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# Pediatric patients transferred for operative management of appendicitis: are they at a disadvantage?

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ABSTRACT

*Purpose:* Many pediatric patients are initially diagnosed with appendicitis at referring hospitals and are subsequently transferred to pediatric facilities. We aimed to compare outcomes of patients transferred to a pediatric referral center to those who present primarily for operative management of appendicitis. Methods: A retrospective review of 326 patients with operative appendicitis from July 2012 to July 2013 was performed. Demographic data, clinical parameters, and outcomes were analyzed. Results: Transferred ($n = 222$, 68%) and primary patients ($n = 104$, 32%) were similar except for mean age (primary 12.4 vs. transferred 11.2 years, $p < 0.01$). Computed tomography scans were performed in 80% of transferred compared to 40% of primary patients. Primary patients were more likely to present between the hours of 09:00 and 17:59 (52%), while transferred arrived equally across all hours. Both groups were more likely to present with acute appendicitis (primary 56% vs. transfer 61%, $p =$ NS). There was no difference in time of diagnosis to time of appendectomy, length of hospital stay, or 30 day complications (primary 8.6% vs. transfer 5.8%, $p =$ NS). Conclusions: Patients transferred for definitive care of appendicitis are not found to have more advanced disease or have increased complications; however, they are exposed to significantly more ionizing radiation during evaluation for appendicitis.



Appendicitis has been described as a progressive inflammatory process induced by luminal obstruction that ultimately leads to infection, ischemic necrosis, and perforation [1–3]. Given this progression, appendicitis is usually considered a disease requiring timely surgical management. It is believed that a delay in diagnosis contributes to a higher perforation rate and in turn increased morbidity, hospital length of stay, and health care costs [4]. One report found a linear relationship between duration of symptoms of appendicitis and risk of perforation in children, rising from 10% at 18 hours to greater than 40% at 48 hours [5]. A second study found that an in-hospital delay greater than 12 hours was associated with a significantly higher perforation rate and longer hospital stay [6].

Many pediatric patients are initially evaluated at non-pediatric hospitals and subsequently transferred to pediatric tertiary referral hospitals. This may be for further work up if there is a concern for appendicitis or further management if there is a confirmed diagnosis of appendicitis. This process may lead to a delay in either diagnosis or treatment in this patient population. While recent studies have demonstrated that a short delay to appendectomy yield the same result as immediate appendectomy, it is believed that this is dependent on timely, correct diagnosis with the initiation of appropriate antibiotic coverage [7,8]. The purpose of this study is to compare outcomes of patients transferred to a pediatric tertiary referral center to those who present primarily to the pediatric hospital for operative management of appendicitis.

## 1. Material and methods

After Institutional Review Board approval (IRB # 13-0601), a retrospective analysis of 326 patients who underwent appendectomy at a free-standing, tertiary children's hospital from July 2012 to July 2013 was performed. Patients who presented primarily for initial evaluation and patients who were transferred from referring hospitals were included. As a tertiary children's hospital, our institution has a large geographic catchment area. While many patients are transferred for definitive care after a diagnosis of appendicitis, other patients are transferred for further workup to rule out possible appendicitis. Our institution has 24 hour ultrasound capability performed by technicians who are specialized in pediatric ultrasonography.

One of four attending pediatric surgeons performed all appendectomies on a rotating basis determined by call schedule with the aid of a pediatric surgery fellow or mid-level provider. Our operating suite has an add-on room that is available for cases that are booked overnight or on an ongoing basis during the day. All patients received preoperative antibiotics prior to appendectomy. Antibiotics are started once the diagnosis of appendicitis is made, and they are continued at the appropriate dosing and timing based on patient age and type of antibiotic

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administered. Appendectomy was performed by an open, multi-port laparoscopic, or single incision laparoscopic technique based on surgeon preference. Pre-operative, peri-operative, and post-operative care is standardized at our institution regardless of the operative technique utilized for appendectomy. During the study period, patients with intraoperative findings of acute appendicitis were admitted following appendectomy, without further antibiotic treatment and discharged once discharge criteria were met. Patients with intraoperative findings of suppurative, gangrenous, or perforated appendicitis were also admitted following appendectomy, however they were continued on intravenous antibiotic treatment until discharge criteria were met. Discharge criteria included temperature <38.5 °C, tolerating an adequate liquid diet, and pain control with oral pain medication.

Patients were grouped into "primary" (those who presented to our institution for initial evaluation) and "transferred" (those who were transferred from referring hospitals). Demographic data were obtained on age, weight, gender, category of appendicitis, surgical procedure utilized, and time of arrival to our emergency center (EC). Quality and outcome measures including time from EC diagnosis at our institution to operating room arrival, modality for diagnosis, post-operative length of stay, and 30-day complications were analyzed. Complications were defined as any event or occurrence that is a departure from the standard course of events following appendectomy. This included events occurring pre-operatively, intraoperatively, post-operatively, and/or within 30 days of surgery. The patient medical records were reviewed by one of two reviewers thoroughly to ensure the same definitions for complications were applied. Surgical site infection was defined as the presence of any localized swelling, erythema, calor, or wound drainage requiring treatment with antibiotics or open drainage by the surgeon. Intra-abdominal abscess was defined as the presence of an intraabdominal collection following appendectomy diagnosed by ultrasound or computed tomography scan. Post-operative ileus was defined as a delay in return of bowel function prolonging a patient's hospital course or requiring re-admission. Descriptive data are reported as mean ± standard deviation and range where appropriate. Statistical analysis was performed using Student's t-test for continuous variables and Fisher's exact test for categorical variables. Significance was set at $p < 0.05$.

## 2. Results

During the study period, a total of 326 patients underwent appendectomy. Two hundred twenty-two (67.7%) patients presented as transfers from referring hospitals, while 104 (31.9%) presented as primary patients for initial evaluation at our institution. Demographic, quality, and outcome measures are described in detail in Table 1. Primary patients were found to be significantly older compared to transferred patients (12.4 vs. 11.2 years, $p < 0.05$). Gender, weight, white blood cell count, and C-reactive protein were similar for both groups and found to be non-significant. The duration of abdominal pain was not significantly different between the two groups (1.39 vs. 1.42 days, $p$ = NS). There were significantly more patients with private insurance and significantly less patients with Medicaid presenting to our institution primarily compared to those transferred. Of the 222 patients who were transferred, 131 (59%) received intravenous antibiotic treatment prior to their transfer. The most commonly administered antibiotics included cephalosporins (35.9%) and broad spectrum, beta-lactamase inhibiting penicillins (62.6%). The remaining 91 patients who were not treated with antibiotics did not have a definitive diagnosis of appendicitis prior to their transfer. For patients who presented for initial evaluation at out institution, 77.9% received Cefoxitin, 12.5% received Zosyn, 5.8% received Ciprofloxacin and Flagyl, and 3.8% received other antibiotics.

The time of arrival to our institution's emergency center was evaluated for all patients. These were divided into three separate time frames: 01:00–08:59, 09:00–17:59, and 18:00–00:59 hours. It was noted that primary patients were more likely to arrive between the hours of 09:00 and 17:59 (51.9%), while those transferred arrived between all hours equally (Fig. 1). When comparing the two groups, primary patients were significantly more likely to arrive between the hours of 09:00 and 17:59 when compared to the transferred patients (51.9 vs. 30.7%, $p < 0.05$); while transferred patients were significantly more likely more likely to arrive between the hours of 01:00 and 08:59 when compared to the primary patients (32.4 vs. 13.5%, $p < 0.05$). When evaluating the modality for diagnosis of appendicitis, transferred patients were more likely to have undergone computed tomography (CT) scans compared to patients who presented primarily (78.8 vs. 39.4%, $p < 0.05$) (Fig. 2). Patients who presented primarily were significantly more likely to undergo ultrasound alone for diagnosis of appendicitis compared to transferred patients (60.6 vs. 21.2%, $p < 0.05$).

**Table 1**
Demographics and outcomes of primary and transferred patient groups.

| Demographics and outcomes | | | |
|---|---|---|---|
| | Primary | Transferred | *p*-Value |
| Number of patients | 104 (31.9%) | 222 (67.7%) | |
| Age (years)[a] | 12.5 ± 3.9 (2.7–20.6) | 11.2 ± 3.7 (1.5–20.5) | 0.004 |
| Males (%) | 60 (57.7%) | 137 (61.7%) | 0.543 |
| Weight (kg)[a] | 48.8 ± 21.2 (13–109) | 45.2 ± 20.8 (11.7–124) | 0.15 |
| Insurance status | | | |
| Private insurance | 52 (50%) | 81 (36.5%) | 0.022 |
| Medicaid | 47 (45.2%) | 134 (60.4%) | 0.012 |
| Self-pay | 5 (4.8%) | 7 (3.2%) | 0.53 |
| Race | | | |
| Asian | 3 (2.9%) | 2 (0.9%) | 0.332 |
| Black | 12 (11.5%) | 10 (4.5%) | 0.163 |
| Caucasian | 74 (71.2%) | 137 (61.7%) | 0.107 |
| Hispanic | 13 (12.5%) | 62 (28%) | 0.002 |
| Other | 2 (1.9%) | 11 (4.9%) | 0.239 |
| White blood cell count[a] | 14.9 ± 5.2 (2.4–30.7) | 14.9 ± 4.9 (3.8–28.3) | 0.981 |
| C-reactive protein[a] | 5.8 ± 7.1 (0.5–30.2) | 4.5 ± 5.7 (0.05–33.7) | 0.131 |
| Abdominal pain duration (days)[a] | 1.39 ± 1.1 (0.5–7) | 1.42 ± 1.1 (0.5–7) | 0.525 |
| Modality for diagnosis | | | |
| Ultrasound (US) | 63 (60.6%) | 47 (21.2%) | 0.0001 |
| Computed tomography (CT) | 22 (21.2%) | 143 (64.4%) | 0.0001 |
| US + CT | 19 (18.2%) | 32 (14.4%) | 0.414 |
| OR findings | | | 0.397 |
| Acute (%) | 58 (55.8%) | 136 (61.3%) | |
| Complex (%) | 46 (44.2%) | 86 (38.7%) | |
| Time of diagnosis to OR (hours)[a] | 5.9 ± 5.2 (0.6–26) | 5.5 ± 4.3 (0.4–31.1) | 0.515 |
| Hospital length of stay (hours)[a] | 46.4 ± 63.7 (3.4–341) | 38.8 ± 70.1 (2.6–760) | 0.353 |
| Complications | 9 (8.6%) | 13 (5.8%) | 0.352 |

[a] Values are reported at mean ± standard deviation and (range).

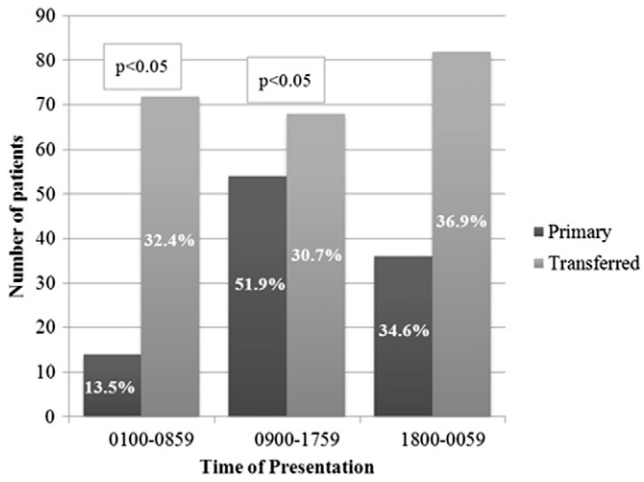


**Fig. 1.** Number of patients presenting to the emergency department in each group over three time periods. Percentages are listed within the bars.