



## Acute and Suppurative Appendicitis: Disease Duration and its Implications for Quality Improvement

***The prevalence of suppurative vs. acute appendicitis has traditionally been used to indicate quality of care, but recently acute and suppurative appendicitis have been suggested to be different disease processes. If so, quality of care might be better determined by measuring speed and accuracy of diagnosis and treatment. We retrospectively reviewed inpatient and outpatient medical charts of 208 health plan members in Raleigh, North Carolina, who had surgery for acute appendicitis during the years 1990 through 1995 to identify and compare duration and clinical features of acute and suppurative appendicitis.***

***Compared with acute appendicitis, suppurative appendicitis caused more days of pain (2.8 ± 2.2 days vs. 1.7 ± 2.1 days), pathology (3.1 ± 2.3 days vs. 1.1 ± 1.3 days), and delay before seeking treatment (1.7 ± 1.6 days vs. 1.1 ± 1.7 days). Suppurative appendicitis was also associated with a higher incidence of atypical history (65.5% vs. 21.6%). Duration of pain was shown to have a nonlinear relation to duration of pathology (R2 = 0.3, P = .0001) for acute appendicitis and a linear relation (R2 = 0.85, P = .0001) for suppurative appendicitis.***

***Our data and current medical literature suggest that unlike acute appendicitis, suppurative appendicitis starts with the suppurative process and has an atypical history which makes diagnosis difficult. Improving the speed of diagnosis and treatment of each condition is also discussed.***

### Introduction

Incidence of suppurative appendicitis has traditionally been used to indicate quality of care for appendicitis: because undiagnosed acute appendicitis was thought to precede suppuration, the latter condition was taken to indicate failure in diagnosis, in treatment, or in both. However, this interpretation of suppurative appendicitis has been challenged by recent studies.

For example, in an elegant epidemiologic study done in Sweden,<sup>1</sup> incidence of suppurative appendicitis cases per 100,000 population was not related to incidence of removing normal appendixes, whereas incidence of acute appendicitis was higher in locales where a high proportion of normal appendixes were removed per 100,000 population. Resolving cases of acute appendicitis were thus being discovered at surgery by surgeons who relied on the least stringent indications for appendectomy. Proportion of

suppurative appendicitis (number of suppurative appendicitis cases divided by total number of appendicitis cases) thus only seemed lower in geographic areas where a high proportion of normal appendixes were removed per 100,000 population, because the denominator was inflated. Incidence of suppurative appendicitis therefore did not reliably reflect quality of care for the population studied.

Researchers are also accumulating evidence that acute and suppurative appendicitis are actually different disease processes. Andersson et al<sup>1</sup> showed that the incidence of suppurative appendicitis is constant for patients of all ages but that the incidence of acute appendicitis is highest at puberty. Suppurative appendicitis is more often associated with delay in seeking care<sup>2</sup> and with obstruction of the appendix by fecalith or hyperplasia,<sup>3</sup> whereas acute appendicitis is associated with mucosal ulceration.<sup>4</sup> Perhaps a viral cause for these ulcerations might explain epidemic clusters of acute appendicitis. If acute and suppurative appendicitis are different disease processes, then speed of diagnosis and treatment (ie, disease duration) might be a better indicator of quality than incidence of suppuration.

Because the author observed empirically that the suppurative process often seemed to have started near the onset of abdominal pain, this study sought to correlate duration of pathologic process with duration of abdominal pain to determine whether suppurative appendicitis is a complication of acute appendicitis (ie, by noting short duration of suppuration after longer history of pain) or a separate disease process (ie, by noting a strong linear correlation between duration of pathologic process and pain in suppurative appendicitis).

### Methods

We retrospectively reviewed the inpatient medical records of all Kaiser Foundation Health Plan members receiving emergency surgery for acute appendicitis at Rex Hospital in Raleigh, North Carolina, from April 1990 through April 1995. Chart review placed special emphasis on operative and surgical pathology reports. Outpatient records were reviewed for duration of abdominal pain and related evaluations. Normal appendixes were defined as those so indicated in the pathology report, although some patients with normal appendix had other disease processes. Suppurative appendicitis was defined as appendicitis with intraperitoneal pus, perforation, gangrene, or abscess. Because perforation is sometimes difficult to recognize at surgery and acts clinically like suppurative appendicitis, perforation was classified as suppurative.

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Because criteria for measuring duration of the pathologic process in appendicitis have not appeared in the biomedical literature, duration of the pathologic process in acute and suppurative appendicitis was estimated for pathologic conditions seen at surgery: erythema, edema, or fibrin on peritoneal surfaces (0.5 day); pus in peritoneal cavity or leukocytic infiltrates at serosa or outside the appendix (1 day); perforation or gangrene without collagen deposition (2 days); collagen formation outside appendix (4 days); early abscess cavity (5 days); and well-defined abscess (7 days). These estimates reflected the number of days which would ordinarily elapse before surgery would yield that finding. The estimates were based on well-

accepted principles of stage of inflammation and wound healing and were adjusted by consensus of 4 Board-certified general surgeons and 6 Board-certified pathologists at Rex Hospital. These estimated durations were then applied to data obtained from operative notes and pathology reports.

Using recently proposed criteria,<sup>5</sup> typical appendicitis-related medical history was defined as abdominal pain which progressed from upper abdomen to right lower quadrant and which was followed by either anorexia, nausea, or vomiting. Atypical appendicitis-related medical history was defined as sudden, nonprogressive lower abdominal pain, vague or absent pain localization, or predominant symptoms of diarrhea or vomiting. Typical appendicitis-related physical examination results were defined as guarding or spasm in the right lower quadrant. Typical laboratory findings were defined as white blood cell count  $>12,000/\text{mm}^3$  ( $12 \times 10^6/\text{L}$ ) as a prominent feature. Delay before seeking treatment was defined as the difference (stated in days) between duration of pain and duration of medical care before appendectomy.

Statistical analysis was done using SPSS software. Statistical significance for differences was determined by using  $\chi^2$  tests for frequencies; and Student's *t* statistic for means. Duration of pain and duration of pathologic process were evaluated for correlation by plotting days away from the mean for each variable and by using the standardized Scatterplot feature of SPSS.  $\chi^2$  (the coefficient of determination) was used to determine whether the relation between duration of pain and duration of pathologic process was linear and strongly correlated ( $R^2 = 1.0$ ) or weakly correlated and nonlinear ( $R^2 = 0.0$ ).

## Results

Of 208 appendectomy cases studied, 116 were acute appendicitis, 37 (17.8%) were normal appendixes, and 55 (32.2%) were suppurative appendicitis. No mortality occurred. Age, sex, and laboratory findings were similar for patients with acute and suppurative appendicitis (which included 27 perforations—15% of all appendicitis cases) (Table 1). Suppurative appendicitis had significantly longer duration of pain ( $2.8 \pm 2.2$  days vs.  $1.7 \pm 2.1$  days,  $p = .001$ ), pathologic process ( $3.1 \pm 2.3$  days vs.  $1.1 \pm 1.3$  days,  $p = .001$ ), delay before seeking treatment ( $1.7 \pm 1.6$  days vs.  $1.1 \pm 1.7$  days,  $p = .03$ ), hospital stay ( $3.8 \pm 2.9$  days vs.  $2.0 \pm 1.7$  days,  $p = .001$ ), and medical observation ( $1.1 \pm 1.7$  days vs.  $0.6 \pm 1.4$  days,  $p = .03$ ) as well as a higher incidence of atypical medical history (65.5% vs. 21.6%,  $p < .0001$ ), atypical results of physical examination (36.4% vs. 12.1%,  $p = .0009$ ), and complications (16.4% vs. 6.9%,  $p = .05$ ) than did acute

**Table 1. Characteristics of study group affected with acute or suppurative appendicitis compared with unaffected patients**

Patient characteristic	Acute appendicitis (n = 116)	Suppurative appendicitis (n = 55)	Healthy appendix (n = 37)
Mean age (yr)	26.4 ± 13.3	27.9 ± 16.1	29.5 ± 13.4
Male sex (%)	45.7	54.5	32.4
Mean duration (days):			
pain	1.7 ± 2.1	2.8 ± 2.2*	2.9 ± 2.8
delay before seeking treatment	1.1 ± 1.7	1.7 ± 1.6*	1.6 ± 2.1
care	0.6 ± 1.4	1.1 ± 1.7*	1.2 ± 1.9
hospital stay	2.0 ± 1.7	3.8 ± 2.9*	2.1 ± 2.0
pathologic process	1.1 ± 1.3	3.1 ± 2.3*	N/A
Typical medical history (%)	78.4	34.5*	27.0
Typical physical findings (%)	87.9	63.6*	64.9
Typical laboratory findings (%)	86.2	72.7	45.9
Complications (%)	6.9	16.4*	5.4

Where applicable, values are expressed as mean ± standard deviation.

\* $P < .05$  for acute vs. suppurative appendicitis.



appendicitis. Duration of pain plotted against duration of pathologic process showed a widely scattered, nonlinear pattern for acute appendicitis ( $R^2 = 0.30$ ,  $p = .0001$ ) (Fig. 1) and a linear pattern for suppurative appendicitis ( $R^2 = 0.85$ ,  $p = .0001$ ) (Fig. 2). Differences noted between suppurative and acute appendicitis are listed in Table 2.

### Discussion

Our data indicate that suppurative appendicitis and acute appendicitis are different disease processes. Suppurative appendicitis is more likely to be associated with atypical medical history and with physical findings which make diagnosis difficult. For this reason, suppurative appendicitis is associated with longer delays before seeking treatment and with longer duration of medical observation. Surgery for suppurative appendicitis yields pathologic findings which correlate well and linearly ( $R^2 = .85$ ) with duration of pain (Fig. 1), indicating that peritonitis in patients with suppurative appendicitis occurred near time of onset of pain. If suppurative appendicitis were a complication of acute appendicitis, duration of the pathologic process would not be expected to be the same or longer than duration of pain. Instead, a typical medical history would be expected early in the disease course and then a shorter duration of the pathologic process would be expected to exist at surgery. Our data therefore support a concept of separate disease processes.

Diagnosing suppurative appendicitis requires appreciating atypical medical history and physical examination results as well as expecting a prolonged course which is difficult to diagnose and which does not show improvement after observation. Observation is currently thought to be safe because perforation rarely occurs during observation; this study explains why: the process has begun at the onset of pain and is already underway. Nonetheless, diagnosis (for which ultrasonography or CT scanning may be useful) and required surgery must be done as early as possible.

In contrast to suppurative appendicitis, acute appendicitis manifests as a mixture of findings seen at surgery (Fig. 2). Some cases show scant inflammation, suggesting that these cases may have been resolving and might have resolved without surgery. The main feature of acute appendicitis, however, is its typical clinical appearance, which allows early diagnosis and surgery—the best therapeutic choice after diagnosis is made. For most cases of acute appendicitis, use of diagnostic ultrasonography or CT scanning is both costly and unnecessary. Understanding acute appendicitis as a viral illness associated with mucosal ulceration—not luminal obstruction—re-

duces concern about perforation but does not remove the obligation to quickly and accurately diagnose the condition, to minimize duration of pain, and to perform appendectomy.

The criteria used in this study for measuring duration of the pathologic process might be criticized as hypothetical or arbitrary. However, the consensus of physicians experienced in this area easily validated the criteria as reflecting well-established

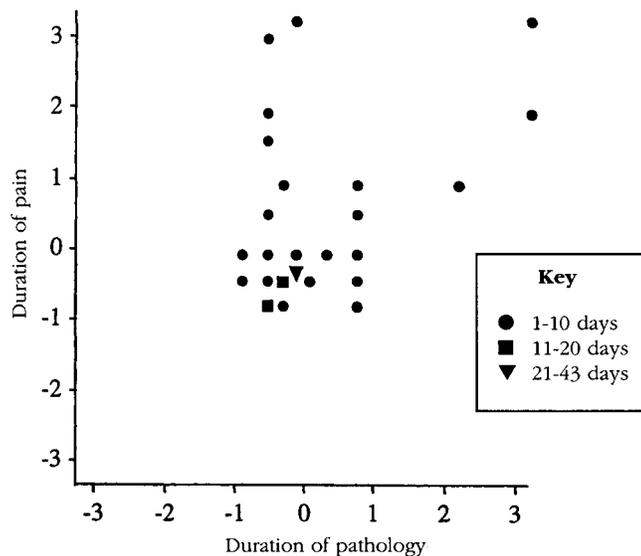


Fig. 1. Days scattered about mean of duration of pain and of pathologic process in acute appendicitis.

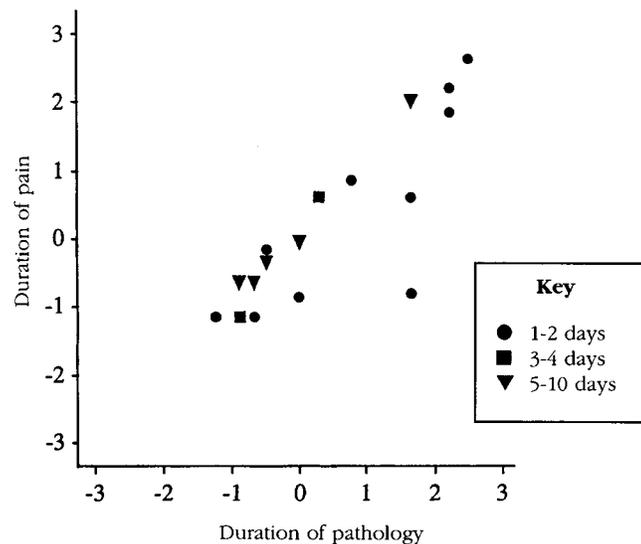


Fig. 2. Days scattered about mean of duration of pain and pathologic process in suppurative appendicitis.

principles of stage of inflammation and wound healing. The linear relation seen between duration of pain and duration of the pathologic process in suppurative appendicitis validates these criteria as useful for describing this disease process. Absence of linear relation between duration of pain and duration of the pathologic process in acute appendicitis also supports the concept that acute appendicitis can resolve spontaneously and can even recur. The criteria used in this study for measuring duration of the pathologic process might be useful not only to surgeons at surgery but also for clinicians deciding whether CT scanning is likely to show abscess. For these reasons, the criteria used in this study deserve further evaluation regarding their validity, not only for appendicitis but also for acute inflammatory processes such as diverticulitis and other inflammatory bowel disease.

Quality of care, then, should be gauged by speed and accuracy of diagnosis and treatment in cases of acute and suppurative appendicitis. The concept that these conditions are distinctly different disease processes requires that suppurative appendicitis should

not be viewed as evidence of a missed diagnosis; instead, duration of each disease process should be shortened. Monitoring duration of illness, incidence of morbidity, incidence of mortality, and population rates of removing normal appendixes can further improve quality of care.

### Summary and Conclusions

Duration of the pathologic process in appendicitis was measured by new criteria developed for findings determined at surgery. Duration of the pathologic process in suppurative appendicitis correlated well and linearly ( $R^2 = 0.85$ ) with duration of pain, showing that the suppurative process begins at onset of abdominal pain and cannot be accurately defined as a complication of acute appendicitis; acute and suppurative appendicitis are different disease processes. Suppurative appendicitis is characterized by an atypical medical history, by atypical results of physical examination, and by obstruction of the lumen. Surgery is indicated when observation shows no clinical improvement. Ultrasonography, CT scanning, or both may be helpful for diagnosing suppurative appendicitis.

Acute appendicitis is characterized by a typical medical history, by typical results of physical examination, by mucosal ulceration, and by a duration of pathologic process which correlates poorly and nonlinearly ( $R^2 = 0.3$ ) with duration of pain. For patients with acute appendicitis, diagnosis is reached more easily, and imaging studies are rarely needed. For both acute and suppurative appendicitis, quality of care should be determined by duration of abdominal pain (which is necessarily shortened by quick, accurate diagnosis). In addition, the incidence of morbidity, mortality, and of removing normal appendixes should be kept as low as possible for any given case mix of acute and suppurative appendicitis. ❖

#### References

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**Table 2. Differences between acute and suppurative appendicitis as determined from retrospective chart review of 208 appendectomy cases, or literature review<sup>1,3,4</sup>**

Disease characteristic	Appendicitis	
	Acute	Suppurative
Medical history, results of physical examination	typical	atypical
Delay in seeking treatment	short	long
Ease of diagnosis	low	high
Incidence	peak at adolescence <sup>1</sup>	consistent throughout life <sup>1</sup>
Pathologic finding	mucosal ulcers <sup>4</sup>	appendiceal obstruction <sup>3</sup>
Course	possible spontaneous recovery or recurrence	progressive worsening
Correlation between duration of pathologic process and duration of pain	poor, nonlinear	good, linear