Effect of Sociodemographic Factors on Surgical Consultations and Hip or Knee Replacements Among Patients with Osteoarthritis in British Columbia, Canada

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ABSTRACT. ***Objective.*** To quantify the effect of demographic variables and socioeconomic status (SES) on surgical consultation and total joint arthroplasty (TJA) rates among patients with osteoarthritis (OA), using population-based administrative data.

Methods. A cohort study was conducted in British Columbia using population data from 1991 to 2004. From April 1996 to March 1998, we documented 34,420 new patients with OA and these patients were followed to March 2004 for their first surgical consultation and TJA. Effects of age, sex, and SES were evaluated by Cox proportional hazards models after adjusting for comorbidities and pain medication used.

Results. During a mean 5.5-year followup period, 7475 patients with OA had their first surgical consultations and 2814 patients received TJA within a 6-year mean followup period. Crude hazards ratio (HR) for men compared to women was 1.25 (95% CI 1.20–1.31) for surgical consultation and was 1.14 (95% CI 1.06–1.23) for TJA. The interaction between sex and SES was significant. Stratified analysis showed among men an HR of 1.42 (95% CI 1.27–1.58) and 1.52 (95% CI 1.26–1.83) for surgical consultations and TJA, respectively, for the highest SES compared with the lowest SES quintiles. Similarly significant results were observed among women.

Conclusion. Differential access to the healthcare system exists among patients with OA. Women with OA were less likely than men to see an orthopedic surgeon as well as to obtain TJA. Patients with higher SES consulted orthopedic surgeons more frequently and received more TJA than those with the lowest SES. (First Release Nov 15 2010; J Rheumatol 2011;38:503–9; doi:10.3899/jrheum.100456)

Key Indexing Terms:
HIP REPLACEMENT ARTHROPLASTY KNEE REPLACEMENT ARTHROPLASTY
TOTAL JOINT ARTHROPLASTY OSTEOARTHRITIS SOCIOECONOMIC FACTORS

Osteoarthritis (OA) of the hip and knee is the most common type of arthritis and the leading cause of longterm disability[1,2,3]. OA has a higher prevalence in older age groups and women are more commonly affected than men[4,5]. Although treatment of OA is symptomatic, with most cases treated conservatively using medications or nonpharmacological modalities such as exercise, total joint arthroplasty (TJA) is a cost-effective treatment option for endstage knee and hip OA[6,7,8,9].

From a clinical point of view, the most important indication for surgery in a patient with OA is pain that is not relieved by medication and is affecting function and quality of life[10]. However, not all patients who would benefit from surgical treatment get TJA[1,11]. Several studies have been

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Supported by a grant from the Canadian Institutes of Health Research. Dr. Kopec is a Michael Smith Foundation for Health Research Senior Scholar. M.M. Rahman received training support from the Canadian Arthritis Network/The Arthritis Society.

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Accepted for publication September 9, 2010.

conducted in Canada and in the United States to determine the predictors of TJA in patients with OA. Among these, severe pain, disability, willingness to undergo TJA, geographic region, sex, race and socioeconomic status (SES) were significant[11,12,13,14,15,16]. Data from the Canadian Joint Replacement Registry (CJRR)[17] demonstrate that women have more TJA than men, with a higher rate per 100,000 population, using age-matched and sex-matched data. Patients' willingness to undergo TJA was not related to SES after adjusting for age, sex, and region[11].

Understanding the association between SES and TJA among patients with OA is important for the optimal provision of health services in this very large group of patients. One of the primary goals of the Canadian Medicare system is to provide universal access to all necessary healthcare services and thus reduce any inequalities attributable to income and education[18,19,20]. In British Columbia, the setting for our study, access to physician services is managed under the auspices of the Medical Services Plan (MSP) and is a publicly funded health insurance program with first-dollar coverage for all services. Similarly, in-hospital services are also provided free of charge by the Hospital Programs division of the Ministry of Health Services. Patients registered with the MSP may self-refer for primary healthcare service to their general practitioner (GP); however, to see a specialist such as an orthopedic surgeon, patients require a referral from a GP. Since physicians' perceptions of patients can be influenced by patients' sociodemographic characteristics[21], such factors may affect who is referred to a specialist and who is not. In previous Canadian studies, self-reported visits to a GP were strongly influenced by a person's need for medical care; however, patients with higher SES used more specialist services[11,22].

There are no previous population-based prospective studies of the role of sociodemographic factors in getting referrals from GP to orthopedic surgeons as well as undergoing TJA in patients with OA. Our objective was to determine the effects of age, sex, and SES on the rates of first surgical consultation and first TJA among patients diagnosed with OA.

MATERIALS AND METHODS

Study population. We used the administrative database collected and maintained by the British Columbia Ministry of Health for the reimbursement of physician visits covered by MSP from April 1991 through March 2004 and hospital admissions records from the Hospital Programs division for the same fiscal years. From data for the entire province we created the British Columbia Musculoskeletal cohort of about 3.5 million subjects with any musculoskeletal diagnosis in the same period. The database also covers all prescriptions through PharmaCare of all residents age 65 years and older.

Exposure assessment. Patients with OA were identified using the case definition of at least 2 visits to a health professional in 2 years or 1 discharge from the hospital with an International Classification of Disease, 9th Revision (ICD-9) code of 715 (Osteoarthrosis and related disorders). A visit was defined as any service with the exclusion of diagnostic procedures and certain other procedures, such as dialysis/transfusion, anesthesia, obstetrics, or therapeutic radiation. Visits to all types of health professionals were included, and the date of diagnosis was coded as the date of the second health professional visit or the date of discharge from hospital. The database contains information regarding date and type of service, physician's specialty code, birth and death dates, sex, SES, and MSP registration start and exit dates. The Population Data British Columbia includes postal codes for all residents registered with the Ministry of Health, as recorded in June of each year. These postal codes were used to determine neighborhood-level income quintiles (SES quintile) based on a methodology developed at Statistics Canada using census data[23,24]. Therefore, SES was assigned based on residential address linked to census data at the level of enumeration area (1 or more adjacent blocks, up to 650 dwellings) and was grouped into 5 income quintiles, from 1 (lowest) to 5 (highest), based on mean household income of those residents.

Outcomes. Surgical consultations or visits to orthopedic surgeons were assessed by checking the physician's specialty codes. Up to 25 diagnosis codes and a maximum of 12 procedure codes (Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures code) were provided for each admission date on hospital discharge summaries. Total hip and total knee replacement surgery cases were identified using the procedure codes 935 and 934.1, respectively. We excluded all surgeries with codes at the time of surgery for injury or poisoning (ICD-9 800-995, 997, and 999), neoplasm other than benign (ICD-9 140-208 and 235-239), and nonmedical external causes of injury (ICD-9 E800-869, E880-E928, E950-E999). Revision procedures were excluded by identifying cases having the above 2 procedure codes with an ICD-9 code of 730 (infections), 996.4, 996.5, 996.6, 996.7, or 998 (complications of certain surgical procedures) in the same hospital discharge record[25].

Study design. The study population consisted of patients with OA who were 20 years of age or older. The outcome "surgical consultation" was defined as the first visit to an orthopedic surgeon. The event time for each patient was calculated in months from the date of OA diagnosis. All patients with OA were identified using this case definition from 1991, and a cohort of new patients with OA were defined as those meeting our case definition in the 2 fiscal years from April 1996 to March 1998, after deleting the prevalent cases. These cases were followed until March 2004. By doing so, we ensured that all patients were followed within the same medical care system during a similar time period. Separate analyses were carried out for time to first visit to an orthopedic surgeon (surgical visit) and time to TJA. Patients were followed until they had these events, died, withdrew from MSP registration, or at the end of observation time in 2004, whichever came first. Patients' age, SES, and comorbidities were assessed at the time of OA diagnosis.

Statistical analysis. Out of all newly diagnosed adult OA cases from April 1, 1996, to March 31, 1998, we had complete information of all variables of interest for 34,420 patients. Separate analyses were carried out for time to first surgical consultation and time to first TJA. Age, sex, and SES quintile were used as predictors for both analyses. All analyses were adjusted for comorbidities, which were obtained from the ICD-9 diagnosis codes on or before the OA diagnosis. We calculated the Charlson comorbidity score[26,27] for all subjects in the study. The Charlson score contains 19 categories of comorbidity and each category of disease has a weight. Total score for each patient was calculated by adding the weights for each condition. In addition, we identified all patients with a diagnosis of diabetes, hypertension, or ischemic heart disease. The effect of each predictor was evaluated using the Cox proportional hazards (PH) models. Multivariable Cox PH models were fitted and the hazard ratios (HR), 95% CI, and p values were reported. The proportionality assumptions for PH models were checked by observing the Kaplan-Meier curves of the survival function versus the survival time, and the graph of the log [–log (survival function)] versus log of survival time[28]. SAS version 9.1 was used throughout the study to perform the analyses[29].

RESULTS

Surgical consultations. In 2 years, 13,571 men and 20,849 women were diagnosed with OA by physicians other than

orthopedic surgeons. The distribution of these patients by sex, age, SES, and comorbid conditions is presented in Table 1. The mean age at diagnosis was 62 years (SD 14.8 yrs). Forty-five percent of the patients were classified as low SES (quintiles 1 and 2), 18% as high SES (quintile 5), and the rest with moderate SES (quintiles 3 and 4). Eleven percent of the patients had diabetes, 36% were diagnosed with hypertension, 23% had a history of ischemic heart disease on or before OA diagnosis, and the mean Charlson comorbidity score was 1.63 (SD 2.3).

During the 5.5 years of mean followup, 7475 persons diagnosed with OA had their first surgical consultations, which translated into 39 new consultations per 1000 person-years. HR and 95% CI from univariable analyses are shown in Table 2. The surgical consultation rate in persons diagnosed with OA was significantly higher for men than for women, with HR of 1.25 (95% CI 1.20–1.31). The average age of patients having an orthopedic surgeon visit was 63 years (SD 12.9). Age and SES showed significant relationships with time to the first orthopedic surgeon visit. Significant interaction was observed between sex and SES ($p < 0.01$), and between sex and age ($p = 0.02$). Consequently, stratified analyses were performed using multivariable PH regression separately for men and women after adjusting for diabetes, hypertension, ischemic heart disease, and Charlson comorbidity score (Table 3). Among men, SES quintile showed a significant and monotonically increasing relationship with the first orthopedic surgeon visit. HR increased from 1.14 (95% CI 1.02–1.27) in quintile 2 to 1.42 (95% CI 1.27–1.58) in quintile 5 (highest SES) compared with the lowest SES quintile. Among women, HR was 1.14 (95% CI 1.04–1.25) and 1.19 (95% CI 1.09–1.31) for SES quintiles 4 and 5, respectively, compared to SES quintile 1. HR increased from 0.75 (95% CI 0.62–0.92) in age group 20–39 years to 1.42 (95% CI 1.22–1.65) in age group 70–79 years, compared with age group ≥ 80 years among men; and among women HR increased from 0.50 (95% CI 0.41–0.60) in age group 20–39 to 1.30 (95% CI 1.16–1.45) in age group 70–79 compared with age ≥ 80 years.

TJA. The distribution of 1187 men and 1627 women who had their first TJA during 6 years of mean followup time is presented in Table 1. The mean age was 66 years (SD 10.6). The distribution of patients ranged from 18% to 22% in 5 different SES groups. Among these patients, 10% had diabetes, 43% had hypertension, and 24% were diagnosed with ischemic heart diseases on or before OA diagnosis, and the mean Charlson comorbidity score was 1.71 (SD 2.2). We observed that patients with OA received 13 new TJA per 1000 person-years. Crude HR and 95% CI estimated from PH regression are shown in Table 2. HR was 1.14 (95% CI 1.06–1.23) for men compared with women. In the crude analyses, both age and SES showed significant association with TJA. Compared to age ≥ 80, age group 60–69 had an HR of 1.48 (95% CI 1.29–1.70) and age group 70–79 had an HR of 1.63 (95% CI 1.42–1.88).

Table 1. Sociodemographic characteristics of patients with incident osteoarthritis (OA) from April 1996 to March 1998, their first orthopedic surgeons' visit, and their first total joint arthroplasty. Numbers are percentages unless otherwise mentioned.

Characteristics	New OA Diagnosis by Nonorthopedic Surgeon, n = 34,420	First Orthopedic Surgeon Visit, n = 7475	First Total Joint Arthroplasty, n = 2814
Women, n (%)	20,850 (61)	4198 (56)	1627 (57.8)
Age, yrs, mean (± SD)	61.6 (± 14.8)	63 (± 12.9)	66 (± 10.6)
SES quintile			
1	24	21	19
2	20.5	19	18
3	19	20	20
4	18.5	20	21
5	18	20	22
Age, yrs			
20–39	8.4	5	1.7
40–49	13.3	10.8	5.5
50–59	21.0	22	15.7
60–69	23.7	28.2	34.3
70–79	22.7	26	34.1
80+	10.9	8.5	8.7
Diabetes	11	10	10
Hypertension	36	38	43
Ischemic heart disease	23	23	24
Mean Charlson comorbidity score (± (SD)	1.63 (± 2.3)	1.60 (± 2.2)	1.71 (± 2.2)

SES: socioeconomic status.

Table 2. Crude hazard ratios (HR) for surgical consultations and for total joint arthroplasty among new patients with osteoarthritis.

Variable	Surgical Consultation HR (95% CI)	p	Total Joint Arthroplasty HR (95% CI)	p
Men	1.25 (1.20, 1.31)	< 0.01	1.14 (1.06, 1.23)	< 0.01
Women	1.00 (reference)		1.00 (reference)	
SES quintile				
1	1.00 (reference)		1.00 (reference)	
2	1.07 (0.99, 1.15)	0.07	1.09 (0.96, 1.22)	0.18
3	1.19 (1.11, 1.28)	< 0.01	1.28 (1.14, 1.44)	< 0.01
4	1.26 (1.18, 1.35)	< 0.01	1.37 (1.22, 1.54)	< 0.01
5	1.33 (1.24, 1.43)	< 0.01	1.50 (1.34, 1.68)	< 0.01
Age, yrs				
20–39	0.62 (0.55, 0.71)	< 0.01	0.19 (0.14, 0.26)	< 0.01
40–49	0.88 (0.80, 0.98)	0.02	0.41 (0.33, 0.50)	< 0.01
50–59	1.14 (1.04, 1.26)	< 0.01	0.74 (0.63, 0.86)	< 0.01
60–69	1.36 (1.24, 1.49)	< 0.01	1.48 (1.29, 1.70)	< 0.01
70–79	1.36 (1.24, 1.49)	< 0.01	1.63 (1.42, 1.88)	< 0.01
80+	1.0 (reference)		1.0 (reference)	

SES: socioeconomic status.

Table 3. Adjusted hazard ratios (HR) for surgical consultation and for total joint arthroplasty, stratified analysis by sex.

Variable	Surgical Consultation HR (95% CI)*		Total Joint Arthroplasty HR (95% CI)*	
	Men	Women	Men	Women
SES quintile				
1	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
2	1.14 (1.02, 1.27)	1.00 (0.91, 1.09)	1.17 (0.97, 1.42)	0.99 (0.85, 1.16)
3	1.31 (1.18, 1.47)	1.07 (0.98, 1.18)	1.42 (1.18, 1.72)	1.11 (0.95, 1.29)
4	1.38 (1.23, 1.53)	1.14 (1.04, 1.25)	1.50 (1.25, 1.81)	1.23 (1.05, 1.43)
5	1.42 (1.27, 1.58)	1.19 (1.09, 1.31)	1.52 (1.26, 1.83)	1.34 (1.16, 1.56)
Age, yrs				
20–39	0.75 (0.62, 0.92)	0.50 (0.41, 0.60)	0.15 (0.09, 0.24)	0.23 (0.15, 0.34)
40–49	1.02 (0.86, 1.22)	0.76 (0.66, 0.87)	0.38 (0.28, 0.52)	0.40 (0.30, 0.52)
50–59	1.25 (1.07, 1.47)	1.04 (0.92, 1.18)	0.68 (0.53, 0.88)	0.73 (0.59, 0.90)
60–69	1.41 (1.21, 1.64)	1.29 (1.16, 1.45)	1.29 (1.02, 1.62)	1.55 (1.29, 1.85)
70–79	1.42 (1.22, 1.65)	1.30 (1.16, 1.45)	1.52 (1.21, 1.91)	1.64 (1.37, 1.97)
80+	1.0 (reference)	1.0 (reference)	1.0 (reference)	1.0 (reference)

* HR was adjusted for diabetes, hypertension, ischemic heart disease, and Charlson comorbidity index. SES: socioeconomic status.

Because of significant interactions between sex and SES ($p < 0.01$) and between sex and age ($p = 0.03$), multivariable PH regression analyses were performed separately for men and women, after adjusting for diabetes, hypertension, ischemic heart disease, and Charlson comorbidity score (Table 3). Among men, HR increased from 1.17 (95% CI 0.97–1.42) in SES quintile 2 to 1.52 (95% CI 1.26–1.83) in SES quintile 5 compared with the lowest SES quintile; and among women, HR increased from 0.99 (95% CI 0.85–1.16) in quintile 2 to 1.34 (95% CI 1.16–1.56) in quintile 5. HR increased from 0.15 (95% CI 0.09–0.24) in age group 20–39 to 1.52 (95% CI 1.21–1.91) in age group 70–79 among men; and among women HR increased from 0.23 (95% CI 0.15–0.34) in age group 20–39 to 1.64 (95% CI 1.37–1.97) in age group 70–79 compared with age ≥ 80 years.

DISCUSSION

We investigated the demographic and socioeconomic factors that may influence the rate of the first orthopedic surgeon visit and the rate of the first TJA in patients with OA using an administrative database. We found that men visited surgeons at a higher rate than women did. After adjusting for age, sex, and comorbid conditions, patients with higher SES were more likely to see a surgeon and to obtain a TJA compared to patients with a lower SES.

In Canada, a referral from the family physician is usual-

ly necessary to see a specialist. Several studies have looked at the relationship between SES and utilization of physician services. Using the National Population Health Survey data, Dunlop, *et al*[20] and Humphries and van Doorslaer[19] found that Canadians with lower income and education were less likely to visit specialists than those with moderate or high income and higher education. Langley, *et al*[30] observed that the patients' wishes (or willingness) were significant factors in getting a referral from a GP to a specialist. Our results show that patients with OA received referrals to an orthopedic surgeon in an average of 39 per 1000 person-years, and patients with high SES had a significantly higher rate of referrals, which coincides with the results of these studies.

Hawker, *et al*[11] found a greater potential need for hip or knee replacement among individuals with less education and low income. They also found that the patient's willingness to consider joint replacement does not differ with SES levels. In another study, Hawker, *et al*[16] found that when willingness was dropped from the model, patient's education became a significant predictor of TJA. These studies did not address the time from diagnosis to surgical consultation. We observed that after diagnosis, only 13 patients had their first TJA in an average of 1000 person-years, and this suggests that two-thirds of the referrals did not receive their TJA.

Women were less likely to be recommended by their physicians for total knee arthroplasty compared to men and consequently women have lower rates of replacement surgeries than men after adjusting for medical factors[1,31]. Possible reasons for this difference could be primary care providers' views regarding the risks of, indications for, and expected outcomes of arthroplasty that make them consider women less appropriate candidates for surgery than men[1]. Other possibilities for sex differences may include, for women, caregiver status, i.e., older women often live alone or are primary caregivers to their spouses[32]. In addition, heavy labor occupations and highly demanding sports are well established risk factors for OA[33,34,35]. These factors might contribute to sex differences in getting surgical consultations and TJA. Our results are consistent with this hypothesis and show that the difference is due to a lower rate of referrals to orthopedic surgeons of women diagnosed with OA. Another interesting finding from our study was the SES and gender interaction. Men in the highest SES group were 42% more likely to obtain a surgical consultation and 52% more likely to have TJA than men in the lowest SES group, while among women, the highest SES group had only 19% more surgical consultations and 34% more TJA compared with the lowest SES group. The reasons for this interaction between SES and sex may include both medical and other social factors. It is also possible that, compared to men, women diagnosed with OA are less often perceived as appropriate candidates for TJA by the GP. Although significant interaction was found between age and gender, we observed that both men and women had monotonically increasing rates of surgical consultations and TJA as age increased.

One of the limitations of our study is that both false-negatives and false-positives may occur because of wrong diagnosis or incorrect recording in the administrative forms. Harrold, *et al*[36] estimated the positive predictive value of administratively coded OA in the general population at 62%. We have tried to minimize false-negatives and false-positives by using a case definition that requires 2 office visits for OA in 2 years. In our data, SES was assigned based on the average household income in the patient's neighborhood (census enumeration area); this may be subject to potential nondifferential misclassification. A validation study was done in the province of Manitoba by Mustard, *et al*[37], examining the measurement validity of ecologic SES measures (i.e., neighborhood-level income) as proxies for individual-level measures. They reported that risk estimates derived from ecologic income measures were not attenuated relative to risk estimates from individual measures of household income, thus providing evidence supporting the use of ecologic-level income measures.

Our study is based on prospective, complete data from a very large, geographically defined cohort of patients, followed for a long time. We used the same large population-based database as that described by Kopec, *et al*[5] that identified the incidence and prevalence of OA in British Columbia by age and sex. In British Columbia, observed prevalence of OA was 6%, using case definition that requires at least 2 visits to a health professional within 2 years or 1 hospital separation with ICD-9 code 715. The estimate was also comparable with previous large population-based studies, such as Felson, *et al*[4], where prevalence was 9% among the population aged 30 years and above and Harrold, *et al*[36], where prevalence was 8.7%. Data on the prevalence of TJA among patients with OA are limited. CJRR estimated that TJA in British Columbia was 2.6 per 1000 population in 2006-07 and 1.3 per 1000 population in 1996-97. In our cohort, we found 1.9 TJA per 1000 individuals in 2003-04. The database covered April 1991 to March 2004. The reason for selecting new patients with OA from April 1996 to March 1998 was to ensure 5 years (1991-1996) of run-in time, i.e., observation time needed to exclude prevalent cases. This was justified by another analysis of the British Columbia administrative database[5], which determined that the incidence rate of OA depended on the number of run-in years but that after 5 years this effect became minimal. Thus, patients in our study were followed for a maximum of 8 years from diagnosis to the first surgical consultation or to the first TJA. By observing time from OA diagnosis to surgical consultations and to surgery, we were able to get additional insight into the process of surgical care for patients with OA and more precise inferences regarding the factors influencing the rates of orthopedic surgeon visits and surgery.

Studies performed in the United States, Canada, and United Kingdom found similar relationships between SES and TJA, mainly that patients with low income had TJA less frequently compared to patients with higher SES. After analyzing US Medicare data, Mahomed, *et al*[38] showed that blacks and individuals with low income had a significantly lower rate of total knee replacement than individuals with high income. From a study conducted with patients in England and Ontario, Hawker, *et al*[39] found variations in knee arthroscopy rates according to patient income. Steel, *et al*[40] concluded that women and other low-income people living in Northern England received relatively fewer hip and knee joint replacements. These findings are also evident in other surgical procedures such as cardiac[41], kidney transplant[42], and melanoma treatment[43]. Further, low SES has been shown to be an increasing influence in the rate of operative mortality[44]. Several studies also explored why and how SES might affect individual health[45,46] and healthcare provision[47,48,49,50].

This database also covers all prescriptions for those aged 65 years and older and is electronically linked to MSP data. The effects of prescribed pain relief medications, such as acetaminophen, nonsteroidal antiinflammatory drugs, and opioids were adjusted for by using data from the British Columbia PharmaCare database. We repeated the same analyses for patients age 65 years and above, adjusting for all the pain medications. Because we did not have data for the disease severity, adjusting for the drug use also controls for the possible bias in the results from the severity of the disease. Even though we adjusted for prescription pain relief medications, the HR for age, sex, and SES remained the same.

Despite British Columbia's prepaid universal healthcare system, there was a significant difference between patients with OA who had low versus high SES in getting referrals to orthopedic surgeons and in the rate of obtaining the first TJA. SES differentials were higher among men, compared to women. After a diagnosis of OA, women were less likely than men to see a surgeon as well as less likely to obtain hip or knee replacement surgeries. These results suggest that sociodemographic factors play a significant role in determining access to surgical care for OA in British Columbia. Our results are likely generalizable to other Canadian provinces but their generalizability to other countries, with different healthcare systems, requires further research.

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