Frailty Among Total Hip and Knee Arthroplasty Recipients: Epidemiology and Propensity Score-weighted Analysis of Effect on In-hospital Postoperative Outcomes

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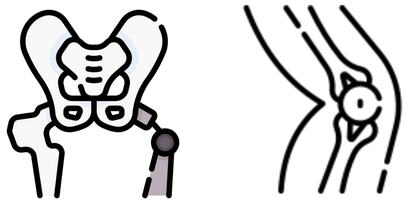
Introduction

- The volume of primary total joint arthroplasty (TJA) is on the rise with projected growth estimating annual rate of 635,000 total hip arthroplasties (THA) and 935,000 total knee arthroplasties (TKA) by 2030.[1]
- While the procedures have a longstanding track-record in substantially improving quality of life when successful, a considerable amount of complications, especially in the short postoperative term remains problematic.[2–4]
- As technological and medical advances continue, and as the quality of life and activity level expectations of an aging population improve, the demand for TJA among elderly patients will increase.
- This trend will further expose surgeons to a population with a higher number of medical comorbidities and risk for frailty. Frailty is the age-related decline in physiological capacity and function, and has been noted to subject patients to adverse health outcomes and complications, especially in the postoperative setting.[5]
- This is a retrospective analysis study that sought to further expand this knowledge and fill this gap in the literature. We hope that the data from this study will allow for better personalization of care-plans and improvement of efficiency in resources allocation in preoperative optimization efforts.



Aims and Objectives

Aim I: Explore the trend in incidence of frailty among TJA recipients.

Aim II: Analyze the differences in the demographic and medical comorbidity profiles between frail and non-frail patients.

Aim III: Compare in-patient postoperative medical and economic outcomes between these two groups.

Methods

Population Selection

- Patient population was extracted from the discharge data from the National Inpatient Sample (NIS) collected between 2006 and the third quarter of 2015.
- All participants aged 50 years older who received either primary THA or TKA were included.
- Nonelective admission and hip fractures were excluded

Data Collection

- Stratified into 2 main cohorts: frail vs. non-frail
- Frail patients were identified with at least 1 of the following ICD-9 codes: pressure ulcers, cachexia, failure to thrive, muscle weakness, abnormal weight loss, muscular wasting, disuse atrophy, senility, malaise and fatigue.
- Discharge data including comorbidity, length of stay, cost, outcomes were collected

Data Analysis

- Inverse Probability of Treatment Weighting was used to balance covariates and minimize confounding bias effects.
- Propensity Score-weighted analysis was done by weighting patient demographics, hospital characteristics, and comorbidities using a modified version of the Elixhauser Comorbidity Index.

Results

Year	Overall Frailty Frequency (P-value < 0.0001)
2006	8,392 (0.10%)
2007	9,130 (0.11%)
2008	12,158 (0.14%)
2009	14,386 (0.17%)
2010	15,110 (0.18%)
2011	16,808 (0.20%)
2012	19,190 (0.23%)
2013	21,240 (0.25%)
2014	22,520 (0.27%)
2015	19,070 (0.23%)

Table 1: Trend in Frequency of Frailty among TJA Recipients by Year

		Frail	Non Frail	P-Value
		(n = 158,005)	(n = 8,276,941)	
Age of Patient (Years)				
	Mean (Standard Error)	69.8 (0.10)	67.4 (0.02)	<.0001
Biological Sex of Patient				
	Male	54,128 (34.26%)	3,220,900 (38.91%)	< 0.0001
	Female	103,873 (65.74%)	5,050,179 (61.02%)	
Expected Primary Payor				
	Medicare	105,465 (66.75%)	4,725,794 (57.10%)	< 0.0001
	Medicaid	4,583 (2.90%)	212,610 (2.57%)	
	Private	42,965 (27.19%)	3,046,465 (36.81%)	
	Other	4,777 (3.02%)	276,021 (3.33%)	
Race of Patient				
	Non-Hispanic White	117,436 (74.32%)	6,019,030 (72.72%)	< 0.0001
	Non-Hispanic Black	11,440 (7.24%)	492,418 (5.95%)	
	Hispanic	8,253 (5.22%)	324,336 (3.92%)	
	Other Race	20,876 (13.22%)	1,441,157 (17.41%)	
Location/Teaching Status of Hospital				
	Rural	15,447 (9.78%)	862,581 (10.42%)	0.19506
	Urban Teaching	58,491 (37.02%)	3,338,971 (40.34%)	
	Urban Non-teaching	64,684 (40.94%)	3,314,535 (40.05%)	
	Unknown	19,383 (12.27%)	760,854 (9.19%)	
Region of Hospital				
	Northeast	25,570 (16.18%)	1,342,964 (16.23%)	< 0.0001
	Midwest	36,916 (23.36%)	2,051,562 (24.79%)	
	South	56,426 (35.71%)	2,658,860 (32.12%)	
	West	20,023 (12.67%)	1,490,666 (18.01%)	

Table 2: Demographic and Hospital Factors, Stratified by Frailty

- From 2006 to the third quarter of 2015, a total of 8,434,946 TJA recipients (5,757,628 TKA with 96,602 frail, and 2,677,318 THA with 61,423 frail) met the inclusion criteria of this study. During the study period, there was a nearly two-and-a-half-fold statistically significant increase in the frailty frequency from 0.10% in 2006 to 0.27% in 2014.

	Frail	Non Frail	P-Value
	(n = 158,005)	(n = 8,276,941)	
Acquired Immune Deficiency Syndrome (AIDS)	104 (0.07%)	3,034 (0.04%)	0.0089
Alcohol Abuse	2,472 (1.56%)	85,790 (1.04%)	<.0001
Deficiency Anemias	30,933 (19.58%)	1,069,921 (12.93%)	<.0001
Rheumatoid Arthritis/Collagen Vascular Disease	8,080 (5.11%)	314,170 (3.80%)	<.0001
Chronic Blood Loss Anemias	4,247 (2.69%)	134,927 (1.63%)	<.0001
Congestive Heart Failure	7,567 (4.79%)	220,334 (2.66%)	<.0001
Chronic Pulmonary Disease	27,510 (17.41%)	1,203,053 (14.53%)	<.0001
Coagulopathy	5,059 (3.20%)	166,727 (2.01%)	<.0001
Depression	24,703 (15.63%)	982,959 (11.88%)	<.0001
Diabetes (Uncomplicated)	30,962 (19.60%)	1,507,902 (18.22%)	<.0001
Diabetes (Complicated)	4,117 (2.61%)	132,831 (1.60%)	<.0001
Drug Abuse	1,306 (0.83%)	37,456 (0.45%)	<.0001
Hypertension	110,999 (70.25%)	5,524,711 (66.75%)	<.0001
Hypothyroidism	26,957 (17.06%)	1,266,655 (15.30%)	<.0001
Liver Disease	1,842 (1.17%)	75,659 (0.91%)	<.0001
Lymphoma	624 (0.40%)	23,202 (0.28%)	0.0002
Fluid and Electrolyte Disorder	22,877 (14.48%)	704,752 (8.51%)	<.0001
Metastatic Cancer	711 (0.45%)	10,951 (0.13%)	<.0001
Other Neurological Disorders	11,201 (7.09%)	311,211 (3.76%)	<.0001
Obesity	35,661 (22.57%)	1,580,967 (19.10%)	<.0001
Paralysis	1,623 (1.03%)	22,048 (0.27%)	<.0001
Peripheral Vascular Disorders	5,842 (3.70%)	182,456 (2.20%)	<.0001
Psychoses	4,968 (3.14%)	152,670 (1.84%)	<.0001
Pulmonary Circulation Disorders	2,482 (1.57%)	78,966 (0.95%)	<.0001
Renal Failure	10,441 (6.61%)	342,730 (4.14%)	<.0001
Solid Tumor without Metastasis	1,094 (0.69%)	39,627 (0.48%)	<.0001
Peptic Ulcer Disease Excluding Bleeding	64 (0.04%)	1,597 (0.02%)	0.0081
Valvular Heart Disease	8,027 (5.08%)	316,558 (3.82%)	<.0001

Table 3: Modified Elixhauser Comorbidities Profile, Stratified by Frailty

	Frail	Non Frail	OR_{IPTW} (95% CI)	P-Value
Any complications	32.28%	23.98%	1.51 (1.42 - 1.61)	<.0001
Central Nervous System	0.14%	0.08%	1.72 (1.29 - 2.30)	0.0002
Cardiac Complication	0.71%	0.66%	1.08 (0.95 - 1.24)	0.2552
Genitourinary (GU) Complication	0.61%	0.52%	1.17 (1.00 - 1.37)	0.055
Gastrointestinal (GI) Complications	0.25%	0.28%	0.91 (0.72 - 1.15)	0.438
Respiratory	0.19%	0.18%	1.07 (0.82 - 1.41)	0.6239
Hematoma/Seroma	0.90%	0.63%	1.42 (1.23 - 1.64)	<.0001
Wound Dehiscence	0.15%	0.09%	1.71 (1.28 - 2.29)	0.0003
Postoperative Infection	0.21%	0.13%	1.59 (1.22 - 2.07)	0.0005
Deep Vein Thrombosis (DVT)	0.43%	0.32%	1.34 (1.13 - 1.59)	0.0008
Pulmonary Embolism (PE)	0.36%	0.35%	1.02 (0.85 - 1.23)	0.8181
Postoperative Anemia	30.37%	22.12%	1.54 (1.44 - 1.64)	<.0001
Home Discharge	45.60%	65.32%	0.61 (0.58 - 0.65)	<.0001
Rehab Discharge	53.93%	34.49%	1.63 (1.54 - 1.72)	<.0001
Length of Stay (LOS) (days)	3.7 (0.03)	3.2 (0.01)	--- (---, ---)	<.0001
Total Charges ($)	59,766 (889.4)	50,601 (431.7)	--- (---, ---)	<.0001

Table 4: Inverse Probability of Treatment Weighting (IPTW) of In-patient Postoperative Outcomes, Stratified by Frailty

- During the study period, several statistically significant differences in demographic and hospital factors between frail and non-frail patients were observed. The average age of the study patient population was 67.02 years old and the female distribution was 61.1%. Notably, frail patients were more likely to be older (69.8 years versus 67.4, $P < 0.0001$), female (65.74% versus 61.02%, $P < 0.0001$), and using Medicare as primary payor (66.75% versus 57.10, $P < 0.0001$).
- A statistically significant positive association between frailty and every comorbidity included in the modified ECI was noted in this analysis. Interestingly, the rate of obesity among frail patients was significantly higher than the general population (22.57% versus 19.10%, $P < 0.0001$).
- With regards to inpatient outcomes, a statistically significant difference in the rate of postoperative complications was noted between the two groups. Frail patients were at significantly higher odds of experiencing any complications (odds ratio (OR) 1.51, $P < 0.0001$), CNS (OR 1.72, $P = 0.0002$), hematoma/seroma (OR 1.42, $P < 0.0001$), wound dehiscence (OR 1.71, $P = 0.0003$), postoperative infection (OR 1.59, $P = 0.0005$), DVT (OR 1.34, $P = 0.0008$), and postoperative anemia (OR 1.54, $P < 0.0001$). Frail patients were found to have significantly lower odds of home discharge (OR 0.61, $P < 0.0001$), required longer LOS (3.7 days versus 3.2 days, $P < 0.0001$), and incurred a higher total hospital charge ($59,766 versus $50,601, $P < 0.0001$).

Conclusions

- As the number of TJAs continues to rise, so does the numbers of frail patients along with the associated complications, risk factors and comorbidities when they undergoing these procedures.
- Frail patients undergoing TJA are older, more likely be female, and use Medicare as primary payor at higher rates, compared to non-frail patients.
- Frail patients to have a significantly higher occurrence rate for all comorbidities in the modified Elixhauser index, compared to non-frail patients.
- The rate of obesity was noted to be higher among frail patients.
- Frail patients had significantly higher odds of experiencing complications such as central nervous system issues, hematoma/seroma, wound dehiscence, DVT, postoperative infection and anemia compared to the control cohort.
- Frail patients were found to have longer LOS and higher rate of discharge to a rehabilitation facility rather than to home, and higher total charges.
- Although this study has several limitations inherent to large registry studies in addition to its retrospective natures, it is the largest available report from a national database to examine the impact of frailty on postoperative outcomes and complications following TJA.

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Acknowledgements

I would like to thank Dr. Hajj Hussein for her continued support and guidance as my Embark research mentor. I would also like to extend gratitude to Dr. Zalikha, Dr. El-Othmani, who helped me immensely during the course of this project and to Jacob Keeley for his help with the data analysis.

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