Hospital-skilled nursing facility referral linkage reduces readmission rates among Medicare patients receiving major surgery

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Background. In the health reform era, rehospitalization after discharge may result in financial penalties to hospitals. The effect of increased hospital–skilled nursing facility (SNF) linkage on readmission reduction after surgery has not been explored.

Methods. To determine whether enhanced hospital–SNF linkage, as measured by the proportion of surgical patients referred from a hospital to a particular SNF, would result in reduced 30-day readmission rates for surgical patients, we used national Medicare data (2011–2012) and evaluated patients who underwent 1 of 5 operative procedures (coronary artery bypass grafting [CABG], hip fracture repair, total hip arthroplasty, colectomy, or lumbar spine surgery). Initial evaluation was performed using regression modeling. Patient choice in SNF referral was adjusted for using instrumental variable (IV) analysis with distance between an individual's home and the SNF as the IV.

Results. A strong negative correlation ($P < .001$) was observed between the proportion of selected surgical discharges received by a SNF and the rate of hospital readmission. Increasing the proportion of surgical discharges decreased the likelihood of rehospitalization (regression coefficient, $-0.04$; 95% CI, $-0.07$ to $-0.02$). These findings were preserved in IV analysis. Increasing hospital–SNF linkage was found to reduce significantly the likelihood of readmission for patients receiving lumbar spine surgery, CABG, and hip fracture repair.

Conclusion. The benefits of increased hospital–SNF linkage seem to include meaningful reductions in hospital readmission after surgery. Overall, a 10% increase in the proportion of surgical referrals to a particular SNF is estimated to decrease readmissions by 4%. This may impact hospital–SNF networks participating in risk-based reimbursement models. (Surgery 2016;159:1461-8.)

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Recent provisions of the Affordable Care Act not only penalize hospitals for unplanned readmissions among Medicare patients but also incentivize improved postacute care coordination through bundled payment programs and the creation of accountable care organizations. The intent of these initiatives is to streamline continuity of care, reduce rehospitalizations, and enhance patient-centered outcomes that may lead to shared savings for hospitals and skilled nursing facilities participating in risk-based reimbursement models.

Although it is acknowledged that hospitals are attempting to redesign care within their walls, less is known about the nature of their relationships with external providers who nevertheless affect
performance on bundled metrics.\textsuperscript{4,6} Rahman et al\textsuperscript{5} reported that hospitals with stronger skilled nursing facility (SNF) linkages, as defined by more concentrated referral patterns, reduced 30-day readmission rates for Medicare patients. Specifically, a 10\% increase in the proportion of discharges from a hospital to a particular SNF was estimated to result in a 1.2-percentage point reduction in 30-day readmissions. It is not known, however, whether such findings apply to individuals discharged to SNFs after operative procedures. Given the complexity of postacute care for surgical patients, as well as greater risks of perioperative morbidity,\textsuperscript{1,2,7} it is possible that hospital–SNF linkage may have a more dramatic effect on readmission reduction among Medicare beneficiaries undergoing operation.\textsuperscript{1}

In this context, we sought to evaluate the effect of hospital–SNF linkage on 30-day rehospitalization among a sample of Medicare patients discharged to SNFs who underwent 1 of 5 common inpatient operative procedures. We hypothesized that enhanced hospital–SNF linkage, as measured by the proportion of surgical patients referred from a hospital to a particular SNF, would result in decreased 30-day readmission rates.

\section*{METHODS}

\textbf{Participants and databases.} Data for these analyses come from 100\% Medicare Part A claims (for hospital and SNF care) and Medicare enrollment data for the years 2011–2012. Additionally, we used 2011 On-line Survey & Certification Automated Record (OSCAR) data to capture SNF characteristics, the 2007 American Hospital Association Survey data for hospital characteristics and the 2010 zip code tabulation area file for zip code location.

Using Part A claims data, we identified all Medicare fee-for-service beneficiaries who were discharged directly from an acute general hospital to a SNF for postacute care between January 1, 2011, and November 30, 2012. We excluded any individual with a SNF stay in the 1-year period before their index hospitalization. We excluded patients with prior SNF use because prior nursing home residence would systematically affect SNF choice. We also excluded those who were treated in hospitals that had fewer than 15 surgical discharges to SNFs over the 2-year study period. Our final sample consisted of approximately 1.5 million Medicare fee-for-service beneficiaries discharged from 1,964 hospitals to 12,112 SNFs. Among this pool of patients, we then identified those who underwent 1 of 5 common operative interventions over the course of the 2-year period using International Classification of Diseases-9 procedure codes (available from the authors upon request). The selected procedures included coronary artery bypass grafting (CABG), total hip arthroplasty, hip fracture repair, colectomy, and lumbar spine surgery. These procedures were selected because they are representative of major operative interventions performed across general surgery, orthopedic, and neurosurgical disciplines, include urgent and elective interventions, and have been used in prior research to evaluate health system surgical performance.\textsuperscript{2,5,7}

\textbf{Primary outcomes.} Our main outcome variable was 30-day hospital readmission, defined as rehospitalization to any acute care hospital within 30 days of the date of discharge from the index surgical hospital stay.

\textbf{Main explanatory variable.} The main explanatory variable was hospital–SNF referral linkage, defined as the proportion of surgical patients from the originating hospital who were discharged to the treating SNF.\textsuperscript{6}

\textbf{Covariates.} Patient characteristics included age, gender, race, comorbidity scores (calculated using Elixhauser\textsuperscript{8} and Deyo-modified Charlson\textsuperscript{9} scales), hospital duration of stay, and intensive care use. SNF attributes from the OSCAR data included the full-time equivalents of different types of nursing staff (registered nurses [RNs], licensed practical nurses [LPNs], and certified nursing assistants [CNAs]), the proportion of Medicaid paid residents,\textsuperscript{14-17} the weighted deficiency score based on state’s inspection of the SNF,\textsuperscript{13,18,19} occupancy rate, chain membership, corporate ownership (for profit or not), and the presence of any physician extenders (eg, nurse practitioners, physician assistants).\textsuperscript{20} Additionally, we included several facility level characteristics from the minimum data set (available at www.ltcfocus.org), including the proportion of black residents, the proportion of residents enrolled in managed care and the Resource Utilization Groups III case mix index.

We included 2 distance variables: distance from the patient’s residential zip code to SNFs and distance from the discharging hospital to SNFs. We geocoded all the SNFs and hospitals using the address in the OSCAR and American Hospital Association files, respectively. We used zip code centroids as a proxy for individuals’ residential location. We calculated patient to SNF distances using the Haversine formula.\textsuperscript{21}

\textbf{Statistical analyses.} Our object was to estimate the effect of increasing the proportion of selected surgical patients discharged from hospital $h$ to SNF $n$ on readmissions ($R_{h,n}$), while adjusting for confounders including patient choice in selecting
the SNF to which they were referred after surgery. The following equation was used in performing these calculations:

\[ R_{h,n} = \alpha_0 + \beta_1 \text{Prop}_{h,n} + \alpha_1 X_i + \alpha_2 X_n + \mu_h + \epsilon_{h,n} \]

\( \text{Prop}_{h,n} \) was our main explanatory variable, the proportion of surgical patients from hospital \( h \) discharged to SNF \( n \). \( X_i \) is a vector of patient’s characteristics, and \( X_n \) is a vector of SNF characteristics. \( \mu_h \) represents the hospital fixed effect. Given the large number of observations and the inclusion of numerous covariates, we estimated a linear probability model even though the outcome was dichotomous. Based on prior research, age, gender, race, Elixhauser and Deyo-modified Charlson comorbidity scores, hospital duration of stay and intensive care unit use, RN, LPN, and CNA full-time equivalents, the proportion of Medicaid paid residents, the weighted deficiency score based on state’s inspection of the SNF occupancy rate, chain membership, corporate ownership, and the presence of any physician extenders were included as covariates in the multivariable regression model.

To account for factors that would influence patient decision making around the SNF they were referred to, we estimated a SNF choice model for surgical patients that predicted the likelihood of a patient going to each SNF available. The choice set was defined based on 3 groups of SNFs: all SNFs within a 22-km radius of the discharging hospital, the nearest 15 SNFs to the hospital, and all SNFs used by the hospital. Using a conditional (fixed effects) logit model, we estimated the parameters for surgical patients. Using the choice model estimated, we predicted the hospital–SNF discharge proportion as if the distance between an individual’s home and the alternative SNFs were the only deciding factor. The corresponding predicted proportion was then used as an instrumental variable (IV) to further adjust the results of our primary analysis. IV analysis has been used widely in the past and is maintained to imitate random assignment in its approach. Further, the use of IV analysis enables the generation of conservative and unbiased estimates, minimizing the potential for type 1 error. Finally, subset analyses were performed using each operative procedure individually. The results of the linear probability model were considered primary, with the results of the IV test used as a confirmatory analysis. Supplemental sensitivity tests were conducted where inclusion was limited to hospitals with ≥25 surgical cases and where subset analyses were performed among institutions with and without inpatient rehabilitation facilities. Statistical significance was set, a priori, for \( P < .05 \) and regression coefficients (RC) and 95% CI exclusive of 0.0.

This investigation received institutional ethical review board approval before commencement.

**RESULTS**

There were 138,163 patients with surgical interventions performed at 1,959 hospitals included in this analysis. The average age of patients was 79.8 ± 7.64 years. Thirty-seven percent of patients underwent hip fracture repair, 36% received total hip arthroplasty, and 10% received CABG. Ninety percent of the population was white and the average hospital duration of stay was 5.75 ± 5.1 days (Table 1). More than one-half of patients underwent one of the included surgical procedures at any given hospital were discharged to 1 of the 3 most preferred SNFs for that institution (Fig 1). The most preferred SNF received close to 40% of patients after one of the selected operative interventions. A greater proportion of patients from our surgical group were discharged to the most preferred SNF than the remaining patients treated at that same hospital for other medical or surgical conditions (Fig 1).

The 30-day readmission rate for the entire cohort was 11.4%. Of these patients, 5.5% of the cohort was readmitted with a primary diagnosis of sepsis. This ranged from a low of 3.2% of readmitted patients after CABG to a high of 6.9% of readmitted patients treated with lumbar spine surgery or hip fracture repair. Readmissions were greatest among those who underwent colectomy or CABG (20.8% and 20.6%, respectively) and least for patients who received total hip arthroplasty (6.8%). A strong negative correlation (\( P < .001 \)) was observed between the proportion of surgical discharges received by a SNF and the rate of hospital readmission (Fig 2). For all surgery patients included in this investigation, SNFs receiving a small proportion of these individuals from a given hospital were found to have rehospitalization rates approximating 12.5%, whereas SNFs receiving 80% of surgical discharges were found to have only a 9% readmission rate.

Given the large size of our sample, most of the factors considered were found to be significant predictors of hospital–SNF referral (Appendix). Those factors with the largest effects included whether the SNF was owned by the hospital (RC, 1.91; 95% CI, 1.86–1.95), whether the SNF was hospital based (RC, −0.4; 95% CI, −0.43 to −0.36) and the distance from a patient’s home to the SNF (RC, −0.11 (−0.1056); 95% CI, −0.1063 to −0.1050).

The results of the regression analysis confirmed that hospital–SNF linkage, as measured by the proportion of surgical discharges, was a significant
predictor of readmission, with an increased proportion of surgical discharges decreasing the likelihood of readmission (RC, -0.04; 95% CI, -0.07 to -0.02]). This result suggests a 10% increase in the proportion of surgical discharges from a hospital to a particular SNF would result in a 4% reduction in rehospitalization rate. Hospital ownership of the receiving SNF was not found to be a significant predictor of readmission (RC, 0.018; 95% CI, -0.0016 to 0.036). Patient age, medical comorbidities, and hospital duration of stay were also found to significantly increase the likelihood of readmission, as did the percentage of Medicaid patients residing at a SNF (Table II). Female sex significantly decreased the likelihood of readmission (RC, -0.02; 95% CI, -0.028 to -0.019). The majority of these findings were preserved after IV analysis (Table II). These determinations were also robust to sensitivity checks that limited consideration to hospitals with ≥25 surgical discharges (RC, -0.03) and those with (RC, -0.04) and without (RC, -0.03) inpatient rehabilitation facilities.

**DISCUSSION**

The current health care environment is increasingly focused on ways to optimize patient care after operative intervention, including a particular emphasis on reducing hospital readmission.
after discharge. At present, the Center for Medicare and Medicaid Services has instituted penalties for hospitals that are found to have higher rates of rehospitalization than those deemed to be clinically acceptable. Furthermore, poor performance in the coordination of postoperative care may impact adversely reimbursement and financial viability for organizations participating in bundled payment programs or accountable care organizations. The enhanced integration of care that may be associated with hospital linkage to SNFs, and consequent decreases in complications and miscommunications that could contribute to hospital readmissions are clearly advantageous to both patients and hospitals.

The present study considered patients who underwent 1 of 5 operations, inclusive of both elective and urgent surgical procedures in general surgery, cardiac surgery, orthopedics, and neurosurgery. The results of this work demonstrated a strong correlation between the proportion of surgery patients discharged to a SNF and the likelihood of readmission. Specifically, rehospitalization rates were decreased among those SNF facilities that received a higher proportion of a hospital’s surgical discharges. These findings were largely preserved after IV analysis and were particularly robust for patients who underwent lumbar spine surgery, CABG, and hip fracture repair, indicating that readmission reductions after these procedures may be more sensitive to the benefits of increased hospital–SNF linkage.

Conversely, patients undergoing colectomy or total hip arthroplasty may be less sensitive to these effects. Increasing the proportion of patients referred from a hospital to a SNF after lumbar spine surgery, CABG, and hip fracture repair by 10% would be anticipated to lead to concomitant reductions in readmission in the range of 3–4%.

The effect of SNF–hospital linkage on readmission for surgery patients can likely be attributed to a number of factors, given the enhanced need for integrated care among surgical patients in the postacute period. If we accept the premise that most, if not all, postoperative readmissions occur as a result of a medical or surgical complication, SNFs receiving a larger proportion of a hospital’s surgical discharges may be more effective at minimizing the development of such events. The high linkage SNFs may have more efficient triage processes and established better communication channels that allow for the effective management of perioperative issues. In less integrated postacute settings, similar perioperative problems might progress to a complication necessitating

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**Table II.** The impact of Hospital–SNF linkage on 30-day readmission rates after linear regression (OLS) and instrumental variables (IV) analysis *

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS (SE)</th>
<th>P value</th>
<th>IV (SE)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of patients discharged to the SNF</td>
<td>−0.04 (0.0083)</td>
<td>&lt;.001</td>
<td>−0.060 (0.031)</td>
<td>.047</td>
</tr>
<tr>
<td>Proportion of patients with Medicaid as a payer</td>
<td>0.0002 (0.0001)</td>
<td>.002</td>
<td>0.0002 (0.0001)</td>
<td>.008</td>
</tr>
<tr>
<td>Age</td>
<td>0.002 (0.0001)</td>
<td>&lt;.001</td>
<td>0.002 (0.0001)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Elixhauser score ≥2</td>
<td>0.006 (0.001)</td>
<td>&lt;.001</td>
<td>0.006 (0.001)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Deyo score&gt;2</td>
<td>0.014 (0.001)</td>
<td>&lt;.001</td>
<td>0.014 (0.001)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female</td>
<td>−0.024 (0.002)</td>
<td>&lt;.001</td>
<td>−0.024 (0.002)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital duration of stay</td>
<td>0.006 (0.001)</td>
<td>&lt;.001</td>
<td>0.006 (0.001)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Only variables found to be statistically significant in linear regression analysis are presented. The insignificant variables we dropped are no. of beds in a SNF, whether a SNF is multifunctional, for-profit, extension of any MD, a hospital’s own SNF or hospital-based SNF, a SNF’s average deficiency score, no. of registered nurses, licensed practical nurses, and certified nursing assistants; and patients’ age, race and gender.

OLS, Ordinary least squares; SE, standard error; SNF, skilled nursing facility.

**Table III.** The impact of Hospital–SNF linkage on 30-day readmission rates for each of the surgical procedure groups after linear regression (OLS) and instrumental variables (IV) analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS (P value)</th>
<th>IV (P value)</th>
<th>No. of observations</th>
<th>Average 30-day readmission rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar spine surgery</td>
<td>−0.047 (.024)</td>
<td>−0.185 (.102)</td>
<td>22,345</td>
<td>11.3</td>
</tr>
<tr>
<td>Total hip arthroplasty</td>
<td>−0.012 (.156)</td>
<td>0.005 (.910)</td>
<td>50,344</td>
<td>6.8</td>
</tr>
<tr>
<td>Hip fracture repair</td>
<td>−0.037 (.005)</td>
<td>−0.121 (.017)</td>
<td>50,794</td>
<td>13.4</td>
</tr>
<tr>
<td>Colectomy</td>
<td>−0.544 (.082)</td>
<td>−8.556 (.937)</td>
<td>742</td>
<td>20.8</td>
</tr>
<tr>
<td>Coronary artery bypass grafting</td>
<td>−0.085 (.019)</td>
<td>0.055 (.763)</td>
<td>13,938</td>
<td>20.6</td>
</tr>
</tbody>
</table>

OLS, Ordinary least squares.
readmission. Improved communication between the treating hospital, surgical care teams, and the SNF may also contribute to enhanced patient care and a consequent decrease in the events associated with rehospitalization.1 For example, increased familiarity on the part of SNF staff with surgical providers may lower barriers to contacting the team regarding indications of clinical deterioration in a surgical patient. Early action guided by the operating surgeon, their nurse practitioner, or physician assistants may then ultimately obviate the need for urgent re-referral to the surgical clinic, emergency room, or an inappropriate rehospitalization.

Risk-based reimbursement models, inclusive of accountable care organizations and bundled payment initiatives, render providers, hospitals, and SNFs responsible for the total cost of surgical care.4,5,26,27 A sizable proportion of existing variation in Medicare payments around surgical conditions has been attributed to the postacute period.3,26,27 Reduced costs associated with postacute care, including optimized SNF services and reduced rates of readmission that result from enhanced hospital–SNF linkage, would lead to increased savings for Medicare as well as the responsible health care organizations.

The strengths of this study include a large cohort of patients derived from national 100% Medicare data as well as a diverse sample of operative procedures with readmission rates comparable with those reported elsewhere in the literature.2,3,7 We recognize, however, that there are limitations associated with this work. First, this analysis was conducted using Medicare data and therefore findings may not be applicable to younger patients undergoing similar operative interventions, or individuals using different types of health insurance. Similarly, given the design of this study and the data available, the results are limited to patients referred to SNFs and should not be extrapolated to those discharged to other providers of postacute rehabilitation, such as long-term acute care facilities. It is important to note, however, that our findings were robust to sensitivity testing that considered hospitals with and without inpatient rehabilitation. Second, because this study relied on administrative data, there is the potential for confounding from unmeasured variables not reported to Medicare or inaccurately captured in the datasets used. We attempted to control for this to the best of our ability using IV analysis, with the distance from patients’ home to the SNF as the IV. Such an approach has been postulated to imitate random assignment and allows for the generation of more conservative and unbiased estimates.1,24 Viewed in this light, it is encouraging that most of our main effects were preserved after IV testing. Third, given the use of claims data, we were unable to adjust for the influence of patient frailty as described in other publications.28 It should be noted, however, that extant frailty indices29 overlap with a number of variables included for adjustment in our regression model and we did control for the presence of comorbidities using accepted Elixhauser and modified Charlson scores.2,3,5,9,25-27 Last, because our data are from 2011 and 2012, they may not be entirely reflective of the current health care environment, particularly because readmission penalties associated with the implementation of the Affordable Care Act were only instituted in 2012.

Despite these limitations, our study results hold important meaning for surgeons, hospitals, third-party payers and government entities. Based on the findings presented herein, it could be anticipated that an enhanced association between hospitals and select SNFs may result in meaningful decreases in hospital readmission after operative intervention. Hospitals should be encouraged to seek integrated relationships with ≥1 SNFs that would be designated the preferred facilities for referral of postoperative patients. Based on our study results, it does not seem that such SNFs necessarily need to be owned by the referring hospital. Such enhanced linkage between hospitals and SNFs may then reduce readmissions and presumably the medical and surgical complications that precipitate the need for rehospitalization. This type of SNF–hospital integration will likely also be associated with better continuity and quality of care, improved patient satisfaction, and, in the era of the Affordable Care Act, reduced financial penalties for hospitals and affiliated health care organizations.

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REFERENCES


Appendix. Predictors of hospital–skilled nursing facility (SNF) referral as determined by a conditional (fixed effects) logit model.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient (SE)</th>
<th>P value</th>
<th>Marginal effect (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance: home to SNF</td>
<td>−0.106 (0.000344)</td>
<td>&lt;.001</td>
<td>−0.1734</td>
</tr>
<tr>
<td>Distance: hospital to SNF</td>
<td>−0.0712 (0.000326)</td>
<td>&lt;.001</td>
<td>−0.1186</td>
</tr>
<tr>
<td>Total no. of beds</td>
<td>−0.000884 (0.000106)</td>
<td>&lt;.001</td>
<td>−0.0015</td>
</tr>
<tr>
<td>% paid by Medicaid</td>
<td>−0.0248 (0.000133)</td>
<td>&lt;.001</td>
<td>−0.0418</td>
</tr>
<tr>
<td>Multifacility SNF</td>
<td>0.0401 (0.00676)</td>
<td>&lt;.001</td>
<td>0.0683</td>
</tr>
<tr>
<td>For profit</td>
<td>0.150 (0.00755)</td>
<td>&lt;.001</td>
<td>0.2188</td>
</tr>
<tr>
<td>Any MD extender</td>
<td>0.0404 (0.00678)</td>
<td>&lt;.001</td>
<td>0.0689</td>
</tr>
<tr>
<td>Hospital’s own SNF</td>
<td>1.907 (0.0237)</td>
<td>&lt;.001</td>
<td>6.0824</td>
</tr>
<tr>
<td>Hospital-based SNF</td>
<td>−0.396 (0.0183)</td>
<td>&lt;.001</td>
<td>−0.5953</td>
</tr>
<tr>
<td>Average deficiency score</td>
<td>−0.00195 (5.96e-05)</td>
<td>&lt;.001</td>
<td>−0.0033</td>
</tr>
<tr>
<td>Total no. of FTE RN</td>
<td>0.0256 (0.000382)</td>
<td>&lt;.001</td>
<td>0.0438</td>
</tr>
<tr>
<td>Total no. of FTE LPN</td>
<td>0.0163 (0.000437)</td>
<td>&lt;.001</td>
<td>0.0278</td>
</tr>
<tr>
<td>Total no. of FTE CNA</td>
<td>0.00227 (0.000241)</td>
<td>&lt;.001</td>
<td>0.0039</td>
</tr>
<tr>
<td>Observations</td>
<td>8,519,910</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Marginal effects are calculated as percentage change in likelihood of being discharged to a skilled nursing facility in response to a 1 unit of change in corresponding characteristics. CNA, Certified nursing assistant; FTE, full-time equivalent; LPN, licensed practical nurse; MD extender, nurse practitioner, physician assistant; RN, registered nurse; SE, standard error.