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Could Distance be a Proxy for Severity-of-Illness? A Comparison of Hospital Costs in Distant and Local Patients.

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Could Distance Be a Proxy for Severity-of-Illness? A Comparison of Hospital Costs in Distant and Local Patients

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Objective. We test the hypothesis that hospital costs, after adjusting for DRG mix, are higher in distant patients than in local patients.

Data Sources and Study Setting. Data were obtained from the Washington State Commission Hospital Abstract Reporting System (CHARS) and included all patients discharged from 15 metropolitan hospitals in the state of Washington during fiscal year 1987 (N = 181,072).

Study Design. Distant patients were initially defined as those patients residing outside a 15-mile radius of the hospital from which they were discharged; all other patients were considered local. Distance was determined using the patient's residence zip code. Hospital charge, calculated for all patients regardless of payer, served as a proxy for cost and was adjusted using the DRG weight.

Principal Findings. Average charge (adjusted for DRG weight) was higher for distant patients in all but two hospitals. Overall adjusted charge for distant patients was 15 percent higher ($p < .001$). This finding persisted when different distances were used to dichotomize distant and local patients. When the 20 most common DRGs were examined individually, little charge difference was found in surgical DRGs that require tertiary center services (tertiary DRGs) and in those DRGs with both moderate and predictable resource use (routine DRGs); the charge difference seemed most prominent in those DRGs with a wide array of possible resource use (heterogeneous DRGs).

Conclusions. Results suggest that patients traveling long distances use more resources and incur higher hospital charges than local patients. This is not accounted for in prospective payment. We postulate that distance might serve in part as a proxy for severity-of-illness.

Keywords. Prospective payment, case mix, referrals, severity-of-illness, hospital costs

There is general consensus that the prospective payment system (PPS)—used either by Medicare or Medicaid or, more recently, in Veterans Affairs (VA) hospitals—needs to improve its accounting of illness severity (Berman, Green, Kwo, et al. 1986; Gonnella, Hornbrook, and Lewis 1984; Horn, Bulkley, Sharkey, et al. 1985; Horn, Horn, and Sharkey 1984; Jencks and Dobson 1987). While most physicians would define illness severity in terms of "sickness," for the purpose of PPS policy it is best defined in terms of resource use. While "sicker" patients are generally those who require more resources, this is not uniformly so. Patients who are mildly sick may require costly diagnostic evaluation, and patients who are very sick may be inexpensive to care for if therapy is unavailable or not desired. But from the reimbursement perspective, at least, measurements of illness severity ought to predict cost (Smits, Fetter, and McMahon 1984).

Illness severity can be accounted for in two ways: with complex clinical measures that reflect resource use, or with simpler proxies. Current efforts to measure illness severity are generally clinical (Brewster, Karlin, Hyde, et al. 1985; Gonnella, Hornbrook, and Lewis 1984; Horn and Horn 1986; Horn et al. 1986; Wagner and Draper 1984; Young 1984). These measures have documented interhospital variation in severity (Horn, Bulkley, Sharkey, et al. 1985), but because they measure "sickness," their relationship to cost is less certain (Horn et al. 1986; Iezzoni, Ash, and Moskowitz 1987).

Furthermore, clinical measures would tend to cause problems if incorporated into PPS. In calculating a severity score, multiple factors would have to be enumerated from a patient's hospital chart, suggesting two major limitations to widespread use. First, the process would call for both more labor and more expense than simply coding diagnosis-related groups (DRGs) would require. Second, because the

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calculation is most accurately performed by the hospital to be reimbursed (where the chart is available), the process would be subject to the same inflationary pressures already evident in DRGs (Simborg 1981)—a "severity creep" resulting in enhanced PPS reimbursement. In order for severity to be widely incorporated into PPS, its measurement would need to be both simple and not easily gamed—criteria that would be difficult to meet with clinical measures.

Alternatively, a proxy for severity of illness might be used, such as an index reflecting the degree to which a hospital serves as a regional center. Other investigators have questioned whether reimbursement rates are sufficient to meet the costs of regional cancer centers (Horn and Sharkey 1986), burn centers (Warden, Saffle, and Kravitz 1986) and critical care centers (Thomas, Fox, Clemmer, et al. 1987; Thomas, Larsen et al. 1986). We hypothesize that the higher costs associated with serving patients coming from a distance are evident in metropolitan general hospitals and across multiple DRGs. To test this hypothesis, this study compares the hospital charges of distant and local patients classified by a simple objective measure: patient proximity to the hospital.

METHODS

DEFINITION OF DISTANT AND LOCAL PATIENTS

We use the distance between patients' residences and the hospital from which they were discharged as the operational basis to dichotomize distant and local patients. If patients have traveled beyond their local hospital for treatment, it seems likely that one of two factors has influenced their decision. First, patients have been told—by someone they recognize as a medical authority—that they require the services of a distant hospital; or second, they perceive that a higher quality of care is necessary and available at a distant facility.

The magnitude of the distance chosen to dichotomize distant and local patients is arbitrary, but certain considerations seem important. The distance should be large enough to ensure that most patients outside the local zone *would not* ordinarily go to the facility in question. The distance should be small enough so that large numbers of patients in the local zone will not be misclassified. Our analysis uses a 15-mile radius as the criterion. Patients living more than 15 miles away from the hospital where they were discharged are classified as "distant"; all others are "local." In a related analysis Robinson et al. (1988) used the

same radius as the maximum distance that a physician would ordinarily be willing to travel among hospitals; we initiate our investigation postulating that the same holds true for patients.

Sensitivity analysis was performed to establish the effect of using different distances to dichotomize distant and local patients. Using the same sample, distant patients were redefined as those patients living more than 10 miles and alternatively, 25 miles from the hospital.

DATA

Data were obtained from the Washington State Commission Hospital Abstract Reporting System (CHARS). The CHARS data base includes all nonfederal hospital discharges within the state of Washington. Staff model health maintenance organizations were excluded, since they do not report patient charge data to CHARS. This analysis was limited to patients discharged in fiscal year 1987 (July 1, 1986 through June 30, 1987).

To facilitate the measurement of distance, we focused on metropolitan areas. A zip code's reach is smallest near the urban core, allowing for greater precision in determining the distance between patients' residences and the hospital. The analysis was therefore restricted to Washington's three largest Metropolitan Statistical Areas (MSAs): Seattle (population 1,725,000), Spokane (357,000), and Tacoma (526,000). The combined population of the three MSAs was 2.6 million in 1985, comprising approximately 60 percent of the population of Washington state (U.S. Department of Commerce 1987). There are six other MSAs in the state, but they are small: each contains fewer than a quarter million people. In addition, only general hospitals within five miles of the urban core (defined as the central post office) of each MSA were considered.

The resulting sample included eight hospitals in Seattle, three in Spokane, and four in Tacoma. The 15 hospitals have a total of 5,118 beds, representing over one-third of the capacity of the 108 licensed general hospitals in the state (Washington State 1987). All discharges from these hospitals occurring during fiscal year 1987 (181,072, or 34 percent of all discharges in the state) were included for study.

A circle with a radius of 15 miles was drawn around each hospital. A residence zip code was obtained on each patient discharged during the study period. Any patient whose zip code was either mostly or entirely within the 15-mile boundary was classified as "local"; all others were considered "distant." Three additional variables were examined for each patient: discharge DRG, DRG weight (the multiplier assigned

each DRG to calculate reimbursement), and actual hospital charge. In the CHARS data base a DRG is assigned and a hospital charge is generated on all patients, regardless of payer.

From a policy perspective, cost—not charge—is the variable of interest (Finkler 1982). The Washington State Hospital Commission requires that hospital charges be within 5 percent of cost. Nevertheless, since cost-to-charge ratios vary from hospital to hospital, it is necessary to use caution when comparing charges in different hospitals. Therefore, the comparison of distant and local patients is best made within each hospital.

ANALYSIS

While average charges for distant and local patients can be compared directly within single DRGs, an adjustment must be made when considering multiple DRGs because the two groups have different DRG mixes (e.g., some DRGs have a higher proportion of distant patients than others). This adjustment is accomplished by standardizing each patient's charge to a DRG weight of one, using the following formula:

$$\textit{adjusted charge} = \textit{actual charge/DRG weight}$$

As reimbursement varies directly with DRG weight, any disparity in adjusted charge reflects an imbalance *not* accounted for in PPS. Mean adjusted charge was calculated for both distant (D) and local (L) patients at each hospital. An adjusted charge ratio was defined within each hospital h as D_h/L_h (see Tables 1 and 2 under Results). To the extent that this figure exceeds 1.0, it suggests that distant patients in this hospital are more expensive than local patients. An adjusted charge ratio of 1.25, for example, implies that distant patients are 25 percent more expensive than local patients.

To test the significance of the adjusted charge ratio, the unit of analysis must be selected. PPS payment should be equitable among hospitals, not necessarily among patients. Therefore, the hospital is the appropriate unit of analysis instead of the discharge.

The adjusted charge ratio was first calculated for each hospital. A summary ratio was then calculated as an average across hospitals, weighted by the number of discharges. A two-sided test of whether this summary *ratio* differs from one has 14 degrees of freedom in our sample. Statistical hypothesis testing based on the *difference* between distant and local patient charges was also performed, using both parametric (paired t-test) and nonparametric (Mann-Whitney) methods.

All three methods yielded similar results; the confidence interval around the summary ratio appears below.

In addition, we examined individually the 20 most common DRGs in the sample. In order to avoid confounding by hospital, we first calculated a DRG-specific adjusted charge ratio for each hospital. The individual DRG data from the 15 hospitals were then summarized as an average, weighted by the number of discharges in the analyzed DRG (see Appendix).

Finally, to develop a taxonomy for our results, two of us (HGW, EBL) placed the sample's 20 most common DRGs into three categories based on our clinical experience. *Tertiary DRGs* (Table 3, under Results) are defined as those that require the services of a tertiary facility and, consequently, are available only in selected hospitals in Washington state. They are all surgical DRGs. *Routine DRGs* (Table 4) are those with both moderate and predictable resource use. These diagnoses appear in hospitals statewide. Assignment of these DRGs implies routine care, for example, *normal* newborn (DRG 391), *uncomplicated* vaginal delivery (DRG 373), or surgeries with *no complications and/or comorbidity* (DRGs 371, 359). *Heterogeneous DRGs* (Table 5) are found in hospitals across the state; however, they are sufficiently broad to encompass a wide array of disease severity and therefore a wide array of possible resource use. These are predominantly medical DRGs, but they include two surgical DRGs that encompass a wide array of procedures: unrelated operating room procedures (DRG 468) and back and neck procedures (DRG 215).

RESULTS

The results combining all DRGs are shown for each hospital in Table 1. Adjusted charge (adjusted for DRG weight) was higher for distant patients in 13 of the 15 facilities. The two exceptions had adjusted charge ratios of 0.99 and 1.00. Ten of the 15 hospitals had a higher case-mix index (average DRG weight) for distant patients than local patients. The other five hospitals were the five smallest in this sample.

Summary analysis of the data is presented at the bottom of Table 1. When all hospitals are combined, distant patients are one-fourth of the sample. The overall distant case-mix index was 1.37, while the overall local case-mix index was 1.09. Even after accounting for their case-mix, the average charge for distant patients is higher than that of local patients. The mean adjusted charge ratio, weighted by the number of discharges in each hospital, is 1.15 and is significantly different

Table 1: Comparison of Distant and Local Patients for 15 Washington Hospitals

			Distant Patients		*Local Patients*		
Hospital	*Total Discharges*	*Classified as "Distant"*	*Case Mix*	*Adjusted Charge*	*Case Mix*	*Adjusted Charge*	*Adjusted Charge Ratio**
Swedish	28953	25%	1.23	$3,488	1.03	$3,374	1.03
Sacred Heart	23416	31%	1.58	$4,496	1.13	$3,627	1.24
Tacoma General	18910	13%	1.12	$4,576	1.00	$3,861	1.19
Deaconess	15853	34%	1.52	$4,665	1.02	$3,807	1.23
University	14863	44%	1.50	$5,113	1.15	$4,323	1.18
St. Joseph	14638	11%	1.34	$4,312	1.08	$3,937	1.10
Virginia Mason	14335	44%	1.41	$3,887	1.09	$3,533	1.10
Providence	13667	23%	1.84	$4,255	1.26	$4,242	1.00
Harborview	11221	23%	1.51	$6,512	1.22	$4,617	1.41
Children's	8119	52%	1.22	$6,583	0.97	$5,094	1.29
Puget Sound	4260	17%	0.87	$4,282	0.93	$4,057	1.06
Ballard	3958	10%	1.05	$4,511	1.18	$4,156	1.09
St. Cabrini	3665	20%	0.93	$5,311	1.02	$4,831	1.10
Humana	3101	9%	1.04	$4,637	1.16	$4,252	1.09
St. Luke's	2113	24%	1.17	$4,474	1.20	$4,519	0.99
All 15 Hospitals	181,072	27%	1.37	$4,560	1.09	$3,950	1.15†

*Ratio of distant to local patient charges after adjustment for DRG weight.

†Average of ratios weighted by number of discharges.

from one ($t = 5.06$, $p < .001$, 95% C.I. = 1.08, 1.22). Hypothesis testing based on charge difference yielded similar results.

The sensitivity of the adjusted charge ratio to varying the distance criterion is shown in Table 2. For 13 of the 15 hospitals the adjusted charge ratio increases as the distance criterion increases from 10 to 15 miles. Going from a 15- to 25-mile criterion has a smaller effect; the adjusted charge ratio increases for only seven hospitals. The summary ratio climbs from 1.11 at 10 miles, to 1.15 at 15 miles, to 1.17 at 25 miles.

DRG-specific data for the 20 most common DRGs in the sample appear in Tables 3, 4, and 5. The tertiary DRGs are shown in Table 3. Since all patients in the tertiary category must go to a limited set of hospitals, we hypothesize that little patient sorting can occur and that the charge difference between distant and local patients will be small. Our limited data tend to support this hypothesis as all tertiary DRGs have distant/local charge ratios of 1.03 or less.

Similarly, we hypothesize that the distant/local charge ratio will be small for the routine DRGs (Table 4) since patients in this category have moderate and predictable resource use. Given this homogeneity, a distant/local distinction is not expected. Again, the hypothesis is tentatively supported in that each of these DRGs has a distant/local charge ratio of 1.06 or less.

In the tertiary category all patients must go to a few urban facilities, and in the routine category there is no reason to go to a distant hospital. Alternatively, we hypothesize that the increased cost of distant patients will be most evident in heterogeneous DRGs (Table 5). In this category, the decision to go to a more distant hospital is discretionary. With two exceptions, heterogeneous DRGs are medical DRGs. While surgical DRGs are procedure based, medical DRGs are diagnosis based and are therefore likely to have greater variation in resource use (Health Care Financing Administration 1987). The heterogeneous DRGs (as defined) all have distant/local charge ratios of 1.06 or more.

DISCUSSION

This study represents a preliminary investigation of a potential "marker" that might help identify hospitals that treat more costly patients. We found that patients coming from a distance have a more complex case mix at the ten largest hospitals studied. More important, even after adjusting for differences in DRG weight, these patients had higher charges than local patients at 13 of the 15 hospitals examined.

Table 2: Sensitivity Analysis—Varying the Distance Criterion

Hospital	*Total Discharges*	*Classified as "Distant"*			*Adjusted Charge Ratio**		
		10 Miles	*15 Miles*	*25 Miles*	*10 Miles*	*15 Miles*	*25 Miles*
Swedish	28953	40%	25%	15%	1.02	1.03	1.04
Sacred Heart	23416	38%	31%	26%	1.18	1.24	1.26
Tacoma General	18910	23%	13%	7%	1.08	1.19	1.23
Deaconess	15853	41%	34%	29%	1.19	1.23	1.23
University	14863	56%	44%	31%	1.10	1.18	1.18
St. Joseph	14638	20%	11%	6%	1.09	1.10	1.16
Virginia Mason	14335	58%	44%	33%	1.07	1.10	1.16
Providence	13667	35%	23%	13%	0.98	1.00	1.06
Harborview	11221	31%	23%	13%	1.38	1.41	1.53
Children's	8119	67%	52%	34%	1.16	1.29	1.19
Puget Sound	4260	24%	17%	11%	1.01	1.06	1.07
Ballard	3958	17%	10%	8%	1.03	1.09	1.05
St. Cabrini	3665	30%	20%	12%	1.08	1.10	1.08
Humana	3101	15%	9%	5%	1.11	1.09	1.02
St. Luke's	2113	33%	24%	21%	0.96	0.99	0.98
All 15 Hospitals	181,072	38%	27%	19%	1.11	1.15	1.17†

*Ratio of distant to local patient charges after adjustment for DRG weight.

†Average of ratios weighted by number of discharges.

Table 3: Adjusted Charge Ratios for Tertiary DRGs

DRG Number	*Description*	*Total Discharges*	*Classified as "Distant"*	*Adjusted Charge Ratio**
107	Coronary bypass without cardiac catheterization	2327	54%	1.03
209	Hip or knee replacement	2383	32%	1.01
125	Cardiac catheterization	2254	48%	0.99
112	Endarterectomy	2010	48%	0.99

*A DRG-specific distant/local charge ratio was first calculated for each hospital. The summary statistic listed here is the average ratio across hospitals weighted by the number of discharges in the DRG.

Table 4: Adjusted Charge Ratios for Routine DRGs

DRG Number	*Description*	*Total Discharges*	*Classified as "Distant"*	*Adjusted Charge Ratio**
373	Vaginal delivery—no complicating diagnosis	10760	14%	1.06
371	Cesarean section—no CC†	2873	17%	1.06
243	Medical back problems	2924	32%	1.00
391	Normal newborn	10641	14%	0.98
359	Uterine and adnexa procedures for nonmalignancy—no CC†	3098	25%	0.97

*A DRG-specific distant/local charge ratio was first calculated for each hospital. The summary statistic listed here is the average ratio across hospitals weighted by the number of discharges in the DRG.

†CC: Complications and/or Comorbidity.

Unless an explanation of statewide "price discrimination" on the part of metropolitan hospitals is entertained (arbitrarily charging distant patients more), patients coming from a distance do appear to be more costly to treat.

Furthermore, our results are not dependent on any single distance criterion. Sensitivity analysis demonstrates higher costs using three distance criteria: 10, 15, or 25 miles. If a pattern exists, it is one of an increasing adjusted charge ratio with increasing distance.

Not all hospitals are affected equally. Using the 15-mile criterion, the proportion of patients classified as distant ranged from 9 percent to 52 percent. The adjusted charge ratio ranged from 0.99 (i.e., local patients incurring slightly higher charges) to 1.41. Table 1 demonstrates this variability: six hospitals had a considerable charge disparity between distant and local patients (> 1.15), and six had a moderate disparity (1.05–1.15), while three had a disparity of little consequence

Table 5: Adjusted Charge Ratios for Heterogeneous DRGs

DRG Number	*Description*	*Total Discharges*	*Classified as "Distant"*	*Adjusted Charge Ratio**
389	Full-term neonate—major problems	2049	22%	1.53
468	Unrelated operating room procedures	1915	37%	1.23
372	Vaginal delivery—complicating diagnoses	2016	19%	1.19
390	Neonate—significant problems	4007	15%	1.14
410	Chemotherapy	3498	44%	1.14
182	Esophagitis, gastroenteritis, and abdominal pain	2075	17%	1.14
127	Heart failure and shock	2341	14%	1.11
462	Rehabilitation	1813	31%	1.09
430	Psychoses	6013	20%	1.07
215	Back and neck procedures	2141	40%	1.07
014	Stroke	1956	18%	1.06

*A DRG-specific distant/local charge ratio was first calculated for each hospital. The summary statistic listed here is the average ratio across hospitals weighted by the number of discharges in the DRG.

(< 1.05). The greatest difference in charge (1.41) occurred at the county hospital in Seattle (Harborview), the facility perhaps least able to absorb the adverse financial impact given the large volume of uninsured patients treated at public hospitals (Thorpe and Brecher 1987). Just as the impact of distant patients varies, it is likely that the mix of distant patients differs among hospitals.

Tables 3, 4, and 5 suggest that diagnoses for which distant patients are particularly expensive are those in which physician or patient discretion may play an important role. This is not to say that physician referrals are inappropriate or that they are an attempt to get rid of expensive patients. More likely these are the patients whose illness severity dictates the services of a major urban hospital. Similarly, patients may have an increased tendency to choose urban hospitals when their illnesses are severe.

This study has several limitations. First, the data are limited to Washington state and their generalizability is unknown. Second, only the 20 most common DRGs were separately analyzed. Although they represent less than 5 percent of all DRGs, they translate to approximately 40 percent of all admissions. Third, this study did not specifically identify transfer patients, who may appear as either distant

patients, local patients, or both. Although the impact of transfers in terms of cost per case is substantial, less than 2 percent of Medicare admissions result in transfers (Jencks and Bobula 1988). Finally, our results provide no causal explanation of why distant patients are more expensive.

DISTANCE AND SEVERITY

We can, however, speculate on why severity might increase with distance. Two theoretical constructs from the geography literature provide a foundation for such speculation. First is the central place theory, which identifies the tendency for higher-order services to be located in major population centers and to attract patients from a large geographic range (Meade, Florin, and Gesler 1985). The second relevant construct is distance decay, the observation that health care utilization falls with distance (Joseph and Phillips 1984; McGuirk and Porell 1984; Weiss, Greenlick, and Jones 1971). The magnitude of decay has been observed to be influenced by diagnosis: the friction of distance decreases with more serious diagnoses (Joseph and Phillips 1984; Mayer 1983; Stock 1983). These two concepts help explain why metropolitan hospitals might serve broadly dispersed populations and preferentially attract "sicker" patients coming from a distance.

A number of logistic considerations may also help explain this phenomenon. Physicians may treat distant patients differently. They may have a higher threshold for discharging patients living at a distance. Increased distance from the hospital to the patient's home may also complicate the disposition process, by making follow-up and support services more difficult, thereby delaying the time of discharge. Alternatively, supportive services may simply be less available to distant patients, thereby necessitating longer stays. Delays may also reflect difficulty in obtaining transportation. Although plausible, these explanations are weakened by the low adjusted charge ratios in those diagnoses that uniformly require referral (e.g., cardiac catheterization, coronary artery bypass, and hip or knee replacement).

Clinical factors are therefore likely to play an important role. Distant patients may be more expensive because they represent a select subset of patients living outside of Washington's urban areas. The case that such sorting occurs is strengthened by the type of diagnosis in which charge discrepancies are found. They are not found among those that uniformly require referral (tertiary DRGs) or among those with moderate and predictable resource use (routine DRGs). Instead they are concentrated among those diagnoses where physicians have some

discretion about treatment site and where a wide array of disease severity is possible (heterogeneous DRGs). Distant patients may be "sicker" in the clinical sense, either having been referred to urban facilities by physicians who recognized increased illness severity or having self-referred after recognizing this themselves. Alternatively, they may not be unusually ill, rather simply "unusual." They may have less clear diagnoses than the average patient or more complicated comorbid conditions, or they may be more demanding.

POLICY RELEVANCE

The finding of this investigation that may be most relevant to PPS policy is that, for certain diagnoses, patients coming to urban hospitals from far away seem to require more resources than those from nearby. Regardless of which foregoing explanation predominates (including complicated disposition), the increased cost of treating distant patients can be justifiably compensated.

Although PPS reimbursement reflects the case-mix difference between distant and local patients, it does not compensate for the greater cost of distant patients *within* DRGs. The impact of this weakness of PPS can be sizable for certain hospitals, particularly if all patients are reimbursed under PPS. For example, one can consider the specific case of Children's Hospital (52 percent distant patients) and ask: What is the dollar impact of reducing its proportion of distant patients to Humana Hospital's level (9 percent)? The net income of Children's Hospital would rise almost $5 million. [In this example, adjusted charge would fall $1,489 ($6,583 minus $5,094) for 41 percent of the 8119 discharges, leading to a savings of $4.96 million. As long as reimbursement was unchanged, this savings would result in increased net income.] The larger the number of distant patients a hospital treats, the more that hospital is penalized when paid prospectively.

Three DRGs for which distant patients are particularly expensive relate to maternal and child care [*full-term neonate—major problems* (DRG 389), *neonate—significant problems* (DRG 390), *vaginal delivery—complicating diagnoses* (DRG 372)], and thus have little bearing on Medicare PPS. However, these DRGs are common in Medicaid programs, a growing number of which use DRGs to pay hospitals—as is the case in Washington state. The authorized expansion of Medicaid eligibility to more women who are pregnant will increase the importance of these diagnoses for public programs.

How might a prospective payment system account for the increased cost of distant patients? Under the Omnibus Budget Recon-

ciliation Act of 1986 (OBRA), Medicare PPS currently gives additional payments to "rural referral centers"; perhaps it could do the same for urban referral centers. This approach would ignore the substantial influence, found in this study, of the specific diagnosis under consideration. Furthermore, the distance categories used in this study may be too large for a densely populated MSA like Chicago or Philadelphia and too small for more dispersed MSAs like Los Angeles or Phoenix. Accounting for diagnosis implies adjustments for each DRG; accounting for variable geography implies adjustments for each MSA.

Such problems, although difficult, could be approached using nationwide Medicare claims data. The availability of the beneficiary's residence zip code and geographic software makes it possible to create a continuous variable for distance. Regression models to predict charge could simultaneously control for DRG and MSA and could characterize the variable influence of distance.

Our investigation, however, must be viewed as a nascent exploration in the relationship between severity and distance. Whether a payment formula simple enough to implement can be devised is an open question. Nevertheless, the impact of patients traveling long distances is substantial and warrants further investigation on the best means to reimburse regional centers. The importance of this exploration will persist even if health care financing changes radically in the future (e.g., national health insurance). While global budgets may replace PPS as a hospital payment mechanism, the need to identify hospitals that treat more expensive patients will remain. Our anecdotal experience as clinicians has been that patients coming long distances have highly variable illness severity; many of them are severely ill and are costly to treat. Our results suggest, on balance, that the prospective payment system penalizes those hospitals that treat large numbers of patients coming from a distance and benefits those that do not.

APPENDIX

Hospitals may attract distant patients by offering more sophisticated (and expensive) services. If distant patients are more common in DRGs that have high adjusted charges, a comparison of distant and local patients may be misleading. Consider the hypothetical case of a two-DRG hospital:

	Distant Patients		*Local Patients*	
	Discharges	*Adjusted Charge*	*Discharges*	*Adjusted Charge*
"Special" DRG	50	$4000	50	$4000
"Standard" DRG	25	$3000	75	$3000
Average		*$3666*		*$3400*

The "special" DRG for this hospital involves expensive services not accounted for by its weight (i.e., it has a high adjusted charge). The second DRG is "standard" and has a lower adjusted charge. The "special" DRG attracts more distant patients than the "standard" DRG. Even if there is no difference between distant and local patient-adjusted charges within each DRG, distant patients appear 8 percent more expensive when combining DRGs.

To avoid the foregoing problem of the high-cost DRG attracting distant patients, we calculated an adjusted charge ratio *within* the 20 most common DRGs (see Tables 3, 4, and 5, under Results), that is, for each row in the preceding example. However, if one first took a simple average across hospitals and then calculated an adjusted charge ratio, a second methodologic problem would arise.

Distant patients may go primarily to hospitals with higher adjusted charges, making them overrepresented in expensive hospitals. Even if distant patients have the same adjusted charge as local patients within each hospital, their unequal distribution among hospitals would lead to a misleading comparison when combining hospitals. This situation is analogous to the problem of the high-cost DRG attracting distant patients and is best understood by considering two hospitals:

	Distant Patients		*Local Patients*	
	Discharges	*Adjusted Charge*	*Discharges*	*Adjusted Charge*
Tertiary hospital	25	$4000	75	$4000
Community hospital	10	$3000	90	$3000
Average		*$3714*		*$3455*

Here distant patients are calculated to be 7.5 percent more expensive than local patients on average because of their unequal distribution among the two hospitals.

In order to avoid this problem when analyzing a single DRG (e.g., *stroke,* DRG 014), we calculated an adjusted charge ratio for each hospital (D_h/L_h). A summary ratio was then calculated across hospitals using a weighted average:

$$\textit{adjusted charge ratio} = [\Sigma_h (D_h/L_h)N_h]/\Sigma_h N_h$$

where N_h is the total number of discharges in hospital h in the analyzed DRG. To the extent that this figure exceeds one, distant patients in this DRG are more expensive than local patients. In the two-hospital case, this figure would be one.

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