



# Age as an Independent Risk Factor for Postoperative Morbidity and Mortality After Total Joint Arthroplasty in Patients 90 Years of Age or Older

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## ABSTRACT

The population of patients over 90 years of age has experienced the fastest growth in recent years. The number of primary total joint arthroplasties (TJA) has also been increasing. Our objectives were to examine in-hospital morbidity, mortality and resource consumption following primary TJA in patients older than 89 years at the national level. Nationwide Inpatient Sample was used to identify 8,340,167 patients who underwent TJA between 1993 and 2008, 58,355 (0.7%) were 90 years of age or older. Older patients were at higher risk of developing cardiac (OR 2.5; 95% CI 2.4–2.6), neurological (OR 2.1; 95% CI 1.8–2.4), respiratory complications and higher risk of mortality (OR 11.5; 95% CI 10.93–12.1) after controlling for baseline comorbidities. Age is an independent risk factor for postoperative complications and mortality. Our data can be used to educate patients on the risks before undergoing primary TJA and aid physicians in assessing and adjusting perioperative risk.

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Between 2000 and 2010, Americans 65 years of age and over grew at a faster rate than the total population in the country (15.1% vs. 9.7%) [1]. Among this older age group, the 85 to 94 year old group experienced the fastest growth between 2000 and 2010, growing by nearly 30% from 3.9 million to 5.1 million. Americans 95 years and over experienced a similar rate of growth, increasing by nearly 26% from 337,000 to 425,000 between 2000 and 2010 [1]. In addition to the growth of the older population, the number of primary and revision joint arthroplasties has also been increasing. This trend is expected to continue, with Kurtz et al projecting that primary total hip and knee arthroplasties are expected to grow by 174% and 673%, respectively, from 2005 to 2030 [2]. They also projected that the demand for hip revision procedures is expected to double by the year 2026, while the demand for knee revisions will double by 2015 [2].

Given the exponential increase in demand for total joint arthroplasties in this growing elderly population, it is critical to further study the risks associated with operating on these patients. By gaining a better perspective at the morbidity and mortality of these procedures in this population, orthopedic surgeons would be armed with more accurate data about the risks and benefits of performing total joint arthroplasties in this group of patients. Furthermore, data allowing for risk assessment and adjustment are currently lacking in this potentially high-risk patient population, which is becoming increasingly important in the evolving healthcare system is the U.S.

The objectives of this study were to examine 1) in-hospital morbidity, 2) in-hospital mortality and 3) inpatient resource consumption following primary total joint arthroplasty in patients 90 years of age or older at the national level compared to a younger cohort. Our hypothesis was that patients 90 years of age or older would have higher rates of postoperative complications, higher adjusted odds ratios for morbidity and mortality, and greater resource utilization than the younger patient population.

## Materials and Methods

The Nationwide Inpatient Sample (NIS) was used to identify 8,340,167 patients older than 45 years old who underwent primary total hip and knee arthroplasty in the United States between January 1, 1993, and December 31, 2008. Only 0.70% of these patients were 90 years of age or older ( $n = 58,355$ ). Age 45 was selected as a cutoff to avoid including patients with unavailable or miscoded age.

The Nationwide Inpatient Sample is a stratified, statistically valid survey of hospitals conducted by the federal Healthcare Cost and Utilization Project [3–5]. Hospitals are randomly selected to achieve an approximately 20% sample of the universe of hospitals. Sampling weights are provided to produce the national estimates. All discharge records from each of the selected hospitals are collected and form part of the Nationwide Inpatient Sample file for a given year. Because of the large size of the database, the Nationwide Inpatient Sample is particularly well suited for epidemiological studies related to specific procedures or diseases in the national population [6,7]. The International Classification of Disease Clinical Modification version 9 (ICD-9-CM) procedure codes were used to identify the procedures, postoperative complications (Table 1) and to calculate a comorbidity

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**Table 1**  
ICD-9 Codes Used to Identify Postoperative Complications.

| ICD-9-CM Code                   | Description                  |
|---------------------------------|------------------------------|
| Procedure Related Complications |                              |
| 9970                            | Central Nervous System (CNS) |
| 9971                            | Cardiac                      |
| 9972                            | Peripheral Vascular (PVD)    |
| 9973                            | Respiratory                  |
| 9974                            | Gastrointestinal             |
| 9975                            | Genitourinary                |
| 9981                            | Hematoma/Seroma              |
| 9983                            | Wound Dehiscence             |
| 9985                            | Postoperative Infection      |
| Other Adverse Events            |                              |
| 4151                            | Pulmonary Embolism           |
| 2851                            | Postop Anemia                |

index as described by Deyo et al [8]. The Deyo index assigns scores of 1 to 6 for 17 diagnostic categories (myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatologic disease, peptic ulcer disease, mild liver disease, moderate to severe liver disease, diabetes, diabetes with chronic complications, hemiplegia or paraplegia, renal disease, any malignancy including leukemia and lymphoma, metastatic solid tumor, and acquired immunodeficiency syndrome). The sum of each score was the overall comorbidity status (the Deyo score). A Deyo score of 0 indicates no comorbidity; 1 to 4, moderate; and 5 to 36, severe [9]. Resource consumption was measured based on length of stay and total charges which in turn were adjusted for inflation using the consumer price index (CPI) to 2008 dollars since the analysis included a 15 year period.

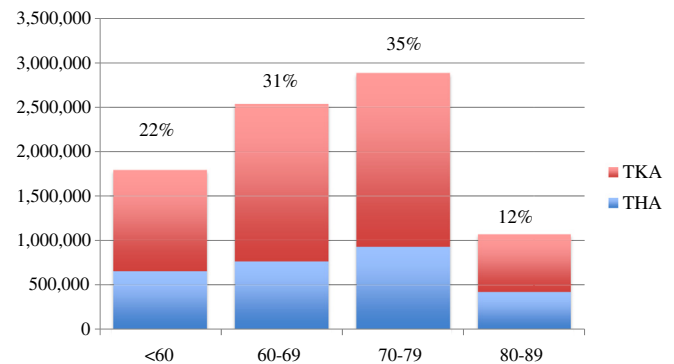
All statistical analyses were performed using SPSS version 20 for Mac (IBM Corp. Armonk, NY). Descriptive statistics were calculated for all variables used within the study. There were few missing values (less than 1%) for all variables used, with the exception of race; cases with missing values were skipped for the purpose of this analysis. The independent sample t-test was used to measure differences between length of stay and charges for patients younger and older than 90 years old. Multivariate modeling with logarithmic transformation was used to examine the risk-adjusted association between patients younger and older than 90 years old. Each model was adjusted for the confounders of gender, type of procedure (THA vs. TKA), baseline comorbidities and is reported as odds ratios with their respective 95% confidence interval. For all comparisons and regressions, statistical significance was assigned at the  $P < 0.01$  levels given our large sample size and the increased probability of false positive results (type I error).

## Results

We identified a total of 8,340,167 patients that underwent TJA between 1993 and 2008. Of those, 58,355 patients were ages 90 years or above, compared to 8,281,811 patients who were between age 45 and 89 years. Figs. 1 and 2 show the age distribution of both groups. As shown in Table 2, the older group had a higher proportion of females (75% versus 62%,  $P < 0.001$ ) and more commonly underwent total hip arthroplasty (65% versus 34%,  $P < 0.001$ ) compared to the younger group. Nonagenarian patients were less likely to have their joint arthroplasty performed for osteoarthritis compared to the younger cohort and were overall sicker in terms of the number of comorbidities preoperatively.

### Postoperative Complications

Overall postoperative medical complications were 32% for older patients, with 28% having one complication and 5% having more than one. In contrast, the younger cohort had 22% of complications, with



**Fig. 1.** Number of patients younger than 90 years old by age group and type of procedure.

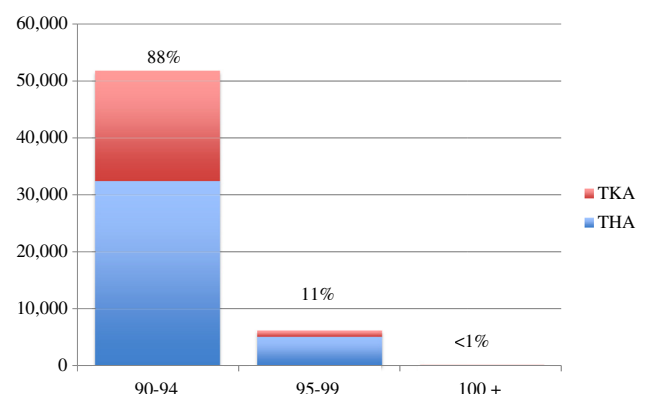
20% having only one and 2% more than one. Patients over 90 years of age had significantly more postoperative complications than the younger cohort except for peripheral vascular related complications, wound dehiscence, and postoperative infection, which were not significantly different (Table 3). The most common complications seen in both groups were anemia, cardiac related complications, and hematoma or seroma formation. In our regression analysis after controlling for gender, type of procedure and preoperative comorbidities, patients older than 90 years of age were at a higher risk of developing cardiac complications (odds ratio 2.52; 95% CI 2.40–2.65), central nervous system complications (odds ratio 2.10; 95% CI 1.83–2.41) and respiratory complications (odds ratio 1.91 95% CI 1.80–2.03) after primary joint arthroplasty.

### Postoperative Mortality

In-hospital mortality was significantly higher in the older cohort compared to the younger group (2.9% versus 0.2%;  $P < 0.001$ ). In our regression model patients older than 90 years were at a significantly higher risk of dying while in the hospital after primary total joint arthroplasty compared with younger patients (odds ratio 11.51; 95% CI 10.93–12.13) after controlling for baseline comorbidities.

### Resource Consumption

Mean length of stay was about 1.5 days longer for the older cohort compared to the younger group (6 days versus 4 days,  $P < 0.001$ ). Total hospital charges were also higher for the elderly group of patients (\$33,174 vs. \$31,559,  $P < 0.001$ ) with a difference of \$1600 on average per patient hospitalization.



**Fig. 2.** Number of patients 90 years of age or older by age group and type of procedure.

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