Keep Safe Anesthesia Care for All New Yorkers

Safe Anesthesia=Physician Anesthesiologist

Testimony for the
Joint Legislative Budget Hearing on
Health and Medicaid

February 12, 2018

10 AM

Hearing Room B

New York State Society
110 East 40th Street, Suite 300
New York, NY 10016

A9507 / S7507 Governor's Budget Bill

Re: Part H
Section 6902 of NYS Education Law amended by adding a new subdivision 4
Practice of Registered Professional Nursing by a Certified Registered Nurse Anesthetist

Introduction

We are here today urging you to reject the Governor's Budget Proposal (A9507 / S7507 – Part H) to codify the practice of nurse anesthetists for the reasons outlined below.

The New York State Society of Anesthesiologists, Inc., ("NYSSA") is a medical society consisting of approximately 3,650 physicians specializing in the medical field of anesthesiology. NYSSA is an organization of physicians and scientists dedicated to advancing the medical specialty of anesthesiology and to providing the safest and highest quality of anesthesia care to the citizens of New York State.

I am Rose Berkun, M.D., a Board Certified Anesthesiologist, the Immediate Past President of the NYSSA, and I practice in western New York.

I am Vilma Joseph, M.D., a Board Certified Anesthesiologist, the President Elect of the NYSSA, and I practice in the Bronx.

Under existing law[1], established nearly 30 years ago, a patient undergoing any medical treatment requiring anesthesia is guaranteed a standard of care that requires a physician anesthesiologist to administer the anesthetic or to supervise a nurse anesthetist in the administration of anesthesia or the operative surgeon accepts responsibility for supervising a nurse anesthetist.

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[1] See NYCRR Section 405.13(a)(1) [Hospitals]; NYCRR Section 755.4 [Ambulatory Surgery Centers]

With this proposal, the Governor is eliminating this time tested standard of care that has resulted in dramatically improved patient safety by removing the physician anesthesiologist entirely from the treatment team, including the preoperative assessment of the patient, the preparation of the anesthetic plan, the intra-operative phase (including induction and emergence), and post-anesthesia care.

Physician anesthesiologists are most qualified to serve as the patient's advocate. The operating room environment requires the physical presence of the physician anesthesiologist to be immediately available for medical interventions to save patient's lives for all surgical procedures when anesthesia is administered. An independent study published in the peer-reviewed journal Anesthesiology (*see attached*) found that mortality and failure-to-rescue rates were higher for patients who underwent operations without medical direction by a physician anesthesiologist *(Silber JH, Kennedy SK, Even-Shoshan O, Chen W, Koziol LFL, Showan AM, Longnecker DE: Anesthesiologist direction and patient outcomes. Anesthesiology 2000; 93: 152-63.)*

Physician anesthesiologists with 12,000 – 16,000 hours of clinical training, compared to a nurse anesthetist's approximately 2,500 hours of clinical training, are best able to perform risk benefit analysis during surgery and have the credibility to tell a surgeon whether future surgery poses a danger to the patient. This advocacy requires the knowledge of a physician.

Anesthesia care is an inherently dangerous undertaking. Some commonly used anesthetics are 1,000 times more powerful than morphine. Emergencies can arise without warning; there are no "routine" surgical procedures.

There have been dramatic improvements in the medical field of anesthesiology due to advances in medical knowledge and physician anesthesiologists' training, implementation of national society practice guidelines which establish best practice standards, better drugs, safer equipment, and adherence to the New York state existing standard of care that physician anesthesiologist accept medical responsibility for the patient undergoing anesthesia. For an objective synopsis of the approach physician anesthesiologists have adopted to dramatically improve anesthesia delivery, *please see the attached* Wall Street Journal dated June 21, 2005 entitled "Once Seen as Risky, One Group of Doctors Changes its Ways." The article notes that efforts to focus on improving patient safety have resulted in a significant decline in adverse patient outcomes in the operating room.

> "Over the past two decades, patient deaths due to anesthesia have declined to 1 death to 200,000-300,000 cases from 1 in every 5,000 cases, according to studies compiled by the Institute of Medicine, an arm of the National Academies, a leading scientific advisory body."

The changing healthcare environment, however, is placing increased pressure on preserving and enhancing safe anesthesia care. With an aging patient population, higher incidents of systemic disease, patients with more severe illnesses and conditions requiring complex surgeries, there is a greater risk for these patients undergoing anesthesia.

At a time when New York state patients are experiencing dramatically improved patient safety outcomes and when the changing healthcare environment is presenting new and more complex medical challenges, the Governor is promoting a model of anesthesia care that removes physician anesthesiologists entirely from the treatment team and in its place authorizes a nurse anesthetist to independently perform every critical function relating to the delivery of anesthesia without a physician anesthesiologist immediately available or an operative surgeon accepting responsibility for the supervision of the nurse anesthetist.

The anesthesia delivery model that is proposed by the Governor (i) has never been tested in the operating room environment in New York State, (ii) will lower the standard of care, (iii) fails to address critical issues that arise in the operating room, (iv) does not provide supporting independent analysis, peer-reviewed studies or data to support this radical policy change; and (v) will impact every patient undergoing a surgical procedure with anesthesia. Furthermore, the Department of Veterans Affairs in January 2017 announced that they rejected a collaborative relationship for nurse anesthetists because of significant questions raised about the safety of "solo" certified registered nurse anesthetist model of anesthesia. The outcome of this final rule was to maintain physician-led anesthesia care in all VA hospitals.

The anesthesia delivery model in the Governor's proposal will negatively impact every patient undergoing a surgical procedure with anesthesia for the following reasons.

1. The Governor's proposal **will create a two-tier delivery system** — without a statewide uniform requirement, as currently exists, hospitals will be free to permit nurse anesthetists to administer anesthesia independently and these decision could be based on patient payer status or other economic considerations.

2. The Governor's proposal **fails to address critical issues that arise in the operating room** resulting in a lower and inconsistent standard of care and confusion.

a. The **collaborating physician need not be a physician anesthesiologist** (the physician of like specialty with a nurse anesthetist); in fact, the collaborative party can be a **hospital with absolutely no restrictions as to the number of nurse anesthetists** it can collaborate with.

b. The **collaborating physician is not required to be present nor immediately available**.

c. The Governor acknowledges that for certain "**complex**" cases it may be in the patient's interest to have a physician anesthesiologist involved; however, **the decision to involve a physician anesthesiologist is discretionary**. The proposal also **fails to qualify how the decision as to the "complexity" is made**. Equally as important, it **fails to take into consideration the need to make medical decisions for complexities that arise during "non-complex" surgery nor for emergency surgical cases**. Nurse anesthetists cannot replace a physician anesthesiologist in making a medical assessment of a patient's special circumstances; a key component of providing high quality of anesthesia care is preparation for and anticipation of a patient's medical needs. As written, the decision as to the complexity of the case and how the decision is made does not indicate the involvement of the physician anesthesiologist.

3. The Governor's proposal **fails to impose any common sense legal oversight in granting 1,240 nurse anesthetists full prescribing authority upon obtaining a vaguely described "certificate"** — at a time that the Governor has

made combating prescription drug and opioid abuse a priority, he is simultaneously promoting a bill that will only exacerbate the public health emergency!

4. The Governor's proposal **inappropriately empowers the Department of Health, without the oversight, responsibility, or regulatory jurisdiction of a licensed professional, to define a critical healthcare professional's scope of practice** — the Department of Health's promotion of this bill is inconsistent with its primary responsibility to promulgate safe anesthesia standards for hospitals and ambulatory surgical centers.

5. The Governor's proposal f**ails to provide any supporting independent analyses, peer reviewed studies or data to support this radical policy change.**

This proposal is being advanced based upon three fundamental misconceptions.

FIRST: The premise advanced by the Governor that the bill is necessary because New York State does not recognize nurse anesthetists under Title VIII, The Professions, under the Education Law, is fundamentally misrepresenting the true objective of this bill which is independent practice for nurse anesthetists — granting a nurse anesthetist's title is not a valid justification to permit independent practice. This proposal is not consistent with the extent of a nurse anesthetist's training and existing practice nor consistent with other states. This bill represents an inappropriate expansion of the nurse anesthetist's practice by permitting independent practice. Nurse anesthetists are not trained as independent anesthesia providers. Clinical training of student nurse anesthetists provides the direct and personal supervision that the Health Code requires. *[10 NYCRR Section 405.13(a)(1)(v): a student enrolled in a school of nurse anesthesia accredited by the Council on Accreditation of Nurse Anesthesia Education Programs may administer anesthesia as related to such course of study under the direct personal supervision of a certified registered nurse anesthetist or an anesthesiologist.]* Most states require medical supervision or medical direction of nurse anesthetists.

SECOND: There are no healthcare cost savings. Under Medicare and Medicaid, reimbursement for anesthesia services is exactly the same whether it is administered by a physician anesthesiologist or by a nurse anesthetist. Independent studies have shown that the odds of an adverse outcome are 80 percent higher when anesthesia is provided only by a nurse anesthetist as opposed to a physician anesthesiologist. Adverse outcomes lead to higher costs for patients in both monetary and physical terms when patients require longer stays in hospitals. *(See attached Memtsoudis SG, Ma Y, Swamidoss CP, Edwards AM, Mazumdar M, Liguori GA: "Factors influencing unexpected disposition after orthopedic ambulatory surgery."* *J Clin Anesth* *2012; 24(2):89-95.).* Additionally, physician anesthesiologists, as perioperative physicians, reduce medical costs.

> "Increasingly, anesthesiologists direct the preoperative assessment and preparation of patients for surgery with the aim of ensuring safe and efficient care while controlling costs by reducing unnecessary testing and preventable cancellations on the day of surgery. Fischer has shown that requests for preoperative medical consultations are reduced by three quarters when the need for a consultation is determined by an anesthesiologist in a preoperative screening clinic rather than by a surgeon. Cancellations of operations due to unresolved medical or laboratory abnormalities are reduced by 88 percent, and the costs of laboratory tests are reduced by 59 percent, or $112 per patient. Unnecessary preoperative laboratory testing results in excessive health care and leads to excess morbidity."
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> — *"Anesthesiology – First of Two Parts" by Richard A. Wiklund, M.D., and Stanley H. Rosenbaum, M.D.,* *The New England Journal of Medicine,* *October 16, 1997, p. 1132*

THIRD: There is no evidence that independent practice of nurse anesthetists will improve access to anesthesia care for rural hospitals. Physician anesthesiologists serve in all areas of New York State, including the rural areas; nurse anesthetists are not the sole provider of anesthesia services in all rural areas. The Center for Health Workforce Studies' (CHWS) survey of hospital administrators in upstate New York in 2014 (paid for by the New York State Association of Nurse Anesthetists — "NYSANA") attempted to make the case that there is a problem associated with the delivery of anesthesia services (presumably due to the lack of physician anesthesiologists in the rural areas). However, the survey results revealed that:

- Only 28 hospital administrators of the 203 hospitals in New York State (about 14%) responded to the CHWS survey and revealed further that less than 13% of the respondent hospital administrators had any serious problems providing anesthesia services (equating to less than 4 out of 203 hospitals across New York State); and

- For those hospitals having trouble attracting physician anesthesiologist, they also had difficulty attracting nurse anesthetists in essentially the same proportion. The first highlight of the CHWS 2014 study claims 40%-50% of anesthesia services were provided by nurse anesthetists in upstate/rural hospitals ignoring the fact, which they later acknowledge in the survey, that a physician anesthesiologist was also involved in 85% of those cases (an operative surgeon was supervising in the rest).

In the absence of a physician-anesthesiologist, the operating practitioner is present to supervise the nurse anesthetist.

New York State patients are demanding physician supervision of anesthesia care. According to a poll from TelOpinion Research

- 89 percent of New York state residents want a physician to directly administer anesthesia or respond to emergencies when they or their family members undergo surgery.

- 85 percent of New York state residents feel strongly that physicians should continue to supervise nurse anesthetists.

- Only 11 percent of New York state residents want to remove the existing regulations regarding physician supervision of nurse anesthetists.

For reasons outlined above, the Governor's Budget Bill (A9507 / S7507) regarding codifying registered nurse anesthetists' scope of practice (Part H) must be rejected.

Attachments:

1. Silber JH, Kennedy SK, Even-Shoshan O, Chen W, Koziol LFL, Showan AM, Longnecker DE: Anesthesiologist direction and patient outcomes. Anesthesiology 2000; 93: 152-63.
2. Wall Street Journal article dated June 21, 2005 entitled "Once Seen as Risky, One Group of Doctors Changes its Ways"
3. Memtsoudis SG, Ma Y, Swamidoss CP, Edwards AM, Mazumdar M, Liguori GA: "Factors influencing unexpected disposition after orthopedic ambulatory surgery." J Clin Anesth 2012; 24(2):89-95.)

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Anesthesiology
2000; 93:152–63

Anesthesiologist Direction and Patient Outcomes

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Background: **Anesthesia services for surgical procedures may or may not be personally performed or medically directed by anesthesiologists. This study compares the outcomes of surgical patients whose anesthesia care was personally performed or medically directed by an anesthesiologist with the outcomes of patients whose anesthesia care was not personally performed or medically directed by an anesthesiologist.**

Methods: **Cases were defined as being either "directed" or "undirected," depending on the type of involvement of the anesthesiologist, as determined by Health Care Financing Administration billing records. Outcome rates were adjusted to account for severity of disease and other provider characteristics using logistic regression models that included 64 patient and 42 procedure covariates, plus an additional 11 hospital characteristics often associated with quality of care. Medicare claims records were analyzed for all elderly patients in Pennsylvania who underwent general surgical or orthopedic procedures between 1991–1994. The study involved 194,430 directed and 23,010 undirected patients among 245 hospitals. Outcomes studied included death rate within 30 days of admission, in-hospital complication rate, and the failure-to-rescue rate (defined as the rate of death after complications).**

Results: **Adjusted odds ratios for death and failure-to-rescue were greater when care was not directed by anesthesiologists (odds ratio for death = 1.08, $P < 0.04$; odds ratio for failure-to-rescue = 1.10, $P < 0.01$), whereas complications were not increased (odds ratio for complication = 1.00, $P < 0.79$). This corresponds to 2.5 excess deaths/1,000 patients and 6.9 excess failures-to-rescue (deaths) per 1,000 patients with complications.**

Conclusions: **Both 30-day mortality rate and mortality rate after complications (failure-to-rescue) were lower when anesthesiologists directed anesthesia care. These results suggest that surgical outcomes in Medicare patients are associated with anesthesiologist direction, and may provide insight regarding potential approaches for improving surgical outcomes. (Key words: Anesthesiologists; anesthesia care team; quality of care; mortality; failure-to-rescue; complication; Medicare; general surgery; orthopedics.)**

AS hospitals and physicians adapt to new financial challenges, the mix of healthcare providers has been changing. Throughout the healthcare system, there are examples of work traditionally performed by specialists that is now allocated to generalists or nonphysicians. Many of the decisions regarding provider mix have been driven by financial considerations or provider availability, rather than by patient outcome data, which would be valuable for such decision-making. There are limited outcome data regarding provider models in specific ar-

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eas, such as adult primary care office practice.[1] However, generalizations among specialties and provider types may not be valid because of differences in the intensity of the care rendered, the severity of illness of the patient, or the extent of the intervention, among others. Large-scale outcome data regarding the meaningful involvement of the anesthesiologist in surgical outcomes are few, yet the delivery of anesthesia services provides a unique opportunity to observe the influences of provider mix on outcomes in a complex medical environment. Anesthesiologists and nurse anesthetists have worked together or separately for many years, in a variety of provider models, ranging from independent practice to the "anesthesia care team" model.[2]

This study seeks to determine whether general and orthopedic surgical outcomes differ depending on whether the anesthesiologist is involved significantly in the delivery of anesthesia services to elderly Medicare patients. The answer to this question could have a significant impact on overall healthcare delivery because each year approximately 1.3 million Medicare beneficiaries are admitted to United States hospitals for orthopedic and general surgical procedures that necessitate anesthesia.[3]

Materials and Methods

Data

All Pennsylvania Medicare claims records for patients 65 yr or older were analyzed for general and orthopedic surgical admissions between 1991 and 1994. The study involved 194,430 "directed" and 23,010 "undirected" patients in 245 hospitals. Outcomes studied included death rate within 30 days of admission, in-hospital complication rate, and the failure-to-rescue rate (defined as the rate of death after complications). We obtained the Medicare Standard Analytic Files for all general surgical and orthopedic DRGs (diagnosis-related groups) in Pennsylvania between 1991 and 1994 (Medicare Part A data). For each patient we created a longitudinal record by appending all medical and surgical inpatient and outpatient claims and physicians' claims (Medicare Part B data) during that time interval. Data also included the American Hospital Association Annual Surveys for 1991-1993, and the Pennsylvania Health Care Cost Containment Council Data Base for years 1991-1994.

Patient Selection

We developed predictive models for a random sample of 50% of Medicare patients who underwent general surgical or orthopedic procedures in Pennsylvania between 1991-1994 and tested our results on the other 50%. Final results are reported regarding the full sample of 217,440 individual patients. The DRGs included in this study are listed in table 1. The first hospital admission for any one of these DRGs triggered the identification of a study hospital admission.

Table 1. DRGs Included in Dataset

General Surgical DRGs	Orthopedic DRGs
146 & 147; 148 & 149; 150 & 151; 152 & 153; 154 & 155; 157 & 158; 159 & 160; 161 & 162; 164 & 165; 166 & 167; 170 & 171; 191 & 192; 193 & 194; 195 & 196; 197 & 198; 199 & 200; 201; 257 & 258; 259 & 260; 261; 262; 263 & 264; 265 & 266; 267; 268; 286; 287; 288; 289; 290; 291; 292 & 293; 285	209; 210 & 211; 213; 214 & 215; 216; 217; 218 & 219; 221 & 222; 223 & 224; 225; 226 & 227; 228 & 229; 230; 231; 232; 233 & 234

For DRG 483 (tracheostomy), we reassigned the DRG that would have been assigned using the primary procedure code had a tracheostomy not been performed.

DRG = diagnosis-related group.

Definitions

During the years discussed in this study, the Healthcare Financing Administration (HCFA) required that anesthesia care be either medically directed or supervised by a physician (supervision is defined as a level of physician participation that is less than that defined by medical direction). According to HCFA, the supervisor or director must have been a licensed physician, but not necessarily an anesthesiologist.[4] To bill for medical direction, as defined by HCFA,[5] physicians must have met all the criteria listed in table 2. Otherwise, the level of involvement was defined as "supervision" and physicians received markedly reduced payment.

Cases billed to Medicare as "personally performed" or directed by an anesthesiologist were defined in this study as directed. Otherwise, cases were defined as undirected.

Personally performed cases also included those in which an anesthesiology resident was directed by an attending anesthesiologist. (Anesthesiologist cases in which residents were directed were billed as personally performed for the first 3 yr of the study interval, and changes in the HCFA guidelines caused direction of

Table 2. Definition of Anesthesia Direction

Personal medical direction by a physician may be paid if the following criteria are met:
- No more than 4 anesthesia procedures are being performed concurrently.
- The physician does not perform any other services (except as provided below) during the same time period.
- The physician is physically present in the operating suite.
- The physician:
  - performs a pre-anesthetic examination and evaluation
  - prescribes the anesthesia plan
  - personally participates in the most demanding procedures in the anesthesia plan, including induction and emergence
  - ensures that any procedure in the anesthesia plan that he or she does not perform are performed by a qualified individual
  - monitors the course of anesthesia administration at frequent intervals
  - remains physically present and available for immediate diagnosis and treatment of emergencies
  - provides indicated post anesthesia care.

Medicare Medical Policy Bulletin. Medical Direction of Anesthesia Services. Bulletin No. A-7A, January 1, 1994.

resident cases to be billed as "directing 2–4 cases" in the final year of the study.)

There were 23,010 patients defined as undirected in this study, of which 14,137 patients (61% of the undirected group) were not billed for anesthesia and 8,873 (39%) were billed for anesthesia. The "no-bill" cases were defined as undirected because there was no evidence of anesthesiologist direction, despite a strong financial incentive for an anesthesiologist to bill Medicare if a billable service had been performed. The cases in which an anesthesiology bill was not submitted showed billing data that indicated that a surgical procedure on our study list was performed. These cases either were supervised by a physician or a staff nurse anesthetist employed directly by the hospital or they represented undirected anesthesiology resident cases. Of these 14,137 no-bill cases, only 1,287 at most were anesthesia resident cases (or 5.6% of all undirected cases), assuming all no-bill cases at institutions with anesthesia residency programs reflected resident cases. The remaining undirected cases consisted of 8,873 patients (39% of the undirected group) for which procedures were supervised but not directed by an anesthesiologist or directed by a nonanesthesiologist physician. None of these cases included residents. Billing codes included "unknown physician specialty" (code 99) or "unknown provider" (code 88) associated with a nurse anesthetist specialty code 43 or nonanesthesiologist physician direction of the nurse anesthetist, including many other specialty designations, such as pathology (code 22) or general medicine (code 11). Of the 217,440 patients, 20,066 (9.9%) patients underwent anesthesia procedures on more than 1 day during their hospital stay. We labeled a patient undirected if on any day of the hospital stay, all anesthesia procedures performed that day were not directed by an anesthesiologist.

In HCFA billing records the specialty code for anesthesiologist is denoted by an "05" designation. Anesthesiologist designation did not imply board certification. We used information from the American Board of Medical Specialties (ABMS) to verify Medicare data. In one instance, Medicare data indicated that the directing physician was a nonanesthesiologist, yet that same physician was noted to be board certified in anesthesiology according to the American Board of Medical Specialties files. We therefore recoded that person as an anesthesiologist for our purposes.

Outcome Statistics

Death within 30 days of admission was determined from the HCFA Vital Status file. Complications (table 3) were identified using a set of 41 events defined by

Table 3. Complications: Defined Using ICD-9-CM and CPT Codes

Cardiac event (*e.g.*, serious arrhythmia)	Perforation
Cardiac emergency (*e.g.*, cardiac arrest)	Peritonitis
Congestive heart failure	GI or internal bleed
Postoperative cardiac complications	Sepsis
Hypotension/shock	Deep wound infection
Pulmonary embolus	Renal dysfunction
Deep vein thrombosis	Anesthesia event
Phlebitis	Gangrene of extremity
Stroke/CVA	Intestinal obstruction
TIA	Return to surgery
Coma/other	Decubitus ulcer
Seizure	Orthopedic complication
Psychosis	Compartment syndrome
Nervous system complications	Malignant hyperthermia
Pneumonia—Aspiration	Hepatitis/jaundice
Pneumonia—Other	Pancreatitis
Pneumothorax	Necrosis of bone/thermal or aseptic
Respiratory compromise	Osteomyelitis from procedure
Bronchospasm	Fat embolism
Postoperative respiratory complications	Electrolyte/fluid abnormality
Internal organ damage	

The algorithms for constructing the complications using ICD-9-CM and CPT codes are available upon request.

CPT = Physician's Current Procedural Terminology, 4th edition; CVA = cerebral vascular accident; GI = gastrointestinal; ICD-9-CM = International Classification of Diseases, 9th revision, Clinical Modification; TIA = transient ischemic attack.

International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) and CPT (Physician's Current Procedural Terminology, 4th edition) codes available from HCFA databases for the hospital stay of interest, previous hospital stays, and outpatient visits within 3 months before the index hospital stay. CPT codes billed before the hospital stay were used to determine long-standing conditions that would aid in distinguishing complications from comorbidities. Failure-to-rescue rate (FR) was defined as the 30-day death rate in those in whom either a complication developed or who died without a recorded complication. It can be expressed mathematically as follows: $FR = D/(C + D|\text{no } C)$ or the number of patients who died (D) divided by the number of patients with complications (C) plus the number of patients who died without complications noted in the claims data (D|no C).[6,7]

Estimates of excess deaths/1,000 patients were derived using a direct standardization approach using the full data set for both the directed and the undirected cases.[8] Using the final fully adjusted model, the probability of death was estimated twice for each of the 217,440 patients in the study, once assuming each case was undirected and once assuming the case was directed. The resultant difference between the sum of the estimated death rates, divided by the sample size, and multiplied by 1,000, provides the number of excess deaths/1,000 patients when cases are not directed. The same method was used to estimate the excess number of failure-to-rescue cases in the undirected group, except the denominator of cases includes only those with complications. The advantage of this standardization approach is that all patients are used for both estimates, hence reducing bias.

Model Development and Validation

We developed three logistic-regression models to adjust for severity of illness and case mix, one for each outcome in the 50% random or "development" sample. Candidate variables were selected if significant at the 0.05 level after univariate analysis for any of the three outcomes. DRG variables were grouped into DRG–principal procedure categories to produce more homogeneous risk groupings based on Haberman residuals[7,9,10] and then included in each model. Each model included 42 DRG–principal procedure variables and 27 patient characteristics. A total of 37 interaction terms were included in the models, having been significant at the Bonferroni adjusted 0.05 level. We validated the derived models for the remaining 50% or "validation" sample. Coefficients were not statistically different between models derived in development and validation sets. Pearson correlation coefficients between predicted outcomes in the development set and the validation set were always greater than 0.93. Final models were constructed using both the development and the validation data sets.

Hospital Analyses

To account for hospital characteristics that may have influenced our results, we adjusted the results using a list of 11 hospital characteristics that we, and others, reported previously.[7,11,12] Further, we constructed an indicator variable for each hospital and report results adjusted for each individual hospital in the logistic-regression modeling. We also performed adjustments for each hospital using Mantel-Haenszel tests[13] in a number of ways. We estimated the odds ratio (OR) associated with outcome and no direction by controlling for each hospital and stratified, in some analyses, using the risk of death or the propensity score[14–18] to predict lack of direction. When stratifying using the risk of death, we refitted the mortality model, deriving new coefficients, using a separate data set of 1995–1996 Pennsylvania Medicare patients. This allowed for unbiased odds ratios derived from the Mantel-Haenszel tests when applied to the main study set comprising 1991–1994 data.

Results

Patient Description

Table 4 describes patient case mix and table 5 displays patient characteristics that were present in at least 1% of the study population among the anesthesia directed and nondirected groups. Two odds ratios are presented in table 5. The first is the unadjusted odds ratio; the second is the Mantel-Haenszel[13] odds ratio after adjusting for DRG category and each of the 245 hospitals in the study. Undirected patients were more likely to be male; to have a history of arrhythmia, congestive heart failure, and non-insulin-dependent diabetes; and to be admitted through the emergency department. Undirected patients were less likely to have cancer.

There were some associations between covariates and direction status that were unexpected. Some of these could be explained when we studied factors that were predictive of direction[14] and factors predictive of procedures. For example, the unadjusted odds ratios in table 5 suggest undirected cases had greater odds of occurrence

Table 4. Medical Diagnostic Categories (MDC) by Direction Status

	Directed		Not Directed	
	N	%	N	%
MDC 6 Diseases and disorders of the digestive system (146 & 147; 148 & 149; 150 & 151; 152 & 153; 154 & 155; 157 & 158; 159 & 160; 161 & 162; 164; 165; 166; 167; 170 & 171)	54,443	28.00	6,805	29.57
MDC 7 Diseases and disorders of the hepatobiliary system (191 & 192; 193 & 194; 195 & 196; 197 & 198; 199 & 200; 201)	24,957	12.84	3,429	14.90
MDC 8 Diseases and disorders of the musculoskeletal system (209; 210 & 211; 213; 214 & 215; 216; 217; 218 & 219; 221 & 222; 223 & 224; 225; 226; 227; 228 & 229; 230; 231; 232; 233 & 234; 257 & 258; 259 & 260; 261; 262; 263 & 264)	111,825	57.51	12,141	52.76
MDC 9 Diseases and disorders of the skin, subcutaneous tissue, and breast (265 & 266; 267; 268)	392	0.20	86	0.37
MDC 10 Endocrine, nutritional, metabolic diseases and disorders (285; 286; 287; 288; 289; 290; 291; 292 & 293)	2,813	1.45	549	2.39
Total	194,430	89.42	23,010	10.58

in patients with insulin-dependent diabetes. However, undirected patients also had greater odds of undergoing wound debridement and skin grafts as a principal procedure, as compared with directed patients (OR = 10.14; 95% confidence interval [CI] = 8.31, 12.36). The higher rate of diabetes in the undirected group may, in part, have been caused by an increased propensity of the caregiver to perform skin graft procedures, and therefore it would not be surprising that there was an association between undirected cases and diabetes. Bickel *et al.*[19] have shown the importance of such adjustments when making inferences concerning selection bias in graduate school admissions policies. Hence, after adjustment, it would appear as though there was far less imbalance in the covariates between directed and undirected cases than was initially appreciated. However, given the remaining differences between groups, careful severity corrections for all outcomes were performed before results could be accurately interpreted.

Hospital Characteristics

The distribution of hospital characteristics according to the presence of anesthesiologist direction is displayed in table 6. Generally, the hospitals in which undirected

Table 5. Comparison of Patient Characteristics (Odds Ratio for Undirected *versus* Directed Cases)*

	Percent of Total Population	Unadjusted		Adjusted by DRG and Hospital	
		Odds Ratio	*P* Value	Odds Ratio	*P* Value
Age older than 85 yr	9.9	1.048	0.040	1.044	0.110
Male	34.7	1.122	0.001	1.053	0.002
Hx congestive heart failure	2.6	1.637	0.001	1.159	0.001
Hx arrhythmia	2.9	1.357	0.001	1.092	0.001
Hx aortic stenosis	1.8	0.979	0.689	0.996	0.946
Hx hypertension	6.6	1.202	0.001	1.017	0.578
Hx cancer	24.2	0.900	0.001	0.903	0.001
Hx COPD	12.1	1.093	0.001	1.024	0.312
Hx noninsulin-dependent diabetes	10.6	1.293	0.001	1.074	0.003
Hx insulin-dependent diabetes	1.7	2.163	0.001	1.046	0.387
Emergency department admission	34.4	1.232	0.001	1.247	0.001

* Odds ratio denotes the odds of a covariate of interest observed in the undirected group *versus* that of the directed group.

COPD = chronic obstructive pulmonary disease; Hx = history.

Table 6. Distribution of Hospital Characteristics by Type of Provider

Hospital Characteristics	Undirected	Directed	*P* Value
No. of beds greater than 200 (%)	32.72	42.49	0.0001
Nurse-to-bed ratio (RNs/bed)	1.38	1.40	0.0001
Percentage of anesthesiology staff board certified (%)	72.70	74.70	0.0001
Percentage of surgical staff board certified (%)	80.40	85.00	0.0001
Trauma Center (%)	21.87	23.90	0.0001
Lithotripsy facility (%)	17.55	15.68	0.0001
MRI facility (%)	33.27	35.90	0.0001
Solid organ/kidney transplant (%)	11.99	13.56	0.0001
Bone marrow transplant unit (%)	5.37	7.22	0.0001
Approved residency training program (%)	40.90	49.20	0.0001
Member, Council of Teaching Hospitals (%)	17.87	21.89	0.0001

MRI = magnetic resonance imaging; RN = registered nurse.

cases occurred tended to be smaller, to have less specialized technology and facilities, and were less likely to be involved with the teaching of medical students and residents.

Adjusting for Patient Characteristics and DRG-Procedure Category

Unadjusted death, complication and failure-to-rescue rates were greater when cases were undirected (table 7). Table 8 displays the influence of anesthesia direction on outcome after results were adjusted for 64 patient characteristics and interaction terms, including demographic information, history variables, whether the patient was transferred from another short-term-care hospital, whether the patient was admitted from the emergency room, and 42 DRG—procedure categories used for this study. As in the unadjusted model, mortality and failure-to-rescue rates were greater when an anesthesiologist did not perform or direct care. The adjusted odds ratios for death and failure-to-rescue were significantly increased: (OR for death = 1.09, $P < 0.021$; OR for failure-to-rescue = 1.12, $P < 0.003$) corresponding to 2.8 excess deaths/1,000 patients and 8.4 excess deaths/1,000 patients with complications. Adding patient race to this model did not change these results.

A second analysis was performed adding admission MedisGroups (MediQual Inc., Westborough, MA) severity score (a physiologic based score) obtained from the Pennsylvania Health Care Cost Containment Council.[6,20-23] During 1991-1994, MedisGroups scores were recorded for only 72.9% of our study patients. The ORs for the anesthesia direction covariate were as follows: (OR for death = 1.09, $P < 0.016$; OR for failure-to-rescue = 1.12, $P < 0.002$; OR for complication = 0.97, $P < 0.052$). These results provided further evidence that the models derived solely from the Medicare data were adequately adjusted.

We also explored whether the increased odds of death and failure-to-rescue in the undirected group were caused by admissions through the emergency department. When the non-emergency department cases were analyzed separately, the odds ratios for death and failure-to-rescue remained greater for those patients who did not receive anesthesiologist direction (adjusted OR for death = 1.17, $P < 0.007$ and adjusted OR for failure-to-rescue = 1.18, $P < 0.005$).

Adjusting for Patient and Hospital Characteristics

The lower portion of table 8 displays the results of anesthesia direction when 11 hospital variables were included in the three outcomes models. Undirected cases were associated with greater death and failure-to-rescue rates: (OR for death = 1.08, $P < 0.040$; OR for failure-to-rescue = 1.10, $P < 0.013$), corresponding to

Table 7. Unadjusted Outcomes

Outcome	Undirected Rate (%) n = 23,010	Directed Rate (%) n = 194,430	Odds Ratio*	95% Confidence Interval	*P* Value
Death	4.53	3.41	1.35	(1.26, 1.44)	0.0001
Complication	47.87	41.15	1.31	(1.28, 1.35)	0.0001
Failure to rescue	9.32	8.18	1.15	(1.08, 1.24)	0.0001

* Odds ratio denotes the odds of an outcome observed in the undirected group *versus* that of the directed group.

Table 8. Logistic Regression Results

Events	No. of Patients	No. of Events	C Statistic	Adjusted Odds Ratio*	95% Confidence Interval	*P* Value
Adjusting for patient characteristics						
Death	217,440	7,665	0.82	1.09	(1.01, 1.17)	0.0208
Complication	217,440	91,024	0.75	0.97	(0.94, 1.00)	0.0345
Failure-to-rescue	92,170	7,665	0.75	1.12	(1.04, 1.21)	0.0025
Adjusting for patient and hospital characteristics						
Death	217,440	7,665	0.82	1.08	(1.00, 1.15)	0.0399
Complication	217,440	91,024	0.75	1.00	(0.96, 1.03)	0.7941
Failure to rescue	92,170	7,665	0.75	1.10	(1.01, 1.18)	0.0128

* Odds ratio denotes the odds of an outcome observed in the undirected group *versus* that of the directed group.

2.5 excess deaths/1,000 patients and 6.9 excess deaths/1,000 patients with complications, whereas the adjusted OR for the complication rate was insignificant (OR for complication 1.00, $P < 0.796$). When the MedisGroups severity score was added to the analysis, death and failure-to-rescue ORs were stable and the associated *P* values became slightly more significant. When a variable reflecting the number of anesthesia procedures per hospital stay was added to the model, we again found the odds ratio estimates to be unchanged.

In a further analysis, we calculated the adjusted odds ratios for each outcome using the Mantel-Haenszel odds ratio, adjusting for all DRG categories and for each of the 245 hospitals in the study, and obtained very similar results. The adjusted odds ratio for death was 1.14 ($P < 0.001$), the odds ratio for failure-to-rescue was 1.11 ($P < 0.008$), and the odds ratio for complication was 1.06 ($P < 0.001$). We next constructed a model adjusting for the same patient characteristics as in table 8 plus a hospital identifier variable for each hospital (grouping hospitals with fewer than 10 deaths into one indicator variable to allow for more stable coefficients). The results were almost identical to those in table 8. The adjusted odds ratio for death was 1.09 ($P < 0.033$), OR for failure-to-rescue was 1.10 ($P < 0.016$), and the OR for complication was 1.02 ($P < 0.333$).

Further Analyses Using Mantel-Haenszel Adjustments and the Propensity Score

We conducted an additional set of analyses concerning the influence of the hospital provider on outcome in this study. Using the full model for patient characteristics, as defined in table 8, we refitted the model coefficients for a separate set of 102,781 Pennsylvania Medicare patients from 1995 and 1996, using the same procedures as in the 1991-1994 study data set. We then calculated the initial risk of death before surgery for each patient in our 1991-1994 study data set and, as suggested by Cochran,[24] we divided these risk scores at the quintiles of this distribution, yielding five risk groups of equal sample size. For each of the 245 hospitals in the data set, we then formed $245 \times 5 = 1{,}225$ cells using these five risk groups. This gave us a $2 \times 2 \times 5 \times 245$ contingency table, recording death by direction status by mortality risk strata by hospital. The associated Mantel-Haenszel odds ratio computed from the $2 \times 2 \times 5 \times 245$ cell contingency table was 1.16 (1.077, 1.246). This ratio was almost exactly the same as the Mantel-Haenszel test results with an odds ratio of 1.14, controlling for the individual hospital and DRG (see previous section in Results), whereas the logit model using hospital indicators also found a very similar odds ratio (1.09). Hence, we obtained almost identical results when the ORs were derived from regression models or derived by performing a Mantel-Haenszel analysis, controlling for risk of death, and forcing all comparisons to be stratified within the same hospital, thereby controlling for the "hospital effect."

To control for selection bias associated with direction or lack of direction, we performed an additional set of analyses using the propensity score to predict direction. Similar to the stratification of mortality risk previously discussed, we divided the propensity score at the quintiles of its distribution, yielding five risk groups of equal sample size. For each of the 245 hospitals in the data set, we then formed a 2 (death status) × 2 (direction status) × 5 (propensity score risk strata) × 245 hospital contingency table. The associated Mantel-Haenszel odds ratio computed from the $2 \times 2 \times 5 \times 245$ cell contingency table was 1.11 (1.03, 1.19). Again, the odds ratio for death associated with direction status was almost identical to that determined by our previous methods using logit regression or methods without the propensity score.

Finally, we performed an adjustment stratifying by mortality risk, propensity score, and hospital using a 2 ×

Table 9. The Marginal and Partial Influence of Hospital Characteristics and of Direction of Anesthesia Care on Outcome, Adjusting for Patient Covariates

		Adjusted Odds Ratios (95% Confidence Interval)	
Variable	Outcome Measure	Marginal	Partial
Hospital beds (≥200 beds *vs.* <200 beds)	Death	0.90 (0.86, 0.95)[g]	0.90 (0.84, 0.97)[d]
	Failure-to-rescue	0.83 (0.80, 0.88)[g]	0.87 (0.81, 0.94)[f]
	Complication	1.22 (1.20, 1.25)[g]	1.11 (1.08, 1.14)[g]
Registered nurse-to-bed ratio (in units of 25% of the mean)	Death	0.95 (0.93, 0.96)[g]	0.95 (0.92, 0.97)[g]
	Failure-to-rescue	0.94 (0.92, 0.96)[g]	0.95 (0.93, 0.98)[g]
	Complication	1.04 (1.03, 1.04)[g]	0.98 (0.98, 0.99)[f]
Magnetic resonance imaging facility	Death	0.96 (0.92, 1.01)	1.04 (0.98, 1.10)
	Failure-to-rescue	0.93 (0.89, 0.98)[c]	1.05 (0.99, 1.11)
	Complication	1.06 (1.04, 1.00)[g]	0.95 (0.93, 0.98)[g]
Bone marrow transplantation unit	Death	0.89 (0.80, 0.98)[b]	0.99 (0.88, 1.11)
	Failure-to-rescue	0.79 (0.72, 0.88)[g]	0.93 (0.82, 1.04)
	Complication	1.34 (1.29, 1.39)[g]	1.17 (1.12, 1.22)[g]
Organ transplantation unit	Death	0.91 (0.84, 0.98)[c]	1.03 (0.94, 1.12)
	Failure-to-rescue	0.83 (0.77, 0.89)[g]	0.97 (0.89, 1.07)
	Complication	1.26 (1.22, 1.29)[g]	1.12 (1.08, 1.16)[g]
Lithotripsy facility	Death	0.92 (0.86, 0.99)[b]	0.97 (0.90, 1.05)
	Failure-to-rescue	0.88 (0.82, 0.94)[f]	0.97 (0.89, 1.05)
	Complication	1.10 (1.07, 1.13)[g]	1.01 (0.98, 1.05)
Trauma center	Death	0.93 (0.88, 0.99)[b]	1.03 (0.96, 1.11)
	Failure-to-rescue	0.89 (0.84, 0.95)[g]	1.05 (0.98, 1.34)
	Complication	1.10 (1.08, 1.13)[g]	0.94 (0.91, 0.97)[g]
Surgical board certification, % (in units of 25% of the mean)	Death	0.97 (0.94, 1.00)[f]	0.99 (0.96, 1.03)
	Failure-to-rescue	0.94 (0.91, 0.98)[g]	0.98 (0.95, 1.02)
	Complication	1.07 (1.05, 1.08)[g]	1.03 (1.01, 1.04)[f]
Anesthesia board certification, % (in units of 25% of the mean)	Death	0.99 (0.97, 1.01)	1.01 (0.99, 1.03)
	Failure-to-rescue	0.97 (0.95, 0.99)[d]	1.00 (0.98, 1.02)
	Complication	1.05 (1.04, 1.05)[g]	1.01 (1.00, 1.02)[d]
Member, Council of Teaching Hospitals	Death	0.91 (0.85, 0.96)[d]	1.03 (0.94, 1.12)
	Failure-to-rescue	0.84 (0.79, 0.89)[g]	1.02 (0.93, 1.11)
	Complication	1.26 (1.23, 1.29)[g]	1.10 (1.06, 1.14)[g]
Approved residency training program	Death	0.94 (0.89, 0.98)[c]	1.03 (0.97, 1.11)
	Failure-to-rescue	0.87 (0.83, 0.91)[g]	0.99 (0.93, 1.06)
	Complication	1.21 (1.18, 1.23)[g]	1.07 (1.04, 1.10)[g]
Anesthesiologist-directed care[a]	Death	0.92 (0.85, 0.99)[c]	0.93 (0.87, 1.00)[b]
	Failure-to-rescue	0.89 (0.83, 0.96)[d]	0.91 (0.85, 0.99)[b]
	Complication	1.04 (0.87, 1.07)	1.00 (0.97, 1.04)

[a] < 0.1; [b] < 0.05; [c] < 0.01; [d] < 0.005; [e] < 0.001; [f] < 0.0005; [g] < 0.0001.

Odds ratio denotes the odds of an outcome observed in the directed group *versus* that of the undirected group.

Marginal analysis reports the odds ratios associated with hospital characteristics added one at a time in the logit model that includes 64 patient and 42 procedure covariates and interaction terms.

Partial analysis reports the odds ratios associated with hospital characteristics added all together to the logit model that includes 64 patient and 42 procedure covariates and interaction terms.

2 × 5 × 5 × 245 cell contingency table. Mortality risk was again estimated for the separate 1995–1996 patient population to avoid bias. This analysis yielded, again, similar results to the logit model reported in table 8, with an OR of 1.07, (0.99, 1.15). The slightly less significant *P* value of 0.09 may reflect the fact that we were controlling for 5 times more strata than in the previous two analyses.

Table 9 displays the results of the "fully adjusted patient model," with the addition of all 11 hospital characteristics and the direction indicator for the three outcomes. For each hospital variable, and the anesthesiologist direction indicator, we present two results. The "marginal" result is computed by adjusting the OR for direction by all patient covariates and a single hospital variable or direction indicator. The "partial" analysis displays the results of a fully adjusted model using all patient covariates, all hospital covariates, plus the direction indicator (this "partial" model is also shown in table 8). The marginal analysis showed that hospitals with more sophisticated facilities, higher nurse staffing ratios, and more educational programs were consistently associated with reduced death and failure-to-rescue rates, whereas complication rates were greater in these hospitals. We reported this same pattern in other studies.[7,11,22] Simultaneously adjusting for all the hospital variables and the anesthesiologist direction variable, we found that three factors continued to show independent effects on death and failure-to-rescue: hospital size, nurse-to-bed ratio, and direction by an anesthesiologist.

Furthermore, we asked whether the odds ratios associated with direction and outcome would have changed had we used only patients who were billed, rather than all records. The resulting logistic-regression derived odds ratios were unchanged. Finally, we asked whether adding variables denoting the size of the metropolitan area would account for the observed differences in outcome. Adjusting for the 11 hospital variables and for five levels of population size from rural to metropolitan areas greater than 1 million, we found very little difference in results (OR for death = 1.07, $P < 0.057$; OR for failure-to-rescue = 1.09, $P < 0.021$; OR for complication = 1.00, $P < 0.853$).

Discussion

After adjustments for severity of illness and other confounding variables, we found higher mortality and failure-to-rescue rates for patients who underwent operations without medical direction by an anesthesiologist. Adjusted complication rates were not associated with medical direction. This finding is not inconsistent with the finding of higher mortality rates in the absence of medical direction. Our previous work showed that complication rates, as reflected in administrative claims data, are indicators of severity of illness,[7,11,22] but adjusted complication rates are not well-correlated with adjusted death rates.[11,22,23] In Medicare surgical patients, complication rates are poor indicators of quality of care[6,7] and are not accurately coded to discern specific intraoperative events. The complication rate in this study reflects the number of patients who had complications, not the number of complications per patient. The complication list was developed to be inclusive and sensitive to most undesirable occurrences during the hospital stay, but was not specific for perioperative complications. Specific perioperative complications may not appear in the Medicare claims data, in which the limited number of fields and variation in recording patterns may prevent the complication rate from reflecting differences in quality. Hence, it is not surprising that adjusted complication rates were not different among providers, whereas 30-day mortality rate—a measure better defined and recorded—was different.

Because of these limitations in all studies involving the Medicare database, the failure-to-rescue rate was developed and validated,[6,7] and complications were used as an adjustment tool for severity of illness, rather than as an isolated outcome measure. Failure-to-rescue assesses how complications are managed by studying the rate of death only in those patients in whom complications develop or in those who die without recorded complications. Failure-to-rescue may provide better insight regarding quality of care than either mortality or complication rates used alone[6,7] because it can more easily account for differences in severity. For the current study, failure-to-rescue rates showed an even greater association with provider characteristics than did death rates. This suggests that advanced medical training may allow for better management of complications, thereby decreasing the severity of such complications, and leading to fewer subsequent deaths.

Adequate severity adjustment is always necessary for studies of the type reported herein. Given the apparent difference in the prevalence of specific comorbidities between the directed and undirected groups, adequate adjustment was especially important. As seen in table 5, much of the difference between groups could be explained by the different distribution of procedures found in the directed and undirected groups. Hence, looking at unadjusted prevalence rates of comorbidities can be deceiving in data sets such as this. A classic example of this same problem was provided by Bickel *et al.*[19] in their 1975 article of graduate admission bias using data from The University of California at Berkeley. Although unadjusted admission acceptance rates would suggest females had been discriminated against because of the observed overall lower admission rates, after adjustment for the departments to which the female students applied, it was shown that there was no significant bias. This was because the female applicants more often applied to departments with lower rates of acceptance (for both males and females), whereas male applicants more often applied to departments with higher rates of acceptance (for both males and females). Hence, the overall, unadjusted numbers suggested an imbalance in admission rates (a bias against females), whereas such an imbalance was not seen at the individual department level.

It was reassuring that, in our study, after adjustment for DRG and hospital, the difference in the prevalence of covariates between the directed and undirected groups became much smaller. In part, this was caused by a tendency for undirected patients to be involved with slightly more minor procedures in patients with a greater number of comorbidities. Although adjustments in table 5 helped to explain these differences in comorbidity rates among groups, more complete model-based adjustments were made when reporting final results.

There is strong supporting evidence that the model-based adjustments used in our study were adequate. Of interest, unadjusted rates of death, number of complications, and failure-to-rescue rates were all increased in the nondirected group. After using models that contained identical patient covariates for each of the three outcomes, we observed that the adjusted odds of development of complications decreased to 1, whereas ORs of death and failure-to-rescue remained greater than 1. Further, the unadjusted OR associated with no direction and failure-to-rescue (table 7) was almost identical to that in the fully adjusted model (table 8). This finding is consistent with a number of studies showing that a strength of the failure-to-rescue concept is that the failure-to-rescue rate appears to be less sensitive to omissions of severity of illness data than is the death or complication rate.[7,22] Finally, when a physiologic severity adjustment measure, MedisGroups Score, was added to the models, results were virtually unchanged. If the association between anesthesiologist direction and outcome was an artifact of failure of the model to adequately control for critical aspects of patient severity, we would have expected the addition of the physiologic-based patient severity score to alter the results. Together, these findings provide consistent supporting evidence that the model was adjusted adequately for severity of illness among groups.

Without further adjustment, these results might still reflect differences in overall hospital quality, rather than differences in the type of anesthesiologist involvement. Therefore, the results were simultaneously adjusted for patient and hospital characteristics, yet the effect of anesthesiologist direction remained significant. When we adjusted for the individual hospital using Mantel–Haenszel adjustments and logistic-regression models, our results were unchanged. Further, adjustments for selection bias using the propensity score again revealed that our results were very stable. It appeared that the increased risk of death associated with lack of direction was not caused by selection bias at the hospital. Thus, these data support the concept that there is a benefit associated with medical direction by an anesthesiologist that is independent of the hospital effect and not a result of selection bias.

Our results were consistent with other large studies of anesthesia outcomes.[25,26] Some studies suggest that the best outcomes may occur when anesthesia is provided by an anesthesia care team directed by an anesthesiologist.[27] We also found that the single most important hospital variable associated with lower death and failure-to-rescue rates was a higher registered-nurse-to-bed ratio,[7] and the importance of nurse staffing has been noted in several other studies.[7,28–30]

Our results also point to a common misconception when assessing anesthesia safety. Since the early (1954) study of Beecher and Todd[31] reported an anesthesia-related mortality rate of 1 death/1,560 patients, anesthesia-related mortality has been the gold standard of gauging anesthesia safety. By 1982, the anesthesia-related mortality had decreased to 1 death/6,789 patients in the United Kingdom,[32] and, by 1989, the anesthesia mortality rate had decreased to 1 death/185,056 patients[33]; whereas Eichhorn,[34] in 1989, reported anesthesia-related mortality of 1 death/151,400 patients among more than 750,000 healthy (American Society of Anesthesiologists physical status I or II)[35] patients in the United States. These studies supported the concept that the incidence of death directly related to anesthetic events had decreased, but the concept of anesthesia-related mortality was narrowly defined. Modern perioperative intensive care (including that provided by anesthesiologists) often prevents immediate postoperative mortality, yet prolonged morbidity and delayed mortality may result even when the precipitating event occurred preoperatively or intraoperatively. Further, there is increasing evidence that anesthetic practice influences subsequent patient outcomes in ways that were not recognized previously. Even relatively simple measures, such as maintaining normothermia or supplying supplemental oxygen in the perioperative period, can decrease the incidence of subsequent morbid events, including perioperative cardiac morbidity (ischemia, infarction, cardiac arrest),[36] and postoperative wound infection.[37,38] Our study underscores the importance of anesthetic practice in overall surgical outcome, potentially influencing mortality at the rate of 2.5 deaths/1,000 patients or 1 death/400 patients, more than 300 times greater than reported by Eichhorn[34] and others,[32,33] who used a far more narrow definition of "anesthesia related" that did not consider these wider associations.

This was a retrospective analysis based on administrative claims data and is limited by the associated errors inherent in using such data. The accuracy of our definitions for anesthesiologist direction (or no direction) is only as reliable as the bills (or lack of bills) submitted by caregivers. We also cannot rule out the possibility that unobserved factors leading to undirected cases were associated with poor hospital support for the undirected anesthetist and patient. Local, temporal, even psychologic factors may play a part in patient outcome, and such factors may not be noted in the available data set. For example, if anesthesiologists had a tendency not to submit bills for patients who died within 30 days of admission, our results could be skewed in favor of directed cases. Although our clinical experience suggests that this scenario is quite unlikely, we cannot rule out this possibility. We also cannot rule out the possibility that undirected cases occur more often in emergency situations that developed outside of the emergency department. For example, it may be that patients who required multiple anesthesia procedures were more ill and were cared for by an undirected anesthetist because of an emergency reoperation that did not allow time for the anesthesiologist to participate in care. Although we could find no evidence of this, because our study results were unchanged when a variable denoting multiple anesthesia procedures was added to the model, more extensive study involving individual chart review may be helpful for exploring these questions.

Future work will also be needed to determine whether the mortality differences in this report were caused by differences in the quality of direction among providers, the presence or absence of direction itself, or a combination of these effects. To address these limitations, we hope to pursue in-depth, large-scale medical chart review of surgical cases in the next phase of this research. We anticipate that review of medical charts will provide more detailed information that will assist in determining the etiology of differences in outcomes among provider type.

In summary, review of Medicare claims data in Pennsylvania suggests that medical direction by an anesthesiologist was associated with lower mortality and failure-to-rescue rates. In light of the large numbers of Medicare patients undergoing operations each day, future research must carefully identify the etiologic factors associated with these findings to define optimal provider models and improve outcomes.

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Heal Thyself

Once Seen as Risky, One Group Of Doctors Changes Its Ways

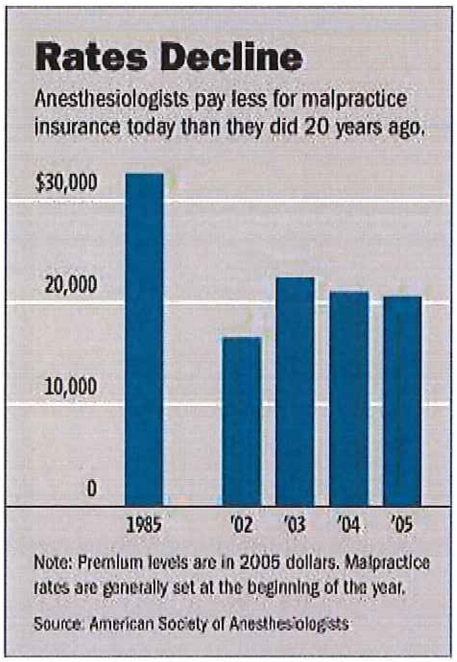
Anesthesiologists Now Offer Model of How to Improve Safety, Lower Premiums

Surgeons Are Following Suit

By JOSEPH T. HALLINAN

Staff Reporter of THE WALL STREET JOURNAL

The rising cost of medical-malpractice insurance has hit many doctors, especially surgeons and obstetricians. But one specialty has largely shielded itself:



Anesthesiologists pay less for malpractice insurance today, in constant dollars, than they did 20 years ago. That's mainly because some anesthesiologists chose a path many doctors in other specialties did not. Rather than pushing for laws that would protect them against patient lawsuits, these anesthesiologists focused on improving patient safety. Their theory: Less harm to patients would mean fewer lawsuits.

Over the past two decades, anesthesiologists have advocated the use of devices that alert doctors to potentially fatal problems in the operating room. They have helped develop computerized mannequins that simulate real-life surgical crises. And they have pressed for procedures that protect unconscious patients from potential carbon-monoxide poisoning.

All this has helped save lives. Over the past two decades, patient deaths due to anesthesia have declined to one death per 200,000 to 300,000 cases from one for every 5,000 cases, according to studies compiled by the Institute of Medicine, an arm of the National Academies, a leading scientific advisory body.

Malpractice payments involving the nation's 30,000 anesthesiologists are down, too, and anesthesiologists typically pay some of the smallest malpractice premiums around. That's a huge change from when they were considered among the riskiest doctors to insure. Nationwide, the average annual premium for anesthesiologists is less than $21,000, according to a survey by the American Society of Anesthesiologists. An obstetrician might pay 10 times that amount, Medical Liability Monitor, an industry newsletter, reports.

In some areas, anesthesiologists can now buy malpractice insurance for as little as $4,300 a year, although premiums ranged as high as more than $56,000, according to the ASA. The ASA survey gave no general explanation for the disparity but did note that premiums were higher for anesthesiologists who had been sued before and for those who perform higher-risk procedures.

A 1999 report by the Institute of Medicine noted that "few professional societies or groups have demonstrated a visible commitment to reducing errors in health care and improving patient safety." It identified one exception: anesthesiologists.

"If there were any specialty where you said, 'Show me who has done anything right,' I would point to the anesthesiologists," says Neil Kochenour, medical director at the University of Utah Hospitals and Clinics. "They have really made some inroads and some impact."

Medical errors are a leading cause of death in the U.S., killing between 44,000 and 98,000 Americans each year, according to various studies.
Medical-malpractice insurance rates for some specialties, such as obstetrics and general surgery, have risen in some areas, especially in the past few years, as insurers have reported higher paid losses. The insurance industry and many doctors groups have blamed greedy plaintiffs lawyers and capricious juries for those losses. As a remedy, insurers and many medical organizations have pushed for legislation that caps damage awards and lawyers' fees. Most states have enacted some form of tort reform.

Many anesthesiologists also support legislative moves to rein in malpractice suits. "Even though we've controlled costs, it's still a big issue for our membership," says Karen B. Domino, chair of the ASA's committee on professional liability.

But overall, anesthesiologists have put more emphasis on improving safety. And now, some doctors in other fields are praising them for choosing a different response. Noting the success achieved by anesthesiologists, other doctors—notably surgeons—have aimed more at improving treatment methods. "There's a lot of room for us to do a better job and decrease liability, not just for patient safety but to reduce liability [premiums]," says F. Dean Griffen, a surgeon in Shreveport, La., who heads the patient-safety and professional-liability committee for the American College of Surgeons. That professional group recently launched a study of cases modeled on one that helped anesthesiologists recognize some of their shortcomings years ago.

For most of its 160-year history, anesthesiology, the practice of rendering a patient unconscious or insensitive to pain, has been fraught with danger. As recently as 30 years ago, doctors in the U.S. still made patients unconscious by administering ether and other flammable gasses. On rare occasions, static electricity sparked explosions. Less rarely, patients asphyxiated during surgery because their breathing tubes mistakenly became disconnected.

In 1982, the ABC news program "20/20" aired a piece on anesthesia-related deaths. "It was a devastating indictment of anesthesia," recalls Ellison C. Pierce Jr., a retired professor of anesthesiology at Harvard Medical School who is considered by many to be the father of the modern anesthesia-safety movement.

Around the same time, anesthesiologists were getting hit by their second wave of big malpractice-insurance premium increases in a decade. The specialty was then considered among the riskiest to insure, and premiums were often two to three times as high as those other doctors paid. Casey Blitt, a 63-year-old Tucson, Ariz., anesthesiologist who has long been active on patient-safety issues, says his insurance soared to $50,000 a year from $20,000 or less. Dr. Pierce says anesthesiologists were "terrified," and anxious to do something.

Dr. Pierce at the time was president of the American Society of Anesthesiologists. In 1985, that group provided $100,000 to launch the Anesthesia Patient Safety Foundation. The new foundation was unusual in medicine: a stand-alone organization solely devoted to patient safety. Working closely with the larger ASA, from which it still receives about $400,000 a year, the foundation galvanized safety research and improvement.

Unlike most other medical groups, the foundation admitted as members not only doctors but nurses, insurers and even companies that make products used by anesthesiologists. Industry's participation initially caused angst over whether the foundation was designed merely to sell machines. But over the years, that concern dissipated, Dr. Pierce says, as company money helped the organization fund important research.

One advance was the development of high-tech mannequins that allow anesthesiologists to practice responses to allergic reactions and other life-threatening situations. Anesthesiologists say the mannequins have also allowed them to become more proficient at performing an emergency procedure akin to a tracheotomy that involves slitting open a clogged airway—something a doctor can't practice on live patients.

Twenty years ago, little was known about people injured or killed during anesthesia. No U.S. database existed, so anesthesiologists set out to create one. They decided to collect information from insurers on closed malpractice claims, those in which insurers had made a payment or otherwise disposed of the complaint.

Most insurers hesitated to cooperate at first, saying they were worried about patient privacy. One company finally agreed: St. Paul Fire & Marine Insurance Co. in Minnesota said it was concerned about heavy losses it had suffered from anesthesia-related injuries and was eager for anesthesiologists to review claims. Soon, other insurers followed suit.

Anesthesiologists left their practices for days at a time to pore over closed insurance claims. The information they collected was fed into a computer at the University of Washington to create an overall picture of how anesthesia accidents tend to occur. It "was a humbling experience," recalls Russell T. Wall, an anesthesiology professor at Georgetown University School of Medicine in Washington, D.C. To date, more than 6,400 claims have been analyzed.

In part by analyzing claims, the anesthesiologists were able to document the extent to which patients were dying because of a simple mistake: Anesthesiologists were inserting the patient's breathing tube down the wrong pipe. Rather than putting it down the trachea, which leads to the lungs, they were accidentally inserting it down the esophagus, which leads to the stomach. The problem was, there was no way to determine quickly whether the tube was in the right pipe. Patients often simply turned blue or their blood turned dark. By then, it was usually too late to save them.

The research contributed to two innovations that between them would all but eliminate death and injury from "intubation" errors. One, known as pulse oximetry, measures the oxygen level in the patient's blood stream by means of a device that clips onto the patient's finger. The other, capnography, measures carbon dioxide in a patient's expelled breath, which helps doctors determine at a glance that a patient is breathing properly.

At the time, though, the new technologies had a drawback, Dr. Pierce says: "It was very hard to get hospitals to buy pulse oximeters and capnographs," he says. When they were introduced in the 1980s, the two devices together cost about $10,000, according to several anesthesiologists.

That's where the safety foundation came in. In 1986, at the urging of the foundation, anesthesiologists made the use of pulse oximetry part of the ASA's basic standards for anesthesia care. A bit later, they added capnography.

Failing to adhere to ASA recommendations can expose hospitals to malpractice liability. By 1990, says Dr. Pierce, almost all American hospitals had pulse oximeters and capnographs.

That change has been accompanied by other less obvious improvements. During surgery, a patient's body temperature can fall as room-temperature intravenous fluids are infused into the blood. This cooling can cause tissue to die and make the body vulnerable to infection. The safety foundation funded research on the problem in the 1990s, and now care is taken to keep patients warm during surgery, often with specially made blankets that can be heated. Blood and fluid warmers are also used.

Anesthesiologists also have become much better at preventing patient exposure to carbon monoxide. The potentially deadly gas can be an unintended byproduct of the process of cleansing a patient's exhaled breath of carbon dioxide before the air is recycled back to the patient's lungs. One simple way to guard against this problem is to make sure that absorbent material in anesthesia machines that filters the recycled air remains moist.

In 1994, the newsletter of the anesthesiologists foundation documented cases in which patients were exposed to high levels of carbon monoxide during surgery on Mondays, presumably after absorbents had spent the weekend drying out. The organization recommended replacing the absorbent material on Monday mornings and several other changes. These are now standard practice, and rates of carbon-monoxide exposure have fallen dramatically.

Anesthesiologists are now focused on alarm bells. Modern anesthesia machines come equipped with audible alarms that sound when certain thresholds, such as oxygen levels, are crossed. But the alarms irritate many surgeons, so some anesthesiologists have turned them off. The foundation has documented 26 alarm-related malpractice claims between 1970 and 2002, or a little more than one a year. Of those, more than 20 resulted in either death or brain damage.

The foundation is pushing to adopt a formal standard that prohibits anesthesiologists from disabling the alarms. "I would not fly on an airplane if the pilot announced all the alarms were being turned off," says Robert K. Stoelting, the foundation's current president. "Our patients deserve the same safety net."

Dr. Stoelting, a retired chair of the anesthesiology department at the Indiana University School of Medicine, runs the foundation from suburban Indianapolis. He has a two-person administrative staff and a relatively modest $1 million annual budget.

As anesthesia fatalities have dropped, so has the percentage of total malpractice suits filed against anesthesiologists. In 1972, according to a recent study by Public Citizen, a consumeradvocacy group in Washington, D.C., anesthesiologists accounted for 7.9% of all medical-malpractice claims, double the proportion of physicians who practiced anesthesiology. Between 1985 and 2001, anesthesiologists accounted for only 3.8% of all claims, roughly comparable to the percentage of doctors who were anesthesiologists.

The size of payments from successful malpractice suits against anesthesiologists also has declined. According to the American Society of Anesthesiologists, the median payment during the 1970s was $332,280. By the 1990s, it had dropped 46%, to $179,010. These amounts are in 2005 dollars and are the most recent figures available.

Claims for serious injuries have become less frequent. In the 1970s, according to the ASA, more than half of anesthesia-malpractice claims involved death or permanent brain injury. In the 1990s, that fell to less than one-third of claims.

Malpractice rates for anesthesiologists have gradually fallen, the ASA says. This year, the average annual premium is $20,572, compared with $32,620 in inflation-adjusted dollars in 1985. That's a decrease of 37% over 20 years. Malpractice rates are generally set at the beginning of the year.

Anesthesiologists still make mistakes and aren't immune to recent moves in insurance rates. Their annual inflation-adjusted premiums have climbed 24% since 2002, when they had dipped to an average of $16,559. Insurers say that overall malpractice rates have risen by that amount or more for other specialties during the same period, but reliable nationwide figures aren't publicly available. As is done in other specialties, anesthesiologists accused of disciplinary problems are referred to state licensing agencies.

Other specialties have noticed how the anesthesiologists have fared. Dr. Griffen of the College of Surgeons says that more surgeons have begun to see a connection between improving patient safety and lowering malpractice premiums. The college's closed-claims study so far involves about 350 cases, and the group hopes it will grow to 500 this year.

At the University of Utah Hospitals and Clinics, Dr. Kochenour says his institution has tried to emulate the anesthesiologists by concentrating more on identifying systemic errors and less on individual blame. But these efforts run headlong into thinking drummed into physicians since medical school, he says. "I don't think physicians are very good systems thinkers, by and large," he says. Many, especially surgeons, prize their independence, he says, and that makes it hard to achieve the kind of cooperation necessary to reduce errors.

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Factors influencing unexpected disposition after orthopedic ambulatory surgery

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Abstract

Study Objective—To analyze whether patient characteristics, ambulatory facility type, anesthesia provider and technique, procedure type, and temporal factors impact the outcome of unexpected disposition after ambulatory knee and shoulder surgery.

Design—Retrospective analysis of a national database.

Setting—Freestanding and hospital-based ambulatory surgery facilities.

Measurements—Ambulatory knee and shoulder surgery cases from 1996 and 2006 were identified through the National Survey of Ambulatory Surgery. The incidence of unexpected disposition status was determined and risk factors for such outcome were analyzed.

Main Results—Factors independently increasing the risk for unexpected disposition included procedures performed in hospital-based versus freestanding facilities [odds ratio (OR) 6.83 (95% confidence interval [CI] 4.34; 10.75)], shoulder versus knee procedures [OR 3.84 (CI 2.55; 5.77)], anesthesia provided by nonanesthesiology professionals and certified registered nurse-anesthetists versus anesthesiologists [OR 7.33 (CI 4.18; 12.84) and OR 1.80 (CI 1.09; 2.99), respectively]. Decreased risk for unexpected disposition were found for procedures performed in 2006 versus 1996 [OR 0.15 (CI 0.10; 0.24)] and the use of anesthesia other than regional and general [OR 0.34 (CI 0.18; 0.68)].

Conclusions—The decreased risk for unexpected disposition associated with more recent data and with freestanding versus hospital-based facilities may represent improvements in efficiency, while the decreased odds for such disposition status associated with the use of other than general

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RH: Unexpected admissions after ambulatory surgery

and regional anesthesia may be related to a lower invasiveness of cases. We found an increased risk of adverse disposition in cases where the anesthesia provider was a nonanesthesiology professional. No difference in this outcome was noted when an anesthesia care team provided care.

Keywords

Ambulatory surgery; orthopedic surgery: knee, shoulder; unexpected disposition

1. Introduction

The number of ambulatory surgery services has increased dramatically over the last two decades [1-3]. Among the reasons commonly attributed to this development are changes in the payment structure favoring the shift of less complex cases to an outpatient basis [4]. However, the cost-effectiveness of ambulatory surgeries depends largely on the ability to discharge patients to their customary residence on the same day that the procedure is performed. Thus, unexpected admissions after ambulatory surgery represent a financial burden on hospitals, insurers, and patients alike. To date, few nationally representative studies exist to identify risk factors for this outcome [5], and there are no data on such outcomes and their temporal factors in the orthopedic ambulatory setting.

In this study, we utilized data from the National Survey of Ambulatory Surgery (NSAS) in 1996 and 2006 to determine patient and health care system-related risk factors for overnight admission after ambulatory knee and shoulder surgery. Data such as these allow for the identification and targeting of factors associated with unexpected disposition status after ambulatory orthopedic surgery and increased health care expenditure.

2. Materials and methods

Data collected for the NSAS were obtained from the Centers for Disease Control (CDC). Detailed information regarding the NSAS has been published previously [6]. In brief, the NSAS was conducted by the National Center for Health Statistics in the years 1994 to 1996, then again in 2006, with the goal of compiling nationally representative data on ambulatory surgery procedures performed in both freestanding ambulatory surgery facilities and hospital-based settings. The hospital universe for this database included Medicare-participating, noninstitutional hospitals exclusive of military institutions, Veteran Affairs hospitals, and other federal facilities in the 50 states and the District of Columbia. To be eligible for inclusion in NSAS, patients had to be scheduled for ambulatory surgery with admission and discharge planned on the same day. Patients admitted to the hospital either on an inpatient basis before surgery or through the emergency department were excluded. Information collected in the survey included age, gender, race, type of anesthesia, anesthesia provider, diagnosis codes, and procedure codes [International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM)].

Although changes were made in the NSAS sampling methodology between 1996 and 2006, both data sets were designed specifically to provide nationally representative weighted data [2]. To maintain consistency, we used weighted data for analysis and variables available in both data sets, thus removing potential bias introduced by these changes. To ensure the reliability of the collected data, a number of steps were taken to maintain the quality and accuracy of data provided in NSAS [6]. Recognizing the utility of this database to answer valuable clinical questions, a large number of studies addressing various aspects across the spectrum of medical specialties, including anesthesia, have been published [5,7-10]. As the data used in this study are sufficiently deidentified, this project was exempt from review by the Institutional Review Board.

2.1 Selection of study sample and statistical analysis

Our study sample consisted of all data in NSAS for the years 1996 and 2006. The two years were chosen so as to assess the impact of temporal changes on the outcome of unexpected disposition status. As our specific focus was on orthopedic surgical procedures, entries with an ICD-9-procedure code indicating knee ligamentoplasty, meniscectomy, and/or arthroscopy as well as shoulder arthroscopy, repair of dislocation, and/or suture of the capsule (81.42-47, 80.6, 80.26, 80.21, 81.82, 81.93, respectively) were included in our analysis. Procedures were then separated into those affecting the knee and the shoulder, respectively. Patient age and gender, health care system type (hospital-based and freestanding facilities), anesthesia type (general, peripheral nerve block, neuraxial anesthesia, and "other", ie, topical, intravenous sedation, and monitored anesthesia care, and others not listed), provider [anesthesiologist, certified registered nurse-anesthetist (CRNA)], and anesthesia care team (ie, anesthesiologist, CRNA, and others) were cross-classified by unexpected disposition status (ie, disposition other than discharge to the patient's primary residence, such as discharge to observation status, discharge to a postsurgical/recovery care facility, hospital admission as an inpatient). We excluded 224 records due to missing entries on disposition status (Fig. 1). An anesthesia category was created if an entry included the specific anesthetic studied. Thus, the 4 categories -- "general", "block", "neuraxial", and "other" -- were not mutually exclusive.

The percentage of procedures performed in each category was tabulated and compared using one-sample Rao-Scott Chi-squared tests. Univariable association analyses using two-sample Rao-Scott Chi-squared tests were followed by multivariable logistic regression to determine whether study characteristics were independently associated with increased risk of unexpected disposition status. Covariates in the regression model included patient age and gender, facility type, procedure type (knee, shoulder), year of the procedure, anesthesia provider, and anesthesia type.

All statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA). To facilitate analysis of data collected in a complex survey design with unequal probabilities of selection, we utilized SURVEYFREQ (SAS Institute) for frequency analysis and SURVEYLOGISTIC (Sas Institute) for multivariable logistic regression. These procedures guarantee consistent estimation of mean and variance parameters by appropriately taking into account the weights attached to the complex survey data [11]. For each covariate, odds ratios (ORs), 95% confidence intervals (CIs), and *P*-values are provided. A *P*-value < 0.05 was considered significant. The area under the receiver operating characteristic curve (AUC), also referred to as the c-statistic (or concordance index), was used for assessing the model's discriminatory power. A c-statistics of greater than 0.75 was reflective of a well calibrated model [12].

3. Results

During the years of study, an estimated 2,470,978 cases of ambulatory knee and shoulder procedures were performed in the United States. Patient and health care system-related characteristics associated with either procedure are shown in Table 1. The majority of cases were performed in men, those aged between 15 and 64 years, in a hospital-based setting, and by anesthesiologists using general anesthesia as a part of care. The number of cases performed in 2006 versus 1996 was higher for both procedures ($P < 0.0001$). Information on the rates of unexpected disposition by study categories is shown in Table 2. The overall rate of unexpected admission in our study sample was 3.8% (71,908/1,884,273) for knee and 7.9% (41,152/520,749) for shoulder procedures.

Disposition other than routine discharge to home residence decreased significantly between 1996 and 2006, from 8.5% to 0.6% for knee ($P < 0.0001$), and 21.5% to 4.8% for shoulder procedures ($P < 0.0001$). While unexpected admission rates remained between 2.7% and 4.8% among all age groups for knee procedures, far greater disparities between different age groups of patients undergoing shoulder surgery were seen (40.4% for those < 15 yrs of age and 6.7% for those aged 15-44 yrs). Freestanding facilities had lower unexpected admission rates for either procedure ($P < 0.0001$).

When comparing unexpected disposition status by anesthesia provider, nonanesthesia professionals were associated with significantly higher rates than were anesthesia professionals ($P < 0.0001$ for knee procedures, $P = 0.02$ for shoulder procedures, respectively). Further, those procedures attended by solo anesthesiologists or in an anesthesia care team model had lower rates than procedures performed by CRNAs alone (Table 2).

When controlling for all covariates, no patient-related characteristics were associated with increased risk of unexpected disposition status. Factors independently increasing the risk for this outcome included procedures performed in hospital-based versus freestanding facilities, shoulder versus knee procedures, and anesthesia provided by nonanesthesiology professionals and CRNAs compared with anesthesiologists. Decreased risk for unexpected disposition was found for procedures performed in 2006 versus 1996 and the use of anesthesia other than regional and general (Table 3).

4. Discussion

In this study of nationally representative data collected by the CDC and the National Center for Health Statistics, we identified a number of risk factors that are independently associated with increased risk for unexpected disposition status after orthopedic ambulatory surgery. Procedures performed in hospital-based versus freestanding facilities, shoulder versus knee procedures, anesthesia provided by nonanesthesiology professionals and CRNAs versus anesthesiologists increased the risk, while procedures performed in 2006 versus 1996 and those utilizing anesthesia other than general and regional were associated with a decrease in the risk for a disposition other than discharge to the patient's primary residence.

We found no patient-related factors associated with altered risk for unexpected disposition status after ambulatory knee and shoulder procedures. Although previous data on the risk for unexpected admission after ambulatory surgery in general may suggest that extremes in age would affect the risk for adverse disposition [13], we could not confirm this finding in the orthopedic population in this study. Discrepancies in findings may be based partly on different patient characteristics and procedure types included in various studies. For example, in our study sample patients were more likely to be younger (< 65 yrs) than the general ambulatory surgical population studied by Fleisher et al (ie, 86% vs 77%) [13].

It must be noted that, by definition, scheduled ambulatory surgery has the goal of performance of procedure and discharge to the patient's primary residence on the same day. Indeed, this concept is a prerequisite listed for entry into the NSAS [6]. Preselection of patients appropriate for ambulatory surgery occurs [13]. Thus, it is likely that procedure extent (ie, invasiveness and length of surgery) and associated complications may contribute more to the risk of unexpected admissions than patient-related characteristics [13,14]. The fact that shoulder procedures, which may be more complex than ambulatory knee surgeries, were associated with higher risk for unexpected disposition in our analysis support this argument.

In this study, we determined that freestanding facilities were associated with a lower risk of unexpected dispositions. The finding that patients presenting for surgery in freestanding facilities have, on average, a lower comorbidity burden, and may therefore be considered more carefully selected, has been reported previously [14] and may explain the lower adverse disposition rates in this particular environment found in our analysis. Further, although speculative, it is feasible that disposition to the patient's primary residence is pursued more aggressively as the capacity of freestanding facilities to admit patients for observation may be more limited than for hospital-based settings.

Interestingly, we noted that the type of anesthesia provider significantly affected the odds for unexpected disposition after ambulatory knee and shoulder surgery. While anesthesiologists were associated with the lowest odds, nonanesthesia professionals (which included other specialty physicians) and CRNAs increased the likelihood of unexpected disposition status by approximately seven- and twofold, respectively. In contrast, the anesthesia care team (ie, anesthesiologist and CRNA) performed similarly to a solo anesthesiologist in this analysis. A previous analysis of national data on herniorrhaphies performed in the mid 1990s showed similar results [5].

While a number of studies have identified the optimal anesthetic for various procedures, the range of findings is wide and inconclusive [15,16]. In our analysis, ORs for anesthetic types did not differ in their influencing the risk for unexpected admission except for a reduction with the use of anesthesia techniques other than general and regional anesthesia. It may be argued that with both modern surgical and anesthetic techniques, the choice of anesthetic may have limited influence on the risk for unexpected disposition. Rather, the type of anesthesia used may reflect the surgical invasiveness of a particular procedure [13,14]. The finding of decreased risk of overnight admission with the use of anesthetics other than general and regional may have to be viewed in this context.

The decreased rates and risk of unexpected disposition status after ambulatory knee and shoulder surgery over time found in this study are likely multifactorial, but may include better patient selection, development of discharge pathways, use of better pain management, and shorter-acting anesthetics with fewer side effects [17]. Certainly, the desire of patients and health care systems to avoid the additional financial burden associated with overnight admissions is a factor to be considered when interpreting this trend.

Our study was limited by a number of factors inherent in the analysis of databases designed for administrative purposes. As such, information on important variables such as clinical details and patient preferences, are not available. In addition, as ambulatory cases tend to be procedure-focused, limited information on comorbidities is available, with the vast majority of entries only including the primary diagnosis necessitating the procedure in the diagnosis fields. Further, no causal relationships can be determined from our data and reasons for our findings must remain speculative. Therefore, our data have to be interpreted in the context of this database construct. And, as is true for any database, we cannot exclude coding bias and collection errors in the NSAS. However, it must be mentioned that a multitude of steps were taken by the National Center for Health Statistics to assure accurate data sampling [6].

Finally, our data are based on only two years of study. Unfortunately, the NSAS was conducted only from 1994-1996 and then again in 2006. We chose to compare only 1996 to 2006 to have the same time frame for each group.

In conclusion, the decreased risk for unexpected disposition associated with more recent data and with freestanding versus hospital-based facilities may represent improvements in efficiency, while the decreased odds for such disposition status associated with the use of other than general and regional anesthesia may be related to a lower invasiveness of cases. However, we found increased risk of adverse disposition in cases in which the anesthesia provider was a nonanesthesiology professional. The odds for unexpected admissions were also higher in cases where CRNAs, not anesthesiologists, provided the anesthesia. No difference in this outcome was seen when an anesthesia care team provided care. As causal relationships cannot be established using our data, investigations to elucidate reasons for our findings are needed.

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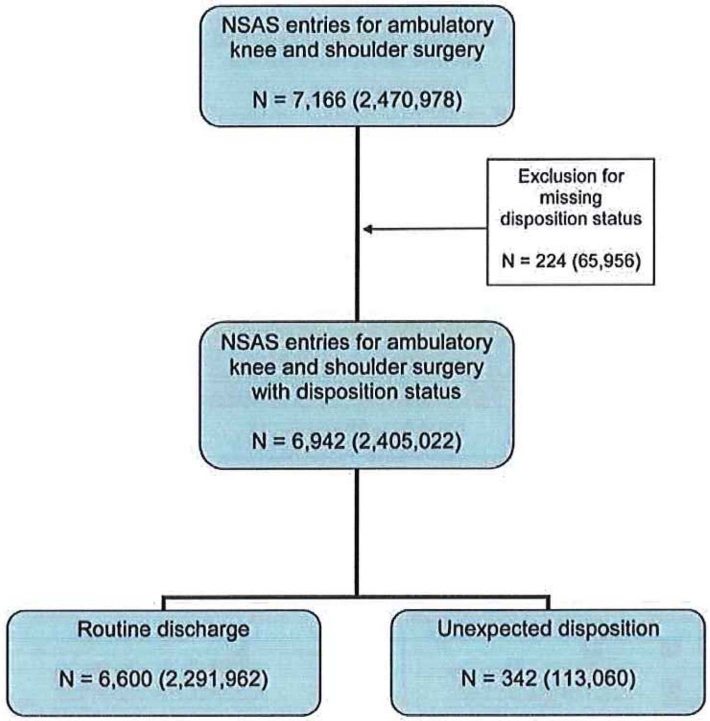

Fig. 1.

Sample selection process. The total numbers (N) represent entries in the National Survey of Ambulatory Surgery (NSAS) database. Numbers in parentheses = the weighted N representing the national sample equivalent.

Table 1

Percentage of procedures by demographics and their comparison

Variable\procedure type	Category	Knee	*P*-value	Shoulder	*P*-value
Total (N)	unweighted	5,832		1,334	
	weighted	1,941,011		529,967	
Study year (%)	1996	40.4	< 0.0001	18.6	< 0.0001
	2006	59.6		81.4	
Gender (%)	male	54.9	0.0004	57.6	0.0070
	female	45.1		42.4	
Age group (%)	< 15 yrs	1.4	< 0.0001	0.2	< 0.0001
	15-44 yrs	43.4		34.3	
	45-64 yrs	41.2		51.6	
	65-74 yrs	10.6		8.9	
	≥75 yrs	3.4		4.9	
Hospital type (%)	hospital-based facility	66.9	< 0.0001	58.0	0.0058
	freestanding facility	33.1		42.0	
Anesthesia provider	anesthesiologist	55.6	< 0.0001	56.9	< 0.0001
	CRNA	15.3		10.7	
	anesthesiologist/CRNA	21.4		25.7	
	other[a]	7.6		6.6	
Type of anesthesia[b]	general	74.4	< 0.0001	86.3	< 0.0001
	block	5.9	< 0.0001	21.8	< 0.0001
	neuraxial	8.4	< 0.0001	N/A	N/A
	other[c]	24.1	< 0.0001	17.8	< 0.0001

CRNA=certified registered nurse-anesthetist.

[a]Includes nonanesthesiologist physicians and other combinations of providers not covered by the listed categories.

[b]The 4 categories are not mutually exclusive and were considered as 4 separate variables in the analysis.

[c]Includes procedures with entries for intravenous sedation, monitored anesthesia care, topical anesthesia, and other anesthesia not captured in the list of categories.

Table 2

Unexpected dispositions within each category and association analysis

Variable\procedure type	Category	Knee	P-value	Shoulder	P-value
Total (N)	unweighted	5,647		1,295	
	weighted	1,884,273		520,749	
Study year (%)	1996	8.5	< 0.0001	21.5	< 0.0001
	2006	0.6		4.8	
Gender (%)	male	3.3	0.0837	7.6	0.7386
	female	4.4		8.3	
Age group (%)	< 15 yrs	4.7	0.0472	40.4	0.1007
	15-44 yrs	4.8		6.7	
	45-64 yrs	2.7		7.0	
	65-74 yrs	4.2		12.9	
	≥ 75 yrs	3.1		15.6	
Hospital type (%)	hospital-based facility	5.4	< 0.0001	12.8	< 0.0001
	freestanding facility	0.6		1.2	
Anesthesia provider (%)	anesthesiologist	2.9	< 0.0001	5.6	0.0200
	CRNA	4.0		10.0	
	anesthesiologist/CRNA	2.7		7.5	
	other[a]	14.0		18.9	
Type of anesthesia[b] (%)	general	4.2	0.0412	8.1	0.6042
	block	3.7	0.9452	4.1	0.0568
	neuraxial	4.6	0.4765	N/A	N/A
	other[c]	2.3	0.0096	5.0	0.1713

CRNA=certified registered nurse-anesthetist.

[a]Includes nonanesthesiologist physicians and other combinations of providers not covered by the listed categories.

[b]The 4 categories are not mutually exclusive and were considered as 4 separate variables in the analysis.

[c]Includes procedures with entries for intravenous sedation, monitored anesthesia care, topical anesthesia, and other anesthesia not captured in the list of categories.

Table 3

Risk factors for unexpected disposition (multivariate regression analysis)

Variable	Category	Odds ratio estimates	95% Confidence intervals		*P*-value
Gender (reference: female)	Male	0.74	0.53	1.02	0.0694
Age group (reference: 15-44 yrs)	< 15 yrs	1.38	0.47	4.02	0.5559
	45-64 yrs	0.89	0.62	1.27	0.5177
	65-74 yrs	1.16	0.67	2.01	0.6084
	≥ 75 yrs	1.64	0.63	4.25	0.3105
Hospital type (reference: freestanding facility)	Hospital	6.83	4.34	10.75	< 0.0001
Anesthesia provider[b] (reference: anesthesiologist)	Other[a]	7.33	4.18	12.84	< 0.0001
	CRNA	1.80	1.09	2.99	0.0229
	Anesthesiologist/CRNA	1.13	0.73	1.77	0.5787
Type of anesthesia[c] (reference: absence of particular anesthetic)	General	1.56	0.77	3.16	0.2158
	Peripheral nerve block	0.85	0.33	2.22	0.7401
	Neuraxial	0.94	0.37	2.37	0.8945
	Other[d]	0.34	0.18	0.68	0.0019
Procedure type (reference: knee)	Shoulder	3.84	2.55	5.77	< 0.0001
Study tear (reference: 1996)	2006	0.15	0.10	0.24	< 0.0001

CRNA=certified registered nurse-anesthetist.

[a]Includes nonanesthesiologist physicians and other combinations of providers not covered by the listed categories.

[b]Due to missing responses for "anesthesia provider", the number of entries included in the multivariable model was reduced to 6,495 (2,289,326). The concordance index for the fitted model was 0.8.

[c]The 4 categories of "type of anesthesia" are not mutually exclusive and are considered 4 separate variables in the analysis.

[d].includes procedures with entries for intravenous sedation, monitored anesthesia care, topical anesthesia, and other anesthesia not captured in the list of categories.