HEALTH ECONOMICS
Health Econ. (in press)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hec.1192

A RE-EXAMINATION OF DISTANCE AS A PROXY FOR SEVERITY OF ILLNESS AND THE IMPLICATIONS FOR DIFFERENCES IN UTILIZATION BY RACE/ETHNICITY†,‡

JAYASREE BASU* and BERNARD FRIEDMAN

Agency for Healthcare Research and Quality, Rockville, USA

SUMMARY

The study analyzes the hospitalization patterns of elderly residents to examine whether the relation between distant travel and severity of illness is uniform across racial/ethnic subgroups. A hypothesis is made that severity thresholds could be higher for minorities than whites. Hospital discharge data from the Healthcare Cost and Utilization Project (HCUP-SID) of the Agency for Health Care Research and Quality for New York residents is used, with a link to the Area Resource File and American Hospital Association's survey files. Logistic models compare the association of distant admission with severity corresponding to each local threshold level, race, and type of hospital admission. The study uses four discrete distance thresholds in contrast to recent work. Also, an examination of severity thresholds for distant travel for different types of admission may clarify different sources of disparities in health care utilization. The findings indicate that minorities are likely to have higher severity thresholds than whites in seeking distant hospital care, although these conclusions depend on the type of condition. The study results imply that if costly elective services were regionalized to get the advantages of high volume for both cost and quality of care, some extra effort at outreach may be desirable to reduce disparities in appropriate care. Published in 2006 by John Wiley & Sons, Ltd.

Received 6 February 2006; Revised 28 September 2006; Accepted 29 September 2006

KEY WORDS: distance; hospital choice; severity of illness; racial/ethnic disparity; elderly

INTRODUCTION

Racial/ethnic difference in travel patterns warrants significant policy attention in view of the growing emphasis on regionalization of care and hospital closures. Health plans and hospital systems have incentives to regionalize expensive services, and there are public policy arguments in favor of regionalizing. The potential for regionalization will increase with more consolidation in the hospital market and among health plans. In view of these changes, there will be increasing needs to identify barriers to access across demographic subgroups.

Despite a growing literature investigating hospital choice, not enough is known about determinants of travel behavior across demographic subgroups. A number of factors that might be associated with patients' travel patterns have been identified in previous studies (Hogan, 1988; Buczko, 1992; Welch *et al*., 1993; Basu *et al*., 1995; Basu and Cooper, 2000; Basu and Friedman, 2001). In particular, past studies have found severity of illness as strongly correlated with distant admissions. (Hogan, 1988; Adams *et al*., 1991; Adams and Wright, 1991; Welch *et al*., 1993; Dansky *et al*., 1998; Basu, 2005; Basu and Mobley, 2006). Studies found that patients who are traveling long distances use more resources and

*Correspondence to: 540 Gaither Road, Rockville, MD 20850, USA. E-mail: Jbasu@ahrq.gov
†The paper was presented at Southeastern Health Economics Study Group Conference, Charleston, South Carolina, USA in November, 2003.

incur higher hospital charges than local patients. (Welch *et al.*, 1993). Because of the strong association, distance has been used as a proxy indicator of patient severity (Welch *et al.*, 1993). Several previous studies also reported racial/ethnic differences in travel behavior (Dranove *et al.*, 1993; Basu and Cooper, 2000; Basu and Friedman, 2001; Basu, 2005) and found that members of minority races are less likely to travel further than the rest of the population. To date, none but one study (Basu, 2005) has investigated the role of illness severity in travel patterns across demographic subgroups of the elderly. The issue warrants further attention as distance poses a significant barrier to access among the elderly (Burgess and DeFiore, 1994; Gregory *et al.*, 2000) as well as among the minorities. (Dranove *et al.*, 1993; Basu and Cooper, 2000; Basu and Friedman, 2001; Basu, 2005).

The present study analyzes the hospitalization patterns of elderly residents to examine whether the relation between propensity to travel longer distances and severity of illness is uniform across racial/ethnic subgroups over a broad distance spectrum. In a previous study, Basu (2005) reported that minorities were less likely to travel longer distances for hospitalization than whites even with the onset of a severe illness. The study, however, used a fixed definition of 'distant admission' by setting local distance based on travel norms in the county of residence. As a result, the study did not explore whether the response to illness severity across demographic subgroups would vary over a longer span of distance. In the present study, we define 'long distance' as four discrete distance thresholds relative to travel norms in the county of residence, thus capturing travel behavior over a wider range of geographic areas. We examine the determinants of the propensity to travel greater distances than the norm for each distance threshold level by demographic subgroups, with a particular focus on the role of illness severity. Furthermore, we make different hypotheses about different types of hospital admissions, therefore trying to clarify multiple sources of disparities. The study also contributes to our understanding of the association between distance and severity in order to evaluate whether distance can be used as a reasonable proxy measure of severity of illness that is also applicable across racial/ethnic subgroups.

Two types of hospital admissions are selected for this study. For the first group, we focus on those admissions for which patients usually are prompted to make long distance travel since the treatment often requires use of specialized technologies and 'high-tech' interventions. These are fairly discretionary, often elective, high technology procedures, which often involve or require a referral from a primary care provider to a procedural specialist (referred as referral-sensitive surgeries). For the second group, we chose ambulatory care sensitive (ACS) admissions which in most cases are avoidable when ambulatory care is adequate. As opposed to referral-sensitive admissions, ACS admissions are often more urgent and mostly non-discretionary. Thus, one aspect of the study is to contrast referred, elective services with more urgent treatments where severity and race should have less effect on distance traveled by the elderly.

CONCEPTUAL FRAMEWORK AND HYPOTHESIS

Hospitalization both locally and long distance assumes a structure to the behavior of consumers and service providers. Generally, a decision for a distant hospitalization is prompted by severity of illness, availability and quality of local hospital care, and insurance coverage. Patients with more severe problems may be more willing to travel to long distance specialized providers. Patients with the best insurance coverage would more likely search for care over a wide area. Cultural traditions and socio-economic factors could leave minorities and some ethnic groups with fewer attractive long distance options for hospital care. The role of these factors could also vary by admission type. Lack of specialized services in local communities and location of specialized facilities in certain areas are typically the reasons why patients travel to another area for referral-sensitive admissions (Gregory *et al.*, 2000). The motivations behind long distance travels for ACS admissions could come from inadequate access to local primary and acute care as well as patient characteristics such as types of insurance and illness severity (Basu and Friedman, 2001).

Although illness severity has generally been found as a significant predictor of long distance travel, its role in predicting travel for hospitalization could vary by admission type (Porell and Adams, 1995). Severity may be hypothesized as a stronger predictor of travel among referral-sensitive admissions because the treatment often requires use of specialized technologies and 'high-tech' interventions at selected regional locations. ACS admissions, on the other hand, could be less complex in nature and more treatable in ambulatory settings, although many are also acute infections or other problems that were not promptly treated and required an urgent admission (e.g. cellulitis, urinary tract infection, dehydration).

The primary hypothesis to be tested in this study relates to how severity is associated with travel pattern across racial/ethnic subgroups. The study examines whether the racial/ethnic gaps in travel patterns found in previous literature (Basu, 2005) persisted as distance between home and hospital had increased. The hypothesis to be tested is that, for minorities, severity of illness would more likely be a significant predictor of hospitalization at relatively longer distances than at shorter distances, compared to non-minorities. The rationale behind this hypothesis is that, despite being generally avert to distant hospitalization, minority patients would likely travel to a very distant hospital under the compelling reason of illness severity. As a result, the observed differences in travel behaviors across racial/ethnic subgroups in response to illness severity (Basu, 2005) will be reduced as distance between home and hospital would increase. The implication is that the distance thresholds at which severity will have a significant effect on travel for hospitalization (alternatively referred as 'severity thresholds' in this study) are expected to be higher for minorities than whites.

Both supply and demand factors could contribute to such disparities in travel behavior in response to illness severity. On the demand side, factors such as poverty, lack of insurance, higher Medicaid enrollment, and patient preferences generally could lead to higher severity thresholds for travel among minorities. Cultural, knowledge, and language barriers could also lead to significant racial gaps in patient's perceptions of needed care. On the supply side, provider bias could be an important factor contributing to higher severity thresholds among minorities, especially when the admission is for a complex procedure and requires a physician referral (Kressin and Petersen, 2001). Lower access to primary care for minorities could also result in higher severity when first admitted to a hospital (Basu and Clancy, 2001). For certain types of ACS admissions (e.g. asthma, pneumonia, diabetes complications), which are emergencies when ambulatory care has not been timely and adequate in quality, race and severity may have less effect on distance traveled by the elderly.

DATA AND METHOD

Study design

One important definitional matter to note concerns how distance is measured. Distance in miles could be a potentially misleading variable because it does not take into account geographic barriers and road conditions. In addition, the extreme skewness of the distance variable makes it difficult to use distance as a continuous variable. Measures excluding high values of distance might not capture the total effect of severity and other factors strongly affecting the distance traveled by the patients especially from rural areas (Basu and Cooper, 2000). Goodman *et al.* (1997) considered time of travel as the determinant of patient choice of hospitals. However, distance and time of travel will often depend on established relationships between local and distance providers, as well as non-uniform distribution (location) of specialized providers. Previous studies (Basu and Cooper, 2000; Basu and Friedman, 2001) have used county as the geographic unit to partially overcome the drawbacks of the distance measure and crossing a county boundary was considered to be a long-distance travel. Obviously, this has its own shortcomings since patients may only go short distances to go to a different county, or may travel a long way to go to a hospital in the resident county.

In this study, we use a distance threshold rather than a county boundary threshold to define a long distance travel. Unlike previous studies, these local thresholds are based on travel norms set by county residents to local hospitals. The study uses a framework where a distant admission is first defined by using different local distance threshold values. The association of distant admission with severity is then examined corresponding to each local threshold level and race. A logistic model compares distant admissions with local admissions for different threshold levels, controlling for patient demographics, patient insurance categories, and county characteristics.

This study focuses primarily on three racial/ethnic subgroups of elderly residents of New York (NY) State in 1997: white (non-Hispanic), African American (non-Hispanic), and Hispanic. The last two groups represent minority populations in this study and consist of 12.4 and 5.2%, respectively, of elderly New York residents hospitalized for ACS conditions, and 4.5 and 2.9%, respectively, of elderly New York residents hospitalized for referral-sensitive procedures in 1997. Of the remaining population, the majority were whites (73.8 and 77.2% of the total for ACS and referral sensitive admissions, respectively), and the rest represented a mixture of different ethnic groups noted as 'other' (4.5 and 4.9%, respectively). A significant number of the elderly with unknown races (4.1 and 10.5%, respectively for ACS and referral-sensitive admissions) are evenly distributed across different racial/ethnic groups.

Although the study primarily focuses on all New York State elderly residents, separate analysis excluding New York City (NYC) areas was conducted where appropriate and feasible. NYC, comprising four large counties (e.g. Manhattan, Bronx, Kings, and Queens) is different from rest of NY because of higher population density, large service availability, and shorter distance to hospitals relative to other areas. Distance travel may, therefore, be less likely to reveal anything systematic about the patient condition or behavioral decision factors. However, since tertiary hospitals are not really spread around as much as other types of care, the costs of utilizing elective, referred services might still be substantial to a lot of residents of the NYC area.

Source of data and description of variables

Information on inpatient hospital discharges during 1997 for New York residents over age 64 hospitalized in New York (NY), Pennsylvania (PA), New Jersey (NJ), and Connecticut (CT) was drawn from complete hospital discharge files for four states: NY, PA, NJ, and CT. These records were assembled, edited, and standardized as part of the Hospital Cost and Utilization Project (HCUP) State Inpatient database (SID) of the Agency for Healthcare Research and Quality (AHRQ, 2004). To create the analytical file, inpatient discharge records of New York residents from HCUP file were linked to the 1997 Area Resource File (ARF) for socio-demographic and other information on patient's county of residence, and to the American Hospital Association's (AHA) survey files for 1997 for information on hospitals where patients were treated.

Referral-sensitive and ACS conditions. These conditions were defined following criteria provided by John Billings (Billings *et al*., 1993). The conditions are usually defined by principal diagnoses diagnostic codes from the International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM) system. In several cases, specific exclusion criteria based on age, sex, and selected procedures have been used. Referral sensitive conditions include hip/joint replacement, breast reconstruction after mastectomy, pacemaker insertion, organ and bone marrow transplantation, most coronary artery bypass graft (CABG) surgery, and coronary angioplasty. ACS diagnoses generally included congenital syphilis, immunization-related and preventable conditions, severe ear, nose and throat infections, chronic obstructive pulmonary disease, diabetes, convulsions, gastroenteritis (requiring hospitalization),

DOI: 10.1002/hec

asthma, congestive heart failure, angina, bacterial pneumonia, tuberculosis, hypertension, cellulitis, hypoglycemia, kidney/urinary tract infection, dehydration-volume depletion, iron deficiency anemia, nutritional deficiencies, failure to thrive, pelvic inflammatory disease and certain dental conditions. However, for elderly, bacterial pneumonia is generally excluded from the list of ACS diagnoses (Blustein *et al.*, 1998).

Dependent variable: distant admission. The study uses a framework where a distant admission is defined by using different local threshold values. First, a local distance is defined based on the average distance traveled by patients to local hospitals. Since data to calculate distance to all available local hospitals was not available (discharge data only reports patient's zip code and zip code of the admitting hospital), we used a proxy measure to indicate local travel distance. By defining county as the geographic boundary for local hospitals, this proxy was calculated as the weighted average distance traveled by those that were hospitalized within their county of residence for a specified type of admission (Basu, 2005). This average local distance was then used as the minimum threshold differentiating distant from local admission. Discrete distance intervals were subsequently defined by each standard deviation increase above this minimum threshold (Basu and Mobley, 2006). Thus, four threshold values are considered, e.g. mean local distance, mean local distance plus one standard deviation, mean local distance plus two standard deviations, mean local distance plus three standard deviations.

This method allows the threshold for each admission type to vary across counties. If the distance traveled by a patient is above a specified threshold, the patient is considered to be a long distance traveler. For each patient, the actual travel distance is compared with this threshold distance (note that this threshold distance would be the same for patients residing in the same county for a specified admission category) and a distant admission value of 1 or 0 is constructed and used as the dependent variable. The process is repeated for each of the four threshold levels mentioned before.

Averaging across all counties of residence, the threshold values for 0, 1, 2, or 3 are as follows: 7, 11, 15, and 19 miles for ACS admissions and 7, 12, and 17, and 21 miles for referral-sensitive admissions. Significant disparity could be observed between NYC versus rest of NY. For example, in NYC, mean local distance is about 3 miles for ACS admissions, while in rural counties it could be as high as 20 miles. Despite such differences, analysis of data shows NYC closely resembling non-NYC areas with respect to proportions of patients traveling long distances as per definition used in this study. For example, at a local threshold level corresponding to mean plus one standard deviation, these proportions were, respectively, 47 and 44% for ACS, and 26 and 21% for referral-sensitive admissions in NYC versus non-NYC areas. These similarities in travel patterns could be attributed to increased barriers to travels in areas with higher population densities such as in NYC, providing justification for using the same definition of distant hospitalization for NYC as in rest of NY.

The distance is calculated by using software which connects latitudes and longitudes of patient zip codes with those of the hospital zip codes. The distance calculated this way is used to estimate average distance to local hospitals and to derive distant admission values for each patient. While using distance as the dependent variable, this measure eliminates the problem of getting highly skewed distribution. Additionally, using this definition, propensity to travel is defined relative to local travel norms in a county, with the 'normal' distance defined by elderly peers with similar medical conditions in the county of one's residence (Basu and Mobley, 2006). Although it does not provide an opportunity for capturing numeric distance values as a continuous variable, the method offers an improvement over using the geographic boundary or an arbitrary radius around the admitting hospital (Welch *et al.*, 1993) as the threshold index. It may be noted that although local threshold is based on residents hospitalized within the same county, local distance does not necessarily indicate a location within the same county for each patient.

Independent variables:

(1) Severity of illness

Two measures were reported to indicate the severity of illness of the admitting patient. First, a direct measure of severity of illness was calculated using a variable called RDSCALE, which is a later development of the Disease staging System by Medstat, Inc. Disease staging is a commercial software product that was originally developed to predict mortality and has been recognized in health services research since mid-1980s (Gonnella *et al*., 1984; Coffey and Goldfarb, 1986). RDSCALE is a continuous resource-based predictor assigned to each patient, and represents a patient's within-diagnosis-related-group (DRG) severity and the complexity of his/her DRG (Christoffersson *et al*., 1988). When used in the logistic regression, the RDSCALE values, usually expressed in percentages, have been divided by 100 in order to make the effect of a unit change more discernable. Second, a specific attribute of the hospital where patient is treated, e.g. teaching status, is used as an indirect measure of severity. Teaching hospitals usually admit a large proportion of more severe cases. Teaching status is indicated by membership in the Council of Teaching Hospitals (COTH), and is a categorical variable obtained from the AHA file.

(2) Patient characteristics

The following patient characteristics are considered: age, race/ethnicity, gender; source of admission, insurance status, and geographic location. Except source of admissions, others represent socio-demographic characteristics of the patient. Following common practice, age is grouped into three categories: 65–74, 75–84, and 85 and above. Race/ethnicity is grouped in four categories: white (non-Hispanic), African American (non-Hispanic), Hispanic and other. Insurance status of patients is closely linked to their socioeconomic status and the ability to pay for health care. Insurance status is grouped into Medicare, Medicare HMO, Medicaid, self-pay, commercial HMO, and all other types of insurance, which is principally private fee for service (FFS) insurance plus a small group of other types of public programs (referred as private FFS in Table AI). Note that Medicaid HMO patients are not separately considered because of their small sample size. Three major sources of admission were included: admission from emergency rooms, transfer from another facility, and all others.

In terms of geographic location, residents fell into three categories: metropolitan, non-metropolitan and adjacent to metropolitan areas, non-metropolitan and not adjacent to metropolitan areas. Among 62 New York counties, 6 are non-metropolitan non-adjacent (completely rural), 18 are non-metropolitan adjacent, and the remaining 38 are metropolitan. NYC, comprising four large counties (e.g. Manhattan, Bronx, Kings, and Queens) is used as an additional control variable because of high density of population and greater proportion of non-white residents.

(3) County characteristics

County-level variables include socio-demographic condition and county resources. Data for these variables are obtained from 1997 Area Resource Files. To capture county demographic factors, data on median county family income and county racial compositions were reviewed. Racial composition of a county was found to be highly correlated with median county income as well as with NYC (correlation coefficient between proportions of whites and county income = 0.6, that between proportion of whites and NYC = −0.94), and was dropped from the final models. Another reason for excluding this variable was the focus of the study on race as an individual characteristic. Four county resource variables were used in this study: inpatient days per capita, hospital outpatient visits per capita, the number of primary care physicians per 1 000 population, the number of specialists per 1000 population. Although reflecting utilization, both outpatient visits and inpatient days per capita represent, respectively, total hospital outpatient and inpatient capacities in the county. Outpatient visits (not emergency) are used in place of total hospital primary care staffing, which is not reported. Since beds are not always reflective of hospital inpatient capacity (Friedman and Pauly, 1981), we used total hospital inpatient days per capita instead of bed-to-population ratios as the indicator of county inpatient capacity. Both inpatient and outpatient capacity variables refer to total admissions and visits, respectively. The counties with no

DOI: 10.1002/hec

hospitals will have values for these variables equal to zero. Primary care physicians outside hospitals include office-based general pediatricians, general internists, and general practice and family practice physicians. Note that this fails to represent the role of nurse practitioners in primary care that may be particularly important for HMOs. The data on county resources and demographic information are used as continuous variables in the model.

Statistical analysis

In order test the hypothesized relationships between severity and race/ethnicity, we performed separate logistic regression analysis for each type of admission with data stratified by race/ethnicity and threshold level. Such split sample analysis allows all model coefficients to vary within each of the scenarios, reflecting 16 different regimes in the modeling. For each admission type, we estimated 16 separate regression models corresponding to each of the four threshold levels, and each of the four racial/ethnic categories (including three racial/ethnic groups and a total of all groups). An alternative method could combine all racial groups in one regression model and test for effects of severity and race interactions. While this method can test for the variability of association between distance and severity across races, it does not appear to be adequate to examine whether and how distance and severity are related in each racial group. For example, a combined model would assume all parameters across racial groups to be the same. By partitioning the sample into racial groups and threshold levels, we take advantage of a large number of observations and examine the variability of the impact of different parameters across these subsets, with the focus on the severity coefficient. However, we also present the results from a combined model in Appendix A (Table AI(a)) to reaffirm the general findings from partitioned models (for all races combined), and also to report the effects of other covariates (due to space limitations, we could not report these parameter estimates from 16 different full models but these data are available from authors).

The results for the main hypothesis of this study are summarized in Tables II to IV. Separate analysis is conducted for each threshold level and race/ethnicity, controlling for patient demographics, patient insurance categories, county characteristics and county resources (as shown in Table AI(a)). Sample means for these variables are presented in Table AI(b) (Appendix A). The odds ratios of RDSCALE and 'teaching hospital admission' as presented in Tables II–IV are estimated from these sixteen separate equations for each of the two admission types (ACS and referral-sensitive). While RDSCALE is a continuous variable, 'teaching hospital admission' is a categorical variable with a referent group indicating 'non-teaching status of the admitting hospital'. The dependent variable in all these models is distant admission, computed for each threshold level separately. Distant admission equals 1 if the patient travels longer than the threshold value, 0 if less. All analysis is done for both ACS and referral-sensitive admissions separately.

As mentioned above, Table AI(a) in the Appendix A additionally displays a full model with other covariates, where threshold levels are used as dummy variables, and where threshold 1 is the reference category. These dummy variables are also interacted with the illness severity score to determine how changes in severity varied with hospitalizations at increasingly longer distances from residence. Separate regressions are run for each admission type. The parameters of all logistic models are estimated by maximum likelihood methods in the STATA software package, using established strategies including the allowance for correlated errors within county of residence (clustering).

PRINCIPAL FINDINGS

Table I provides unadjusted data on long distance travel by racial/ethnic groups for admission types. The table also provides sample size by racial/ethnic group and admission type. Elderly patients more frequently use local hospitals for ACS admissions and distant hospitals for referral-sensitive admissions.

Table I. Total elderly residents (N) and percentage elderly who travel long distances by race above different local thresholds, NY, 1997

Admission type/race	*N*	local threshold = Mean	local threshold = Mean + std.	local threshold = Mean + 2std.	local threshold = Mean + 3std.
ACS					
White	156 172	45.2	24.65	13.01	7.75
African American	26 222	38.7	18.7	9.9	5.02
Hispanic	11 081	39.9	21.81	10.14	4.60
Referral sensitive					
White	35 136	63.48	45.32	33.21	26.48
African American	2 027	55.69	35.82	25.35	17.71
Hispanic	1 290	62.02	44.49	29.61	21.24

The tendency to travel longer distances is less common among non-whites than whites. Hispanics were found to travel more frequently than African Americans, especially for referral-sensitive procedures.

Mutivariate results

Tables II–IV report summarized data on the primary hypothesis of the study. Table II reports odds ratios of two severity measures for ACS admissions by racial/ethnic groups and threshold levels. Table III shows the odds ratios of RDSCALE for ACS admissions for residents in non-NYC areas only. Table IV reports the corresponding odds ratios for referral-sensitive admissions for New York State as a whole. A corresponding analysis for referral-sensitive admissions for non-NYC areas could not be performed because of very small sample size.

Findings on direct severity Score (RDSCALE). Table II demonstrates that the effect of RDSCALE on travel pattern for ACS admissions is similar across whites and African Americans. For Hispanics, RDSCALE was not significant at any threshold level. To eliminate possible confounding with NYC where Hispanics cluster, a test run was performed removing NYC from the list of independent variables, yielding little change in the significance level for Hispanics. As hypothesized, these results may reflect the urgent nature of ACS admissions where severity and race could have less effect on distance traveled by the elderly.

Table III, however, shows non-NYC areas to be somewhat different. Although RDSCALE had significant associations with travel for ACS admissions at all threshold levels for whites, it was not generally significant for non-whites except at a much higher distance. The local threshold level had to be as high as three standard deviations above mean for RDSCALE to have a significant effect among non-whites (both African Americans and Hispanics) outside NYC areas. Although not reported separately, analysis of NYC areas showed no significant association between severity and distance for any racial/ethnic group. This could imply that travel did not represent severity where distance to service is short and services are available in the local area.

Table IV shows the corresponding results for referral-sensitive admissions in NY State as a whole. While RDSCALE was significant even when distance was closer (i.e. above mean local distance) among whites, local thresholds for African Americans were mean plus two standard deviations for RDSCALE to have a meaningful association with distant hospitalization. Hispanics, like whites, were found to go to nearby hospitals for severe conditions, although some extreme cases of higher severity were treated at very distant hospitals (about 21%). Analysis of NYC areas (not reported) shows RDSCALE having similar effects as the overall state. As pointed out earlier, this could indicate that, since tertiary hospitals are not as much spread out as other services, costs of utilizing referred services might still be substantial

Table II. Odds of distant admissions for ACS conditions: effect of severity above varying thresholds, NY, Elderly, 1997

	Mean	Mean + std	Mean + 2std	Mean + 3std
Odds ratios of RDSCALE				
All	NS	NS	1.015 (1.005, 1.025)*	1.022 (1.011, 1.033)*
White	NS	NS	1.015 (1.003, 1.027)**	1.019 (1.005, 1.033)*
African American	NS	NS	1.017 (1.00, 1.03)**	1.027 (1.006, 1.049)*
Hispanic	NS	NS	NS	NS
Odds ratios of teaching hospital admissions				
All	2.22 (1.86, 2.65)*	2.14 (1.65, 2.79)*	2.74 (2.01, 3.75)*	2.983 (1.839, 4.838)*
White	2.32 (1.67, 3.23)*	2.25 (1.46, 3.46)*	2.82 (1.87, 4.26)*	3.293 (1.099, 5.707)*
African American	1.87 (1.00, 3.55)**	1.92 (1.00, 3.69)**	3.009 (1.61, 5.61)*	2.298 (1.438, 3.672)*
Hispanic	2.46(1.75, 3.45)*	3.06 (1.91, 4.89)*	2.78 (1.55, 4.99)*	2.084 (1.256, 3.456)*

*$p<0.01$; **$p<0.05$.
NS = not significant.
Note: The logistic regression models in this table are run by each threshold level and racial group. The models control for patient demographics, patient insurance categories, county characteristics and county resources (sample means of these covariates are shown in Table AI(b)). The standard errors of these models are adjusted for 'clustering' within counties of patient residence.

Table III. Odds of distant admissions for ACS conditions: effect of severity (RDSCALE) above varying thresholds, NY (excludes NYC Areas)

	Mean	Mean + std	Mean + 2std	Mean + 3std
All	1.016 (1.007, 1.024)*	1.023 (1.008, 1.038)*	1.032 (1.017, 1.048)*	1.04 (1.024, 1.059)*
White	1.01 (1.00, 1.03)*	1.024 (1.009, 1.038)*	1.035 (1.02, 1.05)*	1.04 (1.02, 1.06)*
African American	NS	NS	NS	1.04 (1.007, 1.077)**
Hispanic	NS	NS	NS	1.07 (1.005, 1.156)**

*$p<0.01$; **$p<0.05$.
NS = not significant.
Note: The logistic regression models in this table are run by each threshold level and racial group. The models control for patient demographics, patient insurance categories, county characteristics and county resources (sample means of these covariates are shown in Table AI(b)). The standard errors of these models are adjusted for 'clustering' within counties of patient residence.

to a lot of residents, especially non-whites, even in metro areas. Analysis of non-NYC areas could not be conducted because of small sample sizes for African Americans and Hispanics.

In summary, the findings indicate that severity, as measured by RDSCALE, was not generally a significant predictor of long distance travels among non-whites, whereas whites were consistently more likely to travel as severity increased. Severity (RDSCALE), however, had a stronger and statistically significant association with travel among non-whites when the hospital was located at a greater distance. This was observed particularly for referral-sensitive admissions, and for African Americans. For ACS admissions occurring among residents in areas outside NYC, this was observed for both minority subgroups.

Findings on indirect severity measure. Teaching hospital admission is often used as an indirect measure of severity. We found some evidence of the association of severity with race (Tables II and IV) in favor of our hypothesis. Generally, travel was significantly and positively associated with admission to a teaching hospital across most racial/ethnic groups (except Hispanics for referral-sensitive admissions). However, African Americans were found somewhat more likely than other racial groups to travel to a teaching hospital at a greater distance. For example, the odds for teaching hospital admission increased

DOI: 10.1002/hec

Table IV. Odds of distant admissions for R-S conditions: effect of severity above varying thresholds, NY, Elderly, 1997

	Mean	Mean + std	Mean + 2std	Mean + 3std
Odds ratios of RDSCALE				
All	1.08 (1.02, 1.14)*	1.083 (1.04, 1.13)*	1.086 (1.05, 1.13)*	1.089 (1.057, 1.122)*
White	1.08 (1.02, 1.14)*	1.088 (1.04, 1.14)**	1.112 (1.05, 1.18)*	1.089 (1.049, 1.131)*
African American	NS	NS	1.072 (1.017, 1.13)*	1.08 (1.035, 1.127)*
Hispanic	1.08(1.03, 1.14)*	NS	NS	1.05 (1.016, 1.091)*
Odds ratios of teaching hospital admissions				
All	1.92 (1.45, 2.55)*	1.95 (1.41, 2.72)*	2.48 (1.54, 3.97)*	2.27(1.324, 3.891)*
White	2.09(1.53, 2.84)*	2.19 (1.53, 3.12)*	3.16 (1.90, 5.24)*	2.751 (1.532, 4.940)*
African American	2.27(1.64, 3.13)*	2.80 (1.51, 5.18)*	2.62 (1.25, 5.45)*	NS
Hispanic	NS	NS	NS	NS

*$p <$ 0.01; **$p < 0.05$.
NS = not significant.
Note: The logistic regression models in this table are run by each threshold level and racial group. The models control for patient demographics, patient insurance categories, county characteristics and county resources (sample means of these covariates are shown in Table AI(b)). The standard errors of these models are adjusted for 'clustering' within counties of patient residence.

by 60% (from 1.87 to 3.009) for African Americans as the threshold level was increased from mean to two standard deviations above it, as compared to a corresponding increase of 21% among whites (from 2.32 to 2.82). The findings also suggest a greater tendency among African Americans to travel to a teaching hospital than to travel for a complex diagnosis in general.

Secondary findings. Several secondary findings followed from Tables II to IV. Overall, the minimum threshold for a significant effect of RDSCALE was higher for ACS admissions than for referral-sensitive admissions. Another noticeable difference was that the effect of RDSCALE became stronger at higher distance for ACS admissions, while the odds ratios for RDSCALE were comparable across threshold levels for referral-sensitive admissions. These findings could imply that, despite the potential that some ACS admissions could be urgent with little discretion on patient choice of hospitals, distant hospitals were likely to be used for more severe episodes of ACS admissions. Referral-sensitive admissions, on the other hand, were found to be severe irrespective of the location of the hospital.

The Appendix A (Table AI(a)) highlights additional findings. Controlling for severity and other factors, African Americans were 40–45% less likely to go longer distances for ACS hospital admissions. The difference between Hispanics and whites was not statistically significant. As expected, increased distance was significantly associated with fewer admissions, as evidenced in the declining values of threshold coefficients. The rate of decline was lower for referral-sensitive admissions indicating that such admissions would occur at higher distances than ACS admissions. The interaction coefficients of RDSCALE with threshold levels reaffirmed the findings from Tables II to IV that severity plays a greater role in boosting distant travel for ACS admissions than referral-sensitive admissions.

Findings on other covariates. Several findings on other covariates may also be noted (Table AI(a)). Elderly with private insurance coverage were found more likely to travel than those covered by other insurance or no insurance. Medicare HMO and Medicaid patients showed a lesser tendency to travel for both admission types. The travel also declines with age and with increased distances. Male patients are more likely to travel irrespective of distance to be covered than females. As expected, patients from metro-adjacent areas traveled longer than those in metropolitan areas. Availability of outpatient resources was associated with more local admissions for ACS conditions. These findings generally remained the same for regression models stratified by race (data available from authors) with a few exceptions. For example, patient characteristics (e.g. insurance status, gender) were no longer statistically significant among African Americans or Hispanics admitted for ACS conditions. On the other hand, county characteristics such as the availability of primary care physicians and higher median county income were associated with more and fewer local admissions for ACS conditions, respectively, among these minority group members.

DISCUSSION

Interestingly, disparity in hospitalization for referred, elective treatment is found by examining several thresholds defining 'distant' admissions. A significant association between disease complexity and distant hospitalizations occurs for a higher distance threshold level for non-whites, particularly for African American patients (starts at a threshold of mean $+2$ standard deviations). This finding indicates that nonwhite elderly patients had a higher severity threshold than whites in seeking distant hospital care, but the underlying determinants remain open to some debate. The result could reflect weaker information about benefits, or higher cost, of a distant admission for non-whites. Also, referral-sensitive admissions depend quite heavily on referrals by primary care physicians and procedural specialists and thus could be subject to provider bias (van Ryn and Burke, 2000; Kressin and Petersen, 2001). A previous study has shown that barriers to PCP access would more adversely impact referrals among non-whites than whites (Basu and Clancy, 2001). As expected, the study results demonstrate that ACS admissions are often urgent treatments where race and severity have less effect on distance traveled by the elderly (a significant effect of severity on distance, using a threshold level of mean plus two standard deviations for both races). In areas where distance to service is longer and cost of travel is higher (outside NYC), minority patients traveling long distances appear to be more severely ill than whites.

The results in this study may be compared with a previous study which used the same data set for New York elderly residents (Basu, 2005) as was used in the current study. The previous study found that severity of illness is not a significant predictor of long distance travel for minorities but is a significant predictor for long distance travel for whites. Building on this, the current study examines this issue in a generalized framework with different types of admissions and a range of distance measures rather than a single and simpler distance definition. In contrast to previous work and, as hypothesized, this study found that differences in travel response to illness severity across racial/ethnic groups are likely to diminish over a longer span of distance, and that there is variation across types of admissions as to how different racial groups change their travel behavior over the distance spectrum.

It is generally observed that, independent of severity, non-whites are less likely to travel beyond a threshold distance to hospital. The findings of a high threshold for severely ill nonwhite patients with ACS conditions outside NYC (even with a threshold of mean $+2$ standard deviations) is a matter of some concern. Some of these conditions are flare-ups of chronic conditions (e.g. asthma and diabetes). Delays in seeking effective care due to costs and availability of local care, or costs of transportation could have adverse consequences for health and health care costs.

Several tests of sensitivity to the estimation method were conducted. If non-whites generally do not travel as far for hospital services, the racial composition of a county might affect the calculated local thresholds. To adjust for this relationship, we multiplied the threshold values by a correction factor which reflected the difference in average distance to hospitalization due to differential racial compositions in a county versus the whole state. Using this method, however, the threshold values as well as the proportions of distant admissions closely followed those obtained from using the unadjusted mean values. The findings from regression analysis generally remained the same (data available from the authors) for referral sensitive admissions, and for ACS admissions outside NYC. Several other sensitivity tests had little reportable impact. Removing the teaching status variable as a measure of

DOI: 10.1002/hec

severity might be advisable on the grounds that teaching hospitals could more frequently require distant travel. The tests excluding this variable did not change the main findings. Neither did the exclusion of transfer admissions or adding a county racial composition variable change the findings.

The study has some limitations that should be acknowledged. Since ACS and referral-sensitive conditions were used at aggregated levels, the expected effects on travel caused by very detailed differences in diagnostic mix between racial and ethnic groups have not been explicitly addressed in this study. Other limitations in the data were the lack of information at the individual level on SES or transportation to determine whether travel pattern reflected patient preferences or resource constraints. Although the current study examined patient characteristics after adjusting for selected supply side factors, a more detailed level of data was needed to disentangle the supply and demand effects completely. The distance threshold, inferred from actual behavior, may not capture potential local travel. For example, since the threshold is computed as the distance traveled by those that stayed within the home county, for some counties all admissions are classified as distant admissions, even though the actual distance traveled by some patients may have been much shorter than others. To combat this problem, we ran a model using average statewide threshold values to replace county-specific threshold values where they were missing. The difference between the two scenarios was small. Another potential problem particularly for rural areas is the use of centroid of home zip code rather than actual address to calculate distance. A source of rural–urban bias could also come from the differences in road density between urban and rural areas. In rural areas, where road density is lower, the actual distance traveled may be considerably higher and the effect of distance as a barrier to hospitalization may be underestimated.

As a methodological note, the results of the study suggest that distance traveled is not itself a good proxy variable for severity of illness, contrary to some views in previous literature. This is because severity might not predict distance traveled for everyone uniformly. There could be a number of contributing behavioral influences that make it too complicated to be a good proxy. This is important information to researchers because our findings suggest that using distance as a proxy for severity will be confounded with race/ethnicity, by areas, and by types of conditions. To the extent that distance is seen as a proxy for unobserved disease severity, if the approximation is poor or varies with race/ethnicity, then distance is of limited value as a proxy for illness severity and more direct, computationally intensive measures should be used.

The findings in our study have implications for policies to regionalize some hospital services. If costly elective services were regionalized to get the advantages of high volume for both cost and quality of care, some extra effort at outreach may be desirable to reduce disparities. The study highlights the importance of policies to increase local resources, since strong associations were found between the availability of local resources and use of local hospitals for ACS admissions, particularly among the minorities. The study also suggests that travelling over the county line is not the best information of where to increase local resources for ambulatory care to reduce disparities in care and the cost of hospital admissions. The adverse effects due to delay of care would depend on how far the patient has to travel before and after crossing a border. Although this study does not address the question of whether hospitalization in a local area is a better alternative than hospitalization outside the area, there are important cost implications of our study for minorities since the postponement of care as a result of distance could have lasting health impact and higher costs of subsequent problems.

APPENDIX A

The results of logistic regression and means of variables used in the regression models by types of hospitalization anong elderly (65 and above) are shown in Table AI.

Table AI. Results of logistic regression, means of variables used in the regression models by types of hospitalization[a] among elderly (65 and above), New York, 1997

Variables	ACS admissions ($N = 211\,409$)	Referral-sensitive admissions ($N = 44\,528$)
(a) Results of logistic regression: Odds ratio (OR) for distant admission versus local admission		
Patient insurance		
Medicare FFS	0.78 (0.68, 0.91)*	0.87 (0.69, 1.08)
Medicare HMO	0.67 (0.49, 0.92)*	0.36 (0.24, 0.53)*
Medicaid	0.64 (0.46, 0.87)*	0.52 (0.34, 0.78)*
Self pay	0.43 (0.29, 0.85)*	0.65 (0.35, 1.20)
Private HMO	0.87 (0.69, 1.07)	0.95 (0.67, 1.36)
Private FFS	1.00	1.00
Patient demographics		
African American	0.59 (0.50, 0.68)*	0.64 (0.40, 1.01)
Hispanic	0.73 (0.52, 1.02)	1.00 (0.61, 1.65)
White and others	1.00	1.00
Male	1.04 (1.00, 1.09)**	1.18 (1.10, 1.27)*
Age 75–84	0.87 (0.84, 0.94)*	0.80 (0.74, 0.85)*
Age 85+	0.77 (0.71, 0.84)*	0.57 (0.49, 0.67)*
Age 65–74	1.00	1.00
Severity of illness		
Source of admission = ER	0.84 (0.67, 1.03)	0.39 (0.31, 0.48)*
Source of admission = transfer	1.18 (0.95, 1.47)	1.64 (1.33, 2.03)*
Source of admission = All others	1.00	1.00
Severity score (RDSCALE)	1.004 (0.99, 1.01)	1.11 (1.02, 1.20)*
Admission to teaching hospital	2.36 (1.92, 2.91)*	2.10 (1.49, 2.96)*
Admission to non-teaching hospital	1.00	1.00
County characteristics		
Metro-adjacent	2.70 (1.47, 4.95)*	3.58 (1.61, 7.94)*
Not adjacent	0.80 (0.47, 1.35)	2.03 (0.91, 4.53)
Metro	1.00	1.00
New York City (NYC)	1.06 (0.68, 1.64)	2.31 (0.92, 5.82)
Non-NYC areas	1.00	1.00
Median county Income ($000)	0.99 (0.97, 1.016)	1.04 (0.99, 1.10)
County resources		
Outpatient visits/ capita	0.82 (0.72, 0.94)*	0.97 (0.76, 1.24)
PCPs per 1000 pop.	0.11 (0.01, 1.31)	0.19 (0.003, 9.20)
Per capita inpatient days	0.75 (0.43, 1.29)	1.008 (0.57, 1.77)
Specialists per 1000 pop.	1.39(0.65, 2.97)	0.43 (0.16, 1.19)
Threshold indicators		
Threshold2 + +	0.355 (0.32, 0.39)*	0.40 (0.34, 0.48)*
Threshold3 + + +	0.15 (0.14, 0.18)*	0.22 (0.17, 0.29)*
Threshold4 + + + +	0.08 (0.07, 0.09)*	0.15 (0.11, 0.20)
Threshold1 +	1.00	1.00
RDSCALE X Threshold2	1.004 (.99, 1.01)	0.97 (0.92, 1.03)
RDSCALE X Threshold3	1.012 (1.003, 1.021)*	0.96 (0.88, 1.06)
RDSCALE X Threshold4	1.017 (1.005, 1.029)*	0.96 (0.87, 1.05)
(b) Means of variables used in regression models		
Distant Admission	0.2201	0.4232
Patient insurance		
Medicare FFS	0.8359	0.7874
Medicare HMO	0.0316	0.0536
Medicaid	0.0486	0.0254
Self pay	0.0093	0.0037
Private HMO	0.0285	0.0551
Private FFS	0.0461	0.0748

Table AI. *Continued*

	ACS admissions ($N=211\,409$)	Referral-sensitive admissions ($N=44\,528$)
Patient demographics		
African American	0.1248	0.0455
Hispanic	0.0527	0.0289
White and others	0.8225	0.9256
Male	0.3930	0.4835
Age 75–84	0.3986	0.3751
Age 85+	0.2670	0.0994
Age 65–74	0.3344	0.5225
Severity of illness		
Source of admission = ER	0.7237	0.2254
Source of admission = transfer	0.0554	0.1669
Source of admission = All others	0.2209	0.6077
Severity score (RDSCALE)	1.4315	3.6149
Admission to teaching hospital	0.3362	0.5742
Admission to non-teaching hospital	0.6638	0.4258
County characteristics		
Metro-adjacent	0.0613	0.0587
Not adjacent	0.0244	0.0185
Metro	0.9143	0.9228
New York City (NYC)	0.4079	0.3176
Non-NYC areas	0.5921	0.6824
Median county Income ($000)	37.2826	39.1453
County resources		
Outpatient visits/ capita	2.4818	2.4208
PCPs per 1000 pop.	0.5512	0.5614
Per capita inpatient days	1.1032	1.0942
Specialists per 1000 pop.	1.4725	1.5082

[a]Includes all admissions of New York residents in New York State and three neighboring states: NJ, PA, and CT. Small number of cases hospitalized in MA or VT will be missed.

Note: The standard errors of these models in part (a) are adjusted for 'clustering' within counties of patient residence, Pseudo $R^2=0.1610$ and 0.2273 for ACS and referral-sensitive equations respectively.

*$p<0.01$; **$p<0.05$.

+ defined as mean local distance.

+ + defined as mean local distance + 1 standard deviation.

+ + + defined as mean local distance + 2 standard deviations.

+ + + + defined as mean local distance + 3 standard deviations.

ACKNOWLEDGEMENTS

This research is funded wholly by the authors' employer, the Agency for Healthcare Research and Quality. Dr Basu is a Senior Economist with the Center for Primary Care, Prevention and Clinical Partnerships, and Dr. Friedman is a Senior Economist with the Center for Delivery, Organization and Markets. The views expressed in this paper are those of authors. No official endorsement by any agency of the federal government is intended or should be inferred. The authors acknowledge the state data organizations that participate in the HCUP State Inpatient Databases: New York State Department of Health; Pennsylvania Health care Cost Containment Council; Connecticut—Chime, Inc.; New Jersey Department of Health & Senior Services.

REFERENCES

Adams EK, Houchens R *et al*. 1991. Predicting hospital choice for rural Medicare beneficiaries: the role of severity of illness. *Health Services Research* **26**(5): 583–612.

Adams EK, Wright GE. 1991. Hospital choice of Medicare beneficiaries in a rural market: why not the closest? *Journal of Rural Health* **7**(2): 134–152.

AHRQ. 2004. Agency for Healthcare Research and Quality: Healthcare Cost and Utilization Project (HCUP). Rockville, MD. Accessed online December 2005. http://www.hcup-us.ahrq.gov/db/state/siddbdocumentation.jsp.

Basu J. 2005. Severity of illness, race, and choice of local versus distant hospitals among the elderly. *Journal of Health Care for the Poor and Underserved* **16**(2): 391–405.

Basu J, Clancy C. 2001. Racial disparity, primary care, and specialty referral. *Health Services Research* **36**(6 (Part II)): 64–77.

Basu J, Cooper J. 2000. Out-of-area travel from rural and urban counties: a study of ambulatory care sensitive hospitalizations for New York State residents. *Journal of Rural Health* **16**(2): 129–138.

Basu J, Friedman B. 2001. Preventable illness and out-of-area travel of children in New York counties. *Health Economics* **10**(1): 67–78.

Basu J, Lazenby HC *et al*. 1995. Medicare spending by state: the border-crossing adjustment. *Health Care Financing Review* **17**(2): 219–241.

Basu J, Mobley LR. 2006. Illness severity and propensity to travel along the urban-rural continuum. Health and Place. Available at http://www.sciencedirect.com/science?_ob = MImg&_imagekey = B6VH5-4JXY7DN-1-3&_cdi = 6057&_user = 775537&_orig = browse&_coverData = 05%2F12%2F2006&_sk = 999999999&view = c&wchp = dGLbVzSkWW&md5 = 45ffa36eabdc493f0e688668ba1ed221&ie = /sdarticle.pdf

Billings J, Zeitel L *et al*. 1993. Impact of socioeconomic status on hospital use in New York City. *Health Affairs (Millwood)* **12**(1): 162–173.

Blustein J, Hanson K *et al*. 1998. Preventable hospitalizations and socioeconomic status. *Health Affairs (Millwood)* **17**(2): 177–189.

Buczko W. 1992. Factors affecting interstate use of inpatient care by Medicare beneficiaries. *Health Services Research* **27**(3): 295–315.

Burgess Jr JF, DeFiore DA. 1994. The effect of distance to VA facilities on the choice and level of utilization of VA outpatient services. *Social Science and Medicine* **39**(1): 95–104.

Christoffersson JG, Conklin JE *et al*. 1988. The impact of severity of illness on hospital costs. *DRG Monitoring* **6**(1): 1–8.

Coffey RM, Goldfarb MG. 1986. DRGs and disease staging for reimbursing Medicare patients. *Medical Care* **24**(9): 814–829.

Dansky KH, Brannon D *et al*. 1998. Profiles of hospital, physician, and home health service use by older persons in rural areas. *Gerontologist* **38**(3): 320–330.

Dranove D, White WD *et al*. 1993. Segmentation in local hospital markets. *Medical Care* **31**(1): 52–64.

Friedman B, Pauly M. 1981. Cost functions for a service firm with variable quality and stochastic demand: the case of hospitals. *Review of Economics and Statistics* **63**: 620–624.

Gonnella JS, Hornbrook MC *et al*. 1984. Staging of disease. A case-mix measurement. *Journal of American Medical Association* **251**(5): 637–644.

Goodman DC, Fisher E *et al*. 1997. The distance to community medical care and the likelihood of hospitalization: is closer always better? *American Journal of Public Health* **87**(7): 1144–1150.

Gregory PM, Malka ES *et al*. 2000. Impact of geographic proximity to cardiac revascularization services on service utilization. *Medical Care* **38**(1): 45–57.

Hogan C. 1988. Patterns of travel for rural individuals hospitalized in New York State: relationships between distance, destination, and case mix. *Journal of Rural Health* **4**(2): 29–41.

Kressin NR, Petersen LA. 2001. Racial differences in the use of invasive cardiovascular procedures: review of the literature and prescription for future research. *Annals of Internal Medicine* **135**(5): 352–366.

Porell FW, Adams EK. 1995. Hospital choice models: a review and assessment of their utility for policy impact analysis. *Medical Care Research and Review* **52**(2): 158–195.

van Ryn M, Burke J. 2000. The effect of patient race and socio-economic status on physicians' perceptions of patients. *Social Science and Medicine* **50**(6): 813–828.

Welch HG, Larson EB *et al*. 1993. Could distance be a proxy for severity-of-illness? A comparison of hospital costs in distant and local patients. *Health Services Research* **28**(4): 441–458.

DOI: 10.1002/hec