

Trends in Total Knee Replacement Surgeries and Implications for Public Health, 1990–2000

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SYNOPSIS

Objectives. Total joint replacements are important surgical interventions for treating severe arthritis of weight-bearing joints. The most common indication for total knee replacement (TKR) is osteoarthritis of the knee joint. The goals of this study were to assess the trend in rate of TKR in Wisconsin and to describe the economic impact of these surgical procedures on the health care system.

Method. A population-based cross-sectional study of TKR surgeries was conducted among Wisconsin residents aged ≥ 45 years. The Wisconsin inpatient hospital discharge data from 1990 through 2000 were used. Rates were age-adjusted to the 2000 U.S. population, and charges for TKR were adjusted for inflation.

Results. From 1990 through 2000, the age-adjusted rate for TKR increased by 81.5% (from 162 to 294 per 100,000; $p < 0.001$). The rate increased the most among the youngest age group (45–49 years), rate ratio 5.1 for men, 4.2 for women. The total charges for TKR increased from \$69.4 million to \$148 million (109.2% inflation-adjusted increase). Medicare received the highest proportion of charges for TKR procedures, but throughout the study period, the proportion of charges covered by private insurance increased by 39%.

Conclusions. The rate and costs of TKR procedures among Wisconsin residents increased substantially from 1990 through 2000, especially among younger age groups. Changes in medical practices probably accounted for some of this increase, but these trends also may reflect an increased prevalence of osteoarthritis, which in turn may be related to dramatic increases in the number of individuals who are overweight.

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Arthritis affects 70 million U.S. adults, of whom 1.5 million are Wisconsin adults.¹⁻⁴ This disease is the leading cause of disability in the United States. Osteoarthritis, also known as degenerative joint disease, accounts for approximately 90% of all arthritis cases.¹ Although trend data for arthritis is limited, the prevalence of osteoarthritis has increased in recent years.^{2,5,6} The prevalence of arthritis and other rheumatic conditions is projected to rise further by 2020.³ The economic burden of arthritis, specifically osteoarthritis, is enormous. In 2000, the estimated economic cost of arthritis in the U.S. was \$60 billion; it is expected to increase to \$100 billion by 2020.⁷

Total knee replacement (TKR) is an elective procedure to treat severe arthritis of the knee joint. TKR has been one of the major breakthroughs in orthopedic surgery during the past three decades, and in recent years, TKR has made gains in acceptance and patient satisfaction.⁸⁻¹¹ In addition, with an increase in the prevalence of arthritis, obesity, and old age, a further increase in TKR has been anticipated.¹²⁻¹⁶ To date, few studies have assessed trends in TKR rates and TKR-related costs. Trends in utilization and costs for TKR in Wisconsin from 1990 through 2000 were examined using Wisconsin hospital discharge data.

METHODS

We used the 1990–2002 Wisconsin Inpatient Hospital Discharge Database to assess the utilization of TKR among Wisconsin residents aged ≥ 45 years. The Wisconsin Bureau of Health Information, Department of Health, which maintains the inpatient database, collects data on all inpatient and freestanding ambulatory surgery centers in Wisconsin. Detailed information about the database is provided elsewhere.¹⁷ Patient-level data includes information on patient characteristics (i.e., age, sex, and race/ethnicity), diagnoses, procedures, and charges. This information is reported by all non-federal Wisconsin hospitals and is drawn from UB-92 forms, a standard form used by hospitals to bill third party payers. TKR cases were identified by principal procedure codes in the data source. The *principal procedure code* is the primary surgical operation or medical procedure performed on an individual during a visit. Recipients of TKR were identified by searching the inpatient database for the *International Classification of Diseases, 9th revision* (ICD-9), procedure code 8154 for TKR.¹⁸ The primary diagnosis code for those receiving TKR was assessed, as well as the underlying primary diagnosis code, ICD-9 code 715, for osteoarthritis and allied disorders. Rate ratios were calculated by dividing the TKR rates in 2000 by the TKR rates in 1990. All analyses were done using SAS version 8.2.¹⁹

Denominators for calculating TKR rates were based on year-specific census estimates for Wisconsin. Age-adjusted rates were calculated using the 2000 U.S. standard population.²⁰ A two-tailed chi-square test was used to assess the significance of TKR trends for age-adjusted rates. All TKR procedures were included in the analysis, and the primary underlying diagnosis for these procedures was assessed using the ICD-9 code 715. The Consumer Price Index for medical care in Midwestern states was used to adjust for inflation.²¹ The average and total charge of inpatient admissions plus surgical interventions does not include physicians' fees.

We used the Diagnostic Related Groups (DRGs) to assess and compare the charges for TKR utilization with other major surgical procedures. DRGs are a system of categorizing patients based on the primary and secondary diagnoses, primary and secondary procedures, age, and length of stay. Each category has a uniform cost or charge. DRGs set a maximum amount that would be paid for the care of patients.¹⁷

RESULTS

In 1990–2000, a total of 67,475 TKRs were performed in Wisconsin. Of these, 66,781 procedures (98.9%) were performed on adults aged ≥ 45 years. During the study period, the total number of TKRs performed among adults aged ≥ 45 years increased steadily. After adjusting for age, the rate of TKR increased 81.5%, from 162 per 100,000 to 294 per 100,000 ($p < 0.001$) (see Figure). Throughout the study period, the proportion of women receiving TKR was consistently higher (60%) than men (see Table 1).

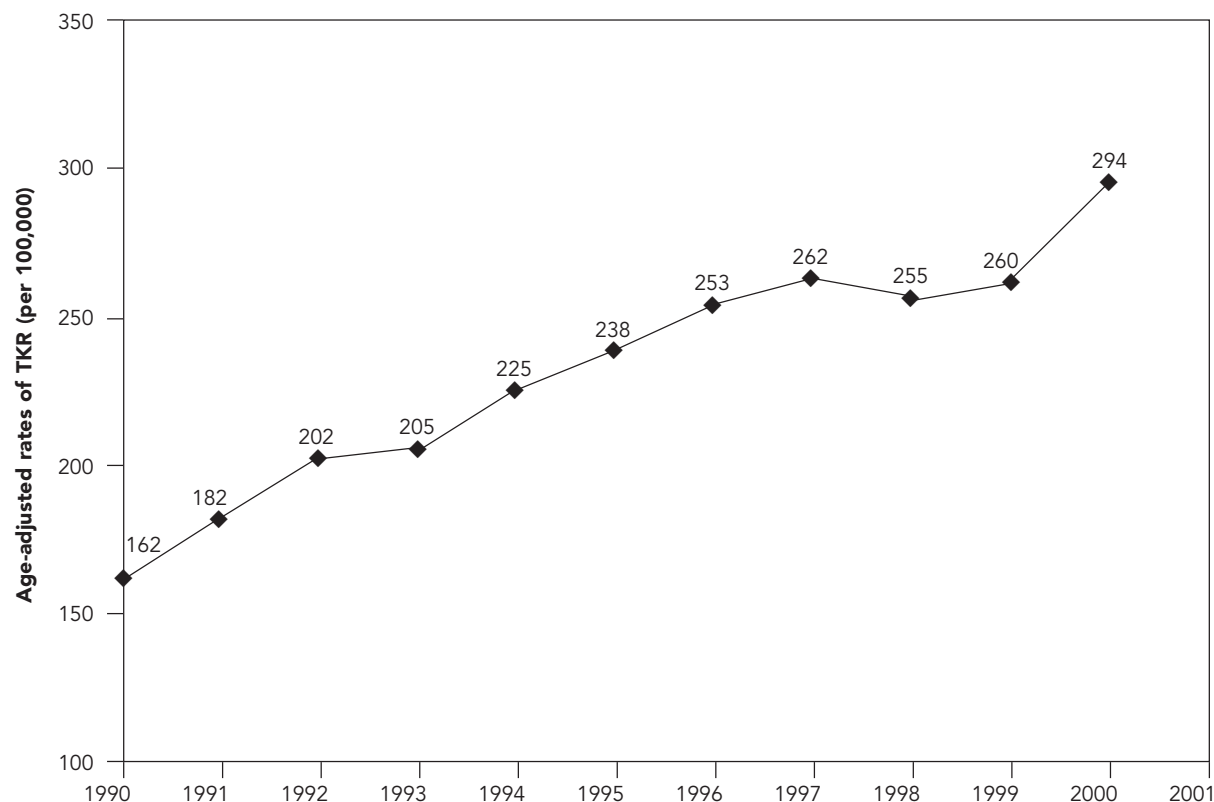
Although the rate for TKR increased for all age groups since 1990, the increase was most pronounced among the younger adults (see Table 1). The youngest age group (45–49 years) had the largest increase of TKR for both men (rate ratio 5.1) and women (rate ratio 4.2). In addition, the average age of individuals undergoing TKR declined from 79.6 to 68.5 years during the study period. In 1990, 73% of all

Table 1. Age-specific rates and rate ratios for total knee replacements (TKR) by age and sex, Wisconsin 1990 to 2000

Age group	Total knee replacements		
	Age-specific rates per 100,000 (n)		Rate ratio ^a (95% CI)
	1990	2000	
Total	270 (4,074)	410 (7,588)	1.5 (1.3, 1.7)
Male			
45–49 years	9 (11)	46 (93)	5.1 (2.6, 9.9)
50–54 years	40 (43)	110 (181)	2.8 (1.9, 3.7)
55–59 years	110 (114)	230 (281)	2.1 (1.6, 2.4)
60–64 years	290 (292)	450 (453)	1.6 (1.4, 1.8)
65–69 years	390 (351)	600 (518)	1.5 (1.3, 1.8)
70–74 years	530 (373)	800 (627)	1.5 (1.3, 1.7)
75+ years	390 (409)	670 (858)	1.7 (1.5, 1.9)
Total male	23 (1,593)	35 (3,011)	1.5 (1.3, 1.5)
Female			
45–49 years	17 (22)	71 (140)	4.2 (2.7, 6.6)
50–54 years	61 (67)	180 (303)	3.0 (2.3, 3.9)
55–59 years	180 (192)	380 (489)	2.1 (1.8, 2.5)
60–64 years	320 (349)	520 (553)	1.6 (1.4, 1.8)
65–69 years	460 (486)	830 (804)	1.8 (1.6, 1.9)
70–74 years	560 (520)	960 (910)	1.7 (1.5, 1.8)
75+ years	450 (845)	630 (1,378)	1.4 (1.3, 1.5)
Total female	30 (2,481)	46 (4,577)	1.5 (1.5, 1.6)

^aRate ratios were calculated by dividing the TKR rates in 2000 with rates in 1990.

CI = confidence interval

Figure. Trends in age-adjusted rates for total knee replacement (TKR) procedures, Wisconsin, 1990–2000

NOTE: Rates (per 100,000) were age adjusted to 2000 U.S. census population.

TKR procedures were performed on individuals aged 65 years compared with 66% of total TKR procedures in 2000. We also assessed the underlying primary diagnosis of those receiving TKR and found that osteoarthritis (ICD-9 code 715) was the primary underlying diagnosis for 93% of individuals in 1990 and for 97% of individuals in 2000.

In 1990–2000, the total inpatient hospitalization charges for TKR in Wisconsin increased 175% (93% inflation-adjusted increase) from \$53 million to \$146 million (see Table 2). This increase in total charges for TKR exceeded the 79% increase in inflation-adjusted charges for all causes of hospitalizations in Wisconsin. The average length of hospital stay for TKR reduced 118% from 1990 to 2000 (9.4 days to 4.3 days), with women's average length of hospital stays decreasing 125% (9.7 days to 4.3 days) and men's average length of hospital stays decreasing 112% (8.9 days to 4.2 days). The difference in average length of stay between men and women did not differ significantly. Despite the 118% reduction in the average length of stay, the average inflation-adjusted charge per TKR procedure increased from \$13,034 to \$19,169, an increase of 47%. In addition, during the study period, the proportion of total charges covered by private insurance increased from 25% to 35%, and the proportion covered by Medicare decreased from 73% to 63% (see Table 2).

DISCUSSION

In Wisconsin, the age-adjusted rate of TKR almost doubled during the past decade, with the greatest increases among individuals aged <55 years. Several possible factors could have led to the increasing TKR rate. Improved instrumentation and prostheses for TKR may have led to increased patient satisfaction with the procedure.^{8,11} Also due to recent advances in joint implant survival to almost 15 years, TKR for relatively younger individuals has become an increasingly attractive surgical option for the treatment of severe osteoarthritis. Another contributor may be an increase in osteoarthritis itself, since in our study, 95% of people receiving TKR had a primary underlying diagnosis of osteoarthritis and previous studies have shown similar results.^{5,22} In turn, the increase in osteoarthritis may be due partly to the rapidly rising proportion of Wisconsin residents who are either obese or overweight. Currently 2002 data from Wisconsin show that 58% of Wisconsin adults are overweight, 22% are obese, and 4% are morbidly obese.^{4,13,23} Obesity is a leading risk factor for osteoarthritis of weight-bearing joints, particularly the knee, and recent studies have shown a strong association between increasing Body Mass Index (BMI) and both total hip replacement and TKR procedures.^{24,25}

Regardless of the cause, the increase in TKR surgeries

Table 2. Trends in total charges^a by primary payer type for total knee replacement (TKR) procedures among adults aged ≥45 years, Wisconsin 1990 to 2000

Primary payer	1990		2000		Percent change in total charge ^b 1990–2000
	n (percent)	Total charges in dollars (percent)	n (percent)	Total charges in dollars (percent)	
Total	4,073	\$53.2	7,592	\$146.2	175%
Medicare	2,964 (72.8%)	\$38.9 (72.6%)	4,867 (64.1%)	\$92.0 (63%)	137%
Private insurance	1,026 (25.2%)	\$13.1 (25.2%)	2,559 (33.7%)	\$51.0 (34.9%)	289%
Medical assistance/other government	41 (1%)	\$0.6 (1.1%)	152 (2%)	\$2.9 (1.9%)	383%
Self-pay/other/unknown	42 (1%)	\$0.6 (1.1%)	14 (0.2%)	\$0.3 (0.2%)	–50%

^aThe amount a hospital or facility bills for a patient's care is known as the charge. This is not the same as the actual cost or amount paid for the care. The amount actually collected by a hospital or facility (the amount paid) is usually less than the amount billed. The hospital charge does not include professional fees such as for the physician and the anesthesiologist.

^bPercent change in total charges (TC) was calculated as follows: (TC in 2000 – TC in 1990 / TC in 1990) × 100.

has a substantial economic impact on the state health care system. This is supported by the fact that in 1990–2000, the total charges (measured in terms of DRGs) for weight-bearing joint replacement procedures including TKR have been the highest among all major inpatient surgical procedures in Wisconsin.^{17,26} In spite of an increase in the aging U.S. population during our study period, the proportion of TKR surgeries covered by private insurance increased from 25% to almost 35% whereas the proportion covered by Medicare decreased from 72.8% to 64.0%. This change may be explained partly by the declining average age of TKR recipients, many of whom are not old enough to qualify for Medicare and many of whom may still be in the work force with employer-based private health insurance.

Although total joint replacement has become popular among the general population and has been accepted as a successful orthopedic procedure, it still carries short-term complications and risks, particularly in the presence of comorbid chronic diseases such as obesity.^{27–31} Its popularity, however, not only increases the burden on the health care system but also could create a surge in the demand for revision knee replacement among younger adults in the coming decades.³²

This study has several limitations. The most suitable denominator to assess the rate increase of total joint replacement procedures would have been all individuals with knee osteoarthritis, but such information was not available through inpatient hospital discharge data. In addition, 17 counties in Wisconsin adjoin the border states of Minnesota, Illinois, and Michigan; this could have led to some people receiving TKR procedures in these neighboring states of Wisconsin or vice-versa. Thus, cross-border delivery of health services could have led either to over- or under-estimation of surgical procedures like TKR. Finally, inpatient databases do not collect height and weight information, so we could not calculate BMI to assess the relationship between TKR and obesity.

TKR has played a significant role in improving the quality of life for individuals affected with severe osteoarthritis of the knee joints.³³ However, the increases in TKR rate and costs further emphasize the need to delay and prevent the

onset of arthritis and improve symptoms of arthritis through conventional methods before surgical intervention. Studies have shown that weight loss and physical activity not only improve symptoms of osteoarthritis, but they also delay progression of degenerative joint conditions among overweight individuals.³³ Preventive methods like regular physical activity and the maintenance of appropriate body weight are likely to have the greatest effect on reducing the burden of arthritis and, in turn, the rapid increase in TKR.

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