



Age stratified analysis of pre-operative factors impacting unplanned thirty day readmission in geriatric general surgery



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ABSTRACT

Background: The geriatrics population can no longer be considered as one homogenous group when it comes to patient-centric and value-based care. We aim to determine if there are pre-operative factors which differ between geriatric age strata (65–74, 75–84, 85 + years) that impact unplanned thirty-day readmission.

Methods: 2015 NSQIP general surgery procedure data was utilized. Chi Square and t-tests were utilized to see if certain pre-operative factors impacted readmission. Regressions with age strata as an interaction term were run to determine if age was an effect-modifier. Significant pre-operative factors were included in a multivariate model with step-wise selection for significant age-stratification interaction terms.

Results: Gender, inpatient status, wound classification, disseminated cancer, origin status, functional status, and RVU were significantly impacted by age strata in unadjusted models. Gender, inpatient status, emergency, and transfer/origin status were significant in our adjusted model.

Conclusions: Exogenous variables between age strata significantly impact unplanned thirty-day readmission in comparison to differing co-morbidity and symptomatology.

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Introduction

The nation's geriatric population is expected to reach 83.7 million by the year 2050, almost double the size from 2012.¹ With the increase in the number of geriatric patients, it is important to not view the population as homogenous. There is no such thing as the “typical geriatric patient”.

Age stratification of the geriatrics population can provide better insight as to how to treat patients over the age of sixty-five. By understanding the possible pre-operative risks of the different age groups within the geriatrics population we can better incorporate either associated medical or environmental factors that ensure the best results for each patient. This type of knowledge will allow for more holistic and targeted care.

There is a limited amount of prior literature analyzing the

impact of geriatric patient age and general surgery outcomes. Existing literature focuses on mortality and complication rate. There is very little written on unplanned thirty day readmission. Polanczyk et al. determined mortality rate increased 2.6% and surgical complication increased by 6.8% in patients over 80 compared to those under the age of 80.² Similarly, Hamblet al determined that 30 day mortality rates for all causes were higher for patients over 80 using the National Surgical Quality Improvement Program data.³

Determining significant predictive factors for unplanned thirty-day readmissions in a stratified geriatrics population has yet to be studied. According to studies conducted by the Medicare Payment Advisory Commission (MedPAC),^{17,18} Medicare hospital expenses due to readmissions are as high as \$12 billion dollars a year. In addition, there are many health care mandates that place penalties on hospitals for unplanned thirty day readmissions, with the implementations of programs like the Hospital Readmission Reduction Program (HRRP) within the Affordable Care Act (ACA). Unplanned readmission indicate shortcomings in care, inadequate assessment before discharge, and can lead to death and post-operative complications that increase poor clinical prognosis and lower future quality of life.^{14,15} As such, there are more incentives and a higher necessity for hospitals to lower their unplanned readmission rates.⁴

Abbreviations: NSQIP-ACS, National Surgical Quality Improvement Program-American College of Surgeons; ANOVA, Analysis of Variance; SAS, Statistical Analysis Software; MedPAC, Medicare Payment Advisory Commission; HRRP, Hospital Readmission Reduction Program; ACA, Affordable Care Act.

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It has yet to be determined if the co-morbidities of a patient or exogenous factors, such as a patient's original location pre-operatively or functional status, have a larger impact on the chance of a geriatric patient being readmitted post-operatively. Thus, the goal of this study is to analyze which pre-operative factors impact a geriatric patient's change of an unplanned thirty day readmission. By stratifying the a geriatric population by age and identifying these clinical and non-clinical factors, we hope to provide a detailed analysis for physicians and surgeons in order to aid in lowering unplanned thirty day readmission in this group of interest.

Materials and methods

Data

The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) was utilized. NSQIP contains risk-adjusted 30 day surgical morbidity and mortality as well as information related to patient demographics and surgical categorization.

Data collection

We collected and compiled data from the NSQIP database for 2015. Inclusion criteria extended to any patient over the age of 65 who underwent a general surgical procedure as per NSQIP criteria in 2015. They were grouped by age as follows: 65–75, 75–85, 85+. Thirty day readmission was defined as per NSQIP definition: unplanned readmission to an acute care hospital setting 30 days to the midnight after their principal operative procedure. In order to have a more accurate capture of re-admitted patients, exclusion criteria, as per Lucas et al., included patients with post-op length of stay greater than ten days and those transferred to another acute care facility.

The following pre-operative factors were collected and analyzed: gender (female), type of principal operative procedure under general surgery, inpatient/outpatient, elective vs. emergency surgery, wound classification, ASA classification, presence of diabetes mellitus (no diabetes, diabetes with no insulin treatment, diabetes controlled with insulin), stroke, disseminated cancer, COPD, hypertension, CHF, Dyspnea (none, upon moderate exertion, at rest), origin status, functional health status, BMI and unintentional loss of more than 10 lbs in the six months prior to surgery.

We specifically chose factors that best reflected the types of factors included in a "frailty index" as defined by the Canada Study of Health and Aging.⁵ These are criteria that are heavily emphasized as important factors in the geriatric population and reflect clinical co-morbidities, nutritional, functional and cognitive status.^{6–13}

Statistical analysis

Distributions of pre-op patient characteristics across age strata were determined by chi-square and ANOVA tests. Unadjusted relationships between these variables and readmission were determined by chi-square and t-tests. To determine if age is an effect modifier for unplanned thirty day readmission, regressions were run for each variable, with age stratification as an interaction term. In a fully adjusted analysis, multivariate stepwise logistic regression was performed across the entire data set to determine significant effects. These effects were then included in model with step-wise selection for interaction terms that were previously demonstrated to be significant in relation to readmission in an univariate analysis. Significance was set at an alpha level of 0.05.

All analyses were conducted using SAS software, Version 9.4 for

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Results

Within general surgery procedures, there were 117,997 geriatric patients above the age of 60 in the NSQIP database in 2015. 73,097 patients were between the age of 65–74, 36,907 patients between the ages of 75–84 and 7993 patients over the age of 85. Out of about 54–60% of the patients were female (54.06%, 54.64%, 59.05% respectively per age group). Univariate analysis (Table 1) indicated that that each pre-operative factor was statistically different between each age strata. As age increased, there was a shift toward a larger percentage of inpatient procedures (52.15% between age 65–74, 57.32% between 75 and 84 and 62.91% in 85+), and smaller percentage choosing elective surgery (from 84.1% between 65 and 74, to 79.54% between the ages of 75–84 to 69.29% over the age of 85). As age increased wound classification and ASA class were also higher. Table 1 details the differences between each of the age strata.

Following this, the impact of each pre-operative factor on unplanned thirty day readmission was analyzed (Table 2). Individually, each pre-operative factors had a significant impact on unplanned thirty day readmission at an alpha level of 0.05. Age was then introduced as an interaction variable between each respective pre-operative factor and unplanned thirty day readmission. Significance at an alpha level of 0.05 for gender, inpatient status, wound classification, disseminated cancer, origin status, functional status and RVU. This was done to assess if age acted as an effect modifier for readmission. It indicated age stratification (whether the patient was between 65 and 74, 75–84, or 85+) impacted unplanned thirty day readmission.

Next, in a multivariate analysis, we included all significant interactions while simultaneously adjusting for all other significant predictors to determine the impact of age strata. Table 3 only presents significant interaction terms and their odds ratios across strata. This analysis yielded gender, inpatient status, emergency, and transfer status as factors particularly impacted by the age group of a patient in regards to an unplanned thirty day readmission.

Discussion

Both our data and past literature show that patients who are older tend to pose higher risk of readmission and have more severe co-morbidities. In addition, our analysis indicated that there are differences in pre-operative risk factors between the different age strata within the geriatrics population. Table 2 represents these results without adjustment for other variables.

When analyzing these factors as pre-operative risk factors for unplanned thirty day readmission between the different age groups, patient's gender, inpatient status, wound classification, disseminated cancer, origin status, functional status, and RVU (representing complexity of surgery) were not static factors between the age groups with regards to unplanned thirty day readmission. Each of these factors impacts the probability of an unplanned thirty day readmission differently depending on which age stratification they are in. When adjusting for confounding factors in the multivariate model (Table 3) gender, inpatient status, emergency, and transfer status. This means that the impact of these factors on unplanned thirty-day day readmission differs on the specific age of the geriatric patient. Interestingly, transfer status and inpatient status for the had decreasing odds ratios as age increased. One possible explanation for that could be that there are

Table 1
Univariate analysis and distributions for all chosen pre-operative variables.

Variable	65-74 (n = 62,961)		75-84 (n = 29,478)		85+ (n = 5761)		p-Value
Distribution of Comorbidities across Age and Outcomes							
Female	34614	54.98%	16304	55.31%	3403	59.07%	<0.0001**
Inpatient	32832	52.15%	16898	57.32%	3624	62.91%	<0.0001**
Elective	52949	84.10%	23446	79.54%	3992	69.29%	<0.0001**
Emergency	4508	7.16%	2693	9.14%	781	13.56%	<0.0001**
Wound Class							
1	31652	50.27%	14122	47.91%	2602	45.17%	<0.0001**
2	23004	36.54%	11131	37.76%	2203	38.24%	
3	4918	7.81%	2429	8.24%	521	9.04%	
4	3387	5.38%	1796	6.09%	435	7.55%	
ASA Class							
1/2	27779	44.12%	9250	31.38%	1328	23.05%	<0.0001**
3	32173	51.10%	17997	61.05%	3756	65.20%	
4/5	3009	4.78%	2231	7.57%	677	11.75%	
Diabetes							
None	49481	78.59%	23572	79.96%	4888	84.85%	<0.0001**
Oral Control	8865	14.08%	4079	13.84%	600	10.41%	
Insulin Control	4615	7.33%	1827	6.20%	273	4.74%	
Dypnea							
None	58367	92.70%	26730	90.68%	5211	90.45%	<0.0001**
Moderate Exertion	4261	6.77%	2568	8.71%	508	8.82%	
At Rest	333	0.53%	180	0.61%	42	0.73%	
Hx COPD	3993	6.34%	2359	8.00%	443	7.69%	<0.0001**
Hx CHF	490	0.78%	470	1.59%	157	2.73%	<0.0001**
HTN w/Medications	39347	62.49%	21064	71.46%	4270	74.12%	<0.0001**
Disseminated Cancer	2289	3.64%	1056	3.58%	151	2.62%	0.0004**
Origin Status							
Home	61302	97.37%	28265	95.89%	5311	92.19%	<0.0001**
Other	83	0.13%	70	0.24%	17	0.30%	
Outside ED	715	1.14%	448	1.52%	125	2.17%	
Nursing Home	3489	5.54%	379	1.29%	204	3.54%	
Other Acute Care	512	0.81%	316	1.07%	104	1.81%	
Functional Status							
Independent	61956	98.40%	28414	96.39%	5286	91.75%	<0.0001**
Partially Dependent	847	1.35%	896	3.04%	387	6.72%	
Fully Dependent	158	0.25%	168	0.57%	88	1.53%	
Weight Loss	1206	1.92%	679	2.30%	166	2.88%	<0.0001**
BMI	29.66	6.82	27.69	5.69	25.85	4.9	<0.0001**
Total RVU	21.44	17.15	21.42	16.01	20	14.28	<0.0001**
OUTCOMES							
Mortality	76	0.12%	77	0.26%	30	0.52%	<0.0001**
Readmission	3804	6.04%	2223	7.54%	502	8.71%	<0.0001**
Return to OR	1241	1.97%	579	1.96%	119	2.07%	0.875

less patients in the geriatric population as age increases and so the sample size is smaller as age increases. Apart from that, we were not able to provide other explanation as to why this pattern results. Most other factors indicated an increasing odds ratio as age increased.

These Results yielded an interesting pattern with regards to our original hypothesis. We aimed to address if there would be a differences between exogenous factors and co-morbidity based factors and their impact on thirty day readmission based on how old a geriatric patient was. Our analysis indicated that it was in fact, the exogenous factors were not static between the geriatric age groups and had significant impact on a patient's chance of unplanned thirty day readmission in comparison to pre-operative co-morbidities. These factors included gender, inpatient status, how infected the wound site is, complexity of surgery, inpatient status and where the patient came from and where they are going to. The majorities of these factors are not directly related to co-morbidities, but are more so related to exogenous factors such as the environment the patient came from, where they needed to be post-operatively, the incision site and complexity of surgery.

Usually, physicians and surgeons usually focus on co-morbidities, symptoms or signs when pre-operatively evaluating patients, with less focus on exogenous factors like functional status and where the patient came from-whether it be from another

hospital or a long term care facility. We demonstrated that these clinical and co-morbidity based factors can be considered relatively equally across all age stratification and within the geriatrics population. However, certain exogenous factors cannot. Thus, addressing these factors and taking them into greater consideration depending on the age of the patient when planning coordinated care in the geriatric population may aid in reducing geriatric unplanned thirty day readmission. Proper pre-operative assessment can help lower unplanned readmission rates, Usually, physicians and surgeons usually focus on co-morbidities, symptoms or signs when pre-operatively evaluating patients, with less focus on exogenous factors like functional status whether a patient came from home, a long term care facility, or another hospital. We demonstrated that these clinical and co-morbidity based factors, cannot be considered relatively equally across all age stratification and within the geriatrics population. As such, incorporating these exogenous factors into preoperative risk assessment will allow physicians to be better attuned to the subtleties within the geriatric population. This understanding will allow for a greater ability to predict adverse outcomes, and provide tailored discharge and care coordination plans. Ultimately, enhancing clinicians' understanding of geriatric risk factors will lead to better outcomes and a reduction of unplanned readmissions.

Table 2
Impact of each pre-operative factor on unplanned thirty day readmission. The last column analyzes each pre-operative factors impact on thirty day readmission with age as an interaction variable. The p-value for the interaction term represents its significance in a multivariate model. A significant (p < 0.05) interaction term indicates the effect of variable X varies with different levels of variable Y.

Variable	No Readmission (n = 91671)		Readmission (n = 6529)		p-value	p-value Interaction
Readmission with no adjustment						
Female	50940	55.57%	3381	51.78%	<0.0001**	0.006**
Inpatient	48206	52.59%	5148	78.85%	<0.0001**	<0.0001**
Elective	75626	82.50%	4761	72.92%	<0.0001**	0.7142
Emergency	7248	7.91%	734	11.24%	<0.0001**	0.0849
Wound Class		0.00%			<0.0001**	0.0018**
1	46447	50.67%	1929	29.55%		
2	33082	36.09%	3256	49.87%		
3	7132	7.78%	736	11.27%		
4	5010	5.47%	608	9.31%		
ASA Class		0.00%			<0.0001**	0.09626
½	36822	40.17%	1535	23.51%		
3	49722	54.24%	4204	64.39%		
4/5	5127	5.59%	790	12.10%		
Diabetes		0.00%			<0.0001**	0.2533
None	73089	79.73%	4852	74.31%		
Oral Control	12584	13.73%	960	14.70%		
Insulin Control	5998	6.54%	717	10.98%		
Dypnea		0.00%			<0.0001**	0.288
None	84553	92.24%	5755	88.15%		
Moderate Exertion	6632	7.23%	705	10.80%		
At Rest	486	0.53%	69	1.06%		
Hx COPD	6050	6.60%	745	11.41%	<0.0001**	0.3272
Hx CHF	961	1.05%	156	2.39%	<0.0001**	0.3148
HTN w/Medications	59996	65.45%	4685	71.76%	<0.0001**	0.1586
Disseminated Cancer	3033	3.31%	463	7.09%	<0.0001**	0.043**
Origin Status		0.00%			<0.0001**	0.0329**
Home	88747	96.81%	6131	93.90%		
Other	158	0.17%	12	0.18%		
Outside ED	1146	1.25%	142	2.17%		
Nursing Home	783	0.85%	149	2.28%		
Other Acute Care	837	0.91%	95	1.46%		
Functional Status		0.00%			<0.0001**	0.0595**
Independent	89478	97.61%	6178	94.62%		
Partially Dependent	1850	2.02%	280	4.29%		
Fully Dependent	343	0.37%	71	1.09%		
Weight Loss	1734	1.89%	317	4.86%	<0.0001**	0.745
BMI	28.86	6.47	28.63	6.91	0.0078**	0.4555
Total RVU	20.83	16.09	28.61	21.99	<0.0001**	0.0144**

Limitations

There were a number of limitations that should be acknowledged in this study. Firstly, we only used one year of NSQIP data which limited our study to 2015 National Surgical Quality Improvement Data. In addition, we used the NSQIP definition of readmission, so that it aligned with our data collection. This was

that readmission was counted as within 30 days of surgery and not 30 days from discharge This definition only partially aligns with the Center for Medicare and Medicaid's definition of thirty day unplanned readmission.

Conclusion

Surgeons should not analyze the geriatric cohort as one generalized group. Factors with a differential impact on readmission risk include gender, inpatient status, wound classification, disseminated cancer, origin status, functional status, and RVU (complexity of surgery) in our un-adjusted models and gender, inpatient status, emergency, and transfer/origin status in our adjusted model. These exogenous factors should be carefully considered in every pre-operative assessment and when designing care coordination pathways. This enhancement to standard screenings will aid in the reduction of 30 day readmission.

Conflicts of interest

None.

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Table 3
Significant Pre-Operative Factors Impacting Unplanned Thirty Day Readmissions which differ based on Geriatric Age Stratification. Only Factors which showed a significant relationship with Unplanned Thirty Day readmission (p < 0.05) were included in table.

Variable	p-value	Age Strata	Odds Ratio
Emergency	0.0019	65–75	0.846
		75–85	0.843
		85+	1.18
Gender (Female)	<0.0001	65–75	0.949
		75–85	0.833
		85+	0.695
Inpatient	0.0401	65–75	2.214
		75–85	1.722
		85+	1.512
Transfer from Long-Term Care	<0.0001	65–75	1.626
		75–85	1.437
		85+	0.739

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