The Gerontologist
Vol. 48, No. 4, 495–504

Postdischarge Environmental and Socioeconomic Factors and the Likelihood of Early Hospital Readmission Among Community-Dwelling Medicare Beneficiaries

Alicia I. Arbaje, MD, MPH,[1,2] Jennifer L. Wolff, PhD,[2,3] Qilu Yu, PhD,[2] Neil R. Powe, MD, MPH, MBA,[4] Gerard F. Anderson, PhD,[3] and Chad Boult, MD, MPH, MBA[3]

Purpose: This study attempts to determine the associations between postdischarge environmental (PDE) and socioeconomic (SES) factors and early readmission to hospitals. ***Design and Methods:*** This study was a cohort study using the 2001 Medicare Current Beneficiary Survey and Medicare claims for the period from 2001 to 2002. The participants were community-dwelling Medicare beneficiaries admitted to hospitals, discharged home, and surviving at least 1 year after discharge (n = 1,351). The study measurements were early readmission (within 60 days), PDE factors, and SES factors. PDE factors consisted of having a usual source of care, requiring assistance to see the usual source of care, marital status, living alone, lacking self-management skills, having unmet functional need, having no helpers with activities of daily living, number of living children, and number of levels in the home. SES factors consisted of education, income, and Medicaid enrollment. ***Results:*** Of the 1,351 beneficiaries, 202 (15.0%) experienced an early readmission. After adjustment for demographics, health, and functional status, the odds of early readmission were increased by living alone (odds ratio or OR = 1.50, 95% confidence interval or CI = 1.01–2.24), having unmet functional need (OR = 1.48, 95% CI = 1.04–2.10), lacking self-management skills (OR = 1.44, 95% CI = 1.03–2.02), and having limited education (OR = 1.42, 95% CI = 1.01–2.02). ***Implications:*** These findings suggest that PDE and SES factors are associated with early readmission. Considering these findings may enhance the targeting of pre-discharge and postdischarge interventions to avert early readmission. Such interventions may include home health services, patient activation, and comprehensive discharge planning.

Key Words: Care transitions, Cohort study, Discharge planning, Socioeconomic factors, Unmet need

The transition from hospital to home is a vulnerable period for hospitalized older patients, and some return to the hospital soon after discharge (Benioff & Lazowski, 2004; Coleman, Min, Chomiak, & Kramer, 2004; Murtaugh & Litke, 2002). Providers, patients, and caregivers often do not coordinate services or communicate effectively during this critical transition phase (Anderson, Herbert, Zeffiro, & Johnson, 2004; Bates et al., 1997; Benioff & Lazowski), resulting in poor patient satisfaction,

We thank the Robert Wood Johnson Foundation, Lipitz Center for Integrated Care at the Johns Hopkins Bloomberg School of Public Health, and the Division of Geriatric Medicine and Gerontology at the Johns Hopkins School of Medicine for providing funding for this research. We also thank the faculty, fellows, and staff of the Robert Wood Johnson Clinical Scholars Program at Johns Hopkins School of Medicine, including Marie Diener-West, PhD, and Leon Gordis, MD, DrPH, who were instrumental to the completion of the study. Robert Herbert and Wenke Hwang, PhD, provided excellent assistance with data management. Finally, we thank Eric A. Coleman, MD, MPH; Linda P. Fried, MD, MPH; Wendy W. Sanders, MA; and Timothy A. Zeffiro, MPH for their valuable guidance and expertise.

Address correspondence to Alicia I. Arbaje, MD, MPH, Assistant Professor and Associate Director of Transitional Care Research, Division of Geriatric Medicine and Gerontology, Department of Medicine, Johns Hopkins University School of Medicine, 5505 Hopkins Bayview Circle, Baltimore, MD 21224. E-mail: aarbaje@jhmi.edu

[1]Division of Geriatric Medicine and Gerontology, Johns Hopkins University School of Medicine, Baltimore, MD.

[2]Center on Aging and Health, Johns Hopkins University School of Medicine, Baltimore, MD.

[3]Department of Health Policy and Management, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD.

[4]Division of General Internal Medicine and Welch Center for Prevention, Epidemiology and Clinical Research, The Johns Hopkins Medical Institutions, Baltimore, MD.

adverse events, and early readmission (Bates et al.; Benioff & Lazowski; Boockvar et al., 2004; Forster, Murff, Peterson, Gandhi, & Bates, 2003, 2005). Although early readmission does not always result from suboptimal care transitions, observational and intervention studies demonstrate a strong association (Benioff & Lazowski; Coleman, Parry, Chalmers, & Min, 2006; Coleman, Smith, Raha, & Min, 2005; Moore, Wisnivesky, Williams, & McGinn, 2003; Phillips et al., 2004; Rich et al., 1995; Van Walraven, Seth, Austin, & Laupacis, 2002; Vinson, Rich, Sperry, Shah, & McNamara, 1990). Older adults are at particular risk for early readmission because they have more chronic conditions, health care providers, complex medical regimens, hospitalizations, and transitions in care (Anderson et al.; Soeken, Prescott, Herron, & J, 1991). Compared with transitions to other facilities, transitions to home are associated with a 9% to 20% increased risk of early readmission or visit to the emergency department (Corrigan & Martin, 1992; Lockery, Dunkle, Kart, & Coulton, 1994; Murtaugh & Litke). This suggests that factors in the home environment may contribute to a patient's early readmission.

Previous Studies on Factors Associated With Early Readmission

Early readmission is important in the Medicare population because readmissions comprise almost 10% of Medicare inpatient hospital expenditures (U.S. Government Printing Office, 2006). Previous studies have identified several demographic and health-related factors that predispose patients to early readmission: increasing age, male gender, diagnosis of congestive heart failure or diabetes, severe illness, visual impairment, prolonged length of stay, and high prior utilization (Anderson & Steinberg, 1984; Boult et al., 1993; Burns & Nichols, 2003; Coleman et al., 2004; Corrigan & Martin, 1992; Gooding & Jette, 1985; Hoskins, Walton-Moss, Clark, Schroeder, & Thiel, 1999; Kind, Smith, Frytak, & Finch, 2007; Soeken et al., 1991). All but two of these studies (Anderson & Steinberg; Boult et al.) were limited to patients from a single institution or region of the country. Five studies were focused either on patients with a limited number of diseases (Gooding & Jette; Hoskins et al.; Kind et al.) or on patients that were not elderly (Corrigan & Martin; Soeken et al.).

Previous Studies on Postdischarge Environmental and Socioeconomic Factors

Postdischarge environmental (PDE) factors include characteristics of the home and caregiving environments of patients after they have been discharged from hospitals. A growing body of evidence has identified socioeconomic status (SES) and PDE factors that are associated with health care utilization. In long-term-care settings, factors include having low SES (Mendoza-Sassi & Beria, 2001), living alone (Linden, Horgas, Gilberg, & Steinhagen-Thiessen, 1997; Lledo et al., 1997), receiving limited social support (Hessel, Gunzelmann, Geyer, & Brahler, 2000), having unmet functional need (Gaugler, Kane, Kane, & Newcomer, 2005), and experiencing increased caregiver stress (Gaugler et al.; Jette, Tennstedt, & Crawford, 1995; Shyu, Chen, & Lee, 2004; Wolff & Kasper, 2004). Specific to early readmission, one study found that 76% of preventable admissions for congestive heart failure were related to inadequacies in discharge planning, follow-up, social support, or patients' self-management skills (Vinson et al., 1990). Other studies have found that lack of education (Marcantonio et al., 1999), low SES (Coleman et al., 2004; Weissman, Stern, & Epstein, 1994), and discharge destination (Kind et al., 2007) are associated with early readmission. To our knowledge, prior studies of PDE and SES factors have not examined their effects on transitional care, early readmission, or the older adult population.

Importance of Further Study

The American Geriatrics Society has called for research to identify persons at risk for complications from suboptimal transitional care (Coleman, 2003). Many studies assessing risk factors for early readmission have been limited to local or younger populations with a single disease, or they have focused on a limited number of PDE factors. It is important to policymakers, payers, providers, and patients to have information to better target known strategies that reduce early readmission, such as interventions developed by Rich and colleagues (1995), Naylor and colleagues (1999), and Coleman and colleagues (2006).

Our objective in this study was to determine the associations between PDE and SES factors and the likelihood of Medicare beneficiaries' early readmission to hospitals. On the basis of the existing literature, we hypothesized that several factors would negatively influence patients' abilities to remain at home after discharge: (a) having no usual source of care (USOC; limited access to care); (b) requiring assistance to see one's USOC (barrier to access to care); (c) having a particular marital status and living alone (less social support or access to caregivers); (d) lacking self-management skills (limited ability to manage one's own illnesses and implement a postdischarge regimen); (e) having unmet functional need (in terms of activities of daily living, known as ADLs, or instrumental activities of daily living, known as IADLs; limited availability of assistance); (f) lacking ADL helpers or living children (less access to caregivers); (g) living in multilevel

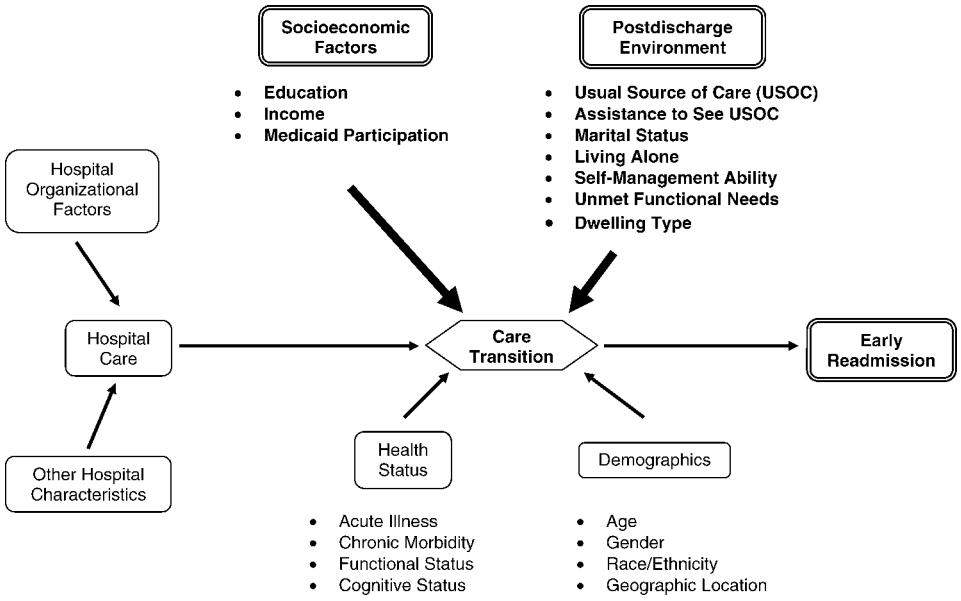

Figure 1. Conceptual model.

homes (physical spaces more difficult to navigate); (h) having limited education (decreased patient activation or limited ability to implement a postdischarge regimen); (i) having low income (limited access to care); or (j) being enrolled in the Medicaid program (low income but having access to care).

The conceptual model guiding our analyses is displayed in Figure 1. Hypothesized relationships between the key constructs of interest, that is, "socioeconomic factors and postdischarge environment" (shown in bold), in relation to care transitions and early readmission are graphically depicted with bold arrows. Boxes containing constructs labeled "health status" and "demographics" represent covariates included in the analyses. These four constructs collectively are hypothesized as influential to early readmission during a care transition by affecting access to care, social support, availability of assistance, and implementation of the postdischarge regimen. The arrows emerging from the "hospital organizational factors" and "other hospital characteristics" boxes represent variables that are unmeasured in this study, but that may also be important in understanding early readmission in community-dwelling older adults.

Methods

Study Design and Setting

We conducted a retrospective cohort analysis of community-dwelling respondents to the Medicare Current Beneficiary Survey (MCBS) in 2001 who, over 1-year follow-up, were admitted to U.S. acute care hospitals during the period from 2001 to 2002. The MCBS is conducted on a nationally representative sample of Medicare beneficiaries and consists of quarterly, in-person interviews on a wide range of sociodemographic and health topics. The response rate for the MCBS averages 85% to 89% per wave. Details of the MCBS are described elsewhere (Centers for Medicare & Medicaid Services, 2006). We linked Medicare claims for hospital care during 2001 to 2002 with MCBS survey data to ascertain beneficiaries' hospitalization experiences, including nonelective readmissions in the year following initial admission. Permission to use the Access to Care files and to publish these results was granted under CMS Data Use Agreement number 12066. The Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health approved this study (protocol number H.30.04.05.10.AX).

Participants

For this study, our sample consisted of community-dwelling beneficiaries (all ages) who participated in the 2001 round of the MCBS, were continuously enrolled in Medicare throughout the calendar year, were hospitalized during the period from 2001 to 2002, and were discharged home (N = 1,351). To identify the study sample, we began with 16,461 beneficiaries interviewed in 2001 and excluded those respondents who did not meet the selection criteria (Figure 2): 9,936 individuals (60.4%) either were not hospitalized or were hospitalized but were not discharged back to the community; 3,391 (20.6%) lacked at least 1 year of claims data because they rotated out of the 2002 MCBS; and 1,783 (10.8%) lacked at least 1 year of claims data because they were lost to follow-up or died between 2001 and 2002. Not all 1,783 who died or were lost to follow-up were lost during the study period, and the exact

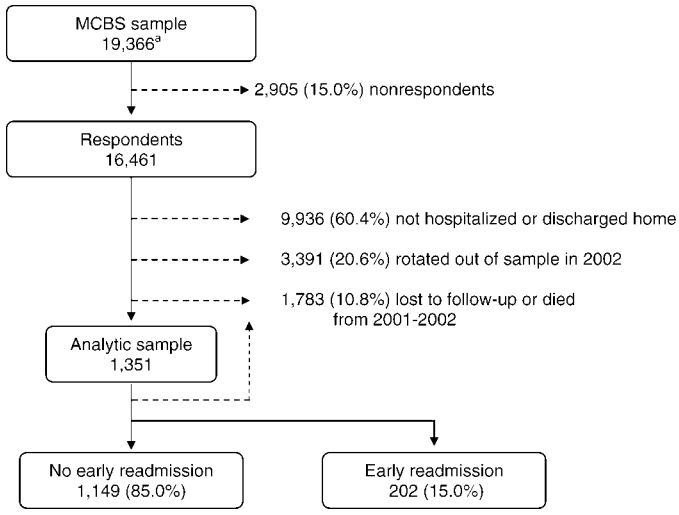

Figure 2. Sample selection; MCBS = Medicare Current Beneficiary Survey. (Note that the superscript *a* denotes an estimated value, based on the reported average response rate of 85% in the MCBS; see the Centers for Medicare & Medicaid Services, 2006.)

number is not obtainable from our data (the Access to Care MCBS files exclude decedents and do not distinguish between decedents and persons lost to follow-up).

Outcome Measure

The primary outcome, early readmission, was the occurrence of a nonelective hospital readmission within 60 days of discharge from the index admission. To determine the index admission, we searched Medicare hospital claims for the first admission occurring after the participant completed the fall interview of the 2001 MCBS. The search for an index admission covered a maximum of 305 days after each participant's 2001 interview date in order to allow at least 60 days of postdischarge observation for early readmission. Once we found an index admission, then we searched Medicare hospital claims until December 31, 2002 for the first hospitalization after discharge from the index admission. If individuals incurred more than one admission after discharge, then we included only the first readmission within 60 days in our analysis. We excluded those admissions classified in the administrative claims data as "elective."

Selection of Variables

For inclusion in the study, we considered PDE and SES characteristics identified from the literature as being relevant to early readmission or hypothesized as negatively influencing a person's ability to remain at home after discharge (Table 1). For inclusion as covariates, we considered demographic, health, and functional variables shown to be related to readmissions in prior studies. Data for all independent variables originated from responses to the MCBS, except for length of stay (LOS) of the index admission, which we obtained from hospital claims.

Demographics, Health, and Functional Ability

Demographic factors included age (years), gender, minority status (non-White race or of Hispanic origin), and living in a metropolitan area (yes or no). Participants rated their general health status compared with others on a 5-point scale (from 1, excellent, to 5, poor). We classified participants as having a disability if they reported having difficulty with any of six ADLs or six IADLs, or if they did not perform the activity because of a health problem. We classified participants as having memory loss if they reported that memory loss interfered with daily activity. Number of chronic conditions summarized respondents' having been told by a doctor they had any of 17 chronic conditions. We categorized the duration of the index admission LOS into tertiles.

PDE Factors

We classified participants as requiring assistance to see their USOC if, instead of walking or driving themselves, they either relied on assistance from another person or used another mode of transportation. Participants indicated their marital status and the number of people in their household; we used the latter item to identify those participants living alone. We classified participants as lacking self-management skills if they indicated no confidence in their ability to perform each of four tasks: (a) identifying when medical care was needed; (b) identifying medication side effects; (c) following self-care instructions; and (d) changing habits as recommended. Those with unmet functional need reported that they had difficulty with an ADL or

Table 1. Characteristics of the Study Population

Characteristic (%)	All Patients	Patients Readmitted	Not Readmitted	*p*
Demographics				
Age	72.6 (0.3)	72.5 (0.8)	72.6 (0.3)	.94
Female	55.8	55.1	55.9	.84
Minority	19.7	19.2	18.6	.85
Lives in nonmetropolitan area	28.7	33.5	28.0	.14
Health and functional ability				
General health status	3.2 (0.2)	3.4 (0.9)	3.2 (0.4)	.01
Any disability	60.2	70.8	58.6	.00
Presence of memory loss	15.0	14.8	15.1	.93
No. of chronic conditions	3.4 (0.1)	3.8 (0.2)	3.4 (0.1)	.01
Index admission LOS (days)				.01
1–6	76.9	67.8	78.4	
7–14	19.3	25.8	18.2	
≥15	3.8	6.5	3.4	
Postdischarge environmental factors				
USOC				.13
No USOC	3.2	4.7	3.0	
Requires assistance to see USOC	37.1	43.0	36.1	
Marital status				.01
Married	48.7	38.6	50.2	
Widowed	35.1	38.7	34.5	
Divorced, separated, or never married	16.3	27.7	15.2	
Lives alone	32.4	39.7	31.2	.04
Lacking self-management skills	20.2	27.2	19.1	.01
Any unmet functional need	43.6	55.2	41.7	.00
Has no helpers with ADLs	37.1	34.7	37.4	.49
No. of living children	3.0 (0.1)	2.9 (0.2)	3.1 (0.1)	.44
Lives in multilevel home	41.2	44.8	40.6	.25
Socioeconomic factors				
No high school diploma	37.6	46.7	36.2	.00
Income < $25,000	66.0	71.7	65.0	.12
Medicaid enrollment	20.5	26.4	19.5	.03

Notes: The study population numbers are as follows: all patients, $N = 1{,}351$; readmitted, $n = 202$; not readmitted, $n = 1.149$. The p value shows a comparison, using a chi-square or t test, between patients who are readmitted and those who are not. Numbers shown along with a value in parentheses signify the mean (standard deviation). General health status is listed from 1 (excellent) to 5 (poor). LOS = length of stay; USOC = usual source of care; ADL = activity of daily living. Having no helpers with ADLs and number of living children are alternative measures of unmet functional need.

IADL and they lacked assistance or supervision with any ADL disability (difficulty walking, eating, bathing, dressing, transferring from a bed to a chair, or using the toilet) or IADL disability (difficulty using the telephone, preparing meals, performing housework, shopping, or managing finances). We classified participants as having any helpers with ADLs (yes or no), and they reported the number of living children they had. Finally, we categorized participants as whether they lived in multilevel or single-level homes.

SES Factors

We categorized education according to whether or not participants had high school diplomas. We categorized participants' annual income on the basis of a cutoff point of $25,000. We categorized participants as enrolled in the Medicaid program or not. We considered both income and Medicaid enrollment because these variables may have opposite effects on health care utilization; earning a low income presents a barrier to receiving prompt care, whereas Medicaid enrollment may facilitate access to care for persons earning low income.

Analysis

We examined the strength of each variable's bivariate relationship with early readmission by using simple logistic regression (Table 2, first column). We then entered all variables into a multivariate model of early readmission (Table 2, second column). To create the final model (Table 2, third column), we discarded those variables that were either conceptually similar to other measures within

Table 2. Logistic Model of the Relationship Between Early Readmission and PDE and SES Factors

Characteristic (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI) Full Model	Final Model
Demographics			
Age	1.00 (0.99–1.01)	1.01 (0.99–1.02)	1.00 (0.99–1.01)
Female	0.97 (0.70–1.34)	0.88 (0.60–1.28)	0.89 (0.62–1.28)
Minority	1.04 (0.69–1.58)	0.92 (0.57–1.49)	0.95 (0.60–1.51)
Lives in nonmetropolitan area	1.30 (0.91–1.86)	1.40 (0.95–2.06)	1.27 (0.89–1.80)
Health and functional ability			
General health status	1.22 (1.06–1.41)	1.11 (0.94–1.31)	1.13 (0.98–1.31)
Any disability	1.72 (1.20–2.45)	1.14 (0.67–1.95)	
Presence of memory loss	0.98 (0.61–1.57)	0.73 (0.44–1.18)	0.76 (0.47–1.24)
No. of chronic conditions	1.11 (1.03–1.19)	1.07 (0.98–1.16)	
Index admission LOS (days)			
1–6 (reference)			
7–14	1.63 (1.12–2.38)	1.57 (1.08–2.29)	1.60 (1.09–2.36)
≥15	2.20 (1.0–4.59)	1.92 (0.89–4.14)	1.96 (0.97–3.95)
PDE factors			
USOC			
No USOC	1.56 (0.72–3.40)	1.49 (0.65–3.40)	
Requires assistance to see USOC	1.38 (0.96–1.98)	1.11 (0.73–1.69)	
Marital status			
Married (reference)			
Widowed	1.46 (1.07–1.98)	1.21 (0.75–1.95)	
Divorced, separated, or never married	1.94 (1.22–3.07)	1.64 (0.90–3.00)	
Lives alone	1.45 (1.01–2.07)	1.17 (0.69–1.97)	1.50 (1.01–2.24)
Lacking self-management skills	1.58 (1.12–2.22)	1.35 (0.93–1.98)	1.44 (1.03–2.02)
Any unmet functional need	1.72 (1.27–2.34)	1.32 (0.87–1.99)	1.48 (1.04–2.10)
Has no helpers with ADLs	1.15 (0.96–1.37)	0.79 (0.51–1.22)	
No. of living children	0.97 (0.91–1.04)	0.97 (0.90–1.05)	
Lives in multilevel home	1.19 (0.89–1.60)	1.28 (0.94–1.75)	
SES factors			
No high school diploma	1.54 (1.16–2.05)	1.52 (1.07–2.17)	1.43 (1.01–2.02)
Income < $25,000	1.36 (0.92–2.01)	0.87 (0.57–1.35)	0.94 (0.61–1.46)
Medicaid enrollment	1.48 (1.04–2.09)	1.02 (0.62–1.69)	

Notes: The number for the table is n = 1,343. PDE = postdischarge environmental; SES = socioeconomic; OR = odds ratio; CI = confidence interval; LOS = length of stay; USOC = usual source of care; ADL = activity of daily living. Having no helpers with ADLs and number of living children are alternative measures of unmet functional need. For demographics, all demographic variables are deemed as conceptually distinct and kept in the final model. For health and functional ability, we removed disability and number of chronic conditions: they were conceptually similar to and correlated with general health status by use of chi-square and t test, respectively ($p < .001$ for both relationships). For USOC variables, we removed them because they correlated with unmet functional need by use of chi-square ($p < .001$). We removed items for marital status, has no helpers with ADLs, and number of living children: they were conceptually similar to and correlated with the lives-alone item by use of chi-square ($p < .001$ for all three relationships). We removed the item for lives in multilevel home because it was not significant in bivariate analyses. For SES factors, we removed Medicaid enrollment: it correlated with low income by use of chi-square ($p < .001$).

each of the four constructs of interest shown in our conceptual model in Figure 1, highly correlated using chi-square or t test, or not significant in bivariate analyses (see the footnotes to Table 2). We deemed all demographic variables to be conceptually distinct and kept them in the final model. We removed "disability" and "number of chronic conditions" because they were conceptually similar to and correlated with "general health status" by use of chi-square and t test, respectively ($p < .001$ for both relationships). We removed USOC variables because they were correlated with "unmet functional need" by use of chi-square ($p < .001$).

We removed "marital status," "has no helpers with ADLs," and "number of living children" because they were conceptually similar to and correlated with "lives alone" by use of chi-square ($p < .001$ for all three relationships). We removed "lives in multilevel home" because it was not significant in bivariate analyses, and we removed "Medicaid enrollment" because it was correlated with low income using chi-square ($p < .001$). We used STATA statistical software, version 8.0, for all data analyses (StataCorp, College Station, TX). We used cross-sectional weights for each beneficiary to reflect the overall selection probability for each person and to account for the complex sampling strategy of the MCBS (Centers for Medicare & Medicaid Services, 2006). The 1,351 persons in the sample population in this study represent 2,883,726

Medicare beneficiaries nationwide who were dwelling in the community, hospitalized, discharged home, and then survived at least 1 year after discharge.

Results

Of the analytic sample of 1,351 hospitalized beneficiaries, 202 (15.0%) were readmitted within 60 days of discharge (Table 1). In bivariate analyses, readmitted persons reported significantly worse health status, more disability, more chronic conditions, and longer index admission LOS (Table 2). Regarding PDE factors, those patients experiencing early readmission were more likely to be unmarried, live alone, lack self-management skills, and have unmet functional needs. Regarding SES factors, readmitted persons were more likely to have limited education and to be enrolled in the Medicaid program.

In the multivariate logistic regression model of early readmission that adjusted for demographics, health, and functional status, persons who lived alone had a 50% increased odds of early readmission compared with those who did not live alone (Table 2, final model). Those who reported having any unmet functional need had a 48% increased odds of early readmission compared with those who did not report any unmet IADL need. Persons lacking self-management skills had a 44% increased odds of early readmission compared with those who did not lack self-management skills. Having limited education was associated with a 42% increased odds of early readmission. Earning a low income did not demonstrate a statistically significant association with early readmission.

Of the covariates, index admission LOS of 7 to 14 days and self-reported general health status were associated with increased odds of early readmission (odds ratio or OR = 1.60, 95% confidence interval or CI = 1.09–2.36 and OR = 1.13, 95% CI = 0.98–1.31, respectively). Index admission LOS of 15 or more days showed a trend toward association with early readmission.

Sensitivity Analyses

We conducted four sensitivity analyses to assess the possibility that these results were affected by the definitions of certain independent variables. We recomputed multivariate analyses by using different definitions of unmet functional need and health status. We limited the definition of unmet functional need to lack of direct assistance from a person, rather than lack of direct assistance *or supervision* from a person, as in the original definition; unmet functional need remained significantly associated with early readmission. There was no significant change in the main findings of the study when we substituted participants' Charlson comorbidity indices (Deyo, Cherkin, & Ciol, 1992) for their self-reported general health status.

To investigate the possible effects of multicollinearity, we computed the variance inflation factor (VIF) for each variable in the final model to provide an estimate of the number of times each variable's variance was increased by multicollinearity. Using a conservative VIF threshold greater than 2.5 to determine multicollinearity in logistic regression models (rather than the usual threshold of 10; see *Multicollinearity in Logistic Regression*, 2007), we found that there did not appear to be significant multicollinearity in the final model; the mean VIF in this analysis was 1.11 (range = 1.02–1.24). When converted to tolerance estimates (tolerance = 1/VIF), the results conveyed that greater than 80% of each variable's variance was independent of all the other variables in the final model.

To test the assumption that important independent variables remained constant during the year of follow-up, we compared participants' responses in 2001 with those in 2002. From 2001 to 2002, there were no major changes in participants' live-alone status or unmet functional need. There was no inquiry about self-management ability in the 2002 round of the MCBS, so we could not track changes in this measure.

Finally, to test the possibility that using a composite measure of the total number of chronic conditions as a covariate might have masked relationships of specific conditions to early readmission, we examined the binary and multivariate associations between early readmission and each of the 17 individual chronic conditions in the MCBS. The main findings of the study did not change with the addition of either an individual chronic condition or a composite of chronic conditions found to be significant or nearly significant in bivariate analyses.

Discussion

In this study we examined the relevance of PDE and SES factors to early readmission among a national sample of community-dwelling Medicare beneficiaries who were hospitalized, discharged home, and survived at least 1 year after discharge. In the study sample, representing almost 3 million community-dwelling beneficiaries, we found that living alone, having unmet functional need, lacking self-management skills, or having limited education was associated with an increased likelihood of early readmission. Our study findings support the hypothesized relationships regarding PDE and SES as influential factors in the quality of transitional care that is delivered before, during, and after a care transition (Figure 1).

Our purpose in this study was to identify screening criteria that institutions, payers, and

providers could consider in identifying hospitalized older adults at risk for experiencing early readmission. The findings are consistent with previous work that has demonstrated associations between living alone, (Linden et al., 1997; Lledo et al., 1997), having unmet functional need, (Gaugler et al., 2005), having a lower level of education, (Marcantonio et al., 1999; Mendoza-Sassi & Beria, 2001), lacking self-management skills (Vinson et al., 1990), and general health care utilization. Our findings contribute additional information about the importance of PDE and SES factors specifically to early readmission in the community-dwelling older adult population nationwide. In this study we also used the definition of early readmission within 60, rather than 30, days to reflect readmission resulting from exacerbations of conditions with longer recovery times. Although it is more difficult to attribute early readmission within 60 days to transitional care quality, because further from discharge other factors may play a greater role in readmission, Coleman demonstrated that improved transitional care from the hospital to the home is associated with decreased readmission rates up to 180 days (Coleman et al., 2006).

Interpretation of Findings

As we hypothesized, PDE and SES factors were related to an increased likelihood of early readmission. Unmet functional need may be associated with limited availability of assistance, which presents challenges to implementing a postdischarge regimen, complicates the care transition, and increases the risk of early readmission (Figure 1). The findings demonstrate that having any ADL or IADL need may be significant for affecting health care utilization. Providing for unmet functional needs (a modifiable characteristic) may affect the occurrence of early readmission in community-dwelling older adults. We found two other studies that showed a relationship between unmet functional need and health care utilization; one was limited to a community in Spain (Fernandez-Olano et al., 2006), and the other was limited to patients with dementia (Gaugler et al., 2005).

We found that living alone, having limited education, and lacking self-management skills had significant associations with early readmission, as we hypothesized. These associations may represent limitations in several characteristics that assist older adults in remaining at home after they have been discharged from the hospital. For example, living alone or having limited education in some cases may be associated with limited social support, restricted access to caregivers, and limited ability to implement complicated postdischarge regimens, such as blood pressure monitoring or anticoagulant administration. Having limited education may also impact the level of patient activation in medical encounters, which in turn would affect the person's ability to manage his or her illness and prevent clinical deterioration requiring early readmission.

These results should be considered in the context of several limitations. First, participants' baseline PDE and SES characteristics could have changed during the year of observation. Our comparison of responses from 2001 with those from 2002 may not have completely overcome this limitation. Second, the data set used in these analyses did not include decedents. Therefore, the study findings are applicable strictly to Medicare beneficiaries who were hospitalized, discharged home, and survived at least 1 year after discharge. Even if PDE or SES factors had different relationships to early readmission among the decedents compared with the survivors, the absence of data from decedents ($n \sim 100$) is unlikely to have biased the study's main findings.

Finally, it is important to interpret the lack of association between low income and early readmission cautiously, because of statistical power limitations and limited early readmission event rates. Bivariate power calculations for having low income revealed that the study sample provided 42% power to detect differences between those participants who were readmitted and those who were not. Had the early readmission rate been higher, then low income may have had significant associations with early readmission, and thus could still be important.

Limitations aside, this study has important strengths. First, the data are nationally representative of community-dwelling Medicare beneficiaries who have been hospitalized, discharged home, and survived at least 1 year after discharge. Second, using Medicare data enables tracking of health care utilization regardless of the site of health care delivery, thus capturing most of beneficiaries' early readmissions. Third, this study identified new associations between early readmission and PDE and SES factors: having unmet functional need, living alone, having a low educational level, and lacking self-management skills. In contrast to previous studies (Anderson & Steinberg, 1984; Corrigan & Martin, 1992; Mendoza-Sassi & Beria, 2001; Soeken et al., 1991), in this study the measures such as age, minority status, gender, and income were not significantly associated with readmission. These negative findings may have resulted, in part, from limitations in statistical power. Alternatively, some of the measures associated with early readmission in previous studies may be correlated with some of the PDE and SES factors included in this analysis.

The proposed study begins to answer the American Geriatrics Society's call for research on transitional care (Coleman & Boult, 2003) and is of interest to key stakeholders. Health care organizations and providers may consider PDE and SES factors in identifying hospitalized patients who might benefit from more intensive postdischarge services to reduce early readmission. The findings of

this study suggest that PDE and SES factors may be important for professionals involved in discharge planning to consider while creating discharge plans to improve care transitions. Depending on individual circumstances, such plans may include comprehensive discharge planning (Phillips et al., 2004), patient activation through transitional care coordinators (Coleman et al., 2006), self-management programs (Lorig et al., 1999), caregiver support (Shyu et al., 2004; Wolff & Kasper, 2004), rehabilitation therapy, medication reconciliation (Boockvar et al., 2004), and home health care (Bull, 1994).

Future studies may screen hospitalized older adults for the PDE and SES factors examined in this study to select patients to target for intervention prior to discharge from the hospital. With the use of PDE and SES screening criteria, specific interventions to be studied may include ensuring caregiver arrangements or providing home health aides for patients' functional disabilities. Other interventions targeting patients with limited education or lacking self-management skills may enhance patient activation through home health referrals, participation in support groups after discharge, or enrollment in disease-management programs. Interventions to improve the transition of older adults at high risk for early readmission might also include ensuring direct communication between inpatient and outpatient providers to ensure timely follow-up after discharge, as well as medication reconciliation before and after discharge.

Institutions and peer review organizations are interested in measuring and improving the quality of transitional care, and the Joint Commission on Accreditation of Healthcare Organizations introduced patient safety goals in 2006 to improve transitional care (Joint Commission on Accreditation of Healthcare Organizations, 2006). Results of this study suggest that accommodating PDE and SES factors may be important in improving quality, that is, by assisting in difficult caregiving situations, improving self-management skills, and addressing health literacy. Future studies of interest to institutions and peer review organizations may include the development and evaluation of incentive programs to improve the quality of discharges of older adults, specifically addressing PDE and SES factors. The relationships between hospital organizational factors and early readmission, as shown in Figure 1, also merit further investigation. Specifically, a high degree of centralization (i.e., vertical and horizontal integration) within health systems and the provision of ancillary services important for the care of vulnerable older adults (e.g., case management, palliative care, and transportation) may be associated with early readmission.

Older adults and their caregivers bear a considerable burden during transitions, and they stand to benefit from well-targeted, effective interventions. This study identifies PDE and SES factors that are associated with early readmission. These findings contribute to a growing body of evidence that may help guide the development of interventions to reduce early readmission and other complicated transitions experienced by older adults.

References

Anderson, G., Herbert, R., Zeffiro, T., & Johnson, N. (2004). *Partnership for solutions: Better lives for people with chronic conditions.* Retrieved May 1, 2007, from http://www.partnershipforsolutions.org

Anderson, G. F., & Steinberg, E. P. (1984). Hospital readmissions in the Medicare population. *New England Journal of Medicine, 311,* 1349–1353.

Bates, D. W., Spell, N., Cullen, D. J., Burdick, E., Laird, N., Petersen, L. A., et al. (1997). The costs of adverse drug events in hospitalized patients. *Journal of the American Medical Association, 277,* 307–311.

Benioff, M. R., & Lazowski, E. D. (2004). *Revolutionizing health care through information technology: Report to the President.* Washington, DC: National Coordination Office for Information Technology Research and Development.

Boockvar, K., Fishman, E., Kyriacou, C. K., Monias, A., Gavi, S., & Cortes, T. (2004). Adverse events due to discontinuations in drug use and dose changes in patients transferred between acute and long-term care facilities. *Archives of Internal Medicine, 164,* 545–550.

Boult, C., Dowd, B., McCaffrey, D., Boult, L., Hernandez, R., & Krulewitch, H. (1993). Screening elders for risk of hospital admission. *Journal of the American Geriatrics Society, 41,* 811–817.

Bull, M. J. (1994). Use of formal community services by elders and their family caregivers 2 weeks following hospital discharge. *Journal of Advanced Nursing, 19,* 503–508.

Burns, R., & Nichols, L. (2003). Factors predicting readmission of older general medicine patients. *Journal of General Internal Medicine, 6,* 389–393.

Centers for Medicare & Medicaid Services. (2006). Retrieved June 4, 2007, from www.cms.hhs.gov

Coleman, E. A. (2003). Falling through the cracks: Challenges and opportunities for improving transitional care for persons with continuous complex care needs. *Journal of the American Geriatrics Society, 51,* 549–555.

Coleman, E. A., & Boult, C. (2003). Improving the quality of transitional care for persons with complex care needs. *Journal of the American Geriatrics Society, 51,* 556–557.

Coleman, E. A., Min, S.-J., Chomiak, A., & Kramer, A. M. (2004). Posthospital care transitions: Patterns, complications, and risk identification. *Health Services Research, 39,* 1449–1466.

Coleman, E. A., Parry, C., Chalmers, S., & Min, S.-J. (2006). The Care Transitions Intervention: Results of a randomized controlled trial. *Archives of Internal Medicine, 166,* 1822–1828.

Coleman, E. A., Smith, J. D., Raha, D., & Min, S.-J. (2005). Posthospital medication discrepancies: Prevalence and contributing factors. *Archives of Internal Medicine, 165,* 1842–1847.

Corrigan, J., & Martin, J. (1992). Identification of factors associated with hospital readmission and development of a predictive model. *Health Services Research, 27,* 81–101.

Deyo, R., Cherkin, D., & Ciol, M. (1992). Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *Journal of Clinical Epidemiology, 45,* 613–619.

Fernandez-Olano, C., Hidalgo, J. D. L.-T., Cerda-Diaz, R., Requena-Gallego, M., Sanchez-Castano, C., Urbistondo-Cascales, L., et al. (2006). Factors associated with health care utilization by the elderly in a public health care system. *Health Policy, 75,* 131–139.

Forster, A. J., Murff, H. J., Peterson, J. F., Gandhi, T. K., & Bates, D. W. (2003). The incidence and severity of adverse events affecting patients after discharge from the hospital. *Annals of Internal Medicine, 138,* 161–167.

Forster, A. J., Murff, H. J., Peterson, J. F., Gandhi, T. K., & Bates, D. W. (2005). Adverse drug events occurring following hospital discharge. *Journal of General Internal Medicine, 20,* 317–323.

Gaugler, J. E., Kane, R. L., Kane, R. A., & Newcomer, R. (2005). Unmet care needs and key outcomes in dementia. *Journal of the American Geriatrics Society, 53,* 2098–2105.

Gooding, J., & Jette, A. M. (1985). Hospital readmissions among the elderly. *Journal of the American Geriatrics Society, 33,* 595–601.

Hessel, A., Gunzelmann, T., Geyer, M., & Brahler, E. (2000). Utilization of medical services and medication intake of patients over 60 in Germany—Health related, social structure related, socio-demographic and subjective factors. *Zeitschrift Fur Gerontologie Und Geriatrie: Organ Der Deutschen Gesellschaft Fur Gerontologie Und Geriatrie, 33,* 289–299.

Hoskins, L., Walton-Moss, B., Clark, H., Schroeder, M., & Thiel, L. S. (1999). Predictors of hospital readmission among the elderly with congestive heart failure. *Home Health Care Nurse, 17,* 373–381.

Jette, A. M., Tennstedt, S., & Crawford, S. (1995). How does formal and informal community care affect nursing home use? *Journal of Gerontology: Social Sciences, 50*B, S4–S12.

Joint Commission on Accreditation of Healthcare Organizations. (2006). 2007 Hospital/critical access hospital national patient safety goals. Retrieved June 4, 2007, from http://www.jointcommission.org/PatientSafety/NationalPatientSafetyGoals/

Kind, A. J. H., Smith, M. A., Frytak, J. R., & Finch, M. D. (2007). Bouncing back: Patterns and predictors of complicated transitions 30 days after hospitalization for acute ischemic stroke. *Journal of the American Geriatrics Society, 55,* 365–373.

Linden, M., Horgas, A. L., Gilberg, R., & Steinhagen-Thiessen, E. (1997). Predicting health care utilization in the very old. The role of physical health, mental health, attitudinal and social factors. *Journal of Aging and Health, 9,* 3–27.

Lledo, R., Martin, E., Jimenez, C., Roca, R., Gil, A., Godoy, E., et al. (1997). Characteristics of elderly inpatients at high risk of needing supportive social and health care services. *European Journal of Epidemiology, 13,* 903–907.

Lockery, S., Dunkle, R., Kart, C., & Coulton, C. (1994). Factors contributing to the early rehospitalization of elderly people. *Health and Social Work, 19,* 182–191.

Lorig, K. R., Sobel, D. S., Stewart, A. L., William Brown, B., Bandura, A., Ritter, P., et al. (1999). Evidence suggesting that a chronic disease self-management program can improve health status while reducing hospitalization: A randomized trial. *Medical Care, 37,* 5–14.

Marcantonio, E. R., McKean, S., Goldfinger, M., Kleefield, S., Yurkofsky, M., & Brennan, T. A. (1999). Factors associated with unplanned hospital readmission among patients 65 years of age and older in a Medicare managed care plan. *The American Journal of Medicine, 107,* 13–17.

Mendoza-Sassi, R., & Beria, J. U. (2001). Health services utilization: A systematic review of related factors. *Cadernos De Saude Publica/Ministerio Da Saude, Fundacao Oswaldo Cruz, Escola Nacional De Saude Publica, 17,* 819–832.

Moore, C., Wisnivesky, J., Williams, S., & McGinn, T. (2003). Medical errors related to discontinuity of care from an inpatient to an outpatient setting. *Journal of General Internal Medicine, 18,* 646–651.

Multicollinearity in logistic regression. (2007). Retrieved March 17, 2007, from http://www.uky.edu/ComputingCenter/SSTARS/MulticollinearityinLogisticRegression.htm

Murtaugh, C. M., & Litke, A. (2002). Transitions through postacute and long-term care settings: Patterns of use and outcomes for a national cohort of elders. *Medical Care, 40,* 227–236.

Naylor, M. D., Brooten, D., Campbell, R., Jacobsen, B. S., Mezey, M. D., Pauly, M. V., et al. (1999). Comprehensive discharge planning and home follow-up of hospitalized elders: A randomized clinical trial. *Journal of the American Medical Association, 281,* 613–620.

Phillips, C. O., Wright, S. M., Kern, D. E., Singa, R. M., Shepperd, S., & Rubin, H. R. (2004). Comprehensive discharge planning with post-discharge support for older patients with congestive heart failure: A meta-analysis. *Journal of the American Medical Association, 291,* 1358–1367.

Revolutionizing health care through information technology: Report to the President. (2004). Washington, DC: President's Information Technology Advisory Committee.

Rich, M., Beckham, V., Wittenberg, C., Leven, C., Freedland, K., & Carney, R. (1995). A multidisciplinary intervention to prevent the readmission of elderly patients with congestive heart failure. *New England Journal of Medicine, 333,* 1190–1195.

Shyu, Y.-I. L., Chen, M.-C., & Lee, H.-C. (2004). Caregiver's needs as predictors of hospital readmission for the elderly in Taiwan. *Social Science and Medicine, 58,* 1395–1403.

Soeken, K., Prescott, P., Herron, D., & J. C. (1991). Predictors of hospital readmission. A meta-analysis. *Evaluation and the Health Professions, 14,* 262–281.

U.S. Government Printing Office. (2006). *Older Americans 2006: Key indicators of well-being.* (2006). Washington, DC: Author.

Van Walraven, C., Seth, R., Austin, P. C., & Laupacis, A. (2002). Effect of discharge summary availability during postdischarge visits on hospital readmission. *Journal of General Internal Medicine, 17,* 186–192.

Vinson, J., Rich, M., Sperry, J., Shah, A., & McNamara, T. (1990). Early readmission of elderly patients with congestive heart failure. *Journal of the American Geriatrics Society, 38,* 1290–1295.

Weissman, J., Stern, R., & Epstein, A. (1994). The impact of patient socioeconomic status and other social factors on readmission: A prospective study in four Massachusetts hospitals. *Inquiry, 31,* 163–172.

Wolff, J. L., & Kasper, J. D. (2004). Informal caregiver characteristics and subsequent hospitalization outcomes among recipients of care. *Aging Clinical and Experimental Research, 16,* 307–313.

Received June 28, 2007
Accepted October 10, 2007
Decision Editor: William J. McAuley, PhD