Original Article

Parental preferences on diagnostic imaging tests for paediatric appendicitis

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Abstract

Objectives: To determine parental preferences for diagnostic imaging tests (DITs) for paediatric appendicitis, to rank the attributes impacting the DIT selection and to identify DIT attributes that would cause parents to switch their DIT.

Methods: Parents of children who had an abdominal ultrasound (US) for right lower quadrant pain were interviewed. Two DITs were compared at a time, parents were asked to indicate their preferred test and to rank its attributes according to the impact each attribute had on their selection. The strength of their preference for the chosen DIT was measured by systematically adjusting attributes of the chosen DIT until the parent changed their choice.

Results: Fifty parents were interviewed. For US versus CT, more parents preferred US (68%, $P=0.02$) with higher importance ranks for cancer risk ($P<0.0001$), test accuracy ($P=0.04$), pain during test ($P=0.3$), and scan length ($P<0.0001$); and lower ranks for sedation ($P=0.02$), intravenous (IV) ($P<0.02$), and oral contrast ($P=0.06$). For US versus MRI, parents preferred MRI (78%, $P<0.0001$) with higher importance ranks for accuracy ($P=0.2$), pain during test ($P=0.06$), and scan length ($P=0.06$); and lower for noise ($P<0.0001$), claustrophobia ($P<0.0001$), use of IV contrast ($P=0.06$), and sedation ($P=0.2$).

Conclusion: US and MRI were the DIT preferred by parents for the investigation of acute paediatric appendicitis.

Keywords: *Parents; Children; Patient-centred; Preferences; Appendicitis; Radiology; Computed tomography; Magnetic resonance imaging; Ultrasound.*

Acute appendicitis is a common cause for abdominal surgery in children (1). Several diagnostic imaging tests (DIT) are currently used for the investigation of appendicitis, including

ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI) (2–7). The decisions regarding the DIT selection are made by physicians and carried

out following informed consent from parents. However, parents' opinions on the DIT to be applied to their children are unknown.

Patient-centred medicine focuses on building a clinical decision-model algorithm, with a patient's health as priority, but also taking into consideration the patient's and parent's perspectives. This approach has been incorporated into the management strategies of certain chronic conditions (8–20). To our knowledge, this approach is relatively new in acute health settings that require urgent care (21).

The objectives of this study were to determine parental strength of preference for the DITs employed in the assessment of paediatric appendicitis; to determine parental strength of importance for the attributes associated with each test; and to identify negative test attributes perceived by parents that would lead them to switch DIT.

METHODS

The study was approved by our institutional research ethics board. Parents were deemed eligible if their child (otherwise healthy) presented to the Emergency Department of a tertiary care level paediatric institution with the chief complaint of right lower quadrant abdominal pain and had undergone an abdominal US as part of their clinical workup. Parents were later approached and asked to participate in this study. The median of years between the US and the time of participation in the study was 5 years (range from 4.5 to 5.5 years). Data from this cross-sectional study was then obtained prospectively and consisted of parents of children interviews performed by three research designees. Informed consent of parents was obtained prior to data collection. Due to the unavailability of a translator for any language other than English at the time of the study, we excluded parents who were unable to speak and read English. One parent per child was interviewed.

A multidisciplinary research team performed thematic analysis of the interview content and design, focusing on current DITs for appendicitis and their attributes (22–27). US is a well-accepted initial DIT to assess appendicitis in the paediatric setting, followed either by CT or MRI (2–7). In our study, we made two comparisons in a randomized fashion: US versus CT, and US versus MRI. The final interview material included a brief summary of the DITs' characteristics including the type of technology and attributes. The DIT attributes were categorized according to different time points of effect as *immediate test attributes*, (physical discomfort/pain, exam length, claustrophobia, noise, use of oral contrast, allergic reaction risk with intravenous [IV] contrast, adverse event risk with sedation); *short-term test attributes* (diagnostic accuracy); and *long-term attributes* (potential risk of cancer with radiation exposure).

Interviewers tested each attribute using theoretical scenarios as follows: with US, increasing levels of abdominal pain ranging from mild to worst pain ever; with CT, increasing/decreasing

a potential risk of cancer associated with radiation exposure; and increasing amount of oral contrast (specifying to parents that the use of contrast would depend on the Radiologist's preference, and that the amount of oral contrast was according to patients' weight. Parents were told they had the option to have their child stop drinking the contrast when they felt that would be the maximum volume tolerated); with MRI, increasing noise level; both CT and MRI, increasing allergic reaction risk associated with IV contrast (emphasizing the worst case scenario, anaphylactic shock), increasing adverse reaction risk associated with sedation (emphasizing the worst case scenario, respiratory arrest, although reassuring the low likelihood of requiring sedation and the very low probability of an adverse event); and increasing/decreasing exam length. Parents then chose one DIT and indicated the level of confidence associated with their test selection using a scale ranging from 'no confidence' (0%) to 'very confident' (100%). The interview process is summarized in Figure 1.

To determine the importance of attributes in helping decide between DIT, parents were asked to rank each attribute on a scale that ranged from 1 to 7 (1 = most important, 7 = least important). Then, to determine the strength of the respondent's preference for their initially chosen DIT, working with one attribute at a time, we systematically either increased or decreased that attribute level, using a threshold method, until the respondent switched to the alternate DIT. The point at which the respondent switched represented the respondent's strength of preference for the original chosen test. Consequently, we obtained a strength of preference score under different attribute conditions. We then reset that attribute back to the baseline and worked with the other attributes. A visual analogue scale (VAS) was employed for the pain attribute, while a threshold method was used for all other attributes. Interviewers explained to parents that an intravenous line is generally placed in the ED to run some blood tests or administer pain medication prior to performing the DIT, so generally there is no need for new venous line placement. Finally, interviewers emphasized that a nurse practitioner, technician, and/or physician are present at all times during the CT or MRI, should an adverse event occur.

Parental characteristics such as age, gender, marital status, first language, profession and level of education were assessed to determine any potential predictors for strength of preference or importance scores. Lastly, parents used a five-point categorical scale to rate the ease-of-use of the threshold method (1 = very difficult, 5 = very easy). Parents used this same scale to rate how useful they thought the VAS and threshold method would be in real-time decision making for assessment of appendicitis (1 = not useful at all, 5 = very useful).

DATA ANALYSIS

Nominal variables were compared using chi squared test or Fisher's exact test. Student's t test and Wilcoxon test were used

Figure 1. The interview process. Step 1. The interviewer initially presented a standard outline on paediatric appendicitis, including prevalence, clinical symptoms and management. Step 2. Then, the parent was informed about the currently available diagnostic imaging tests (DIT) for paediatric appendicitis and their attributes from the point of view of immediate, mid-term, and long-term effects. The parent was asked to picture a hypothetical scenario of their child presenting to the emergency department with the chief complaint of right lower quadrant abdominal pain, and requiring a DIT for assessment of possible appendicitis. Interviewers highlighted that the scenarios were hypothetical, and that a single DIT was not the only test needed to confirm or to exclude appendicitis, or other intraabdominal conditions. Step 3. Parents indicated their test of choice, and indicated their confidence (Step 4) for the selected test. Step 5. Then, parents ranked the test attributes, according to the impact to their selection (most to least important). Step 6. Finally, by using a threshold method we assessed when parents gave up their chosen test.

for continuous and normally distributed and non-normally distributed continuous variables, respectively. All tests of significance were two-sided and statistical significance was set at a *P* value less than 0.05. Predictors of strength of preference for the DIT were identified using logistic regression. All analyses were performed using SAS statistical program for PC, version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

From an original database of 638 parents, 50 (40 female [80%], and 10 male [20%]) agreed to be interviewed in this study (88 had changed address, 30 were non-English speakers, 294 were not interested, and 176 did not meet the study criteria). Most parents were Canadian, married, middle-aged (average age: 47.2 ± 6.4 years), highly educated, and English was their first language (Table 1). Fifty-six per cent ($n=28$) of the parents started the interview comparing US versus CT. When comparing US versus CT (Table 2), parental strength of preference

scores for the DIT were higher for US (68%; $P=0.02$), with 98% of parents expressing 'high/very high confidence' in their selection of US. Parental importance scores for the test attributes were higher for cancer risk ($P<0.0001$), test accuracy ($P=0.04$), pain during test ($P=0.3$), and scan length ($P<0.0001$); and lower for sedation ($P=0.02$), IV contrast ($P<0.02$), and oral contrast ($P=0.06$). The small percentage of parents who chose CT over US, were influenced primarily by the accuracy of CT. These parents ranked the attributes of sedation, IV and oral contrast as *low importance* despite their respective risks including respiratory arrest, anaphylactic shock, and discomfort. Parents stated that they would only switch to CT if the risk of cancer was lowered. On the other hand, those who initially chose CT revealed that they would only switch DIT, if the risk of cancer was increased. Parents mentioned they would accept that their children endured the discomfort associated with US, instead of undergoing a CT.

When assessing parental preference scores for US versus MRI (Table 2), the parental strength of preference scores for

Table 1. Respondent parents and children sociodemographic and clinical characteristics

Gender	N	%
Female respondent	40	80
Male respondent	10	20
Respondent age (years)		
Average	47.2	
SD	6.4	
Child age when hospital visit (years)		
Average	5.3	
SD	4.1	
Child final diagnosis at hospital visit	N	%
Appendicitis	35	70
Other	15	30
Respondent nationality		
Canadian	34	68
Other	16	32
Respondent first language		
English	35	70
Other	15	30
Respondent education		
Less than high school	1	2
Completed high school/college	10	20
Postsecondary	39	78
Marital status		
Married	40	80
Separated/Divorced	8	16
Other	2	4

N Number of subjects; *SD* Standard deviation.

the DIT were higher for MRI (78%; $P < 0.0001$), with 97.5% of parents expressing 'high/very high confidence' in their selection of MRI as their preferred DIT. Parental importance scores for the test attributes were higher for accuracy ($P = 0.2$), pain during test ($P = 0.06$), and scan length ($P = 0.06$); and lower for noise ($P < 0.0001$), claustrophobia ($P < 0.0001$), use of IV contrast ($P = 0.06$), and sedation ($P = 0.2$). Parents continued to choose MRI even when the scan length was increased. The discomforts of noise, use of contrast material, and claustrophobia played little role in parents' selection. Although, parents expressed that the presence/absence of entertainment during the MRI (e.g., movie goggles) would greatly influence how long they felt their child could remain inside the MRI scanner. For those parents who initially chose US, decreasing MRI scan length was an appealing factor to switch to MRI. Also, with the exception of parents who disclosed that their child had claustrophobia, most parents were willing to switch to MRI. Lastly, it was observed that parents who chose US over MRI were willing to subject their child to a higher level of discomfort associated with the US probe, rather than switch to MRI. Interestingly, three parents selected US over

MRI because they perceived MRI to be a DIT used for 'more serious conditions' (i.e., 'brain problems') other than appendicitis.

Linear regression tests revealed that gender, marital status, age, and education level of parents were not predictors of strength of preference for the selection of the DIT ($P > 0.05$). Regarding the interview process and interview material used, 98% of the parents strongly agreed that the interview information was clearly explained. Ninety-four per cent expressed that the decision aids enhanced their understanding. With regard to the VAS, 94% of the parents rated it as 'somewhat useful/very useful' while 100% rated its ease-of-use as 'somewhat easy/very easy'. For the threshold method, 74% of the parents rated it as 'somewhat useful/very useful' while 76% rated its ease-of-use as 'somewhat easy/very easy'.

DISCUSSION

In some institutions, the current clinical diagnostic algorithm for paediatric appendicitis is to perform US, with an interval repeat US if there is ongoing clinical and imaging uncertainty (22). Other institutions perform CT scans more frequently (4,5). MRI is being used following an equivocal US especially in larger paediatric centres, where technology, staff or insurance coverage are available (6,7). MRI may not be available after hours in smaller centres for paediatric appendicitis, although it is increasingly available in real-time across Canada. The decisions regarding DIT selection for assessment of paediatric appendicitis are made by physicians advocating for patients' wellbeing and care. However, in a patient-centred medicine setting, it is also important to communicate to parents about the DIT their children will undergo, and to listen to parents' concerns regarding the tests. This study represents one of the first of its kind to explore parental opinions on DITs for paediatric appendicitis.

In our study, most parents preferred US and MRI as their DIT of choice for paediatric appendicitis. DITs' diagnostic accuracy and the potential risk of cancer associated with CT were the two most important attributes influencing parental decisions. Prior to starting the interview process, interviewers explained to parents the DITs' attributes. However, it is important to mention that the DITs' risk information and attributes were not presented in isolation to parents, but these were discussed with parents in the context of the balance of the clinical benefits and impact on clinical care expected from the DIT.

Regardless of prior knowledge or level of education, parents greatly appreciated the information provided by the interviewers. A similar response was reported in a study by Busey et al., whereby subjects reported a feeling of importance when they were informed about the DITs' characteristics (13). Conversely, we noted that some parents reacted in a similar manner to subjects in another study when provided information about CT, with a decrease in the theoretical willingness to have their children undergo a CT after had been provided

Table 2. Comparison of diagnostic imaging tests' preference and strength of importance scores

Comparing US vs. CT			Comparing US vs. MRI		
DIT preference:			DIT preference:		
	%	P value		%	P value
US	68	0.02	US	22	<0.0001
CT	32		MRI	78	
Confidence for selected test:			Confidence for selected test:		
High/Very high confidence	98%		High/Very high confidence	97.5%	
Strength of importance scores:			Strength of importance scores:		
	Ranks for tests' attributes			Ranks for tests' attributes	
Higher	1. Potential cancer risk	<0.0001	Higher	1. Accuracy	0.2
	2. Accuracy	0.04		2. Pain	0.06
	3. Pain	0.3		3. Length	0.06
	4. Length	<0.0001		4. Noise	<0.0001
Lower	5. Sedation	<0.02	Lower	5. Claustrophobia	<0.0001
	6. OC material	0.06		6. IVC material	0.06
	7. IVC material	0.02		7. Sedation	0.2

CT Computed tomography; DIT Diagnostic imaging test; IVC Intravenous contrast; OC Oral contrast; US Ultrasonography.

Significant $P < 0.05$ for Wilcoxon rank test.

with information about its potential risks (12,15). Although it is difficult to determine if parents' responses in our study were a reflection of the information provided in the interview, previous knowledge/experiences, or what they heard in the media, it is reasonable to infer there were biased perceptions about CT that could have impacted parental choices, despite the potential benefits of this DIT.

We acknowledge that there are several limitations in the design of this study including the small sample size and the fact that our population was not very representative of a general population of paediatric appendicitis patients and their parents. Therefore, the results of this study may not be generalized to other institutions' experiences or different parents' characteristics. The selection bias was also a factor. According to regulations of the local research ethics board, we could only reach out to families of patients who had undergone previous US examinations (solely imaging test) for the assessment of appendicitis. This patient selection restriction yielded a significant spectrum bias toward the application of questionnaires to parents of patients who were asked to compare theoretical experiences of the DIT their child had direct experience with (US), against other DITs they were not familiar with. The time frame between the US and the interview was also a bias, as some parents were no longer interested in participating in the study, and others had a hard time remembering their children's experience. The fact this study was conducted in a tertiary health care centre, may have an implication on positive

and negative predictive values of the DIT for assessment of appendicitis. Also, constructing information to be given to parents about the different DIT attributes was challenging, including the risk of diagnostic doses of radiation, as this is a difficult concept to understand/explain. Finally, the lack of standardized utilities for the assessment of DITs and the fact that we could not elicit utilities from the threshold method employed in this study given characteristics of the method is of consideration. The utility and ease-of-use ratings from parents for the threshold method used in this study revealed that although the method we used was feasible, other techniques like discrete choice experiment could be applied in future studies.

This study showed parental opinions on the DITs for the diagnosis of appendicitis and which DIT attributes were of the greatest importance to parents. It is essential to emphasize that the final decision on which DIT to undergo within available options for a given patient with clinical suspicion of appendicitis relies on the clinician and/or radiologist caring for the patient. Nonetheless, it is important to discuss with parents the DIT attributes and to address parents' concerns as much as possible.

This study represents a first step toward improved understanding on parents of children perspectives on DITs for paediatric appendicitis and may serve as background for more complex studies of larger heterogeneous populations of parents. Understanding parental views on the DITs may also help

physicians to better address common parental concerns, as their early identification may allow for prompt implementation of health care system strategies, including the creation of improved methods for communication to patients and parents with respect to the DITs.

Funding Information

The funding for this study was provided by a peer-reviewed grant from The Physicians' Services Incorporated Foundation.

Potential Conflicts of Interest

In the past 5 years, Dr. Doria has received grants from the Research Support from Bayer Healthcare Inc. (Research Grant), Novo Nordisk Healthcare Inc. (Research Grant), Terry Fox Foundation (Research Grant), Physician's Services Incorporation (Research Grant); advisory committee International Prophylaxis Study Group (not for profit). OMERACT SIG in MRI in JIA (not for profit), Canadian Committee of Point-of-Care Ultrasound; Consultant Baxter Healthcare Inc., Pfizer Healthcare Inc., all unrelated to the current study. All other authors: No reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Results from this project were presented as a Scientific Oral Presentation during the International Pediatric Radiology meeting, in Chicago, Illinois May, 2016. However, we confirm this manuscript has been submitted for publication only to Paediatrics & Child Health.

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