



Original research

Medicaid is associated with increased readmission and resource utilization after primary total knee arthroplasty: a propensity score–matched analysis

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ABSTRACT

Background: Medicaid payer status has been shown to affect resource utilization across multiple medical specialties. There is no large database assessment of Medicaid and resource utilization in primary total knee arthroplasty (TKA), which this study sets out to achieve.

Methods: The Nationwide Readmissions Database was used to identify patients who underwent TKA in 2013 and corresponding “Medicaid” or “non-Medicaid” payer statuses. Demographics, 15 individual comorbidities, readmission rates, length of stay, and direct cost were evaluated. A propensity score–based matching model was then used to control for baseline confounding variables between payer groups. A chi-square test for paired proportions was used to compare readmission rates between the 2 groups. Length of stay and direct cost comparisons were evaluated using the Wilcoxon signed-rank test.

Results: A total of 8372 Medicaid and 268,261 non-Medicaid TKA patients were identified from the 2013 Nationwide Readmissions Database. A propensity score was estimated for each patient based on the baseline demographics, and 8372 non-Medicaid patients were propensity score matched to the 8372 Medicaid patients. Medicaid payer status yielded a statistically significant increase in overall readmission rates of 18.4% vs 14.0% ($P < .0001$, relative risk = 1.31, 95% confidence interval [1.23–1.41]) with non-Medicaid status and 90-day readmission rates of 10.0% vs 7.4%, respectively ($P < .001$, relative risk = 1.35, 95% confidence interval [1.22–1.48]). The mean length of stay was longer in the Medicaid group compared with the non-Medicaid group at 4.0 days vs 3.3 days ($P < .0001$) as well as the mean total cost of \$64,487 vs \$61,021 ($P < .0001$).

Conclusions: This study demonstrates that Medicaid payer status is independently associated with increased resource utilization, including TKA, readmission rates, length of stay, and total cost after TKA.

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Introduction

Over the last 6 decades, the Medicaid program has grown from a health-care coverage program for welfare recipients into a large public health insurance program for low-income and disabled

Americans [1]. Medicaid now provides coverage for over 72 million patients and is the single largest health insurance plan in the United States [2]. The Affordable Care Act (ACA) further expanded the Medicaid program by creating a national Medicaid minimum eligibility level of 133% of the federal poverty level beginning in 2014, which has been estimated to increase the number of covered individuals younger than 65 years of age by approximately 12 million [3,4]. Total knee arthroplasty (TKA) is among the largest and fastest growing health-care expenditures, accounting for nearly \$3 billion in Medicare reimbursement in 2013 alone [5,6]. Recent health-care reform has tasked hospitals, surgeons, and policymakers to reduce cost while maintaining quality in TKA. Medicare programs such as the Medicare Bundled Payment for Care Improvement Initiative and

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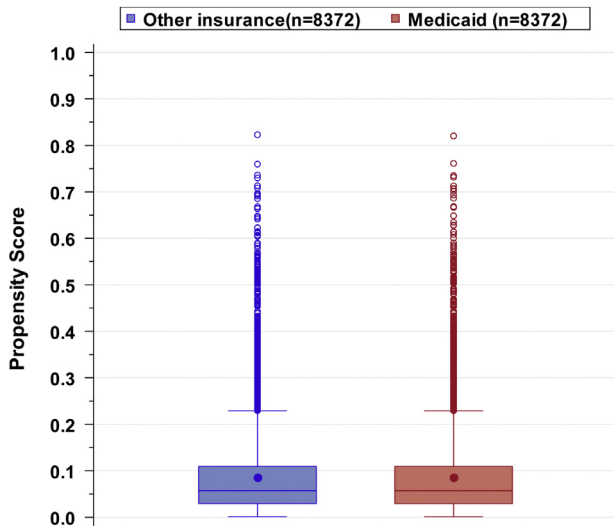


Figure 1. Evaluation of common support using distributions of propensity scores by type of insurance. The degree to which the propensity score has been appropriately specified was ascertained through evaluation of common support. Common support is defined by overlapping distributions of propensity scores between insurance groups. Overlap in the propensity score distributions indicates the potential for a patient in the Medicaid group to be in the “other” insurance group and that patients with each level of covariates may have either exposure status (ie, supporting the assumptions of exchangeability and positivity). A lack of common support or a complete separation of propensity scores without any overlap between the 2 exposure groups (ie, Medicaid patients and patients with “other” types of insurance) indicates severe differences between the 2 exposure groups and the possibility that confounding cannot be reduced using propensity methods. This boxplot demonstrates overlapping ranges of the boxplots of propensity scores between Medicaid patients and patients with “other” types of insurance, which indicates that the propensity model exhibits common support. Circles within each boxplot denote the mean score. The middle line within the box represents the median, the top line represents the 75th percentile, and the bottom line represents the 25th percentile. The upper fence is defined as the third quartile (represented by the upper edge of the box) plus 1.5 times the interquartile range. The lower fence is defined as the first quartile (represented by the lower edge of the box) minus 1.5 times the interquartile range. Observations outside the fences are identified with an open circle.

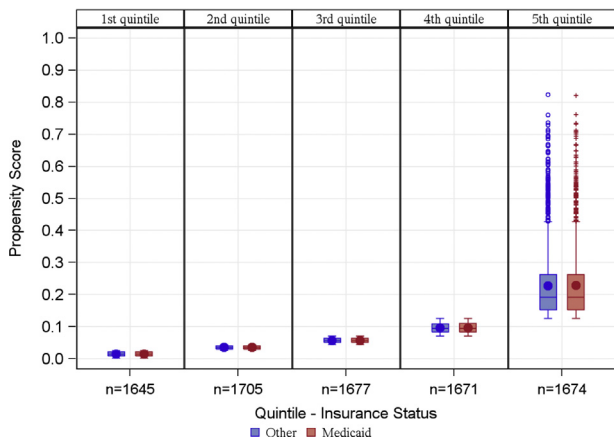


Figure 2. Distribution of propensity scores by quintiles and type of insurance. Boxplot demonstrates distribution of propensity scores among Medicaid patients and patients with other types of insurance by quintiles of propensity scores. Circles within each boxplot denote the mean score. The middle line within the box represents the median, the top line represents the 75th percentile, and the bottom line represents the 25th percentile. The upper fence is defined as the third quartile (represented by the upper edge of the box) plus 1.5 times the interquartile range. The lower fence is defined as the first quartile (represented by the lower edge of the box) minus 1.5 times the interquartile range. Observations outside the fences are identified with an open circle.

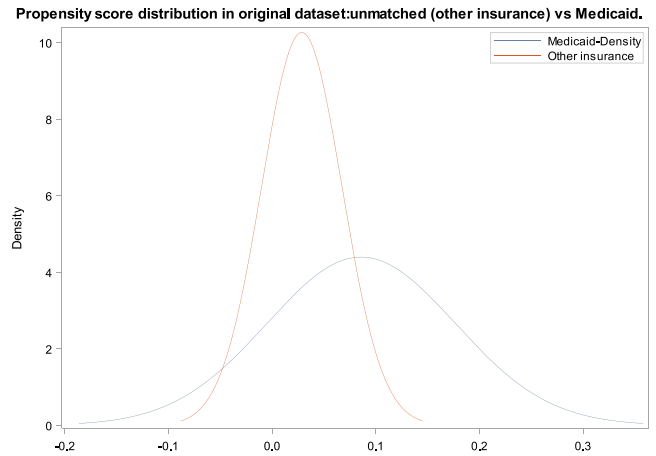


Figure 3. Propensity score distribution of Medicaid vs non-Medicaid insurance in original unmatched datasets and matched datasets.

the Comprehensive Care for Joint Replacement Model aim to align incentives to contain costs through bundling payments for an episode of care from the time of surgery through 90 days after discharge [7-9]. While the early results of these alternative payment models (APMs) seem promising [10], concern remains regarding patient selection and access to care [11].

Medicaid insurance status and lower socioeconomic status have repeatedly been shown to affect risk-adjusted outcomes and resource utilization across multiple medical specialties [12-14]. Varying explanations for this finding have described this disparity including complex interaction between socioeconomic status, access to care, patient factors, and clinical outcome measures. Data have been limited to small retrospective studies that suggest Medicaid patients who undergo total joint arthroplasty are more likely to have a longer length of stay, disposition to a rehabilitation facility, and increased readmission within 90 days [15,16]. Despite evidence that patients with Medicaid status require more resources at increased cost, payers have yet to provide adjustment in reimbursement based on Medicaid payer status. With the increasing prevalence of APMs, there may be a disincentive to perform TKAs on patients with Medicaid status.

The primary purpose of this study was to examine the 90-day readmission rates associated with Medicaid versus non-Medicaid payer status after TKA and a secondary purpose to assess overall readmission, length of stay, and total cost between the 2 cohorts. A large, national administrative database was used to achieve a comprehensive analysis and allow Medicaid patients to be matched one-to-one with control patients who differed only in payer status. This study uniquely examines Medicaid payer status as an independent risk factor for morbidity and increased resource utilization at a national level and is the largest patient sample to date. The primary hypothesis is that Medicaid payer status results increased 90-day readmission rates specific to knee replacement, increased all-cause 90-day comorbidity, longer length of stay with increased resource utilization and total cost compared with a matched cohort of control patients with other payer profiles.

Material and methods

The Nationwide Readmissions Database (NRD) was used to identify patients who underwent primary TKA (International Classification of Diseases-9 code 8154) in 2013 as well as corresponding “Medicaid” or “non-Medicaid” payer statuses. The NRD is

Table 1
Characteristics of the TKA (ICD-9 code 8154) patients from the 2013 NRD.

Risk factors	Before propensity matching			After propensity matching				
	Medicaid, N = 8372	Other insurance, n = 268,261	P Value	Standardized difference	Medicaid, n = 8372	Other insurance, n = 8372	P value ^a	Standardized difference ^b
Age, years (mean ± SD)	56.7 ± 9.4	66.7 ± 9.7	<.0001	1.055	56.7 ± 9.4	56.5 ± 9.6	<.001	0.014
Female sex	6072 (72.5%)	165,227 (61.6%)	<.0001	0.234	6071 (72.5%)	6129 (73.2%)	.004	0.016
Severity of illness (major/extreme loss vs other)	549 (6.6%)	13,685 (5.1%)	<.0001	0.062	547 (6.5%)	477 (5.7%)	<.001	0.035
Discharged to skilled facility	2118 (25.3%)	75,028 (28.0%)	<.0001	0.061	2118 (25.3%)	2142 (25.6%)	.261	0.007
Smoking	2711 (32.4%)	59,997 (22.4%)	<.0001	0.226	2710 (32.4%)	2664 (31.8%)	.038	0.012
Comorbidities								
AIDS	9 (0.1%)	46 (0.0%)	<.0001	0.036	9 (0.1%)	4 (0.0%)	.166	0.021
Alcohol abuse	201 (2.4%)	2490 (0.9%)	<.0001	0.115	201 (2.4%)	148 (1.8%)	<.001	0.044
Deficiency anemia	1049 (12.5%)	29,855 (11.1%)	<.0001	0.043	1048 (12.5%)	1055 (12.6%)	.730	0.003
Rheumatoid arthritis	458 (5.5%)	11,102 (4.1%)	<.0001	0.062	457 (5.5%)	414 (4.9%)	.008	0.023
Chronic blood loss anemia	92 (1.1%)	3227 (1.2%)	.388	0.010	92 (1.1%)	90 (1.1%)	.821	0.002
Congestive heart failure	203 (2.4%)	6289 (2.3%)	.635	0.005	203 (2.4%)	170 (2.0%)	.019	0.027
Chronic pulmonary disease	2100 (25.1%)	38,992 (14.5%)	<.0001	0.267	2100 (25.1%)	2056 (24.6%)	.055	0.012
Coagulopathy	163 (1.9%)	5493 (2.0%)	.520	0.007	163 (1.9%)	134 (1.6%)	.025	0.026
Depression	1676 (20.0%)	34,767 (13.0%)	<.0001	0.191	1675 (20.0%)	1658 (19.8%)	.416	0.005
Diabetes	2179 (26.0%)	57,641 (21.5%)	<.0001	0.107	2179 (26.0%)	2152 (25.7%)	.222	0.007
Peripheral vascular disorders	101 (1.2%)	6613 (2.5%)	<.0001	0.094	101 (1.2%)	67 (0.8%)	<.001	0.041
Drug abuse	257 (3.1%)	1437 (0.5%)	<.0001	0.191	256 (3.1%)	194 (2.3%)	<.001	0.046
Weight loss	47 (0.6%)	1130 (0.4%)	.053	0.020	47 (0.6%)	42 (0.5%)	.553	0.008
Infection	118 (1.4%)	1977 (0.7%)	<.0001	0.065	118 (1.4%)	114 (1.4%)	.728	0.004

^a McNemar's test (a chi-square test for paired proportions). The difference in paired proportions is small for all covariates but statistically significant for several covariates because of the large sample size.

^b A standardized difference less than 0.10 suggests negligible difference in the mean or prevalence of a covariate between the 2 insurance groups.

part of the federal-, state-, and industry-sponsored Healthcare Cost and Utilization Project and created to allow for analyses of national readmission rates across the United States, accounting for 49.1% of all U.S. hospitalizations. Demographics (age, gender, severity of illness, discharge to skilled facility), 15 individual risk factors/comorbidities (smoking, AIDS, alcohol abuse, deficiency anemia, rheumatoid arthritis, chronic blood loss anemia, congestive heart failure, chronic pulmonary disease, coagulopathy, depression, diabetes, peripheral vascular disorders, drug abuse, weight loss, infection), readmission rates, length of stay, and direct cost were evaluated. A propensity score–based matching model was then used to control for baseline confounding variables between payer groups [17,18]. Propensity scores were estimated using binary logistic regression with type of insurance as the dependent variable or outcome variable (ie, the exposure groups). The independent variables for the propensity score model included covariates potentially associated with type of insurance and outcomes. Using the resulting logistic regression equation, the propensity score was calculated as the probability of each patient being in the Medicaid group.

Table 2
Overall readmissions in propensity score–matched Medicaid vs non-Medicaid patients.

	Readmitted (Medicaid)	Not readmitted (Medicaid)	Total
Readmitted (non-Medicaid)	251 ^a	919 ^b	1170
Not readmitted (non-Medicaid)	1287 ^c	5915 ^d	7202
Total	1538	6834	8372 pairs ⁽ⁿ⁾
Paired proportion $P_m: a+c/n$	1538/8372 (0.1837)		
Paired proportion $P_0: a+b/n$	1170/8372 (0.1398)		
RR = $(a+c)/(a+b) = 1.31$			
RR (95% confidence interval)	1.31 (1.23, 1.41) $P = <.001$		

^a Sum of Medicaid and non-Medicaid readmitted patients.

^b Sum of Medicaid not readmitted and non-Medicaid readmitted.

^c Sum of Medicaid readmitted and non-Medicaid not readmitted.

^d Sum of Medicaid and non-Medicaid not readmitted.

Using only the propensity score, Medicaid cases were matched one-to-one to other insurance types using a greedy matching strategy [19]. In this approach, a Medicaid subject is randomly selected, and the control patient (other insurance type) with the closest propensity score that lies within a fixed distance (the propensity score caliper) of the Medicaid subject's propensity score is selected for matching. For these analyses, patients were matched on the logit of the propensity score using a caliper of 0.2 standard deviations of the logit of the propensity score [20]. Standardized differences were used to assess the balance of confounders between the 2 exposure groups.

Standardized differences were defined as the difference in means between the 2 exposure groups divided by a measure of the standard deviation of the variable and were computed for both continuous (ie, age) and binary covariates. Standardized differences are preferred to significance testing (to assess the balance of confounders between the 2 exposure groups) because they are in units of the pooled standard deviation, so they allow for comparisons on the same scale and not influenced by the sample size. The magnitude of the difference in the paired proportions is small even

Table 3
Ninety-day readmissions in propensity score–matched Medicaid vs non-Medicaid patients.

	Readmitted (Medicaid)	Not readmitted (Medicaid)	Total
Readmitted (non-Medicaid)	96 ^a	525 ^b	621
Not readmitted (non-Medicaid)	741 ^c	7010 ^d	7751
Total	837	7535	8372 pairs ⁽ⁿ⁾
Paired proportion $P_m: a+c/n$	837/8372 (0.1000)		
Paired proportion $P_0: a+b/n$	621/8372 (0.0742)		
RR = $(a+c)/(a+b) = 1.35$			
RR (95% confidence interval)	1.35 (1.22, 1.48) $P = <.001$		

^a Sum of Medicaid and non-Medicaid readmitted patients.

^b Sum of Medicaid not readmitted and non-Medicaid readmitted.

^c Sum of Medicaid readmitted and non-Medicaid not readmitted.

^d Sum of Medicaid and non-Medicaid not readmitted.

Table 4

Comparison of total cost after TKA between Medicaid and non-Medicaid patients (n = 8372).

Total cost	Medicaid (95% CI)	Other insurance (95% CI)	Difference (95% CI)	P-value
Median	54,983 (54,107–55,783)	51,463 (50,785–52,092)	2194 (1216–3113)	<.0001 ^a
Mean	64,487 (63,575–65,398)	61,021 (60,232–61,809)	3466 (2274–4657)	<.0001 ^b
STD	41,654	36,027	54,442	
IQR	41,245	35,536	50,899	

CI, confidence interval; IQR, interquartile range; STD, standard deviation.

^a P-value from Wilcoxon signed-rank test.^b P-value from paired t-test.

though several of the P values from the McNemar's test was statistically significant (mainly because of the large sample sizes). A standardized difference less than 0.1 suggests negligible difference in the mean or prevalence of a covariate between the 2 insurance groups in the propensity score–matched sample. Additional details on assessing the balance produced by the propensity model are shown in Figures 1–3. The final step involved estimating the effect of exposure on outcomes, which was readmission (overall readmission and 90-day readmission data were obtained) after TKA. Multivariable regression is not necessary because matching on the propensity scores addressed confounding. The relative risk (RR) and its 95% confidence interval for readmission were calculated based on the two-by-two table for matched pairs, where the outcome is readmission and the predictor is type of insurance. A RR estimate above 1.0 suggests Medicaid patients were at higher risk of readmission after TKA than patients with other types of insurance. Total hospital costs were calculated using the cost-to-charge ratio provided by the Healthcare Cost and Utilization Project files. Length of stay and total cost comparisons were evaluated using the Wilcoxon signed-rank test.

Results

A total of 8372 Medicaid and 268,261 non-Medicaid TKA patients were identified from the 2013 NRD. A propensity score was estimated for each patient based on the available baseline characteristics, and 8372 non-Medicaid patients were propensity score matched to the 8372 Medicaid patients. A summary of patient baseline characteristics and risk factors/comorbidities is provided in Table 1. All standardized differences were less than 0.1, suggesting negligible differences in the mean or prevalence of all patient characteristics and comorbidities between the Medicaid and non-Medicaid groups. Medicaid payer status yielded a statistically significant increase in overall readmission rates of 18.4% vs 14.0% non-Medicaid ($P < .0001$, RR = 1.31, 95% confidence interval [1.23–1.41]) and yielded a statistically significant increase in 90-day readmission rates of 10.0% vs 7.4%, respectively ($P < .001$, RR = 1.35, 95% confidence interval [1.22–1.48]). A RR estimate above 1.0 suggests Medicaid patients were at higher risk of readmission after TKA than patients with other types of insurance, which suggest that the risk of readmission at any time period is 31% higher for TKA patients with Medicaid insurance compared to patients with other types of insurance. The risk of readmission within 90 days is 35% higher for TKA patients with Medicaid insurance compared to TKA patients with other types of insurance. Tables 2 and 3 summarize the overall and 90-day readmission outcomes in propensity score–matched Medicaid vs non-Medicaid patients. The mean length of stay was longer in Medicaid group compared with non-Medicaid group at 4.0 days vs 3.3 days ($P < .0001$) and mean direct cost of \$64,487 vs \$61,021 ($P < .0001$). Tables 4 and 5, respectively, summarize these findings.

Discussion

With continued health-care reform and the ACA, it is expected that Medicaid will expand to millions of uninsured Americans [21]. With this growth, it is expected that the states will be required to fund approximately 10% of the expansion by 2020. In an effort to decrease cost, APMs, such as bundled payments, may become more prevalent. Although the ACA has allowed APMs for Medicaid patients in some states, these models have not been readily adopted for arthroplasty patients as cost data for Medicaid patients are sparse. This study demonstrates that Medicaid payer status is independently associated with increased morbidity and resource utilization following TKA after adjusting for comorbidities and potential confounders. Specifically, Medicaid payer status is associated with increased 90-day and overall readmission rates, length of stay, and direct cost. These findings are consistent with previous orthopaedic literature [22–25] and is the largest patient sample size evaluating Medicaid patients and TKA from a national standpoint. There are a few small retrospective cohort studies evaluating Medicaid status with increased 90-day readmission and 1 large national inpatient sample study looking at Medicaid inpatient reporting only [1,25]. This study is the first to assess a large national database on the impact of Medicaid payer status on resource utilization via 90-day and overall readmission rates, length of stay, and direct cost in TKA patients.

The differences in 90-day outcomes after total knee replacement persist after matching Medicaid patients to non-Medicaid patients. This study design accounts for a wide range of confounding patient demographics and comorbidities that may be encountered in patients with Medicaid payer status. Previous studies have revealed several disparities in preoperative patient characteristics that could influence outcomes. For example, Medicaid patients who undergo total knee replacements are typically younger, positive for smoking history, and have increased medical comorbidities. These are potential confounders that were accounted for in this analysis. Previous studies on this population have been underpowered and lacked confounding variable control.

With the increased prevalence of bundled payment programs, health-care stakeholders have a financial incentive to provide high-quality care to patients at the lowest cost. With postdischarge care accounting for a significant portion of the overall cost, patients who are at increased risk to be discharged to rehabilitation center or be

Table 5

Comparison of length of stay after TKA between Medicaid and non-Medicaid patients (n = 8372).

Length of stay	Medicaid (95% CI)	Other insurance (95% CI)	Difference (95% CI)	P-value
Mean	3.98 (3.91–4.06)	3.34 (3.29–3.39)	0.64 (0.55–0.73)	<.0001 ^a
STD	3.58	2.39		
IQR	1	1		

CI, confidence interval; IQR, interquartile range.

^a P-value from paired t-test.

readmitted within 90 days will significantly increase cost per episode of care [9]. Because of increased cost per episode of care in patients with Medicaid status, providers may be hesitant to take on financial risks associated with Medicaid insurance, thus potentially increasing disparities in patient access to care. This study justifies further investigation into adjusting reimbursement models for TKA patients based on Medicaid payer status.

The strength of the study is the ability to analyze a large number of patient records and control for confounding variables through matching. This is a nationwide sample and is representative of clinical practice. This is the first study to include administrative data on payer status, for 90 days, with sufficient sample size to avoid beta error. The limitations are those inherent in the analysis of large administrative databases, such as incomplete data collection, inaccurate diagnostic and procedural coding, and lack of detailed clinical information or clinical outcomes. There are also limitations inherent to propensity score matching analysis. Specifically, propensity score methods only provide the expectation that measured baseline covariates will be balanced between Medicaid and non-Medicaid groups but make no claim to balance unmeasured covariates. Psychosocial factors such as income, education level, employment status, and race are not available in the NRD and thus not available for propensity score matching. Finally, the insufficient clinical detail prevents conclusions based on pre-operative functional status or the severity of joint disease that can vary inside of International Classification of Diseases–9 code 8154.

Although this study shows that Medicaid status is an independent risk factor for complications, readmission, and increased resource utilization, it does not explain why the association exists nor does it suggest causation or provide reasons for readmissions. The influence of socioeconomic factors on 90-day readmissions and complications is complex, and all potential factors cannot be captured in a study of administrative data. Further studies are needed to identify other possible psychosocial variables that may impact readmission and cost of care. These factors should be considered along with medical comorbidities in reimbursement models, and these models need to be critically evaluated at a continuum to allow policymakers and providers to implement strategies that will improve care and access for a spectrum of patients.

Conclusions

With the continued growth of APMs including bundled payments, access to care for individuals with increased risk of complications, readmission, and discharge to a nursing facility will continue to be an issue. Physicians and hospitals may potentially have a disincentive on patient populations who require increased resource utilization. Medicaid status in this study was predictive of increased 90-day and overall readmission rates, length of stay, and direct cost after TKA. Risk adjustment models accounting for Medicaid status are necessary to avoid decreased access to care for this patient population and avoid financial penalty for physician and hospital alike.

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