GETTING IT RIGHT FIRST TIME

Acute abdominal pain pathway

Interim report of consensus process and consensus recommendations

February, 2022

NHS

GETTING IT RIGHT FIRST TIME

Contents

Background

The Getting it Right First Time (GIRFT) report into Paediatric Surgery highlighted the importance of developing a national pathway for children with abdominal pain, particularly appendicitis. The GIRFT process identified significant variability in the care of children with appendicitis leading to variable rates of repeated presentations before diagnosis, negative appendicectomies, complex appendicitis, length of stay and readmission rates. The formulation of an abdominal pain pathway is intended to provide a consensus best practice clinical and systems guideline on the assessment and management of children with abdominal pain with a particular focus on appendicitis. It is also intended to provide guidance around the delivery of care for children with abdominal pain, commenting on 'process' indicators of good practice as well as clinical outcomes.

The ongoing development of this pathway is being guided by a multi-disciplinary team with national experts identified by NHS England and Improvement, Operational Delivery Networks (ODNs), Royal Colleges and National Associations. These experts are working collaboratively to develop these guidelines. The NHS 111 pathways team have also been involved in the delivery of this work to ensure that parity exists between co-existing NHS systems.

Methods

Identification of contributing MDT experts: Medical and nursing participants in the development of the pathway were identified through ODNs, Royal Colleges of Surgery, Paediatrics, Radiology and Emergency Medicine and relevant associations including the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI) and British Association of Paediatric Surgeons (BAPS). Interested parties were invited to an open meeting in October 2021 to discuss the overall aims of the project and the planned method of devising a consensus guideline.

Methodology of guidance development: Following the initial meeting, participants were invited to join groups considering the following areas of the patient journey:

(1) Assessment of children with abdominal pain and diagnosis of appendicitis
(2) Pre- and peri-operative care of children with abdominal pathology requiring emergency surgery with specific guidance on appendicitis

(3) Post-operative care of children following emergency abdominal surgery with specific guidance on appendicitis

Participants were permitted to join one, two or three groups depending on their expertise. Each group participated in two 2-hour long virtual meetings where clinical guidance were developed and process mapping and process delivery strategies were discussed. In-between the first and second meeting a document was developed and circulated to each group for comments and amendments in the second meeting.

A final consensus meeting was undertaken in December 2021, in which all participants were invited to attend. The written recommendations were circulated prior to the meeting. The key points of the recommendations were summarised as statements and meeting attendees were asked to vote on how strongly or otherwise they agreed with the statements. The voting was performed anonymously using electronic polling software (Mentimeter, www.mentimeter.com, Stockholm, Sweden). Participants were advised that a vote of 1-3 indicated that they disagreed with the statement, a vote of 4-6 indicated that they agreed with the statement and a vote of 7-9 indicated that they strongly agreed with the statement. In-line with Delphi consensus methodology, if >70% of voters scored a statement 7-9 and <15% of voters scored a statement 1-3 then that statement was deemed as gaining consensus. If these criteria were not met then consensus had not been gained. Attendees were advised that they were voting on the broad recommendation and that there continues to be scope for wording changes on further review of the guidance if these do not change the overall message of the recommendation.

Following the consensus meeting, NHS 111 were consulted on their pathways surrounding abdominal pain in children and the indications for referral to the emergency department and primary care after remote review were tweaked to ensure that children would be seen equally quickly through whichever system they make contact with health services.

Consensus Statements

One-hundred and five statements were asked of the group. 20-35 specialists responded to the statements depending on their areas of expertise. The specialists included respondents from both specialist and non-specialist centres, nurses with special interests in pain, surgery,

community care and discharge planning and medics from the specialities of emergency medicine, radiology, infectious diseases, anaesthetics, general surgery and paediatric surgery. All statements, the distribution of responses and the number of respondents to each statement are presented in Appendix 1. Ninety-four out of one-hundred and five (90%) of statements reached consensus from the group.

The statements listed below did not meet the criteria for consensus. Each statement is discussed and the relevant changes to the guidance or the further work required is described below.

- Initial investigations for a child without a specific diagnosis after history and examination to be performed in primary care or the emergency department includes a blood glucose level

A discussion at the time of the consensus meeting highlighted that a child in diabetic keto-acidosis (DKA) would be expected to have ketones and glycosuria. There was agreement that every child should have a urine sample checked and that this should be used to screen for the presence of DKA.

- If there are <2 indicators of severe disease and no risk factors for severe disease it is appropriate to follow the 'non-sick child' pathway

The indications for the 'sick child' pathway were supported. The lack of consensus around this statement may indicate that rather than having two distinct pathways for well and unwell children, that the guidance should demonstrate the common assessment, diagnostic and management points for all children and provide guidance on the additional requirements of an unwell child. This may avoid a child being pigeon-holed into one pathway and potentially reduces the time to recognise a deteriorating child.

- The Children's Appendicitis Score should be the recommended score within the guidance

Support for the Children's Appendicitis Score did not reach consensus. This may be due to the relative novelty of the score and therefore few publications on its reproducibility compared to other scores such as the Shera score. Feedback from the group is requested to understand whether there are particular alternative scores that they feel should be recommended and this may be an area for a further consensus scoring exercise. The group are likely to recommend this as an area for further research, building on the work already undertaken by the RIFT study collaborative.

- If diagnostic uncertainty exists in a non-specialist hospital, discussion with a specialist centre is recommended before undertaking cross-sectional imaging

The consensus meeting and feedback from specialists has highlighted the need for support, mentoring and training of radiologists and sonographers in non-specialist centres by specialist paediatric radiologists and ultrasonographers. Creating a structure for this within ODNs is anticipated to develop the experience and expertise of those in non-specialist centres further and will mean that appropriate decision making is supported locally without always needing to refer to a specialist centre for advice.

- Non-operative management may be routinely offered for all children aged 5 years and over with suspected simple appendicitis
- Non-operative management may be considered in children aged 5 years and over with suspected uncomplicated appendicitis in exceptional circumstances
- Presence of a faecolith is a contraindication to non-operative management
- The Montgomery principle of discussing treatment options including non-operative management for suspected appendicitis is recommended

There was a strong message that the use of non-operative management (NOM) of simple appendicitis did not meet the consensus for recommendation for routine practice within this guidance and the recommendations have been updated to reflect this. It is recognised that some practitioners will use non-operative management in some situations and that almost 80% of respondents said that they agree or strongly agree that it should be given as a

treatment option within the consent process (although consensus was not met that it should always be given). These findings are likely to reflect that there are few published data on NOM of simple appendicitis in children, particularly in healthcare systems such as the national health service. The consensus support for recruitment of children to a clinical trial of NOM of appendicitis highlights the need for further research on this subject.

- Operative management of appendicitis: the principles of operative management are appropriate

This was a broad statement covering a range of recommendations. The surgeons within the group will be approached for further feedback on this and then a specific further consensus process may be undertaken to break down the broad statement into more specific statements on the operative management.

- Specific antibiotic recommendations should be made (i.e. IV cefuroxime and metronidazole / Ciprofloxacin and metronidazole and oral step-down)

The recommendations have been amended to say "Local guidance of appropriate broad spectrum antibiotics which take into account local resistance patterns should be available for intravenous and step-down oral anti-microbial agents."

- The section on post-operative ileus is appropriate

This was a broad statement covering a range of recommendations. The surgeons and nursing staff within the group will be approached for further input to this section and then a specific further consensus process may be undertaken to break down the broad statement into more specific statements on post-operative ileus.

Future work

As described above, further input is required from specialist groups on shaping and honing the recommendations.

- Recommendations:
    - Feedback on clinical risk scores for appendicitis
    - Feedback on the recommendations for operative management
    - Feedback on the management of post-operative ileus

- Engagement with specialist groups
    - Feedback from Primary Care: We have been in touch with some GPs but further engagement particularly when resources have been developed is essential
    - Further input from Paediatrics and from Paediatric Dieticians and Physiotherapists
    - Patient and parent feedback

- Development of resources
    - For patients and parents:
        - Information detailing pre-operative care including investigations, post-operative care and returning to normal life - written and video resources for adults and children
        - Supporting information for schools about return to activity.
    - For all areas of hospital care
        - Pain assessment tool and pain management tool including management of nausea and vomiting
    - For primary care and remote review
        - Indicators of significant disease - history and examination - with recommended review in hospital
        - Indicators of disease requiring face-to-face review
        - Pre-hospital care guidance
    - For ED
        - BRIEF - assessment, diagnosis, management tool including risk factors and indicators of severe disease
    - Transfer decision-making tool/documentation tool

- For Surgical team
  - Appendicitis pathway - Antimicrobial guidance
  - Post-operative care
  - Assessment and management of intra-abdominal collections

Draft Recommendations

Definitions:
Normal appendix: No macroscopic evidence of inflammation
Simple appendicitis: Inflamed appendix
Complex appendicitis: Gangrenous appendix, perforated appendix +/- visible faecolith

1) Analgesia[£]
   a) At the time of making a primary care appointment, attending an urgent care centre, being triaged in A&E or receiving advice from NHS 111, the importance of using simple oral analgesia should be highlighted.
   b) Parents and carers should be reassured that analgesia will not mask serious disease but enables a child to be more comfortable and allows for a more accurate assessment.
   c) Pain should be scored using locally accepted and ratified "age appropriate" scoring tools. Some examples will be VAS for young people and Wong- Baker FACES and FLACC tools, for younger children, in combination with behaviour and physiological parameters. Staff should be aware that adapted scales for neurologically impaired children exist and are recommended.
   d) Pain control
      i) The WHO analgesic ladder is recommended.
      ii) Regular pain assessment should be performed and recorded, including after every intervention is recommended. Local pathways for pain management should be developed if not already in place.
      iii) The enteral route is preferable for the delivery of regular simple analgesics and rescue oral opiates where required.
      iv) Non-steroidal anti-inflammatories (NSAIDs) should be avoided in children who have an increased risk of acute kidney injury or chronic kidney disease or who have a contra-indication (such as asthma or peptic ulcer disease). Short-term use in children who are not eating or drinking is acceptable. Co-prescription of a proton pump inhibitor should be considered for these patients.
      v) Rectally delivered analgesia is a good alternative for children who are vomiting and do not have intravenous access.
      vi) A severe pain (score >= 6) often requires the addition of parenteral opiates to supplement simple analgesics as per WHO Analgesic Ladder. Assessment using the age appropriate pain score, behaviour and physiological parameters should be used to ensure that opiates are administered appropriately.
      vii) Intra-nasal diamorphine, fentanyl or ketamine can be used for children with severe abdominal pain without intravenous access and for whom enteral analgesia is contraindicated in the Emergency Department under local departmental guidance.
      viii) If the pain is moderate to severe then consideration should be given to the use of intravenous opioids initially as bolus doses and then consideration of continuous or PCA's including in the pre-operative period.
      ix) Naloxone should be prescribed PRN for all patients who are prescribed morphine in case of respiratory compromise
      x) Intravenous ondansetron (or dexamethasone in post-operative patients) should be prescribed as an antiemetic if there are no contra-indications in children receiving opioid analgesia and all children undergoing an abdominal surgical

procedure. Droperidol is recommended as a second line treatment for post-operative nausea and vomiting, particularly when dexamethasone is contra-indicated. The use of droperidol is contraindicated in patients with long QT syndrome.(1)

xi) Intra-operative analgesia: Multimodal analgesia along with consideration of regional techniques if no contraindications (e.g. TAP Blocks, wound infusion catheters) depending on the type of surgery performed. Local protocols should exist for the post-operative management of wound catheters if they are used.

xii) Step-down of analgesia after an operation should be undertaken by the clinical team, in conjunction with the nursing staff and the pain / anaesthetic team

e) At discharge

i) Families should receive advice about the use of regular oral analgesia including paracetamol and ibuprofen.

ii) A short course of Oramorph (maximum 24 hours) can be considered for children being discharged with ongoing pain but otherwise clinically ready for discharge.

iii) Local recommendations should be developed to support families in monitoring pain and administering analgesia at home

Justification for recommendations:

It is well recognised that children with abdominal pain often receive sub-optimal analgesia(2, 3) and analgesia does not mask significant pathology. (2) Inadequate analgesia in children has been shown to be associated with future hyperaesthesia and intolerance of painful procedures. (4) CKS guidance offers advice for primary care practitioners on the use of simple analgesics and these guidelines are recommended. (5)

The WHO analgesic ladder(6) is a well-established method of progressing analgesia according to the requirements of the patient, with a focus on providing enteral analgesia when possible. Early administration improves the patient experience and allows for accurate assessment earlier in the patient journey. Intranasal administration of opioids in the pre-operative period are recommended for treatment of severe pain when the intravenous route is not available. Rectal administration can be a useful method of delivering analgesia in children who do not have intravenous access and for delivery of NSAIDs in both the pre- and post-operative period.

It is important to ensure that children receive adequate analgesia, which for some children will include the use of parenteral opioid analgesia. This can include the use of nurse-controlled analgesia (NCA), particularly for young children and older children with learning difficulties or developmental delay. They will therefore be primarily confined to use in specialist centres. Patient-controlled analgesia (PCA) is a good option for children with moderate to severe ongoing pain, both pre- and post-operatively who can understand how to use a PCA. The co-prescription of naloxone and anti-emetics with opioid analgesics is recommended.

Intra-operative local anaesthetic wound infiltration may improve early pain after appendicectomy and rectus sheath blocks have been shown to reduce post-operative morphine requirements.(7-9)

Knowledge gaps:

- The impact of the method of local anaesthetic delivery during a surgical procedure on the post-operative morphine requirements

Audit:

- Children attending an urgent care centre or emergency department should receive analgesia within 20 minutes of attendance (unless given before presentation).
- A pathway for the assessment and management of pain, appropriate for children's age and development should be used in all children receiving analgesia for abdominal pain.
- A pathway for the management of nausea and vomiting in the pre-and post-operative child should be used in all children with abdominal pain.
- Local anaesthetic should be administered intra-operatively to all children undergoing an abdominal surgical procedure (local infiltration, block, wound catheter etc), unless there is a specific contra-indication.

2) Assessment

a) At risk groups
   i) The following groups of children pose difficulty around the differentiation of causes of abdominal pain
      (1) <5 years of age
      (2) Post-pubertal females
      (3) Children with obesity
      (4) Neurodiverse children (e.g. children with learning difficulties, autism spectrum disorder, neurodisability)
      (5) Children or families with difficulty communicating (language barrier, learning difficulties)
   ii) The following groups of children are considered to have risk factors for **severe disease**
      (1) < 5 years of age
      (2) Severe co-morbidity including inflammatory bowel disease or > 2 system co-morbidity
      (3) Immunosuppression
      (4) Recent abdominal surgery

b) Assessment of a child presenting with abdominal pain may include asking about:
   i) Nature of the pain - site, radiation, onset, severity, exacerbating and relieving factors, duration, response to analgesia. Associated abdominal masses, new 'lumps' or swellings.
   ii) Urinary symptoms - dysuria, frequency, haematuria, polydipsia, polyuria
   iii) Bowel symptoms - diarrhoea, constipation, blood, mucous, change in bowel habit
   iv) Nausea and vomiting - presence of bile (green colour), change in appetite
   v) Males - testicular pain, groin swelling
   vi) Females - vaginal bleeding, groin swelling and (over the age of 11 years) menstrual cycle, sexual history and possibility of pregnancy
   vii) Respiratory tract symptoms - cough, coryza, shortness of breath, sore ears, sore throat
   viii) Fever (>38^{0}C)

ix) Others: Rash - particularly lower legs, swelling, trauma (including possibility of NAI), foreign bodies ingested (e.g. neodymium magnets, button batteries) or inserted into the rectum, joint pain, change of gait
x) Systemic features of illness: change in responsiveness
xi) Psychological factors which may be related to pain. The HEADSS assessment is a useful prompt for this.(10)
xii) Past medical history including previous abdominal surgery
xiii) Allergies and drug history
xiv) Social History - including contact with social services, travel history and dietary history

c) History indicators of *significant* disease include:
i) Altered conscious level
ii) Bilious vomiting
iii) Vomiting a large amount of blood
iv) Testicular pain
v) Severe or persistent abdominal pain or pain associated with drawing up legs which does not settle with analgesia
vi) Constant migratory abdominal pain from peri-umbilical to right iliac fossa
vii) Passing melaena, a large amount of blood or redcurrant stools rectally
viii) Inappropriate or inconsistent history with safeguarding concern
ix) Recent previous surgery
x) Recent significant abdominal trauma
xi) Ingested button battery or magnets
xii) No urine output for 24 hours
xiii) Polyuria or polydipsia
xiv) Significant nursing, medical or parental concern

d) Examination of a child presenting with abdominal pain should include the following

i) Measurement of their temperature, capillary refill time, heart rate, respiratory rate and blood pressure (with a size-appropriate cuff)
ii) Inspection for signs of general well-being: level of consciousness, hydration status, anaemia, how consolable they are; cardio-respiratory disease: increased work of breathing, cyanosis; intra-abdominal disease: generalised oedema, jaundice, scars from previous operations, abdominal distension. Assessment of how easily a child can move around the bed or jump if they are developmentally able to.
iii) Upper respiratory tract examination: attempted visualisation of tympanic membranes, tonsils and posterior pharynx
iv) Lower respiratory tract and cardiac examination: Auscultation of the lungs and heart sounds
v) Abdominal examination: Inspect for bruising and consider non-accidental injury, abdominal distension, abdominal or groin masses or hernias. Ask the child to blow-out and suck in their tummy (if able to follow instruction). Gentle palpation of the abdomen and renal angles to assess for tenderness, localised guarding, hepato-splenomegaly and abdominal masses. Percussion to assess for localised

tenderness (starting away from the site of pain). Auscultation is not always useful in children but could be used to assess for bowel sounds and bruits. Examination of the hernial orifices. Rectal examination is not routinely indicated but external inspection of the anus with chaperone presence is appropriate when there is a history of constipation, rectal bleeding, trauma or anal pain.

vi) Genital examination (with chaperone presence): Males: testicular examination +/- transillumination if testicular swelling. Females: Not necessary in all, consider if history in-keeping with foreign body retention, haematocolpos or trauma.

vii) Hip examination: Examination of gait, range of movement of hip joints

viii) Awareness of inconsistency between history and examination findings which may indicate non-accidental injury

e) Examination indicators of *significant* disease include*

i) Airway compromise

ii) Tachycardia after appropriate analgesia or heart rate under 60 bpm +/- prolonged capillary refill time

iii) SaO_2 <92% in room air

iv) Tachypnoea

v) Significant increased work of breathing

vi) Temperature >38^{0}C if aged 0-3 months

vii) Jaundice

viii) Guarding persisting after analgesia

ix) Child reticent to move due to pain after analgesia

x) Abdominal mass

xi) Abdominal distension

xii) Irreducible hernia

xiii) Unilateral testicular tenderness +/- reduced cremasteric reflex, erythema, unilateral hemi-scrotal swelling OR groin pain with undescended testicle

xiv) Change in gait

xv) Non-blanching rash

xvi) Significant nursing, medical or parental concern

xvii) Suspicion of non-accidental injury

f) Recommendations for those undertaking a remote review (telephone or video consultation)

i) Indicators of *significant* disease requiring urgent attendance at the Emergency Department include:

(1) Unconscious or reduced consciousness (cannot be woken up, very difficult to wake, not responding in their normal way, floppy, difficult to keep awake)

(2) Bilious (green) vomiting

(3) Vomiting a large amount of blood

(4) Acute testicular pain (direct referral to surgeon)

(5) Passing melaena, large amounts of blood or redcurrant stools rectally

(6) Non-blanching rash

(7) Safeguarding concerns

(8) No urine output in previous 24 hours

(9) Abnormal or fast breathing

(10) Recent significant abdominal injury
(11) Temperature >38^{0}C if aged 0-3 months
(12) History or suspicion of ingestion of button battery or magnets
(13) Recent abdominal surgery

ii) Indicators of disease requiring in-person assessment in primary care or an urgent treatment centre within a maximum 6 hours of remote consultation include
(1) Reduced activity or lethargy
(2) Irritability
(3) Intractable cry for over 1 hour
(4) Dry tongue or eyes
(5) Reduced or absent urine output in the past 12 hours
(6) Polyuria, polydipsia or urgency
(7) Severe or persistent pain not settling with analgesia
(8) Pain exacerbated with movement or walking
(9) Fever without clear focus of infection
(10) Vomiting a small to moderate amount of blood
(11) Recent previous abdominal surgery

g) Initial investigations of children with abdominal pain without a confirmed specific diagnosis (e.g. of ear infection or tonsillitis) after history and examination should include:
i) Urine dipstix for leucocytes, nitrites, protein, glucose and ketones +/- formal mid-stream urine culture and sensitivity
ii) β-HCG in all females aged 11 and above and girls under 11 years if menses has commenced.

h) Differential diagnoses of children with abdominal pain
i) The potential diagnoses of children with abdominal pain are highly variable and differ according to age, gender and symptomatology.
ii) Diagnosis of urinary tract infection (UTI) should follow the NICE guidance for UTI.

i) Suspicion of testicular torsion should be managed in an expedient manner, following local urgent referral pathways.

Justification for recommendations:
Awareness of children who pose difficulty around diagnosis is important. The differential diagnoses for children with abdominal pain under the age of 5 years is broader than in older children. Their symptoms and signs are more likely to be non-specific. Children under the age of 5 are more likely to have complex appendicitis at the time of presentation to hospital due to the diagnostic difficulty that exists in the age group and are more likely to be physiologically unwell. (11-16) Pubertal females are more likely to have gynaecological causes of pain than younger girls and alternative diagnoses such as pelvic inflammatory disease and ectopic pregnancy can occur in sexually active teenagers. (17) Obesity and neurodiversity have been linked to a higher rate of perforated appendicitis which is thought to be due delayed presentation or delayed diagnosis in children with these underlying conditions. (18, 19) Identification of unwell children has been potentially demonstrated to be poorer in those with language and/or racial differences so awareness of the need for careful evaluation of

those in whom there is a language difference and/or a non-white ethnicity is recommended. (20, 21)

Children with co-morbidities, including immunosuppression have been shown to have an increased risk of severe appendicitis, as have children with previous abdominal surgery. (14-16, 22)

Recommendations on history and examination are taken from a BMJ 'Best Practice' paper(23) along with recent RCEM guidance(24). Indicators of severe disease bring together the guidance developed by 'Healthier Together'(25-27) along with expert opinion within the writing group.

NHS111 pathways have been reviewed to ensure parity exists between this guidance and the national pathways. Whilst NHS111 pathway disposition is based on a cluster of questions rather than individual symptoms and signs, the overall approach in this guidance is equitable to the existing pathways. As the remote review will be undertaken by a clinician these guidance aim to not be too prescriptive and clinicians should decide how a patient should be transported to the Emergency Department (e.g. Category of Ambulance vs parent car) and the time of face-to-face review within 6 hours.

Urinalysis and urinary βHCG are appropriate first line tests to perform both in primary care and in the ED. (23) NICE guidelines on the diagnosis and management of urinary tract infections are recommended. (28) It is noted within this guidance that for children who are aged 3 and over, if the sample is either leucocyte positive and nitrite positive or leucocyte negative and nitrite positive the a urine culture should be sent and antibiotics only commenced if there are obvious urinary symptoms. (28) This is highlighted as children with appendicitis can have leucocyte positive urine without urinary tract infection. (29) The presence of urinary glucose and ketones may be an indicator of diabetic ketoacidosis and should prompt further investigation.

Knowledge gaps:

- The relationship between individual symptoms and clusters of symptoms with the final diagnosis/disposition of the child.

Audit:

- Urinalysis should be performed on all children presenting with abdominal pain and βHCG in eligible females.
- Children with unilateral testicular pain should be urgently referred to the local Emergency Department

3) Referral from primary care and urgent treatment centres to hospital settings

a) For children with suspected surgical causes of abdominal pain, referral is recommended direct to Paediatric or Paediatric Surgical specialties (dependent on local referral pathways) unless the child is critically unwell, when they should be sent directly to the Emergency Department by ambulance.

b) For children with suspected medical causes of abdominal pain which cannot be managed by primary care, referral is recommended to occur directly to Paediatric

specialities unless the child is critically unwell, when they should be sent directly to the Emergency Department by ambulance.

c) Receiving hospital specialities should develop local pathways which enable rapid, smooth transfer of children requiring assessment, minimising delays for patients and referring clinicians

d) Inpatient Consultant Care responsibility of a child with a suspected surgical cause of their abdominal pain:
   i) Non-specialist hospital: Lead Consultant: Consultant Paediatrician in joint care with Consultant General Surgeon if the child is aged 5 years and over.
   ii) Specialist hospital: Consultant Paediatric Surgeon

Justification for recommendations:
Rapid access to the appropriate specialist team for children who require surgical or medical care in hospital reduces the time to definitive management. In children with appendicitis, better outcomes are reported in those who have shorter duration between onset of symptoms and the diagnosis of appendicitis being made. (30) There is therefore a responsibility for the primary care team to perform an assessment which enables referral to the appropriate speciality and for the receiving secondary care team to have a referral system in place which does not create long delays for the primary care practitioners who are referring the patient or for the patient.
In children under 5 years of age with a suspected surgical cause of abdominal pain, referral from primary care should be to the local secondary care unit, rather than directly to a tertiary paediatric surgical unit. This is because, as previously described, these children can pose more diagnostic difficulty than older children. Local assessment enables initial evaluation to be undertaken and resuscitation to be commenced, if required.
Within non-specialist centres it is recommended that a Consultant Paediatrician should be the lead consultant for children admitted with any cause of abdominal pain. General surgical consultants should provide joint care for children aged 5 years and over with a suspected surgical cause of their abdominal pain. For children under the age of 5 years, the Paediatric team have responsibility for the child.
In specialist centres children with suspected surgical abdominal pain should be under the care of a Paediatric Surgical consultant (FRCS Paed).

Audit:
- Appropriate speciality of managing consultant

4) Stabilisation and transfer of children with abdominal pain

   i) Resuscitation guidance
      (1) Risk factors for **severe** disease
         (a) <5 years of age
         (b) Severe co-morbidity including inflammatory bowel disease or >2 system co-morbidity
         (c) Immunosuppression

(d) Recent abdominal surgery

(2) Indicators of **severe** disease
- (a) Moderate to severe tachycardia persisting after appropriate analgesia
- (b) Moderate to severe tachypnoea +/- capillary refill time ≥3 seconds
- (c) SpO2 <92% on air or increase in oxygen requirement
- (d) Reduced urine output (<1ml/kg/hr in children under 12 years, <0.5ml/kg/hr in children aged 12 years and over)(31)
- (e) Parental or carer concern
- (f) Temperature <36^{0}C
- (g) Looks unwell to healthcare professional
- (h) Parental or carer concern
- (i) Behaving abnormally / not wanting to play / doesn't wake when roused / won't stay awake
- (j) Objective evidence of new or altered mental state
- (k) Mottled / ashen / cyanotic / non-blanching rash
- (l) Immunocompromised
- (m) Presence of bilious aspirates/vomits
- (n) Fluid resuscitation volume of >40 ml/kg

(3) If <2 indicators of severe disease and no risk factors for disease follow the pathway
- (a) Provide appropriate analgesia (see analgesia guidance)
- (b) Refer for speciality assessment
- (c) Undertake appropriate diagnostic investigations (investigation of acute appendicitis detailed below)
- (d) Undertake regular reassessment including PEWS in inpatient settings, if evidence of clinical deterioration, move to sick child pathway

(4) If 2 or more indicators of severe disease or 1 indicator of severe disease and a risk factor for severe disease, follow the sick child pathway (below). Simultaneous resuscitation, speciality review and diagnostic investigations should be undertaken.
- (a) Actions
  - (i) Apply high flow oxygen, aim for SaO_2 ≥94%
  - (ii) Gain intravenous (IV) (or intra-osseous (IO)) access x2
    1. Measure a lactate, full blood count, urea and electrolytes, C Reactive Protein, Liver Function Test, Amylase, Group and Save, Blood culture and blood glucose.
  - (iii) Consider fluid resuscitation (repeated 10-20ml/kg boluses of physiological fluid) with repeated monitoring of response to interventions.
  - (iv) Commence broad spectrum intravenous antibiotics according to trust protocol
  - (v) Consider inotropic support early
  - (vi) Nil by mouth, consider nasogastric tube insertion
- (b) Early speciality involvement

(i) Early (within 2 hours of arrival in ED) review by senior specialist decision maker[%]
    1. In non-specialist centres: paediatrics, and general surgery if aged 5 and over
    2. In specialist centres: paediatric surgery

(ii) Multi-disciplinary discussion and review. Specialist hospitals may have a paediatric emergency response team for assessment and management of such children.
    1. Non-specialist centres: Emergency physicians, Paediatrics, anaesthetics OR intensivist and general surgery (aged 5 years and over) +/- paediatric transport team +/- radiology
    2. Specialist centres: Emergency physicians, Paediatric surgery, paediatric anaesthetics OR paediatric intensivists +/- paediatric radiologists
    3. These teams may include nurse practitioners, nurse consultants, IV access team and physician's associates.

Acute Abdominal Pain Pathway – Emergency Department

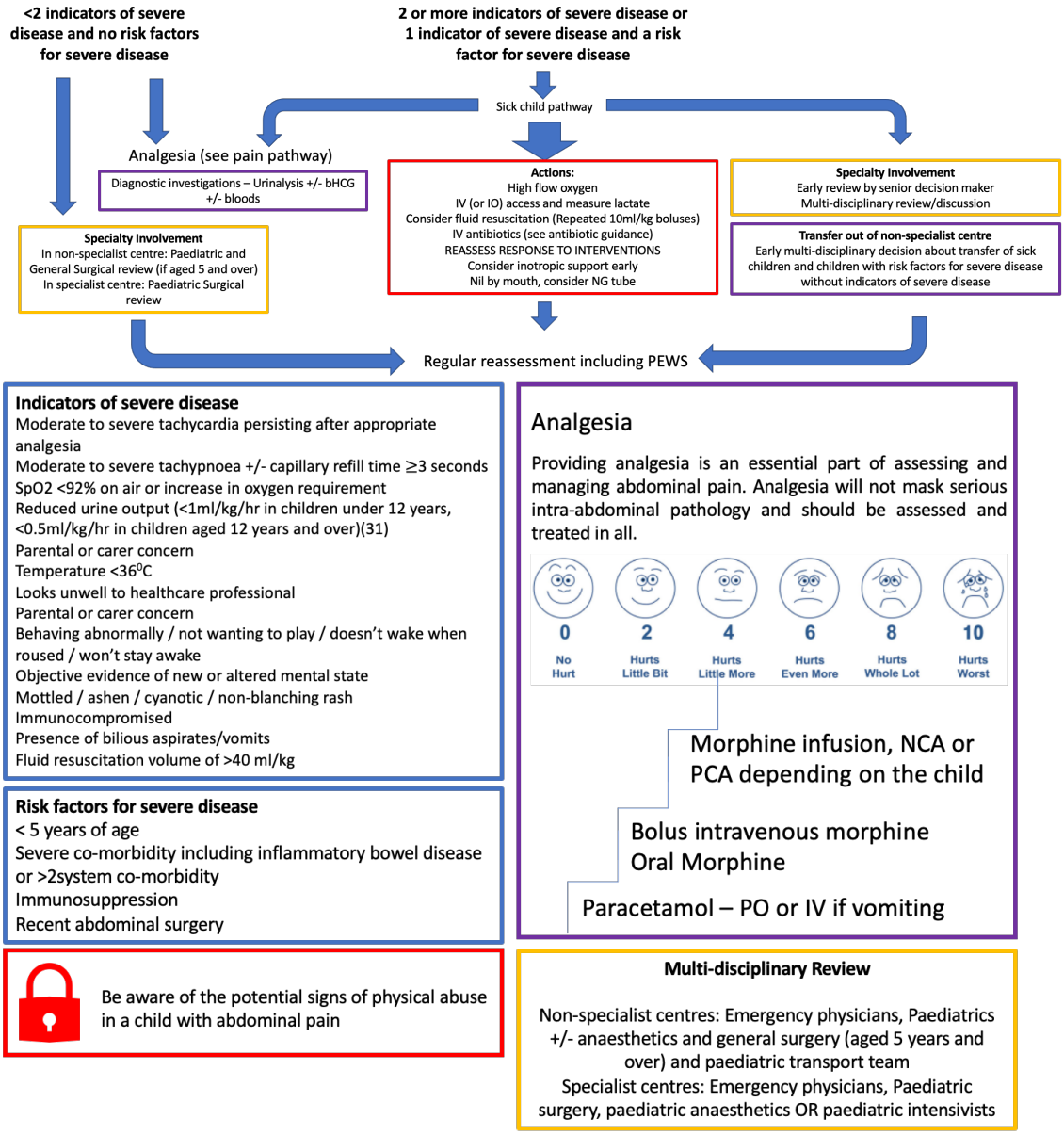

Figure 1. Summary of abdominal pain pathway in the Emergency Department

(5) Transfer from non-specialist to specialist centre

(a) Indications for transfer from non-specialist to specialist centre

(i) Before surgical intervention

1. Child with indicators of severe disease responding to resuscitation but anticipated to require Level 3 (PICU) care post-operatively
2. Child with risk factors for severe disease without indicators of severe disease anticipated to require Level 3 (PICU) care post-operatively

3. Child expected to require specialist to treat the cause of their abdominal pain or sequelae of the operation including children with an appendix mass with intra-abdominal collection who require percutaneous drainage by a paediatric radiologist
4. Child with a surgical cause of abdominal pain under the age of 5 years

(ii) After surgical intervention
1. Critically ill child requiring life-saving surgery in local centre
2. Unexpected post-operative complication requiring specialist intervention or support

(iii) Traumatic mechanism of injury
1. Follow the local major trauma pathway

(b) Decision making for transfer

(i) Multi-disciplinary discussion
1. Local Paediatrician
2. Local General Surgeon if child is aged 5 years or above
3. +/- Local anaesthetist
4. Specialist Paediatric Surgeon
5. Transport team
6. +/- Specialist intensivist or anaesthetist

(ii) Use of a transfer document

(iii) Category of transfer
1. Time critical transfer = local level 2 ambulance transfer
2. Non-time critical - discussion with local transport team

Justification for recommendations:

Early identification of children with severe disease or physiological instability (or both) is a cornerstone of high-quality care for children with abdominal pain. Indicators of severe disease reflect the recommendations of the sepsis trust (31) and the NICE recommendations (32) in addition to those specific to children with abdominal pain recommended by this expert group (i.e. presence of bilious aspirates or vomits and the need for >40 ml/kg resuscitation). The national paediatric early warning score (PEWS) can be used to determine age-appropriate 'moderate' and 'severe' tachypnoea and tachycardia, although it should be noted that these have been developed for paediatric inpatients and have not been validated in the Emergency Department.

Children who are unwell should undergo simultaneous management of their physiological instability and diagnosis and management of the underlying condition. Management of the physiological instability should follow an 'ABCDE' approach, in line with APLS/EPALS and NICE guidance. (33)

At the time of gaining intra-venous access relevant blood tests should be sent. In addition to those recommended above, specific additional blood tests may be recommended depending on the background and presenting history of the child, for example, a child with inflammatory bowel disease may also have measurement of erythrocyte sedimentation rate (ESR), a child with a history in-keeping with paediatric inflammatory multisystem syndrome (PIMS-TS) may have measurement of ferritin, d-dimer, fibrinogen and Troponin T. (34) The blood tests recommended are a minimum set for a child with abdominal pain.

The need for early, senior, multi-disciplinary speciality involvement for a sick child with abdominal pain was strongly supported by the expert group. Identification of a sick child with suspected surgical abdominal pain by ED practitioners is expected to result in a review by the speciality team within 2 hours of arrival in ED. In non-specialist centres this includes paediatricians and general surgeons (when the child is aged 5 and over) and in specialist centres includes the paediatric surgeons. In addition to these specialist teams, a multi-disciplinary team (MDT) discussion or review of the patient is recommended. Some centres may have an 'emergency response team' or 'critical outreach team' for such patients. Alternatively, input by the anaesthetics team and +/- discussion with the transfer team is recommended to aid stabilisation of the patient and consider the onward care of a patient in a non-specialist centre. In specialist centres the paediatric anaesthetic or intensivist team should be consulted to aid with stabilisation.
Decision making around the transfer of a sick child from a non-specialist to specialist centre should be multi-disciplinary, ideally held with all members of the MDT present on one telephone call or video consultation. Utilisation of aids for safe transfer, for example the STOPP tool (35), are recommended to support safe and appropriate transfers of children from one hospital to another. Time critical transfers of sick children should be undertaken by a local level 2 ambulance with support by the clinical team as dictated by the clinical condition of the child and determined by the MDT discussion. Transfers which are not time critical should be discussed with the local transport team.

Knowledge gaps:

- The utility of PEWS in ED settings to facilitate early identification of the unwell child
- The utility of PEWS in ED settings to differentiate between surgical and non-surgical causes of abdominal pain

Audit:

- Multidisciplinary discussion of children meeting the criteria for being a sick child should be undertaken as a minimum. Multidisciplinary review is recommended for most sick children.

5) Investigation of appendicitis in acute care settings. In children with suspected appendicitis the following investigation pathway is recommended (Figure 1)

    a) Serum and molecular markers
        i) Children's Appendicitis Triple Test: White cell count (>10), Neutrophil percentage (>75%), C Reactive Protein (>7).
            (1) If none are raised, appendicitis unlikely unless history is less than 24 hours - consider discharge if no alternative diagnosis evident
            (2) If any of these are raised
                (a) Refer for specialist review
                    (i) In non-specialist centres: paediatrics, along with general surgery if aged 5 and over
                    (ii) In specialist centres: paediatric surgery
                (b) Undertake a clinical appendicitis assessment tool to stratify the likelihood of appendicitis. Recommended scores include the Children's Appendicitis Score and the Shera Score.

ii) Consider the addition of serum markers for alternative differential diagnoses if significant pathology suspected: Urea and electrolytes, Liver Function Tests, Amylase, PIMS-TS blood testing protocol
iii) Consider molecular testing for SARS-CoV-2 (PCR or antigen testing)

b) Diagnostic imaging for appendicitis
   i) Imaging is recommended for children with suspected appendicitis who have:
      (1) An intermediate risk score using the children's appendicitis score
      (2) A high risk score and diagnostic uncertainty
      (3) A low risk score whose symptoms are not resolving
   ii) First-line imaging of all children with suspected appendicitis requiring imaging should be ultrasound scan. Use of a standardised reporting tool may be helpful.

Appendicitis diagnostic pathway

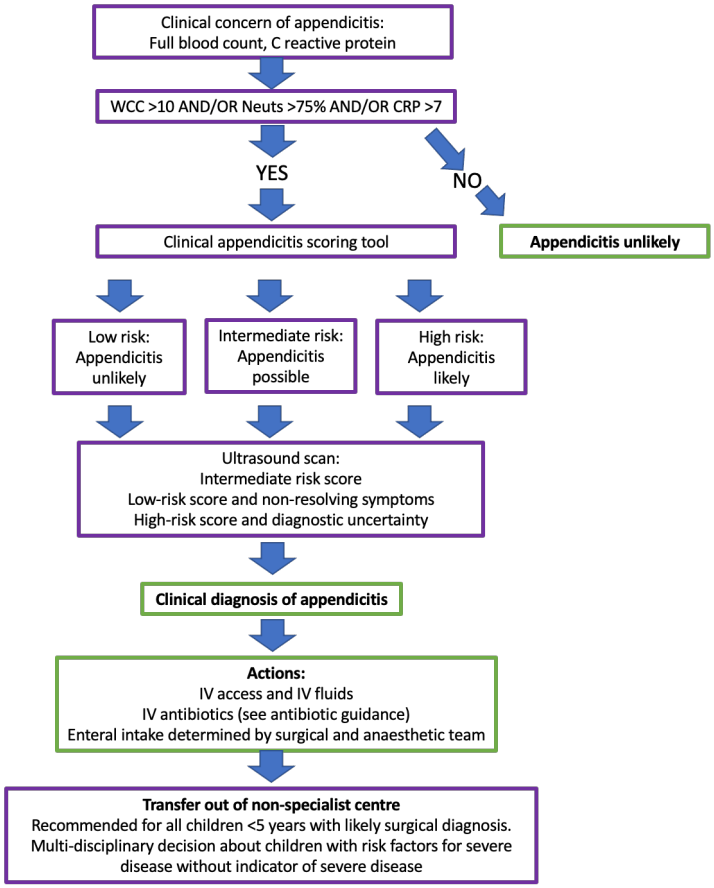

Figure 2. Recommended appendicitis diagnostic pathway

Justification for recommendations:
Tools to support with the diagnosis of appendicitis in children have been heavily research recently. Clinical risk scoring tools have been extensively investigated. These risk scoring tools primarily use clinical symptoms and signs, some in conjunction with laboratory markers, and many are a variation of the original Alverado score. (36) A recent prospective, multicentre validation study of appendicitis scores found that the Sheera score performed best within the models reviewed with a specificity of 49.2% and a failure rate of 4.8%. (37) A criticism of this

paper is that the majority of risk scores assessed used only white cell and neutrophil count within the laboratory measures. Blood tests have been the most frequently investigated tool published within paediatric surgical literature with 96% of these reporting a correlation between white cell count, neutrophil count and/or CRP and a diagnosis of appendicitis. (38) The Children's Appendicitis Score is a two stage score which combines the laboratory tests of white cell count, neutrophil percentage and CRP (the triple test) and a clinical risk score. (39) A normal white cell count, neutrophil count and CRP had a 100% negative predictive value for appendicitis within the paper. If any of these blood tests are elevated then a 'Raw Score' should be undertaken (Table 2). A score <1.5 is associated with a low probability of appendicitis (sensitivity 98.2%, negative predictive value 98.8%). A score >5 is associated with a high probability of appendicitis (sensitivity 99.6%, 94.4% positive predictive value).
Children with a score between 1.5-5 have an intermediate probability of appendicitis and further investigation (imaging) is recommended. (39)

Table 2. Predictors and Weightage of the Children's Appendicitis Score

Predictors	Weightage
Characteristics of the Pain: Constant	1.0
Localised Right Iliac Fossa Tenderness	1.5
Pain on Percussion/Coughing	1.0
Generalised Guarding	1.5
WBC $\geq$ 14,000/L	1.5
CRP $\geq$ 24 g/L	1.0

A similar approach is recommended by the authors of the RIFT study, who note that the Shera score is good at ruling out appendicitis but not as good at confirming appendicitis and therefore imaging is recommended for those 'intermediate' patients. It should be noted that within the RIFT study, the Shera score is stratified according to the child's age and gender (low risk score: <3: Boys aged 11-15 years; <4: All children aged 5-10 years, girls aged 11-15 years). (37) Awareness of the fallibility of any score within a clinical context is recommended. The Children's Appendicitis Score gave a child with ovarian pathology a 'high-risk' score (39) and so awareness of children who can pose difficulty around diagnosis (age <5 years, pubertal females, obese children, neurodiverse children and those with communication difficulties particularly) is important.

There is a strong literature around the use of radiological imaging of children with suspected appendicitis. Seventy nine out of eighty five papers within a systematic review reported that ultrasound improves diagnostic accuracy of appendicitis.(38) Point of care ultrasound has got a small but growing evidence base too(38) but the expert group felt that this could not be recommended within the context of this guidance due to the training and re-validation which would be required to recommend this as a routine part of patient care. Access to ultrasound imaging in non-specialist centre during weekend hours has been identified as a barrier to making this recommendation but the expert group agreed that this is an important part of the pathway and local pathways should be developed to enable this service to be available for children who require imaging.
A standardised reporting template in conjunction with regular training updates on the ultrasound appearance of appendicitis in children has been demonstrated to encourage definitive reporting, improve diagnostic accuracy and reduce the utilisation of computed tomography (CT). (40) Operational delivery networks (ODNs) are expected to be able to

facilitate and support the ongoing training requirements, particularly for radiologists and ultrasonographers in non-specialist centres.

Cross-sectional imaging of children with abdominal pain is a second-line investigation that can be considered when the initial ultrasound scan is non-diagnostic. Magnetic Resonance Imaging (MRI) is strongly supported within the literature as a reliable diagnostic tool in children with suspected appendicitis. A systematic review found that the pooled sensitivity of second line MRI scan is 97.4% (95% CI 85.8-100%) and specificity is 97.1% (95% CI 92.1-99%). (41) However, the limited availability of MRI within many centres may preclude the use of this imaging modality for children where there is diagnostic uncertainty. The sensitivity is likely to be substantially better if the reporting radiologist is used to reporting such work and this therefore limits its use, particularly in younger children, to specialist centres.

Second-line CT scanning has been shown to have a similar pooled sensitivity (96.2% (95% CI 93.2-97.8%)) and specificity (94.6% (95% CI 92.8-95.9%)) to MRI scanning for suspected appendicitis. (41) The use of radiation should follow the ALARA (as low as reasonably achievable) principle and therefore contrast-enhanced low-dose CT is recommended over the use of normal-dose CT. The diagnostic accuracy of the scan is not reduced with low-dose CT but it does significantly reduce the radiation exposure of the patient and paediatric CT protocols should be used. (42) A useful alternative to cross-sectional imaging is to second ultrasound scan by a radiologist with a specialist interest in paediatric abdominal ultrasonography.

Knowledge gaps:

- Comparison between the performance of the Shera Score and the Children's Appendicitis Score in UK practice.
- The utility of additional blood tests, particularly procalcitonin

Audit:

- ODNs should provide a minimum of two training sessions a year on the use of ultrasound in paediatric abdominal pain to radiologists and ultrasonographers who perform ultrasonography on children.
- A radiology network, in combination with a mentorship programme between specialist and non-specialist centres should be established to support the ongoing training of radiologists and ultrasonographers in non-specialist centres.

6) Non-operative management (NOM) of appendicitis
   a) Simple appendicitis
      i) NOM may be considered in children aged 5 years and over with suspected uncomplicated appendicitis within the context of a clinical trial
         (1) All children undergoing NOM of simple appendicitis should have ultrasound imaging to exclude alternative pathology. Treatment can commence prior to imaging.
      ii) A child undergoing NOM should receive IV antibiotics initially with conversion to oral being dictated by their clinical condition
   b) Appendix mass
      i) NOM of children with an imaging-confirmed appendix mass is a reasonable first-line treatment
      ii) Percutaneous drainage of an associated abscess may be a beneficial adjunct

iii) A child undergoing NOM should receive IV antibiotics initially with conversion to oral being dictated by their clinical condition
iv) A discussion with the child and parents about the option of performing or not performing a delayed appendicectomy is advised, including the potential risks from performing delayed appendicectomy and the rate of recurrent appendicitis.

Justification for recommendations:
Non-operative management (NOM) of appendicitis has been undertaken in two main contexts. The first is the treatment of simple appendicitis. Over the past 5 years, there is a body of literature, mainly originating from the USA, which suggests that NOM of simple appendicitis in children is a safe and effective alternative to operative intervention. (43-46) Presence of a faecolith has been associated with a high rate of failure of NOM (47). WSES Jerusalem guidelines advise that NOM is not recommended in children with a faecolith (42) but the expert group did not advise that the presence of a faecolith would be a contraindication to NOM. Imaging is recommended for all patients to exclude an alternative pathology and assess for the presence of a faecolith.
During the first months of the COVID-19 pandemic there was a substantial shift of UK practice for simple appendicitis to using NOM rather than appendicectomy. This appeared to be safe within the 30 day follow-up period that was observed in the UK, with no significant increase in the rate of complications in children treated non-operatively. (48) The longer-term safety of this approach is less clear. A 5-year follow-up study has demonstrated a high rate of appendicectomy following conservative management of simple appendicitis. (49) Upcoming clinical trials such as the CONTRACT study (50) will be enlightening about the place of NOM in UK children with simple appendicitis and this study is supported by the experts in this group. The expert group came to the consensus that it is currently appropriate to undertake NOM in children with simple appendicitis in the context of a clinical trial but is not currently routinely recommended within clinical practice.
The second indication for NOM is for an established appendix mass. NOM has been an established approach for children with an appendix mass for approximately 30 years. (51) A recent systematic review has demonstrated that NOM in patients with an appendix mass is associated with a significantly lower complication rate than operative management. (52) Ultrasound imaging to confirm that the mass is an appendicitis-related mass and not due to an alternative pathology is recommended for all patients during treatment but antibiotics can be commenced prior to imaging. Percutaneous drainage of an associated abscess is recommended if the abscess is large and safely accessible. (53)
The role of delayed appendicectomy after appendix mass remains debated. A prospective study demonstrated that the rate of recurrent appendicitis is around 12% (95% CI 5-23) but the rate of severe complications related to the delayed appendicectomy is around 6% (95% CI 1-17%). (54)
The Montgomery Principle demonstrates the need to gain fully informed consent which includes decision making using a “nuanced negotiation of information”. (55) This includes include the option for NOM of simple appendicitis, even when in the clinician’s preference is for an operative approach and a discussion around the role of delayed appendicectomy after appendix mass. These decisions should be made in conjunction with the patient and their family.

Knowledge gaps:

- The safety and efficacy of NOM in children with simple appendicitis

Audit:

- A radiology network which may include paediatric and adult interventionalists should be established to enable appropriately experienced and trained interventional radiologists are available to undertake percutaneous drainage of intra-abdominal collections in children in an appropriate location.

7) Intravenous access for children undergoing abdominal surgery
    a. Cannula: suitable for children undergoing appendicectomy for a normal appendix, simple appendicitis, manual reduction of intussusception without requiring resection
        i. No post-operative antibiotics
        ii. Minimal ileus expected
        iii. <12 hours 'Nil by mouth' post-op
    b. Mid-line / non-central long line: suitable for most children with complex appendicitis with no significant bowel dilatation, for children with intussusception undergoing a resection and anastomosis, for children having a stoma formation
        i. Medium post-operative course of antibiotics anticipated (<10 days)
        ii. Minimal ileus expected
        iii. <48 hours 'Nil by mouth' post-op
        iv. Consider when a PICC cannot be placed when indicated due to limitations of experience or equipment in non-specialist centres
    c. Peripherally inserted central catheter (PICC): suitable for children with gross peritoneal contamination, significant intra-operative bowel dilatation, multiple bowel anastomoses
        i. Prolonged ileus anticipated
        ii. ≥72 hours 'Nil by mouth' post-op
        iii. Consider insertion of a dual-lumen PICC if incompatibility of drugs is anticipated (e.g. total parenteral nutrition (TPN) and morphine infusion).
    d. Non-tunnelled internal jugular or subclavian lines can be considered in physiologically unstable children who require secure IV access when a PICC cannot be placed (due to time, technical constraints, experience or equipment limitations). Femoral lines are entirely acceptable for children with difficult access or when local expertise means that this is the safest form of access for the child.

Justification for recommendations:
Consideration of the intravenous (IV) access requirements of a child with a surgical abdominal pathology is important and should start in the pre-operative period. Cannulas are a short-term form of IV access. They are important for fluid resuscitation and early antibiotic delivery but have a limited lifespan, particularly in children when they are more likely to become dislodged. A cannula is generally the most suitable first form of IV access for a child and remains so in the post-operative period when a child is not expected to require fluids or

antibiotics post-op. Intra-osseus (IO) access remains an important emergency method of gaining IV access in sick children.

Long peripheral cannulas (also known as non-central long-lines and midlines) have been shown to be a durable method of gaining IV access in children with a surgical abdomen. (56) In the experience of the group they can last in situ without complication for up to 10 days and provide a secure and comfortable route of IV access for children. They can be sited in a ward environment or in theatre after appendicectomy.

Formulations of parenteral nutrition can be given peripherally but if extravasation occurs there is a higher risk of soft tissue irritation than if it is given centrally. For this reasons, if a child undergoing a surgical abdominal procedure is expected to be unable to commence enteral nutrition within 72 hours and have the potential to require parenteral nutrition, a peripherally inserted central catheter (PICC) is recommended. (57)

Non-tunnelled central lines are an appropriate alternative to the options described above if the child is unstable and requires secure intravenous access or drugs that require administration centrally. They can also sometimes be indicated within the operation, particularly if it is not possible to place a PICC. The preferred sites for placement are the internal jugular vein and the subclavian vein. However, it is recognised that non-specialists may feel more comfortable placing a femoral line. Femoral lines are only recommended if essential due to the increased risks of infection and higher rates of thrombosis formation (noted to be particularly in children on ICU).

Audit:

- The need for further interventions for IV access after initial operation

8) Prioritisation of children with appendicitis on the emergency list
   a) Children with appendicitis should undergo appendicectomy within 24 hours of the decision for theatre being made.
   b) Appendicectomy may form part of the resuscitation of a critically unwell child in conjunction with resuscitative measures. Clinical urgency should be determined according to clinical condition, surgical and anaesthetic assessment.

Justification for recommendations:

The British Association of Paediatric Surgeons (BAPS) and the Royal College of Surgeons (RCS) issued commissioning guidance in 2014 stating that >90% of appendicectomies should be performed within 12 hours of decision to operate. (58) There is strong evidence that better outcomes are observed in children who have inpatient waits of less than 24 hours until surgical intervention(38) and some evidence which suggests that operating within 12 hours may confer a benefit.

Knowledge gaps:

- The impact of the duration between diagnosis of appendicitis and appendicectomy when performed within 6 hours, 12 hours and 24 hours for simple and complex appendicitis

Audit:

- Appendicectomy should be performed within 24 hours of diagnosis

9) Operative management of appendicitis
   a) Written consent for operative management of appendicitis should be taken from parents (and the child when appropriate)
   b) Written information leaflets detailing the pre-operative course and imaging, operation, post-operative course and potential complications, and information for discharge should be given to families and visual information for children
   c) A laparoscopic operative approach is recommended for the majority of children with appendicitis
      i) Flow of CO_2 and intra-abdominal pressure should be suitable for the child's age and body habitus
   d) Indications for an open approach include
      i) Pneumoperitoneum is not expected to be tolerated
      ii) Significant bowel dilatation
      iii) Previous abdominal surgery expected to make laparoscopic approach unsafe
      iv) Conversion to open when laparoscopic appendicectomy cannot be safely performed
   e) Principles of operative management
      i) Children should be examined for an appendix mass prior to commencing the operation
      ii) Empty bladder prior to laparoscopy If significant peritoneal contamination is present then consider leaving a urinary catheter in situ.
      iii) In the absence of alternative pathology, an appendix which appears normal should be removed
      iv) Interloop abscesses should be freed
      v) Faecolith should be searched for and removed
      vi) Free fluid and pus should be suctioned
      vii) Irrigation should not routinely be used. It can be considered if there is widespread contamination
      viii) Intra-peritoneal antibiotics are not recommended
      ix) Drains are not recommended in children with appendicitis
      x) The appendix should always be sent for histopathological examination
      xi) Naso-gastric tube placement can be considered in children with significant peritoneal soiling or bowel dilatation
      xii) A standardised operation note is recommended

Justification for recommendations:
Laparoscopic appendicectomy has been demonstrated to have a lower incidence of surgical site infection, less post-operative pain and an improved quality of life compared to open appendicectomy. (42, 59, 60) In some children a laparoscopic approach may not be appropriate. The expert group agreed that indications for an open approach include those listed above. This list is not intended to be comprehensive and it is the responsibility of the surgeon to determine whether the appendicectomy can be performed safely laparoscopically.
An in-and-out catheter at the start of every laparoscopic appendicectomy, particularly when a suprapubic port is used, as is a standard approach for paediatric appendicectomy. A higher rate of bladder injury has been described in children during laparoscopy due to the smaller operative field and a greater portion of the full bladder being within the abdomen. (61)

Distinction between a normal appendix and simple acute appendicitis intra-operatively has been described as challenging. (42, 62, 63) If the appendix appears to be normal then alternative pathology should be considered - particularly ovarian pathology and the presence of a Meckel's Diverticulum. However, if not alternative pathology is identified then the appendix should be removed.

Suction and irrigation of pus has not been demonstrated to improve outcomes compared to suction alone and can substantially prolong operative time(42, 64), but may be indicated if there is widespread contamination. Intra-peritoneal antibiotics have not been shown to reduce post-operative rates of intra-abdominal collection(65) and are not recommended. Intra-operatively placed peritoneal drains during laparoscopic paediatric appendicectomy has not shown an improvement in outcome but have been associated with an increased duration of antibiotics, analgesia and length of stay(66) and are therefore not recommended. (42)

Nasogastric tube placement may be considered intra-operatively if it is felt that the child may experience significant ileus post-operatively although it is also acceptable to place on the ward, dependent on clinical symptoms.

Audit:

- A minimum of 80% of appendicectomies should be performed laparoscopically

10) Antibiotic management for children being treated for appendicitis
    a) Antibiotic choice
        i) Local guidance of appropriate broad-spectrum antibiotics which take into account local resistance patterns should be available for intravenous and step-down oral anti-microbial agents.
        ii) Systemic screening of antibiotic resistance in appendicitis should occur for culture and sensitivity testing and local resistance patterns should determine changes to antibiotic choices
            (1) In simple appendicitis a serosal swab should be taken at the point of maximal inflammation
            (2) In complex appendicitis
                (a) A serosal swab should be taken at the site of gangrene or adjacent to perforation
                (b) A sample of intra-peritoneal pus should be sent
    b) When the clinical diagnosis of appendicitis is made, intravenous antibiotics should be prescribed and administered within 1 hour of the diagnosis being made
    c) Children should receive a dose of IV antibiotics within 1 hour prior to skin incision
    d) Post-operative antibiotics
        i) Macroscopically normal appendix: No post-operative antibiotics
        ii) Simple appendicitis: No post-operative antibiotics
        iii) Complex appendicitis:
            (1) Antibiotics to be administered for a minimum of 72 hours post-operatively
            (2) Consider conversion to oral antibiotics earlier than 72 hours when
                (a) The child has been apyrexial (Temp <37.5^{0}C) for over 24 hours
                (b) The child is tolerating oral intake well
                (c) There is no antibiotic resistance to the selected antibiotic in culture

(3) Consider stopping antibiotics between 3 to 5 days after appendicectomy when
   (a) The child has been apyrexial (Temp <37.5^{0}C) for over 24 hours
   (b) The white cell count is below 10
(4) If a child continues to be pyrexial on day 5, continue antibiotics and consider investigation for intra-abdominal collection if no improvement by day 7.
(5) Organisms such as those within the streptococcus milleri group have a propensity to cause abscess formation and a prolonged duration of antibiotics (2 weeks) should be considered in children when these have been isolated.

Justification for recommendations:
The guidance on which antibiotics to use is based on a systematic review of the literature led by British Society of Antimicrobials Chemotherapy (BSAC) who recommend cefuroxime and metronidazole as the evidence-based choice of antibiotics. Experts within this group report that relatively high rates of antimicrobial resistance have been identified when routinely performing serosal swabs in children with appendicitis. This contradicts some of the literature from over 2 decades ago when clinicians reported in quite low number studies that they were not of use. More recently, a review has demonstrated that there is some equipoise around the utility of intra-operative swabbing and recommends that swabs be taken routinely.(67) These intraoperative swabs can be used to guide local antibiotic policy which should be based on local resistance patterns and antibiotic sensitivity.
There is strong evidence for early delivery of antibiotics after diagnosis (68) and it is recommended that children receive their first dose of antibiotics within 1 hour of the diagnosis of appendicitis.
Evidence and guidance already exists around the delivery of antibiotics within the 1 hour before skin incision. (69, 70) Repeated dosing of antibiotics just before the operation reduces the rate of surgical site infection by ensuring that the serum antibiotic concentration is at its maximum during the procedure. Blood loss and fluid replacement can reduce the serum concentration and an additional dose should be given after fluid replacement if a child loses more than 25ml/kg of blood. (70)
There is good evidence that children with a macroscopically normal appendix or simple appendicitis with no peritoneal contamination can be managed without any post-operative antibiotics. (42)
The post-operative antibiotic regimen for complex appendicitis varies within the literature. A recent meta-analysis reveals that children receiving a course of antibiotics for more than 5 days compared to 5 days or less are more likely to develop an intra-abdominal collection (IAC). (71) This may demonstrate that some children with IAC have evidence of ongoing pyrexia or raised inflammatory markers on day 5 and so antibiotics are continued for this reason. The same systematic review did not denote a difference between the rate of IAC in children who received antibiotics for 3 or fewer days compared to those who received them for longer. (71)
A switch to oral antibiotics at 48 hours for children who are well is recommended within the literature (42) and this timing also enables the intra-operative swab to be checked for the culture and sensitivity results to ensure that the correct oral antibiotic is selected. Checking of the white cell count is recommended on the basis of a prospective study which reduced the duration of antibiotics below 5 days in children who were well without leucocytosis. (72)

Knowledge gaps:

- The optimum antibiotic regime for children with complex appendicitis

Audit:

- The intended and actual duration of post-operative antibiotics for normal, simple and complex appendicitis
- The rate of intra-abdominal collection after appendicectomy for normal, simple and complex appendicitis

11) High-quality post-operative care

a) A collaborative approach between surgeon, physician, nurses, child and family is advocated for all patients, with a focus on communication
   i) Written and online visual information resources for parents and children (age appropriate) should be available
b) Each patient should be reviewed a minimum of once every 24 hours by a senior decision maker[%] until discharge
c) Play therapists are recommended to support children who are young, anxious, have learning or behavioural difficulties or who are having repeated painful procedures
d) A focus on: level of care
   i) Level 0-1: Suitable for most children in the post-operative period. Care needs can be met through normal ward care in an acute hospital, with the potential for additional support from the critical care team (e.g. to manage analgesia).
   ii) Level 2: Consider level 2 care for children identified pre-operatively as being physiologically unstable (i.e. following the 'sick child' pathway)
e) A focus on: Intravenous fluid management
   i) Use body weight to calculate IV fluid and electrolyte requirements
   ii) Assess the fluid status clinically
   iii) Measure fluid input and output hourly and calculate fluid balance with a subtotal every 12 hours and total every 24 hours
   iv) Measure plasma electrolyte concentrations and blood glucose when starting IV fluids and at least every 24 hours when they continue and are established
   v) Calculate fluid requirement as per NICE guidance
   vi) Use 0.9% sodium chloride containing potassium to replace ongoing losses (e.g. NG tube)
   vii) If there is a risk of water retention associated with non-osmotic antidiuretic hormone (ADH) secretion consider restricting fluids to 50-80% routine maintenance needs
f) A focus on: Urethral catheters
   i) Can be removed when children can mobilise from bed to commode to reduce the risk of catheter related urinary tract infection
g) A focus on: lines
   i) Aseptic technique should be used when handling key parts of a line
   ii) Lines should be removed promptly when they are no longer required to reduce the risk of line-associated infection
h) A focus on: chest

i) Families should receive information supporting the need for regular breathing exercises and coughing, ensuring pain is controlled enough to allow children to do this
ii) Nurses should be trained and empowered to support patients undertaking breathing exercises after intra-abdominal procedures
iii) Additional physiotherapy input may be required for children with low saturations, oxygen requirement or signs of worsening atelectasis
iv) Early mobilisation from bed to chair and from bed to toilet should be encouraged and supported

i) A focus on: abdomen
  i) Post-operative ileus
    (1) NG tubes are not required for the majority of patients after appendicectomy. Children with significant peritoneal contamination or bowel dilatation pre-operatively are at increased risk of post-operative ileus.
    (2) Children who remain 'nil by mouth' post-operatively due to ongoing ileus require daily assessment of their fluid status and measurement of their electrolytes
    (3) If an NG tube is in situ, the volume and colour of nasogastric losses should be measured. The volume should be replaced using intra-venous 0.9% saline with the addition of potassium.
    (4) The NG tube can be spigoted when the colour of the loses is light and the volume of losses is low to assess whether the tube can be removed.
    (5) Children anticipated to have (or with) an ongoing ileus or symptoms of obstruction on day 5 after appendicectomy should be considered for parenteral nutrition (PN).
      (a) Clinicians, dieticians and pharmacists should be involved in this decision
      (b) The type of IV access and the ability of non-specialist centres to provide PN should factor into the decision of whether a child needs to be transferred from a non-specialist to specialist centre
    (6) Children treated for appendicitis in non-specialist centres with ongoing NG losses on day 5 should be discussed with a specialist centre to consider whether further investigation for obstruction is required
  ii) Post-operative intra-abdominal collection (IAC) after appendicitis
    (1) Children who remain or become febrile (temperature > 38^0C) on day 7 or beyond after appendicectomy, or who have ongoing abdominal pain, loose stools or other potential symptoms of IAC should be investigated for a focus of infection. Investigations should be governed by clinical symptoms and signs and may include:
      (i) Full blood count, and C Reactive Protein
      (ii) Respiratory viral swabs
      (iii) Chest X-Ray
      (iv) Stool culture and sensitivity
      (v) Urine culture and sensitivity
      (vi) Blood culture and sensitivity
      (vii) Ultrasound abdomen and pelvis

(2) Intravenous antibiotics are recommended as a first-line treatment for IAC in children.
    (i) The culture and sensitivity of intra-abdominal swabs should be checked
(3) Large intra-abdominal collections which are accessible percutaneously or rectally should be considered for drainage
    (i) Children in non-specialist centres should be transferred to a specialist centre for this if local radiology expertise does not allow for this.
    (ii) Fluid should be sent for culture and sensitivity to guide antibiotic choice
    (iii) Re-look laparoscopy or laparotomy is rarely required in children with an IAC.

e. A focus on: analgesia
    i. A child's pain should be controlled enough to allow them to sleep comfortably, to cough and to take deep breaths and mobilise.
    ii. Regular assessment using the tools described in the 'analgesia' section should be utilised and a member of the pain team or the anaesthetic team should be available for advice and review.
    iii. Step-down through the analgesic ladder as a child recovers from their operation should occur

Justification for recommendations:
Communication is the cornerstone of good care of children with abdominal pain throughout the patient journey. Continuing this focus post-operatively allows for multi-disciplinary working and a patient-centred approach to recovery. The important of this is highlighted in the General Medical Council, Good Medical Practice guidance. (73)
The importance of play is highlighted under article 31 in the United Nations Convention on the Rights of the Child: "Children have the right to relax, play and to join in a wide range of cultural, artistic and other recreational activities". A literature review commissioned by NHS England highlights the importance of play in helping children to understand and cooperate with medical procedures. (74)
The experts within this group recommend daily senior review for post-operative patients who have undergone an emergency abdominal procedure. National guidance from the Royal College of Surgeons (RCS) (2011): Emergency Surgery, Standards for unscheduled surgical care (75) recommends that ongoing care is provided by senior trainees (ST3 or above) or trust doctors with equivalent training on children's wards that have paediatric-trained nursing staff.
Paediatric critical care is defined by healthcare resource group (HRG) classifications of Level 1 (Basic Critical Care), Level 2 (Intermediate Critical Care) and Level 3 (Advanced Critical Care). (76) An HRG criteria for level 2 care is the need for >80 ml/kg volume boluses but the group strongly felt that a child requiring >40 ml/kg pre-operatively is at higher risk of requiring critical care support and recommends this as one of the criteria to be included in the indicators of the 'sick child' to identify children who may require a higher level of care.
The management of intravenous fluids is well described by the NICE guidelines. (33, 77) The group supports the use of these guidelines in general. However, post-operatively children are recognised to be at high-risk of developing hyponatraemia due to anti-diuretic hormone (ADH)release. The tonicity and volume of intravenous fluids can affect the development of

hyponatraemia.(78) Children who have risk factors for increased ADH release (which include pre-operative hypovolaemia or hypotension, hypoxia, pain and nausea and vomiting) may require volume restriction to 50-80% of their usual fluid requirements. All patients require regular re-evaluation of their fluid status and daily electrolyte measurement whilst on intravenous fluid therapy.

Avoiding the use of a urinary catheter in the post-operative period is recommended if possible. A catheter may be required post-operatively in a child who has required a laparotomy, who is anticipated to have significant pain post-operatively or who has an epidural catheter in situ. Significantly unwell children may require a catheter in situ to enable accurate fluid-balance monitoring. A small number of children may have a catheter in situ due to an intra-operative bladder or ureteric injury. Understanding the reason for the urinary catheter enables an accurate assessment of when it can be removed.

Urinary catheters can lead to urinary tract infection and cause bladder spasm. Oxybutynin can reduce the risk of bladder spasm and is recommended for children who can take oral medications and has no contra-indications to it. Prophylactic antibiotics are generally recommended for children with a urinary catheter in situ (unless they are on post-operative antibiotics which provide equivalent cover) to avoid ascending urinary tract infection.

Removal of a catheter which is in-situ for a bladder or ureteric injury should be determined by the surgical consultant in charge of the case. A catheter which is in situ due to pain should be removed when the child can mobilise to and from a commode or the toilet with relative comfort. A catheter which is in situ for fluid balance should be removed when a child is haemodynamically stable with a good urine output without requiring cardiovascular support (apart from intravenous fluids).

Line-associated infection is a risk in all children with vascular access devices in situ. Local guidance on the frequency of review of vascular insertion points, dressing types, frequency of dressing changes and recommended longevity of lines should be available for all modes of vascular access (cannula, non-central peripherally inserted catheter, peripherally inserted catheters, non-tunnelled central lines, tunnelled central lines, portacaths and intra-osseus devices) and should be followed. Aseptic technique should be followed when handling key parts of any vascular access device. Indications of line-associated infection such as erythema around vascular insertion point, pyrexia with no other clear cause or unknown cause or an unexplained increase of inflammatory markers should be taken seriously and the line should either be removed or antibiotics commenced if the line tip is centrally placed depending on the clinical condition of the child, what the line is being used for and the ongoing requirement for vascular access. Lines should be removed promptly when they are no longer required to reduce the risk of line-associated infection.

The expert group recommends taking an active approach to avoiding post-operative atelectasis. There are little available data about the overall impact that this has but expert opinion is that undertaking regular breathing exercises and encouraging coughs and sighs should be recommended in all patients. Patients with risk factors for atelectasis, due to their co-morbidities, the operation that they have undergone and their post-operative pain requirements, are recommended to be assessed by the physiotherapy team and have a low threshold for active chest physiotherapy which is appropriate for their age.

Post-operative ileus is common and often transient after abdominal procedures. Prolonged ileus can often result in distressing vomiting requiring a nasogastric tube and uncomfortable abdominal distension. Furthermore, it can lead to a prolonged period without nutrition which is tolerated less well in children and can significantly affect their growth. If a child is

anticipated during their initial operation to have a prolonged ileus lasting for more than 72 hours the advice is to place a centrally cited intravenous line which would allow the administration of parenteral nutrition. If a child is anticipated to have an ileus beyond day 5 after the operation and parenteral nutrition can be commenced sooner, then it is appropriate to do so. If a child continues to have an ileus on day 5 then parenteral nutrition is recommended. The administration of parenteral nutrition should be guided by a dietician and there should be electrolyte monitoring to monitor and treat refeeding syndrome.

There should be management of fluid balance in a child with post-operative ileus with careful measurement of fluid intake and output. Generally, nasogastric losses should be replaced ml for ml with 0.9% saline with KCl unless the child has additional co-morbid factors which alter this. Daily electrolyte monitoring is recommended in children with post-operative ileus. (77) Recording of the volume and colour of NG losses is recommended and signs that an ileus is improving include the reduction in volume and lightening in colour of the NG losses, often with a passage of flatus. If there are persistent high NG losses on day 5 after the operation then consideration should be given as to whether the child may be obstructed and if the child is in a non-specialist centre they should be discussed with a specialist centre for commencement of parenteral nutrition and clinical review.

Children with an intra-abdominal collection (IAC) following appendicectomy may never have been discharged from hospital due to ongoing pyrexia or may have been discharged and then re-present with symptoms suggestive of an IAC. Any child with ongoing temperatures on day 7 should have a full infection screen (excluding lumbar puncture unless there is a specific indication for this) and intra-operative cultures should be checked for antibiotic sensitivity and resistance patterns.

A pragmatic approach to imaging for IAC on day 7 or beyond is based on an experience that prior to this any fluid detected earlier than this may be reactive, inflammatory fluid or residual fluid after intra-abdominal washout. Ultrasound evaluation of the abdomen is recommended to identify post-operative IAC. Documentation of the size and location(s) of collection(s) is recommended, along with an assessment of whether the collection(s) are accessible percutaneously or transrectally for drainage, if deemed to be required.

The first-line approach to children with a confirmed IAC is administration of IV antibiotics. If a prolonged course is anticipated to be required then consideration of the optimal method of IV access should be considered early in the clinical course, The use of a peripherally inserted non-central catheter can reduce the number of IV access procedures that are required by the child and improve their inpatient experience.

As a general principle, drainage of pus can hasten the resolution of an intra-abdominal collection. A recent study has suggested that assessing the volume of pus according to patient weight enables a more accurate assessment of whether antibiotic treatment alone will be successful or whether drainage of pus is likely to be required, with a suggested cut-off of 2ml/kg.(79) Further prospective work is required to enable better identification of children who are likely to benefit from early drainage of IAC. The current recommended approach is to commence IV antibiotics and assess for improvement of clinical symptoms. If there are ongoing temperatures or rising or static inflammatory markers after 48-72 hours of conservative management then drainage of an accessible collection should be considered. This may need to be undertaken in a specialist centre by an interventional radiologist. If a collection is drained then the pus should be sent for culture and sensitivity and antibiotics amended accordingly. Some children may develop an ileus secondary to the IAC and they should be managed according to the ‘ileus’ section above with consideration of their

nutritional requirements too. It is unusual for a child to require an operation to treat an intra-abdominal collection and most will respond to antibiotics +/- drainage.
Superficial wound infections and collections are relatively common after appendicectomy. If they are suspected, the wound should be swabbed and the soft tissue collection drained and antibiotics commenced.
Step-down of antibiotics from IV to oral for both IAC and superficial wound infections should be guided by clinical condition. Children with IAC often require a prolonged course of oral antibiotics which can be administered in the community with regular follow-up by the surgical team. Assessment of inflammatory markers and the resolution of IAC using ultrasound can help to guide the duration of antibiotic therapy.

Knowledge gaps:

- Indications for percutaneous drainage of IAC

Audit:

- A radiology network which may include paediatric and adult interventionalists should be established to enable appropriately experienced and trained interventional radiologists are available to undertake percutaneous drainage of intra-abdominal collections in children in an appropriate location.

12) Discharge and follow-up

a) Readiness for discharge should be determined by the clinical team. The following clinical features suggest that a child with appendicitis is ready for discharge:
   i) Oral or no antibiotics without evidence of ongoing pyrexia
   ii) Tolerating oral intake - drinking well and managing moderate diet
   iii) Mobilising requiring simple, oral analgesia
b) Families should receive safety netting advice with who, when and how to contact the appropriate person (people) if they have a concern about their child after discharge
c) Advice about when to return to school and sport should be given. Information should be made available to schools to support children returning to school.
d) Mechanisms to review all histological specimens should be in place in case of unexpected malignancy
e) Follow-up of children with appendicitis
   i) Most children with appendicitis do not need a routine follow-up review
   ii) Children with a complex course after appendicectomy may benefit from follow-up in person or virtually. An individualised approach should be taken for these patients.

Justification for recommendations:
Communication with patients and their families does not end when they are discharged from hospital and high quality advice and support enables a smooth transition from hospital to community care. Safety netting advice regarding the indications for return to hospital, particularly the indicators of intra-abdominal collection and wound infection is important and should be shared verbally with the family and written or video information can help to support this.

Support for families and schools about the transition of returning to school and what the realistic rate of recovery is expected to be can help to enable children's return to school in a safe and timely way.
Most children with appendicitis do not require a routine follow-up review as if they have a problem post-operatively it is very likely to occur before the appointment (particularly an IAC). Some children may benefit from follow-up and a senior decision maker should decide whether a child requires a follow-up appointment.

Knowledge gaps:

- There are few data available on the patient reported outcomes of time to return to school and quality of life after abdominal operations, particularly appendicectomy. These outcomes are important to families and further research into these outcomes are needed.

Audit:

- Provision of written information to families before discharge

* Using age-appropriate paediatric early warning scores
£ When prescribing any medications please check for allergies, contraindications, medication interactions and prescribe according to age and weight recommendations
% Senior decision maker - ST3 (or equivalent) or above
PEWS - Paediatric early warning scores - validated in inpatient use to support the identification of deteriorating or unwell children.

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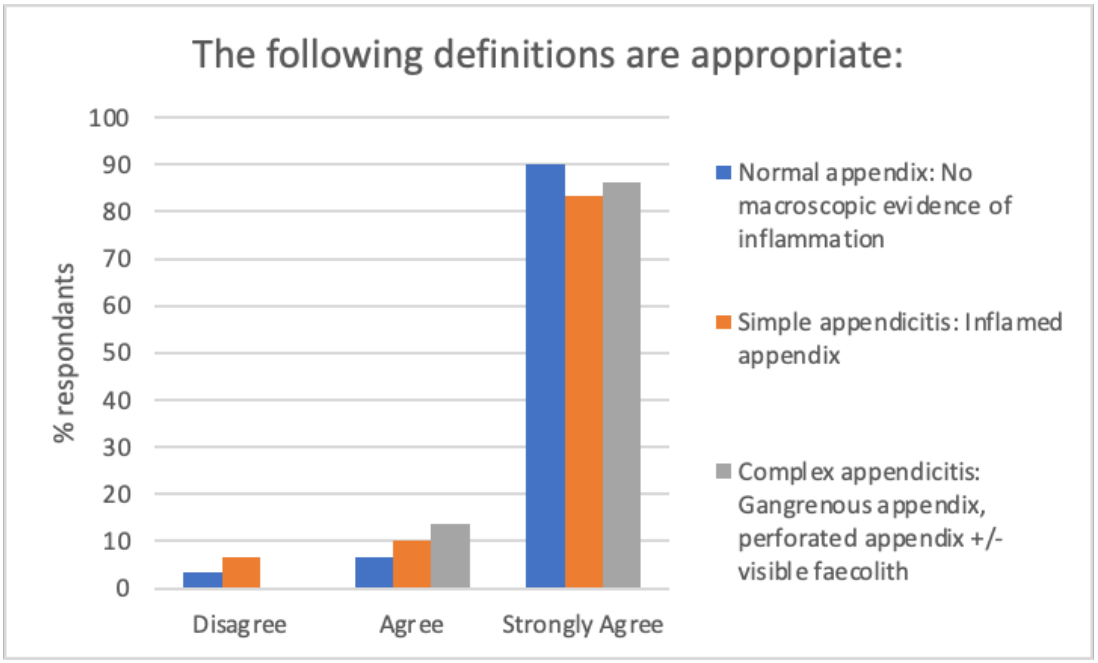
Appendix 1.

Definitions



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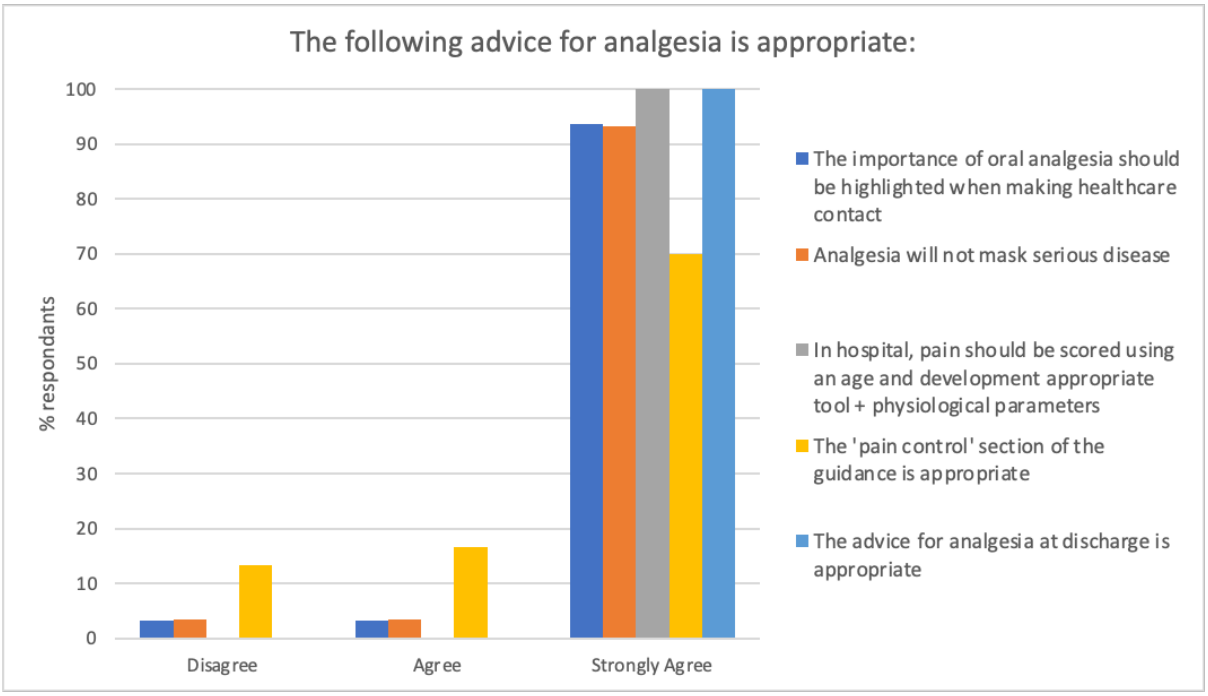
Analgesia



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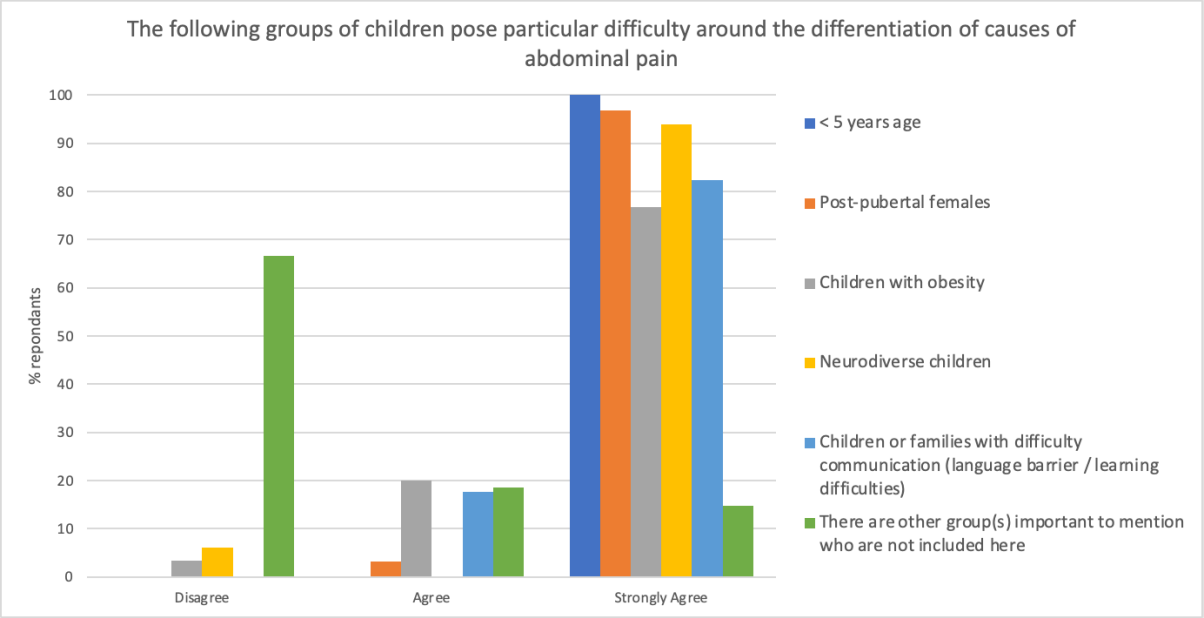
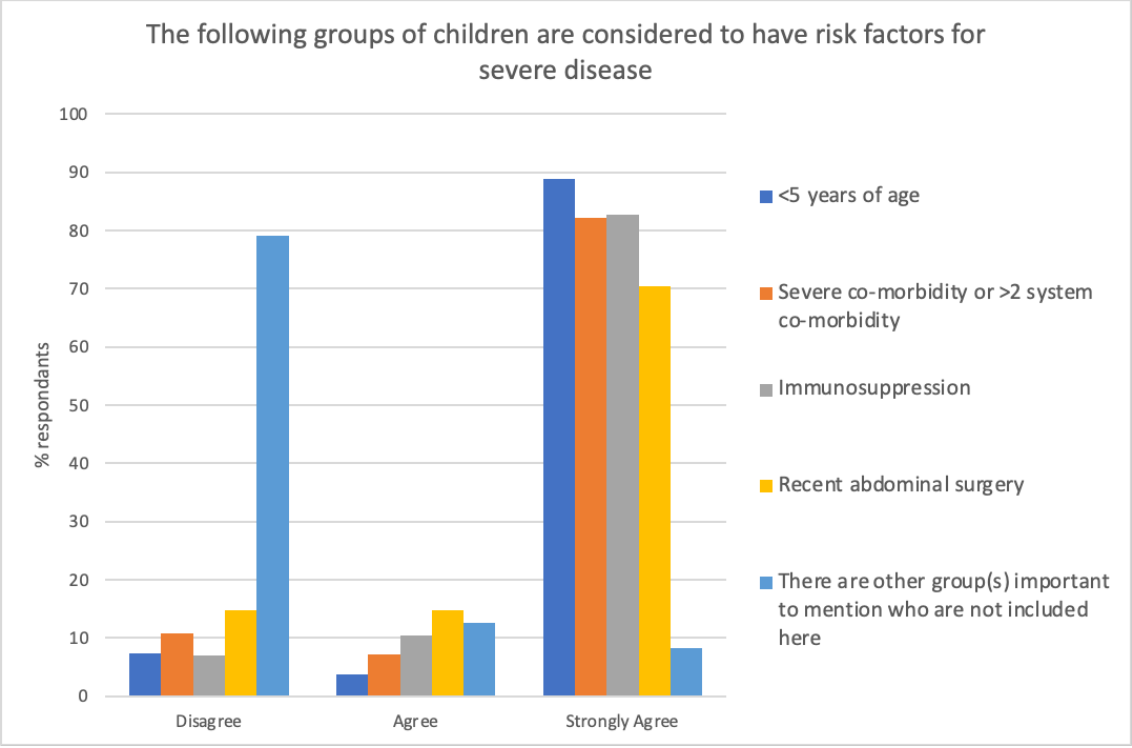
Groups posing diagnostic difficulty



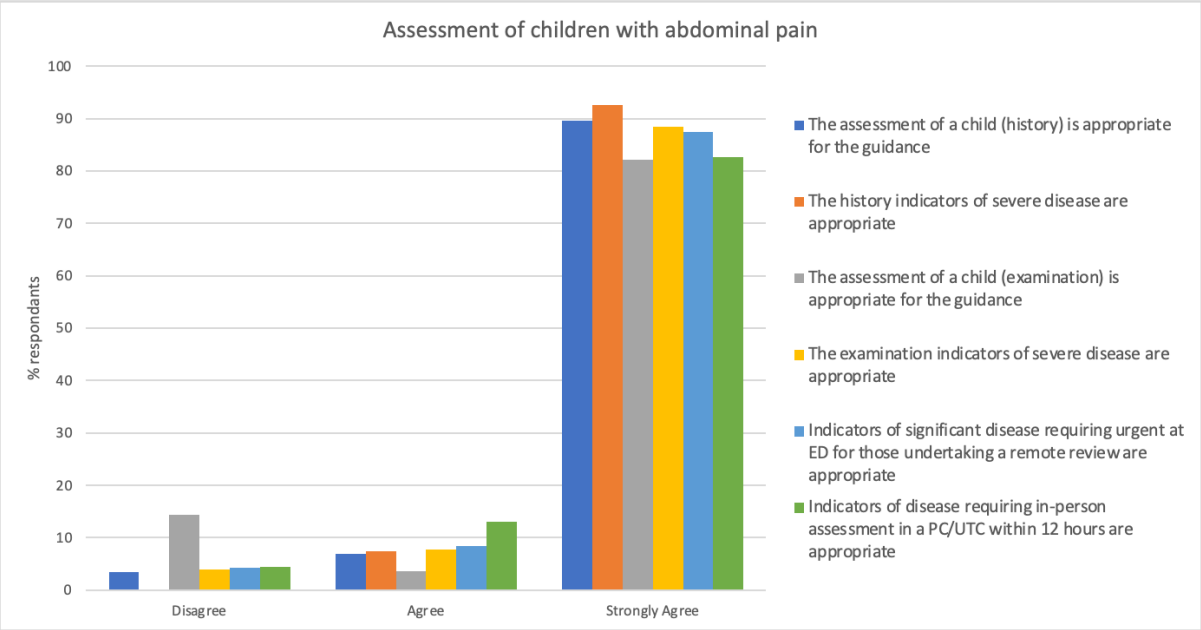
N=35

Groups with risk factors for severe disease



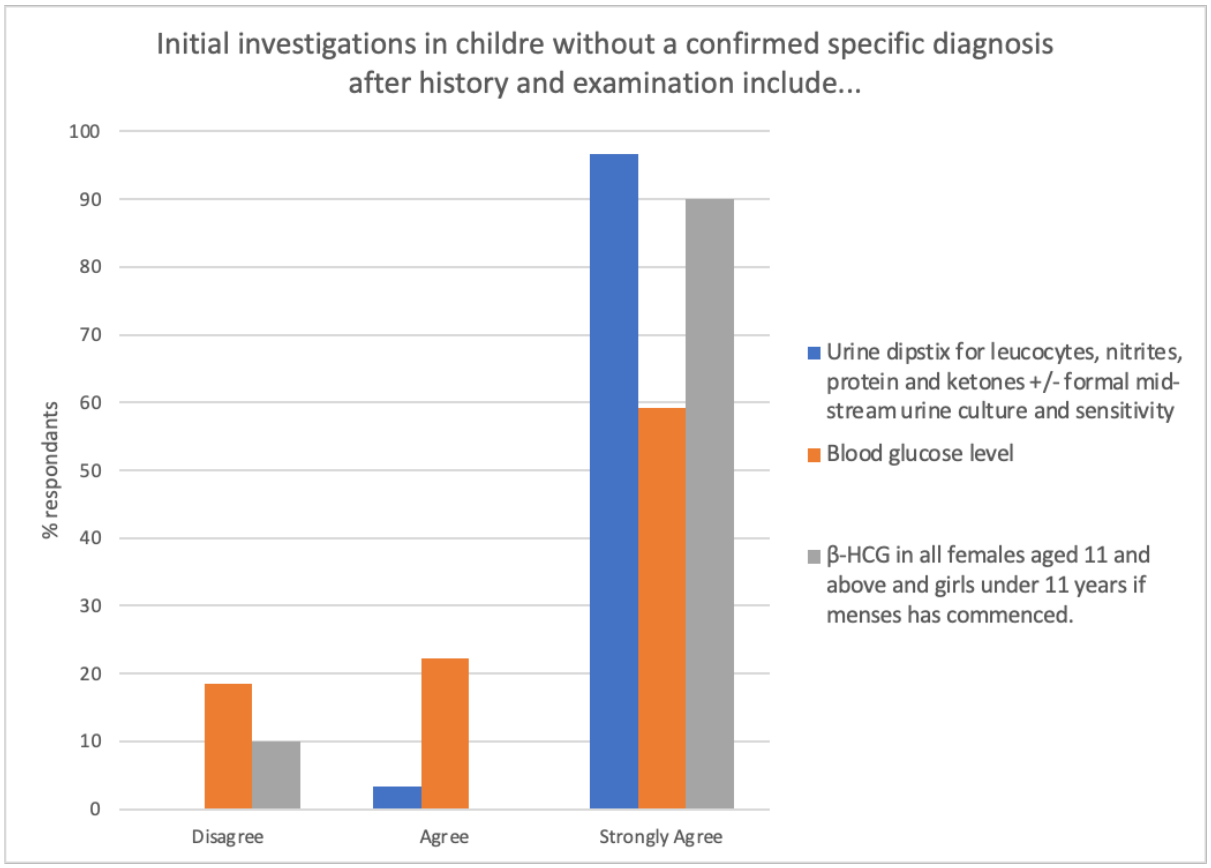
N=33

Assessment of children with abdominal pain



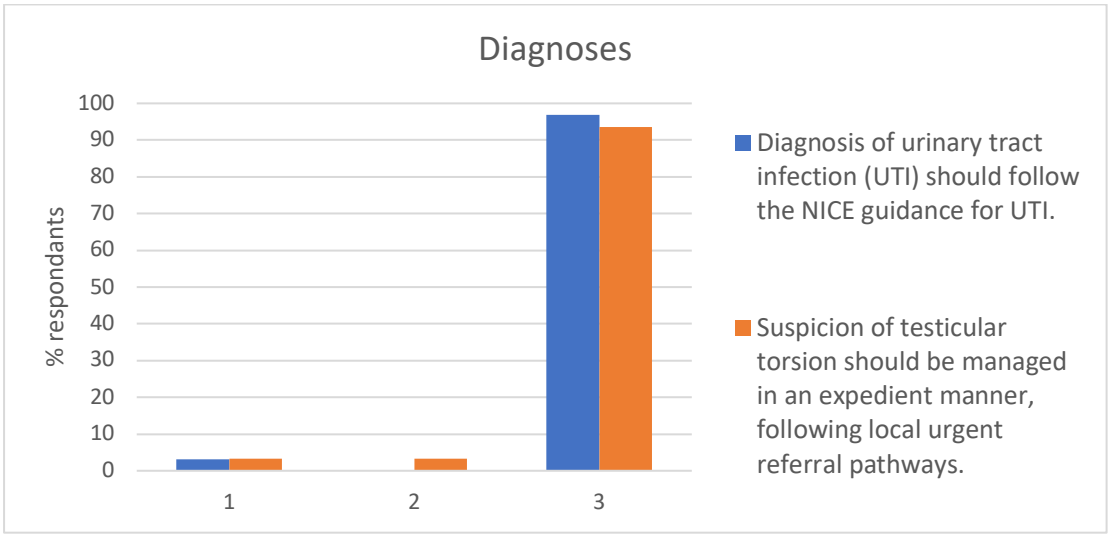
N=32

Initial investigations (primary care or ED)



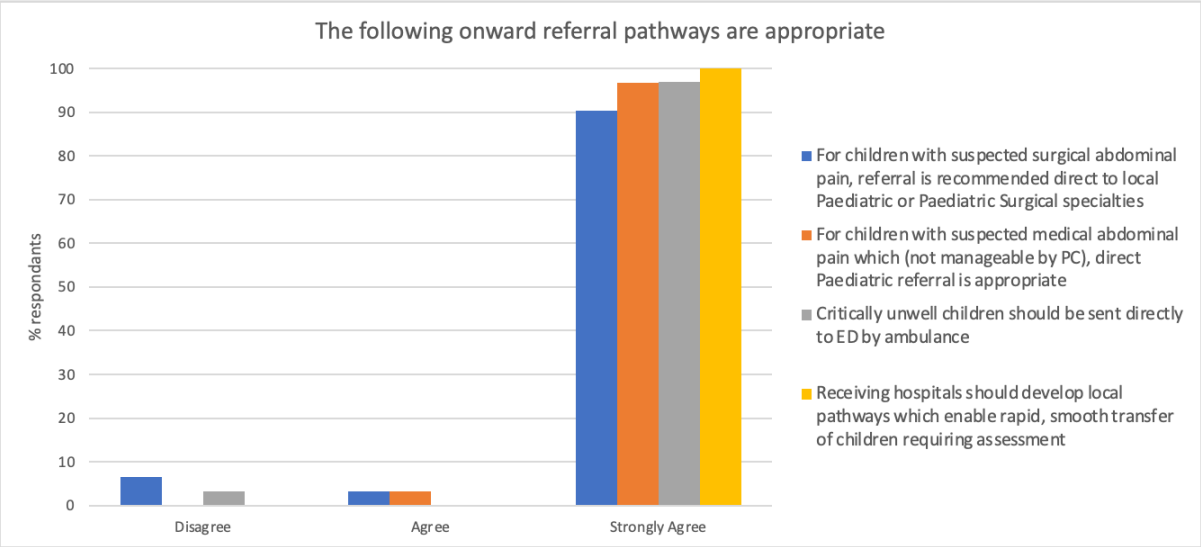
N=32

Specific Diagnoses



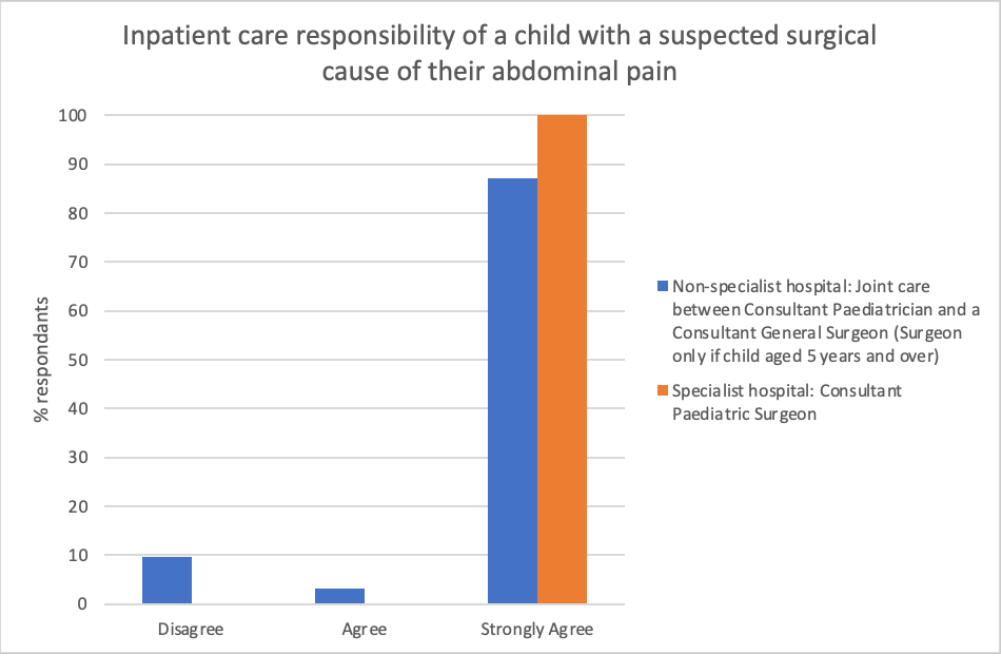
N=33

Onwards referral pathways



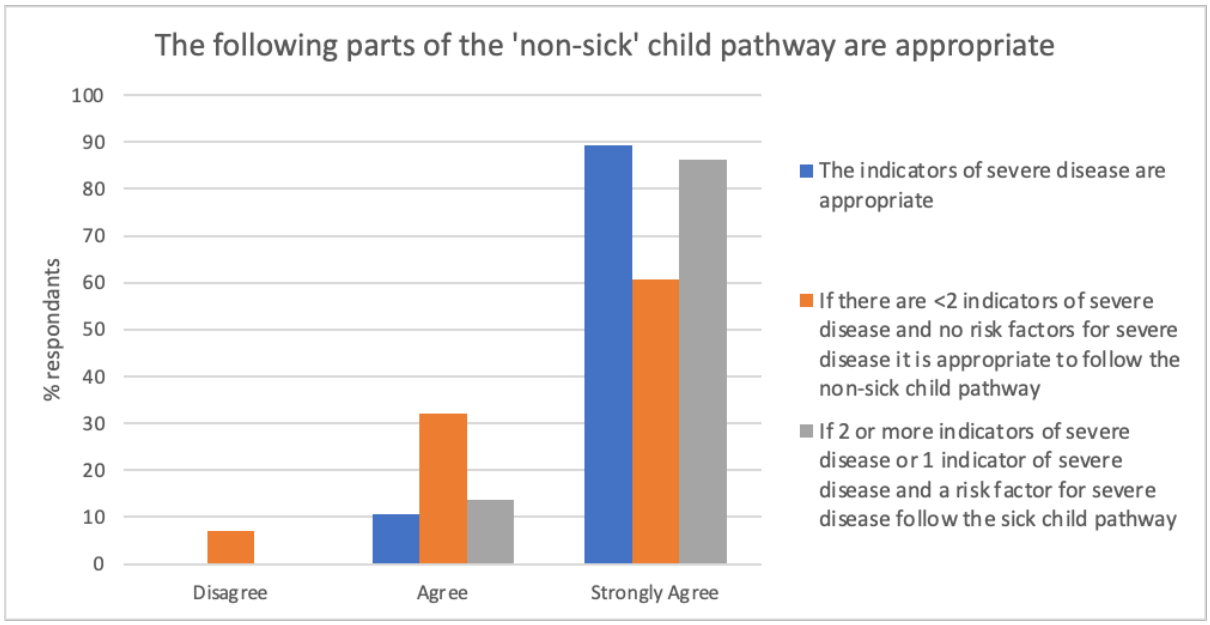
N=32

Inpatient care

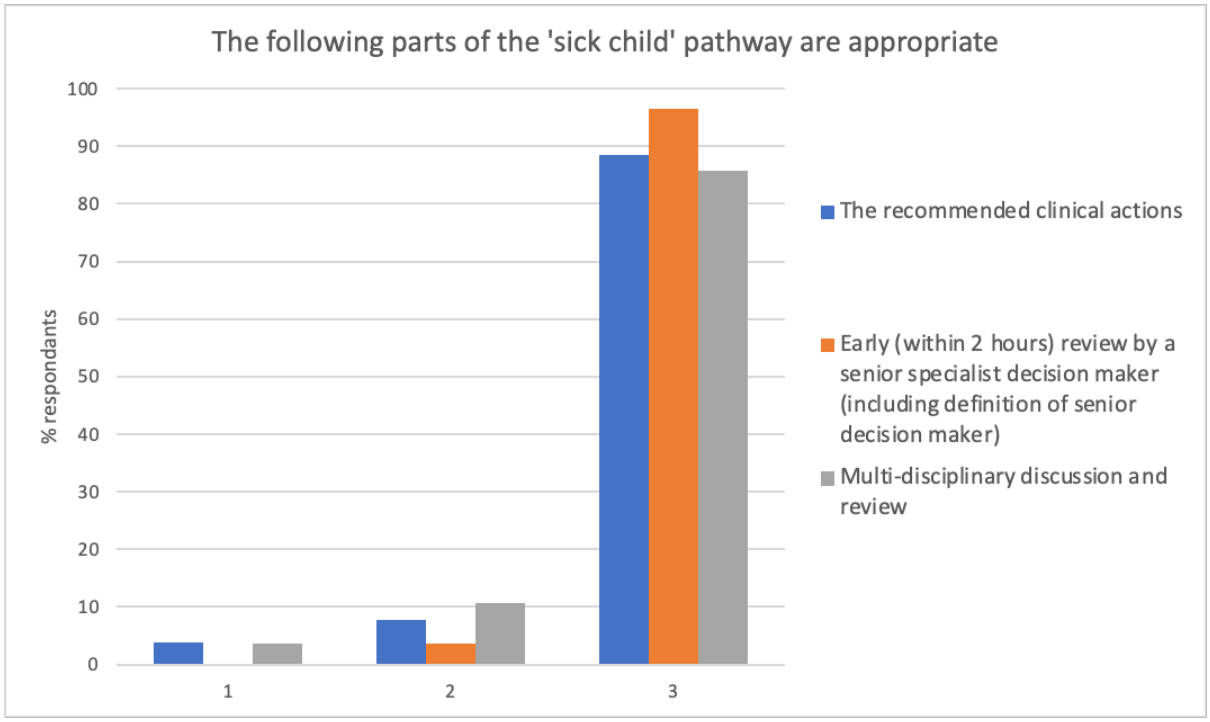


N=32

Patient care pathways

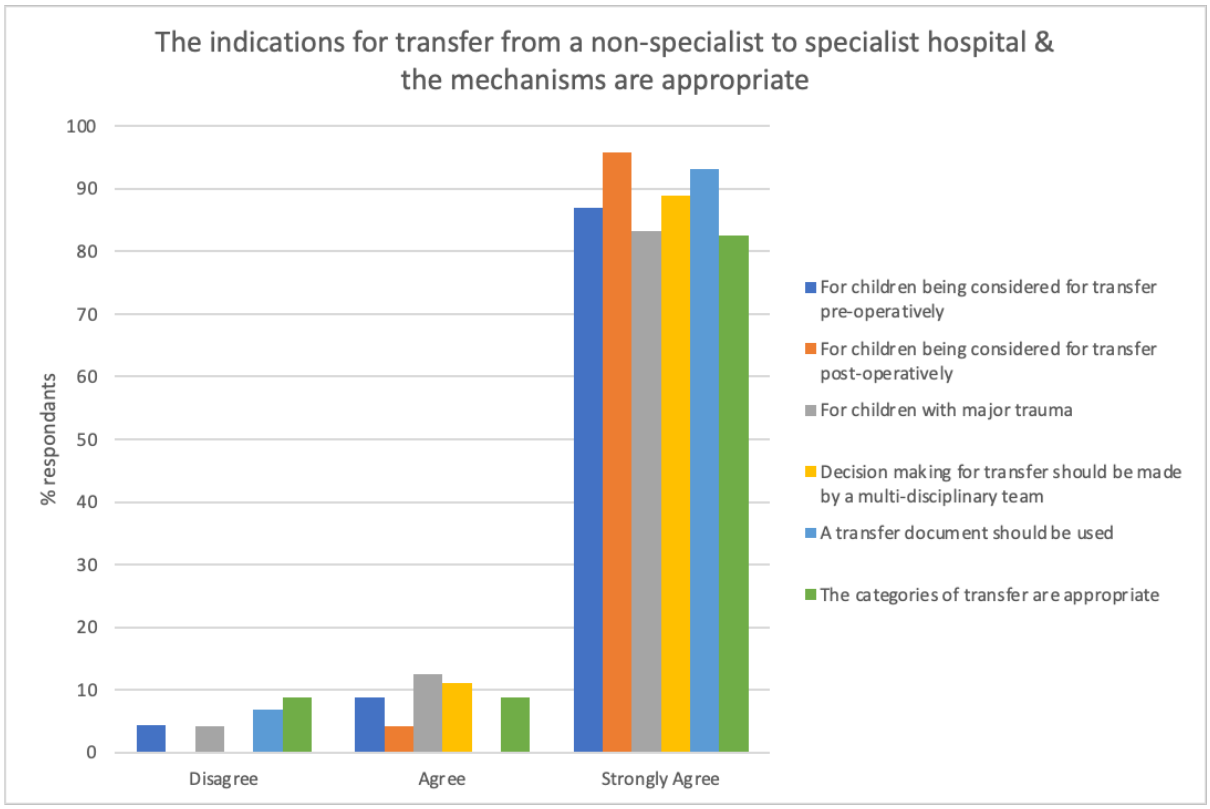

The following parts of the 'non-sick' child pathway are appropriate
% respondants
100
90
80
70
60
50
40
30
20
10
0
Disagree
Agree
Strongly Agree
The indicators of severe disease are appropriate
If there are <2 indicators of severe disease and no risk factors for severe disease it is appropriate to follow the non-sick child pathway
If 2 or more indicators of severe disease or 1 indicator of severe disease and a risk factor for severe disease follow the sick child pathway

N=32


The following parts of the 'sick child' pathway are appropriate
% respondants
100
90
80
70
60
50
40
30
20
10
0
1
2
3
The recommended clinical actions
Early (within 2 hours) review by a senior specialist decision maker (including definition of senior decision maker)
Multi-disciplinary discussion and review

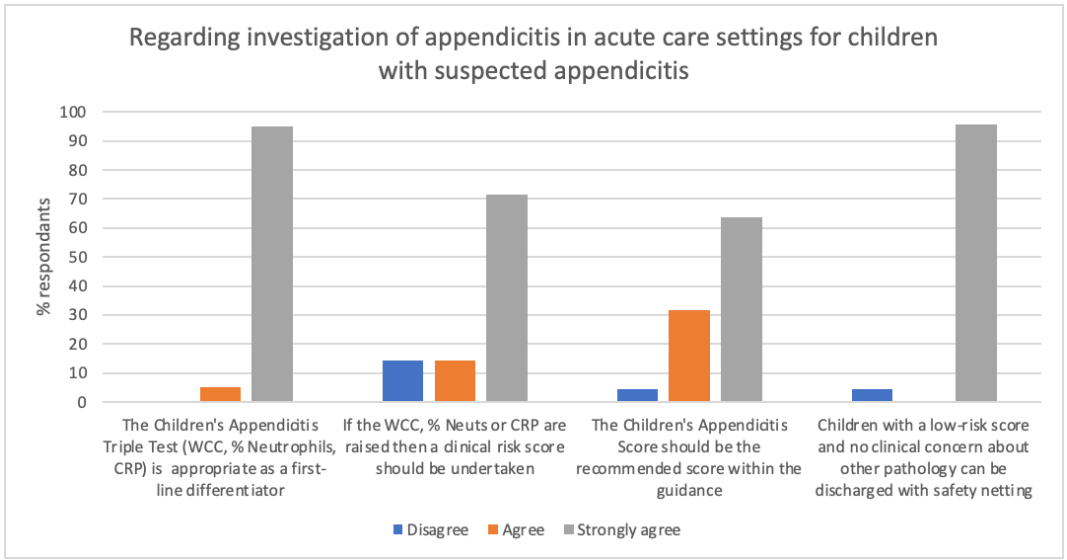
N=32

Indications and mechanisms for transfer to specialist hospitals



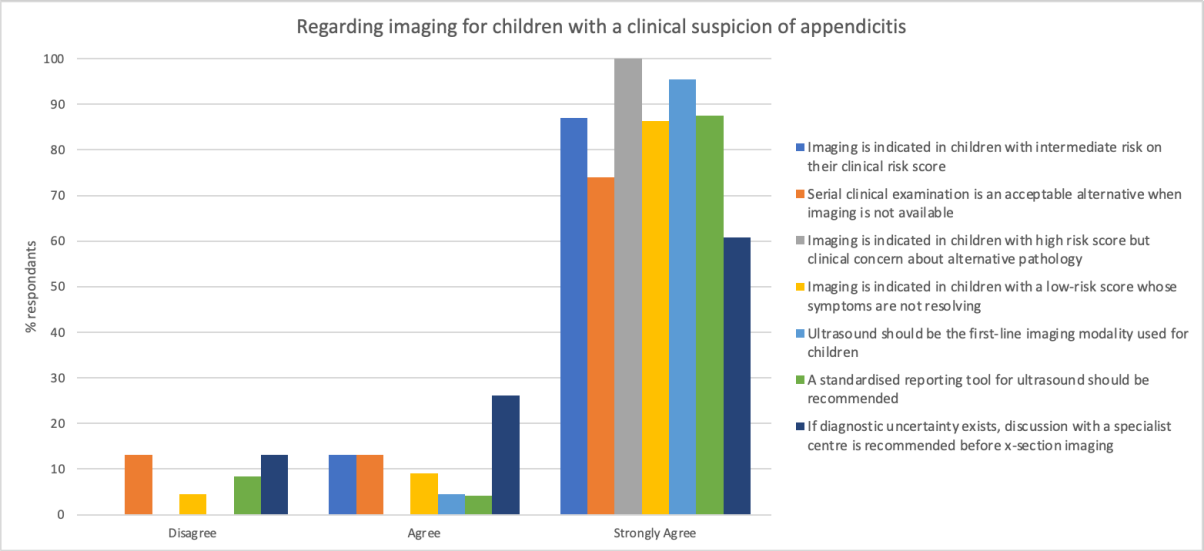
N=30

Investigation of appendicitis



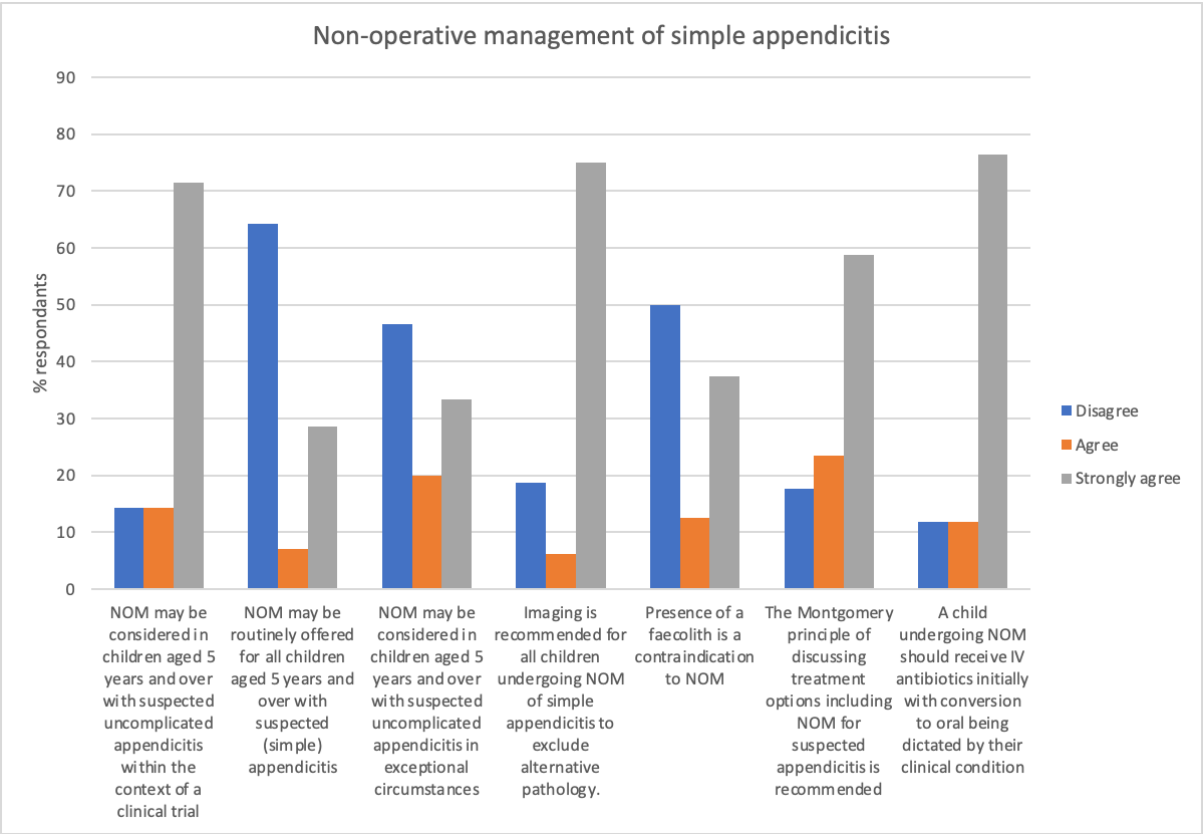
N=32

Imaging of children with suspected appendicitis



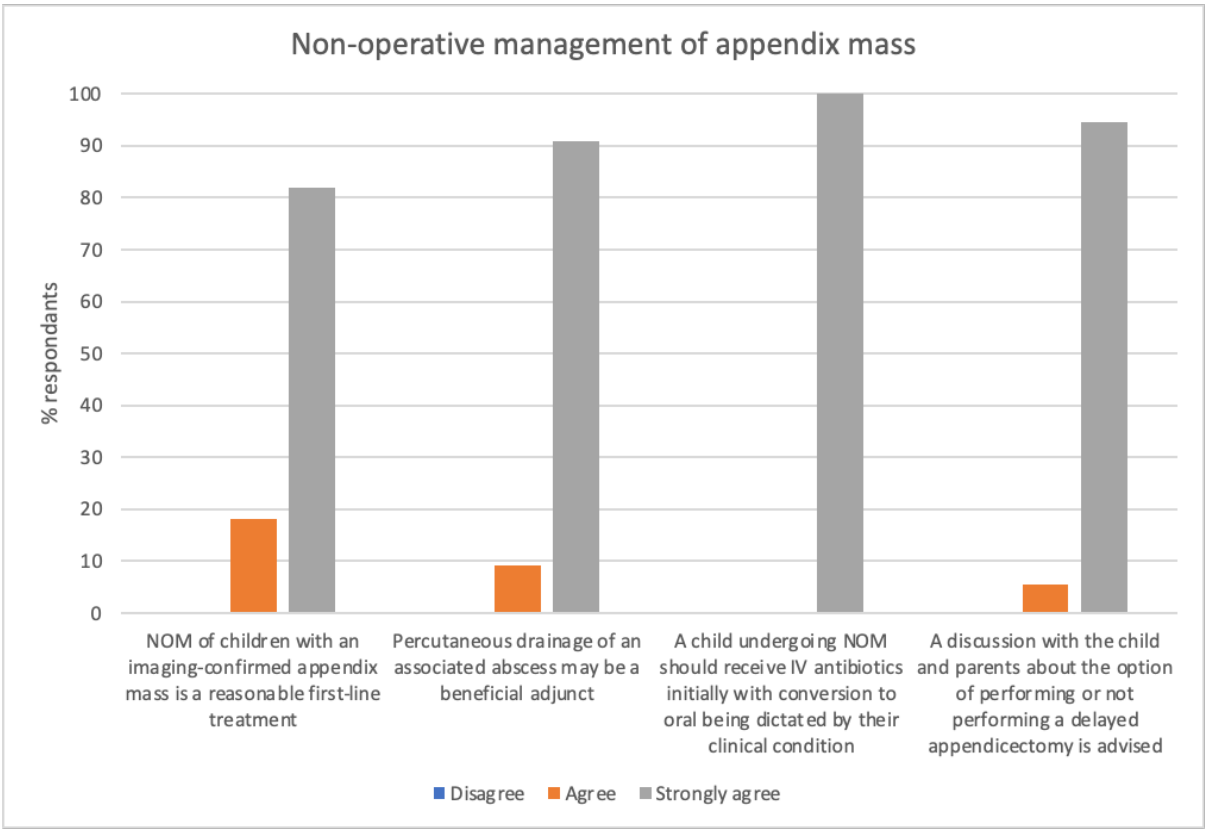
N=29

Non-operative management of simple appendicitis



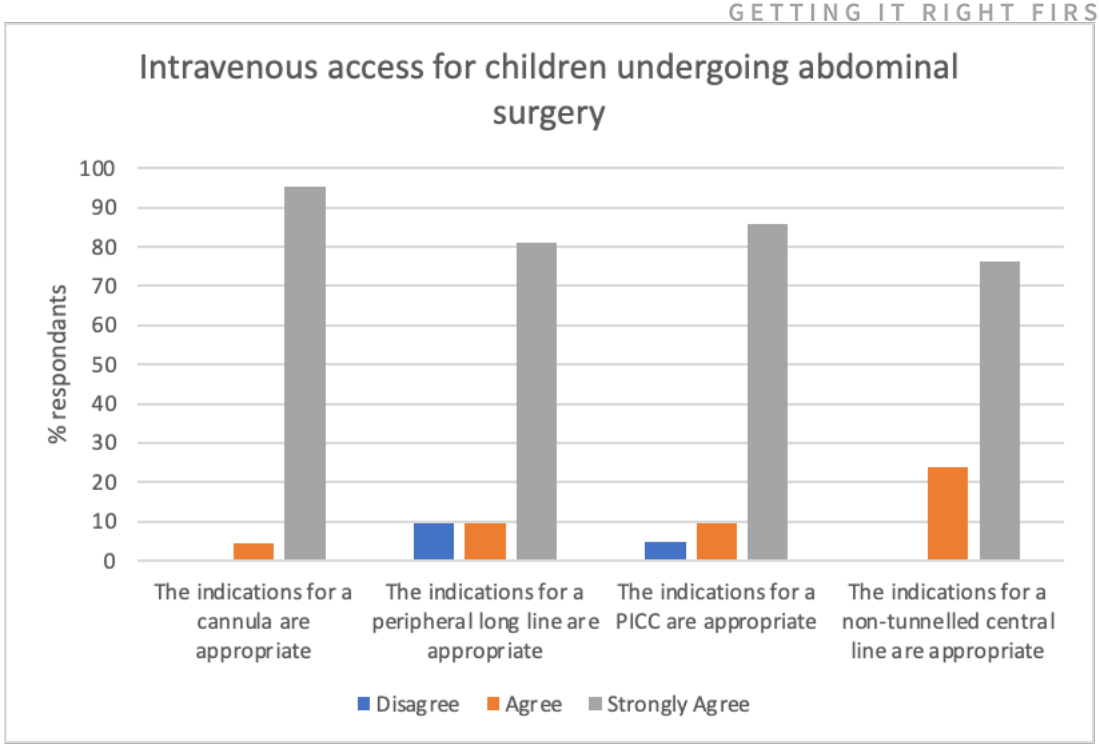
N=27

Non-operative management of appendix mass



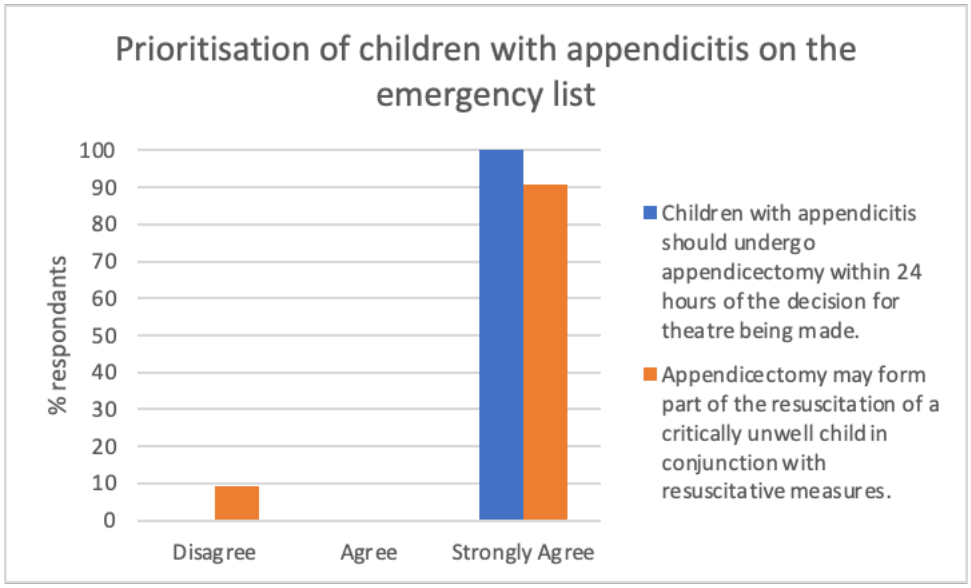
N=23

Intravenous access for children undergoing abdominal surgery

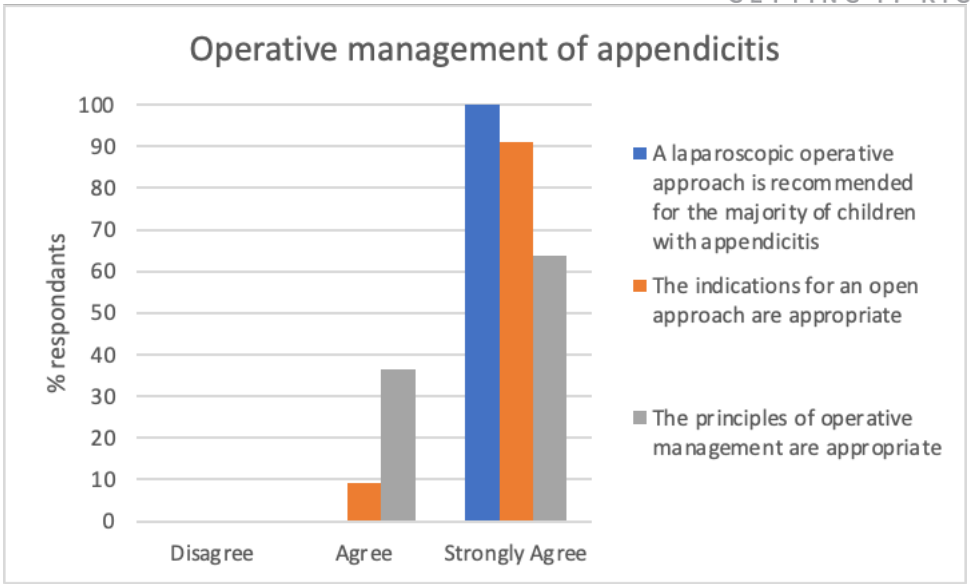


N=23

Operative management of children with appendicitis

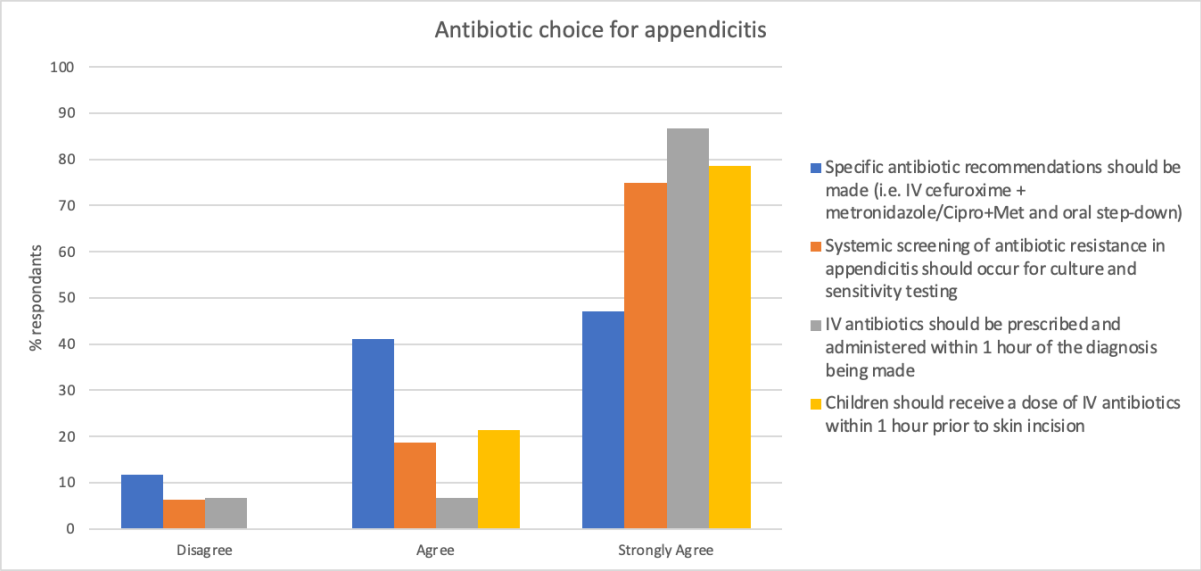


N=24

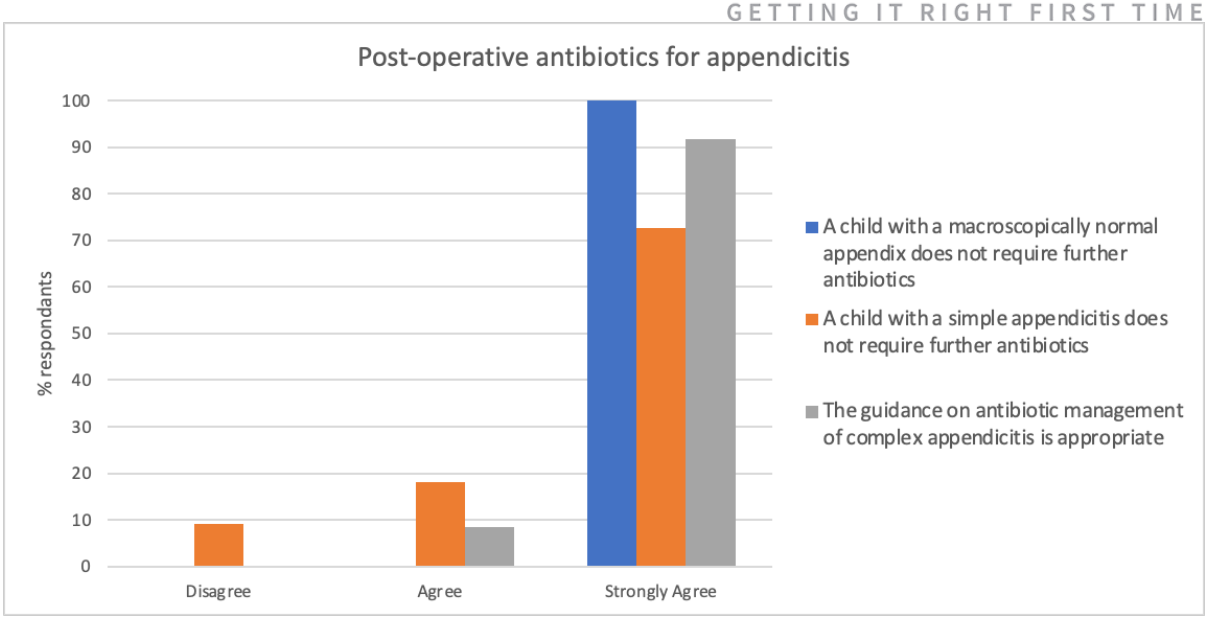


N=21

Anti-microbial management of appendicitis

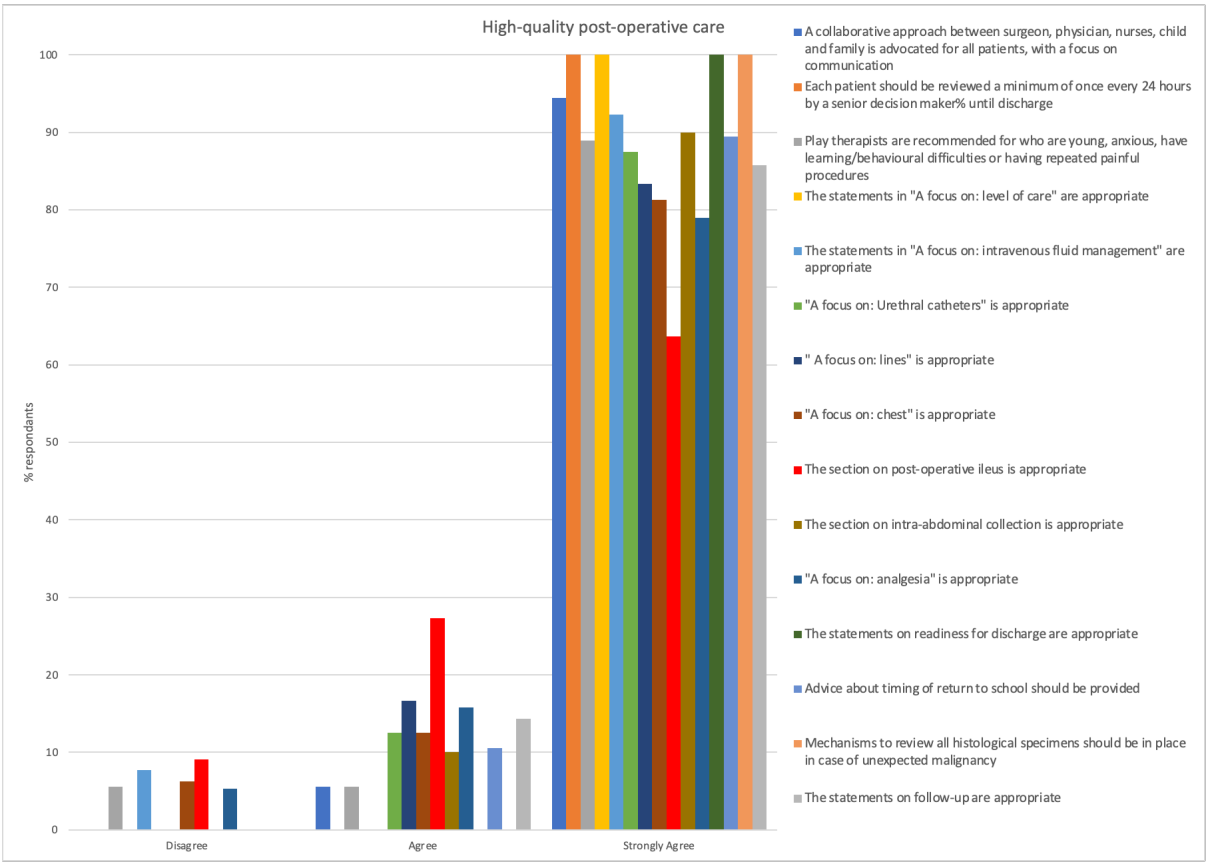


N=22



N=21

Post-operative care



N=20