

Appendicitis in Children

Have We Figured It Out?

McGill Family Medicine Refresher Course
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Disclosures

none

Appendicitis Treatment

The Most Common Way to Make Sick Kids Better

Appendicitis

First Appendectomies

1735

Claudius Amyand performs the world's first successful appendectomy, at St. George's Hospital in London.

1883

Abraham Groves performs first appendectomy in North America in Fergus, Ontario.

300 Years Later!

“Frankly, one would think that after almost 100 years since the development of anesthesia and antibiotics, we would have at least figured out appendicitis. It appears that we have not.”

Clinical Guidelines for Pediatric Complicated Appendicitis Invited Commentary

Invited Commentary

Clinical Practice Guidelines for Pediatric Complicated Appendicitis The Value in Discipline

Diana Lee Farmer, MD, FRCS

Appendicitis has been written about since surgical journals began. There have been randomized trials about when to operate, how to operate (open vs laparoscopic), what antibiotics to use, whether to use drains or not, or, as reported in *JAMA Surgery*, whether to let the patient choose to be operated on.

Frankly, one would think that after almost 100 years since the development of anesthesia and antibiotics, we would have at least figured out appendicitis. It appears that we have not. If the standing-room-only attendance at the 2015 plenary session of the American College of Surgeons meeting is an indication, surgeons continue to seek information about the best treatment scheme. Although the article by Willis et al¹ does not completely illuminate the path (and, in full disclosure, I must confess my West Coast bias against the routine use of drains), it does demonstrate that no matter what technique is used, if everyone in the hospital uses the same protocol and pays attention to following the plan (clinical practice guidelines), the patients in the hospital will do better than they did before.

It reminds me of dieting—I always do better when I actually stick to the plan! It's the season for resolutions; let's make a plan and stick to it. Both patients and physicians will be better for it.

Related article at jamasurgery.com

ARTICLE INFORMATION

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Conflict of Interest Disclosures: None reported.

REFERENCE

1. Willis ZI, Duggan EM, Bucher BT, et al. Effect of a clinical practice guideline for pediatric complicated appendicitis [published online March 30, 2016]. *JAMA Surg*. doi: 10.1001/jamasurg.2016.0194.

Objectives

- To elucidate the role of diagnostic imaging.
- To present the outcomes of non-operative management.
- To emphasize the importance of risk stratification.
- To describe patient and family-centered care approaches.

Clinical Scenario

History

- 7 year old boy w/ 24 hr history of abdominal pain.
- Diffuse then localized to RLQ.
- Vomited X 3, including once in ED.
- Now hungry.
- No diarrhea or sick contacts.

NEXT STEP?

Clinical Scenario

Physical Exam

- Vital Signs
 - HR 110. RR 20. BP 100/60 Temp 37.0.
- Patient lying in bed, appears uncomfortable.
- Prefers not to move.
- Normal cardiorespiratory exam
- Abdomen with RLQ tenderness to percussion and palpation. Remainder abdomen soft.

NEXT STEP?

Clinical Scenario

Labs

- WBC 15.4. Neutrophils 80%
- CRP 50.4
- U/A negative

NEXT STEP?

Next Step

Laparoscopic Appendectomy

Variations in Appendicitis Imaging

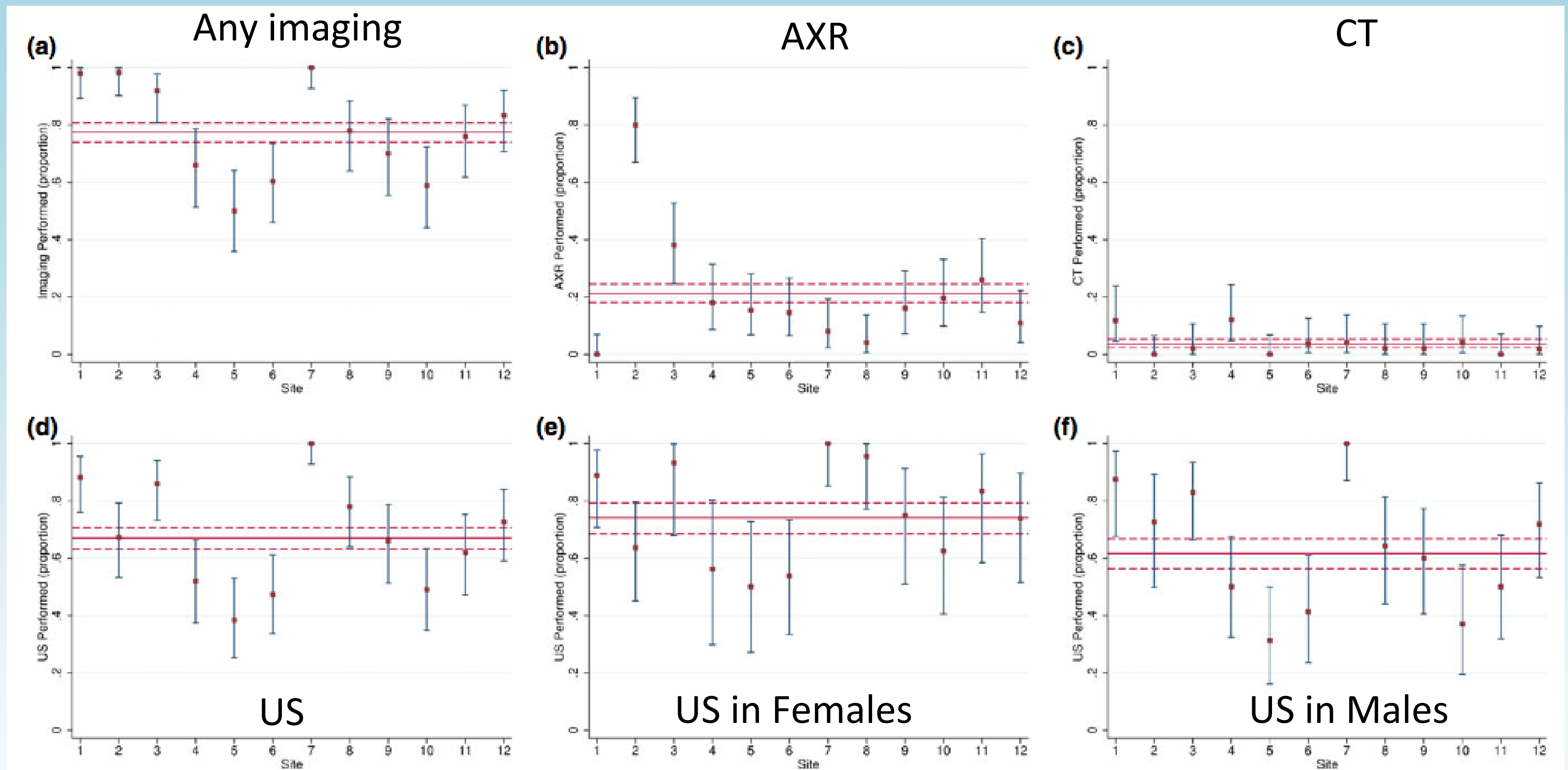


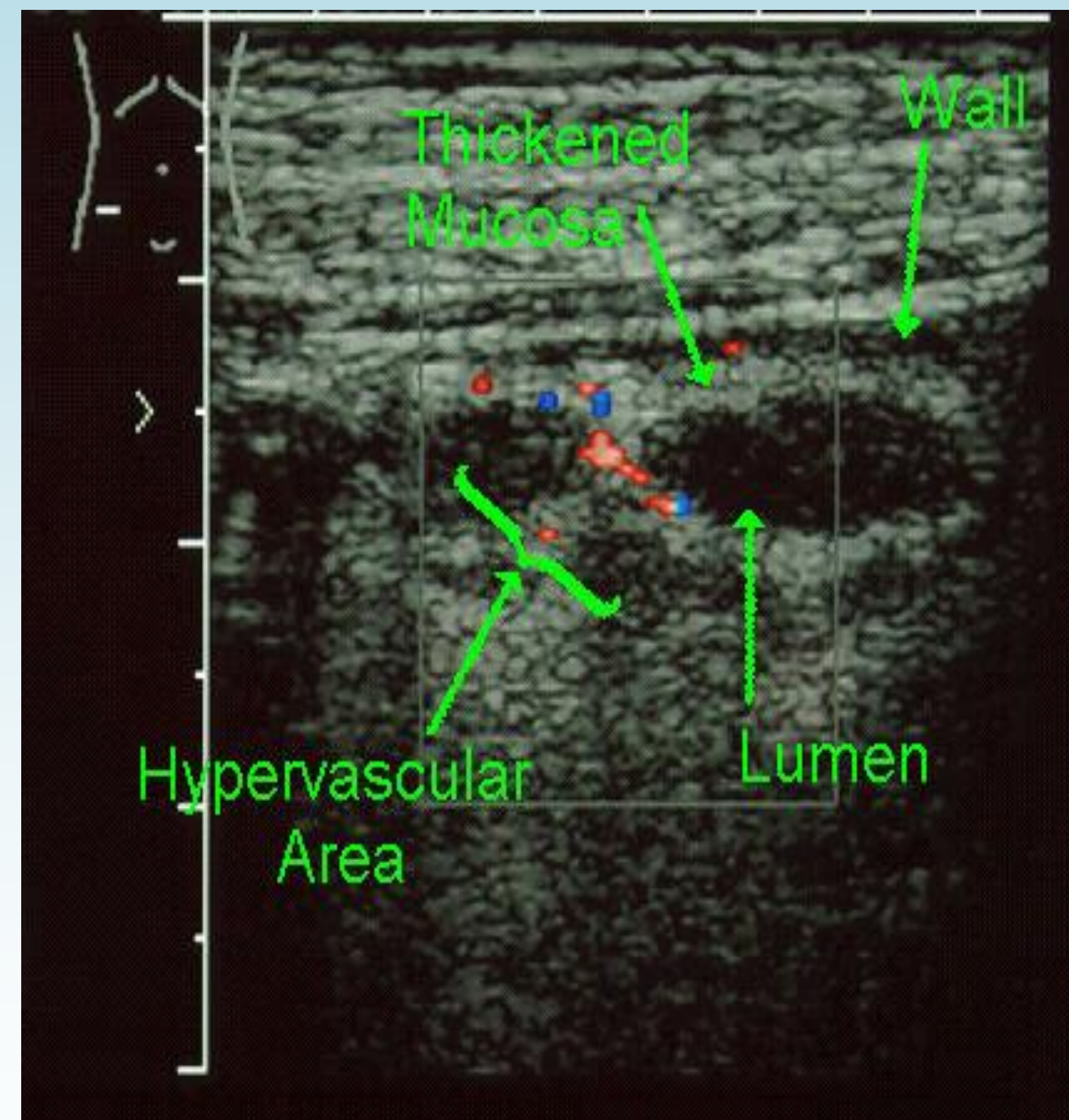
Figure 3. Variations in diagnostic imaging performed in the ED by site. Error bars represent 95% CIs. (a) Any diagnostic imaging performed in the ED; (b) abdominal X-ray performed in the ED; (c) computed tomography performed in the ED; (d) ultrasonography performed in the ED; (e) ultrasonography performed in the ED, females; (f) ultrasonography performed in the ED, males. Horizontal solid and dotted lines represent the proportion in the overall population with 95% CIs. AXR = abdominal X-ray; CT = computed tomography; US = ultrasound.

ACADEMIC EMERGENCY MEDICINE 2015;22:811-822

Appendicitis

Abdominal Sonography

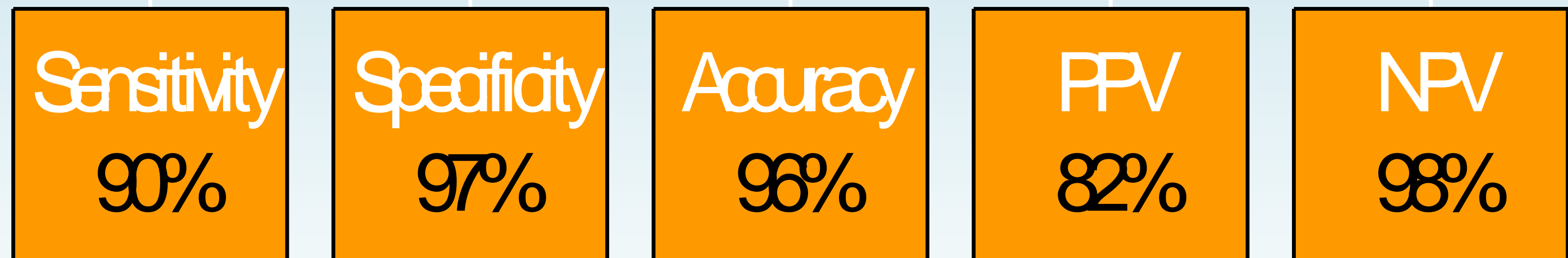
- Enlarged appendix
- Non-compressible
- Free Fluid
- Fecalith



Appendicitis

Abdominal Sonography

3859 children over 7 years



Hahn, Hoepner, Kalle, et al., Pediatric Radiology, 1998

Appendicitis

Abdominal Sonography

Clinical Versus Sonographic Evaluation of Acute Appendicitis in Children: A Comparison of Patient Characteristics and Outcomes

By Sherif Emil, Peter Mikhail, Jean-Martin Laberge, Hélène Flageole, Luong T. Nguyen, Kenneth S. Shaw, Livia Baican, and Kamal Oudjhane
Montreal, Quebec

Purpose: Abdominal sonography has gained popularity in establishing the diagnosis of appendicitis in children with equivocal clinical presentations. However, no clear outcome benefits have been demonstrated to date. The authors conducted a retrospective study to compare the characteristics and outcomes of patients undergoing appendectomy after clinical evaluation only with those undergoing the procedure after sonography.

Methods: The charts of 454 consecutive patients undergoing appendectomy for acute appendicitis between January 1, 1998 and December 4, 1999 were reviewed. Patients operated on after clinical evaluation only were compared with patients operated on after abdominal sonography.

Results: Forty-two percent of patients ($n = 191$) constituted the sonography group. When compared with the clinical group, these patients had higher prevalence of female gender (52% v 38%; $P = .004$), longer symptom duration (2.2 ± 2.5 v 1.6 ± 1.6 days; $P = .003$), higher incidence of preoper-

ative in-patient observation (19% v 4%; $P < .001$), longer duration between evaluation and operation (8.0 ± 3.9 v 4.9 ± 2.9 hours; $P < .001$), higher incidence of normal appendices on pathologic examination (13% v 6%; $P = .006$), and higher incidence of postoperative abscesses or phlegmons (4.4% v 1.2%; $P = .04$). The groups did not differ significantly in age, hospital stay, incidence of complicated appendicitis, or incidence of wound infection.

Conclusions: Patients undergoing sonography before appendectomy have a longer delay before operation, a higher rate of misdiagnosis, and more postoperative complications. Limiting sonography to truly equivocal cases and using it early in the diagnostic workup may improve outcomes in this group of patients.

J Pediatr Surg 36:780-783. Copyright © 2001 by W.B. Saunders Company.

INDEX WORDS: Appendicitis, sonography, ultrasound diagnosis.

Appendicitis

Sonography Results

454 Patients

263

(58%)

Clinical
Dx

191

(42%)

Sonography
Dx

Sensitivity:

90%

PPV:

91%

Appendicitis

Sonography Results

Table 2. Outcomes of the Clinical and Sonography Groups

Outcomes	Clinical Group (n = 263)	Sonography Group (n = 191)	P Value
Preoperative observation (%)	4.2	19.4	<.001
Emergency room to operating room interval (h)*	4.93 ± 2.91	8.04 ± 3.90	<.001
Normal appendix (%)	5.7	13.1	.006
Complicated appendicitis (%)	37.3	35.1	Not significant
Postoperative abscess/phlegmon (%)	1.2	4.4	.038
Wound infections (%)	1.6	0	Not significant
Hospital stay (d)	2.45 ± 2.49	2.82 ± 2.74	Not significant

Appendicitis

CT Scan?

NO!!

- Invasive
- Contrast
- Preparation
- Radiation
- Expensive
- No positive outcome data

Appendicitis

CT Scan

Increased CT Scan Utilization Does Not Improve the Diagnostic Accuracy of Appendicitis in Children

By David A. Partrick, James E. Janik, Joseph S. Janik, Denis D. Bensard, and Frederick M. Karrer
Denver, Colorado

Background/Purpose: Appendicitis continues to present a diagnostic dilemma in children of all ages leading to increased utilization of radiographic studies. Focused computed tomography (CT) scanning has become the diagnostic test of choice in many hospitals. The purpose of this study was to critically evaluate the use of radiographic studies for the evaluation of acute appendicitis in children and to determine if diagnostic accuracy has improved.

Methods: Children undergoing appendectomy for acute appendicitis were reviewed from 1997 to 2001. Diagnostic workup (CT scan, ultrasound [US], or no radiographic study) was recorded as were the final pathology results.

Results: Six hundred sixteen appendectomies were performed. Mean age was 10.4 ± 4.1 years, and 60% were boys. Overall, 194 children (30%) underwent CT scanning, 104 (17%) had US performed, and 310 (50%) had no radiographic study (18 patients had both CT and US performed). A patho-

logically normal appendix was removed in 7% (14 of 202) of CT patients, 11% (14 of 122) of US patients, and 8% (26 of 310) of patients without a study. The frequency of CT scanning increased from 1.3% of all children in 1997 to 58% in 2001, whereas utilization of US decreased from 40% to 7%. Over the same period, the overall negative appendectomy rate did not change significantly from 8% to 7%.

Conclusions: With increased utilization of focused CT scanning, the negative appendectomy rate has remained unchanged. History and physical examination by an experienced surgeon is as accurate as CT in correctly diagnosing acute appendicitis in children.

J Pediatr Surg 38:659-662. © 2003 Elsevier Inc. All rights reserved.

INDEX WORDS: Appendicitis, radiology, CT scan, ultrasound scan, appendectomy.

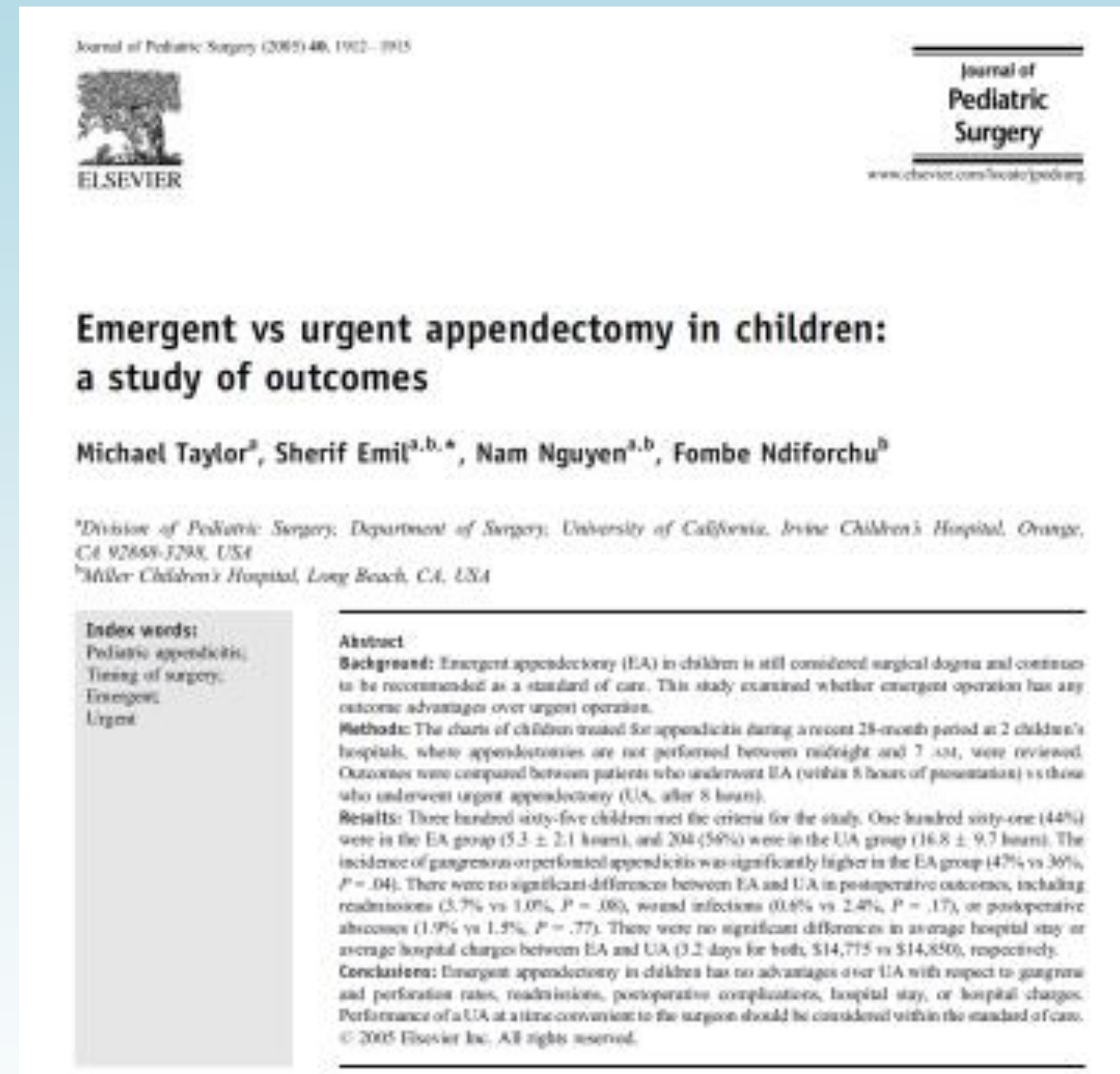
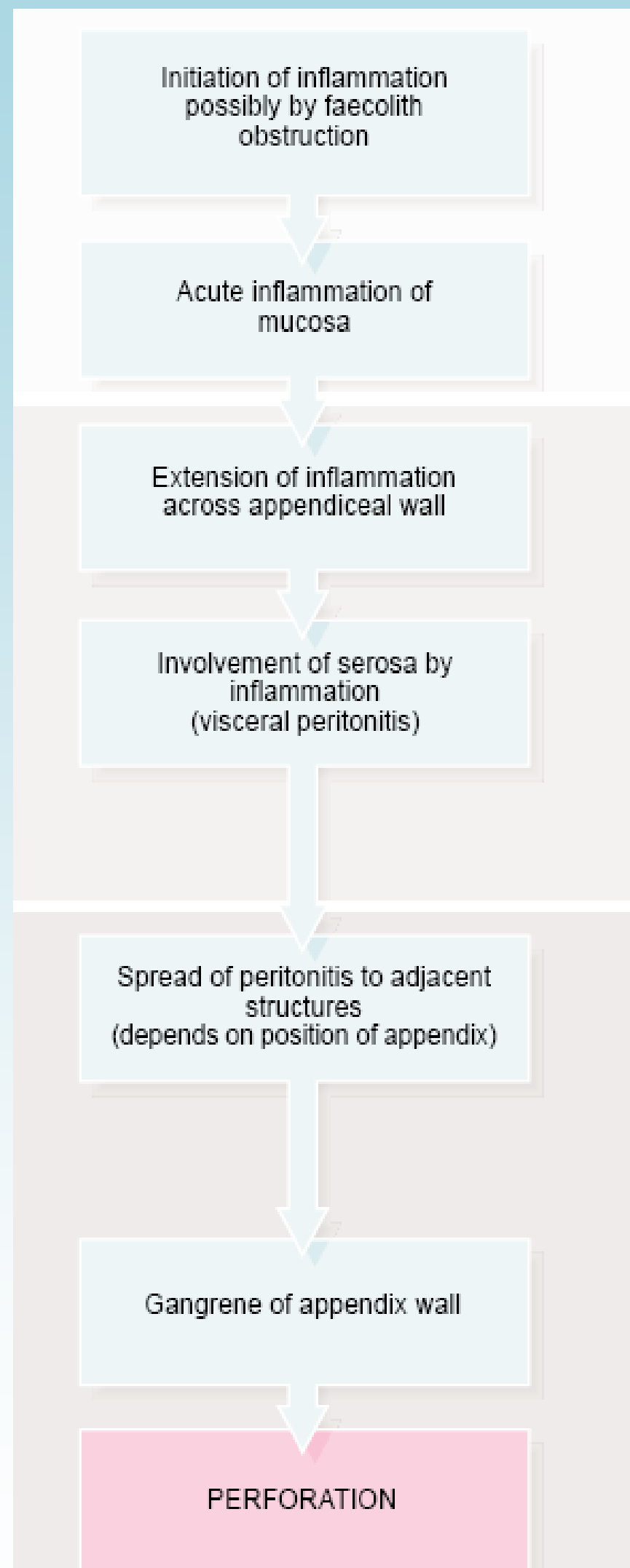
Appendicitis

Diagnosis

The best diagnostic test for acute appendicitis is a *good clinical exam*.

In equivocal cases, the diagnostic test of choice is *Ultrasound*.

Timing of Appendectomy



Appendectomy for acute appendicitis is an urgent, *not* an emergent procedure.

Clinical Scenario

Treatment

- The next morning, the parents call you.
- He slept through the night, tolerated some clear liquids, and the pain is better.
- The parents ask for your opinion as to whether they should just continue antibiotics and avoid surgery.

How would you respond?

Non-Operative Treatment of Appendicitis

Simple

- Reasonably new
- Good literature emerging
- Balance between operative complications and non-operative failure

Perforated

- NOT New
- Poor literature
- Balance between immediate and delayed elective surgery.

Non-Operative Treatment of Simple Appendicitis

Best Literature

Ann Surg 2015;261:67-71

RANDOMIZED CONTROLLED TRIAL

OPEN

Nonoperative Treatment With Antibiotics Versus Surgery for Acute Nonperforated Appendicitis in Children

A Pilot Randomized Controlled Trial

Jan F. Svensson, MD,*† Barbora Patkova, MD,*† Markus Almström, MD,*† Hussein Naji, MD,*† Nigel J. Hall, MD, PhD,‡§ Simon Eaton, PhD,‡|| Agostino Pierro, MD, PhD,§ and Tomas Wester, MD, PhD*†

RANDOMIZED CONTROLLED TRIAL

OPEN

Nonoperative Treatment Versus Appendectomy for Acute Nonperforated Appendicitis in Children

Five-year Follow Up of a Randomized Controlled Pilot Trial

Barbora Patkova, MD,*✉ Anna Svenningsson, MD, PhD,*† Markus Almström, MD, PhD,*† Simon Eaton, PhD,‡ Tomas Wester, MD, PhD,*† and Jan F. Svensson, MD, PhD*†

Ann Surg 2020;271:1030-1035

Research

JAMA | Original Investigation

Association of Nonoperative Management Using Antibiotic Therapy vs Laparoscopic Appendectomy With Treatment Success and Disability Days in Children With Uncomplicated Appendicitis

Peter C. Minneci, MD, MHSc; Erinn M. Hade, PhD; Amy E. Lawrence, MD; Yuri V. Sebastião, PhD; Jacqueline M. Saito, MD; Grace Z. Mak, MD; Christa Fox, MSN; Ronald B. Hirschl, MD; Samir Gadepalli, MD, MBA; Michael A. Helmuth, MD; Jonathan E. Kohler, MD; Charles M. Leys, MD; Thomas T. Sato, MD; Dave R. Lal, MD; Matthew P. Landman, MD; Rashmi Kabre, MD; Mary E. Fallat, MD; Jennifer N. Cooper, PhD; Katherine J. Deans, MD, MHSc; for the Midwest Pediatric Surgery Consortium

IMPORTANCE Nonoperative management with antibiotics alone has the potential to treat uncomplicated pediatric appendicitis with fewer disability days than surgery.

OBJECTIVE To determine the success rate of nonoperative management and compare differences in treatment-related disability, satisfaction, health-related quality of life, and complications between nonoperative management and surgery in children with uncomplicated appendicitis.

DESIGN, SETTING, AND PARTICIPANTS Multi-institutional nonrandomized controlled intervention study of 1068 children aged 7 through 17 years with uncomplicated appendicitis treated at 10 tertiary children's hospitals across 7 US states between May 2015 and October 2018 with 1-year follow-up through October 2019. Of the 1209 eligible patients approached,

← Editor's Note page 594

+ Supplemental content

+ CME Quiz at
jamacmelookup.com

JAMA 2020;324:581-593.

Non-Operative Treatment of Simple Appendicitis

Outcomes

- Failure Rate:
 - 1 Year: 33%
 - 5 Years: 46%
- Disability Days:
 - Operative: 10.9 days
 - Non-Operative: 6.6 days

Operative Treatment of Simple Appendicitis

Table 3. Complications

	Simple	Gangrenous	Perforated
Wound infection	none	1.0%	4.0%
Intraabdominal infections	0.6%	None	8.0%
Other complications	0.8%	3.9%	4.0%

Hospital Stay: 1.39 ± 0.89 days
Readmissions: < 1%

Last 5 Years:
 Same Day Discharge
 No narcotic analgesia

Appendicitis in Children: A Ten-Year Update of Therapeutic Recommendations

By Sherif Emil, Jean-Martin Laberge, Peter Mikhail, Livia Baican, Helene Flageole, Luong Nguyen, and Kenneth Shaw
 Montreal, Quebec

Background/Purpose: In 1990, the authors reported excellent outcomes using a standard protocol to treat pediatric appendicitis. This protocol has been simplified further and a large retrospective review was conducted to assess current outcomes.

Methods: All patients treated for presumed appendicitis between April 1997 and December 1999 were reviewed. All patients received preoperative gentamicin and clindamycin. Patients with complicated appendicitis received postoperative ampicillin, gentamicin, and clindamycin or metronidazole. All wounds were closed primarily without drains. Patients with complicated appendicitis were discharged when their ileus resolved, they remained afebrile for 24 hours, and had a normal leukocyte count.

Results: A total of 648 patients were reviewed. A total of 9.4% of appendices were pathologically normal, 55.6% were simple acute, 15.7% were gangrenous, and 19.3% were perforated.

Hospital stay was 2.21 ± 2.04 days for normal, 1.39 ± .89 for simple acute, 2.97 ± 1.25 for gangrenous, and 6.31 ± 3.51 days for perforated appendices. There were no wound infections in patients with normal or simple acute appendices. Two minor intraabdominal infections (0.56%) occurred in patients with simple appendicitis. Patients with complicated appendicitis (gangrenous or perforated) had wound infection and intraabdominal infection rates of 2.6% and 4.4%, respectively.

Conclusions: The authors' current protocol results in reasonable hospital stays and good outcomes. It serves as an evidence-based standard of care for the treatment of pediatric appendicitis.
J Pediatr Surg 38:236-242. Copyright 2003, Elsevier Science (USA). All rights reserved.

INDEX WORDS: Appendicitis, therapy, outcomes, complications.

What are the True Advantages of a Pediatric Appendicitis Clinical Pathway?

SHERIF EMIL, M.D., C.M., MICHAEL TAYLOR, B.S., FOMBE NDIFORCHU, M.D., NAM NGUYEN, M.D.

From the Division of Pediatric Surgery, Department of Surgery, University of California, Irvine Children's Hospital, Orange, California and Miller Children's Hospital, Long Beach, California

Multiple protocols have been described for pediatric appendicitis, but few have been compared with off-protocol treatment. We performed such a comparison. Children treated for appendicitis by three pediatric surgeons over a 28-month period were studied. A protocol of primary wound closure without drains, standardized use of antibiotics, and patient discharge according to predetermined clinical criteria was compared with individualized drain use, antibiotic selection, and discharge timing. Three hundred ninety-seven children were treated, 43 per cent on pathway (Group I) and 57 per cent off pathway (Group II). The two groups showed similar incidence of acute (45% vs 46%), complicated (50% vs 49%), and normal (5%) appendix. Among patients with simple appendicitis, Group I had less postoperative antibiotic use (16% vs 80% $P < 0.001$), shorter hospital stays (1.44 vs 1.89 days, $P = 0.001$), and decreased hospital charges (\$9,289 vs \$10,751, $P = 0.001$). Among patients with complicated appendicitis, Group I had less drain placement (4% vs 27%, $P < 0.001$), less use of discharge antibiotics (13% vs 39%, $P < 0.001$), and no readmission (0% vs 5%, $P = 0.05$). Infectious complications were similar between the two groups. A clinical pathway decreases the use of unnecessary antibiotics, hospital stay, and charges for simple appendicitis. It decreases the use of unnecessary drains, and eliminates readmissions after complicated appendicitis.

Am Surg 2006;72:885-889

So.....?

- Non-operative treatment of Simple appendicitis is within the standard of care.
- Our group does not recommend it.
- Shared-decision making.

Non-Operative Treatment of Perforated Appendicitis

Selective Approach

- > 3 days of symptoms
- Phlegmon/Abscess
- No generalized peritonitis.
- No bowel obstruction.

Antibiotic Therapy and Interval Appendectomy for Perforated Appendicitis in Children: A Selective Approach

SHERIF EMIL, M.D., C.M., F.A.C.S., F.R.C.S.C., SON DUONG, M.D.

From the Division of Pediatric Surgery, Department of Surgery, University of California, Irvine Children's Hospital, Orange, California and Miller Children's Hospital, Long Beach, California

The role of initial nonoperative treatment in pediatric perforated appendicitis remains controversial. We examined our outcomes after using this approach in a selective manner. Children with perforated appendicitis treated during a 28-month period were retrospectively reviewed. Antibiotics and delayed appendectomy were used if there were more than 3 days of symptoms, absence of bowel obstruction, absence of diffuse peritonitis, and an appendiceal mass. Of 221 patients with perforated appendicitis, 32 (14%) were treated with this approach. Average age was 7.4 ± 4.2 years. Twenty-eight patients (88%) were successfully managed and 26 (81%) underwent appendectomy 8.6 \pm 4.2 weeks after first presentation. Two patients did not respond completely, and underwent appendectomy during the same admission. Two patients initially responded, but had recurrent symptoms necessitating earlier appendectomy. There were no complications. Average total hospital stay was 7.2 ± 3.0 days. Initial nonoperative treatment is highly successful in selected children who meet specific criteria. Failure is not associated with increased morbidity.

Am Surg 2007;73:917-922

A Common Medical Dilemma

- You cannot improve what you cannot measure.
- You cannot measure what you cannot define.

Risk Stratification

- What?
 - Assigning patient populations to risk groups based on underlying conditions, co-morbidities, or disease presentation.
- Why?
 - Because it is the only way to evaluate outcomes.

Appendicitis: A Disease Continuum

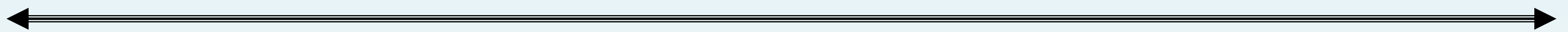
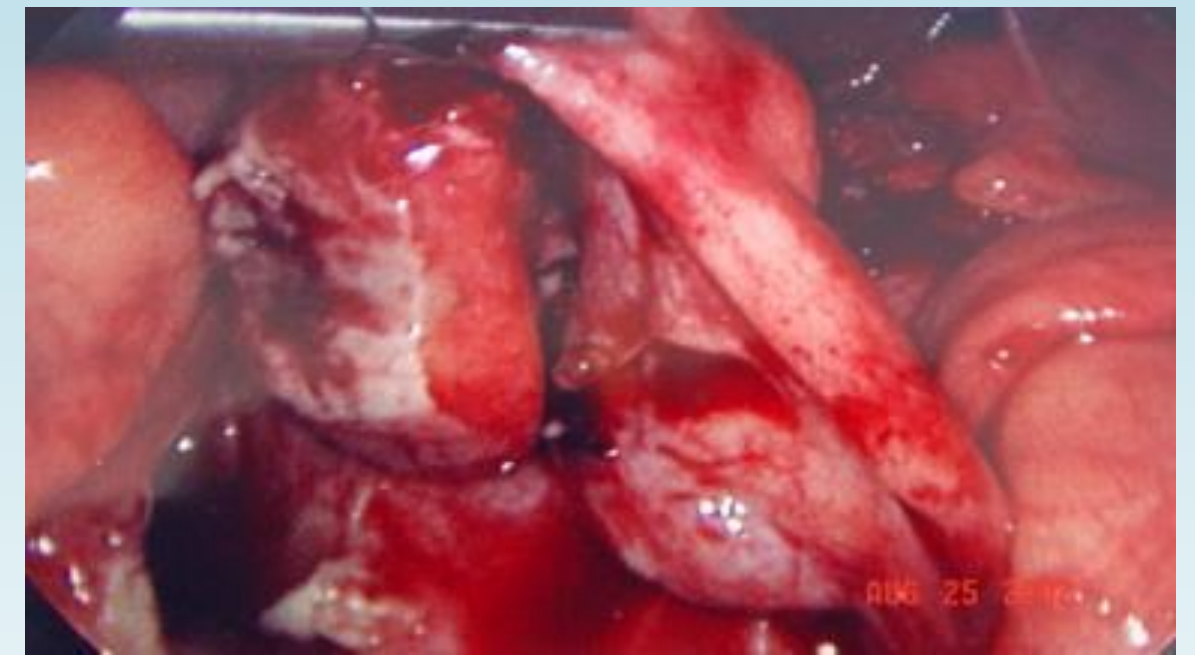
Simple



Gangrenous



Perforated



Simple

Definition ?
Treatment ?
Outcomes ?

Perforated

Gangrenous Appendicitis

Gangrenous appendicitis in children: a prospective evaluation of definition, bacteriology, histopathology, and outcomes[☆]

Sherif Emil, MD, CM,^{a,*} Fady Gaied, MD,^a Andrea Lo, MD,^a Jean-Martin Laberge, MD,^a Pramod Puligandla, MD,^a Kenneth Shaw, MD, CM,^a Robert Baird, MD, CM,^a Chantal Bernard, MD,^b Miriam Blumenkrantz, MD, CM,^b and Van-Hung Nguyen, MD^b

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ABSTRACT

Introduction: The definition and treatment of gangrenous appendicitis are not agreed upon. We performed a prospective study in children to evaluate an objective definition of gangrenous appendicitis, as well as associated bacteriology, histopathology, and outcomes. **Methods:** Five staff pediatric surgeons prospectively enrolled patients in the study at the time of appendectomy if the following five criteria were met: gray or black discoloration of the appendiceal wall; absence of fecalith outside the appendix; absence of visible hole in the appendix; absence of gross purulence or fibrinous exudate remote from the appendix; and absence of intraoperative appendiceal leak. Peritoneal fluid was cultured, and a standard histopathologic review was undertaken. Persistence of fever ($>37.5^{\circ}\text{C}$) and ileus was documented daily. Patients were continued postoperatively on ampicillin, gentamicin, and metronidazole until they tolerated diet, manifested a 24-h afebrile period, and had a normal leukocyte count. Hospital stay, readmissions, and infectious complications were recorded. The study took place over a 12-mo period.

Results: Thirty-eight patients were enrolled, representing 17% of all patients with appendicitis treated during the year. Average age was 10.8 ± 3.5 y. Peritoneal cultures were positive in 53% of cases. Gangrene was documented histologically in 61% of specimens. Hospital stay was 3.2 ± 1.1 d. There were no postoperative infectious complications or readmissions related to the disease. Neither culture results nor histologic gangrene had a statistically significant effect on hospital stay.

Conclusions: An objective definition of gangrenous appendicitis is reproducible and has good histopathologic association. Recovery from gangrenous appendicitis is not influenced by culture or pathology results, and postoperative complications are rare. Limiting postoperative antibiotics to 24 h in gangrenous appendicitis may significantly decrease the cost of treatment without increasing morbidity.

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Benefits of an abridged antibiotic protocol for treatment of gangrenous appendicitis[☆]



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ABSTRACT

Background: We previously reported a validated, objective definition of gangrenous, nonperforated appendicitis. In this study, we compared a cohort of children with gangrenous appendicitis treated with abridged antibiotics (AA) to another treated with prolonged antibiotics (PA).

Methods: In 2012, our service changed its standard of care for gangrenous appendicitis from PA to AA. In PA, patients received postoperative triple antibiotics until ileus resolved, they were afebrile ($<37.5^{\circ}\text{C}$) for 24 hours, and achieved a normal WBC count. In AA, patients received two doses of postoperative triple antibiotics. A PA cohort during a 12-month period (February 2010–January 2011) was compared to an AA cohort during another 12-month period (April 2012–March 2013).

Results: Twenty patients were treated with AA and 38 patients with PA. AA patients had a significantly shorter overall length of stay (2.1 ± 1.58 vs. 3.18 ± 1.09 days, $p = 0.003$), as well as a significantly shorter postoperative stay (1.85 ± 1.42 vs. 2.95 ± 1.14 days, $p = 0.002$). There were no differences between the AA and PA cohorts in wound infections (0%), intraabdominal infections (0%), or appendicitis-related readmissions (0%).

Conclusions: Abridged postoperative antibiotics for gangrenous appendicitis significantly shorten hospital stay without increasing complications.

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Practice Change

- Gangrenous appendicitis is not clinically relevant.
- Post operative antibiotics are not needed.
- Treat as simple appendicitis.
- Cost savings

Our Current Challenge

Perforated Appendicitis

- Perforated appendicitis occurs in ~ 30% of children presenting with acute appendicitis.
- Perforation significantly worsens appendicitis outcomes.
- The development of a postoperative abscess significantly worsens the outcomes of perforated appendicitis.

Perforated Appendicitis

Postoperative Abscess

- Postoperative abscess occurs in 3% – 30% of patients with perforated appendicitis.
- Postoperative abscess doubles the hospital duration and cost
- Significant variability in care.

Knowledge Gap

- Appendicitis is typically considered a *binary* disease in studies and databases reporting outcomes & complications.
- The disease has a clinical spectrum.
- No validated risk stratification systems for pediatric perforated appendicitis.

Study Objective

Prospective application of a risk-stratification system for perforated appendicitis that can predict outcomes and resource utilization.

Prospective evaluation of outcomes of further care standardization

Risk Stratification

- Prospective assessment of all children operated for perforated appendicitis
 - May 2015 – December 2016.
- Clinical pathway covering all points of care instituted
- Intra-operative risk-stratification system instituted

Grade of Perforation	Intra-operative Findings
I	Early or contained perforation
II	Contained abscess with no generalized peritonitis
III	Generalized peritonitis with no dominant abscess
IV	Generalized peritonitis with ≥ 1 dominant abscesses

Care Standardization

Operation

- Retrieve fecalith identified on pre-op imaging (may be within appendix)
- Remove any free fecalith intact
- Inspect omentum to confirm no contained fecalith or appendiceal portion
- Inspect all 4 quadrants and suction/irrigate purulence where needed
- Inspect subdiaphragmatic/perihepatic space and suction/irrigate purulence
- Retract rectosigmoid out of the pelvis and suction/irrigate cul de sac
- Run bowel and evacuate any interloop abscesses.
- Confirm removal of entire appendix.

Care Standardization

Post Operative Care

- Antibiotics
- TPN Indications
- PICC Indications
- Criteria for lab checks
- Criteria for imaging
- Criteria for abscess drainage
- Criteria for discharge
- Follow up protocol

Results

Primary Outcome

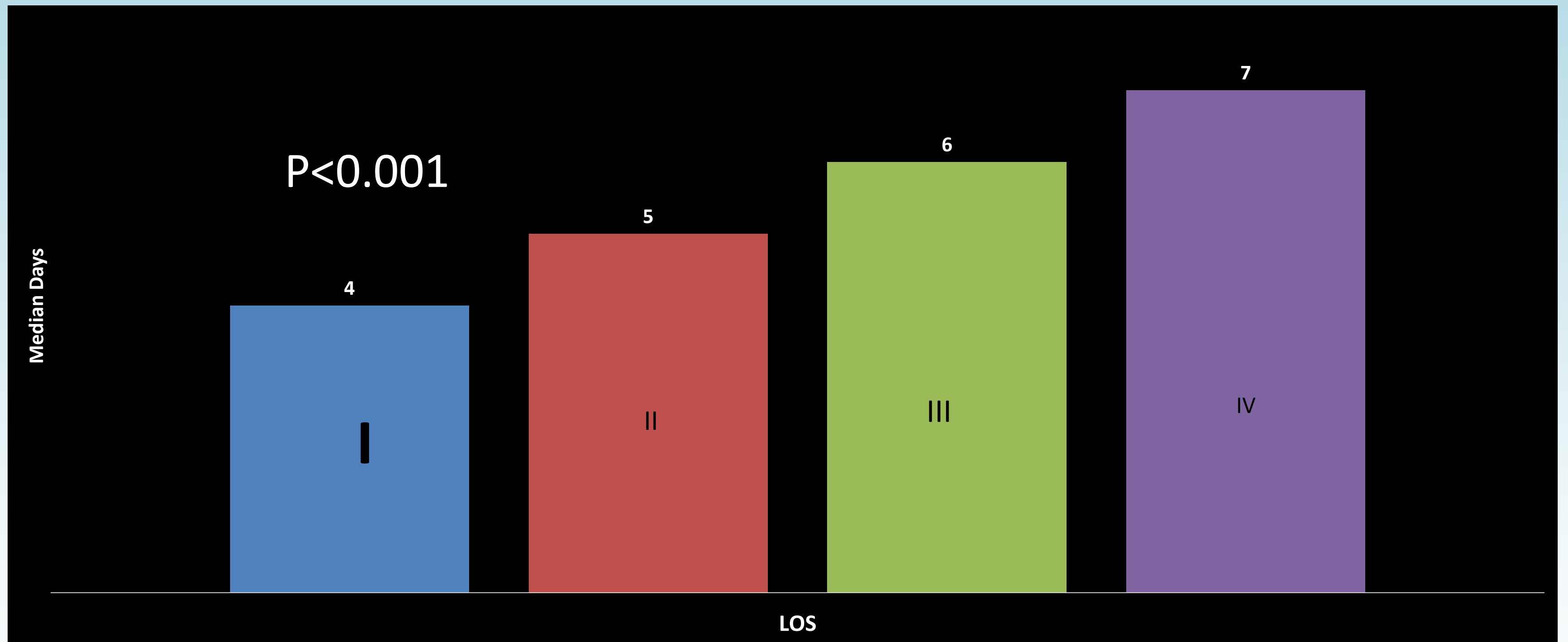
Post-Operative Abscess 12 (9.8%)

Grade I	0/25	(0%)
Grade II	1/46	(2%)
Grade III	0/13	(0%)
Grade IV	11/38	(29%)

$P < 0.001$

Results

Length of Hospital Stay



Results

Resource Utilization

	Gr I N=25	Gr II N=46	Gr III N=13	Gr IV N=38	P-Value
Median Post-Operative Antibiotics; (days)	3	4	5	6	< 0.001
Parenteral Nutrition; n (%)	2 (8)	7 (15)	6 (46)	18 (47)	< 0.001
PICC; n (%)	2 (8)	7 (15)	6 (46)	17 (45)	0.001
Median Narcotic Analgesia; (days)	3	3	4	4	0.050
Post-Operative Imaging; n (%)	5 (20)	4 (8.7)	3 (23)	17 (45)	0.001
Post-Operative Invasive procedures; n (%)	0 (0)	2 (4)	1 (8)	6 (16)	0.088

Conclusions

- Risk stratification scheme is a valid predictor of outcomes and resource utilization in children with perforated appendicitis.
 - without reliance on any clinical, physiological, or imaging factors.
- Potential applications:
 - Benchmarking.
 - Outcome comparison between protocols and surgical centers.
 - Accurate reflection of resource burden for care compensation.

Risk Stratification & Care Standardization

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Standardization of care for pediatric perforated appendicitis improves outcomes

Yasmine Yousef, Fouad Yousef, Michael Homsy, Trish Dinh, Kartikey Pandya, Hayden Stagg, Robert Baird, Jean-Martin Laberge, Dan Poenaru, Pramod Puligandla, Kenneth Shaw, Sherif Emil *

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Perforated appendicitis
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ABSTRACT

Background: The treatment of perforated appendicitis in children is characterized by significant variability in care, morbidity, resource utilization, and outcomes. We prospectively studied how minimization of care variability affects outcomes.

Methods: A clinical pathway for perforated appendicitis, in use for three decades, was further standardized in May 2015 by initiation of a disease severity classification, refinement of discharge criteria, standardization of the operation, and establishment of criteria for use of postoperative total parenteral nutrition, imaging, and invasive procedures. Prospective evaluation of all children treated for 20 months on the new fully standardized protocol was conducted and compared to a retrospective cohort treated over 58 months prior to standardization. Differences between outcomes before and after standardization were analyzed using regression analysis techniques to adjust for disease severity.

Results: Median follow-up time post discharge was 25 and 14 days in the post- and prestandardization groups, respectively. Standardization significantly reduced postoperative abscess (9.8% vs. 17.4%, $p = 0.001$) and hospital stay ($p = 0.002$). Standardization reduced the odds of developing a postoperative abscess by four fold.


Conclusion: Minimizing variability of care at all points in the treatment of perforated appendicitis significantly improves outcomes.

Type of study: Prospective Cohort Study.
Level of evidence: Level II.


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Risk stratification in pediatric perforated appendicitis: Prospective correlation with outcomes and resource utilization

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ARTICLE INFO

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ABSTRACT

Purpose: Despite a wide spectrum of severity, perforated appendicitis in children is typically considered a single entity in outcomes studies. We performed a prospective cohort study to define a risk stratification system that correlates with outcomes and resource utilization.

Methods: A prospective study was conducted of all children operated for perforated appendicitis between May 2015 and December 2016 at a tertiary free-standing university children's hospital. Surgical findings were classified into one of four grades of perforation: I. localized or contained perforation, II. Contained abscess with no generalized peritonitis, III. Generalized peritonitis with no dominant abscess, IV. Generalized peritonitis with one or more dominant abscesses. All patients were treated on a clinical pathway that involved all points of care from admission to final follow-up. Outcomes and resource utilization measures were analyzed using Fisher's exact test, Kruskal–Wallis test, One-way ANOVA, and logistic regression.

Results: During the study period, 122 patients completed treatment, and 100% had documented follow-up at a median of 25 days after operation. Grades of perforation were: I, 20.5%; II, 37.7%; III, 10.7%; IV, 31.1%. Postoperative abscesses occurred in 12 (9.8%) of patients, almost exclusively in Grade IV perforations. Hospital stay, duration of antibiotics, TPN utilization, and the incidence of postoperative imaging significantly increased with increasing grade of perforation.

Conclusion: Outcomes and resource utilization strongly correlate with increasing grade of perforated appendicitis. Postoperative abscesses, additional imaging, and additional invasive procedures occur disproportionately in patients who present with diffuse peritonitis and abscess formation. The current stratification allows risk-adjusted outcome reporting and appropriate assignment of resource burden.

Level of evidence: I (Prognosis Study).

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Pediatric Appendicitis

The PAGE Study



OPEN

SPECIAL ARTICLE

The Canadian Consortium for Research in Pediatric Surgery: Roadmap for Creation and Implementation of a National Subspecialty Research Consortium

Sherif Emil, MD, CM, FACS, FRCSC, Elena Guadagno, MLIS, Robert Baird, MD, CM, FACS, FRCSC, Pramod Puligandla, MD, FACS, FRCSC, Rodrigo Romao, MD, FRCSC, Lisa Van HouWelingen, MD, FRCSC, Natalie L Yanchar, MD, FRCSC, for the Canadian Consortium for Research in Pediatric Surgery (CanCORPS)

Clinical practice should be driven by high-quality research that produces evidence to inform best practices. Generation of such evidence is often challenging, particularly for smaller specialties, such as pediatric surgery, that treat many patients with rare diseases. Multi-institutional collaboration is seen as a major strategy to address these challenges. We have recently created the Canadian Consortium for Research in Pediatric Surgery, a national consortium that includes all major pediatric surgical services across Canada. The mission of the Consortium is to improve pediatric surgical care through high-quality collaborative research. In this article, we describe the rationale and methodology for creation of the Canadian Consortium for Research in Pediatric Surgery, demonstrate its achievements to date, and share a number of foundational concepts that are integral to its success. Our aim is to provide a model for creation of such consortia, ultimately leading to improvements in the quality of clinical research and patient care. (J Am Coll Surg 2022;235:952–961. © 2022 The Author(s). Published by Wolters Kluwer Health, Inc. on behalf of the American College of Surgeons. This is an open-access article distributed under the terms of the [Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 \[CCBY-NC-ND\]](#), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.)

Pediatric Appendicitis Grade Evaluation

The PAGE Study

Grade	Description
0	NORMAL APPENDIX. No signs of inflammation.
1	APPENDICITIS WITHOUT PERFORATION. No visible hole in the appendix. No free fecalith. No extravasation of appendiceal contents in vivo or ex vivo. Gangrenous appendix.
2	PERFORATION CONTAINED. Visible hole or free fecalith or extravasation of appendiceal contents in vivo or ex vivo. Pus and/or fibrinopurulent exudate limited to right lower quadrant and/or pelvis.
3	PERFORATION WITH ABSCESS. Discrete cavity containing pus <i>not</i> in free communication with the peritoneal cavity. No pus or fibrinopurulent exudate outside right lower quadrant and/or pelvis, or between bowel loops.
4	PERFORATION WITH GENERALIZED PERITONITIS. No discrete abscess. Pus and/or fibrinopurulent exudate extending outside the right lower quadrant and/or pelvis to involve at least one of the following: right upper quadrant, left upper quadrant, left lower quadrant, interloop spaces.
5	PERFORATION WITH ABSCESS & GENERALIZED PERITONITIS. Features of both Grades 3 & 4

Pediatric Appendicitis Grade Evaluation

The PAGE Study

OBJECTIVES

- **To establish the reliability and reproducibility of the Pediatric Appendicitis Grade.**
- **To validate the Pediatric Appendicitis Grade as a predictor of clinical, patient-reported, and healthcare resource utilization outcomes.**

The PAGE Study

- CAD\$ 1,615,000 budget
- Firsts
 - PAG
 - Risk Stratification
 - PROPS Evaluation
- International Study
 - 17 centers
 - Canada 12
 - USA 2
 - UK 1
 - Netherlands 1
 - Brazil 1

The Future

It's About The Patient!!

Open access

Protocol

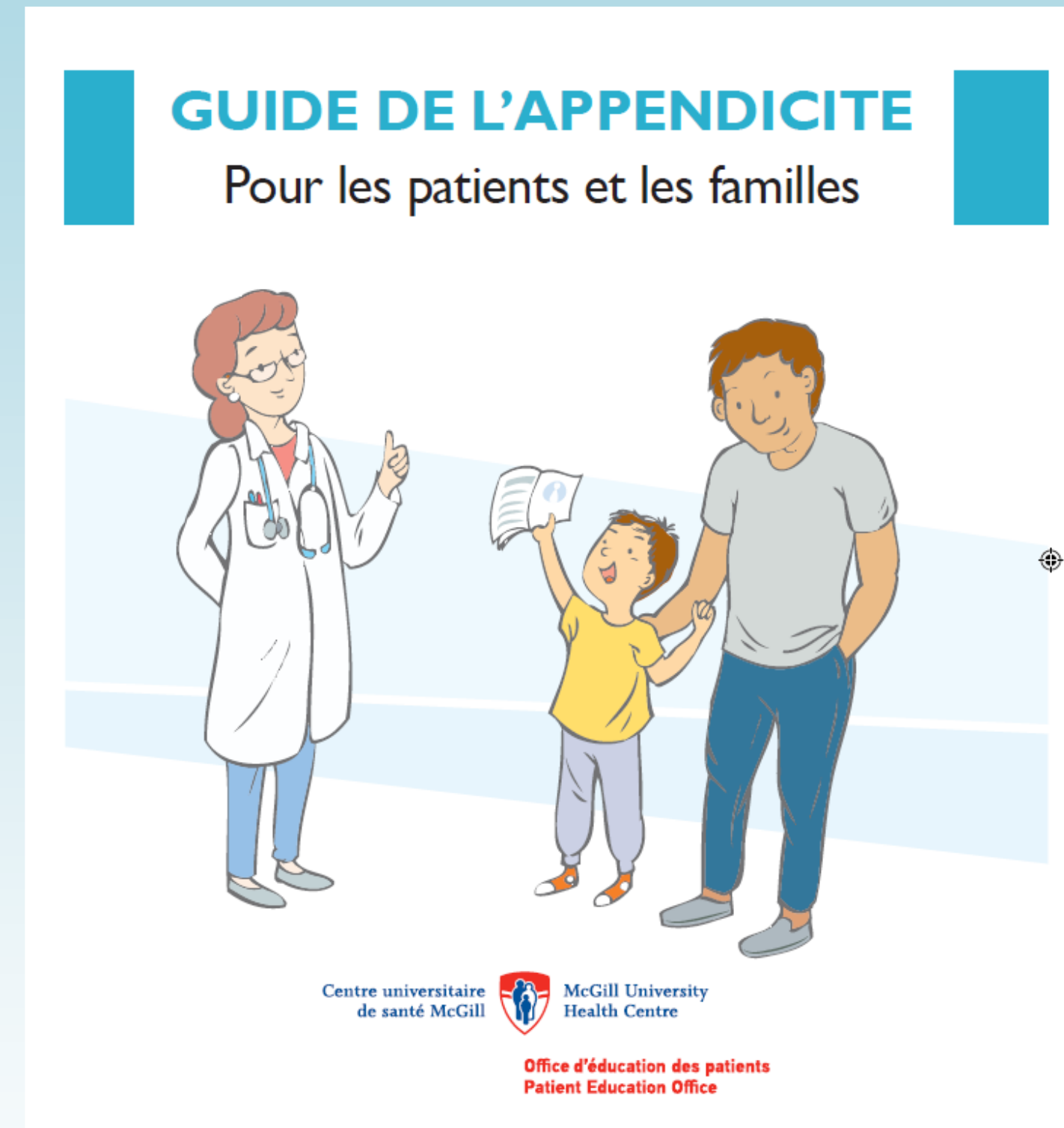
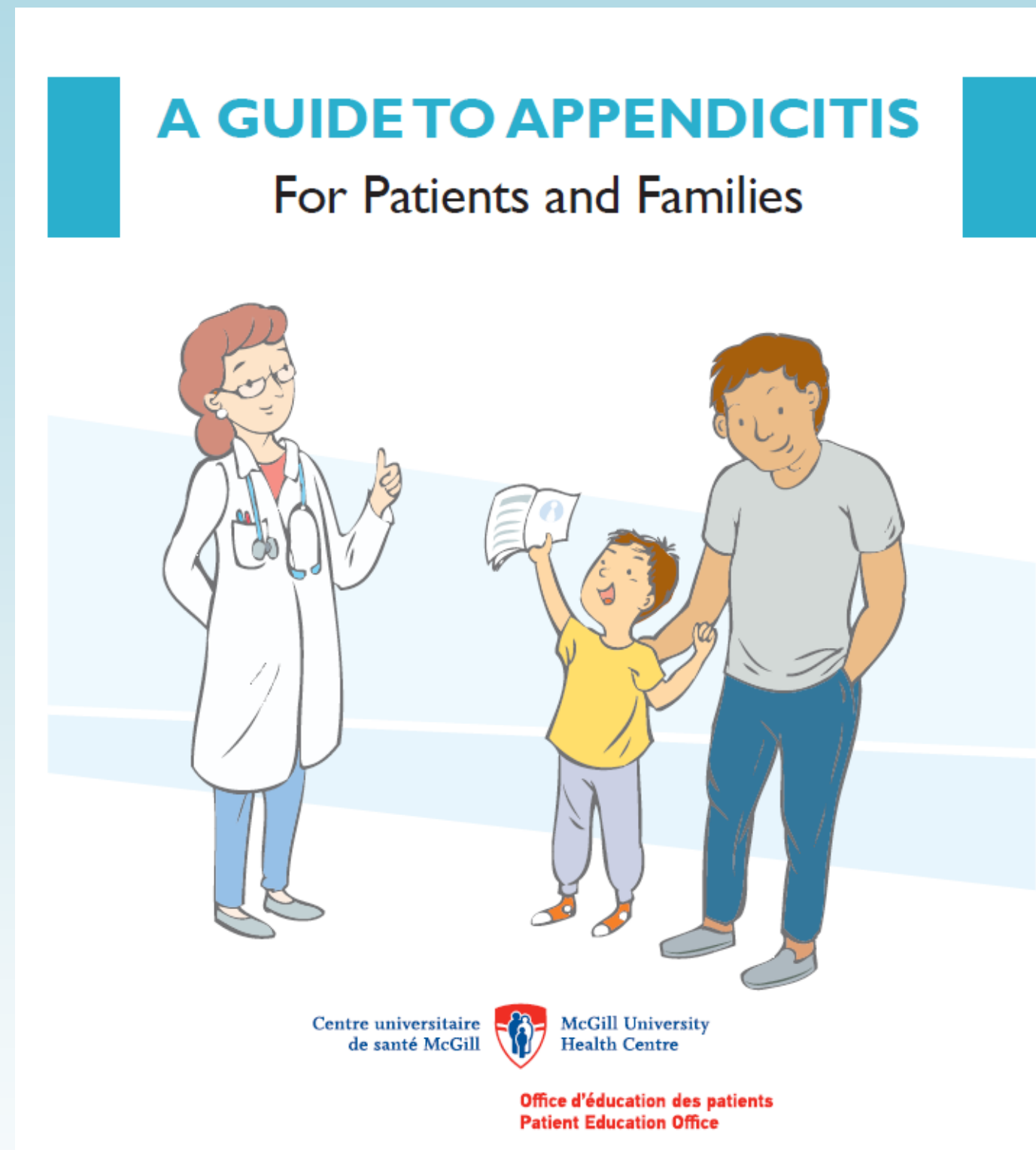
BMJ Open

Establishing a core outcome set for treatment of uncomplicated appendicitis in children: study protocol for an international Delphi survey

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The Future

Impact Of Education On The Family



https://muhcpatienteducation.ca/DATA/GUIDE/Appendicitis_Montreal-Children_English.pdf

https://educationdespatientscsm.ca/DATA/GUIDE/Appendicitis_Montreal-Childrens_French.pdf

Thank You! Merci!



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