Care Fragmentation in the Postdischarge Period
Surgical Readmissions, Distance of Travel, and Postoperative Mortality

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IMPORTANCE Despite policies aimed at incentivizing clinical integration, few data exist on whether fragmentation of care is associated with worse outcomes for elderly patients undergoing major surgery.

OBJECTIVE To determine whether postdischarge surgical care fragmentation is associated with worse outcomes and whether distances between hospitals explain differences in patient outcomes.

DESIGN, SETTING, AND PARTICIPANTS We used the 100% Medicare inpatient file for claims from January 1, 2009, through November 30, 2011. Data on hospital structural features, including zip code of location, were obtained from the 2011 American Hospital Association Annual Survey. We identified patients who underwent coronary artery bypass grafting, pulmonary lobectomy, endovascular abdominal aortic aneurysm repair, open abdominal aortic aneurysm repair, colectomy, and hip replacement.

MAIN OUTCOMES AND MEASURES Thirty-day surgical mortality.

RESULTS A total of 93,062 patients who underwent the surgical procedures of interest were subsequently readmitted within 30 days of discharge; 23,278 of these patients (25.0%) were readmitted to a hospital other than the one where their procedure was performed. Patients who were readmitted to a different hospital generally lived farther from the index hospital than those who were readmitted to the index hospital (20.7 vs 7.4 miles, \( P < .001 \)). We found large state-level variations in the proportion of surgical patients who were readmitted elsewhere. Patients readmitted to a different hospital that was the same distance from their home as the index hospital had 48% higher odds of mortality (odds ratio, 1.48; 95% CI, 1.24-1.78; \( P < .001 \)) than patients who were admitted to the index hospital.

CONCLUSIONS AND RELEVANCE Of older US patients undergoing major surgery, 1 in 4 is readmitted to a hospital other than the one where the initial operation was performed. Even taking distance traveled into account, postsurgical care fragmentation is associated with a substantially higher risk of death. Focusing on clinical integration may improve outcomes for older US patients undergoing complex surgery.
Reducing fragmentation of health care provision is an important policy priority. Although there is no standard definition of care fragmentation, one operational approach can be defined by a lack of continuity of care—care that is provided by disparate health care professionals and without integration of clinical information. Emerging evidence suggests that fragmented care is associated with higher costs and potentially lower quality, whereas continuity of care is associated with better outcomes. As a result, policy efforts, such as the Hospital Readmissions Reduction Program and accountable care organizations, have tried to incentivize health care professionals to engage in more integrated, coordinated health care provision across episodes of care.

Care fragmentation may be particularly problematic for older patients undergoing complex operations in which continuity of care with associated specialized and personalized care plans may be especially important. One example of fragmentation that may be particularly important but that has received little attention occurs in situations when patients are readmitted to a hospital other than the one where the original procedure was performed. Given that most hospitals do not yet electronically share data with each other, readmission to a different hospital rarely involves clinical information exchange or shared approaches to patient management. However, we have little information about how often this type of fragmentation occurs among older US patients undergoing major surgery and its clinical implications. Empirical data would be helpful.

Focusing on fragmentation that occurs as a result of readmissions to other facilities is important for 3 reasons. First, readmissions after surgery are common and vary widely across hospitals. Second, data suggest that the development of postoperative complications is a major driver of readmissions; therefore, fragmentation in this context may be particularly consequential. Third, reducing readmissions and providing better care transitions have become important priorities for hospitals since the enactment of the Hospital Readmissions Reduction Program. Accordingly, understanding whether readmissions that occur at other hospitals contribute to care fragmentation is particularly important because policy makers develop new incentives aimed at promoting more integrated care. Therefore, in this study, we sought to answer 3 closely related questions. First, how often are surgical patients readmitted to a hospital other than the one where the initial surgery was performed? Second, do patients who are readmitted elsewhere fare worse than patients who are readmitted to the original hospital? Third, given that the distance to the original and the readmitting hospitals likely confound the association between readmission elsewhere and outcomes, does accounting for these distances explain why patients who are admitted elsewhere might have different outcomes?

Methods

Data
This study was approved by the institutional review board at the Harvard School of Public Health, and informed consent was not required. We used the 100% Medicare inpatient file claims from January 1, 2009, through November 30, 2011. Data on hospital structural features, including zip code of location, were obtained from the 2011 American Hospital Association Annual Survey. We identified patients who underwent coronary artery bypass grafting, pulmonary lobectomy, endovascular abdominal aortic aneurysm repair, open abdominal aortic aneurysm repair, colectomy, and hip replacement using Medicare Part A and Part B data. We excluded patients who were younger than 65 years or not continuously enrolled in the fee-for-service program for 12 months. We only included patients undergoing surgical procedures in the 50 states and the District of Columbia in a nonfederal hospital.

Variables
The primary outcome of this study was 30-day mortality. Death was obtained from the Medicare Beneficiary Summary File, and anyone who died within 30 days of discharge from the index procedure was considered to have met our outcome. The primary predictor was fragmentation of postdischarge care, which was defined as being readmitted to a hospital other than the index hospital where the original surgical procedure was performed. Patient-level covariates included patient age, sex, race, and comorbidities as determined by the widely used Elixhauser approach. Hospital-level covariates included size, teaching status, ownership, composite surgical volume, and percentage of discharged patients who were Medicare beneficiaries. Rural status was determined using the rural-urban commuting area. Distance from an index hospital to a patient's place of residence was calculated using the longitude and latitude coordinates of the respective zip code centroids.

Statistical Analysis
We first calculated the proportion of patients who were readmitted to a hospital other than the index hospital where the surgical operation was performed. We then assessed differences in the characteristics of patients who were readmitted to the index hospital compared with a different hospital. We used χ2 and Wilcoxon rank sum tests for categorical and continuous variables as appropriate. We then collapsed our patient-level data by patient state of residence and calculated the percentage of patients in each state who were readmitted to a hospital other than the index institution. These state-level rates were then categorized into quartiles to depict state-level variations.

We next built a logistic regression model with hospital random effects and robust SEs to assess whether readmission to a different hospital was associated with higher 30-day mortality. We first built a multivariate risk-adjusted model in which we adjusted for age, sex, race, procedure type, and comorbidities using the Elixhauser approach. Next, we further adjusted this patient risk-adjusted model with hospital-level covariates, including size, teaching status, ownership, rural-urban commuting area, region, composite surgical volume, and percentage of discharged patients who were Medicare beneficiaries. Because we hypothesized that differences in outcomes were in part due to differences in care provision between the index and readmitting hospital in cases in which they
were different, our hospital-level adjustment adjusted for features of the hospital where the index procedures were performed.

Because a patient’s likelihood of being readmitted to a different hospital is likely to be confounded by the distance a patient lives from the original and readmitting hospitals and because travel times may be associated with outcomes, we built an additional regression model. In this analysis, we included all the patient- and hospital-level covariates described above but also simultaneously adjusted for patient distance from the index and readmitting hospitals. If a patient was readmitted to the same hospital, both distances would be the same.

Finally, we were concerned that adjusting for distance alone in a regression model would not fully account for unmeasured confounding. Therefore, we categorized patients into 4 groups: (1) patients who were readmitted to the index hospital, (2) patients who were readmitted to a different hospital that was equidistant to the index hospital, (3) patients who were readmitted to a different hospital that was closer than the index hospital, and (4) patients who were readmitted to a different hospital that was farther than the index hospital. A readmitting hospital was defined as equidistant if it had a distance from the patient that was within 10% of the distance of the index hospital from the patient. Our primary focus was to examine outcomes for patients readmitted to hospitals equidistant to the original hospital, with the assumption that this approach would hold travel time essentially constant and would most closely mimic the effect of readmission fragmentation, taking travel time into account. This approach essentially allows for the analysis of the counterfactual situation in which patients had a theoretic choice between returning to the index hospital or a different hospital that was equidistant to the patient’s residence. We then created a final model with the 4 groups of patients as independent variables. This final model adjusted for the patient and hospital characteristics described above.

### Results

#### Patient Characteristics

A total of 93,062 patients underwent the surgical procedures of interest and were subsequently readmitted within 30 days of discharge. Of these patients, 23,278 (25.0%) were readmitted to a hospital other than the one where their procedure was performed within 30 days of discharge. Compared with patients who were readmitted to the index hospital, patients readmitted to a different hospital were somewhat younger (mean age, 77.7 vs 78.2 years; \( P < .001 \); Table 1) but generally had a similar proportion of comorbidities, such as diabetes mellitus (21.3% vs 21.1%; \( P = .46 \)), chronic obstructive pulmonary disease (22.3% vs 22.6%; \( P = .36 \)), and obesity (7.3% vs 7.3%; \( P = .94 \)).

Patients who were readmitted to a different hospital generally lived farther from the index hospital than those who were readmitted to the index hospital (20.7 vs 7.4 miles; \( P < .001 \); Table 1). Consequently, they were, on average, readmitted to a hospital that was closer than the index hospital (7.8 vs 20.7 miles). They were also less likely to live in urban areas (55.9% vs 64.8%; \( P < .001 \)).

We found large variations in the proportion of surgical patients who were readmitted elsewhere across the 50 states (Figure). States such as Texas, Arizona, Nevada, Alaska, and Maine had a large proportion of their surgical readmission patients going to a different hospital, whereas states such as South Carolina, Idaho, and Montana had very few. These patterns sug-
gest that simple factors, such as the size or rurality of the state or the geographic location, are unlikely to play a major role in determining whether patients are readmitted elsewhere. Understanding why some states with a large rural population (eg, Maine) have a high proportion of patients readmitted elsewhere but other rural states (eg, Montana) have a low proportion would be potentially very useful.

**Association Between Readmission Fragmentation and Mortality Rates**

In models that adjusted for patient-level covariates, we found that patients readmitted to a hospital other than the index hospital had significantly higher odds of mortality (odds ratio [OR], 1.41; 95% CI, 1.31-1.51; P < .001; Table 2). When we further adjusted for hospital characteristics, including size, teaching status, and rural location, we found essentially the same effects, with 41% higher odds of death if the patient was readmitted to a different institution (Table 3). Finally, further adjustment for both distance to the index and readmitting hospitals had little effect: patients who were readmitted to a different hospital still had higher odds of mortality (OR, 1.37-1.59; P < .001). The absolute mortality rate difference was 1.7% (4.1% vs 5.8%), suggesting that if this effect were causal, one would have to avoid 59 readmissions to a different hospital to save one life.

**Association Between Fragmented Readmission and Mortality by Distance**

Of those readmitted to a different hospital, approximately 2359 of 23 678 (10.0%) were readmitted to a hospital equidistant to the index hospital. As expected based on our definitions, these patients were readmitted to a different hospital that was on average 0 miles farther than the index hospital (median differential distance, 0 miles; interquartile range, −1.1 to 0.7 miles). We then assessed the differential distance for those patients who were readmitted to a different hospital from the index hospital. Of patients readmitted to a closer hospital, their median distance difference was −21.2 miles closer (interquartile range, −46.1 to −7.8 miles), whereas of those who were readmitted to a hospital farther than the index hospital, their median differential distance was +9.6 miles (interquartile range, 3.5-28.5 miles).

When we examined patient outcomes based on the differential distance between the index and readmitting hospitals, we found similar results. Patients readmitted to a different hospital that was equidistant from the index hospital had 48% higher odds of mortality (OR, 1.48; 95% CI, 1.24-1.78; P < .001) than patients who were admitted to the index hospital. Similarly, we found that being readmitted to a closer hospital (OR, 1.12; 95% CI, 1.01-1.23; P = .03) and a farther hospital (OR, 1.84; 95% CI, 1.66-2.03; P < .001) were also associated with worse outcomes.

![Figure. State-Level Variation in Fragmentation of Postdischarge Care](http://archsurg.jamanetwork.com/pdfaccess.ashx?url=/data/journals/surg/931936/)
Discussion

We found that 1 in 4 older US patients readmitted after major surgery is hospitalized at an institution other than the one where the procedure was performed. This example of fragmentation appears to be associated with a meaningfully worse outcome: being readmitted to a different hospital after major surgery is associated with a nearly 50% higher odds of death. This association persisted even after accounting for patient factors, hospital factors, and distance to the hospital. Among patients who were readmitted to hospitals equidistant to the original hospital (and, therefore, likely had a choice independent of distance), readmission elsewhere was associated with worse outcomes.

Although we are unsure why readmission to a different hospital is associated with higher mortality, our findings suggest an important area for hospitals and policy makers to focus their efforts. To improve outcomes for readmitted patients, hospitals might focus on 1 of 2 (or both) strategies. First, they could make more of an effort to bring patients with complications back to the original hospitals. Second, they might focus on improving continuity of care by focusing on better clinical data exchange and better clinical integration. Especially for elderly surgical patients with complex medical histories and comorbidities, the continuity of care from being readmitted to the same hospital may result in fewer delays in care from ordering redundant tests and earlier recognition of complications, which are a significant cause of surgical readmissions.10,11 It is possible that such efforts at better clinical data exchange might mitigate some of the negative effects of this example of fragmented care.

Federal policies, such as the Hospital Readmissions Reduction Program, accountable care organizations, and the Bundled Payments for Care Improvement Initiative, may be important initiatives in this area that have the potential to reduce fragmentation. Although the application of the readmissions measure to surgery has been controversial, prior studies9,11 are highly suggestive that much of what drives readmissions in general are complications from the original procedures. Our findings offer an important addition to that narrative—readmissions to other institutions may be an important type of postdischarge fragmentation of care. Older patients, especially those with complex medical comorbidities, are likely better off returning to the original institution. Policy efforts, such as readmissions reduction and bundled payments, often hold health care professionals accountable for use within 30 days without tying these measures to patient outcomes, such as 30-day mortality. If policies were designed to induce hospitals to also focus on patient outcomes, hospitals would not only reduce readmissions through better care transitions and reduction of complications but also provide more integrated and continuous care by helping patients return to the original institution.

Although there is an increasing body of literature on the association between continuity of care and better outcomes, much of the data focus on medical conditions.4,6,14 We know less about the degree to which these issues are salient for surgical patients. For patients undergoing major oncologic surgery, a study15 found that care fragmentation, similarly defined as readmission to a different hospital, was associated with worse outcomes. We are not aware of other work in the surgical population that examines the association between fragmentation as measured by location of readmission and its resultant effects. Our findings, which are consistent with the relatively small amount of literature in this area, suggest that focusing on readmissions may indeed provide a unique window into fragmentation of care. It also provides an opportunity for improvement—by targeting readmissions that occur elsewhere, we may be able to improve patient outcomes.

Our study has limitations. First, we used administrative claims data; as such, clinical details were not available for more refined risk adjustment. However, our risk adjustment is comparable to the one used by federal policy makers for finan-
cially punishing hospitals for high readmission rates and relies on similar administrative claims data. Second, our method of calculating geodesic distance between the patient zip code centroid and the hospital zip code centroid did not factor in actual variations in travel time. Although distance and travel time in general should be highly correlated, there may be individual instances where they are not. Third, as with all observational studies, we cannot determine causation, only association. However, given the size of the effect, we believe that the omitted confounder would have to have a very sizeable association between both the predictor (readmission to a different hospital) and outcome (mortality), which we think is unlikely.

**Conclusions**

One in 4 older US patients undergoing major surgery in the Medicare population who are readmitted to the hospital receives care at a hospital other than the one where the operation was initially performed. Even taking distance traveled into account, we find that this type of postsurgical care fragmentation is associated with a substantially higher risk of death. These findings suggest that focusing on clinical integration through better clinical data sharing or care coordination may improve outcomes for older US patients undergoing complex surgery.

**References**