The Cost of Patient Comorbidities: Analyses of the Revenue, Costs, and Contribution Margin of Total Knee Arthroplasty with Increased Comorbidity Profile

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INTRODUCTION: Recent studies have suggested a trend toward a higher comorbidity burden in patients undergoing total knee arthroplasty (TKA). However, there is a lack of data on the impact of increased patient comorbidities on cost-effectiveness of TKA. The purpose of this study was to compare the financial implications and perioperative outcomes of patients with and without a high comorbidity burden (HCB).

METHODS: We retrospectively reviewed 10,647 patients who underwent an elective, unilateral TKA between 2012 and 2021 and had available financial data. Patients were stratified to HCB (Charlson Comorbidity Index [CCI] ≥ 5 and American Society of Anesthesiology [ASA] scores of 3 or 4) and non-HCB groups, and were further 1:1 propensity matched based on baseline characteristics. Perioperative data, revenue, costs, and contribution margins (CM) of the inpatient episode were compared between groups. Ninety-day readmissions and revisions were also compared between groups. Of the 10,647 patients reviewed (n=1,186 HCB, n=9,461 non-HCB), 1,536 patients were included in the final matched analyses (768 per group).

RESULTS: HCB patients had significantly greater total (p<0.001) and direct (p<0.001) costs, yet hospital revenue did not differ between cohorts (p=0.638). This resulted in a significantly decreased CM for the HCB group (p=0.009). The HCB cohort also had a significantly greater length of stay (p<0.001), and 90-day readmission rate (p=0.005).

DISCUSSION AND CONCLUSION: Increased costs for HCB patients were not met with increased revenue to cover these costs, leading to a decreased CM for these TKAs. Furthermore, an increased length of stay and increased 90-day readmissions in the HCB cohort add to the already disproportionate financial burden of these patients. The capacity of hospitals to cover indirect expenses might be impacted, jeopardizing the accessibility of care for HCB patients who need TKA. To ensure access to care for every patient population, current reimbursement models should be modified to adequately consider the increased financial burden associated with HCB patients undergoing TKA.

Table 1. Baseline Characteristics for Unmatched Group

	Non-HCB (n = 9,461)	HCB (n = 1,186)	p-value
Sex, n (%)			0.012
Male	2,894 (30.6)	405 (34.1)	
Female	6,567 (69.4)	781 (65.9)	
Mean Age (years) [range]	65.0 [21 to 99]	72.8 [42 to 94]	<0.001
Race, n (%)			<0.001
White	4,934 (52.2)	715 (60.3)	
African American	1,965 (20.8)	195 (16.4)	
Asian	497 (5.3)	48 (4.0)	
Other	2,065 (21.8)	228 (19.2)	
Smoking Status, n (%)			<0.001
Current	660 (7.0)	50 (4.2)	
Former	3,238 (34.2)	544 (45.9)	
Never	5,563 (58.8)	592 (49.9)	
Insurance Status, n (%)			<0.001
Medicare	4,454 (47.1)	926 (78.1)	
Medicaid	802 (8.5)	61 (5.1)	
Private	3,731 (39.4)	183 (15.4)	
Workers' Comp	474 (5.0)	16 (1.3)	
ASA score, n (%)			<0.001
1	197 (2.1)	0 (0)	
2	6,080 (64.3)	0 (0)	
3	3,126 (33.0)	1087 (91.7)	
4	58 (0.6)	99 (8.3)	
Mean BMI [range]	32.6 [15.3 to 68.9]	33.1 [18.5 to 57.8]	0.013
Mean CCI ± SD	2.6 ± 1.6	6.5 ± 2.0	<0.001

HCB, High Comorbidity Burden; ASA, American Society of Anesthesiology; BMI, Body Mass Index; CCI, Charlson Comorbidity Index; SD, Standard deviation.

Table 2. Baseline Characteristics for Matched Group

	Non-HCB (n = 768)	HCB (n = 768)	p-value
Sex, n (%)			0.913
Male	243 (31.6)	241 (31.4)	
Female	525 (68.4)	527 (68.6)	
Mean Age (years) [range]	69.7 [47 to 89]	69.6 [45 to 91]	0.844
Race, n (%)			0.243
White	405 (52.7)	435 (56.6)	
African American	156 (20.3)	143 (18.6)	
Asian	58 (7.6)	40 (5.2)	
Other	149 (19.4)	150 (19.5)	
Smoking Status, n (%)			0.176
Current	68 (7.1)	62 (6.5)	
Former	495 (51.7)	514 (53.7)	
Never	394 (41.2)	381 (39.8)	
Insurance Status, n (%)			0.521
Medicare	522 (68.0)	537 (69.9)	
Medicaid	52 (6.8)	51 (6.6)	
Private	184 (24.0)	165 (21.5)	
Workers' Comp	10 (1.3)	15 (2.0)	
ASA score, n (%)			<0.001
1	5 (0.7)	0 (0)	
2	484 (63.0)	0 (0)	
3	274 (35.7)	710 (92.4)	
4	5 (0.7)	58 (7.6)	
Mean BMI (Kg/m²) [range]	33.0 [19.6 to 68.9]	32.9 [18.5 to 57.8]	0.837
Mean CCI ± SD	3.0 ± 1.5	6.5 ± 2.0	<0.001

HCB, High Comorbidity Burden; ASA, American Society of Anesthesiology; BMI, Body Mass Index; CCI, Charlson Comorbidity Index; SD, Standard deviation.

Table 3. Revenue, Costs and Contribution Margins

	HCB vs Non-HCB	p-value
Patient Revenue (% difference, [95% CI])	-1.5% [-8.0, 4.9]	0.638
Total Cost (% difference, [95% CI])	+15.6% [11.6, 19.5]	<0.001
Direct Cost (% difference, [95% CI])	+12.5% [8.8, 16.2]	<0.001
Contribution Margin (% difference, [95% CI])	-19.9% [-34.9, -4.9]	0.009

HCB, High Comorbidity Burden; CI, Confidence interval

Table 4. Clinical Outcomes for Matched Groups

	Non-HCB (n = 768)	HCB (n = 768)	p-value
Mean LOS (days) [range]	2.7 [0.4 to 14.4]	3.3 [0.5 to 20.2]	<0.001
Mean Operative Time (min) [range]	94.9 [40 to 283]	95.4 [40 to 292]	0.757
Discharge Disposition, n (%)			0.131
Home	634 (81.3)	592 (77.1)	
SNF	122 (15.9)	150 (19.5)	
ARF	22 (2.9)	26 (3.4)	
90-day Revisions, n (%)	7 (0.9)	15 (2.0)	0.086
Infection	5 (0.7)	10 (1.3)	
Fracture	1 (0.1)	2 (0.3)	
Mechanical Failure	1 (0.1)	0 (0)	
Dehiscence	0 (0)	1 (0.1)	
Hematoma	0 (0)	2 (0.3)	
90-Day Readmission, n (%)	16 (2.1)	36 (4.7)	0.005
Non-Orthopedic related	7 (0.9)	11 (1.4)	0.343
Orthopedic related	9 (1.2)	25 (3.3)	0.006
Sepsis	0 (0)	3 (0.4)	
SSI	0 (0)	6 (0.8)	
Fracture	3 (0.4)	2 (0.3)	
Prosthetic Joint Infection	2 (0.3)	11 (1.4)	
Dehiscence	1 (0.1)	2 (0.3)	
Hematoma	0 (0)	1 (0.1)	
Mechanical Failure	1 (0.1)	0 (0)	
Pain	1 (0.1)	0 (0)	
Non-Surgical Site Orthopedic	1 (0.1)	0 (0)	

HCB, High Comorbidity Burden; LOS, Lengths of hospital stay; SNF, Skilled Nursing Facility; ARF, Acute Rehabilitation Facility; SSI, Surgical Site Infection.