Diagnostic Imaging Pathways - Paediatric, Abdominal Pain (Acute Non-Traumatic)

Population Covered By The Guidance

This pathway provides guidance on imaging a child with non-traumatic abdominal pain.

Date reviewed: July 2014

Date of next review: 2017/2018

Published: July 2014

Quick User Guide

Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points.
Clicking on the PINK text box will bring up the full text.
The relative radiation level of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

Pathway Diagram

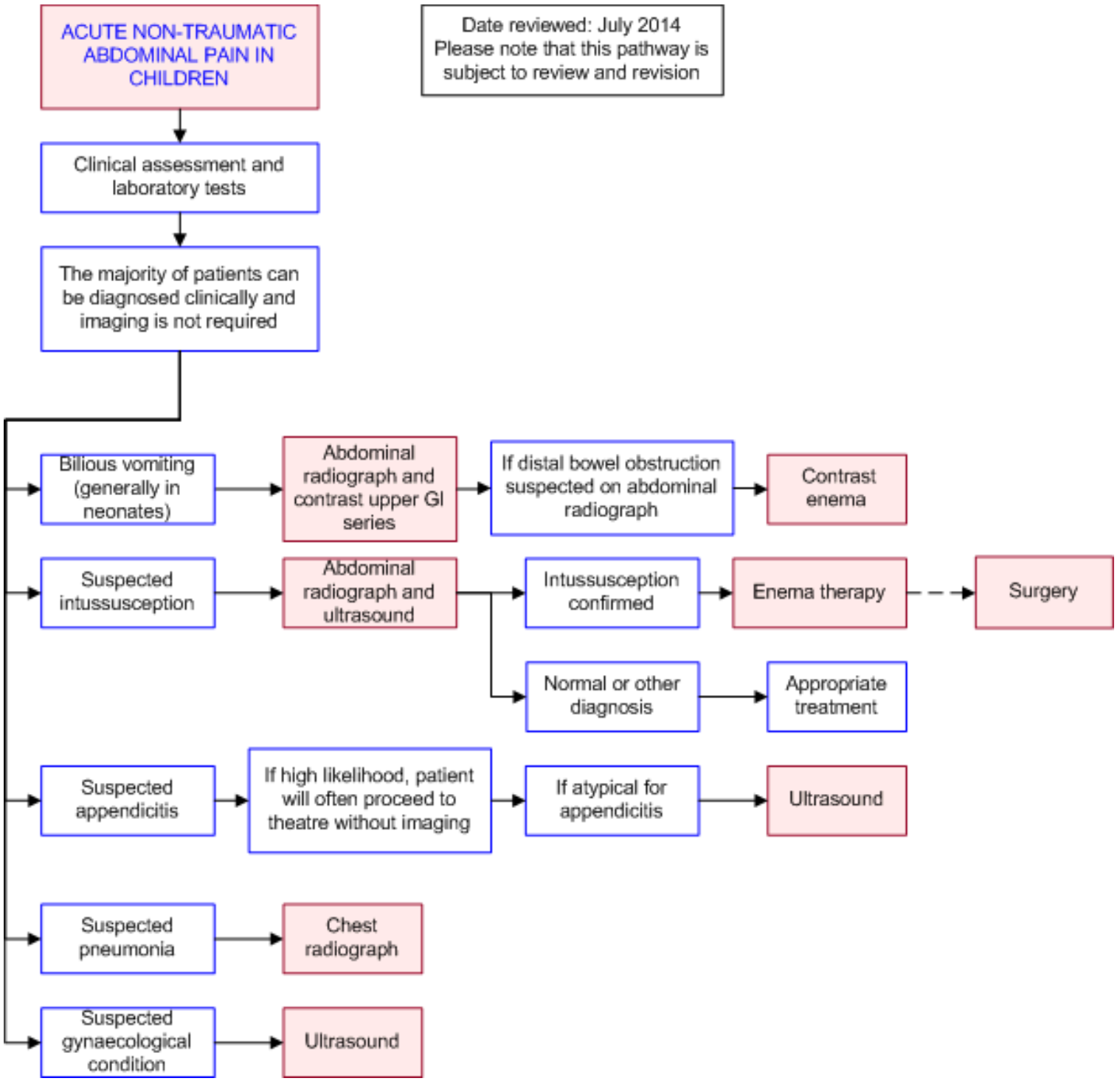

Image Gallery

Note: These images open in a new page

1a

Intussusception

Image 1a (longitudinal), 1b (transverse) and 1c (doppler) (Ultrasound): Intussusception with oedematous bowel walls.

1b

1c

2

Image 2: Resection of a caecal intussusception showing the relationship between the intussusceptum and intussuscipiens.

Teaching Points (Acute non-traumatic abdominal pain)

- The imaging modality of choice is dependant on the clinical history and examination, as well as the most likely differential diagnosis with the age of the child in mind
    - In infants with vomiting, consideration should be given to bowel obstruction or hypertrophic pyloric stenosis (HPS). In the first case plain radiography/contrast enhanced upper GI study is indicated. In HPS an ultrasound is recommended
    - In older infants, intussusception should be considered. Ultrasonography is the imaging modality of choice

Plain Radiography

Bilious Vomiting

- Plain films are appropriate in neonates or infants who present with bilious vomiting as it can help to differentiate proximal from distal bowel obstruction 1
- It may suggest the presence of volvulus-related ischaemia, or specific diagnoses such as volvulus or duodenal atresia 1,2

Intussusception

- Several radiographic signs suggestive for intussusception have been described 3,4,5
- If a normally located caecum containing gas or faeces is seen the diagnosis of intussusception is unlikely 6
- The accuracy of plain radiography for the diagnosis of intussusception has been shown to vary from 40-90%. Plain radiography is no substitute for ultrasonography for diagnosis but may demonstrate other causes of abdominal pain and may show evidence of intestinal perforation which is a contraindication to enema treatment 4,6,7,8
- If there is high clinical suspicion for intussusception, an imaging modality with high sensitivity such as ultrasound is necessary 3,7

Contrast Upper GI Series

- The imaging study of choice to evaluate bilious vomiting in neonates and infants. Exceptions include critically ill patients who require urgent surgical intervention and suspected complete duodenal obstruction 9,10
- Involves the use of a contrast agent to evaluate the stomach, duodenum and position of the duodeno-jejunal junction. Iodinated non-ionic contrast agents are used in acutely unwell patients and barium studies are reserved for non-acute situations where acute surgical intervention is unlikely. Contrast can be administered through a naso-gastric tube (preferred in acute) or orally
- Upper GI contrast studies are primarily used to diagnose malrotation/volvulus and detect other obstructive lesions of the upper GI tract 11
- With malrotation/volvulus, the ligament of Treitz (duodenojejunal junction) is typically located inferiorly and to the right of normal 2,9,10,11,12

Chest Radiography

- Chest radiography is commonly used for the investigation of paediatric pneumonia
- The diagnostic yield of chest radiography for detecting pneumonia is generally low; however chest radiography is warranted in patients with clear clinical manifestations of pneumonia (eg.cough, wheeze, high fever, decreased oxygen saturation, high respiratory rate). The greater number of clinical risk factors, the more likely the diagnosis of radiographic pneumonia 44-46

Contrast Enema

- Its primary use is for evaluation of distal obstruction (eg. atresia, meconium ileus). The location of the caecum and proximal colon can suggest malrotation but it is neither sensitive nor specific in this regard 13

Enema Therapy for Intussusception

- Treatment options for intussusception include enema therapy and surgery. Contrast enema therapy is the treatment of choice for reduction of intussusception 3
- The rationale for enema therapy is to exert pressure on the apex of the intussusceptum and in doing so push it back from the pathological to the normal position 3
- Contraindications for enema therapy include untreated shock, evidence of bowel perforation and/or peritonitis 3
- There are a number of agents used to perform enema therapy including air, barium, water-soluble contrast. There are few randomised control trials, one of which showed no significant difference. However the consensus among paediatric radiologists in Australia employing fluoroscopic guided reduction is the use of air enema if there is no clinical evidence of bowel perforation 22,38-41
- Compared to barium, there is a smaller risk of bowel perforation using air as the agent for enema therapy 41
- If required, fluid resuscitation should occur prior to enema therapy
- If the initial attempt is unsuccessful, the enema can be repeated 1-3 hours later
- The technique of ultrasound guided saline enemas has been shown to be an option that does not require exposure to radiation but is not widely used due to the lack of expertise and concern regarding its ability to detect the occurrence of perforation 3
- Rates of perforation when enema reduction is attempted are reported to be generally <1% and factors like free fluid in peritoneum, bowel wall necrosis, long duration of symptoms and younger

patients (<7 months) may be associated with increased risk of perforation 41
- Recurrence rates following enema reduction using either hydrostatic or pneumatic have been reported to be around 10% and most recurrences occur soon after the initial reduction 41,42,43
- Children with high recurrence rate, non-reduction of intussusception should be investigated for pathological lead points (e.g. Meckel's diverticulum, polyps, lymphomas) which may need surgical intervention

Surgery

- Surgery is indicated if enema therapy fails to reduce the intussusception or is contraindicated(uncorrected shock/perforation/established peritonitis)
- Surgery usually involves manual reduction of intussusception or segmental bowel resection with end-to-end anastamosis if manual reduction fails or if non-viable bowel loops are discovered after manual reduction
- Recurrence rate following manual reduction is 1 % and almost none following surgical resection 43

Ultrasound

Intussusception

- Has a sensitivity of 98-100% for the diagnosis of intussusception 14-17
- Axial and longitudinal images are used to try and identify the intussusception mass 3
- Various terms have been used to describe the characteristic appearance of the mass 17-21

Malrotation / Volvulus

- There are features on ultrasound that may suggest a diagnosis of malrotation/volvulus including inversion of the normal relationship between the superior mesenteric artery and vein; or the 'whirlpool' sign of a side-by-side arrangement of superior mesenteric vessels with opposite flow directions. However, these signs are neither sensitive nor specific and if there is clinical suspicion of malrotation/volvulus, an upper GI contrast study is indicated 23-27

Appendicitis

- Routine imaging is not required if a diagnosis can be established on history and physical examination 28
- The principal imaging technique for evaluating suspected appendicitis is graded-compression sonography. In children this has a sensitivity and specificity of between 78%-100%, and 88%-95% respectively. Sensitivity and specificity is higher for uncomplicated appendicitis compared to cases with appendiceal perforation 28,29,30
- Criteria for sonographic diagnosis is visualisation of an incompressible appendix that has a maximal cross-sectional diameter greater than 6mm, identification of an appendicolith, positive sonographic McBurney sign, demonstration of a complex mass, or focal fluid collection representing a peri-appendiceal abscess following perforation 28,29

Gynaecological Disorders

- Gynaecological disorders should be considered especially in adolescent girls. Disorders include Mittelschmerz syndrome, ovarian torsion, pelvic inflammatory disease, and ectopic pregnancy

References

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. Download the document

1. Strouse PJ. **Disorders of intestinal rotation and fixation ("malrotation").** Pediatr Radiol. 2004;34:837-51. (Review article)
2. McAlister WH, Kronemer KA. **Emergency Gastrointestinal Radiology of the Newborn.** Rad Clinic North Am. 1996;34:819-44. (Review article)
3. del-Pozo G, Albillos JC, Tejedor D, et al. **Intussusception in children: current concepts in diagnosis and enema reduction.** Radiographics. 1999;19:299-319. (Review article)
4. Strouse PJ. **Imaging and the child with abdominal pain.** Singapore Med J. 2003;44:312-22. (Review article)
5. Ratcliffe JF, Fong S, Cheong I, O'Connell P. **The plain abdominal film in intussusception: the accuracy and incidence of radiographic signs.** Pediatr Radiol. 1992;22:110-11. (Level III evidence)
6. Sargent MA, Babylon P, Alton DJ. **Plain abdominal radiography in suspected intussusception: a reassessment.** Pediatr Radiol. 1994;24:17-20. (Level III evidence)
7. Eklöf O, Hartelius H. **Reliability of the abdominal plain film diagnosis in pediatric patients with suspected intussusception.** Pediatr Radiol. 1980;9:199-206. (Level II evidence). View the reference
8. Meradji M, Hussain SM, Robben SGF, Hop WCJ. **Plain film diagnosis in intussusception.** Br J Radiol. 1994;67:147-9. (Level III evidence)
9. Strouse PJ. **Disorders of intestinal rotation and fixation ("malrotation").** Pediatr Radiol. 2004;34:837-51. (Review article)
10. Buonomo C. **Neonatal gastrointestinal emergencies.** Radiol Clin North Am. 1997;35:845-64. (Review article)
11. Jolley SG. **Gastroesophageal reflux disease as a cause for emesis in infants.** Semin Pediatr Surg. 2005;4:176-89. (Review article)
12. Alford BA, McIlhenny J. **The child with acute abdominal pain and vomiting.** Radiol Clin North Am. 1992;30:441-53. (Review article)
13. Torres AM, Ziegler MM. **Malrotation of the intestine.** World J Surg. 1993;17:326-31. (Level III evidence)
14. Wang GD, Liu SJ. **Enema reduction of intussusception by hydrostatic pressure under ultrasound guidance: a report of 377 cases.** J Pediatr Surg. 1988;23:814-8. (Level IV evidence)
15. Bhisitkul DM, Listernick R, Shkolnik A, et al. **Clinical application of ultrasonography in the diagnosis of intussusception.** J Pediatr. 1992;121:182-6. (Level II evidence). View the reference
16. Lim HK, Bae SH, Lee KH, Seo GS, Yoon GS. **Assessment of reducibility of ileocolic intussusception in children: usefulness of color Doppler sonography.** Radiology. 1994;191:781-5. (Level III evidence)
17. del-Pozo G, Albillos JC, Tejedor D. **Intussusception: US findings with pathologic correlation - the crescent-in-doughnut sign.** Radiology. 1996;201:379-86. (Level II evidence). View the reference
18. Verschelden P, Filiatrault D, Garel L, et al. **Intussusception in children: reliability of US in diagnosis - a prospective study.** Radiology. 1992;184:741-4. (Level III evidence)
19. Holt S, Samuel E. **Multiple concentric ring sign in the ultrasonographic diagnosis of intussusception.** Gastrointest Radiol. 1978;3:307-9. (Level IV evidence)
20. Montali G, Croce F, De Pra L, Solbiati L. **Intussusception of the bowel: a new sonographic pattern.** Br J Radiol. 1983;56:621-3. (Level IV evidence)
21. Alessi V, Salerno G. **The "hay-fork" sign in the ultrasonographic diagnosis of**

intussusception. Gastrointest Radiol. 1985;10:177-9. (Level IV evidence)
22. Meyer SE. **The current radiologic management of intussusception: a survey and review.** Pediatr Radiol. 1992;22:323-5. (Level IV evidence)
23. Zerin JM, DiPietro MA. **Superior mesenteric vascular anatomy at US in patients with surgically proved malrotation of the midgut.** Radiology. 1992;183:693-4. (Level III evidence)
24. Dufour D, Delaet MH, Dassonville M, Cadranel S, Perlmutter N. **Midgut malrotation, the reliability of sonographic diagnosis.** Pediatr Radiol. 1992;22:21-3. (Level III evidence)
25. Shimmanuki Y, Aihara T, Takano H, et al. **Clockwise whirlpool sign at color Doppler US: an objective and definite sign of midgut volvulus.** Radiology. 1996;199:261-4. (Level III evidence)
26. Hayden CK, Boulden TF, Swischuk LE, Lobe TE. **Sonographic demonstration of duodenal obstruction with midgut volvulus.** AJR Am J Roentgenol. 1984;143:9-10. (Level IV evidence)
27. Weinberger E, Winters WD, Liddell RM, Rosenbaum DM, Krauter D. **Sonographic diagnosis of intestinal malrotation in infants: importance of the relative positions of the superior mesenteric vein and artery.** AJR Am J Roentgenol. 1992;159:825-8. (Level III evidence)
28. Sivit CJ, Applegate KE, Stallion A, et al. **Imaging evaluation of suspected appendicitis in a pediatric population: effectiveness of sonography versus CT.** AJR Am J Roentgenol. 2000;175:977-80. (Level III evidence)
29. Kaiser S, Frenckner B, Jorulf HK. **Suspected appendicitis in children: US and CT - a prospective randomized study.** Radiology. 2002;223:633-8. (Level III evidence)
30. Lowe LH, Penney MW, Stein SM, et al. **Unenhanced limited CT of the abdomen in the diagnosis of appendicitis in children: comparison with sonography.** AJR Am J Roentgenol. 2001;176:31-5. (Level III evidence)
31. Franken EA Jr, Kao SC, Smith SC, Sato Y. **Imaging of the acute abdomen in infants and children.** AJR Am J Roentgenol. 1989;153:921-8. (Review article)
32. Braffman BH, Coleman BG, Ramchandani P, et al. **Emergency department screening for ectopic pregnancy: a prospective US study**. Radiology. 1994;190:797-802. (Level II evidence). View the reference
33. Barnhart K, Mennuti MT, Benjamin I, et al. **Prompt diagnosis of ectopic pregnancy in an emergency department setting.** Obstet Gynecol. 1994;84:1010-5. (Level II evidence)
34. Gracia CR, Barnhart KT. **Diagnosing ectopic pregnancy: decision analysis comparing six strategies.** Obstet Gynecol. 2001;97:464-70. (Level II evidence). View the reference
35. Wong TW, Lau CC, Yeung A, et al. **Efficacy of transabdominal ultrasound examination in the diagnosis of early pregnancy complications in an emergency department.** J Accid Emerg Med. 1998;15:155-8. (Level II evidence)
36. Sadek AL, Schiotz HA. **Transvaginal sonography in the management of ectopic pregnancy.** Acta Obstet Gynecol Scand. 1995;74:293-6. (Level II evidence)
37. Kaplan BC, Dart RG, Moskos M, et al. **Ectopic pregnancy: prospective study with improved diagnostic accuracy.** Ann Emerg Med. 1996;28:10-7. (Level II evidence)
38. Ginai AZ. **Experimentation evaluation of various available contrast agents for use in the gastrointestinal tract in case of suspected leakage: effects on peritoneum.** Br J Radiol. 1985;58:969-78. (Level III evidence)
39. Stein M, Alton DJ, Daneman A. **Pneumatic reduction of intussusception: 5-year experience.** Radiology. 1992;183:681-4. (Level IV evidence)
40. Meyer JS, Dangman BC, Buonomo C, Berlin J. **Air and liquid contrast agents in the management of intussusception: a controlled, randomised trial.** Radiology. 1993;188:507-11 (Level II/III evidence). View the reference
41. Daneman A, Navarro O. **Intussusception. Part 2: an update on the evolution of management.** Pediatr Radiol. 2004;34:97-108. (Review article). View the reference
42. Irish MS, Shellnut JK, Bovet PM, Grewal H. **Pediatric intussusception surgery.** Updated:April 14,2011. Accessed: March 06,2012. View the reference
43. Kitagawa S, Miqdady M. **Intussusception in children.** In: UpToDate, Basow, DS

(Ed),UpToDate,Waltham, MA, 2012.

44. Bramson RT, Meyer TL, Silbiger ML, Blickman JG, Halpern E. **The futility of the chest radiograph in the febrile infant without respiratory symptoms.** Pediatrics. 1993; 92(4):524-6. (Level III evidence)
45. Patterson RJ, Bisset GS 3rd, Kirks DR, Vanness A. **Chest radiographs in the evaluation of the febrile infant.** AJR Am J Roentgenol. 1990;155(4):833-5. (Level III evidence)
46. Neuman MI, Monuteaux MC, Scully KJ, Bachur RG. **Prediction of pneumonia in a pediatric emergency department.** Pediatrics. 2011;128(2):246-53. (Level III evidence) .

Information for Consumers

Information from this website	Information from the Royal Australian and New Zealand College of Radiologists' website
Consent to Procedure or Treatment Radiation Risks of X-rays and Scans Ultrasound Chest Radiograph (X-ray) Plain Radiography (X-ray)	Plain Radiography/X-rays Radiation Risk of Medical Imaging for Adults and Children Ultrasound Paediatric Abdominal Ultrasound Children's (Paediatric) X-ray Examination Making Your Child's Test or Procedure Less Stressful

.

File Formats

Some documents for download on this website are in a Portable Document Format (PDF). To read these files you might need to download Adobe Acrobat Reader.

Legal Matters