Purpose of admission and resource use during cancer hospitalizations

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This study examined the role of purpose of admission (POA) in hospitalizations for lung, colon, and breast cancers, using the 1985 20-percent Medicare provider analysis and review file. Six POA categories were created from discharge abstract data. Average hospitalization charges, per diem charges, length of stay, and rates of death varied significantly by POA ($p < .001$). Rural and small hospitals were more likely to admit patients for palliation, while urban and large hospitals admitted relatively more patients for active interventions ($p < .0001$). POA and indicators of case complexity added only modestly to the ability of diagnosis-related groups to predict hospitalization charges.

Introduction

Cancer has a catastrophic impact, not only on individuals, but also on society and the health care delivery system. In 1986, cancer caused 22.3 percent of deaths in the United States, second only to heart disease (Silverberg, Boring, and Squires, 1990). Direct health services costs generated by cancer care were $18.1 billion in 1985, and costs resulting from losses of labor and productivity from cancer-related morbidity and death totaled $54.4 billion (Rice, Hodgson, and Capell, 1990). Both the incidence of most malignancies and the consequent utilization of health care resources rise with increasing patient age. For example, in 1986, cancer caused 41.1 hospital discharges per 1,000 population for males 65 years of age or over, compared with 12.3 discharges per 1,000 population for males 45-64 years of age (National Center for Health Statistics, 1988).

Given the demographics of malignancy, much of the burden of paying for cancer care falls on the Medicare program. However, with a few exceptions, Medicare's prospective payment system (PPS) based on diagnosis-related groups (DRG) did not include special provisions for paying for cancer hospitalizations. This generated concern that hospitals treating large numbers of potentially expensive cancer patients could be unfairly paid, especially those institutions that specialize in technologically intensive treatments or diagnostic evaluations. As a result, facilities that qualify as "cancer hospitals" (those involved extensively with treatment for or research on cancer) can apply for exemption from PPS (*Federal Register*, 1990).

One suggestion for an alternative classification scheme for prospective payment of cancer-related hospitalizations has focused on the purpose of admission: Was the patient admitted for costly, technologically sophisticated, aggressive interventions, or was the patient admitted for often less expensive "comfort measures only" or supportive care? The purpose or goals of admission could differ across cancer patients within the same DRG. The major aim of this research was to investigate whether grouping cancer cases by their POA would usefully distinguish cases with different resource utilization during hospitalization. We focused on three cancers common to the elderly Medicare population—lung, colon, and breast. This article presents our POA measure, provides descriptive evidence as a preliminary validation of our POA construct, and examines resource use by POA category across all cases and by hospital type. It also examines the relative abilities of the DRGs and our POA categories to explain resource use for cases with lung, colon, and breast cancers.

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Background

Cancer cases are generally scattered throughout many clinically heterogeneous DRGs, which include not only patients being treated for malignancy but also those admitted for non-malignant diseases. As with non-cancerous conditions, most cancer patients are assigned to DRGs based on their principal diagnosis and the presence or absence of major surgery. Major surgery DRGs are defined by the procedures themselves. For example, DRG 148 covers cases with specified major small and large bowel procedures, regardless of the underlying disease that precipitated the surgery. Thus, this DRG includes not only cases with colonic malignancies but also patients with other conditions, such as diverticulitis and inflammatory bowel disease. Non-surgical cases are assigned to medical DRGs, which also generally include a heterogeneous range of conditions. For instance, DRG 82, respiratory neoplasms, encompasses patients with malignancy of the respiratory tract as well as cancers of the mediastinum and thorax, and non-malignant conditions such as benign neoplasms of the ribs.

One important DRG is defined by a specific medical treatment—DRG 410, chemotherapy, which is grouped within major diagnostic category (MDC) 17, myeloproliferative diseases and disorders and poorly differentiated neoplasms. All non-surgical cancer patients who receive chemotherapy during their admission are supposed to be assigned to DRG 410; thus, DRG 410 contains patients with virtually all malignancies treated by chemotherapy. This makes DRG 410 one of the most common DRGs assigned to hospitalizations for cancer care. Another DRG in MDC 17 is also defined by a non-surgical therapy—DRG 409, radiotherapy.

Analogously, all patients admitted for radiation therapy are supposed to be assigned to this DRG. However, DRG 409 is much less common than DRG 410.

Very little empirical evidence exists exploring the ability of the DRGs to group cancer patients with similar costs. Mortenson and Yarbo (1985) found wide, within-DRG variations in costs, especially for patients in the DRGs representing respiratory neoplasms, major small and large bowel procedures, and lymphoma and leukemia. Using data from a single New York hospital, Muñoz and colleagues (1988) found that in "mixed" medical DRGs (DRGs that include both cancer and non-cancer patients), patients with a diagnosis of malignancy had much higher hospitalization costs, procedure use, and mortality than patients without malignancy. Vertrees and Manton (1986) examined 1981 administrative data from Maryland for patients with lung cancer, leukemia, and breast cancer and concluded that the stage of treatment may be an important predictor of hospitalization costs. Vertrees and Manton also suggested three possible treatment stages—diagnosis, procedure, and terminal stages—all of which could occur during a single admission. These stages also reflect purpose or goals of an admission.

Using 1982 Medicare claims data from two States, Iezzoni and Moskowitz (1984) found large coefficients of variation for hospitalization costs in DRG 82, respiratory neoplasms: 1.03 in New Jersey and 1.23 in North Carolina. More importantly, they found that more than one-half of the patients in DRG 82 had more than one admission during 1982. When physician costs were examined for that subset of patients with more than one admission in DRG 82, the services obtained during the first admission appeared to differ significantly from those provided during the second admission. Physician costs for intensive care unit visits, consultations, diagnostic surgery, radiologic testing, and other tests were statistically significantly higher ($p < .05$) for the first compared with the second admission. These findings suggest that the POA differed between a first and subsequent hospitalization.

Jencks (1990) suggested three factors not reflected in the DRGs that could relate to the costs of cancer hospitalizations: severity of illness, intensity of care, and POA. Given its clinical natural history, cancer care can be broadly classed into phases, characterized by its goals or the purpose of care (Lewandowski and Jones, 1988). An initial period generally involves diagnostic evaluation, to confirm the presence and type of malignancy and document its extent. This is followed by an active treatment period, during which the tumor is surgically resected and/or actively treated by chemotherapy, radiation therapy, or other medical approaches. Clinical complications of the malignancy and/or the administered therapies may also require surgical and/or medical interventions. The final phase involves terminal care for patients for whom active treatment is no longer effective or desirable. This broad rubric is obviously tailored to fit the clinical context of individual patients as well as their goals and wishes. Patient wishes and goals for their hospitalizations may not be captured adequately by DRGs.

Despite this expectation that the POA may be strongly related to resource use during cancer hospitalizations, no conclusive evidence yet exists to confirm this hypothesis. One small study involving 364 patients admitted for respiratory malignancy found that DRGs explained 10 percent of the variation in adjusted hospital charges (Iezzoni et al., 1990), while POA (e.g., diagnostic evaluation only, aggressive medical intervention, or terminal supportive care, as determined through medical record review) explained 15 percent of the variation (Iezzoni et al., 1989). POA also varied by hospital teaching status ($p < .001$): Patients at tertiary teaching facilities were relatively more likely to be admitted for technologically intensive interventions or workups, while patients at non-teaching hospitals were relatively more likely to be admitted for palliative, hospice-type care (Iezzoni et al., 1989).

Thus, POA may add another perspective—one not captured by the DRGs—to explaining variations in resource use for cancer hospitalizations. Our research rested on two assumptions: first, that costs of cancer hospitalizations would vary depending on the use of treatment modalities and diagnostic technologies; and second, that use of such services would implicitly reflect the purpose of the hospitalization.

Methodology

Data base creation

To determine the cancers to be studied, preliminary analyses were conducted on a 20-percent sample of the fiscal year 1984 Medicare provider analysis and review (MEDPAR) file, not including discharges from long-term care facilities and cases that were missing charge data. Cancer-related discharges were identified using the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) (Public Health Service and Health Care Financing Administration, 1980) diagnostic codes contained in the MEDPAR file (MEDPAR includes up to five diagnosis codes per discharge). One-tenth (9.8 percent) or 173,522 of the discharges had an ICD-9-CM cancer code as the principal (i.e., first-listed) diagnosis, and an additional 5.8 percent had cancer listed only as a secondary diagnosis. The six most common cancer principal ICD-9-CM diagnoses were: lung cancer (code 162; 19,161 discharges), admission for chemotherapy (code V58.1; 18,062 discharges), prostate cancer (code 185; 15,983 discharges), colon cancer (code 153; 13,406 discharges), metastases to specified site other than lung or digestive system (code 198; 11,890 discharges), and breast cancer (code 174; 11,297 discharges). Hospitalization charges from lung cancer totaled $158.1 million, for colon cancer $148.4 million, and for breast cancer $68.2 million.

We chose to focus our analyses on lung, colon, and breast cancers. We selected these cancers based on their high frequency and charges relative to other cancers as demonstrated by the 1984 MEDPAR analyses and differences among them in prognosis, patterns of disease progression, and diagnostic and therapeutic approaches.

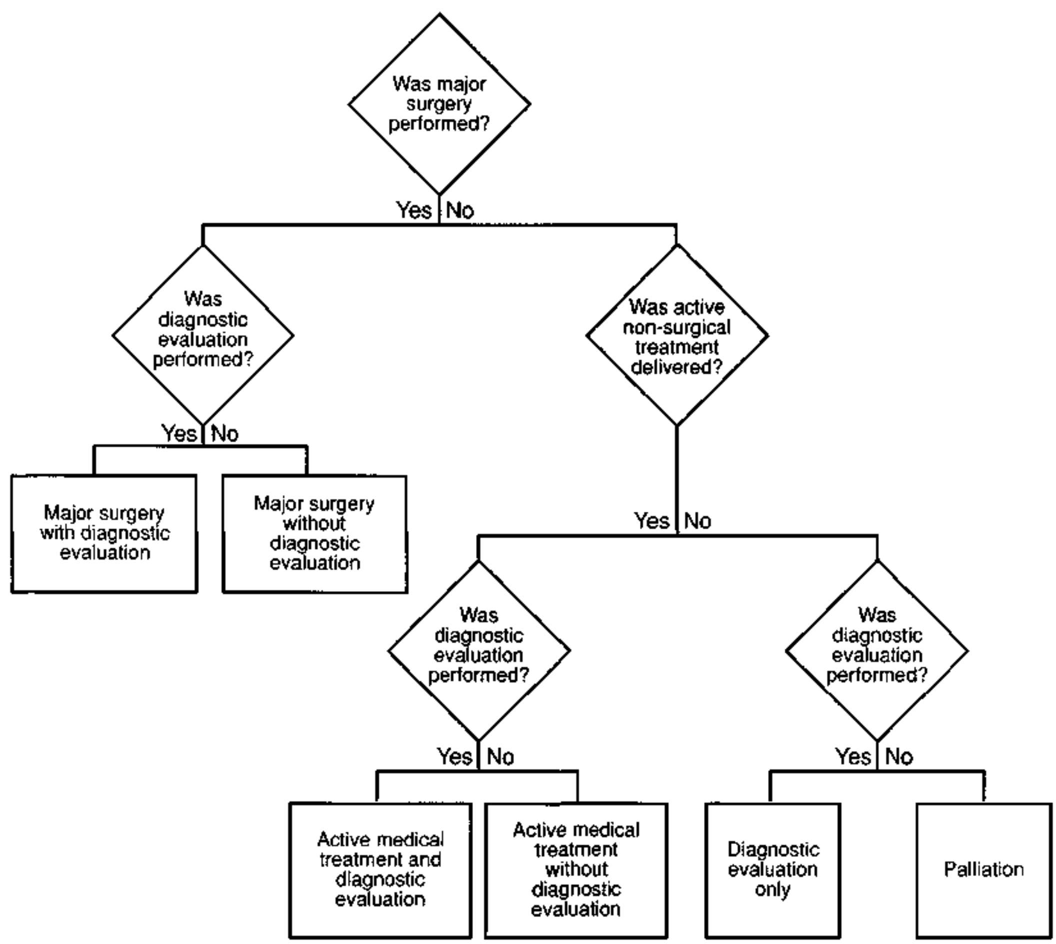
The final analytic data base was drawn from the fiscal year 1985 20-percent MEDPAR file excluding long-term care discharges and cases without charge data. Initially, we extracted all cases with lung, colon, or breast cancer codes as any of the five potential ICD-9-CM discharge diagnoses. However, preliminary analyses of diagnostic coding patterns using the MEDPAR data by the study team suggested that many discharges with cancer coded only in the third, fourth, or fifth positions were probably unrelated to cancer treatment. For example, if the principal diagnosis was acute myocardial infarction and colon cancer was listed as the fourth diagnosis, we hypothesized that the POA was to treat the myocardial infarction, not the cancer. Therefore, we limited the analytic file to all discharges with a principal diagnosis of cancer and to discharges with a diagnosis of cancer in the second position along with a diagnosis considered to indicate metastases or complications of the cancer as the first-listed diagnosis. The final analytic file included 21,788 lung cancer discharges, 16,758 colon cancer discharges, and 9,244 breast cancer discharges. This file was merged with the provider of service file using provider identification numbers to add information on hospital characteristics for each discharge.

Purpose of admission

Six POA categories were delineated using diagnostic, procedural, and charge data contained in the discharge abstract (Figure 1). Diagnostic and procedural codes were assigned to the various categories based on clinical judgment. Complete information about the POA categories and their derivation is presented elsewhere (Henderson et al., 1990).

Our goal in defining the POA categories was to make them predictive of resource use. Therefore, the underlying philosophy was similar to that of the DRGs, starting with identifying cases with major surgery. The major surgery variable was flagged if the patient underwent one or more procedures that are generally intended as therapeutic (not diagnostic) and that must typically be performed in the sterile environment of an operating room or comparable facility.

Figure 1
Decision procedure for establishing categories of purpose of admission



SOURCE: (Henderson et al., 1990).

Table 1
Number and percent of cases and means and standard deviations of total charges, by purpose of admission: Lung, colon, and breast cancer

	Number and percent of cases						Means and standard deviations of total charges					
	Lung		Colon		Breast		Lung		Colon		Breast	
Purpose of admission	Number	Percent	Number	Percent	Number	Percent	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
All cases	21,788	100.0	16,758	100.0	9,244	100.0	$4,882	4,132	$7,730	5,431	$3,841	2,154
Major surgery with diagnostic evaluation	1,473	6.8	4,393	26.2	3,247	35.1	10,174	4,530	9,797	5,098	4,394	2,045
Major surgery without diagnostic evaluation	825	3.8	7,025	41.9	3,897	42.2	9,369	4,349	9,394	5,031	3,760	1,854
Active medical treatment with diagnostic evaluation	1,924	8.8	315	1.9	184	2.0	6,337	4,229	5,381	4,850	4,476	2,997
Active medical treatment without diagnostic evaluation	4,199	19.3	1,082	6.5	433	4.7	3,080	2,925	3,375	3,889	2,351	2,197
Diagnostic evaluation only	8,103	37.2	2,527	15.1	970	10.5	4,846	3,800	3,902	3,985	3,030	2,334
Palliation	5,264	24.1	1,416	8.4	513	5.5	3,658	3,244	3,736	3,604	3,521	2,858

SOURCE: (Henderson et al., 1990).

The diagnostic evaluation variable was flagged if the patient underwent one or more procedures that are generally intended as diagnostic. Our list of diagnostic procedures included several services, such as biopsies, that are classified as surgery by the DRGs. The diagnostic evaluation variable was also flagged if the proportion of total charges accounted for by radiology plus laboratory charges was at or higher than the 75th percentile for the entire distribution of discharges for that cancer. This radiology-plus-laboratory-charge provision accounted for 22 percent of the cases that received a diagnostic evaluation flag.

The active medical treatment variable was flagged if the patient underwent one or more non-surgical, generally therapeutic procedures that can potentially be performed at the bedside (e.g., insertion of chest tubes). This category also included ICD-9-CM codes indicating chemotherapy or radiation therapy, mechanical ventilation, intensive care unit monitoring, and cardiopulmonary resuscitation, as well as cases with intensive care unit, operating room, or inhalation therapy charges. The purpose of the active medical treatment variable was to indicate the use of treatment that would often not be provided to patients who had made the decision to suspend aggressive interventions (e.g., as in the presence of a "comfort measures only" order).

Using the major surgery, diagnostic evaluation, and active medical treatment variables, a hierarchy of purposes of admission was defined, such that a discharge would be assigned to the first POA for which it qualified following the order listed in Table 1. A residual category called "palliation" was created to contain all cases that were not assigned to one of the five previous POA groups. Thus, we use the term "palliation" in a narrow sense, in that it encompasses cases without information suggesting that an active intervention or evaluation was undertaken during the hospitalization.

Case complexity

Given the limitations of the MEDPAR file, it was impossible to account fully for severity of illness. However, we attempted to use the available diagnostic data (up to five ICD-9-CM codes per hospitalization) to indicate something about the extent and complications of the cancers or their therapies, as well as other comorbidities that might be present. Using clinical judgment, ICD-9-CM codes were grouped into three classes to serve as proxies for case complexity, as follows: (1) metastatic disease; (2) complications of the cancer under study, its treatment, or its metastases; and (3) comorbidities, or significant clinical conditions other than the cancer or its complications.

Examples of codes that defined metastatic disease include the ICD-9-CM diagnoses of secondary malignancies in specified organ systems. Examples of diagnoses that qualified as complications of the cancer or its treatment include pulmonary collapse or hemorrhage, respiratory failure, seizures, coma, cauda equina syndrome, persistent vomiting, gastrointestinal hemorrhage, pathological fracture, intestinal obstruction, agranulocytosis, and volume depletion. Comorbidities were ICD-9-CM codes that appear on the DRG complication and comorbidity (CC) list, but that were not included in the other two classes of complexity indicators. Examples of such diagnoses include diabetes with renal manifestations, acute myocardial infarction, malignant hypertension, cholelithiasis with acute cholecystitis, and alcoholic psychosis. Because the complexity indicators allowed us to split DRGs previously split by CCs, our DRG analyses focused on adjacent DRGs (ADRGs, that is, contiguous DRGs ordinarily separated based on the presence of CCs).[1]

All five diagnosis slots per case in the MEDPAR file were scanned by the computer to assign these classes to each admission. An admission could have either no complexity indicators or complexity indicators from one, two, or three different classes. This approach sorted cases

[1] Not all DRGs have such related DRGs that would be linked to form an ADRG. For example, DRG 82, respiratory neoplasms, does not have any contiguous DRGs from which it is split by CCs. DRG 82 contains all respiratory neoplasm cases, regardless of the presence or absence of CCs.

into eight separate, mutually exclusive complexity-indicator groupings (e.g., none; complications only; complications plus metastatic disease; complications plus comorbidities; complications plus metastatic disease plus comorbidities). Complete information about the complexity indicators is presented elsewhere (Henderson et al., 1990).

Hospitalization charges

Information on total hospital charges for each case was obtained from the MEDPAR file used for case selection. The few cases with total charges less than $100 were excluded because they were thought to probably represent erroneous information. Data from the many hospitals represented were not available to us for adjusting the charge data (e.g., cost-to-charge ratios or adjustments for the area wage index, capital costs, or medical education costs). Therefore, the resource use variables employed in these analyses were unadjusted hospital charges and length of stay. This approach is similar to that used by the Federal Government in calibrating the prospective payment levels: Since fiscal year 1986, DRG weights have been based on charge data (*Federal Register*, 1990). Cases with total charges greater than two standard deviations above the mean within each cancer were trimmed from the analyses as outliers. In total, 4.8 percent of cases were trimmed as outliers.

Diagnosis-related group analyses

To compare the ability of the DRGs and the POA categories to predict hospitalization charges, we first explored the distribution of cases across ADRGs by POA categories. In all three cancers, most cases within a single POA category fell into one or two ADRGs, with a scattering across a variety of other DRGs. To accumulate enough cases for meaningful statistical analyses, we conducted all DRG analyses using the following groupings: specific ADRGs that contained a large fraction of the cases (e.g., DRG 82 for lung cancer; ADRG 148/149 for colon cancer); other surgical DRGs within the same MDC as the primary cancer (i.e., MDC 4, diseases and disorders of the respiratory system; MDC 6, diseases and disorders of the digestive system; or MDC 9, diseases and disorders of the skin, subcutaneous tissue and breast); other medical DRGs within the same MDC as the primary cancer; other surgical DRGs outside the MDC of the primary cancer; and other medical DRGs outside the MDC of the primary cancer.

Statistical methods

All analyses were conducted separately within each of the three cancers. Chi-square tests were performed to examine the difference in distribution of cases by POA category for categorical variables of interest, such as in-hospital death, hospital location, patient-age category,[2] and the complexity indicators. Analysis of variance was used to determine whether POA categories differed according to continuous measures, such as total charges, per diem charges, and length of stay. Although p values are listed to indicate the statistical significance of our findings, it is important to note that because of the large sample size, even small differences are likely to attain statistical significance.

Ordinary least-squares regression was used to examine the ability of various independent variables to predict the dependent variable, hospitalization charges. Actual hospitalization charges were used, unadjusted by means such as logarithmic transformations. The independent variables included DRG as previously described, POA category, the complexity indicators, and various interactions among these three types of variables. These factors were entered into the regression models as class variables; for example, POA was entered as six classes and complexity factors were entered as eight classes. The R-squared value $\times$ 100 was used as the measure of relative predictive power of these different models.

Results

The distribution of cases across the six POA categories differed among the three cancers, as seen in Table 1 (chi-square = 30,740, 10 degrees of freedom, $p < .0001$). In lung cancer, the most common POA was diagnostic evaluation only (37.2 percent of cases), followed by palliation (24.1 percent), and active medical treatment without diagnostic evaluation (19.3 percent). In contrast, more than one-half of colon and breast cancer admissions were for major surgery, primarily major surgery without diagnostic evaluation. Admissions for palliation were relatively rare: 8.4 percent of colon cancer and 5.5 percent of breast cancer cases.

Purpose of admission and complexity

Our POA categories and complexity indicators represent new constructs developed by project physicians. However, we were unable to validate (e.g., using medical record data) that these algorithms, based primarily on MEDPAR diagnostic and procedural data, actually captured the true purpose of admission and severity of patient illness. Therefore, as a preliminary validation, we examined the relationships among POA, the complexity indicators, age, and in-hospital mortality, testing a priori clinical hypotheses, including the following:

- Palliation cases would have the highest death rates of the six POA categories.
- Older patients would be more likely to be admitted for palliation, while younger patients would be more likely to be admitted for active interventions.
- Cases with multiple complexity indicators would be more likely to die in-hospital than other cases.
- Patients with metastatic disease would be unlikely to undergo major surgery and would be relatively more likely to be admitted for palliation.

This section summarizes the results of these analyses.

In-hospital death rates across all cases were 17.8 percent for lung cancer, 8.9 percent for colon cancer, and 3.0 percent for breast cancer. However, rates of death differed significantly across the POA categories

[2]The MEDPAR file used for these analyses did not contain actual patient age or date of birth. An indication of age was included in a categorical form as follows: 65-74 years of age; 75-84 years of age; and 85 years of age or over.

($p < .0001$ for all three cancers). Palliation cases were always most likely to end in death, with rates of 35.5 percent for lung cancer, 35.9 percent for colon cancer, and 26.7 percent for breast cancer. The major surgery categories had the lowest death rates across all cancers: Major surgery with diagnostic evaluation had the lowest death rate for lung cancer (5.6 percent); major surgery without diagnostic evaluation had the lowest death rate for colon cancer (3.9 percent); and both major surgery categories had 0.2 percent death rates for breast cancer.

Patient age also varied significantly across the POA categories ($p < .0001$ for all cancers). Lung cancer patients 85 years of age or over were much more likely than younger patients to be admitted for palliation (34.3 percent of admissions, compared with 22.3 percent for persons 65-74 years of age) or for diagnosis only (46.2 percent of admissions compared with 35.4 percent for the younger age group). For colon and breast cancers, persons 85 or over were much less likely than their younger counterparts to be admitted for active medical treatment. Colon cancer patients 85 years of age or over were also much more likely than younger patients to be admitted for diagnostic evaluation only.

Death rates varied widely across complexity categories for all three cancers ($p < .0001$), and the direction of the variation generally concurred with a priori expectations. Rates of death were always highest for cases with all three complexity findings (distant metastases, complications of the cancer or its treatment, and comorbidities): 23.1 percent for lung cancer, 17.7 percent for colon cancer, and 13.8 percent for breast cancer. In contrast, the lowest death rates were found among patients with either no complexity indicators or with comorbidities only: 12.8 percent for lung cancer, 3.4 percent for colon cancer, and 0.5 percent for breast cancer. The majority of deaths had distant metastases coded (59.1 percent of lung cancer deaths, 64.4 percent of colon cancer deaths, and 80.1 percent of breast cancer deaths). Many deaths also had codes indicating a complication of the cancer or its treatment (55.4 percent of lung cancer deaths, 52.5 percent of colon cancer deaths, and 33.4 percent of breast cancer deaths). Therefore, by this crude evaluation, the complexity indicators appear to have some face validity.

The indicators of case complexity varied by POA ($p < .0001$ for all three cancers). Major surgery without diagnostic evaluation always had the highest rate of uncomplicated cases (cases without any complexity indicators): 18.1 percent for lung cancer, 14.8 percent for colon cancer, and 35.8 percent for breast cancer. In contrast, active medical treatment without diagnostic evaluation always had the lowest rate of cases without any complexity indicators: 2.2 percent in lung cancer, 5.1 percent in colon cancer, and 4.4 percent in breast cancer.

Distant metastases were always least frequent in the major surgery category and most frequent in the active medical treatment and palliation categories. In lung cancer, rates of distant metastases were 58.0 percent and 59.1 percent, respectively, for active medical treatment with and without diagnostic evaluation, while the rate of distant metastases was 52.6 percent for palliation cases. In colon cancer, the rate of metastases was the highest for the palliation group at 66.1 percent, followed by active medical treatment with and without diagnostic evaluation (51.5 and 62.4 percent). A similar pattern was observed for breast cancer, with 70.5 percent of the palliation group having distant metastases, as did 65.2 and 56.7 percent of the patients undergoing active medical treatment with and without diagnostic evaluation, respectively.

The lowest rates of complications from the cancer or its treatments were observed in the major surgery categories. By far, across all three cancers, the highest rates occurred for cases with active medical treatment without diagnostic evaluation. Complications from the cancer or its treatment were observed in 85.9 percent of lung cancer patients admitted for active medical treatment without diagnostic evaluation, and 75.2 percent of colon cancer and 76.9 percent of breast cancer patients admitted for this purpose.

In contrast to the other two complexity indicators, comorbidities were most frequent for patients undergoing major surgery with diagnostic evaluation in all three cancers: 68.4 percent of lung cancer, 74.9 percent of colon cancer, and 54.9 percent of breast cancer cases. Comorbidity rates were slightly lower for major surgery without diagnostic evaluation. Across all three cancers, comorbidities were relatively common for patients admitted for diagnostic evaluation only: 65.8 percent for lung cancer, 68.0 percent for colon cancer, and 54.3 percent for breast cancer. Comorbidity rates were also high for active medical treatment with diagnostic evaluation in lung (66.7 percent) and colon (63.6 percent) cancers.

In all three cancers, patients admitted for active medical treatment with diagnostic evaluation were most likely to have all three complexity indicators: 18.1 percent of lung cancer, 16.2 percent of colon cancer, and 17.4 percent of breast cancer cases. In colon cancer, an identical fraction (16.2 percent) of palliation cases had all three complexity indicators.

Purpose of admission, resource use

Average hospitalization charges varied significantly ($p < .001$) across the six POA categories for all three cancers (Table 1). The presence of a diagnostic evaluation always increased the charges for major surgery and active medical treatment admissions: For all three cancers, active medical treatment admission charges were more than $2,000 higher when a diagnostic evaluation was performed compared with when it was not. In lung and colon cancers, major surgery with a diagnostic evaluation was the most expensive POA, while in breast cancer, active medical treatment with diagnostic evaluation was the most costly. The least costly admissions across all three cancers involved active medical treatment without diagnostic evaluation.

Average lengths of stay also varied significantly ($p < .001$) across the six POA categories for all cancers (Table 2). The longest average stays occurred for major surgery with diagnostic evaluation for lung (13.3 days) and colon cancers (14.9 days). For breast cancer, the longest stays were for palliation (9.3 days). In all three cancers, the shortest stays involved active medical treatment without diagnostic evaluation.

Table 2
Means and standard deviations of length of stay and per diem charges: Lung, colon, and breast cancer

	Length of stay in days						Per diem charges					
	Lung		Colon		Breast		Lung		Colon		Breast	
Purpose of admission	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
All cases	8.4	7.3	12.5	8.4	6.8	4.6	$678	400	$645	339	$640	312
Major surgery with diagnostic evaluation	13.3	6.9	14.9	7.3	7.4	3.8	845	378	691	296	660	288
Major surgery without diagnostic evaluation	12.2	6.6	14.1	7.3	6.5	3.7	846	433	707	366	653	308
Active medical treament with diagnostic evaluation	10.8	7.7	9.4	8.3	8.4	7.4	675	347	635	336	731	511
Active medical treatment without diagnostic evaluation	4.7	5.4	6.5	8.9	4.4	4.7	873	524	610	404	643	404
Diagnostic evaluation only	8.5	7.0	7.9	7.8	5.9	5.4	655	351	544	273	617	320
Palliation	8.3	7.7	10.2	10.7	9.3	8.3	488	248	404	209	422	190

SOURCE: (Henderson et al., 1990).

The POA groups also varied significantly ($p < .001$) in per diem charges or a measure of daily resource intensity (Table 2). Despite the short stays, average per diem charges were highest for active medical treatment without diagnostic evaluation in lung cancer. The highest per diem charges involved major surgery for both colon and breast cancer, with almost identical average per diem charges for admissions with and without diagnostic evaluation. In all three cancers, the lowest per diem charges were observed for the palliation admissions, with average per diem charges about $200 less than average per diem charges across all cases.

Purpose of admission, hospital type

An important research hypothesis was that POA would vary by hospital type. We examined three hospital characteristics: number of beds (less than 100, 100-299, 300-500, and more than 500 beds), urban versus rural location, and ownership (non-profit, proprietary, and public). The pattern of discharges across POA categories varied significantly by hospital type. The most notable differences involved bed size (Table 3) and urban and rural location (Table 4).

The distribution of cases across the six POA categories varied significantly by hospital bed size ($p < .0001$ for all cancers). Across all three cancers, hospitals with more than 500 beds had relatively fewer admissions for palliation than did small hospitals. For example, for lung cancer, 16.6 percent of admissions at hospitals with more than 500 beds were for palliation, compared with 49.5 percent of admissions at hospitals with fewer than 100 beds. In contrast, large hospitals were more likely than small hospitals to admit patients for major surgery with diagnostic evaluation and for active medical treatment. For example, 33.7 percent of lung cancer admissions at hospitals with more than 500 beds were for active medical treatment, compared with only 14.3 percent of admissions at the smallest hospitals.

The largest hospitals (with more than 500 beds) always had higher average charges than did the smallest hospitals (with less than 100 beds). However, the discrepancy in charges varied by POA. Average charges for major surgery were virtually identical across small and large hospitals for lung cancer and only slightly higher at the largest facilities for colon and breast cancer cases. The major contrasts occurred for palliation and diagnostic evaluation only. Charges for palliation cases at the largest hospitals averaged 1.5 times those at the smallest hospitals for lung and colon cancers and 1.7 times higher for breast cancer. Average charges for diagnostic evaluation only cases at the largest hospitals were 1.4 times those at the smallest hospitals for lung and breast cancers and 1.9 times higher for colon cancer.

Urban and rural hospitals also varied widely in the distribution of cases across POAs ($p < .0001$). For all three cancers, rural hospitals were more likely than urban facilities to admit patients for palliation. For example, 39.2 percent of rural lung cancer admissions were for palliation, compared with 21.0 percent of urban hospital admissions. In contrast, urban hospitals were much more likely to admit patients for active medical treatment.

Across all cases, average charges at urban compared with rural hospitals were 40 percent higher for lung cancer, 30 percent higher for colon cancer, and 20 percent higher for breast cancer. For all three cancers, average charges at urban hospitals were approximately 1.2 times those at rural hospitals for major surgery with and without diagnostic evaluation. The largest discrepancies in charges between urban and rural hospitals occurred for diagnostic evaluation only for colon cancer (urban hospitals averaging 70 percent more expensive than rural) and breast cancer (50 percent more expensive).

POA assignments also varied somewhat by hospital ownership ($p < .0001$ for lung and colon cancer; $p = .057$ for breast cancer). Public hospitals were more likely to admit patients for palliation than were other hospitals. For example, 31.5 percent of lung cancer discharges from public hospitals were for palliation,

Table 3
Percent of cases discharged by hospital bed size, by purpose of admission: Lung, colon, and breast cancers

Purpose of admission	Hospitals with less than 100 beds			Hospitals with 100-500 beds			Hospitals with more than 500 beds		
	Lung	Colon	Breast	Lung	Colon	Breast	Lung	Colon	Breast
	Percent of cases								
All cases	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Major surgery with diagnostic evaluation	2.2	19.0	25.9	6.8	26.9	36.3	8.4	29.0	37.2
Major surgery without diagnostic evaluation	1.5	39.7	46.2	3.9	42.7	42.3	4.4	40.8	39.9
Active medical treatment with diagnostic evaluation	3.5	1.5	0.8	8.3	1.8	1.9	12.0	2.3	1.8
Active medical treatment without diagnostic evaluation	10.8	4.0	3.6	19.5	6.4	4.5	21.7	8.2	5.9
Diagnostic evaluation only	32.5	21.9	12.3	38.0	14.2	10.0	36.9	13.4	11.0
Palliation	49.5	13.8	11.1	23.5	8.0	5.0	16.6	6.3	4.2
Number of cases	1,988	2,247	1,131	14,514	11,225	6,082	5,260	3,286	2,009

NOTES: Chi-square analyses performed separately within each cancer found significant ($p < .0001$) differences in the distribution of cases across purpose-of-admission categories by hospital bed size (less than 100, 100-299, 300-500, more than 500). Columns may not add to 100.0 because of rounding.

SOURCE: (Henderson et al., 1990).

Table 4
Percent of discharges from urban and rural hospitals, by purpose of admission: Lung, colon, and breast cancers

Purpose of admission	Urban			Rural		
	Lung	Colon	Breast	Lung	Colon	Breast
	Percent of cases					
All cases	100.0	100.0	100.0	100.0	100.0	100.0
Major surgery with diagnostic evaluation	7.3	27.0	36.5	4.2	23.2	29.8
Major surgery without diagnostic evaluation	4.0	42.3	41.6	3.0	40.6	45.1
Active medical treatment with diagnostic evaluation	9.4	2.1	1.8	5.8	1.2	1.5
Active medical treatment without diagnostic evaluation	20.5	6.9	4.8	13.2	4.6	4.4
Diagnostic evaluation only	37.8	14.0	10.3	34.6	19.3	11.3
Palliation	21.0	7.7	5.0	39.2	11.1	7.8
Number of cases	18,001	13,265	7,397	3,761	3,493	1,825

NOTES: Chi-square analyses performed separately within each cancer found significant ($p < .0001$) differences between urban and rural hospitals in the distribution of cases across purpose-of-admission categories. Columns may not add to 100.0 because of rounding.

SOURCE: (Henderson et al., 1990).

compared with 23.0 percent and 22.9 percent from non-profit and proprietary hospitals, respectively. Public hospitals were also less likely to admit lung cancer patients for active medical treatment. For almost all POA categories, proprietary hospitals had the highest average charges and public hospitals the lowest average charges. For all POA groupings, charges at proprietary hospitals averaged 10-30 percent higher than those at public hospitals, except for palliation in breast cancer, in which average proprietary hospital charges were 70 percent higher than those at public hospitals.

Distribution across diagnosis-related groups

POA and DRG assignments often overlapped, although generally not in a one-to-one fashion. Within a given POA category, most cases fell into two or three different ADRGs.

For lung cancer, about 90 percent of the major surgery cases fell into the DRGs for major and other chest procedures (DRGs 75 through 77). Slightly less than 10 percent of these cases were grouped into surgical DRGs outside of MDC 4 (diseases and disorders of the respiratory system). Of the active medical treatment cases, 62.3 percent of those with diagnostic evaluation were assigned to DRG 82, respiratory neoplasms. In contrast, 65.6 percent of those without diagnostic evaluation were grouped in DRG 410, chemotherapy (23.2 percent were in DRG 82). Of cases admitted for diagnostic evaluation only, 72.2 percent were in DRG 82. Palliation cases also fell primarily into DRG 82 (69.2 percent). Therefore, DRG 82 encompassed cases with a variety of POAs.

A similar pattern was observed for colon cancer. Roughly 90 percent of admissions for major surgery fell into the two digestive surgery ADRGs (146/147, rectal resections, and 148/149, major small and large bowel procedures). Of the active medical treatment cases, 72.0 percent of those with diagnostic evaluation were grouped into the medical digestive malignancy ADRG

172/173. In contrast, 60.5 percent of those without diagnostic evaluation were classed in DRG 410 (29.9 percent were in ADRG 172/173). Of cases admitted only for diagnostic evaluation, 75.5 percent were in ADRG 172/173, and palliation cases also fell mainly into ADRG 172/173. Thus, ADRG 172/173 captured cases with a range of POAs.

Finally, the pattern of breast cancer DRG assignments differed somewhat. Almost 100 percent of major surgery admissions fell into the ADRGs for total mastectomy (257/258) and subtotal mastectomy (259/260). However, non-surgical admissions were more dispersed. For example, patients admitted for active medical treatment with diagnostic evaluation were assigned to a variety of ADRGs, such as medical treatment for breast malignancy (274/275, 30.1 percent), medical DRGs in other MDCs (24.6 percent), surgical DRGs in other MDCs (12.6 percent, e.g., for biopsies of metastatic lesions), and chemotherapy (8.7 percent). Of those admitted for active medical treatment without diagnostic evaluation, 59.2 percent were assigned to DRG 410, chemotherapy. Palliation cases were assigned primarily to the medical breast malignancy ADRG (274/275, 69.3 percent) and medical DRGs in other MDCs (30.3 percent). Therefore, many non-surgical breast cancer admissions appear to be for principal diagnoses in other organ systems, probably relating to metastatic disease and/or complications.

Predicting hospitalization charges

Although the POA categories did group cases into classes with differing average charges, how well did they predict hospitalization charges, especially in comparison with DRGs? A variety of regression models were constructed for predicting hospitalization charges using DRG, POA, the complexity indicators, and different interaction terms, and results of seven of these are shown in Table 5 (the other models produced comparable R-squared values). The predictive power of the POA categories was similar to that of DRGs, although it was slightly less for colon and breast cancers. The complexity indicators were relatively poor predictors of hospitalization charges.

Table 5

Ability (R-squared × 100) to predict hospitalization charges for models based on diagnosis-related groups (DRG), purpose of admission (POA), and complexity indicators: Lung, colon, and breast cancer

Model	Lung	Colon	Breast
DRG only	22.2	27.0	7.3
POA only	22.4	24.3	6.3
Complexity indicators only	4.0	4.1	4.0
DRG and POA	26.8	27.6	9.7
DRG, POA, and interaction of DRG/POA	27.0	27.8	10.8
DRG, POA, complexity indicators, and interaction of DRG/POA	29.1	32.0	15.2
DRG, POA, complexity indicators, and interactions of DRG/POA, DRG/complexity, and POA/complexity	29.7	32.9	16.6

NOTE: All R-squared values significant at $p < .0001$.

SOURCE: (Henderson et al., 1990).

Combining DRG, POA, and an interaction term for the relationship between POA and DRG improved the predictive power by 21.6 percent over that for DRG only for lung cancer (R-squared values of 27.0 compared with 22.2) and by 47.9 percent for breast cancer (10.8 compared with 7.3). The most complicated model, which considered DRG, POA, the complexity indicators, and three interaction terms, produced R-squared values that were 33.8 percent higher than that for DRG alone for lung (29.7 compared with 22.2), 21.9 percent higher for colon (32.9 compared with 27.0), and 127.4 percent higher for breast cancer (16.6 compared with 7.3).

Discussion

These results suggest that the resources consumed during hospitalization for cancer may vary by POA. However, the tests of explanatory power suggest that our POA categories should not replace DRGs as a method for paying hospitals for inpatient cancer care: POA category alone explained a similar fraction of variability in charges to that predicted by DRGs alone. But considering both POA and the complexity indicators in addition to DRGs may improve the understanding of resource use during cancer hospitalizations. One finding with potential policy significance is the apparent difference across hospital types in the purposes for which patients are admitted. Small, rural hospitals were much more likely to care for patients seeking palliation only, whereas large, urban hospitals were much more likely to admit patients for active interventions, especially in conjunction with diagnostic evaluations. Given the large differences in charges across these POA categories, these findings raise questions about fairness of payment to hospitals of different types.

These findings must be viewed as preliminary. Our approach represents the clinical judgment of only the project team, and it requires further scrutiny by other investigators. A major limitation was the well-known and significant drawbacks of the administrative data used to create our POA categories (McMahon and Smits, 1986; Vertrees and Manton, 1986; Hsia et al., 1988; Lloyd and Rissing, 1985; Simborg, 1981; Green et al., 1990; Iezzoni, 1990). From the retrospective ICD-9-CM diagnostic and procedural data contained in the MEDPAR file, we could only create a proxy measure of POA. Despite this, we were able to create POA categories with reasonable "face validity": As shown by the results, our a priori clinical hypotheses about the relationships among POA and a variety of other factors (age, mortality, case complexity) were largely confirmed.

Not only were death rates and complexity indicators generally as expected for the different POA categories, but also the distribution of cases across POA groupings varied as anticipated for the three cancers. Cancer is not a single disease: Clinical courses, prognoses, and therapeutic approaches differ widely depending on the organ system in which the malignancy arises and the cell type of the tumor. As a result, the patterns of hospitalization, choice of medical versus surgical treatment modalities, setting of diagnostic evaluation, and other indicators of resource use vary across diseases. The findings of this study matched our a priori clinical expectations about patterns of admission purposes for lung, colon, and breast cancer.

Colon and breast cancers are much more likely than lung cancer to be treated with surgery because of differences in extent of disease at initial presentation. These cancers also have a better chance of cure or long-term remission as a result of surgery; consequently, a single surgical admission may be all that is required over the course of these diseases. In addition, the diagnostic technologies employed for colon and breast cancers (e.g., radiographic barium studies of the colon, colonoscopy, needle biopsies of the breast) are generally performed on an outpatient basis; an admission purely for diagnostic evaluation would be relatively uncommon for these cancers. These expectations were met in the findings. The preponderance of colon and breast cancer admissions were for surgery, death rates were low, and 10-15 percent of admissions were for diagnostic evaluation only. However, as might be expected because of their greater frailty, patients 85 years of age or over were more likely than younger patients to be admitted for diagnostic evaluation alone.

In contrast, lung cancer, which is generally more extensive at initial presentation, is less likely to be treated surgically, and it carries a relatively poor prognosis. Techniques employed for diagnostic evaluation are commonly invasive (e.g., open lung biopsy), sometimes necessitating an inpatient stay. Treatments often involve chemotherapy of a sort that requires intravenous therapies to compensate for its acute toxicities. Therefore, chemotherapy for lung cancer is often administered in an inpatient setting. In contrast, chemotherapy for colon and breast cancers is generally well tolerated, with less risk for acute toxicity, permitting its administration in an outpatient environment. The findings also reflected these expectations: Relatively few lung cancer admissions involved major surgery, but many (37.2 percent) were for diagnostic evaluation only; lung cancer death rates were high; and rates of admission for active medical treatment, including chemotherapy, were much higher for lung cancer than for colon and breast cancers.

One area in particular raised questions about the validity of our POA categories when viewed in conjunction with the complexity indicators—the finding that major surgery admissions had the highest rates of comorbidities of the six POA groupings. However, this may result from an artifact of diagnostic coding relating to the allowance of only five diagnoses in the Medicare administrative record. In a cancer patient, it is likely that the occurrence of distant metastases or complications of the malignancy or its treatment would dominate diagnostic coding. Codes indicating such conditions would take precedence in the five allotted slots to such comorbidities as diabetes mellitus and chronic pulmonary disease.

This hypothesis parallels that offered by Jencks, Williams, and Kay (1988), who found that patients with diagnoses listed for conditions such as diabetes mellitus, unspecified anemia, essential hypertension, old myocardial infarction, and angina, died much less frequently than did those without like diagnoses. They attributed this counter-intuitive finding to coding bias in the listing of secondary diagnostic codes: "Medicare's limit of reporting five diagnoses would be more likely to truncate chronic diagnoses from the diagnosis list ... Such a bias is plausible because there are numerous acute diagnoses, such as cardiac arrest ... and concurrent pneumonia, that are likely to take precedence when a patient dies or is very ill at the time of discharge" (Jencks, Williams, and Kay, 1988).

Finally, the models of predictive power provided modest evidence that considering POA and case complexity might improve an understanding of resource use during cancer hospitalizations. The DRGs and POA categories had very similar predictive abilities when viewed alone. All models yielded the lowest *R*-squared values for breast cancer. This probably stems from the similarity of charges across surgical and medical treatments for breast cancer (e.g., average charges for ADRG 259/260, subtotal mastectomy, were $3,199, whereas average charges for ADRG 274/275, medical treatment for breast cancer, were $3,439). The most predictive model tested—comprised of DRG, POA, complexity indicators, and interaction terms—provided a modest increment in predictive power in numeric terms. However, the relative increase in *R*-squared values was substantial for breast cancer, with an increase of 127.4 percent over that observed for DRG alone, and 33.8 percent and 21.9 percent for lung and colon cancers, respectively.

It is important to note than an improved *R*-squared value should not be the only criterion by which a case classification measure is judged. Other considerations include ease of application, immunity from manipulation, clinical meaningfulness, and statistical stability (Jencks et al., 1984). In particular, if POA categories were to be added to DRGs, the number of patient groups would probably become too large and unwieldy and the sample size too small to permit a workable payment scheme. However, it appears that the POA categories may provide information not captured by DRGs or even case complexity that might be useful in understanding differences in resource use for cancer hospitalizations, especially across institutional types. For example, using the coefficients and constant values produced by the most complete model in Table 5, a 66-year-old patient discharged with DRG 82, respiratory neoplasm, with comorbidities and complications, had expected hospital charges of $7,155 if admitted for active treatment with diagnostic evaluation. The identical patient admitted for palliative care had expected charges of $4,386, a 63-percent difference.

Policy implications

This study suggests that POA should not replace DRGs as the mechanism for cancer-related hospital payments, but considering POA may improve the understanding of resource consumption for cancer care. Two findings are particularly pertinent. First, POA may be capturing a somewhat different dimension than either DRGs or case complexity in explaining resource use. Second, systematic differences may exist across hospital types in the purposes for which patients are admitted, and these differences may be linked to disparities in resource use. Small and rural hospitals had relatively high fractions of palliation patients, whose care was generally less expensive. In contrast, large and urban hospitals were more likely to admit patients for relatively costly active medical treatments, especially those with diagnostic evaluation. In most instances, these palliation and active medical treatment with diagnostic evaluation cases were within the same medical DRG. Therefore, if hospitals are receiving average DRG payments, inequities could potentially arise due to systematic differences in purpose of admission. Small and rural hospitals may be overpaid for their palliation admissions, and large and urban hospitals may be underpaid for their patients receiving active medical treatments with diagnostic evaluation.

Critics of Medicare's PPS have often focused on the potential insensitivity of DRGs to illness severity (Gertman and Lowenstein, 1984). This study suggests that resource use may vary even for cases at the same severity or complexity levels, depending on the POA. With cancer, higher severity (viewed as increasing risk of in-hospital mortality) may actually often be inversely related to hospital charges. For example, major surgery admissions were always the most costly, but they were also relatively low risk, with low mortality rates and lower prevalence of indicators of case complexity. In contrast, distant metastases were common and death rates high for patients admitted for palliation at relatively lower cost. These very sick patients, from a clinical perspective, were relatively inexpensive. This finding agrees with clinical experience: Given extensive disease, many cancer patients opt for interventions aimed primarily at maintaining comfort, such as continuous intravenous morphine, administered at low cost. However, other patients may choose continued aggressive treatment, with expensive intensive care unit stays and rigorous therapies. Therefore, the relationship of resource consumption to severity may depend on the therapeutic choices and personal goals of the individual cancer patient.

These preliminary results suggest several areas in which further investigation might be warranted. Analyses should be conducted to determine whether fairness of payment at the hospital level would be improved by considering POA. A special emphasis should be placed on comparing hospitals that have a disproportionate number of resource-intensive admissions (such as large, urban, or teaching facilities) with those that treat relatively more inexpensive types of admissions (small, rural hospitals) within the same DRG. A parallel study should explore the relationship of POA to widely publicized hospital outcomes, such as mortality. Finally, data limitations prevented one potentially important analysis: distinguishing initial admissions for malignancy from subsequent followup or treatment (Jencks, 1990). Initial evaluations and therapy may have very different costs from admissions later in the course of the cancer, and the types of hospitals at which patients seek initial and subsequent care for malignancy may also differ.

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