patients with uncomplicated care. For example, the episode-of-care costs of patients who die after cardiac surgery has been estimated to be \$60,000–\$74,000 more than that of patients with uneventful cardiac surgery (36,37). The Institute of Medicine's report (38) cites several studies that examine the increased costs associated with adverse outcomes. For example, Thomas et al. (39) examined the medical records of 15,000 hospital discharges in Colorado and Utah in 1992. The study reported 265 preventable adverse events. When these data were weighed to represent all discharges in each state, there were an estimated 8,859 preventable adverse events at an estimated direct medical cost of \$159,245,000 or \$17,975 per preventable adverse event (1996 constant dollars). Perioperative complications were even more costly at \$34,843 per event (>\$43,000 in 2002 constant dollars) (35). We reasoned that the increased 30-day mortality seen with nonmedically directed nurse anesthesia, as suggested by the Silber et al. study (7), was a preventable perioperative complication. Therefore, we conservatively assumed in our reference case analysis that the costs incurred with perioperative death are approximately \$43,000—the average cost of preventable perioperative events and approximately half the cost of death after cardiac surgery. These values, however, varied in sensitivity analyses to assess the strength of our model results to changes in this value.

Results

Cost-Effectiveness of Physician Anesthesia

Reference case analyses were conducted from both the private and public payer perspective. Reference Case 1 assumes the provision of anesthesia care to a 50-yr-old commercially insured patient and considers our survey results on commercial anesthesia conversion factors, adjusted to 2002 constant dollars, in analysis. Reference Case 2 assumes the provision of anesthesia care to a 75-yr-old Medicare insured patient with physicians and nurses considered Medicare participating providers "taking assignment" (i.e., payment for anesthesia care does not differ by provider type at a rate of \$16.60, on average, per anesthetic unit).

There is great variability in terms of the complexity and type of surgical procedures done from practice to practice. However, studies of anesthesia practices and workforce models have shown that the average anesthetic generates approximately 13 anesthesia units per case (our assumption in both reference case analyses) (15,34,40). Thus, the incremental professional cost of physician anesthesia per case in Reference Case 1 would be:

[1] PCCF and NCCF adjusted to 2002 constant dollars using the Medical Care Component of the Consumer Price Index are \$51.32 ± \$14.27 and \$49.49 ± \$15.12 per anesthesia unit, respectively (35).

(PCCF − NCCF) × 13 anesthesia units

= ($51.32 − $49.49) × 13 = $23.79 per anesthetic

The results of Silber et al. (7) suggest that 1 additional patient will be alive 30 days after surgery for every 400 cases when nurse anesthetists are medically directed by anesthesiologists. Thus, the direct incremental cost for this improved outcome is:

$23.79 × 400 cases = $9,516 per life saved

Average estimated life expectancy for a 50-yr-old patient, based on published national health statistics, is 30 yr—20.19 yr when discounted at 3% as recommended by current economic guidelines (23,24,41). Considering the cost savings associated with reduced mortality and this assumed discounted life expectancy, the estimated cost-effectiveness of physician anesthesia compared with nurse anesthesia would be:

($9,516 − $43,000)/20.19 years = −$2,601/YLS

Similarly, for Reference Case 2 with an assumed discounted life expectancy of 9.75 yr (42), the estimated cost-effectiveness of physician anesthesia compared with nurse anesthesia would be:

($0 − $43,000)/9.75 years = −$4,410/YLS

Sensitivity Analysis

We undertook a variety of univariate and multivariate sensitivity analyses to determine how robust our cost-effectiveness results were to changing variable estimates. In univariate sensitivity analyses, we estimated the cost-effectiveness of physician anesthesia when key model variables (such as monetary conversion factor or assumed outcomes differential) were independently changed, keeping all other variables at reference-case levels. Multivariate sensitivity analyses estimate cost-effectiveness when multiple model variable values are allowed to change simultaneously.

Results of these sensitivity analyses are seen in Tables 1 and 2. Results from the private payer perspective (Table 1) were most sensitive to assumptions regarding differences in reimbursement between physicians and nurses as well as the assumed mortality gains with physician-directed anesthesia. For example, when there is maximal variance of commercial conversion factors (i.e., 2 standard deviation increase in PCCF to $79.86 and 2 standard deviation decrease of NCCF to $19.25), the estimated incremental cost-effectiveness of physician anesthesia is $13,481/YLS. Similarly, under an extremely conservative assumption of 1 life saved per 10,000 anesthetics [i.e., 25 times worse than the results seen in Silber et al. (7)], the estimated cost-effectiveness increased to >$9,600/YLS. The ratio increases to $38,778/YLS under multivariate "worst case" assumptions (i.e., those least favorable to physician anesthesia compared with nurse anesthesia).

Table 1. Results of Sensitivity Analyses for 50-Yr-Old Commercially Insured Patient

Variable estimates	Cost-effectiveness (2002 $/YLS)
Professional cost difference	
PCCF = $65.59; NCCF = $34.37	$5,911
PCCF = $79.86; NCCF = $19.25	$13,481
Outcomes gained	
1 life saved per 1000 anesthetics	−$952
1 life saved per 10,000 anesthetics	$9,653
Cost savings with reduced mortality	
$10,000	−$24
$5000	$224
Worst case assumptions	
PCCF = $79.86; NCCF = $19.25; 1 life saved per 1000 anesthetics; $5000 cost savings with reduced mortality	$38,778

PCCF = average commercial physician anesthesia conversion factor, NCCF = average commercial anesthesia conversion factor for non-medically directed nurse anesthetists; YLS = year of life saved.

Table 2. Results of Sensitivity Analyses for 75-Yr-Old Medicare Insured Patient

Variable estimates	Cost-effectiveness (2002 $/YLS)
Professional cost difference	
PMCF = $17.37; NMCF = $16.60	−$4,000
PMCF = $18.14; NMCF = $16.60	−$3,589
Outcomes gained	
1 life saved per 1000 anesthetics	−$4,410
1 life saved per 10,000 anesthetics	−$4,410
Cost savings with reduced mortality	
$10,000	−$1,026
$5000	−$ 513
Worst case assumptions	
PMCF = $18.14; NMCF = $16.60; 1 life saved per 1000 anesthetics; $5000 cost savings with reduced mortality	$1,541

PMCF = Medicare physician anesthesia conversion factor, NMCF = Medicare anesthesia conversion factor for nonmedically directed nurse anesthetists; YLS = year of life saved.

Sensitivity analyses for our elderly patient example, however, suggest that our cost-effectiveness model results were robust to alternative physician reimbursement patterns in this patient population (Table 2). For example, physicians have the option of being a Medicare-participating provider taking assignment and accepting the Medicare payment rate or they can choose to be a non–Medicare-participating provider allowed to bill up to 109.25% of the Medicare payment rate. In univariate sensitivity analyses, therefore, we assumed anesthesia care was provided by a non–

Table 3. Estimated Cost-Effectiveness of Accepted Medical Interventions (35)

Intervention	Cost-effectiveness (2002 $/YLS)[a]
Physician anesthesia	(−$4,410)–$38,778
Coronary artery bypass surgery for left main disease (1)	$12,294
Three-drug treatment for HIV (43)	$15,164–$26,829
PAP smear screening (every 3 yr starting at age 20) (1)	$33,668
Breast cancer screening (annually women aged 55–65 yr) (1)	$57,501
Neonatal intensive care unit (infants 500–999 g) (1)	$108,195

HIV = human immunodeficiency virus; YLS = year of life saved.
[a] Costs adjusted to 2002 constant dollars using the Medical Care Component of the Consumer Price Index (35).

Medicare-participating physician who billed and received payment at 50% and 100% of the maximal allowable Medicare anesthesia conversion factor (i.e., PCCF of 1.04625 * ($16.60) = $17.37 and 1.0925 * ($16.60) = $18.14 per anesthetic unit, respectively). Both analyses also assumed Medicare-participating nurse anesthetists taking assignment and receiving payment, on average, of $16.60 per anesthetic unit. Under these assumptions, results suggest incremental cost-effectiveness ratios of −$4,000/YLS and −$3,589/YLS, respectively—not significantly different from reference case results. Multivariate "worst case" analysis resulted in an estimated incremental cost-effectiveness ratio of $1,541/YLS.

Discussion

The cost-effectiveness results presented herein rely primarily on limited estimates from secondary sources. As sensitivity analyses indicate, the assumed outcome differences between medically and nonmedically directed anesthesia are important variables affecting the relative cost-effectiveness of physician anesthesia from the private payer perspective.[2] Additional anesthesia outcomes research is warranted to determine whether the outcomes differential observed in the work of Silber et al. (7) persist in additional studies across a variety of surgical populations. However, even under extremely conservative assumptions regarding mortality rate differences by provider type, the incremental cost-effectiveness of physician anesthesia in our younger patient example was estimated at <$10,000/YLS, well in the range many have deemed acceptable by societal standards as evidenced by regular payer reimbursement (Table 3).

Our study only considered the relative impact of physician anesthesia on the costs and outcomes of the operative practice. In most institutions, anesthesiologists care for patients outside of the operating suite (e.g., nonoperative procedure suites, intensive care units, pain clinics, preoperative evaluation clinics, resuscitation teams, and consultation services). The potential impact these activities may have on patient quality of care and direct medical costs was not considered in our model. Further research is clearly warranted to determine the clinical and economic impact of the nonoperative practice of anesthesiologists for a complete assessment of the incremental cost-effectiveness of medically directed versus nonmedically directed anesthesia care models.

Our cost-effectiveness results for our assumed younger privately insured patient were also sensitive to the assumed differences in reimbursement (commercial conversion factors) by provider type. With a small survey sample size, small response rate, and survey sample based on ASA membership, it is possible that our reimbursement estimates are somewhat biased. Our results for physician reimbursement data, however, are consistent with previous surveys of anesthesiologist reimbursement (34). Furthermore, the fact that commercial anesthesia conversion factors were similar between anesthesiologists and nurse anesthetists in our sample is also consistent with public and private payer reimbursement patterns (26–29). The average NCCF from these sources, in fact, is 94.7% ± 10.7% of the PCCF compared with our survey results of 96.5% ± 11.2%, $P = 0.618$. In our sensitivity analysis, with reimbursement assumptions clearly in economic favor of nonmedically directed nurse anesthesia (i.e., when there is maximal variance of conversion factors), the estimated incremental cost-effectiveness of physician anesthesia remains reasonable at $13,481/YLS (Table 1).

Multivariate sensitivity analyses offer additional economic evidence in favor of medically directed anesthesia. Under a set of "worst case" model assumptions least favorable to physician anesthesia, the estimated cost-effectiveness ratios for both our patient populations still compare favorably with the estimated cost-effectiveness of other medical interventions (such as coronary bypass surgery or breast cancer screening) (Table 3). In the worse case scenario,

[2] The incremental cost-effectiveness of physician anesthesia for an elderly Medicare insured patient, however, remains fixed at −$4410/YLS regardless of assumed mortality rate differences by provider type; assumed gain in outcome is obtained at no additional anesthesia provider cost for Medicare-participating providers taking assignment.

improved outcomes can be obtained at a cost less than the often accepted threshold of $50,000–$80,000/YLS (2). In fact, under these worse case assumptions, additional threshold analyses suggest that physician-directed anesthesia needs to improve outcomes by only 1 death avoided per 1,287 anesthetics relative to nonmedically directed nurse anesthesia [i.e., >3 times worse than the results seen by Silber et al. (7)] for physician anesthesia to be considered cost-effective by these threshold standards in our younger patient example. Similar "worst case" threshold analysis in our elderly patient example indicate that an observed outcome gain of only 1 death avoided per 24,600 anesthetics needs to be obtained with physician-directed anesthesia for this model of care to be considered cost-effective relative to nonmedically directed nurse anesthesia.

Currently, >90% of anesthetics in the United States are medically directed by physicians (5). This study offers economic evidence in support of maintaining this current practice pattern. This is not to say, however, that the use of nurse anesthetists should be discontinued. When nurse anesthetists are medically directed by anesthesiologists as essential members of the health care team, anesthesia-related mortality is very small (10,11,16,17). In those medical environments where physician anesthesia is unavailable, nurse anesthetists may be the only choice for emergency surgical treatment.

Over the last 50 years, there has been significant improvement in anesthesia outcomes. These improved patient outcomes correlate with the involvement of anesthesiologists in the care of the surgical patient (15). This study demonstrates that provider costs for physician-directed anesthesia are similar to provider costs for nonmedically directed nurse anesthesia and, when cost savings with reduced mortality are considered, physician anesthesia seems to decrease net health care costs. Even if all model assumptions are least favorable to physicians, these cost-effectiveness analyses suggest that incremental gains in life expectancy with a physician-directed versus nonmedically directed nurse model of care can be obtained at a cost deemed reasonable by society.

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