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Effect of Pediatric Surgical Practice on the Treatment of Children With Appendicitis

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ABSTRACT. *Objective.* Acute appendicitis in children is managed by both general surgeons (GSs) and pediatric surgeons (PSs). Our objective was to investigate the economics of surgical care provided by either GSs or PSs for appendicitis.

Methods. The outcome of children within our state who underwent operative treatment for appendicitis (January 1994 to June 1997) by board-certified GSs were compared with the results of PSs. Data were sorted according to patient age and diagnosis according to the *International Classification of Diseases, Ninth Revision*. Analysis of variance was performed on continuous data, and χ^2 analysis was performed on nominal data; data are depicted as mean \pm standard error of the mean.

Results. GSs ($n = 2178$) managed older children when compared with PSs ($n = 1018$; 11.0 ± 0.1 vs 9.1 ± 0.1 years) and less frequently treated perforated appendicitis (18.8% vs 31.9%). Independent of diagnosis (simple or perforated appendicitis), younger children (0–4 years, 5–8 years, and 9–12 years) who were treated by PSs had a significantly shorter hospital stay and/or decreased hospital charge when compared with those who were treated by GSs. However, older children (13–15 years) seemed to have comparable outcomes.

Conclusions. Younger children with appendicitis have reduced hospital days and charges when they are treated by PSs. *Pediatrics* 2001;107:1298–1301; *appendicitis, children, specialization, managed care, surgical outcome.*

ABBREVIATIONS. GS, general surgeon; PS, pediatric surgeon; DOH, Department of Health; APSA, American Pediatric Surgical Association; ANOVA, analysis of variance.

As recent health care reform has attempted to limit specialty access, much debate surrounds the quality and cost-effectiveness of care provided by generalists and specialists. Although specialization has been cited as 1 factor that is responsible for recent increases in health care costs,

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several studies,^{1–5} but not all,^{6–9} have suggested that patients who are cared for by medical specialists have improved outcomes and lower hospital costs when compared with patients who are treated by generalists.

Acute appendicitis is the most common reason for a pediatric abdominal operation and typically is managed by both general surgeons (GSs) and pediatric surgeons (PSs). Our objective was to investigate the economics of surgical care provided by either GSs or PSs for appendicitis.

METHODS

The Missouri Department of Health (DOH), Center for Health Information Management and Epidemiology, receives information abstracted from patient medical records of hospitalizations, emergency department visits, outpatient surgery, and selected other services and procedures. These data are reported to the DOH each calendar quarter by hospitals and ambulatory surgery centers and are held in a secure and confidential data file known as the Patient Abstract System. In coordination with the Missouri DOH, we reviewed patient abstracts of all children (≤ 15 years old) who underwent operative treatment for appendicitis between January 1994 and June 1997. The current study was approved by the Institutional Review Board at Saint Louis University Health Sciences Center (IRB#9517).

The name of the surgeon is reported to the Patient Abstract System. To keep the study blinded, we sent to the DOH a list of all surgeons within the state of Missouri who were certified by either the American Board of Surgery or the Royal College of Surgeons of Canada (GS) and who were not members of the American Pediatric Surgical Association (APSA) or pediatric surgeons (PS) who were APSA members. The DOH subsequently coded with each patient abstract the type of surgeon as either GS or PS. To ensure patient confidentiality, the authors also were blinded to the name of the patient. The reason we used APSA as a criterion to be a PS is that membership to this organization is very stringent. APSA membership usually requires 1) certification by the American Board of Surgery or the Royal College of Surgeons of Canada and, after 1977, Certification of Special Qualifications in Pediatric Surgery by the American Board of Surgery or the Royal College of Surgeons of Canada; 2) a practice devoted entirely to pediatric surgery; and 3) completion of 2 years of practiced pediatric surgery after the completion of the required pediatric surgical training.

Collected data included patient age, gender, length of hospitalization, and hospital charge. Data also were sorted by *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis as follows: simple (or acute) appendicitis (540.9) and perforated appendicitis (with or without an abscess; 540.0 and 540.1). No children were excluded from the study. We performed analysis of variance (ANOVA) using a Scheffe posterior contrast test on all groups with continuous data because it is more strict than other ANOVA comparisons and is exact when group sizes are unequal.² χ^2 or Fisher's exact test was used for analysis of nominal data. $P < .05$ defined statistical significance, and all data are presented as mean \pm standard error of the mean. StatView 4.5 (Abacus Concepts, Inc, Berkeley, CA) was used for all statistical analysis.

RESULTS

Between January 1994 and June 1997, on the basis of data from the Missouri DOH Patient Abstract System, 2178 and 1018 children underwent operative treatment by GSs and PSs, respectively, for appendicitis. During this time period, there were 17 PSs working in the 3 largest cities within the state of Missouri: St Louis (59%; $n = 10$), Kansas City (35%; $n = 6$), and Columbia (6%; $n = 1$). In contrast, 631 GSs were included in the study. The majority of GSs (59%) also practiced within larger cities: St Louis (42%; $n = 266$), Kansas City (10%; $n = 65$), and Columbia (7%; $n = 43$).

GSs treated older children when compared with PSs (11.0 ± 0.1 vs 9.1 ± 0.1 years; $P < .001$). The age distribution of children who were treated by GSs and PSs is depicted in Fig 1. Overall, 57% (1811 of 3196) of the children were male; gender distribution was similar between children who were treated by GSs or PSs (58% male versus 55%; $P = .09$). PSs more frequently treated perforated appendicitis when compared with GSs (31.9% vs 18.8%; $P < .001$). As patient age increased, perforation rates were lower among both GSs and PSs. Perforation rates, sorted by surgeon and patient age, are shown in Fig 2. Overall, the perforation rate was not different in boys (24.0%) versus girls (21.6%; $P = .11$).

Altogether, mean length of hospitalization was shorter when PSs managed either simple appendicitis (1.8 ± 0.1 vs 2.3 ± 0.1 days; $P < .001$) or perforated appendicitis (7.4 ± 0.1 vs 8.7 ± 0.2 days; $P < .001$). The distributions of hospital days, sorted by surgeon and diagnosis, are shown in Fig 3. Overall, hospital charges associated with patient care by PSs were similar with simple appendicitis ($\$5270 \pm 54$ versus $\$5354 \pm 60$; $P = .67$) but lower with perforated appendicitis ($\$13\,270 \pm 406$ versus $\$15\,186 \pm 619$; $P = .04$) when compared with GSs.

When sorted by child age, younger children (0–4 years, 5–8 years, and 9–12 years) who were treated by PSs, independent of diagnosis (simple or perforated appendicitis), had a significantly shorter hospital stay and/or decreased hospital charge when compared with those who were treated by GSs. However, older children (13–15 years) seemed to

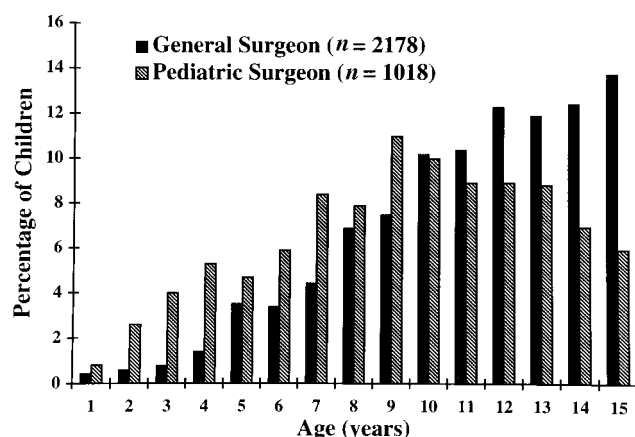


Fig 1. Age distribution, separated according to surgeon, of children who underwent operative treatment for appendicitis.

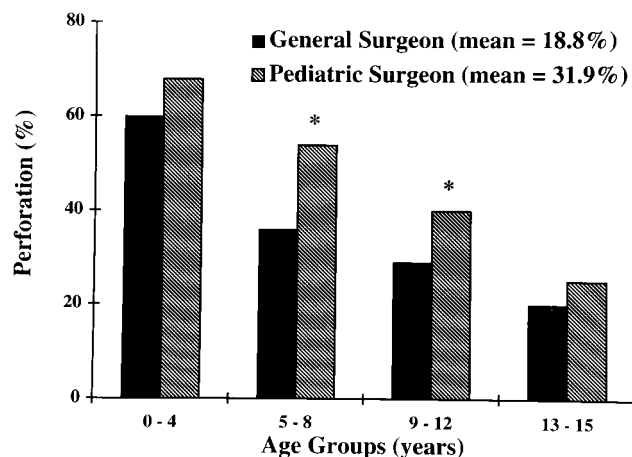


Fig 2. Perforation rates, sorted by patient age group and surgeon, of all children who underwent appendectomy. (* $P < .001$ vs children treated by a GS).

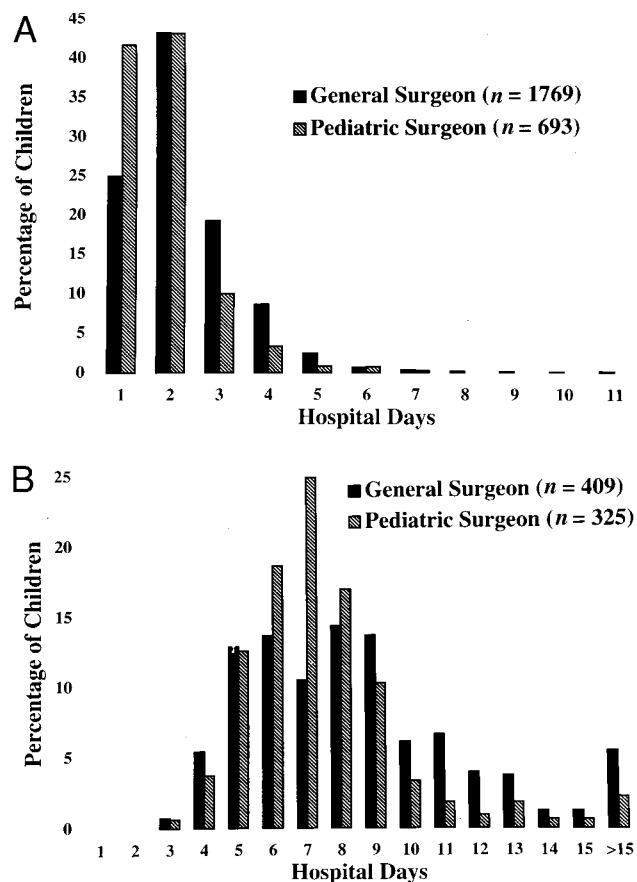


Fig 3. Distribution of hospital days, sorted by surgeon, of children who underwent operative treatment for either simple (A) or perforated (B) appendicitis.

have comparable outcomes. These data are depicted in Figs 4 and 5.

DISCUSSION

There is a concern within the medical community that specialization has played a major role in increasing health care costs. Such reasoning is based on studies that have suggested that medical specialists have utilization rates that are considerably higher

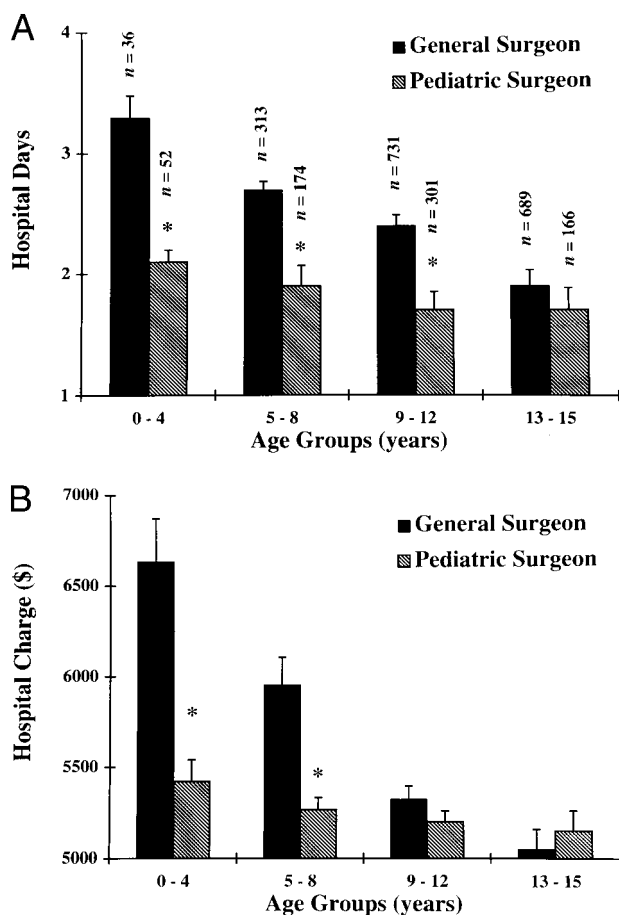


Fig 4. Mean length of hospitalization (A) and hospital charge (B) of children who underwent treatment for simple appendicitis categorized according to surgeon. The number of patients (*n*) is depicted above each group in A. (**P* < .001 vs children treated by a GS).

than those of generalists.^{6,7} As a result, managed care organizations and health care providers strive to use generalists and discourage specialist referrals. Bearing this concept in mind, our major objective was to determine whether, in fact, the care of children with a common surgical problem was more costly when achieved by surgical specialists. To the contrary, our data demonstrate that younger children with appendicitis have reduced hospital days and charges when they are treated by PSs, thus suggesting that surgical care by specialists may be cost-effective.

Reports of care provided by medical specialists have demonstrated similar findings. Zarling et al² reported that when patients with diverticulitis were treated by gastroenterologists, as compared with family practitioners or internists, the hospital stay was shorter and the risk for readmission was lower. Quirk et al³ reported that patients who were treated by gastroenterologists for upper gastrointestinal bleeding had a shorter mean hospital stay and lower cost when compared with internists or GSs. Specialty care by cardiologists versus generalists may be associated with a lower cost and improved survival.^{1,4} Carson et al⁵ suggested that patients who are treated by critical care specialists may have improved outcomes with lower costs.

To our knowledge, only 1 previous study evalu-

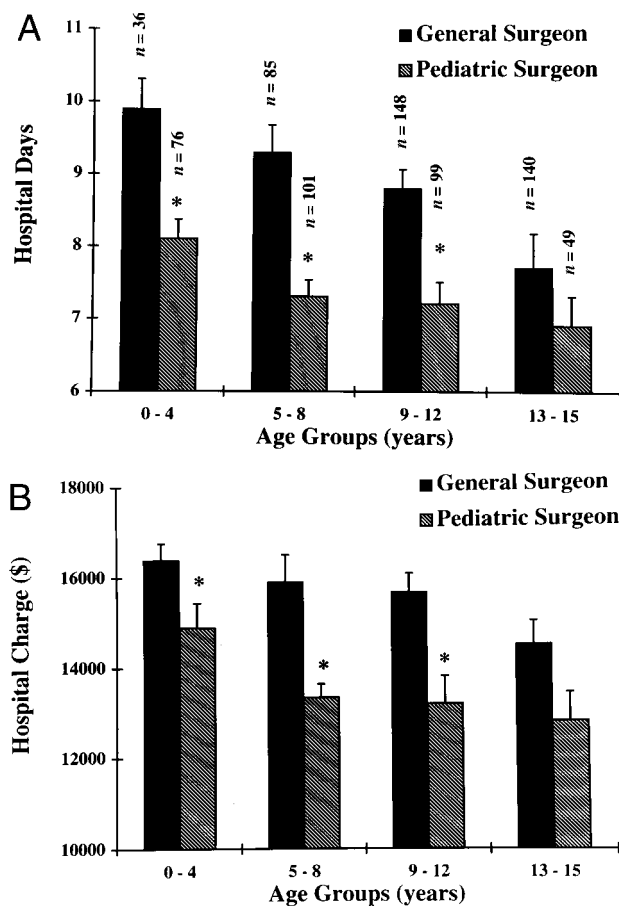


Fig 5. Mean length of hospitalization (A) and hospital charge (B) of children who underwent treatment for perforated appendicitis categorized according to surgeon. The number of patients (*n*) is depicted above each group in A. (**P* < .001 vs children treated by a GS).

ated the effect of pediatric surgical subspecialization. Snow et al¹⁰, in a single-institution study, assessed the outcome of children who underwent ureteronecystostomy for the treatment of vesicoureteral reflux. They reported that children who were treated by fellowship-trained pediatric urologists (*n* = 136 patients) had lower hospital charges and complication rates when compared with those who were treated by general urologists (*n* = 48). These data suggested that urologic specialization in pediatric care is cost-effective.

PSs may provide more cost-effective care as a result of greater medical efficiency gained by additional years of training. Studies have shown that specialists have a greater understanding of diseases within their field.^{11,12} In addition, physicians maintain their clinical knowledge by reading journals, through discussions with colleagues, and by participation in conferences. The pediatric surgical community also has ongoing efforts directed toward improving the treatment of children with appendicitis. For example, PSs recently assessed the role of early ultrasonography when the clinical findings of acute appendicitis are equivocal,¹³ challenged the role of intraoperative culture in the setting of perforated appendicitis,¹⁴ and investigated various clinical algorithms for decreasing hospital stay and costs after

appendectomy.^{15,16} In general, such studies are published in journals that target PSs.^{13,14,16}

In the present study, we used board certification and/or APSA membership to define the level of training. It is unknown whether our findings are applicable to surgeons with extensive training and experience in managing pediatric diseases but lack certification or do not meet APSA membership criteria. In addition, all of the PSs within our state practiced within either an academic children's hospital ($n = 13$; 76%) or a teaching hospital with a large pediatric component ($n = 4$; 24%). Thus, it is unclear to what degree the ancillary support of a children's hospital (eg, pediatric emergency department physicians, radiologists, anesthesiologists, nurses) contributed to our current observations. Perhaps the outcome of PSs versus GSs working in the same environment would be similar. Thus, an alternative conclusion of the present study is that the care of younger children with appendicitis within an urban (teaching) children's hospital is at least as cost-effective as care within a community (private) hospital.

The rate of appendiceal perforation among PSs (32%) was significantly higher than that of GSs (19%; see Fig 2). Once the symptoms of appendicitis occur, postponed surgery is the greatest predictor of perforation.^{17,18} Although a delay in diagnosis and/or treatment after arrival to the hospital cannot be ruled out, reports from our institution and others suggested that the largest delay associated with appendiceal perforation results from late presentation.^{17,19,20} Thus, the present study suggests that patients who present to PSs at children's hospitals may have had symptoms for a longer period of time. One explanation, although speculative, for this observation is that urban teaching hospitals are more prone to treat Medicaid and uninsured patients. Braveman et al¹⁷, in a study that used California hospital discharge data, reported that lack of medical insurance or Medicaid coverage was perhaps the most significant risk factor for rupture of the appendix. Insurance-related delays may result from fears of large hospital bills and an inability to pay, a lack of a primary care physician, or longer outpatient waiting times to be diagnosed and/or referred to a physician. In addition, physicians may be reluctant to accept Medicaid patients for fear of low reimbursement rates or administrative hassles.¹⁷

A strength of the present study is that we were able to evaluate a large number of children who underwent operative treatment for appendicitis by GSs and PSs within an entire state. There are, however, inherent limitations when evaluating data generated from the Patient Abstract System of the Missouri DOH. Although we were able to separate children according to degree of appendicitis, we were unable to assess accurately the complication rates. Children could have been readmitted to a hospital and/or seen as an outpatient for treatment of complications related to their initial operation without our knowledge. In addition, although hospital cost rather than charge is the preferred means of performing cost analysis, only hospital charge was submitted to the Patient Abstract System. Finally,

errors may have occurred when individual hospitals recorded and/or subsequently reported data to the Missouri DOH. Study limitations aside, our data do suggest that younger children (<12 years old) with both simple and perforated appendicitis have reduced hospital days and/or charges when they are treated by PSs. Thus, surgical care provided by PSs at academic children's hospitals seems to be cost-effective.

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