DO WE NEED TO OPERATE EMERGENTLY FOR APPENDICITIS?
THE APPENDIX IS A LONG TRUE DIVERTICULUM

WHY WOULD YOU COME IN EMERGENTLY FOR APPENDECTOMY?
BECAUSE YOU ARE CONCERNED ABOUT PROGRESSION OF DISEASE TO PERFORATION?
WHAT IF WE DIDN’T OPERATE INITIALLY ON PATIENTS WITH NON-PERFORATED APPENDICITIS?
EARLY OPERATION VERSUS DELAYED OPERATION

- Retrospective comparison in adults between operation < 12 hrs or > 12 hours
  - 308 patients
  - No difference in OR time, complications, % with advanced appendicitis or length of stay

OPERATION AT PRESENTATION VERSUS THE FOLLOWING DAY

- Retrospective comparison in children between operation < 6 hrs or the following day
  - 126 patients (38 early vs 88 late)
  - No differences in operating time, perforation rate or complications
OPERATION AT PRESENTATION VERSUS THE FOLLOWING DAY

- Retrospective comparison in adults between operation < 10 hrs or the following day²
  - 81 patients
  - Mean time to OR was 3 vs 16 hrs
  - No difference in OR time, complications or length of stay

ANTIBIOTICS ONLY VS APPENDECTOMY FOR NON-PERFORATED APPENDICITIS

- Retrospective comparative study found no differences in complications between appendectomy or abx alone at presentation
  - 5% recurrence rate

ANTIBIOTICS ONLY FOR NON-PERFORATED APPENDICITIS

- 4 prospective trials have compared early appendectomy to antibiotics for the treatment of acute appendicitis.
- All 4 have concluded that acute appendicitis can be treated with antibiotics.
- Many methodology concerns
  - Mostly about the recurrence rate.
ANTIBIOTICS ONLY FOR NON-PERFORATED APPENDICITIS

- A prospective randomized trial between operation or antibiotics only for non-perforated appendicitis on CT\(^1\)
  - Non-operative arm received 2 days IV abx followed by PO abx to complete 10 day course
  - No interval appendectomy planned
  - Patients not improving in symptoms within 24 hours underwent appendectomy

Prospective Trial of Antibiotics for Acute Appendicitis

**Appendectomy**
- 119 patients
- 18% found to have complicated appendicitis
- 14% post-operative complication rate

**Antibiotics Only**
- 120 patients
- 88% improved with antibiotics
- 29% had recurrent symptoms at 1 year
- Overall 37% appendiceal rate at 1 yr
TREATMENT OF NON-PERFORATED APPENDICITIS

- Antibiotics constitutes initial management with an effect toward resolution.

- Currently, recurrence rate doesn’t justify avoiding appendectomy in children.

- Appendectomy can be performed at next available OR time.
PERFORATED APPENDICITIS

Many centers do not operate at presentation on patients suspected to have perforated appendicitis


Early Vs Interval Appendectomy For Children With Perforated Appendicitis


Interventions

- All patients
  - Intravenous Ceftazidime + Clindamycin q 8 hr
  - CVL at discretion of surgeon

- Early appendectomy
  - Within 24 hours of admission

- Interval appendectomy
  - Planned 6-8 weeks after initial discharge
  - Earlier appy done if considered in best interest of pt
# Adverse Events

<table>
<thead>
<tr>
<th>Event</th>
<th>Early (n = 63)</th>
<th>Interval (n = 67)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any adverse event - n (%)</td>
<td>18 (28.1 %)</td>
<td>35 (52.2 %)</td>
<td>.007</td>
</tr>
<tr>
<td>Intra abd abscess</td>
<td>12 (18.8 %)</td>
<td>25 (37.3 %)</td>
<td>.02</td>
</tr>
<tr>
<td>SBO</td>
<td>0</td>
<td>7 (10.4 %)</td>
<td>.01</td>
</tr>
<tr>
<td>Wound infection</td>
<td>6 (9.4 %)</td>
<td>6 (9.0 %)</td>
<td>NS</td>
</tr>
<tr>
<td>Re-admission</td>
<td>3 (4.7 %)</td>
<td>20 (29.9 %)</td>
<td>.0002</td>
</tr>
<tr>
<td>CVL related</td>
<td>1 (1.6 %)</td>
<td>4 (6.0 %)</td>
<td>NS</td>
</tr>
<tr>
<td>IR related</td>
<td>0</td>
<td>1 (1.5 %)</td>
<td>NS</td>
</tr>
<tr>
<td>Other</td>
<td>2 (3.1 %)</td>
<td>11 (16.4 %)</td>
<td>.02</td>
</tr>
</tbody>
</table>

Recurrent appendicitis in interval group: 6/67 (9 %)

Primary Outcome

- **Early**
  - Mean = 13.8
  - Median = 11
  - Range: 4 - 30

- **Interval**
  - Mean = 19.4
  - Median = 19*
  - Range: 7 - 45

*Wilcoxon rank sum, p= .0001

## Hospital Stay

<table>
<thead>
<tr>
<th></th>
<th>Early</th>
<th>Interval</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean LOS (days)</td>
<td>6.7 (2.6 – 23.9)</td>
<td>13.3 (3.3 – 40)</td>
<td>.006</td>
</tr>
</tbody>
</table>

“Failed” Interval Patients

- 23/67 (34.3%) of interval appendectomy patients had appendectomy earlier than planned

- Reasons for failure
  - Small bowel obstruction  n = 10 (43%)
  - Persistent symptoms  n = 6 (26%)
  - Recurrent appendicitis  n = 5 (22%)
  - Intra-abdominal abscess  n = 1
  - Parental demand  n = 1

Diagnostic Accuracy

- **Early Group**
  - 7 incorrect diagnoses
  - 89% accuracy rate

- **Interval Group**
  - 1 incorrect diagnosis discovered
  - Definitive signs of prior RA often difficult to document at interval appy

- **Actual diagnoses**
  - **Early**
    - Acute appy – 5
    - SB volvulus – 1
    - 1° peritonitis - 1
  - **Interval**
    - Ovarian tumor

How do you determine perforation without an operation?

- When patients do undergo an operation at presentation, there is no agreement from surgeons on what constitutes perforation.

- Patients treated with initial non-operative management do not undergo early operation to determine if perforation is actually present.

  - Determination of perforation is heavily dependent on CT.
At our institution we perform laparoscopic appendectomy at presentation on all patients with appendicitis who do not have a well-formed abscess

- Perforation declared according a strict intra-operative definition

Since 2005, we have employed the intraoperative definition for perforation as:

- Hole in the appendix
- Fecalith in the abdomen

Shown to delineate those at risk for post-operative abscess from those without (Journal of Pediatric Surgery 2008; 43: 2242-5)
<table>
<thead>
<tr>
<th></th>
<th>No Definition</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERFORATED</strong></td>
<td><strong>(n=131)</strong></td>
<td><strong>(n=161)</strong></td>
</tr>
<tr>
<td>Abscess Rate</td>
<td>14.0%</td>
<td>18%</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>9.4 +/- 4.2</td>
<td>7.4 +/- 8.8</td>
</tr>
<tr>
<td><strong>NON-PERFORATED</strong></td>
<td><strong>(n=292)</strong></td>
<td><strong>(n=388)</strong></td>
</tr>
<tr>
<td>Abscess Rate</td>
<td>1.7%</td>
<td>0.8%</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>1.9 +/- 1.3</td>
<td>1.5 +/- 1.5</td>
</tr>
</tbody>
</table>

Accuracy Of Computed Tomography In Predicting Appendiceal Perforation

Fraser JD, Aguayo P, Sharp SW, Snyder CL, Rivard DC, Cully BE, Sharp RJ, Ostlie DJ, St Peter SD.

CT for Perforation

- 200 patients with a pre-operative CT scan who underwent appendectomy
  - All patients treated since 2005 with the standard definition of perforation
  - 101 perforated appendicitis
  - 99 acute non-perforated appendicitis

- Each CT was evaluated by 8 physicians who were blinded to
  - Operative finding
  - Initial radiology interpretation
STUDY DESIGN

- Reviewers asked to decide between perforated or non-perforated appendicitis

- Reviewers included
  - 2 – Surgical Residents
    - Junior (PGY-3) and Senior (PGY-5)
  - 4 – Attending Pediatric Surgeons
    - 3, 6, 15, 30 years experience
  - 2 – Pediatric Interventional Radiologists
RESULTS

Accuracy of CT Interpretation

- 72% total correct
- 62% sensitivity
- 81% specificity
- 67% positive predictive value
- 77% negative predictive value
## RESULTS

### Accuracy of CT Interpretation

<table>
<thead>
<tr>
<th></th>
<th>Missed</th>
<th>Correct</th>
<th>% Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior Resident</td>
<td>59</td>
<td>141</td>
<td>71</td>
</tr>
<tr>
<td>Senior Resident</td>
<td>53</td>
<td>147</td>
<td>74</td>
</tr>
<tr>
<td>Surgery Attending 1</td>
<td>48</td>
<td>152</td>
<td>76</td>
</tr>
<tr>
<td>Surgery Attending 2</td>
<td>61</td>
<td>139</td>
<td>70</td>
</tr>
<tr>
<td>Surgery Attending 3</td>
<td>61</td>
<td>139</td>
<td>70</td>
</tr>
<tr>
<td>Surgery Attending 4</td>
<td>68</td>
<td>132</td>
<td>66</td>
</tr>
<tr>
<td>Radiology Attending 1</td>
<td>39</td>
<td>161</td>
<td>81</td>
</tr>
<tr>
<td>Radiology Attending 2</td>
<td>64</td>
<td>136</td>
<td>68</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>453</strong></td>
<td><strong>1147</strong></td>
<td><strong>72</strong></td>
</tr>
</tbody>
</table>
## RESULTS

### Accuracy of CT Interpretation

<table>
<thead>
<tr>
<th></th>
<th>Sens (%)</th>
<th>Spec (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior Resident</td>
<td>52</td>
<td>89</td>
<td>82</td>
<td>64</td>
</tr>
<tr>
<td>Senior Resident</td>
<td>66</td>
<td>83</td>
<td>83</td>
<td>66</td>
</tr>
<tr>
<td>Surgery Attending 1</td>
<td>75</td>
<td>77</td>
<td>77</td>
<td>75</td>
</tr>
<tr>
<td>Surgery Attending 2</td>
<td>63</td>
<td>76</td>
<td>73</td>
<td>67</td>
</tr>
<tr>
<td>Surgery Attending 3</td>
<td>64</td>
<td>75</td>
<td>72</td>
<td>67</td>
</tr>
<tr>
<td>Surgery Attending 4</td>
<td>53</td>
<td>62</td>
<td>72</td>
<td>79</td>
</tr>
<tr>
<td>Radiology Attending 1</td>
<td>78</td>
<td>83</td>
<td>83</td>
<td>79</td>
</tr>
<tr>
<td>Radiology Attending 2</td>
<td>45</td>
<td>88</td>
<td>79</td>
<td>61</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>62</strong></td>
<td><strong>81</strong></td>
<td><strong>67</strong></td>
<td><strong>77</strong></td>
</tr>
</tbody>
</table>
CONCLUSIONS

- CT scan does not perfectly predict perforation
  - When perforation is defined as hole in the appendix or fecalith in the abdomen
- Therefore, the triage of patient care based on a preoperative CT diagnosis of perforation may subject a portion of the population to an unnecessarily prolonged course of care
What if they have a big abscess?

Retrospective review of 52 patients presenting with perforated appendicitis and a well formed abscess

**Outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of CT scans</td>
<td>3.5 ± 2.0</td>
</tr>
<tr>
<td>Total hospital days</td>
<td>7.0 ± 3.9</td>
</tr>
<tr>
<td>Number of health care visits</td>
<td>7.6 ± 2.8</td>
</tr>
<tr>
<td>Recurrent abscess</td>
<td>17.3%</td>
</tr>
<tr>
<td>Repeat drainage</td>
<td>11.5%</td>
</tr>
<tr>
<td>Major drain complications</td>
<td>7.7%</td>
</tr>
<tr>
<td>Total charges</td>
<td>$40.4K ± 20.0K</td>
</tr>
</tbody>
</table>

CAN WE DO BETTER WITH AN INITIAL OPERATION?
Initial Laparoscopic Appendectomy Versus Initial Nonoperative Management And Interval Appendectomy For Perforated Appendicitis With Abscess: A Prospective, Randomized Trial

St Peter SD, Aguayo P, Fraser JD, Keckler SJ, Sharp SW, Leys CM, Murphy JP, Snyder CL, Sharp RJ, Andrews WS, Holcomb GW 3rd, Ostlie DJ.

Prospective Randomized Trial

Inclusion Criteria

- Patients under 18 years of age
- Perforated appendicitis with a well-defined abdominal or pelvic abscess on CT
  - Abscess identified by radiologist
  - Confirmed by staff surgeon

Exclusion Criteria

- Co-morbid condition that would limit their recovery beyond present condition
Methods

- Pilot Design
  - 20 patients in each group

- Individual unit randomization
  - Non-stratified sequence
  - Blocks of 4

- Statistical Evaluation
  - Continuous variables: 2-tailed Student’s t-test
  - Discrete variables: Chi Square with Yates correction
Protocol

Operation at Presentation (OP)

- All appendectomies initiated laparoscopically
- No nasogastric tubes left after the operation
- Once-a-day dosing of antibiotics for a minimum 5 days
  - Ceftriaxone (50mg/kg)
  - Metronidazole (30mg/kg)
- WBC drawn on POD 5
  - If normal, home with no antibiotics
  - If elevated, repeat on POD 7, if remains elevated, obtain CT
Protocol

Interval Appendectomy (IA)

- All patients were evaluated by an interventional radiologist for drainage and peripherally inserted central catheter placement
- Once-a-day dosing of antibiotics X 2 weeks
  - Ceftriaxone (50mg/kg)
  - Metronidazole (30mg/kg)
- Discharge criteria: Tolerating diet
- Drain removed when output minimal
- Follow-up by a single provider after completion of antibiotic course; scheduled for interval appendectomy at 10 weeks after initial presentation
Results

Operation at Presentation

- One conversion to open
  - Fragmented appendix and the appendiceal base could not be identified
  - Right lower quadrant incision
- One patient underwent laparoscopic-assisted ileocecectomy for a dense inflammatory mass around the cecum
- No major operative complications
Results

Interval Appendectomy

- 4 (20%) required early appendectomy
  - On day 2 for progressive peritonitis
  - On day 5 for unrelenting bowel obstruction
  - On day 21 for persistent fevers, pain and persistent abscess on imaging
  - On day 48 for persistent nausea and occasional emesis
- Mean time to operation in remaining patients = 69 +/- 8 days
- No major drain complications
<table>
<thead>
<tr>
<th>Outcome</th>
<th>OP</th>
<th>IA</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation Time (min)</td>
<td>62.1 ± 38.7</td>
<td>42.0 ± 45.5</td>
<td>0.06</td>
</tr>
<tr>
<td>Total Length of Stay (d)</td>
<td>6.5 ± 3.8</td>
<td>6.7 ± 6.6</td>
<td>0.92</td>
</tr>
<tr>
<td>Recurrent Abscess</td>
<td>20%</td>
<td>25%</td>
<td>0.98</td>
</tr>
<tr>
<td>Total Health Care Visits</td>
<td>2.8 ± 1.1</td>
<td>4.1 ± 1.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Number of CT scans</td>
<td>1.5 ± 0.7</td>
<td>2.1 ± 1.1</td>
<td>0.04</td>
</tr>
<tr>
<td>Total Hospital Charges</td>
<td>$44,195</td>
<td>$41,687</td>
<td>0.68</td>
</tr>
</tbody>
</table>
CONCLUSIONS

- There are no differences in total hospital days, total hospital charges or recurrent abscess rate when treating children presenting with an abdominal abscess with either laparoscopic appendectomy at presentation or initial non-operative management followed by interval appendectomy.

- There was a significant decrease in the number of CT scans between the two groups in the prospective trial as well as between the prospective trial and the retrospective study.

- A protocol should be used for interval appendectomy with set criteria for repeat imaging.
What about the stress on the family?
Quality Of Life Assessment Between Laparoscopic Appendectomy At Presentation And Interval Appendectomy For Perforated Appendicitis With Abscess: Analysis Of A Prospective Randomized Trial

Schurman JV, Cushing CC, Garey CL, Laituri CA, St Peter SD.

Measures

- Parent-Report
  - Child’s Quality of Life
  - Parenting Problems
    - Frequency
    - Difficulty
Parent-Reported Quality of Life

- Baseline
- 2 Week Post-Admission
- 12 Week Post-Admission

Clinical Significance

Initial operation
Initial nonoperative management
Frequency of Parenting Problems

- Initial operation total
- Initial nonoperative management total
Difficulty of Parenting Problems

Baseline 2 Week Post-Admission

120

110

100

90

80

70

60

50

40

30

20

Initial operation total

Initial nonoperative management total

Baseline 2 Week Post-Admission 12 Week Post-Admission
Conclusions

- Parenting and child stresses are extended to a greater degree with delayed appendectomy
- Treatments affect families differently
- Surgeons performing interval appendectomy may consider the family stress and social circumstance for coping
Summary

- Appendectomy is not an emergency operation.
- Interval appendectomy provides a simple subsequent operation.
- There is the possibility for mistriage if interval appendectomy is chosen without a well-defined abscess.
- Even in the face of an abscess, patients can be managed with primary laparoscopic appendectomy.
- Interval appendectomy prolongs care which some families may be ill equipped to handle.