Utilization of Elective Hip and Knee Arthroplasty by Age and Payer

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Abstract Elective joint arthroplasty improves the quality of life for patients with severe arthritis. In the United States, utilization of services varies with insurance status. We asked the following questions: (1) Is there an increase in the utilization of elective hip and knee arthroplasty after age 65? (2) Does the difference in utilization between the insured and general populations decrease at age 65 (the age at which Medicare provides near universal coverage)? (3) Does Medicare become the primary payer of elective hip and knee arthroplasty after the age of 65? We used the National Inpatient Sample to identify patients and payers of elective hip and knee arthroplasties by age. We analyzed these data using regression models. At age 65, there was an upward shift in the incidence of arthroplasties in the general and the insured populations and the difference between these two populations decreased. Medicare was the primary payer for the majority of arthroplasties after age 65. We conclude at age 65 the following occurs: (1) utilization of elective joint arthroplasty increases; (2) the difference between the insured population and the general population decreases; and (3) Medicare becomes the primary payer of arthroplasties.

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Introduction

Degenerative joint disease is a chronic debilitating condition affecting 43 million Americans at an estimated cost of \$60 billion per year [18]. Although some patients should be managed conservatively with medical treatment, many will face considerable disability from progressive loss of hip or knee function. For these individuals, elective arthroplasties of the hips and knees improve quality of life [7, 12]. Some authors argue replacement should be considered with “radiographic evidence of joint damage and moderate to severe persistent pain or disability, or both” [9]. Although most hip and knee arthroplasties are elective, the availability of these procedures has a considerable impact on physical function and quality of life for affected individuals.

In the United States, utilization of many medical services varies depending on health insurance status, and lack of health insurance has been linked to numerous adverse outcomes. Patients without insurance are less likely to see a primary care physician for basic preventive services, such as cholesterol screening and mammography [2, 11, 14]. Lack of health insurance leads to greater rates of rupture and emergent surgical care with appendicitis and abdominal aortic aneurysms [4, 5]. Lacking health insurance is associated with substantially higher adjusted mortality among white adults and a decline in overall health among uninsured persons between the ages of 51 and 61 years [3, 15]. Insurance coverage among Americans younger than 65 years is highly variable. In 2003, approximately 47.0 million Americans were without any form of insurance coverage [21]. Because of near-universal coverage through Medicare, Americans older than 65 years rarely are uninsured (1.5%) [21]. The effect of near-universal coverage through Medicare has increased utilization of

basic preventive services and admissions for osteoarthritis and chronic ischemic heart disease at age 65 [6, 14].

We explored the following questions: (1) Is there an increase in the utilization of elective hip and knee arthroplasties after age 65? (2) Does the difference in utilization between the insured population and the general population decrease at age 65 (the age at which Medicare provides near universal coverage)? (3) Does Medicare become the primary payer of elective hip and knee arthroplasties after the age of 65?

Materials and Methods

To answer the above questions, we performed a secondary data analysis of hospital discharges. From this data set, we extracted all elective hip and knee arthroplasties and the primary payer of these procedures in patients between 45 and 75 years and we used this in the numerator of our incidence rate calculation. The US census data served as the denominator of our rate calculation. We used linear regression to evaluate the trends in utilization before and after age 65.

The Healthcare Cost and Utilization Project Nationwide Inpatient Sample (NIS) provided the basis for procedure rates of elective hip and knee procedures by age [1]. The NIS is a stratified sample of hospitals, approximating a 20% random sample of all discharges and includes nearly eight million inpatient discharges annually. It provides discharge-specific information, such as demographic information, diagnosis codes, payer information, and total charges. Discharge weights on each observation extrapolate the sample to national estimates. For our purposes, the NIS also categorizes each admission as one of the following: emergency, urgent, elective, newborn, or other. We used NIS data for 2001, 2002, and 2003.

The US Census provided population estimates by state and age for use as denominators in national incidence estimates.

The March supplement of the Current Population Survey (CPS) surveys approximately 100,000 US [20] households on income, work experience, and health insurance coverage at any time during the past year. It identifies several insurance coverage types (Medicare, Medicaid, private, Champus) and includes sample weights that allow national estimates of insurance coverage to be calculated; individual demographic information allows insurance coverage to be tied to age.

States participating in the NIS release data for each age, except for Texas, which collapses data into 5-year blocks. Consequently, all NIS, census, and CPS data from Texas were dropped from the incidence calculations. The pattern of incidence in Texas for collapsed age categories was

similar to the pattern observed when ages in the other states were collapsed to the same categories (data not shown).

The three data sources described above provided the national estimates necessary to calculate the incidence of elective hip and knee arthroplasties in the total population and the insured population.

We identified included hip and knee arthroplasties from the NIS if the primary International Classification of Diseases, 9th Revision (ICD-9), Clinical Modification procedure codes were 81.51, 81.52, and 81.54 and if the procedure was categorized as elective. The NIS 2001 and 2002 data were pooled to create a sample for our model; the 2003 NIS data provided a sample for testing our model's fit. Estimates of total procedures in the United States were produced using the discharge weights from the NIS data set. We summed knee and hip arthroplasties and divided by two to create the total elective joint arthroplasty estimates.

We calculated annual total incidence figures for total joint arthroplasties per 100,000 for each year of age by dividing the annual procedure estimates from the NIS by the population estimates from the US Census. Annual insured incidence figures were calculated in a similar manner using annual joint arthroplasty figures that excluded discharges with self-pay as the primary and secondary payer and using an estimate for the insured population created by multiplying the total population estimate by the insurance rate estimated from the CPS. We posited a general trend of increasing incidence in age for an age range likely to benefit from elective joint arthroplasty, ages 45 to 79. We were limited to an upper bound of 79 by the fact that the census data collapse everyone 80 years or older into an over 79 category. The lower bound was chosen based on clinical considerations and to allow for a statistically desirable sample size. From the data, we produced a simple plot of incidence and age.

The 2001 and 2002 NIS contained 74,810 hip arthroplasty records and 112,624 knee arthroplasty records that extrapolated to 365,536 national hip arthroplasties and 549,589 knee arthroplasties, respectively, for the population of patients aged 45 to 79. Restricting the data set to elective procedures reduced these numbers to an estimated 272,618 hip arthroplasties and 507,095 knee arthroplasties.

To examine if there was an increase in elective hip and knee replacements after age 65, we used linear regression models with an indicator variable for age greater than or equal to 65 and a variable to allow for the change in slope after age 65. We combined the 2001 and 2002 samples to generate the regression model and we tested the predicted incidence from this model against the observed incidence from the 2003 data. The resulting R-square was compared with the original model R-square to check the model performance.

To evaluate whether the difference in utilization between the insured population and the general population decreases at age 65, we used a two-tailed *t* test comparing the mean difference between the insured and the general populations before and after age 65.

To determine the primary payer of arthroplasties, we used the NIS data for each of the ages between 45 and 75.

Results

The first question asks whether there was an increase in the utilization of elective hip and knee arthroplasties at age 65. Results from our linear regression model (Table 1) show for the general population there is an upward shift in incidence of elective hip and knee arthroplasties of 171.0/100,000 ($p = 0.00000023$) at age 65 and for the insured population there is a one-time upward shift in incidence of 103.1/100,000 ($p = 0.00068$) at age 65.

The second question asks whether the difference between the insured and the general population decreases at age 65 (the age at which Medicare creates near-universal coverage). Before age 65, the mean difference between the insured and the general population was 41 cases per 100,000 population per year. After age 65, this difference decreased to seven cases per 100,000 population per year ($p = 0.000093$). To examine this visually, we graphed the incidence between the general population and the insured population (Fig. 1).

The third question asks whether Medicare will become the primary payer of arthroplasties after age 65. Before age 65, most of the arthroplasties are paid by private payers with Medicare and Medicaid paying approximately 20%. After age 65, Medicare is the primary payer for greater than 80% of the procedures (Fig. 2).

Discussion

This analysis was conducted to study the effect of turning 65 on the utilization of elective hip and knee arthroplasties. We found at age 65 there is an increase in the utilization of

Fig. 1 The incidences of elective hip and knee arthroplasties by age and insurance status are shown. White squares with the dotted line represent all elective arthroplasties; black circles with the solid line represent elective arthroplasties in the insured population only. This graph shows an increase in utilization of arthroplasty at age 65 and a decrease in the difference in utilization between the insured population and the general population.

elective hip and knee replacements. Further, the difference in utilization between the insured and the general population decreases and Medicare becomes the primary payer for the majority of the procedures.

The primary limitations of this study have to do with our inability to assess causation from an ecologic study and from weaknesses in using administrative data. We cannot document the various reasons why individuals delay arthroplasty nor can we determine how much each of these factors contributes to our findings. It is likely as a population the nonelderly uninsured are demographically distinct from those with insurance. Other authors have shown cultural and ethnic factors account for considerable variability in the uptake of arthroplasty independent of health insurance status, which our data cannot show [19]. Prior research has shown little variation in hip and knee arthroplasties between high- and low-spending regions but has shown considerable variation among hospital referral regions [8, 17]. Unfortunately, our study can draw no conclusions regarding the important implications of these regional variations. Given the heterogeneity of private health plans in the United States, we cannot document what

Table 1. Results from the regression model

Variable	Total population	Insured population
Change in incidence per year before age 65	27.3 (24.4–30.3)*	31.4 (28.3–34.5)*
Incidence shift at age 65	171.0 (118.2–223.9)*	103.1 (47.4–158.8)*
Change in incidence per year after age 65	21.6 (13.2–29.9) [†]	21.2 (12.3–29.9)*
R-square for 2001 and 2002 data	0.987	0.985
R-square using the 2001 and 2002 regression model in the 2003 data	0.974	0.970

Incidence is reported per 100,000, with 95% confidence intervals in parentheses; * $p < 0.001$; [†] $p \leq 0.05$.

Fig. 2 A bar graph shows the primary payer (Medicare, Medicaid, private insurance, or self-pay) for elective hip and knee arthroplasties by age. White = Medicare; dark gray = Medicaid; light gray = private insurance; black = self-pay. This graph visually shows the large shift in payer status that occurs at age 65, with private insurance being the predominant payer before age 65 and Medicare being the predominant payer after age 65.

financial incentives favor the use of Medicare over private insurance for these procedures. Medicare may have lower copays and deductibles or fewer bureaucratic barriers to access the procedure than private insurance, creating an incentive to the individual to seek this form of financing. Certainly profit-driven health plans have an incentive to discourage the use of expensive procedures such as arthroplasty, but our study cannot explore or document any such effect. Additionally, we cannot explore any potential incentives among providers to delay the procedure, yet we hypothesize the effect would be the opposite because Medicare generally reimburses at a lower rate than private plans.

There are additional limitations that arise from our data sources. Our principal findings come from billing codes that are error-prone and our economic figures reflect charges, which may poorly reflect the true cost of the procedures. Although the NIS attempts to create a nationally representative sample, it is unlikely to perfectly accomplish that task and limits the generalizability of our findings. The exclusion of Texas data likely led to underestimation of the national incidence. Although that is not likely to change the trend coefficients in the model, it would lead to smaller coefficients on the effect observed at age 65. Furthermore, the NIS includes only 32 states and may not exactly represent the entire United States. Although this may change our incidence calculations, it is unlikely to change our trends. To create a denominator, we used census data and CPS data to estimate the national insured and uninsured populations. These sources are not likely to have systematic bias in their population estimates by age; however, if our estimate of the insurance rate is faulty, then the estimates for

procedures delayed because of insurance status may be inaccurate. The CPS gathers information on whether individuals had coverage at any time during the past year rather than whether individuals had coverage during the entire year, and therefore we may have overestimated the number in the insured population. This would lead to underestimating the incidence in the insured population during this period and would render our estimates of forgone procedures conservative.

Our data show a considerable upward shift in the incidence of elective hip and knee arthroplasties at age 65 and suggest a noteworthy factor driving the increased utilization is the acquisition of insurance coverage by those previously uninsured. Our data also show a smaller increase in the incidence of elective hip and knee arthroplasties among people who had insurance before age 65.

There may be many reasons for delaying joint arthroplasty. For most Americans, reaching the age of 65 is a major milestone. Although 65 traditionally was considered the age of retirement and is the age at which Social Security benefits are paid in full for those born before 1937, the mean age of retirement in 1999 was actually 63.7 [22]. Previously insured patients may delay elective joint arthroplasty until after either their or their partner's retirement so the long recovery from the procedure does not interfere with work. Previous research suggests retirement behavior is closely linked to availability of health insurance and separating the effect of one from the other with this study design is impossible [10, 23]. Some individuals may delay because Medicare coverage for the procedure is more generous or more easily obtained than their existing coverage. Cultural and ethnic orientation may further influence the decision to have the procedure [19].

Our data suggest delaying joint arthroplasty until after age 65 is more common among the uninsured than among those with health insurance. Although some uninsured individuals may have simply chosen not to pursue joint arthroplasty or may have electively chosen to delay the procedure for various reasons, it is likely many, if not most, of the procedures were delayed involuntarily because these individuals had no other options and no means of accessing or financing the procedure [19]. This observation is in line with previous studies showing an increase in the use of health care when insurance is obtained [11, 14]. If we presume utilization among insured patients approximates an optimal rate of arthroplasty in the population, then we also can presume many who delay care will have experienced extra disability and considerable loss of quality of life as a result of this involuntary delay. At least one prior study confirms this presumption and shows patients without Medicare are referred for joint arthroplasty at a lower functional and health status [13]. This study confirms literature documenting uninsured persons often do not receive appropriate and indicated health care [3, 15] and that they increase their utilization of health services when barriers are removed [6, 14].

We compared the utilization model of the insured population with that of the total population to estimate the potential number of delayed procedures in the near-65 population. Subtracting the predicted incidence in the full population from the predicted incidence in the insured population for ages 61 to 64, we calculated the forgone incidence of elective arthroplasty in the population for each age and then applied the incidence to the total population figures to arrive at 6296 procedures forgone annually because of insurance coverage. Differences between the insured and uninsured population in utilization related to demographic differences also may contribute to the difference, but we are unable to estimate the effect with our data limitations.

American healthcare policy has long sought to preserve private health insurance as the cornerstone of our healthcare financing system. Public financing of the healthcare needs of the elderly through Medicare was created in the 1960s when there was widespread agreement among policymakers that this population was not adequately covered by private insurance plans [16]. The creation of Medicare in essence created two distinct healthcare financing regimes: Americans younger than 65 years are to be covered by private insurance (the poor and disabled can seek help through Medicaid and Medicare), whereas the healthcare needs of Americans older than 65 years will be funded publicly through Medicare. This study documents a considerable difference in utilization between one financing regime and the other.

For policy makers, the implications of this study are several. This study adds to the growing body of data that

the current system of private, largely employer-based health insurance fails to provide for the needs of large numbers of individuals and that many of those needs are not met until those individuals can qualify for public programs. Still other individuals, whose needs could be met by private insurance, elect to delay care for various reasons, so ultimately the care is financed by Medicare.

References

1. Agency for Healthcare Research and Quality. HCUP Databases. Rockville, MD: Healthcare Cost and Utilization Project (HCUP); 2001, 2002, 2003.
2. Ayanian JZ, Weissman JS, Schneider EC, Ginsburg JA, Zaslavsky AM. Unmet health needs of uninsured adults in the United States. *JAMA*. 2000;284:2061–2069.
3. Baker DW, Sudano JJ, Albert JM, Borawski EA, Dor A. Lack of health insurance and decline in overall health in late middle age. *N Engl J Med*. 2001;345:1106–1112.
4. Boxer LK, Dimick JB, Wainess RM, Cowan JA, Henke PK, Stanley JC, Upchurch GR Jr. Payer status is related to differences in access and outcomes of abdominal aortic aneurysm repair in the United States. *Surgery*. 2003;134:142–145.
5. Braveman P, Schaaf VM, Egerter S, Bennett T, Schecter W. Insurance-related differences in the risk of ruptured appendix. *N Engl J Med*. 1994;331:444–449.
6. Card D, Dobkin C, Maestas N. The impact of nearly universal coverage on health care utilization and health: evidence from Medicare. NBER Web site; 2004. Available at: www.nber.org/aginghealth/spring04/w10365.html. Accessed December 18, 2007.
7. Ethgen O, Bruyere O, Richy F, Dardennes C, Reginster JY. 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*. 2004;86:963–974.
8. Fisher ES, Wennberg DE, Stukel TA, Gottlieb DJ, Lucas FL, Pinder EL. The implications of regional variations in Medicare spending. Part 1: the content, quality, and accessibility of care. *Ann Intern Med*. 2003;138:273–287.
9. Hawker GA, Wright JG, Badley EM, Coyte PC. Perceptions of, and willingness to consider, total joint arthroplasty in a population-based cohort of individuals with disabling hip and knee arthritis. *Arthritis Rheum*. 2004;51:635–641.
10. Karoly L, Rogowski J. Effects of access to post-retirement health insurance on retirement behavior and insurance coverage. *RAND Health Research Brief*. 1998;RB-4701-1.
11. Kaspar J, Giovannini T, Hoffman C. Gaining and losing health insurance: strengthening the evidence for effects on access to care and health outcomes. *Med Care Res Rev*. 2000;57:298–318.
12. Kawasaki M, Hasegawa Y, Sakano S, Torii Y, Warashina H. Quality of life after several treatments for osteoarthritis of the hip. *J Orthop Sci*. 2003;8:32–35.
13. Lavernia CJ, Lee D, Sierra RJ, Gomez-Marín O. Race, ethnicity, insurance coverage, and preoperative status of hip and knee surgical patients. *J Arthroplasty*. 2004;19:978–985.
14. McWilliams JM, Zaslavsky A, Meara E, Ayanian JZ. Impact of Medicare coverage on basic clinical services for previously uninsured adults. *JAMA*. 2003;290:757–764.
15. McWilliams JM, Zaslavsky AM, Meara E, Ayanian JZ. Health insurance coverage and mortality among the near-elderly. *Health Aff (Millwood)*. 2004;23:223–233.

16. Oliver TR, Lee PR, Lipton HL. A political history of Medicare and prescription drug coverage. *Milbank Q.* 2004;82: 283–354.
17. Preference-sensitive care. The Dartmouth Atlas of Health Care; 2007. Available at: www.dartmouthatlas.org/topics/preference_sensitive.pdf. Accessed December 18, 2007
18. Reginster J. The prevalence and burden of arthritis. *Rheumatology.* 2005;41(suppl 1):3–6.
19. Suarez-Almazor ME, Soucek J, Kelly PA, O'Malley K, Byrne M, Richardson M, Pak C. Ethnic variations in knee replacement: patient preferences or uninformed disparity? *Arch Intern Med.* 2005;165:1117–1124.
20. US Census Bureau. *Annual Demographic Supplement to the March 2002 Current Population Survey.* Washington DC: US Census Bureau; 2002.
21. US Census Bureau. US Census; 2006. Available at: http://www.census.gov/hhes/www/hlthins/hlthin06/p60no233_table6.pdf. Accessed December 18, 2007.
22. Wiatrowski W. Changing retirement age: ups and downs. *Mon Labor Rev.* 2001;124:3–12.
23. Woodbury R. Health insurance and retirement. Research Highlights in the Demography and Economics of Aging. Issue No. 1, May 1998. Available at: <http://healthpolicy.stanford.edu/CDEHA/docs/Hilite1.pdf>. Accessed December 18, 2007.