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Quality of Acute Care for Patients with Urinary Stones in the United States

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The institutional review boards of the RAND Corporation determined that the study design was exempt from the requirement for review.

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Abstract

Objective—To describe guideline adherence for patients with suspected upper tract stones.

Methods—We performed a cross-sectional analysis of visits recorded by the National Hospital Ambulatory Medical Care Survey (ED component) in 2007–2010 (most recent data). We assessed adherence to clinical guidelines for diagnostic laboratory testing, imaging, and pharmacologic therapy. Multivariable regression models controlled for important covariates.

Results—An estimated 4,956,444 ED visits for patients with suspected kidney stones occurred during the study period. Guideline adherence was highest for diagnostic imaging, with 3,122,229 (63%) visits providing optimal imaging. Complete guideline-based laboratory testing occurred in only 2 of every 5 visits. Pharmacologic therapy to facilitate stone passage was prescribed during only 17% of eligible visits. In multivariable analysis of guideline adherence, we found little variation by patient, provider or facility characteristics.

Conclusions—Guideline-recommended care was absent from a substantial proportion of acute care visits for patients with suspected kidney stones. These failures of care delivery likely increase costs and temporary disability. Targeted interventions to improve guideline adherence should be designed and evaluated to improve care for patients with symptomatic kidney stones.

Keywords

kidney stones; quality of care; emergency care; guidelines

Introduction

Kidney stones impose a large and rising burden of disease in the United States: their prevalence has nearly doubled over the past 15 years, and stone disease now affects 1 of every 11 persons.[1,2] Kidney stones occur primarily in a working age population, and up to 50% of patients experience a recurrence.[3,4] Stones are among the most costly urologic conditions in terms of aggregate direct costs, in addition to the indirect costs of work loss and temporary disability from pain.[4,5]

Extreme pain often causes patients to seek care in the emergency department (ED). Coincident with the rising prevalence of stone disease, the rate of ED visits for kidney stones has increased by 91% over 1992–1994 baseline.[6] Initial acute care is provided primarily by non-urologists.[7] Given rising acute care visits by patients with symptomatic stones, and the gateway role for further intervention that the ED serves, understanding quality of this acute care is critical.

One potential measure of quality is adherence to published, evidence-based guidelines. Current guidelines suggest that patients should be assessed for signs of sepsis or renal failure, each of which is an indication for urgent intervention.[8] Patients with bacteriuria should be empirically treated with antibiotics to prevent urosepsis.[8] The most sensitive initial imaging modality for most patients is non-contrast computerized tomography (CT), which serves to confirm the clinical diagnosis and determine prognosis for passage of the stone.[9,10] For appropriately selected patients, a trial of pharmacologic medical expulsive therapy (MET) is recommended; randomized controlled trials suggest that this will obviate 1 surgical intervention for every 4 patients treated.[11]

The few existing analyses of acute care for patients with suspected kidney stones focus primarily on broad utilization patterns, rather than guideline adherence.[6,12–14] Prior analyses of MET utilization examined data collected prior to guideline endorsement,[15] or did not explore factors associated with utilization of MET.[6] Given this context, we sought to assess adherence to guidelines for acute care of patients with suspected kidney stones. Specifically, we sought to characterize guideline adherence in the areas of laboratory testing, imaging, and use of MET, and to describe variation in guideline-adherent care delivery.

Patients and Methods

Data Source

We used data from the Emergency Department component of the National Hospital Ambulatory Medical Care Survey (NHAMCS-ED). The NHAMCS is a multistage probability survey of outpatient and emergency department encounters at non-federal hospitals located in all 50 states and the District of Columbia.[16] The survey is designed to produce nationally representative estimates of ED encounters in the United States; each observed (unweighted) visit (n=1341) is weighted according to National Center for Health Statistics (NCHS) procedures to generate national estimates.[16] De-identified data for each sampled visit include patient demographics, diagnoses, services, medications prescribed, and disposition. The institutional review board determined that this study was exempt from review.

Study Population

The study population consisted of all visits for patients with suspected kidney stones between 2007 and 2010 (most recent data available). We used established claims algorithms based on International Classification of Disease 9th edition (ICD-9) diagnostic codes to identify patients with encounters for kidney stones.[15,17] Patients younger than 18 years of age were excluded.

Outcomes

To assess guideline adherence, we examined three discrete outcomes implicit in current guidelines (see eMethods). We defined adherence with laboratory testing guidelines as an encounter where a patient underwent a complete blood count (assess for signs of sepsis[8]), measurement of serum creatinine (assess renal function[8]) and urinalysis (assess for bacteriuria).[8] We measured adherence to imaging guidelines[9] by the performance of a CT scan during the visit. As a pre-specified sensitivity analysis, we identified visits in which an ultrasound or plain x-ray was performed; guidelines suggest these may be appropriate in certain circumstances.[9] We identified MET utilization as prescription of an alpha-blocker or a calcium channel blocker, using established algorithms for this dataset.[6,15] We excluded ineligible patients using established algorithms.[6,15] As a pre-specified sensitivity analysis, we repeated the analysis only among those with a highly specific ICD-9 code (592.1) for ureteral stones.[18] No patients in the MET cohort were admitted to hospital or underwent procedural intervention.

Covariates

A number of factors could potentially be associated with provision of guideline-adherent care. Patient-level covariates included age and sex. The prevalence of kidney stones varies importantly by race and ethnicity.[2] For this reason, and in accordance with National Center for Health Statistics (NCHS) analytic guidelines regarding sample size,[16] we classified race and ethnicity as reported by NHAMCS into three groups: white non-Hispanic, Hispanic, and other. Payer type was recoded as private, Medicare, Medicaid, and self/other. We included arrival by ambulance transport. Quartiles of household income, percent of population in poverty, and percent of adults with a bachelor's degree or higher in the patient's ZIP code served as a proxy for socioeconomic status.

We created an indicator variable for whether the patient was seen by a non-physician provider (i.e., nurse practitioner). Facility-level covariates included teaching status and ownership. Given the known geographic variation in stone prevalence,[1] we included region as a covariate. In addition, we used an indicator variable to identify hospitals located in metropolitan areas. To identify potential changes in guideline adherence over time, we included survey year as a covariate.

To examine potential associations between health information technology and care delivery, we included indicators for whether the ED had computerized systems to provide reminders about guideline-based interventions, as well as an indicator variable for a computerized lab ordering system. At the time of our analysis, these data elements for the 2010 survey were not yet publically available. Therefore, we limited this analysis to the 2007–2009 data and *a priori* designated this as a secondary analysis.

Statistical Analysis

Using NCHS-recommended design and weighting variables, we calculated nationally representative estimates of the percent of encounters that provided guideline-adherent care. All results are reported as nationally representative (weighted) estimates unless otherwise specified. We constructed logistic regression models for each of the three outcomes (laboratory testing, imaging and MET use) to identify associations between provision of guideline-adherent care and patient, provider, hospital and geographic area covariates, accounting for the complex survey sample design. Regression models for laboratory testing and imaging included age, sex, race, payer, arrival by ambulance, non-physician provider, teaching status, hospital ownership, region, year, education level, household income, poverty level, and metropolitan status. Due to the smaller number of eligible subjects and NCHS analytic guidelines regarding cell size, only patient age, sex, region household income and education were included in the MET guideline adherence regression model. We performed several sensitivity analyses to address potential selection bias from cohort identification (eMethods). In no case did the proportion of visits including guideline-adherent care differ substantively from the main analysis. We used SAS 9.2 (Cary, NC) for all analyses. Results were considered statistically significant with two-sided $\alpha = 0.05$.

Results

An estimated 4,956,444 ED visits nationally occurred between 2007 and 2010. Visits for patients eligible for MET constituted 4,214,570 (85%) estimated national ED visits for kidney stones. The average age of the patients was 43.2 ± 0.58 years and males comprised 55% of the study population (Table 1).

The degree to which clinical care was adherent to current guidelines varied widely depending on the guideline of interest (Figure, Table 2). Imaging guideline adherence was highest, with 63% of visits including a CT scan. Only 2 of every 5 visits included all guideline-based laboratory testing. MET utilization was very low, with only 14% of eligible visits resulting in prescription of MET to patients discharged from the ED. Similar results were obtained when restricting the analysis to only patients with a primary diagnosis of stone, as well as the subpopulation with only a diagnostic code for ureteral stone (eMethods).

Laboratory Testing

Overall, 40% of ED visits included the provision of all three guideline-recommended laboratory tests. For each individual test, utilization varied widely. Patients underwent urinalysis at 85% of visits. Renal function was assessed at 47% of visits, whereas a complete blood count was performed at 68% of visits. Guideline adherence was not substantially different in the sensitivity analyses.

On multivariable analysis, there was little variation in the odds of a patient undergoing guideline-adherent laboratory testing at a visit (Table 3). As age increased, the odds of undergoing laboratory testing increased (OR 1.01 per year, $P = 0.04$), but there were no statistically significant differences in testing by gender, race/ethnicity, payer, or measures of socioeconomic status (Table 3). Similarly, provider and facility characteristics were not associated with the receipt of guideline-adherent laboratory testing. Visits to hospitals within a metropolitan statistical area were more likely to include guideline-adherent testing (OR 1.82, $P = 0.008$).

Diagnostic Imaging

Overall, 63% of visits included a CT scan. The proportion of visits including imaging increased only slightly (66%) in sensitivity analyses. Because other imaging modalities, such as ultrasound, may be clinically appropriate in certain populations, we also performed a sensitivity analysis for any possible stone-directed imaging (i.e., CT scan, ultrasound, plain x-ray). In this analysis, the proportion of visits that included imaging was 72%.

Similar to the findings with laboratory testing, there was almost no statistically significant variation along patient, provider or facility characteristics in the odds of undergoing guideline-adherent imaging (Table 3). The odds of a CT scan were nearly twice as high at hospitals within a metropolitan statistical area (OR 1.95, $P = 0.009$). Similar results were noted when the model outcome was any stone-directed imaging (data not shown).

Medical Expulsive Therapy

Providers prescribed MET at only 14% of eligible visits on a nationally representative basis. Because randomized controlled trials supporting MET focus on ureteral stones, we performed a sensitivity analysis on the subpopulation of those visits that included a diagnostic code for ureteral stone, and otherwise fulfilled eligibility criteria for MET. Restricting our analysis to this highly selected group increased the proportion of guideline-adherent visits only to 16.8%. Due to the relatively small number of visits where MET was prescribed, the multivariable model included only age, gender, region and markers of socioeconomic status (Supplementary Table 1). The odds of females receiving MET was less than half that of men (OR 0.47, $P<0.001$).

Health Information Technology

A sensitivity analysis examined associations between delivery of guideline-adherent care and specific information technology systems. No statistically significant associations existed between laboratory testing, imaging or MET utilization endpoints and reminder systems for guideline-based interventions. Similarly, no statistically significant association was observed between laboratory testing adherence and the availability of a computerized lab ordering system.

Discussion

In this novel analysis of guideline adherence for the acute evaluation of patients with suspected kidney stones, we find that care fails to meet recommendations in a substantial proportion of cases. Only 2 in 5 patients undergo laboratory evaluation that indicates whether immediate surgical intervention is necessary, and only 1 in 7 receive therapy that has been shown to reduce the risk for future surgical intervention by 25%.[11] These findings suggest substantial opportunities for improving quality of acute care for patients with kidney stones, a disease that afflicts nearly 1 in 11 persons in the United States.[2]

The potential consequences for patients of these apparent failures of care are significant. Laboratory testing provides crucial information to diagnose renal failure or early signs of sepsis. Renal failure and evidence of systemic infection in the presence of an obstructing stone are each indications for immediate procedural intervention.[8] Lack of assessment for leukocytosis is associated with an increased risk of ED revisits,[19] possibly due to missed sepsis.

Of particular concern is the apparent utilization of MET in only 1 of every 7 eligible patients, and the dramatically lower use of MET among women (9% vs 17% for men). We found that the guideline adherence rate was 14%, meaning that approximately 900,000 patients annually do not receive this highly effective therapy. Based on a number needed to treat of 4,[11] this failure to deliver a well-tolerated, relatively inexpensive pill results in a projected 226,000 avoidable surgical procedures annually. The direct and indirect costs of these potentially unnecessary surgical interventions are likely substantial.[20]

That only 14% of eligible visits result in a prescription for MET is concerning, but this proportion represents a relatively sharp rise in utilization compared to prior analyses.[6,15]

Using similar methodology, Hollingsworth et al[15] examined MET use between 2000 and 2006 in the NHAMCS-ED dataset, before this intervention received guideline endorsement.[8] In 2006, after 11 randomized controlled trials had been published supporting the intervention, utilization of MET was estimated at only 3.9%.[15] While overall utilization tripled between 2006 and 2010, the fact remains that a decade after the publication of the first randomized controlled trials of MET, only 1 in 7 eligible patients receive the intervention.

Patients with acute symptoms of kidney stones are primarily treated by physicians other than urologists,[7] but urologists conducted the randomized controlled trials and developed guidelines supporting pharmacologic intervention. The existence of single-specialty guidelines often challenges the dissemination of practice into other specialties, such as emergency medicine; our results should be considered in this context. Lack of dissemination into the general medical literature for MET[15] and other specialist-driven advances speaks to one of the challenges of providing high quality, coordinated care in a fragmented and highly specialized healthcare environment.

Use of health information technology could potentially improve care delivery. The results of our sensitivity analysis regarding clinical decision support showed no benefit of these systems in terms of increasing guideline adherence for patients with suspected kidney stones. The NHAMCS-ED dataset lacks information regarding the specific conditions supported by local health information technology systems. Therefore it remains unknown whether our findings imply a limitation of clinical-decision support technology, or simply failure to provide information regarding treatment of patients with suspected kidney stones. However, recent analyses suggest that one of the main consequences of widespread health information technology adoption has been an increase in costs without commensurate changes in the quality of care delivered.[21] Thus it remains to be seen whether health information technology will fulfill the promise of helping providers deliver better care at lower cost.

Our findings must be considered in the context of several limitations. Classification bias could impact measurement of outcomes. However, the NHAMCS dataset specifically records performance of the laboratory tests recommended in evidence-based guidelines (e.g., urinalysis). We used previously validated algorithms[15] to identify patients eligible for MET, and up to 8 medications prescribed by providers were specifically noted.

The NHAMCS dataset provides encounter level information, and therefore providers' prior knowledge of a patient's history or medical condition could confound our results. However, sensitivity analyses limited to first presentations for the stone and excluding patients with recent encounters for other reasons yielded no clinically important changes in our results. A related potential source of selection bias is the use of diagnostic codes that may identify only those with a confirmed stone, and thus miss those with a differential diagnosis much broader than a urinary stone. We believe it likely that any bias from this selection would be towards the appearance of greater adherence.

With respect to our findings regarding low utilization of MET, important clinical detail regarding stone size and location is lacking. The diagnostic code for renal stones is not specific (that is, in practice it is applied to patients with both renal and ureteral stones) and therefore the cohort may include patients with symptomatic renal stones, for whom MET may not be beneficial.[18] However, even when limiting the analysis to a highly specific diagnostic codes for a ureteral stone,[18] we did not find substantial improvement in MET use.

We lacked important detail as to whether and to what extent these apparent failures in care delivery impact patient-relevant outcomes. In other datasets, lack of laboratory testing is associated with an increased risk of ED revisit, but other outcomes (i.e., sepsis) were not examined.[19,22] Measurement of blood counts and serum creatinine are not explicit in current guidelines, but aside from exam findings (i.e., fever, hypotension), leukocytosis or renal failure detected through laboratory testing typically indicate the need for urgent procedural intervention. Given the magnitude of potential harms (i.e., severe sepsis, death) and the relatively low cost of the recommended laboratory tests suggest that focused efforts towards improvement are warranted. In the light of emerging evidence regarding potential iatrogenic harms of radiologic exams,[23–26] it remains unclear whether our results represent ideal patterns of imaging use, or potential overutilization of computerized tomography. Finally, increasing use of a well-tolerated, low-cost pharmacologic intervention that can prevent costly surgical procedures in 1 out of 4 patients seems a straightforward opportunity to maximize value in healthcare delivery.

Conclusion

These limitations notwithstanding, our findings compel immediate action; at a minimum, individual institutions should examine their own guideline adherence in this dimension. The NHAMCS dataset is specifically designed to generate nationally representative estimates of ED care. Our results document apparent failures in care for an increasingly prevalent disease, with important consequences for healthcare spending and patient health. Physicians must engage in multidisciplinary partnerships to design and assess interventions to reliably deliver high quality, guideline-adherent care for patients with symptomatic kidney stones.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Dr. Scales had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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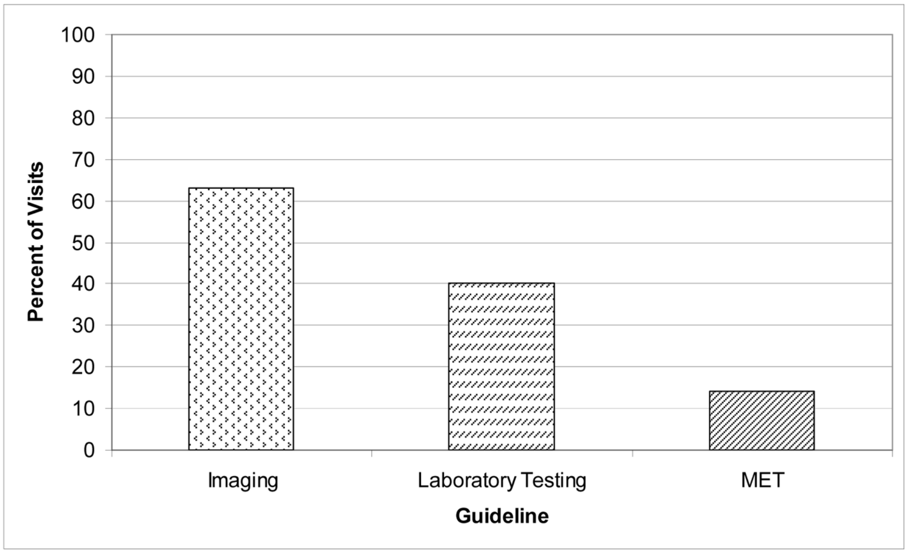

Figure.
Nationally representative percentage of emergency department visits with documentation of guideline-adherent care, 2007–2010.

Table 1

Characteristics of Study Population

Characteristic	Unweighted N	Weighted N (%)
Age, mean (SD)	--	43.2 (0.58)
Sex		
Male	741	2733333 (55)
Female	600	2223111 (44)
Race/ethnicity		
White, Non-Hispanic	1045	3910766 (79)
Hispanic	153	501395 (10)
Black/Other, Non-Hispanic	143	544283 (10)
Primary Payer		
Private	687	2655266 (56)
Medicare	154	572476 (12)
Medicaid	170	556907 (12)
Self-pay/other	261	934213 (20)
Region		
Northeast	290	872739 (18)
Midwest	310	1127245 (23)
South	492	2001262 (40)
West	249	955198 (19)
Year		
2007	355	1243701 (25)
2008	310	1226116 (25)
2009	339	1311817 (26)
2010	337	1174810 (24)
Education[a]		
Quartile 1	371	1445058 (31)
Quartile 2	298	1127320 (24)
Quartile 3	316	1095093 (24)
Quartile 4	287	968250 (21)
Household Income		
Quartile 1	300	1138142 (25)
Quartile 2	307	1094107 (24)
Quartile 3	347	1292451 (28)
Quartile 4	318	1111021 (24)
Poverty Level in ZIP		
< 5%	274	1001206 (22)
5–9.99%	400	1455914 (31)

Characteristic	Unweighted N	Weighted N (%)
10–19.99%	401	1413158 (30)
≥ 20%	197	765443 (17)
MSA		
No	187	852158 (17)
Yes	1154	4104286 (83)

[a] % adults with Bachelor’s degree in patient’s ZIP code, quartile

Table 2

Nationally representative visits with provision of guideline-adherent care among patients with suspected kidney stone (univariate analysis).

Characteristic	Laboratory Testing	*P* Value (Labs)	Imaging	*P* Value (Imaging)	Medical Expulsive Therapy	*P* Value (MET)
Overall	1957851 (40)	--	3122229 (63)	--	570060 (14)	--
Sex						
Male	1083744 (40)	0.93	1796672 (66)	0.04	413640 (17)	<0.001
Female	874107 (39)		1325557 (60)		156420 (9)	
Race/ethnicity						
White, Non-Hispanic	1586552 (41)		2502077 (64)		468174(14)	
Hispanic	180062 (36)	0.50	318810 (55)	0.37	*a*	--
Black/Other, Non-Hispanic	191237 (35)		301342 (64)		*a*	
Primary Payer						
Private	989881 (37)		1723633 (65)		376442 (17)	
Medicare	247181 (43)	0.64	349162 (61)	0.78	*a*	--
Medicaid	236513 (42)		335773 (60)		*a*	
Self-pay/other	374774 (40)		590113 (63)		*a*	
Arrived by EMS						
No	1722880 (39)	0.68	2738400 (63)	0.44	520305 (14)	--
Yes	165578 (42)		268450 (68)		*a*	
Physician Extender Seen						
No	1738589 (39)	0.33	2784148 (62)	0.32	476270 (13)	--
Yes	219262 (44)		338081 (68)		*a*	
Teaching Status						
No	1776968 (39)	0.42	2837503 (62)	0.30	519321 (13)	--
Yes	180883 (44)		284726 (69)		*a*	
Ownership status						
Voluntary non-profit	1542097 (40)		2435064 (64)		448649 (14)	
Government, non-federal	222555 (42)	0.31	326393 (61)	0.81	*a*	--
Proprietary	193199 (33)		360772 (60)		*a*	
Region						

Characteristic	Laboratory Testing	*P* Value (Labs)	Imaging	*P* Value (Imaging)	Medical Expulsive Therapy	*P* Value (MET)
Northeast	398652 (46)		563439 (65)		102389 (14)	
Midwest	486608 (43)	0.03	769342 (68)	0.40	152627 (17)	0.57
South	797775 (40)		1218130 (61)		229834 (13)	
West	274816 (29)		571318 (60)		85210 (10)	
Year						
2007	507584 (41)		734217 (59)		*a*	
2008	478792 (39)	0.53	789569 (64)	0.39	129657 (13)	--
2009	463739 (35)		804220 (61)		175414 (16)	
2010	507736 (43)		794223 (68)		197120 (20)	
Education[b]						
Quartile 1	504392 (35)		870354 (60)		139974 (11)	
Quartile 2	503030 (45)	0.23	714568 (63)	0.72	129651 (14)	0.82
Quartile 3	412890 (38)		726009 (66)		121007 (13)	
Quartile 4	412295 (43)		625283 (65)		123134 (15)	
Household Income						
Quartile 1	433027 (38)		637187 (56)		104273 (10)	
Quartile 2	435424 (40)	0.98	712343 (65)	0.16	134708 (15)	0.68
Quartile 3	514344 (40)		836659 (65)		147288 (14)	
Quartile 4	449812 (40)		750025 (68)		127497 (13)	
Poverty Level in ZIP						
< 5%	439730 (44)		667829 (67)		127260 (15)	
5–9.99%	551827 (38)	0.60	987029 (68)	0.12	163741 (13)	--
10–19.99%	562922 (40)		847981 (60)		130764 (11)	
≥ 20%	278128 (36)		433375 (67)		*a*	
MSA						
No	254588 (30)	0.02	427876 (50)	0.002	516492 (15)	--
Yes	1703263 (41)		2694353 (66)		*a*	

[a]Too few unweighted observations for reliable estimate per NCHS analytic guidelines. -- indicates no statistical hypothesis test performed due to NCHS guidelines.

[b]% adults with Bachelor's degree in patient's ZIP code, quartile

Table 3

Association between patient, provider and facility characteristics and receipt of guideline-adherent care at visit, multivariable model (nationally representative estimates).

Characteristic	Laboratory Testing Odds Ratio (95% CI)	*P* Value	Imaging Odds Ratio (95% CI)	*P* Value
Age	1.01 (1.00—1.02)	0.04	1.00 (0.99—1.01)	0.93
Sex				
Male	reference	0.77	reference	0.093
Female	0.952 (0.68—1.32)		0.778 (0.58—1.04)	
Race/ethnicity				
White, Non-Hispanic	reference		reference	0.45
Hispanic	0.861 (0.50—1.49)	0.69	0.710 (0.41—1.24)	
Black/Other, Non-Hispanic	0.779 (0.42—1.43)		0.870 (0.49—1.54)	
Primary Payer				
Private	reference		reference	
Medicare	1.18 (0.71—1.96)	0.23	1.05 (0.57—1.92)	0.97
Medicaid	1.62 (0.99—2.66)		0.914 (0.55—1.53)	
Self-pay/other	1.35 (0.87—2.10)		0.982 (0.64—1.51)	
Arrived by EMS				
No	reference	0.83	reference	0.77
Yes	1.06 (0.64—1.74)		1.10 (0.59—2.07)	
Physician Extender Seen				
No	reference	0.58	reference	0.31
Yes	1.13 (0.73—1.76)		1.27 (0.80—2.03)	
Teaching Status				
No	reference	0.76	reference	0.092
Yes	1.09 (0.64—1.84)		1.70 (0.92—3.15)	
Ownership status				
Voluntary non-profit	reference		reference	
Government, non-federal	1.36 (0.90—2.05)	0.32	1.17 (0.78—1.74)	0.67

Characteristic	Laboratory Testing Odds Ratio (95% CI)	*P* Value	Imaging Odds Ratio (95% CI)	*P* Value
Proprietary	0.963 (0.55—1.67)		0.911 (0.53—1.57)	
Region				
Northeast	reference		reference	
Midwest	0.962 (0.55—1.68)	0.05	1.34 (0.80—2.26)	0.66
South	0.846 (0.49—1.46)		1.16 (0.71—1.88)	
West	0.545 (0.33—0.89)		1.00 (0.60—1.66)	
Year				
2007	reference		reference	
2008	0.838 (0.47—1.49)	0.94	1.28 (0.82—1.99)	0.42
2009	0.868 (0.53—1.42)		1.09 (0.72—1.67)	
2010	0.901 (0.44—1.48)		1.40 (0.89—2.20)	
Education[a]				
Quartile 1	reference		reference	
Quartile 2	1.39 (0.87—2.21)	0.38	0.828 (0.51—1.34)	0.28
Quartile 3	1.17 (0.74—1.85)		0.966 (0.57—1.64)	
Quartile 4	1.56 (0.86—2.84)		0.671 (0.40—1.12)	
Household Income				
Quartile 1	reference		reference	
Quartile 2	0.862 (0.49—1.52)	0.71	1.26 (0.74—2.15)	0.60
Quartile 3	0.701 (0.38—1.28)		1.08 (0.59—1.97)	
Quartile 4	0.706 (0.30—1.66)		1.46 (0.64—3.29)	
Poverty Level in ZIP				
< 5%	reference		reference	
5–9.99%	0.802 (0.51—1.26)	0.61	1.06 (0.65—1.75)	0.83
10–19.99%	0.863 (0.48—1.55)		0.897 (0.50—1.62)	
≥ 20%	0.667 (0.31—1.44)		0.770 (0.36—1.63)	
MSA				
No	reference	0.008	reference	0.009
Yes	1.82 (1.17—2.82)		1.95 (1.17—3.23)	

[a] % adults with Bachelor's degree in patient's ZIP code, quartile