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Preoperative Cognitive Impairment as a Perioperative Risk Factor in Patients Undergoing Total Knee Arthroplasty

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Abstract

Background: The study assessed whether pre-existing cognitive impairment (CI) prior to elective total knee arthroplasty (TKA) is associated with worse postoperative outcomes such as delirium, in-hospital medical complications, 30-day mortality, hospital length of stay and non-home discharge. **Methods:** A retrospective database analysis from the NSQIP Geriatric Surgery Pilot Project was used. There was an initial cohort of 6350 patients undergoing elective TKA, 104 patients with CI were propensity score matched to 104 patients without CI. **Results:** Analysis demonstrated a significantly increased incidence of post-operative delirium (POD) in the cohort with pre-op CI ($p = < .001$), a worsened functional status ($p = < .001$) and increased nonhome discharge postoperatively compared to the group without CI ($p = 0.029$). Other post-operative outcomes included 30-day mortality of 0% in both groups, and low rate of complications such as infection (2.88% vs 0.96%), pneumonia (1.92% vs 0%), failure to wean (0.96% vs 0%), and reintubation (0.96% vs 0%). Some other differences between the CI group and non-CI group, although not statistically significant, included increased rate of transfusion (10.58% vs 6.73%), and sepsis (1.92% vs 0%). The length of stay was increased in the non-CI group (4.28% vs 2.32%, $p = 0.122$). **Conclusion:** CI in patients undergoing TKA is associated with an increased risk of POD, worsened postoperative functional status, and discharge to non-home facility.

Keywords

cognitive impairment, postoperative, delirium; functional status, discharge destination, cognitive dysfunction

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Introduction

Total knee arthroplasty (TKA) is a commonly performed surgery, with a projected increase by 143% calculating to 725 procedures/1000,0000 from 425 procedures/100,000 in the United States by 2050 due to the expanding population of older adults of the age 65 and above.[1] With studies showing an increased quality of life after TKA in older adults,[2] it is expected there will be a higher demand for TKAs in the future.[3] This population undergoing TKA tend to have a higher likelihood of comorbidities and have an increased incidence of pre-existing cognitive impairment (CI) prior to surgery relative to a younger population. To date, the impact of preexisting CI in older adults undergoing TKA remains unclear, with few robust studies assessing the association between preoperative CI and key postoperative outcomes after TKA.

Multiple studies have shown increased postoperative mortality in patients who are cognitively impaired in other surgical procedures.[4-6] It has also been shown that there is a significantly decreased functional capacity at baseline in patients with preoperative CI. Mukka et al showed that patients with CI exhibited less mobility vs the control group after hemiarthroplasty for femoral neck fracture[7] Culley et al that showed that patients with a Mini-Cog score less than or equal to 2 were likely to be discharged to a place other than home after lower

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extremity orthopedic surgery.[8] A study in Finland suggested that patients with low preoperative cognitive test scores were more likely to experience postoperative delirium (POD) after arthroplasty or need for follow up care in a healthcare facility.[9] The study did not specify the type of follow up care that was required for these patients.

However, these studies did not specifically differentiate TKA from total hip arthroplasty (THA) outcomes. There is also no data available on post-operative length of stay in TKA or an association between CI and postoperative outcomes. Given the lack of data specific to TKA and the large number of these procedures performed in older adults, we sought to examine the impact of pre-operative CI on post-operative outcomes after elective TKA. We hypothesized that patients undergoing an elective TKA who have co-existing CI will have an increased incidence of discharge to a rehabilitation facility rather than home, and show an increased incidence of delirium and other postoperative complications. With this data, we want to emphasize the importance of a multidisciplinary approach to caring for patients pre-operative CI and with the older population's increased need for TKA, understand the long-term effects it could have on a patient's recovery and overall health.

Methods

Data Source

This manuscript adheres to the appropriate STROBE guidelines. The study was approved by the Institutional Review Board and exempted from the consent requirement due to the deidentified nature of the data. All data were derived from the American College of Surgeons National Safety Quality Improvement Program (ACS-NSQIP) Geriatric Surgery Pilot Program.[10] This pilot program contains information on individual surgeries retrospectively compiled from 25 participating clinical settings between January 1, 2014 and December 31, 2018 that collected data on patients aged 65 and older.[11] We retrospectively examined patients who underwent total knee arthroplasty and had pre-existing cognitive impairment which was identified by NSQIP via preoperative documentation that the patient had dementia or listed predefined descriptors consistent with dementia.[11]

Patient Selection

The NSQIP Geriatric Surgery Research files for years 2014 through 2018 were compiled into a single data file containing 52,894 surgical cases. The cases were matched using their unique identifier codes to case information from the NSQIP participant user file for the same years, resulting in a total of 298 variables for each unique case. The combined data file was then queried for patients undergoing TKA as defined by CPT code 27447, "Arthroplasty, knee, condyle and plateau; medial and lateral compartments with or without patella resurfacing (total knee arthroplasty)". Exclusion criteria included patients under age 65 years at the time of operation, trauma cases, transplant surgeries, cases failing to report the procedure CPT code or the variable defining pre-existing cognitive impairment and all cases where the patient was listed as an ASA physical status class 6, representing a brain-dead organ donor.

CI is defined in NSQIP to capture whether the patient has some degree of pre-existing dementia, with the following description: "Dementia is a chronic or persistent disorder of the mental processes caused by brain disease or injury and marked by memory disorders, personality changes, and impaired reasoning. Dementia may be recorded as: Dementia, Alzheimer's disease, Vascular dementia, Parkinson's dementia, Lewy Body Dementia, small vessel dementia, mild cognitive impairment (MCI), long term cognitive impairment, long term memory impairment, small vessel disease or white matter changes in the brain, memory disorder, cognitive disorder, chronic organic brain syndrome or chronic organic mental disorder".[12]

Demographic and Baseline Variables

The present investigation compared the characteristics of patients undergoing TKA, grouped by whether the patient had pre-existing cognitive impairment. Baseline demographic variables included age, gender, ethnicity, American Society of Anesthesiologists (ASA) physical status (PS) classification, and body mass index (BMI). Co-morbid conditions included for the analysis were diabetes, smoking history with number of pack years, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), chronic kidney disease (CKD), steroid dependence, presence of wound infection, bleeding disorders, sepsis and weight loss. Functional status in NSQIP is divided into 3 categories: independent, partially dependent, and totally dependent. Independent is defined as having no assistance from another person required for any ADLs, including patients who function independently with prosthetics, equipment or other supportive devices. Partially dependent is requiring some assistance from another person for ADLs and totally dependent is requiring total assistance for ADLs.[11]

Outcomes of Interest

The primary outcome was 30-day mortality. Secondary outcomes included rates of post-operative complications, including returning to the operating room, reintubation, failure to wean from ventilation, surgical site infections, dehiscence, pneumonia, acute kidney injury, renal failure, stroke, cardiac arrest, acute myocardial infarction, transfusion requirements, sepsis, urinary tract infections, venous thromboembolisms, total number of complications for each patient, and hospital length of stay. Post-operative delirium in patients was identified via chart audits. ACS NSQIP data abstractors routinely examined the entire medical record and assigned delirium if words characterized an acute confused state such as "mental status change, confusion, disorientation, agitation, delirium, inappropriate behavior, inattention, hallucination, combative".[12]

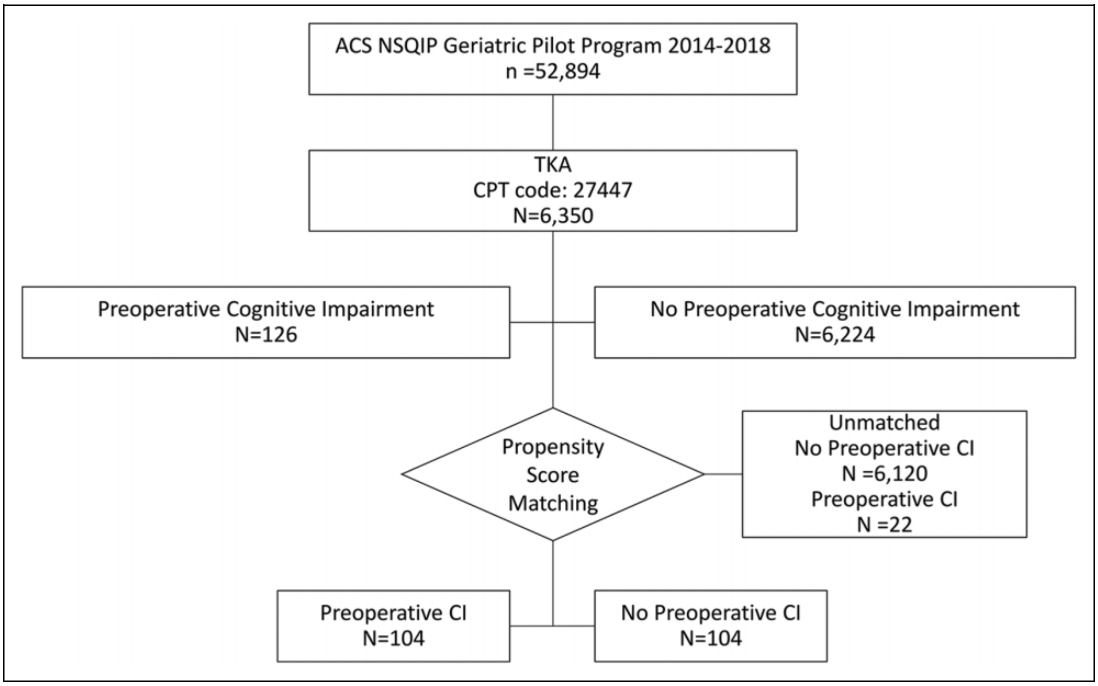

Figure 1. Study Flow Diagram TKA: total knee arthroplasty; CPT: current procedural terminology; CI: cognitive impairment.

Statistical Analysis

The surgical cohort was stratified by the presence or absence of CI. Initial comparison of the cohort with and without CI was performed utilizing Student's t-test for continuous variables and chi-squared test for categorical variables along with conditional univariable logistic regression. Risk adjustment between the 2 cohorts was performed using propensity score matching. To develop the matched cohort, we analyzed this initial data set, shown in **Appendix**, for statistically significant associations, which were defined as a p value < 0.05 on a Student's *t* or chi-square testing or a 95% confidence interval not containing 1.0 on logistic regression. We incorporated these variables into a propensity score model. To perform matching, we used a 1:1, greedy, nearest neighbor matching strategy, with a caliper set to 0.1, which resulted in the matching of 104 cases in patients with CI to 104 patients without CI. We then assessed the adequacy of this matching using Student's *t* test for continuous variables and Pearson's chi-square test for categorical variables along with univariable logistic regression as well as calculation of the absolute standardized differences for each variable, demonstrating adequate matching between cohorts. We then analyzed the association between CI and patient outcomes in this propensity-matched cohort using univariable logistic regression. In order to understand the effect of CI on individual patient outcomes, we calculated the total number of complications per patient as the sum incidence of all reported postoperative outcomes for each patient. For the multiple comparisons required to perform the outcomes analysis, we applied a Bonferroni correction with a selected omnibus criterion of significance of 0.05, yielding an adjusted p-value of significance of 0.0028 to maintain the familywise error rate at 0.05. All outcomes reported as significant in this manuscript were significant after application of this correction. Sample size was prespecified by the availability of TKA cases in the dataset. We performed all analyses using R Studio Version 1.1.463 (Boston, MA) and R Project for Statistical Computing, v.3.6.3 (Vienna, Austria).

Results

Baseline Patient Characteristics Before Propensity Matching

Descriptive information about the patients included in this cohort is shown in **Appendix**. The ACS NSQIP Geriatric Pilot Program contained a total of 52,894 patients between 2014-2018 (Figure 1). 6,350 corresponded to CPT code 27447 (TKA), which included 126 patients with preoperative CI and 6,224 patients without CI. Baseline characteristics were divided into 2 groups, 1 with preoperative CI and 1 without. The primary age group was between 70-80 years old (50%), majority being white females, with an average body mass index (BMI) of 29-31. Most patients were categorized as ASA physical status (PS) 1 or 2 in the non-CI group, and ASA 3 in the CI group. The ASA PS classification system is to assess and communicate a patient's pre-anesthesia medical co-morbidities The classification does not predict perioperative risks, but used with other factors (e.g., type of surgery, frailty, level of deconditioning), it can be helpful in predicting perioperative risks ASA PS is classified 1- 6, with 1 being a normal healthy patient, 2 is a patient with mild systemic disease, 3 is a patient with severe systemic disease, 4 is a patient with severe systemic disease that is. Constant threat to life, 5 is a moribound patient who is not expected to survive without the operation and 6 is a declared brain-dead patient whose organs are being removed for donor purposes.[13] Prevalent baseline comorbidities in both groups at baseline included hypertension (69%), history of chronic obstructive pulmonary disease (COPD) (4%), diabetes (17-19%), steroid use, smoking and history of bleeding diathesis. The functional status of these patients was stratified according to whether they had dyspnea and how severe it was as well as their independence with activities of daily living (ADLs). The majority of patients had no dyspnea (96%) at baseline and were independent (94% in CI group and 98.6% in non-CI group). Baseline laboratory values were mostly within normal limits. Spinal anesthesia was the most common type of anesthesia used (80% in CI group and 75% in non-CI) followed by general anesthesia with a small number of patients receiving an epidural as the primary anesthetic.

Post-Operative Patient Outcomes

Baseline characteristics of the matched cohort were divided into the CI and non-CI group of 104 patients in each group as seen in Table 1. The average age was 75, and the majority of patients were white females. These patients were mostly classified as an ASA 3 (60% in CI group vs 67% in the non-CI group). The anesthesia type was primarily spinal (83% in the CI group vs 73% in the non-CI group). Post-operative outcomes are displayed in Table 2. 30-day mortality was 0% in both groups, and complications such as infection (2.88% vs 0.96%), pneumonia (1.92% vs 0%), failure to wean (0.96% vs 0%), and reintubation (0.96% vs 0%) were low. The cohort with CI had significantly higher rates of POD compared to the cohort without CI (26.92% vs 0.96%, $p < 0.001$). The cohort with CI was also more likely to be partially dependent/fully dependent in ADLs postoperatively (82.69% vs 51.92%, $p < 0.001$) and was more likely to get discharged to a facility rather than home (50 vs 35.58%, $p = 0.029$).Other complications that were seen in the CI group, although not significantly different between the groups, included increased rate of transfusion (10.58% vs 6.73%), and sepsis (1.92% vs 0%). Interestingly, the length of stay was increased in the non-CI group (4.28% vs 2.32%, $p = 0.122$).

Discussion

In this retrospective chart review, we studied post-operative outcomes associated with pre-existing cognitive impairment in geriatric patients who underwent an elective TKA. Using the NSQIP Geriatric Surgery Pilot, we report a significant increase in POD in patients with pre-existing CI (OR 40.15; 95% confidence interval 5.3-304.13). Additionally, patients with CI were most likely to be discharged to a facility rather than home (OR 1.89; 95% confidence interval 1.07 – 3.35), and were less likely to be independent with ADLs compared to the no CI cohort (OR 4.26; 95% confidence interval 2.24 – 8.1). Our study offers some novel insights into increased postoperative risk in patients with existing CI and provides important data for risk stratification and prevention strategies.

Postoperative Delirium

Although the mechanism of POD has not been clearly described, there are multiple risk factors that are associated with its development. Previously reported common preoperative risk factors include age > 70, pre-existing CI, use of benzodiazepines, and previous history of POD.[14] Interestingly, opioid utilization at higher dose levels is also associated with significantly reduced POD. This reflects the notion, supported by existing data, that inadequate pain management is known to precipitate POD.[15] Ravi et al showed that prolonged surgical duration in hip fractures was associated with POD.[16] Wang et al also found that orthopedic surgery lasting longer than 3 hours was a risk factor for POD.[17]

It is important to identify patients at risk for POD as it has been shown to increase in-hospital (and long-term) mortality rates.[18,19] POD is also associated with increased postoperative complications, longer length of hospital stay, and higher rates of discharge to an outside facility.[20] A substantial portion (approximately 20%) of elective surgical patients in the geriatric population without dementia have CI at baseline before surgery.[21,22] Studies have shown that preoperative cognitive screening of older surgical patients may be valuable for risk assessment and risk stratification, especially for identification and possible prevention of POD.[7] A Mini-Cog examination can be performed prior to surgery and the patient may need a referral for further evaluation by primary care physician, or geriatrician.[8,23] A 2020 recommendations statement from the Society of Perioperative Assessment and Quality Improvement (SPAQI) makes recommendations about the use of various screening instruments for CI.[24] Many of these tests, such as the Clock drawing test command and copy (CDT), Mini-Cog, and the mini mental status exam (MMSE) show enough sensitivity and specificity for detecting CI. These tools can be used by lay or experienced examiners, are not very time consuming, and are freely available. In fact, a recent American College of Surgeons (ACS) guideline for geriatric surgical patients recommends performing a preoperative assessment of patients who may be at a higher risk for delirium, including those over age of 65, as well as patients with chronic cognitive decline or dementia, vision or hearing problems, infection, and severe illness.[25]

Studies have also suggested that the incidence of delirium can be as high as 10.4% after a TKA.[26] In our study, the incidence of POD in patients with preoperative CI was 26.92%. It is important to decrease rates of POD through early identification of patients at risk and by prevention via both non-pharmacological and pharmacological routes. Non-pharmacological routes that have been shown to be effective in the perioperative setting include early mobilization, communication, minimal use of psychoactive drugs and proper sleep.[27] Effective pharmacological techniques for the prevention of POD are still being studied, and there have not been

Table 1. Baseline Demographics and Comorbidities after Propensity Matching.

	Cognitive impairment		No cognitive impairment			
Variable	Mean	SD	Mean	SD	OR (95% CI)	p-value
Age	75.75	6.27	75.32	6.17	1.01 (0.97 - 1.06)	0.617
Age Groups	n	%	N	%	OR (95% CI)	p-value
65-70	21	20.19	20	19.23	Reference	0.979
70-80	55	52.88	55	52.88	0.95 (0.46 - 1.95)	
>80	28	26.92	29	27.88	0.92 (0.41 - 2.05)	
Sex						
Male	32	30.77	31	29.81	Reference	0.88
Female	72	69.23	73	70.19	0.96 (0.53 - 1.73)	
Demographics						
White	88	84.62	89	85.58	Reference	0.652
Black	7	6.73	9	8.65	0.79 (0.28 - 2.21)	
Not Reported	9	8.65	6	5.77	1.52 (0.52 - 4.44)	
	Mean	SD	Mean	SD	OR (95% CI)	p-value
BMI	29.53	5.91	29.23	5.45	1.01 (0.96 - 1.06)	0.706
BMI Groups	n	%	n	%	OR (95% CI)	p-value
<18.5	1	0.96	0	0	2394464.32 (0 - Inf)	
18.5-24.9	23	22.12	26	25	Reference	0.727
25-29.9	41	39.42	38	36.54	1.22 (0.6 - 2.49)	
>30	39	37.5	40	38.46	1.1 (0.54 - 2.25)	
Functional status						
No Dyspnea	100	96.15	101	97.12	Reference	0.605
Dyspnea with moderate exertion	3	2.88	3	2.88	1.01 (0.2 - 5.12)	
Dyspnea at rest	1	0.96	0	0	2139361.78 (0 - Inf)	
Independent	102	98.08	102	98.08	Reference	0.98
Partially/Totally Dependent in ADLs	2	1.92	2	1.92	1 (0.14 - 7.24)	
ASA class						
1/2	39	37.5	33	31.73	Reference	0.14
3	60	57.69	70	67.31	0.73 (0.41 - 1.29)	
4	5	4.81	1	0.96	4.23 (0.47 - 38.05)	
Comorbidities						
Smoking	4	3.85	5	4.81	0.79 (0.21 - 3.04)	0.733
Hypertension	71	68.27	82	78.85	0.58 (0.31 - 1.08)	0.084
Diabetes	20	19.23	20	19.23	1.00 (0.50 - 1.99)	1
COPD	5	4.81	1	0.96	5.20 (0.60 - 45.32)	0.098
Steroid use	5	4.81	5	4.81	1.00 (0.28 - 3.56)	1
Bleeding disorder	6	5.77	8	7.69	0.73 (0.25 - 2.20)	0.58
Sepsis	0	0	0	0	Reference	
Labs						
Creatinine	0.94	0.30	0.96	0.33	0.83 (0.35 - 1.97)	0.677
Hematocrit	39.7	5.00	40.1	4.50	0.86 (0.48 - 1.52)	0.596
Platelets	238	68	243	74	0.9 (0.61 - 1.33)	0.6
Anesthesia						
Spinal	87	83.65	76	73.08	Reference	0.036
General	15	14.42	28	26.92	0.47 (0.23 - 0.94)	
Epidural	2	1.92	0	0	Inf (0 - Inf)	

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists; ADLs, activities of daily living; COPD, chronic obstructive pulmonary disease.

controlled trials on this topic. However, theoretically several groups of drugs targeting the cholinergic, dopaminergic, serotonergic or noradrenergic system could be used to prevent delirium.[28] It has been suggested that intraoperative neuraxial anesthesia may decrease postoperative cognitive dysfunction when compared with general anesthesia, but this issue remains controversial, and there are ongoing, randomized trials to answer this important question.[29] Unfortunately, we did not have enough data to show whether the choice of anesthesia (general versus regional) has any effect on POD.

Post-Operative Decline in Independence

Our study showed a significant difference in reduction in functional status in patients with pre-operative CI (from 94% of patients being independent in the baseline cohort to only

Table 2. 30-Day Patient Outcomes.

	Cognitive impairment		No cognitive impairment			
Outcomes	n	%	N	%	OR (95% CI)	p-value
Death	0	0	0	0	–	–
Return to the OR	5	4.81	0	0	–	0.994
Failure to wean	1	0.96	0	0	–	0.997
Reintubation	1	0.96	0	0	–	0.997
Surgical site infection	3	2.88	1	0.96	4.17 (0.4 - 42.99)	0.231
Pneumonia	2	1.92	0	0	–	0.997
Renal insufficiency	1	0.96	0	0	–	0.998
Acute MI	0	0	1	0.96	0 (0 - ∞)	0.997
Transfusion	11	10.58	7	6.73	1.72 (0.63 - 4.68)	0.291
VTE	3	2.88	2	1.92	1.32 (0.21 - 8.13)	0.764
UTI	3	2.88	2	1.92	1.83 (0.29 - 11.66)	0.521
Sepsis	2	1.92	0	0	–	0.998
Readmission	9	8.65	7	6.73	1.57 (0.54 - 4.51)	0.405
Post-operative Delirium	28	26.92	1	0.96	40.15 (5.3 - 304.13)	<0.001
Length of stay	3.62	2.32	3.35	4.28	1.12 (0.97 - 1.3)	0.122
Number of complications	1.26	0.72	1.11	1	1.15 (0.89 - 1.49)	0.272
Post op Functional Status						
Independent	18	17.31	50	48.08	Reference	
Partial/Totally Dependent	86	82.69	54	51.92	4.26 (2.24 - 8.1)	<0.001
Discharge Location						
Home	52	50	67	64.42	Reference	
Not Home	52	50	37	35.58	1.89 (1.07 - 3.35)	0.029

Abbreviations: OR, operating room; MI, myocardial ischemia; VTE, venous thromboembolism; UTI, urinary tract infection.

17% post- operatively). Poor functional status correlates with increased morbidity and mortality; patients needing assistance are likely to develop post-operative complications including pneumonia, infections, and reintubations.[6] Thorough pre-operative evaluation of CI and possible intervention, or rehabilitation could improve outcomes for functional status post operatively.[30] A study performed in Norway showed patients who underwent preoperative and postoperative rehabilitation at a sports medicine clinic showed superior patient-reported outcomes 2 years postoperatively compared to patients who received usual care. The prehabilitation program was 5 weeks long and included heavy resistance strength training.[31] Another study showed that co-management of hip fracture patients by geriatricians and orthopedic surgeons had shorter length of stays, fewer cardiac complications, and decreased incidence of delirium and infection.[32] Prehabilitation has also been shown to reduce total healthcare expenditure, although there needs to be further research in whether this is helpful in patients with preoperative CI undergoing a TKA.[32]

Having a more multidisciplinary team consisting of anesthesiologists, geriatricians, orthopedic surgeons, nurses and other clinical staff could improve patient outcomes with integration of prehabilitation.[33] Additionally, physical therapists are critical members of the team in optimization of post-operative recovery. One study has shown that just a one-time session with a physical therapist to learn and practice postoperative precautions, exercises, bed mobility preoperatively achieved readiness to discharge from PT faster than the control group.[34]

Recent SPAQI recommendations for the preoperative management of frailty[35] as well those on launching a dedicated geriatric surgery center[36] have outlined specific steps and considerations in vulnerable populations undergoing elective surgery. This includes active screening for frailty as well as developing clinical pathways, and incorporating geriatric co-management, shared decision-making, and multimodal prehabilitation to improve postoperative outcomes. In fact, frailty assessment can facilitate preoperative counseling regarding post-operative disposition and discharge planning.[37]

Discharge Destinations

Non-home discharge adds $1.82 billion annually to postoperative rehabilitation costs.[38] There are several factors that could predict being discharged to acute rehabilitation facilities such as living status, age, preoperative systemic health and medical insurance. The ARISE (Arthroplasty Rehabilitation Initial Screening Evaluation) trial which investigated patient characteristics associated with postoperative disposition, incorporated psychological, functional, and socio-demographic factors to determine discharge destination.[38] It showed that pre-operative patient beliefs regarding rehabilitation and future home social support are highly predictive of discharge destination after primary TKA. The only demographic variable that is predictive is increasing age, and in particular, age 75 years and over. Our study showed increased likelihood of discharge to a facility other than home in a patient with preoperative CI.

A recently published study on non-home discharge (NHD) in the general surgical population showed that it is indeed multifactorial and includes risk factors such as advanced age, high risk surgeries (orthopedic, cardiac, and neurosurgery), prior use of mobility aid, fall within 3 months, and body mass index > 30.[39] Other associated factors include access to home services, addressing patient's pre-surgical beliefs about perceived challenges of rehabilitation at home, as well as multimodal pain management and early mobilization. Another interesting finding in our study was that the non-CI group had increased length of stay. One possible explanation could be that patients destined for non-home discharge (such as rehabilitation) would be able to leave the hospital sooner and therefore have decreased length of stay in the CI group.[40]

Limitations

This analysis was based on data acquired through the NSQIP dataset and is therefore limited by the study's retrospective nature and limitations of data collection as have been described previously.[41] However, a large and diverse group of hospitals with different practice models submit their noncontrolled data to the NSQIP, therefore we still believe that this study's findings are broadly generalizable to current practice. The incidence of delirium was based off a manual chart review by NSQIP trained clinical reviewers, looking for keywords that are suggestive of delirium. These data could potentially be underreported if the healthcare provider failed to document characteristics of delirium. Literature suggests that that the incidence of postoperative delirium depends on the type of surgery, with hip fracture being the highest followed by cardiac surgery, however, there is variation in this data as well due to the different methods used to report incidence of delirium.[20] CI was identified in patients through documentation by a nurse or doctor stated that the patient had dementia or listed predefined descriptors consistent with dementia.[11] This could limit the sensitivity of the variable to capture early CI and therefore it may have been underestimated. Another confounding factor which could change outcomes post-TKA is the lack of standardization or data available regarding frequency of physical therapy and occupational therapy. Considering how much of an impact pre-op CI had on functional status, it would've been important to know the amount of physical therapy these patients had post operatively. Additionally, due to the incidence of cognitive impairment in our cohort, we are unable to comment on the impact of anesthesia type, such as spinal versus general anesthesia, on outcomes in patients undergoing TKA.

Conclusions

Post-operative outcomes such as delirium and reduction in ADLs are associated with an increase in morbidity and mortality. Our study showed that preoperative CI is a predictor for post-operative delirium, non-home discharge and functional decline in patients undergoing TKA. These outcomes could affect patients' quality of life and also increase burden on the healthcare system. Early identification of patients with CI and preemptive interventions such as multidisciplinary care involving geriatricians and/or neurocognitive specialists may decrease adverse outcomes for these high-risk patients.

Appendix. Baseline Characteristics and Comorbidities in Unmatched Cohort.

	Cognitive impairment		No cognitive impairment			
Variable	Mean	SD	Mean	SD	OR (95% CI)	p-value
Age	75.48	6.21	73.14	5.92	1.06 (1.03 - 1.09)	<0.001
Age Groups	n	%	N	%	OR (95% CI)	p-value
65-70	25	19.84	2075	33.34	Reference	0.001
70-80	68	53.97	3124	50.19	1.81 (1.14 - 2.87)	
>80	33	26.19	1025	16.47	2.67 (1.58 - 4.52)	
Sex						
Male	38	30.16	2307	37.07	Reference	0.112
Female	88	69.84	3917	62.93	1.36 (0.93 - 2)	
Demographics						
White	103	81.75	5049	82.23	Reference	0.222
Black	13	10.32	425	6.92	1.5 (0.84 - 2.69)	
Not Reported	10	7.94	666	10.85	0.74 (0.38 - 1.42)	
	Mean	SD	Mean	SD	OR (95% CI)	p-value
BMI	29.7	5.89	31.11	6.01	0.96 (0.93 - 0.99)	0.009
BMI Groups	n	%	N	%	OR (95% CI)	p-value
<18.5	1	0.79	14	0.23	2.31 (0.29 - 18.23)	0.016

(continued)

Appendix. (continued)

Variable	Cognitive impairment		No cognitive impairment		OR (95% CI)	p-value
	Mean	SD	Mean	SD		
18.5-24.9	27	21.43	874	14.07	Reference	
25-29.9	46	36.51	2023	32.56	0.74 (0.45 - 1.19)	
>30	52	41.27	3302	53.15	0.51 (0.32 - 0.82)	
Functional status						
No Dyspnea	122	96.83	6024	96.79	Reference	0.219
Dyspnea with moderate exertion	3	2.38	190	3.05	0.78 (0.25 - 2.47)	
Dyspnea at rest	1	0.79	10	0.16	4.94 (0.63 - 38.88)	
Independent	119	94.44	6134	98.55	Reference	<0.001
Partially/Totally Dependent in ADLs	7	5.65	90	1.45	3.44 (1.47 - 8.01)	
ASA class						
1/2	47	37.6	3290	52.93	Reference	0.001
3	73	58.4	2814	45.27	1.82 (1.25 - 2.63)	
4	5	4	112	1.8	3.12 (1.22 - 8.01)	
Comorbidities						
Smoking	4	3.17	236	3.79	0.83 (0.3 - 2.27)	0.719
Hypertension	86	68.25	4332	69.6	0.94 (0.64 - 1.37)	0.745
Diabetes	25	19.84	1049	16.85	1.22 (0.78 - 1.9)	0.376
COPD	5	3.97	232	3.73	1.07 (0.43 - 2.64)	0.888
Steroid use	6	4.76	228	3.66	1.31 (0.57 - 3.02)	0.517
Bleeding disorder	7	5.56	149	2.39	2.4 (1.1 - 5.23)	0.023
Sepsis	1	0.79	5	0.08	9.95 (1.15 - 85.8)	0.01
Labs						
Creatinine	0.95	0.31	0.92	0.4	1.14 (0.84 - 1.56)	0.274
Hematocrit	39.9	4.90	41.3	4.10	0.48 (0.33 - 0.7)	0.002
Platelets	234	67	243	66	0.8 (0.6 - 1.07)	0.145
Anesthesia						
Spinal	94	80.34	4194	75.26	Reference	0.025
General	21	17.95	1358	24.37	0.69 (0.43 - 1.11)	
Epidural	2	1.71	21	0.38	4.25 (0.98 - 18.38)	

Abbreviations: BMI, body mass index; ASA, American Society of Anesthesiologists; ADLs, activities of daily living; COPD, chronic obstructive pulmonary disease.

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