

Misdiagnosed Acute Appendicitis in Children in the Emergency Department

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Background: To identify clinical features that distinguish children with appendicitis who visited the emergency department twice or more from those diagnosed on the first visit to the emergency department.

Methods: A retrospective review of all children with appendicitis diagnosed in the emergency department between January and December 2004 was conducted. Records were reviewed for all patients on their initial presentation to the emergency department. Clinical features were compared between those children who were misdiagnosed and those who were diagnosed correctly.

Results: One hundred seventy-three cases were included (mean age, 10.4 years). Twenty-six (15%) were seen twice or more in the emergency department before appendicitis was diagnosed. Misdiagnosed patients had a relatively shorter duration of symptoms at their initial visit, and most presented late at night. Eighteen misdiagnosed patients (69.2%) initially visited the emergency department within 24 hours of onset of symptoms. Compared with patients diagnosed correctly on initial presentation, misdiagnosed patients had a significantly shorter hospital stay, fewer laboratory tests, and fewer physical findings of right lower quadrant tenderness, muscle guarding, rebound tenderness, fever, and migrating pain. Patients diagnosed late at night had a significantly shorter hospital stay and fewer abdominal ultrasound evaluations. On final presentation, initially misdiagnosed patients had a higher rate of appendiceal perforation than did correctly diagnosed patients.

Conclusion: Misdiagnosed appendicitis is a problem in the emergency department. A shorter stay in the emergency department, fewer laboratory tests, less diagnostic imaging, and fewer physical findings may be responsible for misdiagnosed appendicitis late at night in the emergency department.

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Key words: appendicitis, children, diagnostic error

Appendicitis is the most common condition requiring an emergency abdominal operation in

childhood.⁽¹⁾ Appendicitis is ultimately diagnosed in 2.3% of children who present to ambulatory clinics

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or emergency departments with acute abdominal pain.⁽²⁾ Despite the relatively high incidence of this common emergency, it remains a difficult diagnosis for clinicians.⁽³⁾ Early diagnosis of appendicitis in infants and children can prevent perforation and postoperative complications, and can decrease costs by shortening hospitalization.⁽⁴⁾ Missing the diagnosis of appendicitis in the emergency department may increase the probability of perforation of the appendix, as well as the rate of other complications.⁽⁵⁾

This study was designed to identify clinical features of pediatric appendicitis that differ between cases initially misdiagnosed, and those diagnosed correctly on the first physician encounter.

METHODS

A retrospective chart review was performed for all children with the diagnosis of appendicitis proven by surgical findings and pathological examination at a medical center. Children less than 18 years old admitted between January and December 2004 with a final diagnosis of appendicitis and admission through the emergency department (ED) were included in this study. Age, gender, signs and symptoms, radiologic studies, time of presentation to the ED, the interval between the initial and final visits to the ED, and operative and pathologic findings were tabulated and analyzed. "Misdiagnosed" was defined when a patient with appendicitis was discharged home without surgery after the initial presentation to the ED. "Late at night" was defined as a time between 22:00 and 06:00 hours. Each diagnosis of appendicitis was corroborated by histopathologic examination. The actions of the emergency physicians and clinical features of the patients at initial presentation were analyzed and compared using Fisher's exact test and the Mann-Whitney U test. A $p < 0.05$ was considered statistically significant.

RESULTS

One hundred seventy-three cases of appendicitis in 65 girls and 108 boys were identified. The mean age was 10.4 years (range, two to 17 years), and 84.6% of patients were over five years of age. One hundred forty-nine patients were diagnosed with appendicitis at the first visit (correctly diagnosed group). Twenty-six cases (15%) (misdiagnosed

group) were seen twice or more in the ED before the diagnosis of appendicitis was made. The average interval prior to return was 20 hours (range, 3–112 hours) after the first visit, and the rate of perforation in the misdiagnosed group was 73.1%. The rate of appendiceal perforation was 60% in misdiagnosed patients who returned within 12 hours, but was significantly greater (81.2%) when the interval was greater than 12 hours ($p = 0.031$). The average interval between the first visit and the appendectomy was 30.5 hours (range 19–73 hours) for those returning after 12 hours. The most common initial diagnoses in the misdiagnosed group were gastritis (54.1%) and constipation (41.6%). Ten (38.4%) of the misdiagnosed cases had laboratory evaluations. Seven of ten had leucocytosis (with respect to patient age) and five of the ten had a left shift.

The baseline data and outcomes of the misdiagnosed and correctly diagnosed patients are shown in Table 1. Patients in the misdiagnosed group had a shorter duration of symptoms at initial presentation

Table 1. Comparison of Baseline and Laboratory Data between Pediatric Patients with Misdiagnosed and Correctly Diagnosed Appendicitis

	Misdiagnosed group (n = 26)	Correctly diagnosed group (n = 147)	<i>p</i>
Age(y)	10.0 ± 4.5	10.6 ± 3.8	.520
Male	57.6%	63.2%	.661
Duration of symptoms (d)	0.7 ± 1.0	1.9 ± 1.9	< 0.001
Visit late at night	76.9%	24.8%	< 0.001
Attending physician	23.1%	30.6%	.437
Perforated appendicitis	73.1%	49%	.032
Laboratory exam	38.4%	100%	< 0.001
Leucocytosis	70%	80.1%	.442
Left shift	50%	76.6%	.061
Length of stay (h)	1.9 ± 2.4	3.9 ± 3.2	.003
Discharge late at night	65.4%	33.8%	.002

in the emergency department (0.7 ± 1.0 days vs. 1.9 ± 1.9 days, $p < 0.001$). Eighteen patients with missed diagnoses (69.2%) visited the ED within the first 24 hours of symptoms. The rate of missed diagnosis was 32.7% when the duration of symptoms was < 24 hours, 11.1% when symptoms had been present for between 24 and 48 hours, and 6.1% when duration of symptoms was > 48 hours.

Misdiagnosed patients more commonly presented late at night than did those whose appendicitis was correctly diagnosed (76.9% vs. 24.8%, $p < 0.001$) and were more commonly discharged late at night (65.4% vs. 33.8%, $p = 0.002$). Those misdiagnosed patients also had a shorter length of the stay in the emergency department (1.9 ± 2.4 hours vs. 3.9 ± 3.2 hours, $p = 0.003$). Misdiagnosed patients had a higher rate of appendiceal perforation than correctly diagnosed patients did (73.1% vs. 49%, $p = 0.032$). There were no statistically significant differences between groups in the age or gender of the patients, or whether care was delivered by attending physicians or residents.

The clinical manifestations of patients in both groups on initial presentation are listed in Table 2. The most common symptoms at initial presentation were abdominal pain (97.7%) and vomiting (65.9%).

Table 2. Clinical Presentations

	Misdiagnosed group	Correctly diagnosed group	<i>p</i>
Abdominal pain	92.3%	98.6%	0.10
Vomiting	72%	64.9%	0.48
Fever	24%	60.8%	0.001
Diarrhea	16%	18.2%	0.787
Migrating pain	3.8%	32.2%	0.003
RLQ tenderness	7.7%	75.2%	< 0.001
Rebounding pain	3.8%	43%	< 0.001
Muscle guarding	0%	25.5%	0.004

Nineteen misdiagnosed children (73%) had two or more symptoms including abdominal pain, vomiting, and fever at their initial presentation. The chief complaint in the misdiagnosed group when they returned was progressive or persistent abdominal pain (88.4%), fever (7.6%), and vomiting (3.8%). On initial presentation, the misdiagnosed patients were less likely to have right lower quadrant (RLQ) tenderness (7.7% vs. 75.2%, $p < 0.001$), muscle guarding (0% vs. 25.5%, $p < 0.001$), rebound tenderness (3.8% vs. 43%, $p = 0.004$), shifting pain (3.8% vs. 32.2%, $p = 0.003$), and fever (24% vs. 60.8%, $p = 0.001$). No difference was found in the frequency of abdominal pain, vomiting, and diarrhea between groups. An analysis of baseline data and clinical presentations between the misdiagnosed and correctly diagnosed groups is showed in Table 3. According to multiple logistic regression, a shorter duration of symptoms, absence of fever, absence of RLQ tenderness, visit at night and perforated appendicitis were strongly associated with the misdiagnosed group.

Table 4 shows the clinical and imaging data of patients presenting late at night and at other times. Patients presenting late at night had a shorter duration of symptoms (1.05 ± 0.99 days vs. 2.08 ± 2.15 days, $p < 0.001$), and less right lower quadrant ten-

Table 3. Analysis of Baseline Data and Clinical Presentations Between Misdiagnosed and Correctly Diagnosed Groups

Variable	Odds Ratio	95% Confidence Interval		<i>p</i>
		Lower	Upper	
Duration of symptoms	0.12	0.03	0.54	0.005
Length of stay	0.79	0.52	1.19	0.255
Perforated appendicitis	32.22	2.03	510.11	0.014
Fever	0.06	0.01	0.59	0.016
Migrating pain	2.16	0.12	39.02	0.602
RLQ tenderness	0.00	0.00	0.07	0.000
Rebounding pain	0.20	0.02	1.69	0.139
Visit late at night	15.17	1.65	139.60	0.016

Table 4. Comparison of Clinical and Radiographic Features between Patients Visiting the Emergency Department Late at Night and at Other Times

	Late at Night (n = 55)	At other times (n = 118)	<i>p</i>
US or CT	18.1%	44.0%	0.001
Plain abdominal radiograph	96.4%	98.3%	0.593
RLQ tenderness	58.1%	86.6%	< 0.001
Attending physician	32.7%	28%	0.522
Duration of symptoms (d)	1.05 ± 0.99	2.08 ± 2.15	< 0.001

Abbreviations: US: ultrasound; CT: computed tomography; RLQ: right lower quadrant.

derness (58.1% vs. 86.6%, *p* < 0.001). The emergency room pediatricians used ultrasound (US) and computed tomography (CT) less often late at night compared with other times (18.1% vs. 44.0%, *p* = 0.001). There was no difference in whether the children were cared for by attending physicians or residents late at night or any other time.

DISCUSSION

The diagnosis of appendicitis in children is generally considered more difficult than in adults.⁽⁶⁾ Prior studies have noted that the detection of appendicitis in children is often delayed due to misdiagnosis.^(7,8) Reported rates of misdiagnosis vary from 7.5% to 37% for children.^(5,9) Our rate of misdiagnosis, 15.2%, is consistent with these prior studies. The list of erroneous diagnoses of appendicitis in children is extensive. In our study, the most common diagnosis in the misdiagnosed patients was acute gastritis. Many other authors have documented that gastroenteritis is the most common misdiagnosis in cases of misdiagnosed appendicitis.^(2,10) Most of our patients were over five years of age, with an average age of 10 years. Acute gastroenteritis is the most common gastrointestinal inflammatory process in children, with a peak incidence in young children.⁽¹¹⁾ Appendicitis is usually a disease of older children

and adolescents, with a peak incidence at 9 to 12 years of age.⁽¹²⁾ Vomiting is a common feature of gastrointestinal upset, but it is not specific for acute gastritis.⁽¹³⁾

Seventy percent of misdiagnosed patients in this study had leucocytosis. The white blood cell count and C-reactive protein level can be helpful in the diagnosis of appendicitis.⁽¹⁴⁾ The diagnostic accuracy for pediatric appendicitis in this study was high (up to 80%) when the white blood cell count was >14.6 × 10⁴/μL at 12 hours, and >14.8 × 10⁴/μL after 49 hours. Physicians should not discount appendicitis in children with vomiting and laboratory evidence of leucocytosis, especially in those over five years of age. The rate of appendiceal perforation in the misdiagnosed cases in this study was up to 81.2% when they returned after >12 hours. In order to prevent complications, first-line emergency physicians should also educate patients to follow up without delay if abdominal pain persists or progresses.

Patients in the misdiagnosed group had a higher rate of perforation than those in the correctly diagnosed group. This phenomenon was also observed in previous studies.^(5,15) The clinical features of children with missed appendicitis differed from those of children with appendicitis initially diagnosed correctly. In our study, most children with misdiagnosis had minimal findings on their initial physical examination, compared with children with the correct initial diagnosis. This may be because appendicitis typically begins with vague central abdominal pain associated with a single episode of vomiting.⁽¹³⁾

Several authors stress that the presence of right lower quadrant tenderness is probably the most sensitive physical finding in early appendicitis.⁽¹⁶⁾ Only 7.7% of misdiagnosed patients in our study had right lower quadrant tenderness, which may, in part, explain why they were not thought to have an acute abdomen. It is possible that patients with misdiagnosed appendicitis sought medical attention early in the course of disease with a shorter duration of symptoms, and had not yet manifested all of the typical clinical features of appendicitis. In our study, the rate of misdiagnosis was highest when symptoms had been presented for less than 24 hours. Seventy-three percent of misdiagnosed children had two or more symptoms with abdominal pain, fever, and vomiting. In order to decrease the rate of misdiagnosis, physicians should be aware of the characteristic

symptoms, and should order appropriate laboratory tests to corroborate their suspicions.

It is interesting that cases of missed appendicitis occurred mostly late at night in our study. There is a lack of empirical data assessing whether it is better to be a patient in the ED during the daytime or at night.⁽¹⁷⁻²¹⁾ Rollison and colleagues demonstrated declines in memory, vigilance, and psychomotor testing in physicians during just one night in the emergency department.⁽¹⁹⁾ Silbergleit identified a measurable but very small increase in mortality in patients receiving emergency care at night.⁽²¹⁾ Although there was no difference in whether pediatric care was delivered by attending physicians or residents late at night compared with other times, the accuracy of the diagnosis may be affected by differences in daytime and nighttime behavior patterns of physicians taking a history and performing physical examinations. In our study, emergency pediatricians also tended to use ultrasound and CT less often late at night compared with other times. Ultrasound is considered by many experts to be the imaging test of choice in children with appendicitis. Experienced ultrasonographers can achieve sensitivities of 85% to 90% and specificities of 95% to 100% in acute appendicitis.⁽²²⁾ CT offers the advantages of great accuracy, the ability to identify alternative diagnoses, and in some studies, low rates of negative laparotomy.⁽²³⁾ In addition, patients presenting late at night in our study had a shorter duration of symptoms and less right lower quadrant tenderness than those presenting at other times. The key to diagnosing appendicitis in children is conducting a careful history and physical examination. Factors related to patients as well as those related to doctors may affect the diagnosis of appendicitis late at night.

Appendicitis remains a challenging diagnosis in children in the emergency department. Initial misdiagnosis was associated with a shorter duration of symptoms, fewer pertinent physical findings, fewer laboratory examinations, a shorter hospital stay, and presentation late at night. Most patients with appendicitis are preadolescent children. A high level of clinical suspicion, combined with awareness of the significance of misdiagnosis, may aid the clinician in establishing the correct diagnosis at the initial visit to the emergency department.

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兒童急性闌尾炎的延遲診斷

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- 背景：**分析兒童闌尾炎在急診一次就診斷和求診2次以上才診斷的臨床特色區別。
- 方法：**以病歷回溯的方式分析從2004年1月至2004年12月間在急診室診斷的兒童闌尾炎。收集每個病人在急診的初次病歷來作回溯分析。將延遲診斷的病人與正確診斷的病人其臨床差異做分析與比較。
- 結果：**一共有173位病童確診，他們的平均年齡是10.4歲；其中26位延遲診斷的病童(15%)在開刀確診前於急診求診2次以上，延遲診斷的病人在初次求診時有相對比較短的病程而且常發生在深夜。18位延遲診斷的病人(69.2%)在症狀開始的24小時內求診；初次來急診的表徵中，延遲診斷的病人通常在醫院的留觀時間較短暫，較少接受抽血檢查，有較少的右下腹痛，肌肉僵硬，反彈痛，發燒，及轉移痛。深夜診斷的病人在醫院留觀時間較短，及比較少安排腹部超音波檢查。在預後部份，一開始延遲診斷病人的闌尾炎有較高破裂機會。
- 結論：**延遲診斷闌尾炎是急診常見的問題。在急診室較短暫的留觀，較少的抽血檢查，及診斷性影像評估，和較輕微的理學檢查發現與深夜延遲診斷闌尾炎相關。
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關鍵詞：闌尾炎，兒童，診斷錯誤

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