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Acute appendicitis: variation in outcomes by insurance status

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ABSTRACT

Background: Acute appendicitis (AA) is often studied as a surrogate for acute care surgery. Previous studies have shown differences in outcomes based on insurance status, but associated costs to health care systems are in need of further study. The purpose of the present study was to investigate how treatment, outcomes, and health care resource utilization differ between the uninsured and commercially insured in the setting of AA.

Methods: Patients with AA were identified by *International Classification of Diseases, ninth edition*, codes using the Agency for Health Care Administration Florida Hospital inpatient discharge data sets for 2002–2011. The outcomes studied were admission with complicated *versus* uncomplicated appendicitis, receiving laparoscopic *versus* open appendectomy and experiencing a perioperative complication, length of stay, and overall hospital cost. Data were analyzed using logistic, negative binomial, and least squares multivariate regression. A P value <0.05 was considered significant. All equations controlled for patient demographics, comorbidities, and year and hospital-fixed effects.

Results: The uninsured were more likely to present with complicated appendicitis (odds ratio = 1.31, $P < 0.01$), less likely to receive laparoscopic appendectomy (odds ratio = 0.70, $P < 0.01$), had longer length of stay, greater costs but had similar rates of perioperative complications in comparison to the commercially insured.

Conclusions: Insurance status is known to affect health care utilization. The uninsured may delay seeking medical assistance, causing greater incidence of complicated disease and increased costs of treatment. Increasing the number of insured via the Affordable Care Act may improve patient outcomes and decrease costs related to AA. These findings may also apply to other acute care surgery conditions.

1. Background

Acute appendicitis (AA) is a common condition in acute care surgery (ACS) and is often studied as a surrogate for the field because of its independence from other disease processes and relatively high incidence [1]. Delay in presentation to the emergency department is associated with poorer outcomes, including appendicial perforation, abscess formation, postoperative ileus, and longer length of stay (LOS) [2,3]. Furthermore, patients who are uninsured or of low socioeconomic

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status (SES) have greater likelihoods of presenting with AA complicated by perforation [3]. Recent studies have challenged that finding by concluding that, after adjusting for population and hospital-level factors, there is no difference in perforation rates by race [4]. Others have focused on payer status [5,6]. Livingston *et al.* reported that differences in perforation rates among black, white, and Latino children were not explained by insurance status or other measurable factors. Most recently, a 2013 study by Loehrer *et al.* found that racial disparities in outcomes and resource utilization in minimally invasive surgery decreased after the 2006 Massachusetts insurance expansion [7].

The purpose of this study is to more precisely define the relationship between the patient presentation, management, outcomes, and costs in AA, whereas adjusting for patient demographics, comorbidities, SES, and insurance status. The authors hypothesize that uninsured patients suffer poorer outcomes have longer hospital stays and higher cost of care.

2. Data and methods

Patient data from the Agency for Health Care Administration (AHCA) Florida inpatient discharge data set were collected from 2002 to 2011. The primary inclusion criterion was the presence of a principal diagnosis *International Classification of Diseases, ninth edition*, (ICD-9) code of 540.0, 540.1, 540.9, or 541, corresponding to AA. Exclusion criteria were patients <16 or >64 y of age, those not receiving an appendectomy (defined as having a principal procedure ICD-9 code of 47.01 or 47.09), and those with an LOS >14 d to focus on the archetypal model of the patient with appendicitis.

The model was estimated for five separate outcomes: appendicitis type, operation type, the occurrence of a perioperative complication, LOS, and patient care cost. The latter was estimated for a shortened period from 2007–2011, as the cost data were not available for the earlier years. All cost data were inflation adjusted to 2013 levels. Patients were classified by ICD-9 codes as either having uncomplicated (540.9 and 541) or complicated (540.0 and 540.1) appendicitis. Operation type was classified as either laparoscopic (LA) or open appendectomy (OA), defined as an ICD-9 procedure code of 47.01 or 47.09, respectively. Perioperative complications were defined by ICD-9 codes and grouped into eight categories as listed in Appendix A. Patient care costs were calculated using cost-to-charge ratios which were imputed for each of 25 revenue groups reported in the AHCA data. The ratios were, subsequently, applied to each charge category and aggregated to generate a weighted patient care cost per hospitalization.

Model explanatory variables may be divided into patient demographics and SES, comorbidities as defined by the Agency for Healthcare Research and Quality [8], insurance status, and hospital-fixed effects. Patient insurance status was defined by the primary payer of services rendered. Uninsured patients were defined as an aggregate of those designated in the data set as "uninsured," "nonpayment," or "charity."

Patient SES was approximated using 5-y median incomes over the year 2007–2011 as reported by the US Census. Florida zip codes were sorted into quintiles by median income over this period and then, patients were assigned to quintiles by their zip code of residence. Less than one percent of patients in the data set, listed as having Florida residence, could not be assigned to an income quintile because of missing or incorrectly recorded zip code. These patients were excluded from the analysis. This method has been used in prior studies and is generally accepted as a valid surrogate for patient SES status [9,10]. Demographic variables included in the model were sex, age, and self-reported race to account for potential differences associated with these factors. Hispanic ethnicity was not recorded consistently in the data and was therefore not included in the estimation. The number of patient comorbidities as specified by Agency for Healthcare Research and Quality [8] was included in the analysis.

Data were analyzed using SAS 9.4. A multivariate regression model was generated for the outcomes of interest, controlling for age, insurance status, sex, year, race, comorbidities, SES, and hospital-fixed effects. The models examining the probability of presenting with complicated appendicitis, receiving LA, or experiencing a perioperative complication were estimated using logistic regression. The model examining the LOS in days was estimated using a negative binomial regression model. The negative binomial regression, as opposed to Poisson, was selected to account for the overdispersion in the LOS variable. Finally, the cost equation was estimated using least squares regression.

3. Results

Table 1 contains the means and percentages of the model variables for the overall and six subsamples. The data show significant variability across the subgroups. Although males made up 55% of the overall sample, they accounted for almost 59% of who presented with complicated appendicitis. Similarly, males made up 62.7% of patients experiencing a perioperative complication. They also are overrepresented in the uninsured group (66%). The uninsured accounted for 11.3% of the overall sample but 16.3% of the patients undergoing OA. The percentage of patients presenting with complicated appendicitis who were also uninsured was 12.7, 1.4% greater than their representation in the overall sample. In contrast, the uninsured made up a smaller percentage of patients experiencing a perioperative complication (10.6%). The average age of the overall patient sample is 36.3 y but shows significant variation across the subgroups. Patients presenting to the hospital with complicated appendicitis are, on average, 5 y older at 41.2; patients undergoing LA and OA have an average age of, respectively, 35.6 and 37.4 y; patients who experience a perioperative complication are significantly older on average at 42 y; finally, the uninsured are younger on average compared to the commercially insured (33.3 *versus* 38.3 y). The table also shows the age distribution by 10-y intervals. It is noteworthy that almost 60% of the uninsured are between 16 and 34 y old, again illustrating that this group is relatively young. In contrast, only 41% of the commercially insured are in the same age range. It is worth reiterating here that patients <16 y and >65 y were excluded from the analysis, so the average age of the present sample should not be