Title: PHYSICIAN PAYMENT REFORM: AN ANESTHESIOLOGY CASE STUDY

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Objectives: Health care expenditures have increased dramatically, in part due to inflationary payment mechanisms. Following imposition of a prospective payment system to control hospital expenditures in the Medicare program, federal interest has shifted to reforming payments to physicians. Among approaches considered is a soon-to-be implemented, resource-based relative value system (RBRVS) and, several years ago, a single payment for both physician and hospital charges according to the diagnosis-related group of the surgical procedure (MD-DRG). These systems are expected to redistribute payments across physician services and specialties. We examined the distributional effects of these payment systems within anesthesiology.

Methods: We merged Medicare Part A (hospital) and Part B (anesthesiology) payment data for 7,770 patients in 16 hospitals, who had 10,431 surgical procedures within 27 DRGs during the second half of 1986. Data included surgical and anesthesia time, ASA basic relative value units, and ASA physical status. DRGs included Medicare's most frequently performed surgical procedures. Hospitals were chosen to represent different geographic regions (urban, rural, suburban), bed size, and teaching status. Assuming budget neutrality (i.e., constant total expenditure for anesthesiology services) and using proposed methodologies, we simulated RBRVS and MD-DRG systems and evaluated their effects on payments for anesthesiology services for specific surgical procedures and in specific types of hospitals.

Results: There was substantial variation in the data: Individual surgical procedures had a two- to more than four-fold variation in duration, with 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 payments; however, anesthesia time was highly correlated with surgical time (r=0.86-0.96). RBRVS and MD-DRG systems were associated with systematic variation in payments:

Anesthesiology Payments Compared to Present
(average difference in dollars per case)

	Rural	Nonrural	Teaching	Nonteaching
MD-DRG	+183	—66	—73	+11
RBRVS	+ 52	—31	—40	+ 9

In either system, payments would decrease 10-20% for common cardiac, major vascular, and major orthopedic procedures. After adjusting for complexity of procedure, the distribution of payment gains and losses was a function of duration of surgery, with longer cases of a given surgical procedure resulting in payment decreases.

Conclusions: The primary objectives of physician payment reform are to reduce Medicare spending by improving efficiency and to pay physicians more equitably without compromising quality of care. Yet, this study shows that anesthesia time is dependent on duration of surgery, which is not influenced by the anesthesiologist, who is thus limited in his ability to enhance efficiency. Moreover, under either payment option, in the absence of a time factor in the payment formula or an adjustment for certain practice settings, payments across practice settings would be systematically inequitable, such that anesthesiologists in rural and nonteaching facilities would be paid more per case than their colleagues in urban and teaching hospitals, altering incentives to anesthesiologists and possibly affecting access to care. These results document the importance of retaining a time factor in the payment methodology for anesthesiology services relating to surgery to maintain equitable payment across practice settings, an objective of physician payment reform.

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TITLE: A PROTOTYPE EXPERT SYSTEM AIDS IN THE DIFFERENTIAL DIAGNOSIS OF AN ACUTE DECREASE IN END-TIDAL CO_2

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A decrease in end-tidal CO_2 ($PetCO_2$) may have its origin in malfunctions of the anesthesia breathing circuit, reduced CO_2 production, or decreased pulmonary blood flow. We developed a prototype expert system to rule out malfunctions of the breathing circuit and changes in CO_2 production, thus narrowing the differential diagnosis.

From standard front-end monitors, the inspiratory airway pressure and expiratory flow waveforms, the capnogram, and data from the current fresh gas flow, ventilator settings, and a pulse oximeter are obtained. These data, combined with the patients height, weight, and gender serve as input into a rule-based expert system implemented on an IBM PC/AT to evaluate, in real time, the integrity of the circle anesthesia breathing circuit during mechanical ventilation, to estimate the adequacy of ventilation, or to detect other causes for the observed physiologic changes. The system uses an acute transient decrease in $PetCO_2$ to exclude mechanical malfunctions or decreased CO_2 production.

The system was evaluated in an experiment with 5 anesthetized male sheep (weight, 90 - 120 lbs) during mechanical ventilation. To introduce a change in pulmonary blood flow in each animal, 0.25 cc/kg of air was injected through a central venous catheter while observing the result of the evaluation of the rule base by our expert system at the end of each breath, and possible alarm messages produced by the front-end of physiologic monitoring equipment. Also, 31 mechanical malfunctions and 10 other physiologic perturbations were introduced (mainstream intubation, hyper- and hypoventilation, etc.) to detect possible false alarms of pulmonary emboli.

In all 5 sheep, the expert system correctly identified the change in pulmonary blood flow while ruling out mechanical malfunctions or a decrease in CO_2 production as possible cause for the change in $PetCO_2$. No false positive or false negative alarm message was generated. In all these cases, the front-end equipment failed to trigger an alarm message when alarm limits were set appropriately for the current animal.

Our tests indicated that our expert system can be an important aid for the clinician to narrow down the differential diagnosis when change in $PetCO_2$ is observed. This system also shows that intelligent alarms are possible when the system is able to integrate information from a number of sources for the evaluation of changes in physiologic parameters to aid the clinician in the differential diagnosis of critical events.