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Physician Payment Reform: Anesthesiology as a Case Study

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We examined the effects of Resource-based Relative Value Scale (RBRVS)- and physician diagnosis-related groups (MDDRG)-based payment for anesthesiology services related to surgery by simulating these physician payment reform options. We merged Medicare Part A (hospital) and Part B (anesthesiology) payment data for 7,770 patients for the MDDRG analysis and examined 10,431 surgical procedures for the RBRVS analysis within 27 diagnosis-related groups (DRGs) during the second half of 1986 in 16 hospitals representing different geographic regions, bed size, and teaching status. Assuming budget neutrality (*i.e.*, constant total expenditure for anesthesiology services) and using the proposed methodologies, we simulated RBRVS and MDDRG payments and compared them to current payments for anesthesiology services. Individual surgical procedures demonstrated a two- to more than four-fold variation in duration, accompanied by a similar variation in anesthesiology payments. Within DRGs, there was a three- to ten-fold variation in duration, and a two- to seven-fold variation in anesthesiology payments. Anesthesiology time was highly correlated with surgical time (r = 0.86–0.96). Compared to the current system, RBRVS and MDDRG systems were associated with systematic variations in payments, such that on average, on each case, anesthesiologists practicing in rural and nonteaching hospitals would gain, whereas those in urban or suburban and teaching facilities would lose. After adjusting for complexity of procedure, the distribution of payment gains and losses was a function of duration of surgery, which is not influenced by the anesthesiologist. Longer cases of a given surgical procedure result in payment decreases. The results document the importance of retaining a time factor in the payment methodology for anesthesiology services to maintain equitable payment across practice settings—an objective of physician payment reform. (Key words: Anesthesiology services, Reimbursement: Medicare reimbursement, Physician diagnosis-related groups, Resource-based relative value scale; Anesthesia time.)

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HEALTH CARE EXPENDITURES in general and physician charges in particular have increased dramatically over the last 10 yr. Expenditures for physician services have increased from $46.8 billion in 1980 to $92 billion in 1986,[1] and Medicare physician expenditures have grown substantially faster than those for hospital services. Physician expenditures by Medicare increased by 29.5% between 1983 and 1986.[2] Over this same period, total Medicare-allowed charges per beneficiary for anesthesiology services increased by 28%.[2]

The movement toward physician payment reform has been influenced by the continued increase in health care expenditures, the growth of alternative delivery systems (*e.g.*, health maintenance organizations and preferred provider organizations), the shift of medical care from inpatient to outpatient settings, and the increase in the number of physicians in the United States.[3] These trends have prompted the exploration of alternative strategies for physician payment reform.[4–7]

The current system for reimbursing physician services to Medicare beneficiaries is based on usual, customary, and reasonable (UCR) charges. The approved charge for a physician service is calculated as the lowest of either the physician's actual charge, the physician's customary charge for the service, or the prevailing charge. For covered services, Medicare pays 80% of the approved charges that exceed the beneficiary's annual deductible. Increases in the prevailing charges are limited to those determined by the Medicare Economic Index.[8] This reimbursement policy exists for both inpatient and outpatient services. With some exceptions, the UCR concepts are comparable to those used by most Blue Shield plans and by many of the commercial insurance carriers. Despite its near universality, however, there is considerable dissatisfaction with this approach. UCR systems are believed to encourage fee inflation and to distort relative payments between dif-

ferent types of services and between different geographic regions. Moreover, these systems are both difficult to administer and difficult for patients and physicians to understand.[3,4,6,7,9-13]

Medicare physician payment reform is now law. The primary objective of this reform is to control expenditures; the secondary secondary objective is to reduce perceived inequities across and within physician specialties and services.[2,12,13] Although both objectives might be addressed through a reform in fee schedules, there is concern that, whereas a fee schedule might reduce fee escalation, it might not reduce the volume of services sufficiently. For this reason, a reform addressing both price and volume would be of relevance.

The most recent addition to these discussions is the Resource-based Relative Value Scale (RBRVS), developed by Hsiao and associates.[14-18] A fee schedule that evolved from this effort might well reduce perceived inequities in payment by setting more rational relative prices. It might also give easier access to payment information for both patients and physicians, and thereby enhance competition. However, because it is believed that such a fee schedule could lead to physician volume increases to compensate for fee decreases, alternative strategies need to be considered. For example, capitation has many advocates as a global strategy for both physician and hospital services, although this has not been considered seriously for physician services only. Since 1983, however, there has been intermittent interest in a system in which all physician services provided during a hospitalization would be paid with a single payment that would be the same for all patients in a particular diagnosis-related group (DRG).

Either the RBRVS or physician DRG (MDDRG) system of payment reform will likely result in the redistribution of monies across procedures and services and across physician specialties. Although there has been some examination of interspecialty distributional effects attendant to implementing these systems, there has been little attention paid to the potential effects of these systems on the physicians within a specialty. This study examines the distributional effects of two different systems of physician payment for Medicare services within anesthesiology. Anesthesiology was selected because both payment systems have been recommended for this specialty and because a relative value system is already used for anesthesiology services.

First, we constructed a merged hospital and physician data base that included the main elements of Medicare Part A and B data sources and included information on surgical time, anesthesia time, basic relative value units, and the patient's ASA physical status. These additional elements were judged important for explaining variation in existing charges and distributional reimbursement effects under different physician payment systems. Second, using this unique data base, we simulated a MDDRG system. This approach was seriously considered in 1987 by both Congress and the Reagan Administration for hospital-based physicians. Although the MDDRG concept is not being actively considered at this time, it may be reexamined in the future as a policy alternative, if there is a need for a system to control for volume or intensity of services. Third, we simulated the distributional effects that a RBRVS payment system, such as that developed by Hsiao *et al.*,[14-18] may have on payment for anesthesiology services.

Methods

Data Sources

The study involved the collection and analysis of data on anesthesiology services and charges from 16 hospitals in the United States (table 1). Specific hospitals were selected to represent different geographic regions and types of hospital. Relevant hospital characteristics included: 1) number of beds; 2) location (*e.g.*, rural *vs.* urban or suburban); and 3) teaching status. Hospitals were located in the Northeast, Midwest, Southeast, and West. Within each hospital, data were collected for all Medicare patients hospitalized between July 1, 1986 and December 31, 1986 for any one of 27 surgical DRGs. Individual DRGs that represent the most frequent hospital admissions for surgery among Medicare beneficiaries were selected; these included admissions for prostatectomy, cholecystectomy, repair of inguinal hernia, open reduction of fracture, hip arthroplasty and replacement, hysterectomy, coronary artery bypass surgery, and heart valve replacement.

The two primary data sources used were the hospital (*e.g.*, Medicare Part A) and physician (*e.g.*, Medicare Part B) billing records. Hospital service and charge data were obtained for 7,770 patients from the Medicare hospital billing form, which includes patient identifiers, DRG, length of stay, and diagnosis and procedure codes associated with the hospitalization. The primary surgical procedure, as listed on the hospital form, was studied in those cases where multiple procedures occurred during a hospitalization. Information on surgical time, defined as the time of initial incision to closure, was abstracted from hospital records for 60% of the cases, representing half of the geographic areas. Anesthesiology service and charge data were obtained from hospital or physician billing services for 10,431 cases. These records included patient identifiers, surgical procedure code, date of service, basic relative value and modifier units, anesthesia time, and total anesthesia charges.

The hospital records were merged with the anesthesiology records through the Medicare identification number and date of service. Anesthesiologist bills were avail-

TABLE 1. Hospital Characteristics and Percent Change in Anesthesiology Charges Due to Physician DRGs

Hospital	Bed Size	Admissions	Teaching Status*	Rural/Urban†	N‡	Difference in Average per Case Charge ($)	Percent Change
A	375	13,749	NT	U	201	121	31
B	416	18,031	NT	U	161	149	36
C	96	4,865	NT	R	117	121	34
D	214	7,062	NT	U	176	140	24
E	457	20,204	T	U	128	148	33
F	250	5,842	NT	U	88	144	39
G	415	18,956	NT	U	49	96	18
H	669	20,258	T	U	652	−111	−18
I	1,802	58,172	T	U	3,783	−86	−13
J	378	14,832	T	U	578	−62	−14
K	358	10,187	T	U	189	−197	−26
L	484	16,343	T	U	348	124	28
M	971	31,146	T	U	150	74	16
N	137	4,251	NT	R	231	206	68
O	189	8,958	NT	R	136	198	73
P	310	13,049	T	U	750	−234	−36

Source: American Hospital Association.[20]
* Teaching status: T = teaching; NT = nonteaching.
† Rural/Urban: R = rural; U = urban/suburban.
‡ Number of merged hospital and anesthesia records.

able for all hospital records. The data for the MDDRG simulation are the merged hospital and physician billing record. The analyses of the RBRVS-based payment system are based on the 10,431 physician billing records.

The total anesthesiology charge for each surgical case equals the billed charge for all anesthesia services for the case, as reported by the anesthesia billing service or the hospital. The anesthesia supply component of the hospital bill is not included in this charge. Approved charges were estimated by multiplying the total billed charges by the Medicare carrier-specific average reduction in Medicare Part B charges for the fourth quarter of 1986. For example, in Washington state the average reduction was 23.7%. Therefore, all of the claims for a hospital located in this state were multiplied by 0.763 to derive estimated Medicare reimbursable charges.

Anesthesiology Relative Value System

Like other physicians, anesthesiologists are paid by Medicare on a UCR charge basis. However, in effect, anesthesiologists perform only one service, namely, one unit of anesthesia service. In determining the number of anesthesiology service units provided during any one surgical procedure, three factors are considered; these are: 1) basic relative value units, 2) time units, and 3) if necessary in some areas, modifier units. Basic value units weigh the average complexity and risk of the specific anesthesia procedure. Basic units for all procedures have been tabulated into a relative value guide (RVG) developed by the ASA. Time units represent the actual time the anesthesiologist spends preparing the patient for surgery, delivering anesthetics and monitoring vital functions during surgery, and transferring the patient to the care of personnel in the postanesthesia care unit after surgery. Modifier units have been developed to incorporate the severity of the patient's physical condition and the resulting complexity of the anesthesia procedure.[19] The aggregated number of units is multiplied by a conversion factor to generate a unique charge for the anesthesiology services provided to an individual patient.

The ASA first developed a relative value guide based on the American Medical Association's Current Procedure Terminology (CPT-4) in 1977. The most recent version of the ASA RVG was published in 1989.[19] Until recently, individual anesthesiology billing services and Medicare carriers throughout the United States used a variety of RVGs, and one third of carriers allowed modifier units. Since 1989, a single national RVG is used for anesthesiology services delivered to Medicare patients, and modifier units are no longer allowed by Medicare carriers.

Data Analysis

The analysis was performed in stages, beginning with descriptive statistics, and followed by the various physician payment simulations.

Descriptive Analysis

Descriptive statistics were computed by DRG and selected procedure. Variables for the descriptive analysis included the approved anesthesiology charges and anesthesia time. Two summary measures of variation were used in the current study—the coefficient of variation (CV) and the adjusted ratio of maximum to minimum (max/min). CV is a measure of variation defined as the

standard deviation divided by the average value. Max/min was computed by omitting the upper and lower 2.5% of the values in the distribution, and so provided a more conservative estimate of the amount of variation in anesthesia charges and time.

MDDRG Payment Simulation

MDDRG-based anesthesiology payments were estimated under the assumption of budget neutrality; that is, aggregate Medicare expenditures nationwide for anesthesiology services were considered to remain unchanged by the new payment schedule, although the distribution of payments across anesthesiologist practices might change. Note that this simulation was based on charge data only for anesthesiologists rather than for all physicians. These estimates by DRG were generated through the use of carrier-specific information on the average reimbursed claims and number for all Medicare Part B services during the fourth quarter of 1986. In the following discussion, "region" refers to Medicare carrier geographic region. The appendix contains details on the calculation of the DRG-based estimates of anesthesia payment.

Comparisons were made between the estimated approved anesthesiology charge and the DRG-based anesthesiology charge. The relationship between length of surgery and the distribution of gains and losses was also examined. Payment status was subdivided into three categories: 1) gain ($50 or more), 2) no difference (± $49), and 3) loss ($50 or more). The $50 criterion was selected to allow comparison with previous studies of physician DRGs.[21] Surgical time was classified as representing 1) long operations and 2) average and short operations. Long operations were defined as those in which surgical time falls into the top 25% of the distribution for a particular DRG.

RBRVS Payment Simulation

The examination of the possible consequences of a RBRVS-based payment system for anesthesiology services was accomplished by estimating RBRVS values for the 10,431 procedures. First, we developed a prediction equation for the RBRVS values for the 14 anesthesiology procedures reported by Hsiao *et al.*[18] by using total units (*i.e.*, the sum of basic relative value and time units) as the independent variable (see appendix). Basic relative value units were obtained from the 1988 ASA RVG. The average number of time units for each procedure was obtained from the current anesthesiology time data. Average time was used because actual time, though now supported by Hsiao for use in anesthesiology payments, was not originally incorporated into the RBRVS methodology.[18] The use of average time in the RBRVS simulation was not intended to reflect actual practice or recent legislation. The resulting prediction equation explained 96% of the variance in RBRVS values. The coefficients of this regression equation were used to estimate RBRVS values for those procedures not included in the Harvard study.[18]

The estimated conversion factor was generated, under assumptions of budget neutrality, by dividing the total sum of approved anesthesiology charges for all procedures by the total sum of the RBRVS values for all procedures. The estimated approved anesthesiology charges under the RBRVS-based system were computed by multiplying the RBRVS value for each procedure by this conversion factor. The estimated anesthesiology charges were then compared to the existing anesthesiology charges to explore gains and losses under a RBRVS-based payment system. Gains and losses were defined according to the $50 criterion used in the MDDRG comparisons. All data analyses were weighted by the volume of Medicare Part B claims for each state for the fourth quarter of 1986.

Results

Variation in Anesthesiology Services

Table 2 summarizes the variation in approved anesthesiology charges and time for selected DRGs. The CVs for approved anesthesiology charges ranged from 0.21 to 0.53. For individual DRGs, there was a 2- to 7-fold variation in charges. There was a three- to ten-fold variation in anesthesia time (table 2). Even greater variation was detected in the duration of surgery (data not shown). Surgical time varied from 3- to 12-fold within DRGs. Anesthesia time was correlated 0.94 with surgical time. Within individual DRGs, the correlation ranged from 0.86 to 0.96.

Variation in anesthesiology charges and time by selected CPT-4 procedure are reported in table 3. The CVs for anesthesiology charges ranged from 0.21 to 0.43. There was a two- to four-fold variation in charges and two- to more than four-fold variation in procedure length. Anesthesia time varied more than charges within individual procedures. Similar variation was observed in surgical time (data not shown).

MDDRG Simulation

Comparisons were made between current anesthesiology charges and estimated DRG-based charges by teaching status, hospital location, and selected surgical procedure. Average approved charges were $541 for teaching hospitals, $476 for nonteaching hospitals, $343 for rural hospitals, and $522 for nonrural hospitals. Anesthesiologists providing services in teaching hospitals tended to lose under a DRG-based system by an average of $73 per case ($t = 22.95$, $P < 0.0001$). Physicians working in non-

TABLE 2. Variation in Anesthesiology Charges and Length of Procedure by DRG, All Selected Hospitals

DRG	n	Charges ($)			Time (min)		
		Mean	CV*	M/M†	Mean	CV*	M/M†
5 Extracranial vascular	380	652	0.40	4.2	211	0.41	5.5
105 Cardiac valve without cardiac catheter	239	1207	0.39	4.6	351	0.36	6.1
107 Coronary bypass without cardiac catheter	392	1171	0.31	3.6	350	0.34	6.8
110 Vascular	712	914	0.46	6.9	302	0.41	6.1
148 Major small, large bowel	876	534	0.49	5.5	204	0.46	6.3
154 Stomach, esophagus, duodenum	262	673	0.53	6.4	242	0.52	10.2
161 Hernia	282	296	0.34	4.5	116	0.41	4.9
195 Cholecystectomy with bile duct	121	516	0.43	4.3	211	0.49	5.8
197 Cholecystectomy	305	425	0.33	3.7	151	0.45	4.9
209 Major joint	1524	534	0.35	3.5	214	0.32	3.9
210 Hip and femur	427	457	0.38	4.0	157	0.41	4.5
257 Breast masectomy	266	370	0.26	2.7	152	0.32	3.7
334 Major pelvic	124	587	0.30	4.0	208	0.38	3.9
336 Prostatectomy	836	329	0.32	3.5	101	0.44	4.8
337 Prostatectomy	112	308	0.26	3.4	91	0.30	3.9
354 Hysterectomy	222	433	0.35	3.5	170	0.45	4.9
471 Major joint lower extremity	117	695	0.26	4.2	248	0.31	2.9

* Coefficient of variation.

† Adjusted maximum/minimum.

teaching hospitals are estimated to gain approximately $11 per surgical case ($t = -1.90$, $P < 0.06$). These differences were even greater between rural and nonrural hospitals. On the average, anesthesiologists practicing in rural hospitals were estimated to gain $183 per case ($t = -40.45$, $P < 0.0001$), whereas those working in suburban or urban hospitals were estimated to lose approximately $66 per case ($t = 22.79$, $P < 0.0001$).

There were differences in the estimated gains and losses for individual surgical procedures within different DRGs. In 43% of surgical cases anesthesiologists gained or lost more than $50. The average per cent difference between existing and DRG-based payments for 16 selected procedures are summarized in table 4. Gains for some procedures were as large as 23%. Several cardiovascular and orthopedic procedures lost between 10 and 20% per case.

For example, within DRG 107 (coronary bypass without cardiac catheterization), it was estimated that there may be a $68–192 decrease in anesthesiology payments for coronary artery bypass graft surgery under an MDDRG-based payment system (table 4). The patterns of gains and losses for individual procedures within other DRGs were equally dramatic. Within the DRG for major joint and limb reattachment, physicians were estimated to gain $59 for each total knee replacement procedure and lose $118–122 for a total hip replacement. In the case of replacement of the femur head, an anesthesiologist could lose approximately $3 or gain $70, depending on whether the procedure used methyl methacrylate.

The relationship between length of surgery and the pattern of gains and losses for individual cases also was explored. Anesthesiologists involved in longer operations

TABLE 3. Variation in Anesthesiology Charges and Length of Procedure by Selected Procedure, All Selected Hospitals

Surgical Procedure	n	Anesthesiology Charges ($)			Anesthesia Time (min)		
		Mean	CV*	M/M†	Mean	CV*	M/M†
Total hip replacement	823	603	0.33	3.0	223	0.33	3.6
Open treatment of femoral fracture	551	413	0.36	2.9	142	0.38	3.5
Total knee replacement surgery	656	473	0.27	2.5	210	0.26	2.5
Coronary artery bypass surgery, three grafts	535	1357	0.20	2.7	335	0.28	2.7
Aortic valve replacement	126	1205	0.30	2.8	347	0.31	3.1
Femoral popliteal bypass	198	696	0.43	4.8	263	0.42	4.7
Cholecystectomy with cholangiography	218	360	0.30	3.2	133	0.54	4.7
Cholecystectomy	292	467	0.29	2.8	159	0.44	4.6
Transurethral prostatectomy	1031	323	0.31	3.1	99	0.37	3.7
Total hysterectomy	176	418	0.31	2.8	165	0.42	4.5
Repair inguinal hernia	184	275	0.32	3.3	106	0.39	4.5

* Coefficient of variation.

† Adjusted maximum/minimum.

TABLE 4. Comparison of DRG-Based Charges with Existing Anesthesiology Charges for Selected Procedures

Surgical Procedure	Mean Anesthesiology Charge ($)	DRG-Based Charge ($)	Difference from Mean Charge to DRG-Based Charge (%)
Coronary artery bypass surgery, two grafts	1,192	1,124	−6
Coronary artery bypass surgery, three grafts	1,233	1,093	−11
Coronary artery bypass surgery, four grafts	1,347	1,155	−14
Right hemicolectomy	510	508	−0.3
Sigmoidectomy	533	504	−5
Total knee replacement	497	556	12
Total hip replacement: methyl methacrylate	639	521	−18
Other total hip replacement	609	487	−20
Replacement of femur head: methyl methacrylate	517	514	−0.6
Other replacement of femur head	435	505	16
Transurethral prostatectomy	327	309	−6
Total abdominal hysterectomy	445	450	1
Vaginal hysterectomy	369	454	23
Repair of direct inguinal hernia	260	310	19
Repair of indirect inguinal hernia	293	276	−6
Total cholecystectomy	437	424	−3

were more likely to lose under a MDDRG-based system than under their current charge system (chi-squared = 760.31, $P < 0.0001$). Seventy-seven per cent of the anesthesiology services delivered in long operations were likely to lose more than $50, compared to only 33% of services in the shorter operations. When this relationship was explored by individual DRG, 23 of 27 of the analyses supported this interpretation. The remaining four DRG level comparisons were based on small sample sizes, and therefore may have lacked sufficient statistical power to detect differences.

RBRVS Simulation

The results of the RBRVS simulation suggest that approximately 31% of anesthesiology claims would lose more than $50 compared to existing payment rates. Thirty-five per cent of the claims fell in the no-difference category. Teaching hospitals were likely to lose more than $50 on 40% of their anesthesiology services, whereas nonteaching hospitals lost on only 29% of services (table 5). For teaching hospitals, this translates into an average reduction of $40 per case compared to only $9 per case for nonteaching hospitals. Anesthesiologists practicing in rural hospitals gained an average of more than $50 on 50% of their services, whereas those practicing in nonrural hospitals gained in 29% of their cases. In rural hospitals, the average anesthesiology charge increased $52 per case, and that in nonrural hospitals decreased $31 per case.

The potential impact of a RBRVS-based payment system was examined for 11 high-volume surgical procedures (table 6). Losses averaged from 4.1 to 17.6% per case, depending on the individual procedure. The greatest losses occurred in several cardiovascular procedures—coronary artery bypass graft surgery with three grafts ($239 per case), aortic valve replacement ($116 per case), and femoral–popliteal bypass ($72 per case). Total knee replacements and cholecystectomy with cholangiography gained as much as $40 and $21 per case, respectively. Cholecystectomy was estimated to lose $44 per case.

Discussion

This study was designed to examine the potential impact of two different reimbursement reform methods on anesthesiology services relating to surgery in the United States. The primary objectives of physician reimbursement reform are to reduce Medicare program costs by improving efficiency and to ensure more equitable payment to physicians without compromise of quality of care.

TABLE 5. Potential Impact of RBRVS-Based Payment on Anesthesiology Charges, by Hospital Type

Hospital Type	Frequency Distribution of Cases*† (%)			Average per Case ($)
	Loss	No Difference	Gain	
Teaching	40	30	30	−40
Nonteaching	29	39	32	−9
Rural	19	31	50	52
Nonrural	36	35	29	−31

* Rows sum to 100%.

† Loss = Cases losing more than $50; No Difference = Cases within plus or minus $50; Gain = Cases gaining more than $50.

TABLE 6. Comparison of RBRVS-Based Charges with Approved Anesthesiology Charges for Selected Procedures

Surgical Procedure	Mean Anesthesiology Charge ($)	RBRVS-Based Charge ($)	Difference From Mean Charge to RBRVS-Based Charge (%)
Total hip replacement	603	613	1.6
Open treatment of femoral fracture	413	374	−9.5
Total knee replacement	473	513	8.4
Coronary artery bypass surgery, three grafts	1,357	1,118	−17.6
Aortic valve replacement	1,205	1,089	−9.6
Femoral–popliteal bypass	696	624	−10.4
Cholecystectomy with cholangiography	360	381	6.0
Cholecystectomy	467	423	−9.4
Transerethral prostatectomy	323	276	−14.5
Total hysterectomy	418	401	−4.1
Repair inguinal hernia	275	256	−6.9

Several caveats associated with the current study may bias its findings. First, the MDDRG-based charges and the RBRVS-based charges were constructed by assuming budget neutrality within anesthesiology services and not across all Medicare physician services. When the recently approved RBRVS-based system, which favors evaluation/management services, is implemented, total expenditures for anesthesiology services are expected to decrease, although the qualitative relationships among payments across different practice settings reported here are expected to persist. Therefore, actual gains and losses attributable to the two payment systems may differ from those estimated in this study. Second, the data provided by the hospitals were incomplete with regard to the involvement of certified registered nurse anesthetists (CRNAs) in delivering anesthesia services. Depending on whether the CRNA is employed by the hospital or by the anesthesiologist, anesthesiology charges for the anesthesiologist–CRNA team may differ from those of the anesthesiologist working alone.[22] It could not be determined whether a large number of physician-employed CRNA anesthesiology services were included in the data; if they were, it is possible that anesthesia charges were inflated.

Third, the findings are based on an analysis of data from only 16 hospitals. It is likely that this limitation introduced some bias, in that anesthesiology services and charges in these hospitals do not reflect anesthesiology charges and services in the entire United States. Although the hospitals were selected to represent different geographic regions, rural or urban (or suburban) locations, hospital sizes, and teaching status, the data may not be representative of services and charges of all anesthesiologists to Medicare patients. However, the CVs for charges in this study are similar or smaller to those reported in a Health and Human Services (HHS) study on the MDDRG system, which used data from 100% Medicare Part B files for all of 1984 in eight states.[23] This suggests that our data may be representative of more complete Medicare claims data.[24] The comparisons also suggest that any systematic differences may result in a conservative bias with respect to variation in anesthesiology charges. This may be due to reduced heterogeneity within a limited number of physician practices in the current study compared to a larger number of physician practices in the HHS study.

This study documents considerable heterogeneity in anesthesiology charges and anesthesia time within DRGs and in surgical procedures within DRGs. Yet, there is a strong and consistent temporal relationship between surgical and anesthesiology services, which suggests that much of the variation in anesthesia time depends on the duration of the surgical procedure. The variation demonstrated in surgical time is even greater than that observed for anesthesia time and charges. Since the duration of surgery is determined by surgeons, anesthesiologists are not in a position to decrease operative time in the delivery of services to patients. The majority of DRGs exhibited a four-fold or greater variation in approved anesthesiology charges. Within several DRGs, charges for anesthesiology services ranged from $85 to over $2,500, depending on the particular surgical procedure.

This extreme variation is due to several factors. First, several different surgical procedures may fall into a single DRG. These procedures have different levels of anesthesiology technical complexity and different average times. Therefore, depending on the procedure within a DRG, these factors result in systematic under- and overvaluation of the procedure in a MDDRG system. Second, some of the observed variation in anesthesiology charges is due to differences in patient severity of illness and the association between the patient's physical condition and duration of surgery. Finally, this variation in charges represents, in part, geographic differences in anesthesiology practice and differences in the content of practice within DRGs.

The results of the MDDRG analysis suggest that in a MDDRG system, anesthesiologists practicing in rural and nonteaching hospitals would be likely to gain, whereas other anesthesiologists working in large suburban or ur-

ban or teaching hospitals would lose. These findings are consistent with previous research indicating that rural hospitals would gain and urban or teaching hospitals would lose under a MDDRG system.[23,25,26] This study also found a relationship between the duration of the surgery and the gains and losses in a DRG-based system for anesthesiologists. Anesthesiologists involved in longer surgery for a given procedure were more likely to lose in a DRG-based system compared to the approved charges in the current system. This finding is important for those surgical procedures that are systematically long or short. In this study, teaching hospitals tended toward longer surgical times compared to those of nonteaching hospitals. The greater longer duration of these surgical procedures could be due to teaching activities concurrent with the operations or to the presence of more severely ill cases.

Therefore, much of the variation observed in either anesthesia time or approved charges appears to be based on clinical factors that may be under the control of the surgeon, and not based on inefficiency on the part of the anesthesiologist. If this association is confirmed, then the results of this study suggest that a prospective payment system for anesthesiology services based on DRGs may not achieve the desired objective, the encouragement of more efficient care. Although an adjustment could be made to control for geographic and hospital characteristics, there would remain the problem of significant differences in the complexity and duration of surgical procedures within individual DRGs. It was found that differences in the case mix of procedures within DRGs between different types of hospitals accounted for most of the gains and losses associated with the implementation of a MDDRG-based system.

The findings of the RBRVS simulation also relate to the case mix of anesthesiologists practicing in different hospitals or regions of the United States. For example, in the current study, anesthesiologists who provide services for coronary artery bypass graft surgery and transurethral resection of the prostate were more likely to lose, whereas those providing anesthesiology services for total knee replacements or cholecystectomy with cholangiography tended to gain under a RBRVS-based system. Physicians practicing in nonrural or teaching hospitals were also more likely to lose compared with those in rural or nonteaching hospitals.

Physicians working in teaching and large urban hospitals were likely to receive lower payments under either an MDDRG-based or RBRVS-based system compared to those under the current system. In the absence of some adjustment to reduce the disparity between rural and urban and teaching and nonteaching hospitals, anesthesiologists employed in urban and teaching settings may risk losses in income from clinical services. For academic medical centers, where practice revenues are increasingly used to help support scholarly activities, these reductions in clinical revenues may make it harder for departments of anesthesiology to support additional residents, research fellows, nonclinical time for faculty, and unsponsored research. Thus, depending on the form of payment reform, recruitment of anesthesiologists may be more difficult in teaching and inner-city hospitals, and so potentially threaten access to and quality of anesthesiology care for patients who receive services in these settings.

Regardless of the hospital setting, surgery- and patient-related factors were also likely to result in systematic underpayment. The anesthesiology procedures related to prostatectomy are relatively low in technical complexity. However, both the patient's physical condition and the complexity of the surgical procedure may result in a longer operation for some patients. For coronary artery bypass surgery, the anesthesiology procedure is of moderately high complexity, but is similar for any number of grafts. Again, the complexity of the surgical procedure combined with the physical condition of the patient may increase the length of surgery. This variation in surgical complexity and patient physical status within a single type of procedure leads to variation in the length of the surgical procedure. The lower end of the distribution of surgical time is necessarily restricted (*e.g.*, the procedure must take at least a minimum of some time), but the upper bound is not restricted; therefore, increased variation is likely to result in longer operations. This situation will create the potential for losses when the average length of the procedure rather than the actual length of the procedure provides part of the basis for payment.

The RBRVS, under development by Hsiao and colleagues,[14–18] will be designed to extrapolate a system of relative values from a small subset of procedures to all anesthesiology procedures, by using the existing ASA RVG[17] and estimates of average anesthesia procedure time. The major difference between the RBRVS approach and the current anesthesiology payment system is that the RBRVS-based system does not incorporate the existing large variation of time within procedures with comparable basic relative value units. For example, the average procedure time for a cholecystectomy was 155 min; however, this procedure can take from 45 to 520 min to complete. Moreover, the RBRVS-based system does not incorporate the severity of the patient's physical condition into the payment system. The RBRVS assumes a constant relationship between time and other factors used to define the amount of physician work involved in a procedure. The findings from this analysis indicate that this assumption may not hold true, at least for selected high-volume procedures.

More importantly, there are additional problems associated with using averages, with respect to time or procedure complexity, when constructing an RBRVS. Even

under conditions of budget neutrality, the assumption is that on the average, given a large enough number of cases, gains and losses offset one another. However, it is likely that there will be case-mix differences in kind and number of procedures within and among individual physician practices. It is possible, however, to reduce this risk to individual anesthesiologists through prospective payment to the department of anesthesiology or medical staff, where physicians working in a hospital pool their risk.[27] The fairness of the RBRVS for anesthesiology services depends on how surgical time and other factors (*e.g.*, severity of patient illness), hospital adjustments, and physician risk pools are incorporated into the final system.

In contrast, the existing ASA RVG does attempt to integrate the complexity of the anesthesiology procedure, the duration of the surgical procedure, and the patient's physical condition into a form that can be used to generate payments. The association between RBRVS values and the RVG-based values for selected procedures suggests that the existing method is valid for anesthesiology services. The ASA RVG system for determining charges represents an alternative approach since it incorporates units representing the major clinical and practice factors affecting anesthesiology procedures. It includes steps for periodic review of basic relative value units, representing procedure complexity, in order to factor in the technologic advances in anesthesia monitoring and delivery systems. In addition, hospital record reviews can be used to ensure that the number of units billed actually reflects the procedure, duration of surgery, and patient characteristics. The incorporation of duration of each procedure would normally seem an anathema to a physician payment scheme, except that, for anesthesiology services, time is controlled by the surgeon and not by the anesthesiologist. Retention of a time factor maintains equitable payment across practice settings—a primary objective of physician payment reform.

Appendix

This appendix summarizes the assumptions, data sources, and methods used to estimate the payment to anesthesiologists under the MDDRG-based system and the RBRVS-based system. A more complete description of the methods can be found in a previous report by the authors.[24]

MDDRG-Based System Simulation

MDDRG-based system payments for anesthesiology services were estimated for each individual DRG included in this study. Several assumptions were made in order to generate these payment estimates. First, it was assumed that aggregate MDDRG-based payments for anesthesiology services would remain unchanged under the new payment schedule (*i.e.*, budget neutrality was assumed). Second, we assumed that the charge data and distribution of high-volume DRGs and procedures from the 16 hospitals in this study were fairly representative of anesthesiology practices in the United States. The primary data sources for calculating these estimates were the charge and service data on the 7,770 merged hospital and physician bills collected in the current study and carrier-specific data on average reimbursed claims and volume of services for Medicare Part B services during the fourth quarter of 1986.

The DRG-based anesthesia reimbursement amount for individual DRGs was estimated with the following equation:

$$A_{DRGi} = \frac{\sum_{k}^{k} w_k u_k a_{DRGik}}{k}$$

where A_{DRGi} = estimated DRG-based anesthesiology charge for the ith DRG; a_{DRGik} = average approved anesthesiology charge for the ith DRG for the kth carrier region; w_k = weight for the volume of Medicare Part B services for the kth carrier region; and u_k = weight for the average reimbursed claim for Medicare Part B services for the kth carrier region.

Weights were constructed from data on the average reimbursed Part B charge by region to adjust for differences in the average costs for physician services in different geographic areas of the United States. These weights were multiplied by the estimates of Medicare reimbursable anesthesiology charges to derive regional cost-adjusted reimbursable anesthesiology charges for each DRG.

To control for the varying number of cases among different hospitals and regions of the country, the previously adjusted anesthesiology charges were multiplied by weights representing state or regional Medicare volume. The weights were derived from carrier-specific information on the volume of Medicare Part B claims filed during the fourth quarter of 1986 for the states or regions represented by the sample of hospitals. For example, the anesthesiology charge data from the California hospitals were combined and averaged for each DRG. The weights for these averages were derived using the number of Medicare Part B claims files in California. Finally, for each region the estimated national DRG-based payment was reinflated using regional cost indicators (*e.g.*, average reimbursed Medicare Part B charge). The final result was a national estimated regional cost-adjusted, reimbursable anesthesiology charge for each surgical DRG.

RBRVS-Based System Simulation

RBRVS-based system payment for anesthesiology services was estimated for each individual procedure included in this study. Several assumptions were made in order to generate these payment estimates. First, budget neutrality within aggregate RBRVS-based payments for anesthesiology services was assumed. Second, we assumed that the charge data and distribution of procedures from the 16 hospitals in this study were fairly representative of anesthesiology practices in the United States. Third, average time was used because actual time was not originally incorporated into the RBRVS methodology.[18] The primary data sources for calculating these estimates were the charge and service data on the 10,431 anesthesiology service bills collected in the current study and the RBRVS estimates for 14 procedures contained in the current study and the study by Hsiao *et al.*[18]

A prediction equation was developed, using regression analysis, to estimate RBRVS values for those procedures not originally included in the Hsiao study. First, we regressed total units on the RBRVS values (see Hsiao *et al.*[18]) for the 14 anesthesiology procedures that were contained in both our study and the study by Hsiao and colleagues.[18] Total units equal the sum of basic relative value units and time units for a particular procedure. Basic relative value units for each procedure were obtained from the 1988 ASA RVG. The average number of time units for the 14 procedures was estimated using the anesthesia time data collected in this study. Average time was used since the RBRVS simulation was not intended to reflect actual practice or recent legislative action. This regression equation explained 96% of the variance in RBRVS values. The prediction equation was:

$$\text{RBRVS value} = 38.289 + 17.677 \text{ total units}$$

The coefficients of this regression equation were used to estimate RBRVS values for the those anesthesiology procedures not contained in the Harvard study.[18] For example, anesthesia services for transurethral resection of the prostate resulted in a RBRVS value of 409 (*i.e.*, 38.289 + 17.677 (7 basic units + 14 time units)).

The conversion factor for the RBRVS-based system was estimated, under the assumption of budget neutrality, by dividing the aggregate summation of approved charges for anesthesiology services for all procedures by the total sum of the RBRVS values for all of these procedures. The estimated anesthesiology charges under the RBRVS-based system were calculated by multiplying the RBRVS value for each procedure by the estimated conversion factor.

References

1. Health Care Financing Administration: National health expenditures, 1986–2000. Health Care Financ Rev 8:1–36, 1987
2. Mitchell J, Wedig G, Cromwell J: The Medicare physician pay freeze: What really happened? Health Aff 8:21–33, 1989
3. Jencks S, Dobson A: Strategies for reforming Medicare's physician payments: physician diagnostic-related groups and other approaches. N Engl J Med 312:1492–1499, 1985
4. Congressional Budget Office: Physician Reimbursement Under Medicare: Options for Change. Washington, DC, United States Congress, Congressional Budget Office, 1986
5. Lundberg G: How should physicians be paid? JAMA 254:2638–2639, 1985
6. Office of Technology Assessment: Payment for Physician Services: Strategies for Medicare. Washington, DC, United States Government Printing Office, 1986
7. Physician Payment Review Commission: Medicare Physician Payment: An Agenda for Reform. Washington, DC, Physician Payment Review Commission, 1987
8. Dutton B, McMenamin P: The Medicare economic index: Its background and beginnings. Health Care Financ Rev 3:137–140, 1981
9. American Medical Association: Medicare Physician Reimbursement: An AMA Perspective. Chicago, American Medical Association, 1987
10. Holahan J, Etheredge L: Medicare Physician Payment Reform: Issues and Options. Washington, DC, Urban Institute, 1986
11. Roe B: The UCR boondoggle: A death knell for private practice? N Engl J Med 305:41–45, 1981
12. Roper W: Perspectives on physician payment reform: the resource-based relative-value scale in context. N Engl J Med 319:865–867, 1988
13. Iglehart J: Payment of physicians under Medicare. N Engl J Med 318:863–868, 1988
14. Hsiao W, Braun P, Yntema D, Becker E: Estimating physician's work for a resource-based relative-value scale. N Engl J Med 319:835–841, 1988
15. Hsiao W, Braun P, Dunn D, Becker E, DeNicola M, Ketcham T: Results and policy implications of the resource-based relative-value study. N Engl J Med 319:881–888, 1988
16. Hsiao W, Braun P, Kelly N, Becker E: Results, potential effects, and implementation issues of the resource-based relative value scale. JAMA 260:2429–2438, 1988
17. Hsiao W. Braun P, Dunn D, Becker E: Resource-based relative values: An overview. JAMA 260:2347–2353, 1988
18. Hsiao W, Braim P, Becker E, Causino N, Couch N, DeNicola M, Dunn D, Kelly N, Ketcham T, Sobol A, Verrilli d, Yntema D: A National Study of Resource-Based Relative-Value Scale for Physician Services: Final Report. Boston, Harvard University School of Public Health, 1988
19. American Society of Anesthesiologists: Relative Value Guide, 1989. Park Ridge, American Society of Anesthesiologists, 1989
20. American Hospital Association: American Hospital Association Guide, 1985 Edition. Chicago, American Hospital Association, 1986
21. Mitchell J: Physician DRGs. N Engl J Med 313:670–675, 1985
22. Cromwell J, Rosenbach M: Reforming anesthesia payment under Medicare. Health Aff 7:5–19, 1988
23. Secretary of Health and Human Services: A Prospective Payment System for Radiology, Anesthesia and Pathology Services Furnished to Hospital Inpatients. Washington, DC, United States Department of Health and Human Services, 1987
24. Human Affairs Research Centers: Examination of Variation in Hospital Anesthesiology Services and Charges: An Exploration of Possible Effects of a DRG Payment System for Anesthesiologists. Washington, DC, Battelle Human Affairs Research Centers, 1988
25. Mitchell J, Rosenbach M, Stockard R: DRG-Based Payment for Radiology, Anesthesia, and Pathology Services. Needham, MA, Center for Health Economics Research, 1987
26. Culler S, Ehrenfried D: On the feasibility and usefulness of physician DRGs. Inquiry 23:40–55, 1986
27. Welch W: Prospective payment to medical staffs: A proposal. Health Aff 8:34–49, 1989