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Hospital Readmissions

Necessary Evil or Preventable Target for Quality Improvement

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Objectives: To evaluate readmission rates and associated factors to identify potentially preventable readmissions.

Background: The decision to penalize hospitals for readmissions is compelling health care systems to develop processes to minimize readmissions. Research to identify preventable readmissions is critical to achieve these goals.

Methods: We performed a retrospective review of University HealthSystem Consortium database for cancer patients hospitalized from January 2010 to September 2013. Outcome measures were 7-, 14-, and 30-day readmission rates and readmission diagnoses. Hospital and disease characteristics were evaluated to evaluate relationships with readmission.

Results: A total of 2,517,886 patients were hospitalized for cancer treatment. Readmission rates at 7, 14, and 30 days were 2.2%, 3.7%, and 5.6%, respectively. Despite concern that premature hospital discharge may be associated with increased readmissions, a shorter initial length of stay predicted lower readmission rates. Furthermore, high-volume centers and designated cancer centers had higher readmission rates. Evaluating institutional data (N = 2517 patients) demonstrated that factors associated with higher readmission rates include discharge from a medical service, site of malignancy, and emergency primary admission. When examining readmission within 7 days for surgical services, the most common readmission diagnoses were infectious causes (46.3%), nausea/vomiting/dehydration (26.8%), and pain (6.1%).

Conclusions: A minority of patients after hospitalization for cancer-related therapy are readmitted with potentially preventable conditions such as nausea, vomiting, dehydration, and pain. However, most factors associated with readmission cannot be modified. In addition, high-volume centers and designated cancer centers have higher readmission rates, which may indicate that readmission rates may not be an appropriate marker for quality improvement.

Keywords: cancer, hospital readmissions, NCI designation, volume-outcome relationship

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Readmission rates have emerged as a new quality metric with financially important ramifications. The cost of rehospitalization is significant, both in terms of financial impact on the health care system and increased patient morbidity. Medicare estimated the annual cost of readmission to be $17 billion, and the same study showed that more than half of patients discharged after surgery were rehospitalized or died within a year of discharge.[1] With the United States Readmissions Reduction Program set to reduce hospital payments for higher-than-expected readmission rates within 30 days of surgery for Medicare patients,[2] research to characterize risk factors for readmission is essential.

Given the increased focus on readmission, numerous studies have attempted to identify clear predictors of an increased risk for rehospitalization. Several studies have found that patient factors such as age and preexisting comorbidities are important predictors of readmission.[3–5] Also, the association between postoperative complications and both an increased risk for readmission and increased costs to the health care system is well established.[1,3,4,6–12] Finally, some have suggested that efforts to reduce costs by decreasing hospital length of stay (LOS) may reflexively cause an increase in rehospitalization rates[4,5,13]; however, the impact of shortened LOS on hospital readmission rates is uncertain.

Currently, the majority of research on readmissions is largely procedure-specific and may not be widely applicable to other surgical treatments. It is unclear which factors associated with readmission are modifiable and the effects of hospital factors on readmission. The objective of this study was to characterize readmissions for a large group of patients at risk for rehospitalization—cancer patients. In particular, we examine potentially preventable readmissions and the impact of hospital factors on readmission rates.

METHODS

We performed a retrospective review of data from the University Health System Consortium (UHC) database, an alliance of 120 academic medical centers and 302 of their affiliated hospitals representing the nation's leading academic medical centers. It is an administrative database of inpatient and outpatient encounters submitted by 240 of the hospitals and derived from billing data with the purpose of bringing about performance improvement through collaboration. Analysis included all cancer patients hospitalized from January 2010 to September 2013. Our main outcome measures were 7-, 14-, and 30-day readmission rates and adjusted LOS (LOSa; defined as the ratio of observed to expected LOS based on patient factors) for both initial and readmission hospitalizations. Only patients considered inpatient admissions were evaluated; those admitted to the hospital for outpatient observation (ie, <24 hours of hospitalization) were excluded. Additional factors such as hospital volume (defined as the number of cancer-specific hospital admissions during the study period; limited to surgical admissions for surgical subset analysis), whether or not the admitting hospital was a National Cancer Institute (NCI)-designated comprehensive cancer center, and specialty of discharging physician were also measured. Readmission data focused on related readmissions (defined as readmission diagnosis related to initial admission); planned readmissions for chemotherapy, radiation therapy, or rehabilitation were excluded.

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We then narrowed our search to institutional data from the UHC database for all cancer patients hospitalized at the University of California Davis Medical Center (UCDMC) over the same time period (January 2010–September 2013). Main outcome measures were 7-, 14-, and 30-day readmission rates and readmission diagnoses. Variables studied included site of malignancy, specialty of discharging physician, category of initial admission (emergency, urgent, elective) as identified by all patient refined diagnosis-related groups, and individual physician volume. Readmission diagnoses were studied for surgical patients treated by General Surgery, Surgical Oncology, Gynecological Oncology, Thoracic Surgery, and Urology services, based on the top-4 *International Classification of Diseases, Ninth Revision*, diagnosis codes listed for the readmission hospitalization.

Univariate analysis was performed using the χ^2, Fisher exact, Wilcoxon rank-sum, and Kruskal-Wallis tests when appropriate. For nonparametric testing of the relationship between readmission rates with LOSa, LOS was dichotomized by lower-than-expected LOS (<1.0) and higher-than-expected LOS (≥ 1.0); hospital and physician volume independent predictors were separated into quartiles for analysis. Analysis was performed for the entire UHC cohort and the UHC surgical cohort separately. Additional analyses comparing NCI-designated cancer centers versus nondesignated centers and for institutional data were also performed.

Fitted robust linear regression was used to analyze the relationship between readmission rates and LOSa, hospital volume, and physician volume.[14] Multivariable robust regression analysis was performed to assess the relationship between 30-day readmission rate and the 4 predictive variables: LOSa (based on <1.0 and ≥ 1.0), hospital volume (divided by quartile), discharge by medical or surgical service, and NCI-designated comprehensive cancer center status. A P value less than 0.05 was considered significant. All analyses were performed with SAS version 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

A total of 2,517,886 patients were hospitalized for cancer treatment at 235 UHC hospitals between January 2010 and September 2013. Of these, 1,108,999 were surgical patients and 1,408,887 were medical patients. Overall mean readmission rates at 7, 14, and 30 days postdischarge were 2.2%, 3.7%, and 5.6%, respectively. On comparing readmission rates for medical and surgical services, medical services had higher rates of readmission at 7, 14, and 30 days (2.51%, 4.20%, and 6.55%, respectively) than surgical services (1.84%, 2.88%, and 4.17%, respectively) ($P < 0.0001$ for all time points) (Fig. 1).

We next examined the impact of LOSa from the initial hospitalization on readmission rates. This line of investigation examined whether patients with a shorter LOSa may have a higher readmission rate due to potential premature discharge. First examining the entire cohort, a longer LOSa, from the primary hospitalization, demonstrated slightly higher readmission rates at 7, 14, and 30 days (Fig. 2). Nonparametric testing demonstrated that the relationship was statistically significant at all time points ($P = 0.0001$, $P = 0.0006$, $P = 0.0006$, respectively); however, regression analysis revealed that there was only a weak relationship between LOSa and readmission rate ($R^2 = 0.023$, $R^2 = 0.025$, $R^2 = 0.024$, respectively). When analyzing this relationship for just surgical patients, we again saw a statistically significant ($P = 0.0001$, $P < 0.0001$, $P < 0.0001$, respectively), but weak linear, relationship between increased LOSa from the index hospitalization and increased readmission rates at 7, 14, and 30 days ($R^2 = 0.044$, $R^2 = 0.082$, $R^2 = 0.110$, respectively) (Fig. 3). We then analyzed the effect of hospital volume on readmission rates. There was a statistically significant association between high-volume centers and higher readmission rates at 7, 14, and 30 days for both the entire cohort ($P < 0.0001$ for all) and the surgical services

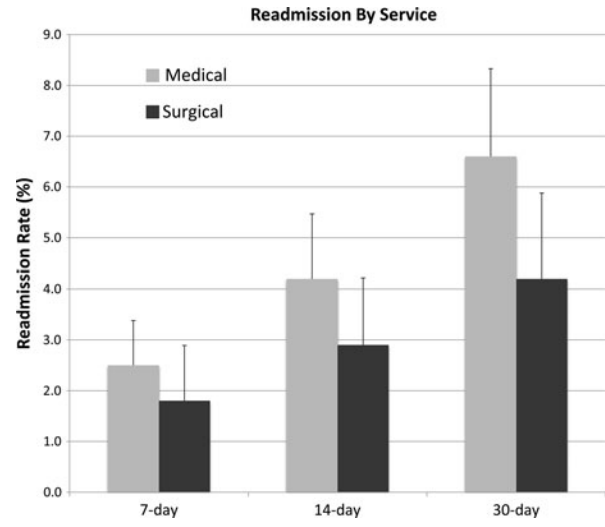

FIGURE 1. Readmission by service. Within the UHC system, discharge from a medical service was associated with higher average rates of readmission at 7, 14, and 30 days (2.51%, 4.20%, and 6.55%, respectively) than discharge from a surgical service (1.84% 2.88%, and 4.17%, respectively) ($P < 0.001$ for all by the 2-sided Wilcoxon rank-sum test). Error bars represent 1 SD.

($P = 0.0006$, $P < 0.0001$, $P < 0.0001$, respectively). Again, regression analysis revealed that the relationship was not linear, nor very strong, for either the entire group ($R^2 = 0.062$ at 7 days, $R^2 = 0.099$ at 30 days) or surgical patients ($R^2 = 0.035$ at 7 days, $R^2 = 0.110$ at 30 days) (Fig. 4).

NCI-designated comprehensive cancer centers are a small component of the nation's academic medical centers recognized by the federal government. To determine whether these centers provided care that led to differences in readmission rates, NCI-designated comprehensive cancer centers (n = 35) were compared with the remainder of the UHC cohort (n = 199). Although NCI-designated comprehensive cancer centers may treat patients with more comorbidities and have a significantly larger volume of cancer-specific hospital admissions, there was no difference in LOSa for the initial hospitalization for the entire group ($P = 0.21$) or surgical patients ($P = 0.37$) (data not shown). Interestingly, readmission rates at 7, 14, and 30 days were higher at NCI-designated cancers centers than at nondesignated centers (2.5%, 4.1%, and 6.2% vs 2.2%, 3.5%, and 5.2%, respectively; $P < 0.0001$ for all) (Fig. 5A). These differences persisted when only the surgical patients were similarly analyzed for 7-, 14-, and 30-day readmissions (2.0%, 3.38%, and 5.0% vs 1.8%, 2.8%, and 4.0%, respectively; $P = 0.02$, $P = 0.0002$, $P < 0.0001$, respectively) (Fig. 5B). Multivariable analysis revealed that both hospital case volume and discharging physician specialty (medical vs surgical) were statistically significant predictors of readmission rates within 30 days ($P < 0.0001$ for both); however, neither LOSa of the initial admission nor NCI designation was associated with the 30-day readmission rate (Table 1).

To try to identify more detailed variables that are related to cancer readmissions, we examined our UCDMC institutional data; a total of 2517 cancer patients were hospitalized between January 2010 and September 2013. Seven-, 14-, and 30-day readmission rates were 3.4%, 5.8%, 9.4%, respectively. The relationship between the annual admitting volume of each physician (n = 488) and readmission rates was examined; contrary to our belief, increased physician

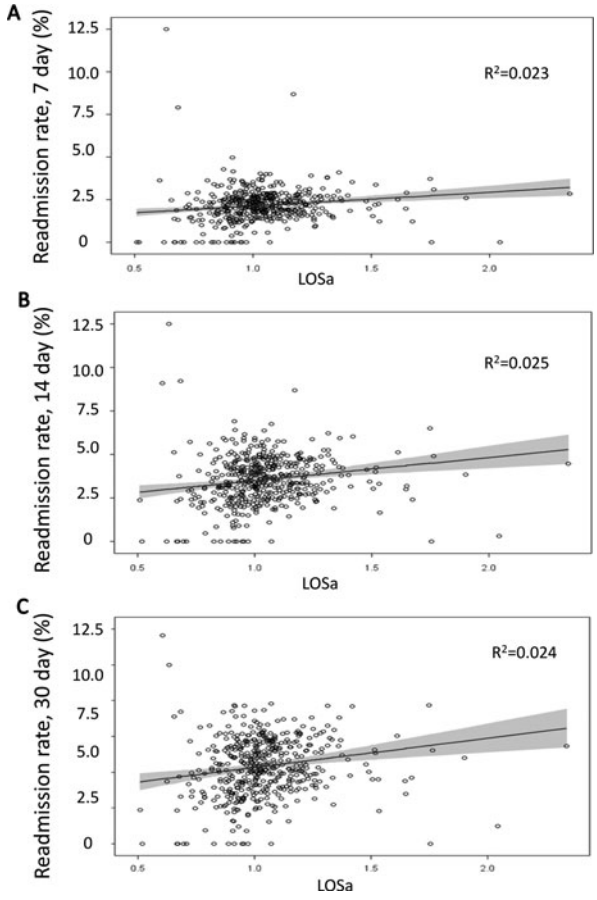

FIGURE 2. Readmission by LOSa. Relationship between LOSa from initial hospitalization and readmission rate at (A) 7 days ($P < 0.0001$), (B) 14 days ($P < 0.0001$), and (C) 30 days ($P < 0.0001$), with associated fitted robust linear regression and R^2 correlation value.

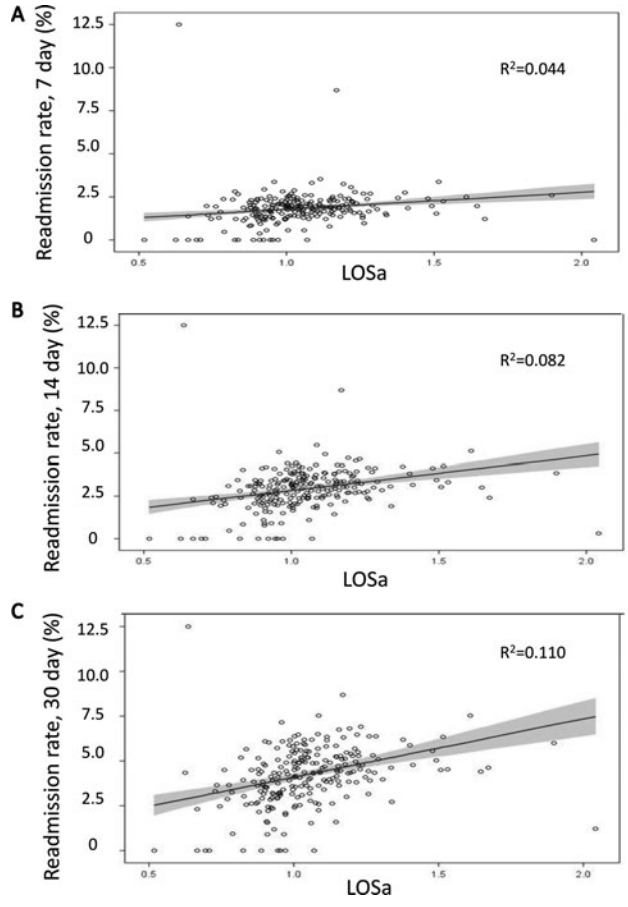

FIGURE 3. Readmission by LOSa for surgical patients. Relationship between LOSa from initial hospitalization for patients discharged from a surgical service and readmission rate at (A) 7 days ($P < 0.0001$), (B) 14 days ($P < 0.0001$), and (C) 30 days ($P < 0.0001$), with associated fitted robust linear regression and R^2 correlation value.

volume was statistically associated with higher readmission rates ($P < 0.0001$ at 7, 14, and 30 days). However, the relationship poorly correlated at any time point of readmission ($R^2 = 0.156$, $R^2 = 0.141$, $R^2 = 0.117$, respectively) (Fig. 6). Additional patient-related variables were examined for any potential relationship with readmission. Of the 2505 index cancer patients admissions to UCDMC (12 excluded because of uncertain admission status), 917 (36.6%) were elective admissions, 612 (24.3%) were urgent, and 977 (38.8%) were emergency admissions. Readmission rates at 7, 14, and 30 days were lowest when the initial hospital admission was elective (1.2%, 3.6%, and 6.7%, respectively). Both urgent and emergency admissions had higher rates of readmission than patients admitted electively at 7, 14, and 30 days ($P < 0.0001$, $P = 0.001$, $P = 0.001$, respectively) (Fig. 7). Site of malignancy was another important variable associated with readmission rates. Highest rates of readmission at all time points were seen for hepatobiliary, musculoskeletal, and otolaryngology/ENT ($P = 0.0003$ at 7 days, $P < 0.0001$ at 14 and 30 days). The lowest readmission rates were seen for breast, genitourinary, and gynecologic malignancies (Table 2). Interestingly, gastrointestinal malignancies had one of the lowest 7-day readmission rates (1.4%) but the highest 30-day readmission rate (19.3%) due to the development of postoperative infectious complications more than 7 days after discharge. Also, approximately half of the 30-day readmissions for musculoskeletal and hepatic/pancreatic/biliary complications occurred within 7 days of discharge from the initial hospitalization.

We then focused on readmissions within 7 days of discharge for surgical patients to determine potentially preventable readmissions within this group as these patients were readmitted quickly. The most common readmission diagnoses at 7 days were infectious causes (46.3%), nausea/vomiting/dehydration (26.8%), pain (6.1%), and thromboembolism (4.9%). At 30 days, these were again the most common reasons for related readmissions, although percentages varied slightly at 51.2% for infectious causes, 14.7% for nausea/vomiting/dehydration, 3.3% for pain, and 2.8% for thromboembolism.

DISCUSSION

With potentially huge financial consequences associated with higher-than-expected readmission rates, the identification of clear, modifiable risk factors is critical. Cancer patients are at an increased risk for readmission,[3,15] and the present study investigates readmission in this group at an institutional and national level to better elucidate potential areas for quality improvement. We identified a minority of patients readmitted with potentially preventable conditions

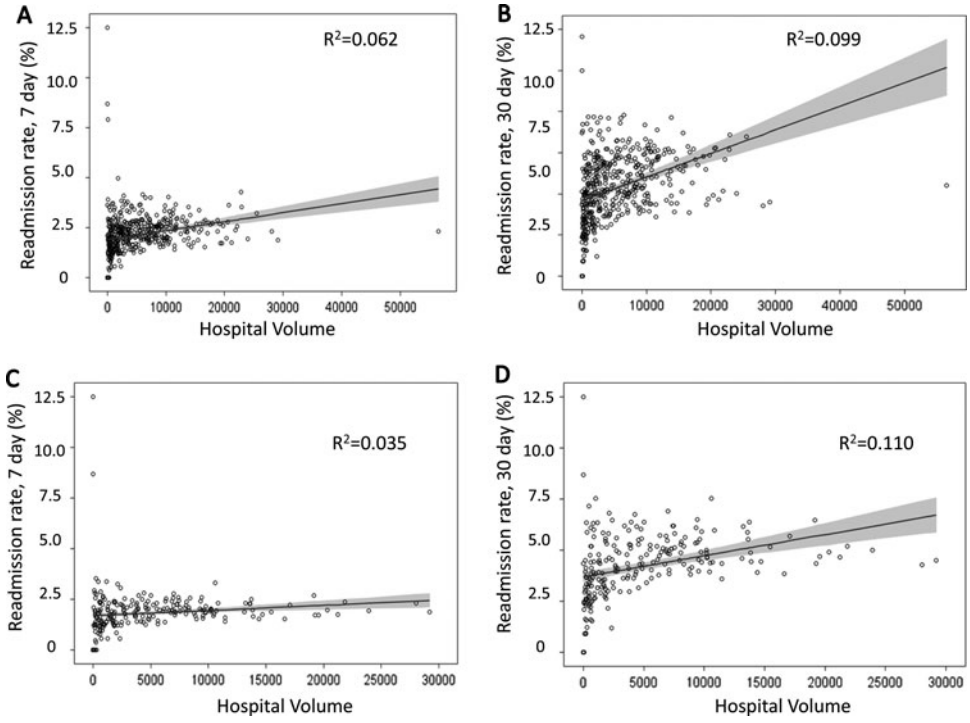

FIGURE 4. Readmission by hospital volume. Relationship between LOSa from initial hospitalization and readmission rate at (A) 7 days ($P < 0.0001$) and (B) 30 days ($P < 0.0001$) for the entire cohort or for just those patients discharged from a surgical service (C, D). The associated fitted robust linear regression is shown as the R^2 correlation value for each relationship.

such as nausea, vomiting, dehydration, and pain. However, the majority of factors associated with readmission identified in this study cannot be modified. Most importantly, several traditional markers of quality care were actually associated with increased readmission rates.

Almost one third of patients readmitted in our study were rehospitalized within 7 days of discharge. When looking at the reasons for readmission, 33% of these were due to potentially preventable problems such as nausea, vomiting, dehydration, and postoperative pain. We deemed this group to be potentially preventable based on a suspected need for improved patient care coordination as a means to provide care to these patients in the absence of readmission. It is possible that closer discharge follow-up, establishment of observational units for administration of fluids, or enhanced palliative care programs may have prevented these readmissions. Although we focused on these diagnoses as potentially preventable at our institution, the need for standardized definitions in this field of study is critical. Efforts to enhance coordinated care will be critical at both an institutional and national level to provide quality care in the absence of readmission.

We saw no relationship between a shorter index hospitalization LOS and increased readmission rates in our study, but we actually saw an increased risk for readmission with longer LOS. This relationship has been previously seen[7,12,16,17] and is likely due to the complex relationship between postoperative complications, LOS, and readmission. Although clinical care pathways have proven as an effective means to reduce costs and LOS,[18,19] an essential component of these pathways needs to be a focus on addressing complications and patients at risk for readmission.[11,20] Evaluation of such interventions has yet to be shown. These questions are essential to address with further research, as the financial impact of reducing even a small proportion of these readmissions would be significant.

Although we identified several factors associated with higher readmission rates, the vast majority of these were nonmodifiable. Discharge from a medical service was associated with a high risk for readmission. In addition, both emergency surgery and complex procedures have been demonstrated to be associated with increased complications and readmissions, but these are simply not factors that can be adjusted.[3,12,21] The decision to readmit patients suffering from such a complication should not be penalized if it is the best option for appropriate care. Brown et al[22] discusses the notion of failed discharge versus early rescue with a review of regional data that revealed that the surgeon with the lowest mortality rate after colon resection also had the highest readmission rate. This observation was born out in a larger study of Medicare patients who underwent pancreaticoduodenectomy showing that hospitals with the lowest readmission rates also had the highest mortality rates; interestingly, these were the low-volume hospitals.[23]

The concept of readmission as a "rescue" is important. Perhaps, the decision to rehospitalize patients reflects good judgment rather than poor care, and other authors have acknowledged that perhaps readmission after surgery is unavoidable.[24] Our analysis revealed that markers of quality care such as higher physician and hospital volumes are associated with increased readmission rates. Furthermore, NCI-designated comprehensive cancer centers, centers ranking in the top 4% of the cancer centers in the United States and known as leaders in quality care for cancer patients, demonstrated increased readmission rates. Perhaps, focusing on readmission rates as a quality metric is misguided. Although the financial and patient costs of readmission are clear, it is not obvious that readmission is an indicator of poor care; in fact, it may be just the opposite.

The study is limited by the retrospective nature and the known pitfalls of using an administrative database.[25,26] Administrative databases have been criticized as an inaccurate source of

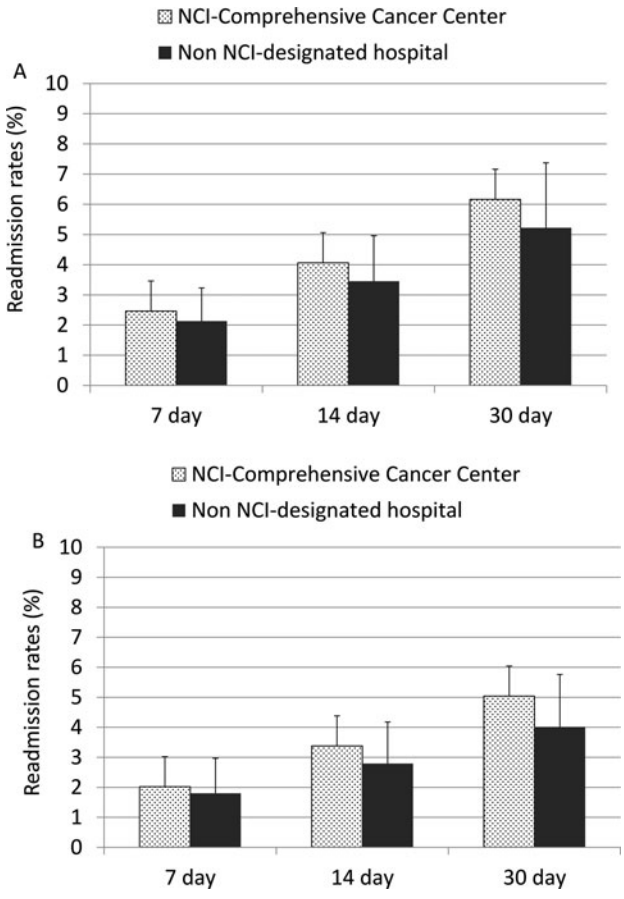

FIGURE 5. Readmission by NCI-comprehensive cancer center status. A, Higher median rates of readmission at 7, 14, and 30 days (2.03%, 3.38%, and 5.05%, respectively) were observed for cancer patients treated at NCI-designated comprehensive cancer centers than at nondesignated centers (1.80% 2.79%, and 4.01%, respectively) ($P < 0.0001$ for all time points by the 2-sided Wilcoxon rank-sum test). These findings persisted after evaluation of patients discharged from a surgical service (B) ($P = 0.02$, $P = 0.0002$, < 0.0001, respectively, by the 2-sided Wilcoxon rank-sum test). Error bars represent 1 SD.

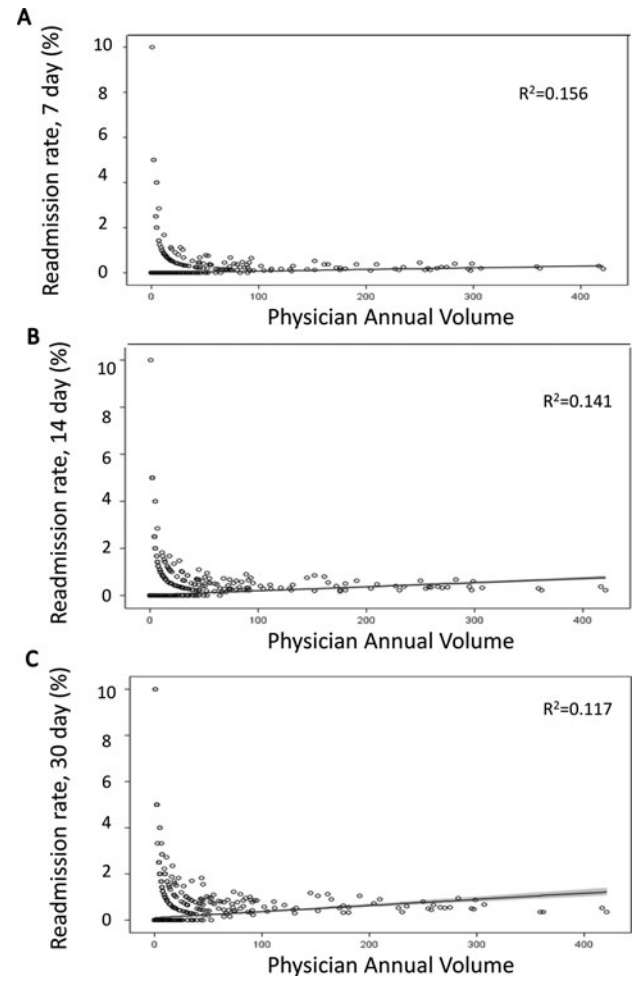

FIGURE 6. Readmission by physician volume. Relationship between individual physician volume and (A) 7-day, (B) 14-day, and (C) 30-day readmission rates at the UCDMC. The associated fitted robust linear regression is shown as the R^2 correlation value for each relationship.

TABLE 1. Result of Multivariable Robust Regression Analysis for the Relationship Between Readmission Rate Within 30 Days and the 4 Predictors

Parameter	Variable	Estimate	95% Confidence Limits	P*
LOSa	≥1 vs 1	0.0020	−0.0005, 0.0045	0.1236
Hospital case volume				**<0.0001**
	1st vs 2nd quartile	0.0136	0.0102, 0.0170	
	1st vs 3rd quartile	0.0201	0.0166, 0.0237	
	1st vs 4th quartile	0.0205	0.0166, 0.0245	
Service specialty	Medical vs surgical	0.0225	0.0202, 0.0248	**<0.0001**
NCI designation	Yes vs No	0.0026	−0.0009, 0.0061	0.1441

The 4 predictors are as follows: LOSa (based on <1, ≥1); hospital case volume (broken into quartiles with 1st quartile reflecting the lowest volume [971 cases per year] and 4th quartile reflecting the highest volume [8227 cases per year]); medical versus surgical service of index hospitalization; and NCI cancer center (yes/no).

∗Bold values indicate $P < 0.01$.

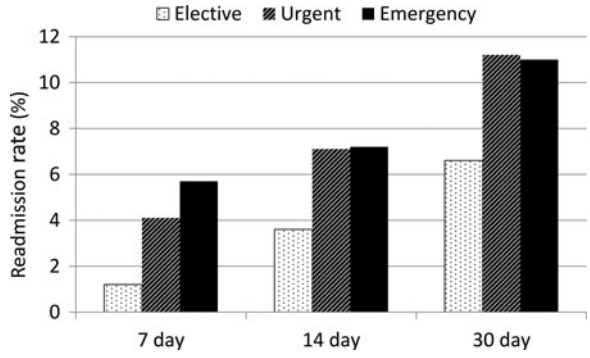

FIGURE 7. Readmission by the type of admission for index hospitalization. Readmission rate at 7, 14, and 30 days after index hospitalization classified as elective, urgent, or emergency among the 2505 patients hospitalized at the UCMDC.

TABLE 2. Comparison of Readmission Rates Among 11 All Patient Refined Diagnosis-Related Group Diagnoses of Index Hospitalization Among 2517 Cancer Patients Admitted to UCDMC

		Readmission Rate		
Discharge Diagnosis	**n**	**7 d**	**14 d**	**30 d**
Gynecologic	228	0.9%	1.3%	4.8%
CNS neoplasms	168	1.2%	4.2%	7.1%
GI	218	1.4%	12.4%	19.3%
Breast	308	1.6%	2.9%	7.1%
GU	301	1.7%	3.0%	4.0%
Respiratory	166	1.8%	4.2%	9.0%
ENT	55	1.8%	9.1%	16.4%
Hematologic	767	4.2%	6.8%	9.8%
MSK	116	6.0%	9.5%	12.9%
HPB	190	6.8%	8.4%	12.6%

CNS indicates central nervous system; ENT, ear, nose, and throat; GI, gastrointestinal; GU, genitourinary; HPB, hepatic, pancreatic, biliary; MSK, musculoskeletal.

capturing events related to quality due to the abstracting derived from billing records.[27] Because hospital readmission is a patient care event that is not dependent on interpretation due to medical abstracting, the UHC database is appropriate for analyses evaluating such quality metrics as readmission. However, the inability of the UHC database to capture readmissions to outside facilities is a significant limitation of this study and it is likely to disproportionately affect those communities with higher market competition and some high-volume centers. Given that high-volume centers already had the highest rates of readmission, it is possible that the differences demonstrated in this study are even more drastic than we appreciated. Second, the UHC database represents only university-based hospitals with an inherent bias toward education and quality improvement; therefore, these findings may not be generalizable to all hospitals. However, the foundation of this database is to provide benchmark data for member hospitals to improve quality care and we were attempting to show nationwide trends for readmission in a complex group of patients. The study includes both medical and surgical cancer patients and also separately analyzes all surgical patients recognizing that surgical patients are, indeed, a very different subgroup of patients. All findings were consistent across the entire group and for surgical patients alone. Finally, we chose to focus on related readmissions. These rates are significantly lower than all-cause readmissions but represent those readmissions most likely to be influenced by interventions to reduce readmissions. The all-cause readmission rates from this analysis were similar to those seen in other studies.

CONCLUSIONS

Readmission is a complex issue with a myriad of interacting variables. In a large review of readmission rates for cancer patients, we identified only a small percentage of potentially preventable readmission diagnoses; however, given the exorbitant costs of readmission, even slight reductions in rehospitalization rates will have a significant impact on patient quality of life and reductions in health care costs. The majority of variables associated with higher readmission rates (emergency status, site of malignancy, readmission for care of postoperative complications) were not modifiable. Most importantly, care at high-volume centers and NCI-designated cancer centers was not associated with decreased readmissions. These findings lead us to conclude that perhaps readmission is not an appropriate measure of quality care.

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DISCUSSANTS

S. Weber (Madison, WI):

I congratulate the authors on a well-presented study and very nicely written manuscript on this very large series of more than 2.5 million cancer patients, more than 40% of which were surgical.

My largest concern is the underrepresentation of the scale of the problem and its impact on the conclusions in Jencks' original *The New England Journal of Medicine* article in 2009. The overall readmission rate for Medicare patients was 21% for medical patients and 15% in the surgical group. Although the UHC database represents a different patient group, as it includes data from academic centers and their affiliated hospitals that therefore includes younger patients, your readmission rates, at 6.5% and 4%, are markedly lower than those reported by Jencks and other groups. There may be a number of contributing reasons why this is the case, including the fact that UHC only captures readmissions to the index hospital. This has been shown to underrepresent readmissions in 25% to 50% of cases and occurs more frequently at comprehensive cancer centers, likely due to the distance patients travel to be cared for. Do you have other potential explanations for why the readmission rate is so low, especially in this high-risk population? Also, considering that this may have disproportionately affected high-volume centers, please comment on how this may impact your conclusions, particularly regarding the impact of hospital volume.

Other studies have shown contradictory results regarding the impact of hospital volume on the risk of readmission, with many studies showing that high-volume centers have decreased readmission rates. A recent publication from Tim Pawlik's group in the December 2013 issue of *JAMA Surgery* attempted to evaluate the source of variation in readmission using complex multivariate modeling and showed that variation in readmission was nearly entirely accounted for by patient-specific factors (95%) whereas hospital factors accounted for only 4% of the variability and surgeon volume only 1%, implying that patient comorbidity drives readmission more than hospital or surgeon volume. The finding that high-volume hospitals had higher readmission rates in this study may be due to the lack of control of case mix—the higher acuity patients with increased comorbidity are the very patients who are referred to high-volume hospitals. Please comment on this, and I would also encourage you to control for case mix in your model—adjusting for factors that others have found to impact readmission, including distance traveled, socioeconomic status, insurance, and comorbidity, to better understand the true impact of hospital volume on readmission.

Finally, I congratulate your group in adding to the growing body of literature that would suggest readmission is, at best, a poor metric of hospital quality. The work from Justin Dimick's group (*Ann Thorac Surg*. 2014;97:1214–1218) has shown that reliability of hospital readmission as a quality metric is poor—that much of the variation is due to statistical noise due to variations in case volume. The area where there is certainly more consensus regarding a path forward to enhance quality is the recognition that the transitions of care can be improved, and much work is now being done in this area. Is there anything we can conclude from your study regarding how to focus our efforts on improving the transitions of care for these complex patients, particularly those who were readmitted early?

Response From R.J. Bold:

To actually state something that is not in the disclosure, this is really not my research. This came about from Debbie Burgess, who is the QA nurse in our cancer center. The other hat I wear is the Associate Director for Clinical Operations. About a year and a half ago, she came to me and said this is on the horizon. Unless we tackle it proactively, we will really be behind the curve, because there's going to be a big financial impact coming our way. She really drove this, trying to benchmark us against the UHC, and that's why we chose the UHC. That does have some impact on our data analysis.

In terms of Dr Weber's first request—why is our readmission rate lower than has been reported in several other studies—I think there are a couple of factors that contribute to this. The first is that this is a university consortium, so we addressed readmissions only back to the index hospital. I think with care coordination in university settings, there are often readmissions at secondary hospitals that we are not capturing.

The second is that we looked at only what is termed "related readmissions." This is a term used by UHC in which, using all patient refined diagnosis-related groups, the secondary readmission is tagged as causally related to the first index. What this does is it excludes the 65-year-old man who has a low anterior resection and gets readmitted 29 days later for a kidney stone or for a gout flare in which the diagnosis does appear linked. We think that these are really the ones that are the burden of readmissions that we can potentially address.

We did exclude those related to planned readmissions, chemotherapy, or in our hospital and most hospital systems, transfer within the center or transfer to a rehabilitation facility, which are considered readmissions. We really didn't want to consider those as preventable, so those were excluded.

When we did look at the UHC database for all readmissions, the numbers are actually about what has been reported, somewhere around 20% for medical patients and about 15% for surgical. We were capturing about half of those as a point for intervention.

In terms of the question related to high-volume centers, we are in the process of doing the multivariate analysis controlling for comorbidities. We have that information for the adjusted index LOS. High-volume centers essentially look like the rest of everybody else. They do take care of sicker patients, but the UHC database allows us to control for them. So I think it's probably going to fall out. Still, the high-volume centers really don't do any better job, and readmission rates are dictated by the patient, patient diseases, and factors not related to the volume of the hospital.

Finally, in terms of what we can do to actually improve this, we really kind of came down and found out that this is really only going to be a small percentage of patients that we can intervene in. But we can use these patient-derived factors to identify those who are at a greatest risk for readmission and do a risk stratification intervention or patient-centered care. So patients with gastrointestinal complications going home after a low anterior resection don't need to be seen in

7 days. Their organ space infection is going to happen at 10 or 14 days, so their postoperative visit can happen at that point. However, ENT patients are going to suffer dehydration and be readmitted within 7 days. They need to be seen sooner in perhaps places such as rapid access or infusion centers to address the complications that they are going to develop.

As an intern I was always told to see the patient back 7 days postoperatively. I think that that's the wrong approach. We can get to patient-centered care in the transition from inpatient to outpatient setting.

DISCUSSANTS

M. Moon (St. Louis, MO):

Just last month, our group published our readmission rate after cardiac surgery at 14%. The major indications for readmission were congestive heart failure and, like your study, infection. Also, as in your study, we too found that early discharge was not associated with readmissions. In fact, we found the exact opposite; patients who had a prolonged hospital stay had a higher readmission rate.

But interestingly, the most important factor that we found that predicted readmission was the failure of the patient to see a physician in the early postoperative period, which is in contradistinction to your findings. We considered visits to the patient's primary care physician, cardiologist, or surgeon. Failing to have a follow-up visit was associated with a 6-fold increase in the risk of readmission.

Since we discovered that, we are beginning to develop a program of early appointments, within 2 weeks, to see a physician and hope that this may impact things, because they can medically modify their regimens and maybe perform some simple wound care or start oral antibiotics if necessary.

Based on your findings and your suggestion that some of these reasons for readmission are preventable, such as nausea, vomiting, dehydration, and pain, do you have any recommendations of how we should follow up with these patients? Do you feel we are facing this problem with overkill by seeing our patients back in the office? Should we set them up with a nurse practitioner or, as some people have suggested, with a phone call?

Response From R.J. Bold:

When we said "contact," that was either a telephone call or a clinic visit. It was about equally split. I think what people are doing are using things such as telemedicine or other ways to reach patients. But sometimes there is no good surrogate for actually seeing a patient physically and then placing a phone call with some kind of assessment. Maybe, the patient really doesn't know that he or she is heading into trouble. But you are absolutely right that we may be overkilling the situation, because it's a small fraction of patients who are seeing their physician early.

I think we can probably get to some things in terms of really centered evaluation for patients who are at risk so that those patients who are predicted from cardiac surgery to be in congestive failure have perhaps a 3-day visit. But, on the contrary, if those patients don't have risk factors for that kind of event happening postoperatively that would necessitate a readmission, they don't need to be seen. I really think that getting to a tailored approach, eliminating unnecessary use of resources that broadly cover people at a low risk is really where we are going to end up going.

DISCUSSANTS

D. Fry (Chicago, IL):

I have nothing to declare, on this subject anyway. I would rise to contest the conclusion that readmission is a poor indicator of quality of care. We just reported last month in the *American Journal of Surgery* a study of 2 million elective surgical cases among Medicare beneficiaries across 21 different groups of surgical operations. And what was not reported in that particular article was the risk-adjusted rates of readmission among the specific hospitals.

The top decile to the bottom decile has about a 5-SD difference. You can't tell me that this is due to random events when we look at hospital performance. There are hospitals that are doing this well; there are hospitals that are doing it not so well.

Our data clearly indicated that risk-adjusted LOS not only predicted readmissions at 90 days but also predicted postdischarge death. And postdischarge death in elective surgical cases in Medicare exceeds the deaths in the hospital for all operative groups. A little bit of a sobering observation.

So my questions are: we have used 90 days, because 90-day readmission rates still don't plateau out consistent with age-adjusted patients in the Medicare population. They are still being readmitted at a more rapid rate than would be anticipated for that age-adjusted population. I would like to raise the question to you and to the group in general as to whether the time point of 90 days for postdischarge readmission becomes a more appropriate measure.

I'm also interested in the issue of how you adjusted for noninstitutional readmission to your study group, because that is a big deal. That's why we have used the Medicare data, because we capture all of them. One third of readmissions go to hospitals other than the hospital where their index operations were performed.

My final question is a methodological one. When you do risk adjustment of populations with continuous variables across multiple hospitals, you have to put hospital dummy variables into the equation. If you don't, bad-performing hospitals end up distorting the intercept of the analysis and everything regresses back to the mean. Because you had some 230 hospitals in this analysis, I would ask whether you put hospital variables in the regression. A highly technical question for the American Surgical but it's a very relevant one relative to interpreting the data.

Response From R.J. Bold:

I think you are correct in stating that the 30-day time point may inaccurately reflect the impact that we as surgeons have on the care of our patients and that there is a tremendous amount of care provided beyond that time point, both in terms of morbidity and mortality, that we have really underestimated and is certainly a point for assessment in the future.

We chose 30 days as a traditional time point. We actually were looking much more closely in terms of the early events as something that could be a point for intervention, and perhaps the low-hanging fruit, because, as the interns sit there, look in the emergency department, and shake their head, it's like another bounce-back. I think that that concept is where we are really hoping to intervene, because maybe those are the patients where we are going to have the greatest impact.

You are absolutely correct. We did not have any information related to noninstitutional readmissions. Reports are that this happens between 30% and 50%, depending on the market environment and geography. We are looking at that in our next study.

In terms of using covariates within hospitals to account for that, we do have quite a bit of information about hospital-specific characteristics and patient-specific characteristics. We are now in the process of actually extending the analysis to integrate a lot more of those in terms of the multiple variables that do impact the readmission.

As you noted, there is a huge amount of variability in readmission rates, multiple standard deviations away from each other. But what we are really trying to get to the point is understanding what affects that variability. What we have discovered is that it's not really due to adjusted hospital volume, nor to provider volume, but it is due

to variables that we may not be able to control. Therefore, I think financially we shouldn't be penalized for that.

DISCUSSANTS

K.C. Kent (Madison, WI):

A quick comment and a question. In our own data on readmissions using the Medicare data set, about a third of the patients are readmitted to another hospital. Any data set that you use that doesn't take into consideration readmissions to associated hospitals will be flawed and underpredict the number of readmissions in your analysis.

I have to say I agree with Dr Fry. I think much can be done about readmissions. That's really the task at hand for all of us as surgeons. About 50% of your local readmissions at UC Davis were related to infection. The implication during your presentation was that you couldn't do anything to prevent a postdischarge infection. Do you really believe that, or are there opportunities in that regard?

Response From R.J. Bold:

That was a very good question, Dr Kent. We really didn't emphasize that. We tried to hint at that a little bit, which is, we may not be able to prevent the infection, but I think we can do things. Dr Weber was really asking us specifically to prevent the readmission related to the infection. I think that's where, again, that risk-adjusted, patient-centered care coordination and the transition of care may help us improve that care so that the patient who is really at risk for an infectious event necessitating readmission is seen in a different environment in a time frame to allow intervention before the serious infection necessitates a readmission.