Delays by patients, emergency physicians, and surgeons in the management of acute appendicitis: retrospective study

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Objectives. To compare the contributions of patients, emergency physicians, and surgeons in the delay of diagnosis and treatment of appendicitis, and the effects of delay on disease stage and complication rate.
Design. Retrospective study.
Setting. Accident and emergency department of a district public hospital, Hong Kong.
Patients. All patients undergoing emergency appendectomy between August 1998 to September 1999.
Main outcome measures. Patient delay in presentation, emergency physician delay in hospital admission, and surgeon delay in performing the operation; operative findings; and postoperative complications.
Results. Of 158 patients undergoing emergency operation, 14 had no pathological diagnosis and four had a diagnosis other than that of acute appendicitis. Of the 140 pathologically confirmed cases of appendicitis, the mean patient delay was greater in advanced appendicitis than it was in simple appendicitis (42.0 hours versus 24.9 hours; $P<0.005$). The mean emergency physician delay in advanced appendicitis was also greater than it was in simple appendicitis (17.9 hours versus 5.8 hours; $P<0.05$). The difference in the mean surgeon delay in simple (10.9 hours) and advanced (16.3 hours) appendicitis, however, was not significant. The mean emergency physician delay showed a significant association with the postoperative complication rate ($P=0.05$). The delay was mainly because of a failure to diagnose the condition and admit the patient at the first visit to the accident and emergency department (22.1%). The diagnostic accuracy showed a significant association with the level of experience of the emergency physician involved ($P<0.05$).
Conclusion. There should be a higher index of suspicion, better surgical training, and better senior supervision at accident and emergency departments, to avoid preventable morbidity and mortality in acute appendicitis.

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Key words: Acute disease; Appendectomy; Appendicitis/diagnosis; Appendicitis/surgery; Emergency medical services; Time factors

Introduction

Acute appendicitis is a common surgical disease[1-4] and a potentially dangerous condition. If the inflamed appendix is not attended to urgently, it will proceed to gangrene and perforation, and result in peritonitis or abscess formation.[5-7] In adolescents and adults, perforation of the appendix can occur within 36 hours of the onset of symptoms. In young children, however, the perforation rate ranges from 10%[8] to 74%,[6,9] and perforation can occur within 8 to 24 hours.[1,6] Perforation of the appendix is associated with substantially increased morbidity and mortality,[8,10-16] especially in the elderly.[7,17] Hospital stay is also prolonged,[10,15,18-21] which poses an additional financial burden.

The symptoms of appendicitis overlap considerably with other clinical conditions, which include gastro-enteritis, urinary tract infection, and pelvic inflammatory disease.[1,5,6] There is no single diagnostic test that can accurately diagnose appendicitis in all cases. The definitive treatment of acute appendicitis is emergency appendectomy. It has been asserted that the failure to diagnose appendicitis (and the resulting delay in appendectomy) is one of the leading sources of expensive malpractice claims in emergency medicine in the United States.[1,13,16,22]

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This study compared the contributions of patients, emergency physicians, and surgeons in the delay of diagnosis and treatment of appendicitis, and the effects of delay on disease stage and complication rate. By identifying the main factors responsible for delay, remedial actions may be directed more specifically in the management of this common clinical problem.

Methods

All emergency appendectomies that were performed in the North District Hospital from 6 August 1998 to 16 September 1999 were reviewed. Accident and Emergency (A&E) departmental records and hospital medical records of all patients with a discharge diagnosis of acute appendicitis were retrieved and studied. The Clinical Management System was used to electronically record the diagnosis, procedures, and treatment of both in-patients and out-patients. The A&E Information System was used to scan all departmental records into the computer and register the number of different steps of patient encounters within the department. The list was counterchecked with the computer record of appendectomies in the operating theatre. Only cases of appendicitis that had been confirmed by pathological examination were analysed in detail.

The following data were extracted from the A&E Department's records (including previous related emergency department visits): sex, age, chief complaint, duration of symptoms before the emergency department visit, emergency department registration time, time of hospital admission, rank of emergency physician, and the provisional diagnosis. The following data were retrieved from the hospital patient records: date and time of operation, operative findings, type of operation, findings from the pathological examination, and postoperative complications (including reoperation). The time interval from the onset of symptoms to initial presentation to the A&E Department was regarded as patient delay; this figure was entered in units of half-days (in hours). This approach was used because, unlike other time data retrieved from the hospital records, the information on the onset of symptoms was often imprecise. A patient's self-discharge against medical advice was also taken as patient delay, which was calculated as the interval between the onset of symptoms to the time of registration at the second visit to the A&E Department. The time interval from first registration at the A&E Department (except for those who discharged themselves) to final hospital admission was regarded as delay due to the emergency physician (in minutes).

In Hong Kong, emergency physicians customarily have full authority in admitting patients directly to the wards of various clinical specialties. In the majority of cases, there is no requirement for consultation with the specialties before admission. In this study, all admission and discharge decisions were made by emergency physicians. The time interval from hospital admission to the start of the operation was regarded as surgeon delay (in minutes).

All data were analysed by the Statistical Package for Social Science (Windows version 8.0; SPSS Inc., Chicago, United States). Since the time distribution was skewed, statistical significance was analysed with the independent sample *t* test with logarithmic transformation. The Chi squared test and logistic regression were used as appropriate. A probability level of $P<0.05$ was regarded as statistically significant.

Results

One-hundred and sixty-five patient records with a discharge diagnosis of acute appendicitis were retrieved. Seven patients responded to conservative treatment and were initially discharged for elective interval appendectomy; these patients were excluded from the analysis. Of the remaining 158 patients undergoing emergency surgery, 14 had no pathological diagnosis and four had other subsequent pathological diagnoses—namely, carcinoma of the caecum, missed Meckel's diverticulitis, reactive lymphoid hyperplasia, and pelvic abscess. Hence, the misdiagnosis rate by surgeons was 11.4% and the negative exploration rate was 8.9%. These 18 misdiagnosed cases were also excluded from further analysis.

Of the 140 patients with confirmed appendicitis, 88 were male and 52 were female: a ratio of 1.7 to 1. The mean age was 33 years (range, 4-86 years); 70% of the cases occurred in the 10- to 50-year age-group. Seventy-five (53.6%) patients had simple, uncomplicated appendicitis. Gangrenous (n=11) or perforated (n=39) appendicitis and appendicular abscess (n=15) were classified as advanced-stage disease (total = 65 patients; 46.4%).

Of the 140 patients, all but one presented with abdominal pain (lower abdominal, periumbilical, or epigastric). Some had other associated complaints such as fever, vomiting, diarrhoea, constipation, or dysuria. One patient presented with chief complaints of vomiting and diarrhoea, although he also had abdominal pain; he had been discharged home at the first visit to the A&E Department. Tenderness of the right lower

Table 1. Delay (hours) in relation to stage of disease

		Patient*	Emergency physician†	Surgeon‡
Simple appendicitis, n=75	Mean§	24.9	5.8	10.9
	Median	17.5	2.3	7.0
	Interquartile range	21.3	3.7	8.8
Advanced appendicitis, n=65	Mean§	42.0	17.9	16.3
	Median	32.4	3.4	7.8
	Interquartile range	51.1	15.8	15.9
P value		0.003	0.023	0.074

* Time of onset of symptoms to first registration to the Accident and Emergency Department
† Time of first registration to hospital admission
‡ Time of hospital admission to start of operation
§ True means are shown

Table 2. Delay (hours) in relation to postoperative complications

		Patient*	Emergency physician†	Surgeon‡
No complications, n=122	Mean§	32.0	8.1	13.0
	Median	21.2	2.3	7.4
	Interquartile range	37.7	4.8	12.3
Complications, n=18	Mean§	38.3	34.1	15.9
	Median	26.5	9.2	6.0
	Interquartile range	58.8	67.5	6.5
P value		0.818	0.05	0.862

* Time of onset of symptoms to first registration to the Accident and Emergency Department
† Time of first registration to hospital admission
‡ Time of hospital admission to start of operation
§ True means are shown

abdomen was the most common physical finding. Eight (5.7%) patients, however, presented with periumbilical tenderness, four (2.9%) with epigastric tenderness, and two (1.4%) with abdominal distension. In 11 (7.9%) patients, abdominal tenderness was either not recorded or entered as absent. The majority of the confirmed cases (122; 87.1%) had an uneventful postoperative recovery. Ten (7.1%), however, had wound infection or dehiscence, and six (4.3%) had postoperative sepsis or paralytic ileus, which subsided after prolonged periods of conservative treatment. One patient developed intra-abdominal abscess postoperatively and required reoperation. There was one death because of multi-organ failure; the mortality rate was thus 0.7%.

The distribution of the mean delay by patients, emergency physicians, and surgeons was analysed in relation to the stage of disease (Table 1) and postoperative complications (Table 2) by using the independent sample *t* test with logarithmic transformation. Medians and interquartile ranges were also calculated. Two patients discharged themselves against medical advice at their initial visit to the A&E Department and one patient left against medical advice after the initial admission. These were regarded as patient delay (delay in presentation).

Thirty-one (22.1%) patients were discharged home by emergency physicians at their first visit (emergency physician delay, or delay in admission). Of these discharged patients, 20 (64.5%) received a diagnosis of non-specific abdominal pain, 10 (32.2%) had gastroenteritis diagnosed, and one (3.2%) had urinary tract infection diagnosed. The mean emergency physician delay for these 31 patients was greater than that for the 109 patients who were admitted at the first visit to the A&E Department (40.1 hours [interquartile range, 48.2 hours] versus 3.2 hours [interquartile range, 2.4 hours]). These two groups of patients showed significant differences in relation to the stage of disease at operation and postoperative complications ($P<0.01$; Chi squared test) [Tables 3 and 4, respectively]. Seventy-three (97.3%) of the 75 patients with simple appendicitis had an uneventful postoperative course. In contrast, only 49 (75.4%) of the 65 patients with advanced appendicitis had uncomplicated postoperative recovery. The disease stage had a positive association with the postoperative complication rate ($P<0.001$; Chi squared test).

The rate of patient discharge at the first visit showed an inverse relationship to the rank of the emergency physician ($P<0.05$; Chi squared test) [Table 5]. Logistic regression analysis confirmed that patient delay ($P<0.005$) and physician delay ($P<0.005$) were significant predictors of an advanced stage of appendicitis. Sex, age, rank of emergency physician, and surgeon delay were not statistically significant factors.

Table 3. Effect of initial discharge from the Accident and Emergency Department on the stage of disease

	Stage of disease		
	Simple appendicitis No. (%)	Advanced appendicitis No. (%)	Total*
Admitted at initial visit	66 (60.6)	43 (39.4)	109
Discharged at initial visit	9 (29.0)	22 (71.0)	31
Total	75 (53.6)	65 (46.4)	140

* P<0.01 (χ^2 test)

Table 4. Effect of initial discharge on postoperative complication

	Postoperative course		
	No complications No. (%)	Complications No. (%)	Total*
Admitted at initial visit	100 (91.7)	9 (8.3)	109
Discharged at initial visit	22 (71.0)	9 (29.0)	31
Total	122 (87.1)	18 (12.9)	140

* P<0.01 (χ^2 test)

Table 5. Relationship between rank of emergency physician and initial discharge

Rank of doctor	Admitted at initial visit No. (%)	Discharged at initial visit No. (%)	Total§
Consultant*	6 (100)	0	6
Senior Medical Officer†	58 (81.7)	13 (18.3)	71
Medical Officer‡	45 (71.4)	18 (28.6)	63
Total	109 (77.9)	31 (22.1)	140

* Head of department
† Senior doctor with higher postgraduate qualification
‡ Junior doctor without higher postgraduate qualification
§ P<0.05 (χ^2 test)

Discussion

The results of this study show that discharge at the first visit to an A&E department is the most significant factor associated with advanced-stage appendicitis and postoperative complications. This finding is not surprising, as failure to diagnose appendicitis and the inappropriate discharge would certainly cause a substantial delay in appendectomy.

Appendicitis may mimic other clinical conditions. Inflammatory and infectious disorders such as gastroenteritis and respiratory infections may cause lymphoid follicle hyperplasia, which results in luminal obstruction and appendiceal inflammation. The classical symptoms of migrating right-lower quadrant pain, fever, anorexia, nausea, vomiting, and constipation occur in only 50% to 60% of cases.[11,23] Many patients, however, present with atypical findings such as diarrhoea, dysuria, and symptoms of the upper respiratory tract.[13,16,17] As the position of the appendix can vary, the initial pain may be poorly defined and tenderness poorly localised. This is especially true in the young,[1,2,5,16] the elderly,[2,17] women of child-bearing age,[10,11,24] and pregnant women.[13]

Patients with appendicitis may not be able to recognise the implications of their initial symptoms,[5] and they may attribute the symptoms to 'stomach flu' or to gastro-enteritis. Elderly patients are commonly late in seeking medical treatment.[7,17] Furthermore, emergency physicians encounter a wide spectrum of patients presenting with abdominal pain of all aetiologies in their daily practice—from self-limiting disorders to surgical emergencies.[1] The significance of a specific symptom, sign, or test result is determined not only by a test's sensitivity and specificity, but also by disease prevalence in the population—that is, positive and negative predictive values. In general, the disease prevalence of appendicitis is high in surgical wards but low in emergency departments,[1,16,21] which may explain why emergency physicians and surgeons misdiagnose appendicitis in opposite directions. An estimated 10% of adults who develop appendicitis are not correctly diagnosed at their first physician encounter. The rate of initial misdiagnosis is inversely related to the age of the patient and can be as high as 25% to 57% in children.[5,6,9,16,21] Diagnostic delay has been attributed to primary care physicians. However, statistics concerning emergency department encounters are scarce in the medical literature. Surgeons face a relatively small population of patients who are referred for suspected appendicitis. Their dilemma is to reduce unnecessary appendectomy, while attempting to operate at an early stage to avoid perforation.[8,21] The morbidity of negative appendectomy is not negligible, with complication rates from 6% to17%.[24]

In uncertain cases, delay of surgery and repeated assessment are commonly practised to achieve a more precise diagnosis. All these factors may contribute to diagnostic or therapeutic delays in the management of acute appendicitis.

Delay in treatment is regarded as the main cause of perforation and complications, but there are controversies as to whether preadmission or postadmission delay is more important.[5,7,9,21] Fortunately, death due to acute appendicitis is now rare (mortality rate, 0%-2.4 %).[4,7,13,17,18,24,25] Nevertheless, failure to diagnose appendicitis early is still a leading cause of increased perforation and complications (complication rate, 3.4%-33%).[10,12,14-16,19-21,23,25] This study showed that patient delay in presentation to an A&E department results in a more advanced stage of disease at surgery. However, it was difficult to estimate this time interval accurately in this retrospective study. To reduce patient delay and thus improve the outcome, health education to increase public awareness—especially in parents of young children and the elderly—of the symptoms and risks of appendicitis may be helpful.

This study also showed that preadmission delay by emergency physicians was associated with an advanced stage of disease and an increased rate of complications. More than one fifth of the patients were discharged at their first visit to the A&E department, their cases being labelled with non-specific diagnoses such as abdominal colic or gastro-enteritis. If these patients were admitted at their first visit, substantial time might have been saved (>24 hours) in definitive care—that is, performing an appendectomy. It was fortunate that these patients subsequently returned to the A&E department. There was always the possibility that a proportion of the discharged patients might have sought treatment at other hospitals, thus leading to an underestimate of the misdiagnosis rate. The diagnostic accuracy seemed to increase with the increasing experience of emergency physicians, although other confounding factors might have been involved. More senior supervision and proper surgical training need to be emphasised in A&E departments to improve the quality of care.

The most useful clinical tools in assessing acute appendicitis are still a good history and physical examination, serial abdominal examinations,[1,13,26] and a high index of suspicion. Migrating pain from the epigastric or periumbilical area to the right lower quadrant is the classical and most discriminating historical feature, which has high sensitivity and specificity. It has been suggested that the presence of right-lower quadrant tenderness is the most sensitive physical finding in early appendicitis.[16] It is present in nearly all patients with appendicitis, but it is a very non-specific finding. In case of doubt, the white blood cell count,[27] C-reactive protein level,[28] plain abdominal radiography,[29] ultrasonography,[22,30,31] computed tomography,[32-34] and even radionuclide scanning[35] may be helpful. Other ancillary diagnostic tools include computer-aided diagnosis[36] and clinical diagnostic scores such as the MANTRELS (migrating pain, anorexia, nausea/vomiting, tenderness, rebound tenderness, elevated temperature, leukocytosis, and shift of leukocytes) score.[37] Patients who are discharged home with a diagnosis of 'abdominal pain of unknown aetiology' should be given detailed discharge instructions regarding their return if their condition does not improve, or an early follow-up—within hours, not days—should be arranged. Emergency physicians should always consider the possibility of appendicitis before discharging patients with a diagnosis of gastro-enteritis or undifferentiated abdominal pain.[1,13,38] These diagnoses may imply that a 'benign' condition has been determined with certainty. As a result, treatment may be delayed if a more serious problem is the underlying cause.[1]

When the cause of the abdominal pain is uncertain, emergency physicians should always consider acute appendicitis in the differential diagnosis. The right-lower quadrant should always be palpated to detect tenderness in patients with abdominal discomfort. At the very least, patients with right-lower quadrant tenderness who are suspected of having a benign pathology should be reassessed within a short period, in terms of hours. Although this study did not find a statistical association between postadmission delay and the stage of disease or complication rate, delay in surgery should be avoided as much as possible once the decision to perform emergency appendectomy has been made. It is common practice to admit and observe patients when the diagnosis is in doubt, and to delay surgery until the diagnosis is more definite to avoid unnecessary operations.[2,21] The ancillary measures mentioned above will help clarify the issue in the majority of cases, but they are not foolproof. In general, close observation and timely intervention under surgical specialist care will not adversely affect patient outcome in undiagnosed abdominal pain,[5,22,39] although it must be borne in mind that there can always be exceptions.

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References

1. Mace SE. Issues in pediatric emergency medicine. Foresight. 1999;47:5-6.
2. Korner H, Sondenaa K, Soreide JA, et al. Incidence of acute nonperforated and perforated appendicitis: age-specific and sex-specific analysis. World J Surg 1997;21:313-7.
3. Blewett CJ, Krummel TM. Perforated appendicitis: past and future controversies. Semin Pediatr Surg 1995;4:234-8.
4. Moore SW, Schneider J. Acute appendicitis in childhood: Experience in a developing country. Pediatr Surg Int 1995; 10:71-5.
5. Lau WY, Fan ST, Yip WC, et al. Acute appendicitis in children. Aust NZ J Surg 1987:57:927-31.
6. Rappaport WD, Peterson M, Stanton C. Factors responsible for the high perforation rate seen in early childhood appendicitis. Am Surg 1989;55:602-5.
7. Franz MG, Norman J, Fabri PJ. Increased morbidity of appendicitis with advancing age. Am Surg 1995;61:40-4.
8. Velanovich V, Satava R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implications for quality assurance. Am Surg 1992;58:264-9.
9. Brender JD, Marcuse EK, Koepsell TD, et al. Childhood appendicitis: factors associated with perforation. Pediatrics 1985;76:301-6.
10. Ricci MA, Trevisani MF, Beck WC. Acute appendicitis: a 5-year review. Am Surg 1991;57:301-5.
11. Jess P, Bjerregaard B, Brynitz S, et al. Acute appendicitis. Prospective trial concerning diagnostic accuracy and complications. Am J Surg 1981;141:232-4.
12. Law D, Law R, Eiseman B. The continuing challenge of acute and perforated appendicitis. Am J Surg 1976;131:533-5.
13. Domeier RM. Acute appendicitis. Foresight. 1996;39:1-5.
14. Lee CM, Teoh MK. Perforated appendicitis: the Malaysian experience. J R Coll Surg Edinb 1990;35:83-7.
15. Neilson IR, Laberge JM, Nguyen LT, et al. Appendicitis in children: current therapeutic recommendations. J Pediatr Surg 1990;25:1113-6.
16. Rothrock SG, Skeoch G, Rush JJ, et al. Clinical Features of Misdiagnosed Appendicitis in Children. Ann Emerg Med 1991;20:45-50.
17. Burns RP, Cochran JL, Russel WL, et al. Appendicitis in mature patients. Ann Surg. 1985:201:695-704.
18. Roake JA, Morton J. Acute appendicitis: a quality assurance analysis. NZ Med J 1983;96:788-90.
19. Bennion RS, Thompson JE Jr. Early appendectomy for perforated appendicitis in children should not be abandoned. Surg Gynecol Obstet 1987;165:95-100.
20. Stringel G. Appendicitis in children: a systematic approach for a low incidence of complications. Am J Surg 1987;154: 631-5.
21. Eldar S, Nash E, Sabo E, et al. Delay of surgery in acute appendicitis. Am J Surg 1997;173:194-8.
22. Henry GL, George JF. Selected medical problems. In: Henry GL, editor. Emergency medicine risk management: A comprehensive review. Dallas (TX): American College of Emergency Physicians; 1991:415-31.
23. Schwerk WB, Wichtrup B, Ruschoff J, et al. Acute and perforated appendicitis: current experience with ultrasound-aided diagnosis. World J Surg 1990;14:271-6.
24. Douglas P, Webster DO, Cary N, et al. Differentiating acute appendicitis from pelvic inflammatory disease in women of childbearing age. Am J Emerg Med 1993;11:569-72.
25. Marchildon MB, Dudgeon DL. Perforated appendicitis: current experience in a children's hospital. Ann Surg 1977; 185:84-7.
26. Anderson KD, Parry RL. Appendicitis. In: Rowe MI, Grosfeld JL, editors. Pediatric surgery. St Louis (MO): Mosby; 1998: 1369-79.
27. Gronroos JM, Gronroos P. Leucocyte count and C-reactive protein in the diagnosis of acute appendicitis. Br J Surg 1999; 86:501-4.
28. Gurleyik E, Gurleyik G, Unalmiser S. Accuracy of serum C-reactive protein measurements in diagnosis of acute appendicitis compared with surgeon's clinical impression. Dis Colon Rectum 1995;38:1270-4.
29. Rao PM, Rhea JT, Rao JA. Plain abdominal radiography in clinically suspected appendicitis: diagnostic yield, resource use, and comparison with CT. Am J Emerg Med 1999;17: 325-8.
30. Orr RK, Porter D, Hartman D. Ultrasonography to evaluate adults for appendicitis: Decision making based on meta-analysis and probabilistic reasoning. Acad Emerg Med 1995; 2:644-50.
31. Schulte B, Beyer D, Kaiser C. Ultrasonography in suspected acute appendicitis in childhood: report of 1285 cases. Eur J Ultrasound 1998;8:177-82.
32. Rao PM, Rhea JT, Novelline RA. Helical CT combined with contrast material administered only through the colon for imaging suspected appendicitis. Am J Roentgenol 1997;169: 1275-80.
33. Rao PM, Rhea JT, Novelline RA. Effect of computed tomography of the appendix on treatment of patients and use of hospital resources. N Engl J Med 1998;338:141-6.
34. Rao PM, Rhea JT, Rattner DW. Introduction of appendiceal CT: impact on negative appendectomy and appendiceal perforation rates. Ann Surg 1999;229:344-9.
35. Rypins EB, Evans DG, Hinrichs W. Tc-99m-HMPAO white blood cell scan for diagnosis of acute appendicitis in patients with equivocal clinical presentation. Ann Surg 1997;226: 58-65.
36. de Dombal FT, Dallas V, McAdam WA. Can computer aided teaching packages improve clinical care in patients with acute abdominal pain. BMJ 1991;302:1495-7.
37. Ohmann C, Yang Q, Franke C. Diagnostic scores for acute appendicitis. Eur J Surg 1995;161:273-81.
38. Henry GL. Specific high-risk clinical presentations. In: Henry GL, Sullivan DJ, editors. Emergency medicine risk management: a comprehensive review. 2nd ed. Dallas (TX): American College of Emergency Physicians; 1997:475-94.
39. Kraemer M, Kremer K, Leppert R, et al. Perforating appendicitis: is it a separate disease? Eur J Surg 1999;165:473-80.