

Time-of-day and appendicitis: Impact on management and outcomes

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Background. Observational research has shown that delayed presentation is associated with perforation in appendicitis. Many factors that affect the ability to present for evaluation are influenced by time of day (eg, child care, work, transportation, and office hours of primary care settings). Our objective was to evaluate for an association between care processes or clinical outcomes and presentation time of day.

Methods. The study evaluated a prospective cohort of 7,548 adults undergoing appendectomy at 56 hospitals across Washington State. Relative to presentation time, patient characteristics, time to operation, imaging use, negative appendectomy, and perforation were compared using univariate and multivariate methodologies.

Results. Overall, 63% of patients presented between noon and midnight. More men presented in the morning; however, race, insurance status, comorbid conditions, and white blood cell count did not differ by presentation time. Daytime presenters (6 AM to 6 PM) were less likely to undergo imaging (94% vs 98%, $P < .05$) and had a nearly 50% decrease in median preoperative time (6.0 h vs 8.7 h, $P < .001$). Perforation significantly differed by time-of-day. Patients who presented during the workday (9 AM to 3 PM) had a 30% increase in odds of perforation compared with patients presenting in the early morning/late night (adjusted odds ratio 1.29, 95% confidence interval, 1.05–1.59). Negative appendectomy did not vary by time-of-day.

Conclusion. Most patients with appendicitis presented in the afternoon/evening. Socioeconomic characteristics did not vary with time-of-presentation. Patients who presented during the workday more often had perforated appendicitis compared with those who presented early morning or late night. Processes of care differed (both time-to-operation and imaging use). Time-of-day is associated with patient outcomes, process of care, and decisions to present for evaluation; this association has implications for the planning of the surgical workforce and efforts directed at quality improvement. (Surgery 2016;■:■-■.)

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OBSERVATIONAL RESEARCH has suggested that time prior to presentation for patients with acute appendicitis is a risk factor for perforation.¹⁻⁴ This observation suggests that patient decision-making prior to presentation may influence clinical outcomes. Among several considerations, including symptom severity, health awareness, and insurance coverage, time-of-day may be a factor that influences the decision to present for evaluation. Patients with severe symptoms may be motivated to present late at night, whereas those with mild or early symptoms may wait until morning. Availability of child care, employment, school, transportation, or access to primary care are all influenced by time-of-day, and all may impact when patients are able to be evaluated for acute appendicitis. Time-of-day also may affect care processes used in the evaluation and treatment of patients with appendicitis. Finally, the epidemiology of presentation patterns may generate data pertinent to surgical staffing and optimizing benefits of the acute care surgery (ACS) model, which is becoming more prevalent in the care of acute surgical conditions.

The Washington State Surgical Care and Outcomes Assessment Program (SCOAP), a physician-led quality surveillance program initiated in 2006, provides several benefits to evaluating the relationship between time and both the processes of care and clinical outcomes including a large number of diverse institutions, large numbers of patients, individualized chart review by trained abstractors, specific data on hospital arrival time, and operating room (OR) start time, as well as direct review of pathology reports (ie, diagnoses are not based on data such as ICD-9 codes).

This study was designed to investigate the following 4 questions: (1) When do patients with appendicitis present to the hospital for evaluation? (2) Are there differences in clinical, demographic, or socioeconomic characteristics among those who present at different times? (3) Do processes of care vary by time-of-day, in particular, the use of imaging or duration of time from presentation to the OR? (4) And finally, are outcomes different for patients who present at different times? Specifically, are there differences in frequency of perforation or negative appendectomy (NA)? Our hypothesis was that a greater percentage of patients with advanced disease present at night and that care processes would be influenced by time-of-day.

METHODS

Study population and setting. This study is based on data collected prospectively on consecutive adult patients (≥ 18 years) who underwent nonelective appendectomy in 1 of 56 SCOAP

hospitals in Washington State between January 1, 2010, and December 31, 2011. Estimates based on the Washington Department of Health chart abstraction program suggest that SCOAP captures $>85\%$ of the nonelective appendectomies performed in Washington State.⁵ The SCOAP protocol for data collection was designed to evolve and has been modified occasionally to answer new quality or research questions. Time of arrival to the hospital was added to the abstracting template in 2010. The University of Washington Human Subjects Division evaluated our study protocol and waived institutional review, because the research team had no access to original SCOAP data, and all research was conducted on completely anonymous data.

Predictor, descriptive, and outcome variables.

The primary predictor of interest was the time at which patients presented to the hospital. Variables were abstracted from each patient's clinical record using standardized definitions. SCOAP abstractors have clear directions in their handbook for recording times as data points. Many patients present to an emergency department (ED) as their first hospital contact, but the dataset is designed to register those patients who present to the hospital via other routes as well (eg, direct admission via the primary care provider). Time variable definitions are shown in [Box](#). White blood cell (WBC) count was based on the last result prior to operation. The SCOAP comorbid condition score has been described previously.⁶

One analysis was based on elapsed time from presentation to surgical start ("presentation-to-OR"). There were a small number of clear outliers, many of whom had obviously misclassified data (for instance, time < 0 [118 of 7,548 patients]). For this reason, when working with elapsed time, we restricted the analytic cohort to those patients whose presentation-to-OR time was within 63.05 hours (99th percentile of all patients). Outliers were included in all other analyses. Sensitivity analyses suggested that results were not impacted by including or excluding these patients.

Descriptive statistics were generated to characterize patients who present at different times. Additionally, we evaluated processes of care and clinical outcomes and their relationships, if any, with time-of-day. Process outcomes were presentation-to-OR time and use of advanced preoperative imaging. Clinical outcomes were NA or perforation as determined by the final pathology report.

Statistical analysis. Patients were ordered by the time when they presented to the hospital. We then divided the 24-hour day into four, 6-hour blocks

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