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A national analysis of readmissions for wound healing complications following the repair of lower back, hip, and buttock pressure ulcers using the Nationwide Readmissions Database

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ABSTRACT

Background: Traditionally, a 30-day postoperative period is used to assess outcomes in surgery. However, it is not clear if this is sufficient. Our study assessed readmissions and their risk factors following the surgical repair of pressure ulcers in a 90-day postoperative period.

Methods: Patients with a pressure ulcer to the lower back, hip, and/or buttocks who underwent a pedicled or flap based wound operation were identified in the National Readmissions Database. We then analyzed risk factors for overall 0–90-day readmissions, early readmissions (0–30 days), and late-readmissions (31–90 days).

Results: 3329 patients were identified, of which 154 (4.66%) had surgical wound-related readmissions. A majority of these occurred after 30 days (53.89%). 90% of patients with a surgical-wound related readmission were readmitted within 63 days of index procedure.

Conclusions: The traditional 30-day outcome period is not enough to properly assess outcomes in pressure ulcer surgery such as readmission. We demonstrate that a period of at least 10 weeks and perhaps the entire global 90-day postoperative period would be more appropriate to evaluate readmissions after ulcer repair.

Introduction

Pressure ulcers are a common and complex issue caused by pressure over bony prominences and are often found in patients with poor wound healing. The majority of these ulcers occur over the sacrum (lower back), femoral trochanters (hip), and ischial tuberosities (buttocks).[1] They are often a problem in patient populations with greater immobility and multiple comorbidities such as persons with paraplegia or quadriplegia, stroke patients, obese patients, patients with dementia, or the elderly. It is estimated that pressure ulcers affect greater than 2.5 million people in the United States each year with recent data placing prevalence rates at 9.3% of US patients regardless of facility type and patient population.[2,3] It is estimated that the US health care system incurs 11 billion dollars in costs per year associated with pressure ulcer care. In particular, each ulcer-related hospitalization averages about a $48,000 charge.[4,5]

The high morbidity and mortality of pressure ulcers is well documented.[6–10] Mortality rates have been reported as high as 26.9% within 1 year of hospital acquired pressure ulcers.[11] Mainstays of care include frequent monitoring of the wound, avoiding further pressure to the wound, negative pressure wound therapy, and operative debridement.[12] Reconstructive surgery is considered a viable option for patients with large, late stage ulcers with inadequate wound healing or chronic osteomyelitis.[13,14] Musculocutaneous, fasciocutaneous, and perforator-based flaps are all viable options with similar rates of complication.[9] Common complications of pressure ulcer surgery include recurrence, hematoma, seroma, dehiscence, and infection.[9,10] Previous research has shown patients with pressure ulcers to have higher risk of adverse outcomes after major operations, yet little research into readmissions after surgical repair of ulcers exists.[15–17]

Most commonly, 30-day outcomes are used to assess postoperative complications. This is in large part due to the Hospital Readmission Reduction Program under the Patient Protection and Affordable Care Act of 2009.[18] This window may not adequately describe all postoperative complications. We sought to assess rates of admission within 90-days of discharge following the index

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surgical procedure for pressure ulcer repair of hip, back, or buttock as well as to identify and compare predictors of readmissions at different time intervals within the 90-day postoperative window.

Methods

The Nationwide Readmissions Database (NRD) was queried to perform a nationally representative analysis of patients with pressure ulcers located on the lower back, hip, and/or buttocks having undergone pedicled or flap procedures from 2013 to 2014. The NRD was created for the Healthcare Cost and Utilization Project (HCUP) by the Agency for Healthcare Research and Quality (AHRQ) for research tracking longitudinal inpatient healthcare utilization across hospitals in the United States. The data collected is from twenty-seven states across differing geographic regions, and from various hospital settings.[19] The NRD is unique given that it captures hospital readmissions that occur beyond the initial 30-days following an index hospital admission.[20,21]

For our research, adult patients (18 years or older) with a principal diagnosis of pressure ulcer located on the lower back, hip, and/or buttocks were identified using ICD-9 diagnosis codes (see Supplemental Table). Pedicle or flap graft based wound operations were identified using ICD-9 procedural codes (see Supplemental Table). For patients having this combination of diagnosis and procedure, we considered their first admission identified through each year of the NRD their index hospital admission from which we would track subsequent hospital readmissions (see Fig. 1).

We chose to examine readmissions during the global surgery period – between 0 and 90-days after the index hospital admission and operation.[22] Because the NRD can only be used to track patients within a given year, we chose to examine patients whose index hospitalization was between January 1 and October 2 for each of 2013 and 2014, which insured we would have data for each patient up to 90 days after their index admission.

Various patient demographic, socioeconomic, hospital-related, and comorbidities data were compared to readmissions in differing time-periods. For statistical tests employed in this research, we considered covariates including sex, age, payer type (Medicare, Medicaid, private insurance, and other), income based on median household income within the zip-code of a patient's residence, hospital teaching status, hospital urban versus rural designation, transfer to a facility upon discharge, and presence or history of COPD, diabetes, hypertension, metastatic renal failure, obesity (defined as BMI >= 30, or ICD-9 indicating failed image test due to excess body fat (793.91), or ICD-9 indicating obesity hypoventilation syndrome (278.03), or ICD-9 indicating obesity complicating pregnancy (649.10)), tobacco use disorder, paraplegic status, and quadriplegic status.[23] All variables listed above except for tobacco use disorder, paraplegic status, and quadriplegic status are built into and included in the NRD. Tobacco use disorder (305.1), paraplegic status (344.1), and quadriplegic status (344.00, 344.01, 344.02, 344.03, 344.04, 344.09) were identified using ICD-9 diagnosis codes at the time of index hospital admission.

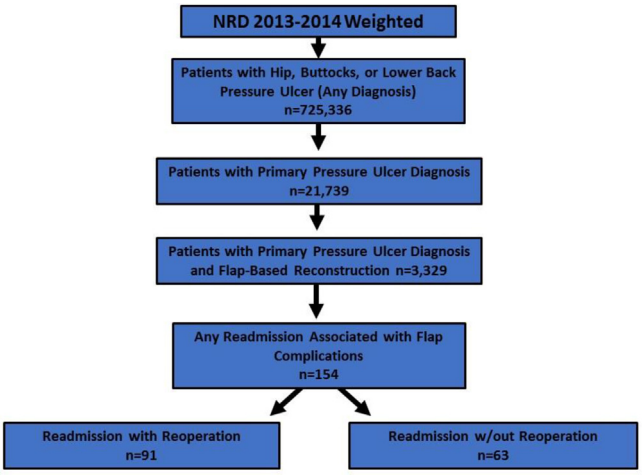

Fig. 1. Diagram for weighted cohorts.

With our cohort organized, our outcomes of interest included hospital readmissions, where primary diagnoses included postoperative infection or wound failure associated with the pedicle or flap graft-based procedure that occurred at index admission, and hospital readmissions where such diagnoses were present alongside additional wound care such as debridement, or the revision or addition of a pedicle or flap graft. We analyzed readmissions where reoperations were or were not present, but where infection or wound care diagnoses were present, or where wound operation was present at readmission. All such diagnoses were identified using ICD-9 diagnosis codes (see Supplemental Table), and wound reoperations were identified using ICD-9 procedural codes (see Supplemental Table).

Consistent with recommendations provided by HCUP, we utilize a hospital discharge weight that is both built into the NRD and associated with the index admission to reweight the stratum for national estimates.[20] All subsequent analyses were performed using the discharge weighted estimated population. We initially provide descriptive statistics such as population cohort size estimates, proportions, means, medians, quartiles, and the interquartile range, where appropriate to describe our cohort, the timing to and reasons for hospital readmissions, and costs associated with different readmission classifications. To identify risk factors for our postoperative readmissions of interest, we compared the demographic, hospital and comorbidity characteristics to each binary outcome using multivariable logistic regression. In these models, we model readmission with wound failure and/or postoperative infection in the 0–90-day postoperative period as a function of all covariates listed above, we model readmission with wound failure and/or postoperative infection and wound reoperation in the 0–90-day postoperative period, and readmission with wound failure and/or postoperative infection in the 0–90 day postoperative period without wound operation, each as a function of all covariates listed above. We similarly model readmission with wound failure and/or postoperative infection, wound failure and/or postoperative infection with wound reoperation, and wound failure and/or postoperative infection without wound reoperation in the 0–30-day (early) and 31–90-day (late) postoperative periods as a function of all demographic, hospital, and comorbidity characteristics. Wald tests were used to compute p-values associated with the null hypothesis of no-effect for each covariate of interest in each model. Coefficients are reported as odds-ratios for categorical and continuous predictors.

We compute two-sided p-values for all regression analyses and consider effect sizes significant given the corresponding p-value<0.05. All data management and analyses were performed using STATA 15.[24] Given the public availability of the Nationwide Readmissions Database and the lack of patient identifiable information, the University of Utah assigned the study exempt status.

Results

There were 3329 patients identified from the weighted NRD with the combination of a diagnosis of pressure ulcer to the lower back, hip, and/or buttocks and a pedicle or flap based wound operation. During the 90-day postoperative period, 4.66% (n = 154)

of patients had a surgical wound-related readmission. Of the patients with surgical wound-related readmissions, 59.09% underwent reoperation on the wound. The mean and median days to readmission of the overall cohort were 35.54 (SD = 18.56) and 33 days, respectively. Of those who underwent reoperation, the mean and median days to readmission were 39.22 (SD = 19.27) and 33, respectively (Tables 1 and 2).

The mean cost for surgical wound-related readmissions was $58,701.41. Readmissions for patients readmitted but not requiring reoperation had a mean cost of $38,984.27, which jumps to $72,339.08 in those requiring reoperation. (Table 1).

The mean age for those with a surgical wound-related readmission was 54.23 years (SD = 15.47). Of those patients readmitted, 61.36% (n = 95) were Medicare funded, 21.1% (n = 33) were Medicaid funded, and 11.41% (n = 18) were privately funded. The majority of patients (58.52%) with readmission had annual income greater than $40,000. Of the patients requiring a surgical wound-related readmission, 48.24% (n = 63) had their index procedure at a teaching hospital and 90.35% (n = 140) had their index procedure in an urban hospital. Of those readmitted, 18.50%% (n = 29) were diabetic, 11.64% (n = 18) were obese, 44.80% (n = 68) were paraplegic, and 12.47% (n = 19) were quadriplegic. Patients readmitted with a surgical wound-related readmission had been transferred to a facility following their index operation 50.66% (n = 78) of the time.(Table 1).

Less than half (46.11% or n = 71) of total surgical wound-related readmissions occurred in the early time period following their index procedure. A greater percentage occurred in the late time-period (53.89% or n = 83). For patients with a surgical wound-related readmission, 90% were readmitted within 63 days. For patients readmitted without reoperation, 90% were readmitted by 50 days. For patients readmitted requiring reoperation, 90% were readmitted by 68 days (Table 2).

Multivariable analysis was used to assess risk factors and protective factors for surgical wound-related readmissions in the overall 0–90 day postoperative period, surgical wound-related readmissions either requiring or not requiring reoperation, surgical wound-related readmissions in the early postoperative period (0–30 days), and surgical wound-related readmissions in the late postoperative period (31–90 days). There were no risk factors for overall surgical wound-related readmissions in the 0–90 postoperative period or for surgical wound-related readmissions without reoperation in the 0–90 day postoperative period. The only risk factor identified for 0–90-day surgery-related readmission requiring a reoperation was income less than $40,000 (OR = 3.67, CI 1.08–12.49, p = 0.037). Initial procedure at a teaching hospital was protective against 0–90 day surgical wound related readmissions (OR = 0.39, CI 0.23–0.67, p = 0.001) as well as surgical wound-related readmissions that would require reoperation (OR = 0.35, CI 0.17–0.75 p = 0.007). (Table 3).

No risk factors for surgical wound-related readmissions were identified in either the early or late postoperative periods. There were two protective factors against early surgical wound-related readmissions: household income between $51,000 and $65,999

Table 1
Cohort descriptive summary.

	Total Cohort	Patients with Any 90-Day Surgical Wound Related Readmission	Patients with 90-Day Surgical Wound-Related Readmission w/No Reoperation on Wound	Patients with 90-Day Surgical Wound-Related Readmission and Reoperation on Wound
All Patients	N = 3329 (Weighted)	N = 154 (4.66% of index surgical cohort)	N = 63 (1.89% of index surgical cohort, 40.91% of readmissions)	N = 91 (2.73% of index surgical cohort, 59.09% of readmissions)
Charges Associated with Readmission		Mean = $58701.41 Min = $3348 25th Percentile = $24476 Median = $35651 75th Percentile = $63094 Max = $350408	Mean = $38984.27 Min = $3348 25th Percentile = $15958 Median = $25439 75th Percentile = $41174 Max = $188632	Mean = $72399.08 Min = $17204 25th Percentile = $29108 Median = $39411 75th Percentile = $85805 Max = $350408
Age (Years)	Mean = 53.15 (Std. Dev = 17.16)	54.23 (15.47)	59.18 (17.00)	50.79 (13.87)
Female	35.01% (N = 1165)	44.8% (69)	44.8% (28)	44.04% (40)
Payer Type				
Medicare	61.09% (2033)	61.36% (95)	64.78% (41)	58.99% (54)
Medicaid	17.89% (595)	21.1% (33)	28.96% (18)	15.64% (14)
Private Insurance	16.1% (536)	11.41% (18)	6.27% (4)	14.98% (14)
Other	4.94% (165)	6.14% (9)	0% (0)	10.4% (9)
Median Household Income				
<$40,000	30.83% (1011)	41.48% (63)	37.35% (24)	44.42% (40)
$40,000-$50,999	30.16% (989)	23.91% (37)	19.67% (13)	26.92% (24)
$51,000-$65,999	22.36% (733)	18.78% (29)	15.02% (10)	21.45% (19)
>= $66,000	16.64% (546)	15.84% (24)	27.97% (18)	7.21% (6)
Hospital Variables				
Transferred to Facility upon Discharge	52.19% (1737)	50.66% (78)	60.21% (38)	44.03% (40)
Teaching Hosp.	67.88% (2259)	48.24% (75)	50.05% (32)	46.98% (43)
Urban Hosp.	93.45% (3111)	90.35% (140)	93.46% (59)	88.19% (81)
Comorbidities				
COPD	9.65% (321)	8.16% (13)	10.45% (7)	6.58% (6)
Diabetes	16.15% (537)	18.5% (29)	23.18% (15)	15.24% (14)
Hypertension	37.08% (1234)	41.47% (64)	51.4% (33)	34.57% (32)
Renal Failure	5.56% (185)	1.16% (2)	0% (0)	1.97% (2)
Smoker Status	13.11% (436)	17.43% (27)	14.14% (9)	19.71% (18)
Obesity	10.29% (342)	11.64% (18)	15.6% (10)	8.89% (8)
Paraplegic Status	49.61% (1651)	44.8% (69)	39.94% (25)	48.18% (44)
Quadriplegic Status	17.07% (568)	12.47% (19)	10.84% (7)	13.6% (12)
Length of Stay at Index	17.058 (24.78)	9.66 (8.29)	10.78 (9.42)	9.56 (7.91)

Table 2
Timing of surgical wound-related readmissions.

	Timing to Overall Readmission	Proportion Readmitted in 0–30 Day Postoperative Period (If Readmitted)	Proportion Readmitted in 31–90 Day Postoperative Period (If Readmitted)
Overall Readmission Cohort	Mean = 35.54 (SD = 18.56) Median = 33 Interquartile Range = (22, 48) 90% of Patients Readmitted within 63-Days	71 (46.11%)	83 (53.89%)
Patients Readmitted without Reoperation	Mean = 30.25 (SD = 15.86) Median = 32 Interquartile Range = (20, 39) 90% of Patients Readmitted within 50-Days	31 (49.92%)	32 (50.08%)
Patients Readmitted with Reoperation	Mean = 39.22 (SD = 19.27) Median = 33 Interquartile Range = (23, 53) 90% of Patients Readmitted within 68-Days	40 (43.46)	52 (56.54%)

(OR = 0.19, CI 0.04–0.99, p = 0.049) and index procedure performed at a teaching hospital (OR = 0.31, CI 0.12–0.76, p = 0.011). There were no protective factors identified in the late postoperative period (Table 4).

Discussion

Our data shows that there are clinically significant outcomes that occur beyond the 30-day postoperative period of surgically repaired pressure ulcers. In fact, more than half of surgery-related readmissions found in our study occur beyond the 30-day post-operative period. These findings suggest that the traditional 30-day outcome measure is not sufficient and that extending the postoperative period measured shows findings that can significantly impact patient care and healthcare policy.

Literature has long shown a high complication rate for patients undergoing flap based reconstruction of pressure sores.[25–27] A previous study at our institution found that over 35% of patients undergoing surgical repair of ulcer would have a post-operative complication, though this was thought to be a conservative estimate as the dataset only included complications in the 0–30 day post-operative period.[27] Our current study found that 4.66% of patients who underwent surgical repair of pressure ulcer would be readmitted. Previous studies do not assess readmissions, but assess only complications in the post-operative period, not distinguishing between index stay, readmissions, or other healthcare interactions.[6,7,9,17,19,20,22,27]

Studies have shown that a significant amount of recurrences occur in later time-periods, with one study reporting that 52% of recurrences were in later time periods.[26] Our study supports this data with 53.89% of readmissions occurring after the 30-day post-operative period. The current model of assessing outcomes within a 30-day period is clearly not sufficient.

Neither obesity nor diabetes were identified as risk factors for surgical wound-related readmissions of any type. This is somewhat surprising as both have previously been found to be predictors of complications in pressure ulcer surgery.[27,28] With no comorbidities identified as risk factors, it is possible that the complications from pressure ulcer surgery that lead to readmissions may be unavoidable, regardless of health status. This also suggests that data that

Table 3
Factors associated with overall surgery-related readmission and overall wound reoperation (multivariable).

	0–90-Day Readmission related to index surgery			0–90-Day Readmission Related to Index Surgery W/out Reoperation			0–90-Day Readmission Related to Index Surgery with Wound Reoperation		
	OR	95%CI	P-Value	OR	95%CI	P-Value	OR	95%CI	P-Value
Age (by decade)	0.99	(0.81, 1.21)	0.905	1.15	(0.81, 1.64)	0.428	0.89	(0.71, 1.12)	0.333
Female	1.45	(0.81, 2.59)	0.210	1.02	(0.53, 1.95)	0.956	1.77	(0.72, 4.38)	0.213
Payer Type									
Medicare	1.33	(0.52, 3.39)	0.548	1.84	(0.39, 8.61)	0.439	1.15	(0.37, 3.56)	0.807
Medicaid	1.63	(0.46, 5.78)	0.451	4.65	(0.74, 29.30)	0.102	.7988426.	(0.14, 4.55)	0.800
Private Insurance	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Other	1.82	(0.44, 7.57)	0.407	N/A	N/A	N/A	2.47	(0.55,11.12)	0.238
Median Household Income									
<$40,000	1.49	(0.65, 3.37)	0.343	0.71	(0.25, 2.02)	0.520	3.67	(1.08, 12.49)	0.037
$40,000-$50,999	0.87	(0.35, 2.14)	0.755	0.44	(0.12, 1.59)	0.211	2.07	(0.56, 7.64)	0.274
$51,000-$65,999	1.00	(0.38, 2.65)	1.000	0.45	(0.10, 2.10)	0.311	2.56	(0.73, 9.06)	0.143
>= $66,000	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Hospital Variables									
Transfer to Facility upon Discharge	0.87	(0.51, 1.48)	0.616	1.18	(0.48, 2.88)	0.712	0.72	(0.37, 1.39)	0.322
Teaching Hosp.	0.39	(0.23, 0.67)	0.001	0.48	(0.20, 1.15)	0.100	0.35	(0.17, 0.75)	0.007
Urban Hosp.	1.35	(0.40, 4.57)	0.633	1.67	(0.21, 13.65)	0.630	1.18	(0.28, 5.05)	0.823
Comorbidities									
COPD	0.66	(0.18, 2.35)	0.520	0.77	(0.16, 3.74)	0.749	0.60	(0.10, 3.75)	0.585
Diabetes	1.10	(0.51, 2.39)	0.803	1.36	(0.46, 4.04)	0.581	0.92	(0.31, 2.72)	0.880
Hypertension	1.14	(0.55, 2.35)	0.725	1.36	(0.43, 4.30)	0.602	0.98	(0.38, 2.47)	0.959
Renal Failure	0.17	(0.02, 1.36)	0.095	1 (Omitted)	(Omitted)	(Omitted)	0.37	(0.04, 3.09)	0.355
Smoker Status	1.36	(0.66, 2.78)	0.401	1.15	(0.39, 3.39)	0.796	1.46	(0.58, 3.67)	0.421
Obesity	1.20	(0.58, 2.47)	0.630	1.49	(0.55, 4.07)	0.437	0.92	(0.34, 2.51)	0.875
Paraplegic Status	0.71	(0.41, 1.25)	0.238	0.66	(0.29, 1.50)	0.324	0.79	(0.37, 1.69)	0.547
Quadriplegic Status	0.67	(0.27, 1.63)	0.374	0.56	(0.14, 2.22)	0.407	0.80	(0.28, 2.33)	0.687

Table 4
Factors associated with surgery-related hospital readmissions per time-period (multivariable).

	0–30 Day Readmit			31–90 Day Readmit		
	OR	95%CI	P-Value	OR	95%CI	P-Value
Age (by decade)	0.99	(0.72, 1.35)	0.932	1.00	(0.79, 1.27)	0.967
Female	1.04	(0.40, 2.75)	0.933	1.81	(0.93, 3.53)	0.079
Payer Type						
Medicare	4.28	(0.56, 32.85)	0.161	0.75	(0.24, 2.33)	0.623
Medicaid	3.94	(0.35, 44.68)	0.268	1.15	(0.31, 4.29)	0.830
Private Insurance	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Other	3.52	(0.31, 40.07)	0.310	1.55	(0.27, 8.84)	0.620
Median Household Income						
<$40,000	1.10	(0.38, 3.20)	0.864	2.22	(0.73, 6.75)	0.162
$40,000-$50,999	0.50	(0.14, 1.83)	0.295	1.73	(0.55, 5.48)	0.349
$51,000-$65,999	0.19	(0.04, 0.99)	0.049	2.77	(0.87, 8.86)	0.085
>= $66,000	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)	(Reference)
Hospital Variables						
Transfer to Facility upon Discharge	1.11	(0.48, 2.59)	0.800	0.71	(0.35, 1.42)	0.330
Teaching Hosp.	0.31	(0.12, 0.76)	0.011	0.51	(0.26, 1.01)	0.055
Urban Hosp.	0.87	(0.18, 4.27)	0.865	2.67	(0.51, 14.04)	0.244
Comorbidities						
COPD	0.16	(0.02, 1.35)	0.091	1.20	(0.33, 4.37)	0.782
Diabetes	0.83	(0.21, 3.38)	0.798	1.32	(0.52, 3.37)	0.558
Hypertension	1.01	(0.31, 3.31)	0.989	1.29	(0.64, 2.58)	0.471
Renal Failure	1 (Omitted)	(Omitted)	(Omitted)	0.27	(0.03, 2.24)	0.223
Smoker Status	1.93	(0.68, 5.45)	0.217	0.99	(0.39, 2.56)	0.991
Obesity	0.32	(0.05, 2.21)	0.249	1.78	(0.81, 3.93)	0.152
Paraplegic Status	0.65	(0.27, 1.58)	0.339	0.80	(0.36, 1.75)	0.569
Quadriplegic Status	0.27	(0.06, 1.20)	0.085	1.22	(0.40, 3.77)	0.728

includes pressure ulcer specific risk factors is needed to understand how to improve postoperative care.

For patients whose index operation was at a teaching hospital, there was a significantly smaller risk of overall 0–90 day surgical wound-related readmissions, any 0–90 day surgical wound-related readmissions requiring reoperation, and surgical wound-related readmissions in the early postoperative period. This may point out the benefit of greater patient and caregiver education. Due to the presence of residents and medical students, patients and their supportive caregivers are likely to receive extra education on wound care, giving them the ability to recognize the need to seek assistance with wound care.

Household income less than $40,000 was a significant predictor of 0–90 day surgery wound-related readmissions with wound reoperation. Household income between $51,000 and $65,999 was protective against surgery wound-related readmissions in the early postoperative period. These two results likely point out the importance of access to resources. Patients in the lowest income bracket are at higher risk for readmission with reoperation likely because they have less access to wound care services, transport to appointments, and supplies for wound care.

This study provides evidence to suggest our hypothesis that only a small portion of surgery-related complications after the surgical repair of pressure ulcers would be seen in the 0–30 day postoperative window is true, as 53.89% of surgery-related readmissions in the 0–90 day postoperative period occurred after 30 days. 90% of all of those readmissions occurred by 63 days. That number was slightly higher at 68 days for those readmissions that required a reoperation. We can therefore say that compared to a 30 day postoperative window, 70 days (or 10 weeks) is a more efficient window for assessing the majority of postoperative complications. This falls within the global 90-day postoperative period during which charges for normal postoperative care are covered by bundled global surgery fees. Therefore, assessing outcomes and readmissions in this entire global period is warranted for this and possibly other patient populations in order to create treatment strategies aimed at preventing later complications.

This is a difficult population to study with a great amount of variability. We attempted to create the most efficient query possible in order to get an accurate cohort, but limitations exist when using the Nationwide Readmissions Database. While we were able to differentiate between readmissions with or without reoperation, those readmissions could not be further stratified. We also cannot assess outpatient management of complications using this database. It is possible that with our methodology in the use of certain codes we are not capturing all readmissions and despite our use of specific postoperative complication codes, it is possible that some of our readmissions were not initially for the postsurgical wound. We were surprised by the small size of our cohort, further suggesting we may be missing a portion of pressure ulcer surgery patients and their readmissions. Coding for pedicle flaps can vary. While we chose the codes we felt most representative of the procedures, we may be missing some in our cohort. There are some factors we would have liked to include in our multivariable analyses that the database cannot not efficiently track, such as nutritional status or active osteomyelitis. We also could not be sure if this was each patient's first operation on their pressure ulcer. The use of a large national database such as the Nationwide Readmissions Database allows for broad generalizations about this cohort. A specific pressure ulcer database would be extremely helpful for a more granular analysis. Beyond these known limitations, there are some typical disadvantages of retrospective database reviews: inferiority to prospective studies, difficulty of determining causal relations through associations, and the possible presence of unknown confounding risk factors.

Conclusion

Pressure ulcers are a significant issue in healthcare for patients, physicians, nurses, hospitals, and insurance companies. Cost for surgery-related readmissions are high and rise significantly when requiring reoperation. Patient optimization through education and modifying risk factors, high attention to wound care, and careful planning for flap coverage are necessary to provide a high chance at

successful surgical coverage. It is important to provide more awareness of pressure ulcer risks and their wound care to at-risk patients and their caregivers. Research is needed so that the analysis of postoperative readmissions can be expanded to other surgical procedures. Our study shows that the 30 day postoperative period is too short to identify patterns of readmissions associated with certain risk factors in pressure ulcer patients. We conclude that the appropriate window for monitoring surgical outcomes should be increased to at least 10 weeks and perhaps for the entire global 90-day postoperative period.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2018.12.013.

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