



Presented at the Academic Surgical Congress 2019

Treatment of appendicitis: Do Medicaid and non-Medicaid–enrolled patients receive the same care?



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ARTICLE INFO

Article history:

Accepted 30 June 2019

Available online 9 August 2019

ABSTRACT

Background: Studies using national data sets have suggested that insurance type drives a disparity in the care of emergency surgery patients. Large databases lack the granularity that smaller, single-institution series may provide. The goal of this study is to identify factors that may account for differences in care between Medicaid and non-Medicaid enrollees with appendicitis in central Massachusetts.

Methods: All adult patients with acute appendicitis in an academic medical center between 2010 and 2018 were included. Sociodemographic and clinical characteristics were compared according to Medicaid enrollment status. Analyses were performed to assess differences in the frequency of operative treatment, time to surgery, length of stay, and rates of readmission.

Results: The sample included 1,257 patients, 10.7% of whom ($n = 135$) were enrolled in Medicaid. The proportions of patients presenting with perforated appendicitis (28.9% vs 31.2%, $P = .857$) and undergoing laparoscopic appendectomy (96.3% vs 90.7%, $P = .081$) were similar between the 2 groups, as were length of stay (20 hours 30 minutes versus 22 hours 38 minutes, $P = .109$) and readmission rates (17.8% vs 14.5%, $P = .683$). Medicaid enrollees did experience somewhat greater time to surgery (6 hours 47 minutes versus 4 hours 49 minutes, $P < .001$).

Conclusion: Despite anticipated differences in population, the treatment of appendicitis was similar between Medicaid and non-Medicaid enrollees. Medicaid enrollees experienced greater time to surgery; however, further studies are needed to explain this disparity in care.

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Introduction

Disparities in health care related to insurance status have been a predominant topic of political focus in the United States for the past decade. With the implementation of the 2010 Patient Protection and Affordable Care Act (ACA), the percentage of uninsured individuals in the United States decreased to a low of 8.8% in 2016. With the expansion of Medicaid, more than 20 million people gained health insurance with the number of people covered under government plans (Medicaid, Medicare, and Military health care),

increasing to 120 million. Yet, despite the overall increase in coverage, there remains a well-documented difference in outcomes based on insurance type.^{1–3}

The Medicaid and uninsured patient populations have been found to have worse outcomes compared with privately insured patients across many medical and surgical specialties. Emergency general surgery is a particular area of interest because it represents both a substantial portion of all surgical admissions and patient morbidity and mortality. For most emergency general surgical conditions, the onset is acute, and without treatment, the progression of disease is rapid. As such, delays in access to care and its delivery are associated with increased morbidity and mortality.¹

Research from our institution demonstrated that nationally, patients with acute appendicitis, acute cholecystitis, acute diverticulitis, and incarcerated ventral or inguinal hernias with Medicaid

Presented at the 2018 Academic Surgical Congress.

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insurance were operated on less frequently, with greater wait times to operative intervention, greater hospital stays, and greater rates of in-hospital morbidity.⁴ The underlying social factors, institutional practices, or geographic processes that account for these disparities in care, however, are yet to be identified.

Geographic information has been used to study and improve medical outcomes since the first outbreak of cholera in the 1850s. Using geographic information systems, local factors contributing to disparities in emergency surgical care can be defined more clearly. A recent study by Khubchandani et al⁵ reported a disproportionate lack of emergency general surgery hospitals in rural counties across the United States and in counties with greater proportions of uninsured individuals, of nonwhite race or ethnicity, and with lesser levels of formal levels of education.

Nevertheless, emergency general surgical conditions such as appendicitis affect individuals of different races, socioeconomic status, education level, and insurance type alike. Appendicitis is often used as a surrogate in the field of emergency surgery for the study of access to and quality of care because of its high incidence, independence from other disease processes and consistent, time-sensitive natural history progressing toward perforation.^{6–8} Here we focus on patients with acute appendicitis at a single institution to identify geographic and socioeconomic factors that may account for disparities in care based on insurance type.

Methods

Patient selection and data extraction

A retrospective review was performed for all adult patients 18 years of age and older who presented with acute appendicitis at either the University of Massachusetts Medical Center University Campus or Memorial Campus (both in Worcester, MA) between October 1, 2010, and August 30, 2018. Patients were identified using International Classification of Disease (ICD)-9 and ICD-10 diagnosis codes for acute appendicitis and all sub-codes (with generalized peritonitis [ICD-9 540.0, ICD-10 K35.2], with peritoneal abscess [ICD-9 540.1, ICD-10 K35.3], without mention of peritonitis [ICD-9 540.9], and unspecified [ICD-10 K35.80]). For a more uniform patient population, we excluded children, pregnant women, incarcerated individuals, patients > 65 years of age or enrolled in Medicare, and patients who underwent appendectomy for other reasons or who were found to have malignancy on final pathology.

Patient information was extracted from the EPSi database (Chesterfield, MO, USA) and Soarian Clinicals (Cerner Ltd., London, UK) database. Demographics included date of birth, age, sex, race, ethnicity, marital status, and insurance provider, which was classified as Medicaid or non-Medicaid. Clinical data included ICD9/ICD10 code, admission date and time, discharge date and time, time to surgery ([TTS] from emergency department [ED] admission time), length of stay ([LOS] as ED admission time to discharge time), number of primary care provider (PCP) visits, and ED visits within 1 year before admission. Readmission status was classified as at least 1 inpatient encounter of any problem within 30 days of discharge. Procedures, dates, and times of surgery were generated from Perioperative Systems (Picis Clinical Solutions Inc., Wakefield, MA). Comorbidities included anxiety, asthma, coronary heart disease, depression, diabetes mellitus, hypercholesterolemia, hypertension, obstructive sleep apnea, and smoking status. A subgroup analysis was performed for patients with acute appendicitis from October 2017 to October 2018, using the same inclusion and exclusion criteria as we have discussed earlier in this report. During this time, additional clinical and sociodemographic variables were generated from Epic EHR Clarity version 2017 (Epic Systems Corp, Verona, WI, USA). Final variables from Epic EHR included admission

temperature, heart rate, systolic and diastolic blood pressure, white blood cell count, lactic acid, time to computed tomography ([CT] from ED admission time), primary language, and need for an interpreter.

Information regarding a patient's address (street, town, and state) was extracted from clinical databases and transformed to geographic coordinates using ArcGIS 10.6 (Esri, Redlands, CA, USA). Geographic-based variables, including travel distance to hospital, household income, and neighborhood characteristics (median income and education level), were extracted from Google Maps API (Google, Mountain View, CA, USA) and census data, respectively, and integrated using ArcGIS 10.6 (Esri).

Statistical analysis

Univariate analysis was performed using Python 3.6 (Python, Beaverton, OR, USA) and the SciPy library (Enthought Inc., Austin, TX). Median and 25th and 75th percentiles were used to summarize non-normal variables and evaluated by the Shapiro-Wilkes test. Differences between groups for continuous variables were compared using the Mann-Whitney *U* ranked test to evaluate between insurance types and χ^2 tests for categorical variables.

Multivariate analysis was performed for TTS because it was the only outcome variable that provided statistically significant results between Medicaid and non-Medicaid enrollees in the univariate analysis. The distribution of this sample (TTS converted to total seconds as a continuous variable) was positively skewed and matched a Poisson distribution. Poisson regression was used to test the effects of Medicaid insurance on TTS, in combination with other variables found statistically significant from the univariate analyses, which were age at admission, marital status, select comorbidities (diabetes, hyperlipidemia, and hypertension), neighborhood household income, neighborhood proportion with a high school diploma, neighborhood proportion of nonminorities, and travel distance to the hospital. Data were normalized and all categorical variables turned binary. Collinearity was checked using Pearson correlation. Travel distance and neighborhood proportion with high school diploma were found collinear ($r = -0.7$), so high school diploma was removed from the multivariate analysis to avoid bias. Poisson regression was evaluated at a significance level of .05, and model fit was tested using both the Pearson χ^2 test and the deviance and log-likelihood ratio test for goodness of fit.

Results

The sample consisted of 1,257 patients, 46.4% were female, 72.5% were non-Hispanic white, and 41.4% were single. The overall mean age was 39.4 years (Table I). The median household income for the sample was \$66,500, and the median distance to the hospital was 7.6 miles. A total of 135 patients were enrolled in Medicaid (10.7%). A total of 1,148 (91.3%) patients underwent laparoscopic appendectomy, with a median TTS of 4 hours 51 minutes and a median LOS of 22 hours and 37 minutes (Table I).

When comparing baseline sociodemographic factors between Medicaid and non-Medicaid enrollees, those with Medicaid were younger (33.5 years versus 40.1 years, $P < .0001$), more likely to be unmarried (73% vs 48.1%, $P < .0001$), and belong to a nonwhite race or ethnicity (54.1% vs 24.4%, $P < .0001$). Medicaid enrollees were more likely to live in a neighborhood that was closer to the hospital (4.0 miles vs 8.3 miles, $P < .0009$), have a lesser median annual income (\$40,400.00 vs \$67,700.00, $P < .0001$), and have a lower level of formal education (82.9% vs 91.6% with high school diploma, $P < .0001$). In addition, a greater proportion of individuals in the Medicaid group belonged to a racial or ethnic minority (31.0% vs 17.1%, $P < .0001$; Table II).

Table I
Sociodemographic and clinical factors for adults with acute appendicitis at UMMC (2010–2018)

N	1,257
Sociodemographic	
Age, mean y (SD)	39.4 (16.0)
Female (%)	46.4
Non-Hispanic white (%)	72.4
Marital status (%)	
Single	45.6
Married	41.4
Divorced	5.3
Unknown	7.7
Medicaid enrollee (%)	135 (10.7%)
Median income (25% percentile, 75% percentile)	\$66,500 (\$40,600, \$91,300)
Median proportion in neighborhood with high school diploma (25% percentile, 75% percentile)	0.912 (0.842, 0.983)
Median proportion in neighborhood who are non-Hispanic white (25% percentile, 75% percentile)	0.817 (0.696, 0.938)
Median distance from home to hospital, miles (25% percentile, 75% percentile)	7.6 (1.8, 13.4)
Greater than 20 miles from Worcester, MA, hospitals (%)	17.3
Clinical	
Medical history (%)	
Anxiety	5.6
Asthma	6.6
Coronary heart disease	2.1
Depression	4.8
Diabetes	3.1
Hyperlipidemia	10.4
Hypertension	13.0
Obstructive sleep apnea	3.1
Smoking	9.8
Laparoscopic appendectomy (%)	1,148 (91.3)
Median length of stay (25% percentile, 75% percentile)	22 h 37 min (10 h 12 min, 35 h 03 min)
Readmitted within 30 days of discharge (%)	15.3
Median time to surgery from admission (25th percentile, 75th percentile)	4 h 51 min (1 h 07 min, 8 h 35min)

UMMC, University of Massachusetts Medical Center.

Medicaid enrollees were significantly less likely to present with preexisting medical comorbidities that include diabetes mellitus, hyperlipidemia, and hypertension. Patients enrolled in Medicaid were also more likely to have visited their PCP or the ED in the year before their admission for acute appendicitis compared with non-Medicaid enrollees (Table II).

In the subgroup of adult patients with acute appendicitis from October 2017 to October 2018 at our institutions, there was no difference in the proportion of patients on antiplatelet medications (aspirin, clopidogrel, ticagrelor, prasugrel) or anti-coagulants (warfarin, enoxaparin, rivaroxaban, apixaban, dabigatran) between the two groups. Vital signs (heart rate, systolic blood pressure, diastolic blood pressure) and laboratory values (white blood cell and lactic acid) at the time of admission were also similar between the two groups. We observed no difference in the proportion of patients who required an interpreter or in the time to CT between Medicaid and non-Medicaid enrollees (Table III).

In the entire sample, there were no differences between the number of Medicaid and non-Medicaid enrollees who presented with perforated appendicitis (28.9% vs 31.2%, $P = .857$) or who underwent laparoscopic appendectomy (96.3% vs 90.7%, $P = .081$). Although LOS (20 hours 30 minutes versus 22 hours 38 minutes, $P = .109$) and 30-day readmission rates (17.8% vs 14.5%, $P = .683$) were similar between the 2 groups, there was a difference in the median TTS, with Medicaid enrollees waiting longer for the

operation, even after adjusting for social and clinical characteristics (6 hours 47 minutes versus 4 hours 49 minutes, $P < .001$; Tables IV and V). This disparity was also not explained by any differences in TTS for patients presenting during the day (6:00AM–6:00PM) compared with at night (6:00PM–6:00AM; $P = .50$).

In the multivariate analysis for TTS, Medicaid enrollment, age, neighborhood household income, and travel distance to hospital were predictors of TTS ($P < .002$ each). All of their coefficients are negative, representing negative correlation with TTS (Table V). Pearson χ^2 and log-likelihood ratio tests of fitness resulted in $P > .05$ (0.891 and 0.928, respectively), which indicates that there is no strong evidence of lack of fit for the model.

Discussion

Acute appendicitis is the most common, intra-abdominal infection requiring operation.^{6,9} Its predictable natural course without treatment has led to the use of perforated appendicitis as a quality metric and a proxy measure for assessing equality in access to and delivery of healthcare.^{10,11} Several large US studies have demonstrated that Medicaid insurance and nonwhite race are associated with greater rates of perforation and lesser rates of a laparoscopic appendectomy in patients with acute appendicitis when compared with whites and the privately insured.^{12–17} Although Medicaid enrollees in our study were indeed more likely to be non-white, unmarried, and younger, with lower levels of formal education and lesser median annual income when compared with their non-Medicaid counterparts, we found similar rates of appendicitis with peritonitis or perforation and similar use of laparoscopic appendectomy between groups.

These findings may reflect the numerous state and federal health care reforms that have occurred during the past 15 y. In 2006, the Massachusetts Health Care Reform expanded Medicaid coverage, resulting in a substantial decrease in uninsured residents from 548,000 to 247,000 within the first 3 years.¹² In 2013, Loehrer et al¹² reported the disappearance of the previously recognized racial disparity in the treatment of acute appendicitis and acute cholecystitis in Massachusetts, with similar proportions nonwhite and white patients undergoing laparoscopic surgery after the Medicaid expansion.¹²

In 2009, the Affordable Care Act aimed to improve access to health care across the United States similarly through the expansion of Medicaid to an additional 30 million individuals.^{1,12} The Dependent Coverage Provision was also introduced and is estimated to have increased insurance coverage for approximately 3% to 7% of previously uninsured young adults.¹¹ In 2016, Scott et al¹¹ reported decreased rates of perforated appendicitis among young adults with acute appendicitis across the United States. The decrease in rates of perforated appendicitis was most prominent among patients belonging to racial or ethnic minorities, lower-income communities, and those presenting to urban hospitals. These observations suggested improved access to care. Moreover, newly insured individuals reported increased access to care, decreased delays in seeking care, and improved overall mental and physical health status.¹¹

At the national level, uninsured and underinsured individuals experience substantial delays in care, which results in more complex diseases at presentation across a variety of emergency surgical diagnoses.¹ A patient's perceived inability to pay for treatment has been identified as a common reason to delay seeking medical attention. In addition, insurance status has been identified as the most important factor associated with severity of disease at presentation.¹⁷ Delay in presentation and in TTS have both clearly

Table II
Baseline sociodemographic and clinical factors for adults with acute appendicitis at UMMC by insurance type (2010–2018)

	Non-Medicaid	Medicaid	P value
N	1,122	135	
Sociodemographic			
Age, mean y (SD)	40.1 (16.3)	33.5 (11.8)	<.0001*
Female (%)	46.5	45.2	.120
Non-Hispanic white (%)	75.6	45.9	<.0001*
Marital status (%)			
Single	42.7	69.3	
Married	43.5	24.4	
Divorced	5.4	3.7	
Unknown	8.4	2.2	
Median income, (25% percentile, 75% percentile)	67,700 (44,000, 91,400)	40,400 (20,500, 60,200)	<.0001*
Median proportion in neighborhood with high school diploma (25% percentile, 75% percentile)	0.916 (0.856, 0.976)	0.829 (0.744, 0.913)	<.0001*
Median proportion in neighborhood who are non-Hispanic white (25% percentile, 75% percentile)	0.829 (0.702, 0.956)	0.690 (0.578, 0.802)	<.0001*
Median distance from home to hospital, miles (25% percentile, 75% percentile)	8.3 (2.4, 14.3)	4.0 (0.9, 7.1)	<.0001*
Clinical			
Medical history (%)			
Anxiety	5.9	3.7	.580
Asthma	6.5	7.4	.548
Coronary heart disease	2.4	0.0	.154
Depression	5.1	2.2	.220
Diabetes	3.3	1.5	.040*
Hyperlipidemia	11.4	2.2	.004*
Hypertension	13.8	5.9	.026*
Obstructive sleep apnea	3.1	3.0	.778
Smoking	9.1	15.6	.118
Mean (mode), number of visits to PCP in year prior	0.33 (0)	0.65 (0)	.019*
Mean (mode), number of visits to emergency department in year prior	0.71 (0)	1.2 (1)	<.0001*

UMMC, University of Massachusetts Medical Center.

* Statistically significant.

been associated with worse outcomes in acute appendicitis, a greater rate of perforation, more frequent development of an intraperitoneal abscess, postoperative ileus, greater LOS, and increased overall health care costs.^{16,18,19}

Although both prehospital and in-hospital factors may contribute to delays in TTS, the literature has cited prehospital delays frequently as the most important factors contributing to perforation and morbidity in appendicitis.^{11,16,18,19} Prehospital delays may originate from patients' perceived inability to pay for care, lack of familiarity with ways to access care, lack of routine

preventative care, and inability to take time off or to secure child-care while they seek medical attention.^{10,11,20} Although patients enrolled in Medicaid are more likely to live close to tertiary care facilities because they both tend to be in urban areas, Hall et al²¹ reported that a disproportionately low percentage of Medicaid patients undergo specialty procedures at specialized, high-volume hospital centers, despite relative close geographic proximity. This study suggests that Medicaid enrollees may have difficulty accessing care even with large hospital centers within close geographic proximity. In-hospital delays are less discussed in

Table III
Baseline sociodemographic and clinical factors for adults with acute appendicitis at UMMC by insurance type (2017–2018)

	Non-Medicaid	Medicaid	P value
N	154	16	
Primary language (%)			
English	90	81.3	.049*
Spanish	3.2	12.5	
Other	9.8	6.2	
Interpreter needed (%)	11	18.8	.615
Antiplatelet at admission (%)	4.6	6.3	.754
Anticoagulant at admission (%)	2	6.3	.831
Acute appendicitis with peritonitis and/or abscess (%)	31.2	38.9	.857
Median blood pressure systolic (25th percentile, 75th percentile)	119 (110.5, 127.5)	121.5 (107.9, 135.1)	.341
Median blood pressure diastolic (25th percentile, 75th percentile)	71.0 (64.5, 77.5)	70.5 (66.4, 74.6)	.200
Median temperature (25th percentile, 75th percentile)	98.2 (98.0, 98.5)	98.2 (97.9, 98.5)	.134
Median heart rate (25th percentile, 75th percentile)	76.0 (10.3, 15.1)	75.0 (64.0, 86.0)	.450
Median white blood cell count (25th percentile, 75th percentile)	12.7 (10.3, 15.1)	10.7 (8.8, 12.6)	.073
Median lactic acid (25th percentile, 75th percentile)	1.05 (0.8, 1.4)	1.45 (1.1, 1.8)	.006
Median time to CT (25th percentile, 75th percentile)	00 h 45 min (00 h 15min, 1 h 15 min)	1 h 2 min (00 h 40 min, 01 h 24 min)	.335

UMMC, University of Massachusetts Medical Center.

* Statistically significant.

Table IV
Outcome measures for adults with acute appendicitis at UMMC by insurance type (2010–2018)

	Non-Medicaid	Medicaid	P value
N	1,122	135	
Laparoscopic appendectomy (%)	90.7	96.3	.081
Median time to surgery from admission (25th percentile, 75th percentile)	4 h 49 min (1 h 12 min, 8 h 26 min)	6 h 47 min (3 h 37 min, 9 h 57 min)	.001*
Median length of stay (25th percentile, 75th percentile)	22 h 38 min (10 h 9 min, 35 h 8 min)	20 h, 30 min (8 h 32 min, 32 h 28 min)	.109
Readmitted within 30 days of discharge (%)	14.5	17.8	.683

UMMC, University of Massachusetts Medical Center.

* Statistically significant.

Table V
Multivariate Poisson regression for TTS for patients with acute appendicitis at UMMC (2010–2018)

	Coefficient	95% CI	P value
Medicaid insurance	−0.967	−1.58 to −0.353	.002*
Age	−2.05	−3.04 to −1.06	<.001*
Marital status (married)	−0.078	−0.462 to 0.306	.692
Diabetes	−0.168	−1.14 to 0.803	.735
Hyperlipidemia	0.3225	−0.302 to 0.946	.312
Hypertension	0.293	−0.308 to 0.893	.340
Household income	−4.82	−5.53 to −4.11	<.001*
Travel distance	−1.81	−2.71 to −0.914	<.001*

UMMC, University of Massachusetts Medical Center.

* Statistically significant.

existing literature but may include prolonged emergency room wait times, lack of an available surgeon, or operating room availability.^{10,17,20}

Our study confirmed that Medicaid enrollees lived closer to our hospitals and that they presented with similar disease severity as their non-Medicaid counterparts, as demonstrated by similar rates of perforated appendicitis, vital signs, and laboratory values at the time of admission. Similar rates of disease severity at presentation indicate that prehospital factors were unlikely to be substantial deterrents in a patients' decision or ability to seek medical attention. TTS was different, however, between groups, with Medicaid enrollees waiting just under 2 hours more for their appendectomy.

Other studies have demonstrated greater rates of obesity, smoking, dyslipidemias, hypertension, and diabetes mellitus in uninsured adults¹⁷ and have suggested that uninsured and underinsured patients are more likely to have undiagnosed comorbidities.²² These undiagnosed comorbidities have been associated with increased overall of perioperative morbidity and mortality in Medicaid-enrolled or uninsured patients, despite seemingly low Charlson comorbidity indices.²² Patients with multiple medical problems often require additional preoperative testing or treatments for safe risk stratification and optimization; however, in our study, Medicaid enrollees had fewer comorbidities and frequented their PCP or the ED more often in the year before their admission with appendicitis. Although this finding may be explained by younger average age, it also helps exclude multiple comorbidities and lack of routine preventive medical care as an explanation for the greater TTS in the Medicaid group. Moreover, the multivariate analysis of TTS that adjusted for select, statistically significant comorbidities among insurance types in the univariate analysis showed that diabetes, hyperlipidemia, and hypertension were not predictors of TTS (Table V).

Our subgroup analysis of patients with appendicitis 2017 to 2018 revealed that, although a greater proportion of Medicaid enrollees reported speaking a language other than English as their

primary language, there was no difference in the need for an interpreter, thus eliminating the need for translation as a source of possible delay to surgery. Moreover, in this group, there was no difference in the time to CT between groups, removing imaging delays as a potential reason for prolonged TTS. Although this subgroup provides exceptional granularity into potential delays in care contributing to the greater TTS for Medicaid enrollees, our sample size is small, because our access to Epic EHR related variables is limited to 2017 and onward. Finally, despite a slightly greater TTS among Medicaid enrollees, overall care appears to have been similar between Medicaid and non-Medicaid enrolled patients with acute appendicitis at our institution. Although we find it difficult to explain a difference in TTS of just more than 2 hours between groups, next we suggest several possible contributing factors.

Contributing factors

First, our multivariate analysis revealed that, along with Medicaid enrollment, age, household income, and travel distance to the hospital were also negative predictors of TTS. It would seem that younger age, greater household income, and greater travel distance from home address to the hospital all favor a shorter TTS. Because patients in the Medicaid group were younger than those in the non-Medicaid group (mean 33.5 y ± 16.3 years vs 40.1 years ± 11.8 years, $P < .0001$) and all patients were adults, this possibility seems like an unlikely explanation for the difference in TTS between the 2 groups. Household income and travel distance of home address to the hospital are closely related in our sample; however, it is difficult to explain how they may affect TTS. This is especially so considering that our initial time used (ED admission time) does not consider any prehospital (ie, transport or travel) factors because it is the time the patient was placed in an ED bed. Moreover, household income is unknown to providers across the board and was generated by our research staff through the use of geographic information systems. Therefore, we find it highly unlikely that physician biases toward patients based on socioeconomic factors (race or ethnicity, sex, marital status, primary language, income, education, and geographic factors) can explain a delay in TTS of approximately 2 hours for Medicaid enrollees. Moreover, although we did not intend to investigate implicit physician bias in our study, a recent study of surgeons at a large academic medical center found that unconscious bias toward socioeconomic status or race or ethnicity was not associated with differential treatment of patients.²³

Difficulties with communication may have had an important effect on TTS because we observed that Medicaid enrollees in our subgroup analysis were more likely to report a primary language other than English. Although there was similar use of an interpreter in both groups, it is still possible that language barriers

lead to delays in obtaining a history and informed consent, and ultimately resulted in greater TTS in the Medicaid group. Otherwise, there are certain practices that affect underinsured and uninsured patients exclusively, such as the routine consultation of financial assistance services, which may also contribute to delays in treatment unique to Medicaid enrollees. A final explanation is that the number of Medicaid enrollees in our study is fairly small, and we may lack enough power to detect sociodemographic and clinical factors that contribute to a longer TTS for this patient group.

Although we find it difficult to explain a difference in TTS of just over 2 hours between groups, we also consider the practical implications of this finding. This small difference in TTS may be of little clinical importance because LOS or 30-day readmission rates were comparable between groups. The TTS in both groups are also markedly less than the national average TTS for adults with acute appendicitis, which we recently reported as 2.2 days and 1.9 days for Medicaid enrollees and privately insured patients.⁴ With TTS in both groups being less than 7 hours and LOS being less than 24 hours in both groups, we attribute in large part these successes to the dedication of the acute care surgery service to general surgical emergencies at our institution, 24 hours a day, 7 days a week.

The model of acute care surgery has gained increasing popularity in the United States and worldwide during the past 2 decades. Traditionally combining trauma surgery, emergency general surgery, and surgical critical care, the various models of acute care surgery were created in an attempt to improve surgeon satisfaction, increase recruitment in the setting of decreased cases of operative trauma, and to improve availability and efficiency in emergency general surgery.^{24,25} Single-center studies have found that programs of acute care surgery have been more efficient in the management of emergency general surgery conditions such as acute appendicitis, and have reported shorter TTS and LOS with similar rates of complications and readmissions.^{24,25} The acute care surgery service at our institution is staffed with an on-call attending, several junior and senior residents, on-call operating room staff, anesthesiologists, and a dedicated acute care surgery operating room, at all times.

Limitations

Our study is not without limitations. Misclassification bias is inevitable with any retrospective study because of the inability to determine causation. Prospective studies are necessary to investigate institutional processes that may differentially affect patients based on insurance type. With these results, we hope to expand the study to examine these results across a larger cohort. Although our subgroup analysis of patients 2017 to 2018 provided meaningful details regarding potential sources of delays in care, it is underpowered and we were unable to identify factors explaining the greater TTS for Medicaid enrollees. Nonetheless, this large, single-institution series provides us with additional granularity that is currently lacking from previously published, national studies using large data sets, ultimately allowing us to better understand the local delivery of care to patients with acute appendicitis based on insurance type.

These findings are important, because we have shown that, within the confines of an acute care surgery program at a safety-net hospital in a state with near universal health insurance, disparities based on insurance type are minimal among patients presenting with appendicitis. We have shown that under this set of favorable circumstances, the treatment of patients with appendicitis is similar between Medicaid and non-Medicaid enrollees.

Investigate disparities

We hope that this study will encourage hospital administrators and surgeons to investigate disparities at their own institutions and explore the factors that drive disparities within their health systems. The implementation programs, protocols, and pathways dedicated to improving efficiency and standardization of treatment of emergency surgical conditions should be considered. We believe that the dedication of staff and resources to the treatment of emergency surgical conditions through an acute care surgery program separate from trauma allows the institution of a fast-track pathway (for appendicitis, cholecystitis, and incarcerated hernias), which has contributed to uniform and equal treatment of patients with appendicitis regardless of insurance type at our institution.

Funding/Support

All funding was departmental. There were no private organizations or grants funding our study.

Conflict of interest/Disclosure

The authors have indicated that they have no conflicts of interest regarding the content of this article.

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