

Research Article

Impact of the COVID-19 Pandemic on Total Knee Arthroplasty Outcomes in US Veterans

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Introduction

Previous studies demonstrate that retired service members who undergo total joint arthroplasty (TJA) through the Veterans Affairs (VA) healthcare system experience poorer short-term outcomes than the general population. Given that many healthcare disparities were exacerbated during the COVID-19 pandemic, the aim of this study is to determine if veterans who underwent total knee arthroplasty (TKA) at a single VA medical center experienced poorer 30-day outcomes during versus before COVID-19.

Methods

A retrospective review of electronic medical records was conducted to identify patients who underwent primary TKA between July 2017 and November 2021 at a single VA medical center. A total of 208 patients (n=238 knees) were included in the study and divided into two cohorts: TKAs performed before COVID-19 (July 2017-March 2020, n=143 knees) and TKAs performed during COVID-19 (June 2020-November 2021, n=95 knees). Inpatient outcomes of interest included length of stay (LOS), pain, opioid use, and physical therapy (PT) attendance and performance. Outpatient outcomes of interest included 30-day complication, readmission, and mortality.

Results

Veterans in the COVID-19 group had a significantly shorter LOS (1.02 vs. 1.42 days) than the pre-pandemic group ($p < 0.0001$; $d = -0.61$, 95% CI: -0.87, -0.34). The COVID-19 group further demonstrated significantly greater PT attendance on postoperative day

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[Conflicts of Interest Statement for Dr. Peterson](#)

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(POD) 0 ($p = 0.0419$; $RR = 1.51$, 95% CI: 0.98, 2.30), and reported less pain ($p = 0.0185$; $d = -0.32$, 95% CI: -0.58, -0.06), required fewer opioids ($p < 0.0001$; $d = -0.59$, 95% CI: -0.85, -0.32), and demonstrated superior PT performance on POD 1. There was no significant difference in 30-day complication, readmission, or mortality between groups.

Conclusion

In general, veterans who underwent TKA during COVID-19 had better 30-day outcomes than their pre-pandemic counterparts, which is consistent with trends observed in the general population.

INTRODUCTION

Total joint arthroplasties (TJA) are among the most common elective procedures among older adults, with more than one million cases performed annually in the United States (Maradit Kremers et al. 2015). Both total knee arthroplasty (TKA) and total hip arthroplasty (THA) are highly effective in improving the quality of life among patients with severe joint disease or trauma, with advanced osteoarthritis (OA) being the most common indication for joint replacement (Ethgen et al. 2004). The Veterans Affairs (VA) health system is a well-known source of TJA for US veterans, who broadly report higher rates of medical comorbidities, unemployment, homelessness, and poverty than the general population (Agha et al. 2000). An analysis of short-term TJA outcomes revealed that veterans experience poorer 30-day outcomes than the general population, including increased length of stay (LOS) and higher 30-day complication and readmission rates, even after adjusting for differences in comorbidity burden (Frisch et al. 2020).

Many existing health disparities were exacerbated during the COVID-19 pandemic, declared a global health emergency by the World Health Organization on March 11, 2020 (Willems, Castells, and Baptist 2022). Hospitals quickly became overwhelmed, and nonessential surgical procedures, including TJA, were temporarily suspended to preserve resources and limit nosocomial exposure. Once TJAs resumed, studies conducted in the general population reported a significantly shorter postoperative LOS, likely attributed to increased outpatient procedures, hospital capacity pressures, and fear of COVID-19 exposure among inpatients (Abdelaal et al. 2022; Shah et al. 2022; Piple et al. 2023; Gordon et al. 2022). In addition, some studies found that the demographic of patients undergoing TJA during the COVID-19 pandemic tended to be younger and/or healthier than in previous years, likely due to the potential contraindication for non-essential inpatient procedures among high-risk adults (Abdelaal et al. 2022; Shah et al. 2022; Piple et al. 2023).

In this study, we compare short-term clinical outcomes among veterans who underwent TKA at a single VA medical center before versus during the COVID-19 pandemic. The primary outcomes of interest included inpatient LOS and 30-day complications, readmission, and mortality, though clinical factors which influence LOS, including self-reported pain scores, physical therapy (PT) attendance and performance, and opioid use, were also examined secondarily. Our aims are to determine if 30-day outcomes changed during COVID-19 at a single VA medical center, and

whether these changes compared to trends observed in the general population.

METHODS

This study was reviewed and approved by the VA Central Institutional Review Board. The medical records of a board-certified orthopedic surgeon were retrospectively reviewed to identify all primary TKAs performed at a single urban VA medical center prior to IRB submission (July 2017–November 2021). Patients were eligible for inclusion regardless of their indication for TKA (i.e. osteoarthritis versus inflammatory arthritis), though patients undergoing revision or without 30-day follow-up available for review were excluded.

A total of 238 TKAs in 208 patients were included in the study. There were 143 TKAs performed in 119 patients prior to the COVID-19 lockdown (July 1, 2017 – March 15, 2020), and 95 TKAs performed in 89 patients during COVID-19 (June 1, 2020 – November 8, 2021). All TKAs were performed via the medial parapatellar approach under general anesthesia with patellar resurfacing and cement fixation. Most were cruciate-retaining, though a minority were converted to posterior-stabilized as indicated. All patients received local infiltration anesthesia intraoperatively with a cocktail containing 1.3% liposomal bupivacaine (20 mL), 0.25% bupivacaine (60 mL), saline (58 mL), 0.1 mg/mL clonidine (1 mL), and 30mg/1ml ketorolac (1 mL). Both groups followed a standardized postoperative pain management protocol consisting of acetaminophen 975mg PO scheduled q8h and ketorolac 15mg IV PRN q8h for pain $\geq 6/10$. Refractory pain was managed with oxycodone 5mg PO PRN q4h followed by morphine 2mg IV PRN q4h.

Inpatient medical records were reviewed to determine patient demographics, LOS, and self-reported numerical pain scores (0–10), PT attendance and performance, and opioid use in morphine milligram equivalents (MME) on POD 0–3. PT performance was measured using ambulation distance and degrees of active knee flexion and extension achieved during inpatient sessions. Outpatient follow-up records were reviewed for 30-day complication, readmission, and mortality rates. The VA's notification system captured external emergency department visits or readmissions, which were verified during postoperative follow-up visits.

Statistical analysis was performed in Microsoft Excel. Continuous variables were analyzed using two-tailed, independent samples t-tests with effect size reported as Cohen's d and interpreted as small ($d \approx 0.2$), medium ($d \approx 0.5$),

Table 1: Patient Demographics

	Pre-COVID-19 (n = 143)	COVID-19 (n = 95)	P Value
Average Age (years)	65.4	66.1	0.5475
Sex			0.4150
Male	132 (92.3%)	91 (95.8%)	
Female	11 (7.7%)	4 (4.2%)	
Race			0.1254
Non-Hispanic White	95 (66.4%)	51 (53.7%)	
Hispanic White	12 (8.4%)	17 (17.9%)	
Black or African American	23 (16.1%)	18 (19.0%)	
Other ^a	3 (2.1%)	4 (4.2%)	
Declined to Answer	10 (7.0%)	5 (5.3%)	

^aIncludes patients self-identifying as Asian, Native Hawaiian or Pacific Islander, or American Indian or Alaska Native

or large ($d \approx 0.8$). Categorical outcomes were compared using Pearson's chi-square, or Fisher's exact test when $n < 5$, with effect size reported as relative risk. Statistical significance was defined as $p < 0.05$. Effect sizes and 95% confidence intervals were reported in lieu of a priori power analysis given the fixed number of TKAs available for inclusion and the lack of reliable prior effect-size estimates

RESULTS

PATIENT DEMOGRAPHICS

A summary of patient demographics is provided in [Table 1](#). There was no significant difference in age, sex, or racial diversity between groups ($p > 0.1$). The mean age at the time of operation was 65.4 years in the pre-pandemic group (range 45-88) and 66.1 in the COVID-19 group (range 39-79). In both cohorts, >90% of cases were male and >50% of cases were Non-Hispanic White.

LENGTH OF STAY, POSTOPERATIVE PAIN, AND OPIOID USE

Clinical outcomes including LOS, self-reported pain scores, and opioid use on POD 0 and POD 1 are shown in [Table 2](#). The decision to exclude POD 2 and POD 3 from statistical analysis was made because >80% of patients had been discharged home by this time. More than 95% of patients remained inpatient on POD 1.

The average LOS was 0.4 days shorter during the COVID-19 pandemic ($p < 0.0001$; $d = -0.61$, 95% CI: -0.87, -0.34). Only 3.2% of patients in the COVID-19 group had LOS >1 day, compared to 27.3% of patients in the pre-COVID-19 group ($p < 0.0001$; RR = 0.15, 95% CI: 0.05-0.46). Self-reported pain scores and opioid use were similar between groups on POD 0, but the COVID-19 cohort reported significantly less pain ($p = 0.0185$; $d = -0.32$, 95% CI: -0.58, -0.06) and was prescribed significantly fewer opioids ($p < 0.0001$; $d = -0.59$, 95% CI: -0.85, -0.32) on POD 1. Total opioid use on POD 1 decreased by 48.5% during COVID-19,

with 44% of patients requiring no opioid analgesia, compared to 18% in the pre-pandemic cohort ($p < 0.0001$).

PHYSICAL THERAPY ATTENDANCE AND PERFORMANCE

While both cohorts had >99% PT attendance on POD 1, a significantly greater proportion of patients in the COVID-19 group attended PT on POD 0 ($p = 0.0419$; RR = 1.51, 95% CI: 0.98, 2.30) as shown in [Table 3](#). Among patients who attended PT, those in the COVID-19 group were able to ambulate approximately 2x further than those from the pre-pandemic group on both POD 0 ($p < 0.0001$; $d = 0.74$, 95% CI: 0.47, 1.01) and POD 1 ($p < 0.0001$; $d = 0.80$, 95% CI: 0.53, 1.07). The COVID-19 group further demonstrated greater average active flexion on POD 0 and POD 1, though neither result was statistically significant. A greater proportion of patients in the COVID-19 group achieved full extension on POD 0 and POD 1, and the difference on POD 1 was statistically significant ($p = 0.0099$; RR = 1.49, 95% CI: 1.06, 2.08).

COMPLICATIONS, READMISSIONS, AND MORTALITY

The overall 30-day rates of postoperative complication and readmission were 5.46% and 4.20%, respectively ([Table 4](#)). The COVID-19 group had higher 30-day rates of complication and readmission, but neither result was statistically significant. During the pandemic, veterans were more likely to be readmitted for observation of fever, though none were diagnosed with sepsis. Neither group had any deaths within 30 days of TKA.

DISCUSSION

In this single-site study, we observed a significantly reduced LOS among veterans undergoing TKA during the COVID-19 pandemic. This reduced LOS was associated with improved PT utilization and outcomes, lower self-reported pain scores, and less opioid analgesic prescription in the COVID-19 group versus the pre-pandemic group. There was

Table 2. Length of Stay, Pain, and Opioid Use

	Pre-COVID-19 (n = 143)	COVID-19 (n = 95)	P Value	Effect Size (95% CI)
Length of Stay (LOS)				
Average LOS (days)	1.42	1.02	<0.0001	d = -0.61 (-0.87, -0.34)
LOS >1 day	39 (27.3%)	3 (3.2%)	<0.0001	RR = 0.15 (0.05, 0.46)
Average Pain (0-10)				
POD 0	2.20	2.16	0.9190	d = -0.01 (-0.27, 0.25)
POD 1	3.79	2.74	0.0185	d = -0.32 (-0.58, -0.06)
Average Opioid Use (MME)				
POD 0	4.24	3.75	0.6598	d = -0.07 (-0.33, 0.19)
POD 1	14.32	7.37	<0.0001	d = -0.59 (-0.85, -0.32)

MME = morphine milligram equivalents

Table 3. Physical Therapy Attendance and Outcomes

	Pre-COVID-19 (n = 143)	COVID-19 (n = 95)	P Value	Effect Size (95% CI)
PT Attendance (N [%])				
POD 0	99 (69.2%)	77 (81.1%)	0.0419	RR = 1.51 (0.98, 2.30)
POD 1 ^a	140 (99.3%)	93 (100%)	0.4157	
Average Ambulation Distance (ft)				
POD 0	50.6	106.0	< 0.0001	d = 0.74 (0.47, 1.01)
POD 1 ^a	120.1	206.0	< 0.0001	d = 0.80 (0.53, 1.07)
Average Active Flexion (°)				
POD 0	88.1	92.3	0.0713	d = 0.30 (0.04, 0.56)
POD 1 ^a	74.4	78.3	0.1210	d = 0.18 (-0.09, 0.44)
Full (0°) Active Extension (N [%])				
POD 0	43 (57.3%)	43 (65.2%)	0.2530	RR = 1.46 (1.08, 1.98)
POD 1 ^a	67 (54.9%)	59 (72.8%)	0.0099	RR = 1.49 (1.06, 2.08)

^aOn POD 1, n=141 for the Pre-COVID-19 group and n=93 for the COVID-19 group

no significant difference in the 30-day rate of complication, readmission, or mortality between cohorts.

LOS was 0.4 days shorter during COVID-19, and patients were 85% less likely to have LOS >1 day. The observed reduction in LOS post-TJA is consistent with previous studies conducted in the general population, which reported LOS reductions ranging from 0.12-0.7 days (Abdelaal et al. 2022; Piple et al. 2023; Gordon et al. 2022). However, we found that patients undergoing TKA during COVID-19 tended to be slightly older than their pre-pandemic counterparts, refuting the assumption that LOS was reduced due to patients being younger. In addition, the number of patients under-

going TKA on an ambulatory basis (LOS = 0) did not change during the pandemic.

Our interpretation of the collected data is that early mobilization and PT intervention on POD 0 may have contributed to greater PT performance, reduced postoperative pain, and lower opioid use on POD 1. Although the benefits of early mobilization – including improved patient satisfaction and reduced LOS, rate of complication, morbidity, and mortality – are well documented (M. J. Chua et al. 2017), the frequency and definition of early mobilization varies between institutions. While some studies report that nearly 50% of patients mobilize on POD 0 (Yakkanti et

Table 4. Rate of Post-Operative Complication, Readmission, and Mortality

	Pre-COVID-19 (n = 143)	COVID-19 (n = 95)	P Value
30-Day Complication (%)	7 (4.90%)	6 (6.32%)	0.6367
Deep Vein Thrombosis	1 (0.70%)	0 (0.00%)	
Pulmonary Embolism	1 (0.70%)	0 (0.00%)	
Acute Kidney Injury	0 (0.00%)	1 (1.05%)	
CHF Exacerbation	1 (0.70%)	0 (0.00%)	
UTI/Genitourinary Infection	1 (0.70%)	1 (1.05%)	
Cellulitis	1 (0.70%)	0 (0.00%)	
Hyperglycemia	0 (0.00%)	1 (1.05%)	
Wound Problem	2 (1.40%)	0 (0.00%)	
Anemia	0 (0.00%)	1 (1.05%)	
Kidney Stones	0 (0.00%)	1 (1.05%)	
30-Day Readmission (%)	3 (2.10%)	7 (7.37%)	0.0939
30-Day Mortality (%)	0 (0%)	0 (0%)	

CHF = congestive heart failure; UTI = urinary tract infection

al. 2019), others report much lower rates, at 0-10% (M. J. Chua et al. 2017; H. Chua et al. 2020). In our study population, early mobilization on POD 0 was associated with improved outcomes. Restricted access to visitors, fear of contracting COVID-19, and encouragement by providers and hospital staff may have motivated patients to rehabilitate more quickly during COVID-19 (Jeffery et al. 2020). There were no changes to PT availability or protocols during COVID-19, to our knowledge.

An alternative argument is that LOS prior to the COVID-19 pandemic was unnecessarily long and the result of laxity regarding discharge timelines and early mobilization efforts. A shorter LOS offers many benefits for both patients and hospitals, including avoidance of nosocomial complications and unnecessary costs, preservation of hospital resources, increased patient turnover, and an accelerated return to activities of daily living (Giamberardino et al. 2007). Providers should continue to encourage early mobilization and PT attendance starting on POD 0, as well as early discharge, when possible. In this study, discharging patients earlier was not associated with significant safety concerns such as an increased rate of complication, readmission, or mortality.

Patients in the COVID-19 cohort were also more likely to utilize NSAIDs and acetaminophen as their primary source of inpatient analgesia rather than opioids, despite no changes to the standardized pain management protocol. While the decision to prescribe opioid analgesics for post-operative pain management should be made on an individualized basis, it is generally recommended that providers limit opioid use as much as possible to reduce narcotic-associated complications. One study found that patients who were prescribed opioids on an inpatient basis were roughly twice as likely to continue using opioids for pain control after discharge (Donohue et al. 2019). Additional studies have shown that a small percentage of opioid-naïve patients who filled opioid prescriptions after discharge were

prone to long-term misuse (Brat et al. 2018; Johnson et al. 2016; Calcaterra et al. 2016).

The primary limitation of this study is its small sample size. Although a formal power analysis was not performed, effect sizes were generally substantial for significant outcomes. Similarly, use of a single VA medical center may limit the generalizability of these findings to other VA sites. Recruitment of additional patients, surgeons, and VA sites could yield different results and increase the power of conclusions drawn. Other limitations include the potential for inaccurate or inconsistent documentation and the inability to establish causation due to retrospective design.

CONCLUSIONS

This single-center, retrospective study demonstrated a reduced LOS, greater PT utilization, and improved clinical outcomes among VA beneficiaries undergoing TKA during versus before the COVID-19 pandemic. Increased PT attendance and early mobilization on POD 0 was associated with improved PT performance and reduced post-operative pain and opioid use on POD 1. Although veterans tend to have poorer postoperative outcomes than the general population, the trends identified in this study aligned with those observed at non-VA hospitals during COVID-19.

COMPLIANCE WITH ETHICAL STANDARDS

No disclosures nor conflicts of interest. This study was reviewed and approved by the VA Central Institutional Review Board.

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REFERENCES

- Abdelaal, M. S., I. Small, M. B. Sherman, P. M. Courtney, and P. F. Sharkey. 2022. "One Year Later: The Lasting Effect of the Covid-19 Pandemic on Elective Hip and Knee Arthroplasty." *J Am Acad Orthop Surg* 30:e1474–82. <https://doi.org/10.5435/jaaos-d-22-00245>.
- Agha, Z., R. P. Lofgren, J. V. VanRuiswyk, and P. M. Layde. 2000. "Are Patients at Veterans Affairs Medical Centers Sicker? A Comparative Analysis of Health Status and Medical Resource Use." *Arch Intern Med* 160:3252–57. <https://doi.org/10.1001/archinte.160.21.3252>.
- Brat, G. A., D. Agniel, A. Beam, B. Yorkgitis, M. Bicket, M. Homer, K. P. Fox, D. B. Knecht, C. N. McMahon-Walraven, N. Palmer, et al. 2018. "Postsurgical Prescriptions for Opioid Naïve Patients and Association with Overdose and Misuse: Retrospective Cohort Study." *Bmj* 360:j5790. <https://doi.org/10.1136/bmj.j5790>.
- Calcaterra, S. L., T. E. Yamashita, S. J. Min, A. Keniston, J. W. Frank, and I. A. Binswanger. 2016. "Opioid Prescribing at Hospital Discharge Contributes to Chronic Opioid Use." *J Gen Intern Med* 31:478–85. <https://doi.org/10.1007/s11606-015-3539-4>.
- Chua, H., B. Brady, M. Farrugia, N. Pavlovic, S. Ogul, D. Hackett, D. Farag, A. Wan, S. Adie, L. Gray, et al. 2020. "Implementing Early Mobilisation after Knee or Hip Arthroplasty to Reduce Length of Stay: A Quality Improvement Study with Embedded Qualitative Component." *BMC Musculoskelet Disord* 21:765. <https://doi.org/10.1186/s12891-020-03780-7>.
- Chua, M. J., A. J. Hart, R. Mittal, I. A. Harris, W. Xuan, and J. M. Naylor. 2017. "Early Mobilisation after Total Hip or Knee Arthroplasty: A Multicentre Prospective Observational Study." *PLoS One* 12:e0179820. <https://doi.org/10.1371/journal.pone.0179820>.
- Donohue, J. M., J. N. Kennedy, C. W. Seymour, T. D. Girard, W. H. Lo-Ciganic, C. H. Kim, O. C. Marroquin, P. Moyo, C. H. Chang, and D. C. Angus. 2019. "Patterns of Opioid Administration among Opioid-Naïve Inpatients and Associations with Postdischarge Opioid Use: A Cohort Study." *Ann Intern Med* 171:81–90. <https://doi.org/10.7326/m18-2864>.
- Ethgen, O., O. Bruyère, F. Richy, C. Dardennes, and J. Y. Reginster. 2004. "Health-Related Quality of Life in Total Hip and Total Knee Arthroplasty. A Qualitative and Systematic Review of the Literature." *J Bone Joint Surg Am* 86:963–74. <https://doi.org/10.2106/00004623-200405000-00012>.
- Frisch, N. B., P. M. Courtney, B. Darrith, L. A. Copeland, and T. L. Gerlinger. 2020. "Veterans Undergoing Total Hip and Knee Arthroplasty: 30-Day Outcomes as Compared to the General Population." *J Am Acad Orthop Surg* 28:923–29. <https://doi.org/10.5435/jaaos-d-19-00775>.
- Giamberardino, H. I., E. P. Cesário, E. R. Carmes, and R. A. Mulinari. 2007. "Risk Factors for Nosocomial Infection in Trauma Patients." *Braz J Infect Dis* 11:285–89. <https://doi.org/10.1590/s1413-86702007000200024>.
- Gordon, A. M., M. L. Magruder, C. A. Conway, B. K. Sheth, and O. Erez. 2022. "The Effect of Covid-19 on Elective Total Knee Arthroplasty Utilization, Patient Comorbidity Burden, and Complications in the United States: A Nationwide Analysis." *J Am Acad Orthop Surg* 30:e1599–1611. <https://doi.org/10.5435/jaaos-d-22-00193>.
- Jeffery, M. M., G. D'Onofrio, H. Paek, T. F. Platts-Mills, W. E. Soares 3rd, J. A. Hoppe, N. Genes, B. Nath, and E. R. Melnick. 2020. "Trends in Emergency Department Visits and Hospital Admissions in Health Care Systems in 5 States in the First Months of the Covid-19 Pandemic in the Us." *JAMA Intern Med* 180:1328–33. <https://doi.org/10.1001/jamainternmed.2020.3288>.
- Johnson, S. P., K. C. Chung, L. Zhong, M. J. Shauver, M. J. Engelsbe, C. Brummett, and J. F. Waljee. 2016. "Risk of Prolonged Opioid Use among Opioid-Naïve Patients Following Common Hand Surgery Procedures." *J Hand Surg Am* 41:947–57.e3. <https://doi.org/10.1016/j.jhsa.2016.07.113>.
- Maradit Kremers, H., D. R. Larson, C. S. Crowson, W. K. Kremers, R. E. Washington, C. A. Steiner, W. A. Jiranek, and D. J. Berry. 2015. "Prevalence of Total Hip and Knee Replacement in the United States." *J Bone Joint Surg Am* 97:1386–97. <https://doi.org/10.2106/jbjs.N.01141>.
- Piple, A. S., J. C. Wang, G. J. Bouz, B. C. Chung, C. K. Mayfield, M. K. Richardson, D. A. Oakes, J. R. Lieberman, A. B. Christ, and N. D. Heckmann. 2023. "The Persistent Effects of the Covid-19 Pandemic on Total Joint Arthroplasty Changes in Practice Patterns in the United States from 2020 to 2021." *J Arthroplasty* 38:1438–43.e1. <https://doi.org/10.1016/j.arth.2023.01.048>.

Shah, K. C., J. Poeran, N. Zubizarreta, K. McCardle, J. Jebakumar, C. S. Moucha, and B. L. Hayden. 2022. "Comparison of Total Joint Arthroplasty Care Patterns Prior to the Covid-19 Pandemic and after Resumption of Elective Surgery during the Covid-19 Outbreak: A Retrospective, Large Urban Academic Center Study." *Knee* 38:36–41. <https://doi.org/10.1016/j.knee.2022.05.004>.

Willems, S. J., M. C. Castells, and A. P. Baptist. 2022. "The Magnification of Health Disparities during the Covid-19 Pandemic." *J Allergy Clin Immunol Pract* 10:903–8. <https://doi.org/10.1016/j.jaip.2022.01.032>.

Yakkanti, R. R., A. J. Miller, L. S. Smith, A. W. Feher, M. A. Mont, and A. L. Malkani. 2019. "Impact of Early Mobilization on Length of Stay after Primary Total Knee Arthroplasty." *Ann Transl Med* 7:69. <https://doi.org/10.21037/atm.2019.02.02>.