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Systematic Review and Meta-Analysis

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Systematic Review and Meta-Analysis on the Influence of Surgeon Specialization on Outcomes Following Appendicectomy in Children

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Abstract: The aim of this study is to assess the influence of surgeon specialization on outcomes following appendicectomy in children.

General surgeons and pediatric surgeons manage appendicitis in children; however, the influence of subspecialization on outcomes remains unclear.

Two authors searched Medline and Embase to identify relevant studies. Eligible studies were comparative and provided data on children who had appendicectomy while under the care of general or pediatric surgical teams. Two authors initially screened titles and abstracts and then full text manuscripts were evaluated. Data were extracted by 2 authors using an electronic spreadsheet. Pooled risk ratios and pooled mean differences were used in analyses.

We identified 9 relevant studies involving 50,963 children who were managed by general surgery teams and 15,032 children who were managed by pediatric surgery teams. A normal appendix was removed in 4660/48,105 children treated by general surgery units and in 889/14,760 children treated by pediatric units (pooled risk ratio 1.79; 95% confidence interval [CI] 1.26–2.54; $P = 0.001$). Children managed in general units had shorter mean hospital stays compared with children managed in pediatric units (pooled mean difference −0.70 days; 95%CI −1.09 to −0.30; $P = 0.0005$). There were no significant differences regarding wound infections, intra-abdominal abscesses, readmissions, or mortality.

We found that children who were managed by specialized pediatric surgery teams had lower rates of negative appendicectomy although mean length of stay was longer. Our article is based upon a group of heterogeneous and mostly retrospective studies and therefore there is little external validity. Further studies are needed.

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Abbreviations: CI = confidence interval, CT = computed tomography, IQR = interquartile range, N/A = not available, PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses, SD = standard deviation, SEM = standard error of the mean.

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INTRODUCTION

Appendicitis is the most common pediatric surgical emergency.[1] There are in excess of 40,000 cases in England annually[1] and its incidence is about 9.4 cases per 10,000 patient years.[2] In 2010, the Global Burden of Disease Study estimated that appendicitis causes 19 years of life lost per 100,000 population and 21 disability adjusted life years per 100,000 population globally;[3] therefore, it is important that we strive to improve the management of appendicitis.

An expanding body of evidence suggests that surgeon subspecialization affects outcomes; studies found that colorectal surgery subspecialization[4] and orthopedic surgery subspecialization[5] lead to improved results and that outcomes from a variety of cancers are improved with subspecialization.[6] Higher volume surgeons have also been shown to generate improved outcomes.[7] At present, appendicitis in pediatric patients is managed by both general surgeons and specialized pediatric surgeons;[8] however, the influence of surgeon subspecialization on outcomes is unclear. We performed a systematic review and meta-analysis to determine the influence of surgeon subspecialty on outcomes following appendicectomy in children. Our hypothesis was that surgeon specialization influences outcomes in appendicitis in children.

METHODS

This systematic article was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. There was no requirement for ethical approval.

Eligible studies were comparative and provided data on children who had appendicectomy while under the care of general or pediatric surgical teams. Randomized and observational studies were eligible. Eligible studies had to report on at least 1 of the following outcomes: normal appendicectomy rate, wound infections, intra-abdominal collections, readmissions, mortality, and length of stay. We excluded studies that reported selectively on laparoscopic or open procedures. We also excluded review articles, case reports, and case series and we limited eligibility to English language studies.

In order to identify studies and determine eligibility, 2 authors (DD and MM) independently searched Medline and EMBASE up to June 24, 2015 using the following search strategy "([paediatric surgery OR pediatric surgery OR pediatric surgeon OR paediatric surgeon] AND (appendectomy OR appendicectomy)]." The search terms were inputted as free text. Titles and abstracts were examined initially and then full manuscripts were obtained to finalize eligibility. The reference lists of eligible studies were examined to identify further studies. In cases where there was disagreement regarding eligibility, a third reviewer (DH) was consulted. In addition, conference abstracts from a variety of pediatric surgery meetings were searched by 1 author (EM). These comprised the Surgical Section of the American Academy of Pediatrics (2004–2014), the British Association of Paediatric Surgeons (2004–2014), the American Pediatric Surgical Association (2004–2014), the Canadian Association of Paediatric Surgeons (2004–2014), the Pacific Association of Pediatric Surgeons (2004–2014), the Association of Surgeons of Great Britain and Ireland (2004–2014), and the American College of Surgery (2004–2014).

Two authors (DD and DH) independently extracted data from eligible studies using an electronic spreadsheet. Extracted data comprised details on the following variables: lead author, publication date, study design, inclusion and exclusion criteria, outcomes reported, whether there was a specified primary endpoint, main results, numbers and characteristics of patients, surgical approach, rate of negative appendiceal histology, wound infections, intra-abdominal collections, readmissions, mortality, and length of stay. The outcomes for the meta-analysis were rates of negative appendiceal histology, wound infections, intra-abdominal collections, readmissions, mortality, and length of stay. Definitions and timeframes for these outcomes were those specified in individual manuscripts.

Study quality was assessed using the Downs and Black tool.[9] This involves 27 questions that evaluate reporting quality as well as internal and external validity. The checklist allows scores from 0 to 32 which includes a score of 0 to 5 for sample size estimation. We modified the sample size estimation section by awarding 1 point for providing justification for sample size and no point in the absence of justification. Therefore, our quality checklist could award scores varying from 0 to 27 with larger scores denoting higher quality.

Statistical analyses were completed using RevMan version 5.3[10] (Cochrane Collaboration, Copenhagen, Denmark). Pooled risk ratios and pooled mean differences were used to evaluate the effect of treatment by general surgery units or pediatric surgery units on dichotomous and continuous outcomes, respectively. We used Mantel Haenszel random effects models. The potential for publication bias was evaluated by visually inspecting funnel plots. Statistical heterogeneity was assessed using the I^2 statistic. Higher I^2 values indicate increased heterogeneity. Results were given with 95% confidence intervals (CIs) and *P* values where appropriate and we used the 5% level for significance.

RESULTS

We identified 1035 Medline sources and 1868 Embase sources. Figure 1 summarizes the results of the search. A total of 1841 citations were excluded based on titles and abstracts. A total of 27 full text manuscripts were examined and 9 studies were finally eligible for inclusion. No additional studies were identified from the gray literature search or from searching included article reference lists.

Characteristics of the 9 included studies[8,11–18] are shown in Table 1 and results from the studies are provided in Table 2. In total the studies comprised 50,963 children who were managed by general surgery units and 15,032 children who were managed by pediatric surgery units. Nine of the studies[11–18] were retrospective cohort studies and 1[8] was a prospective cohort study. Two studies (63,282 children) were retrospective analyses of registry-based hospital discharge data.[13,18] The other 7 studies (2713 children) concerned specified institutions and were either single-center[12,17] or multicenter.[8,11,14–16] Recruitment dates for included studies spanned the period from 1993 to 2012. The age ranges for the eligibility of patients within studies also varied – the maximum age of any included patient was 18 years. No study reported explicitly on criteria that determined whether patients were managed by general surgery teams or pediatric surgery teams – however we think that allocation is likely to have reflected the nature of the on-call team and available resources at any particular time. Most of the studies reported on the proportions of patients who underwent laparoscopic or open appendicectomy procedures[8,11,12,14,16,17] although these data were not reported in some studies.[13,15,18,19] Few studies reported conversion rates from laparoscopic to open surgery.[8,16] Only 2 studies[8,17] specified a single primary endpoint: 1 favored the pediatric surgery group[8] and there was no primary outcome difference in the other.[17] The results of the quality assessment are available in a supplementary table and are also summarized in Table 1.

Seven studies[8,11–14,16,18] (62,865 children) reported on numbers of histologically negative appendicectomies. A normal appendix was removed in 4660/48,105 children treated by general surgery units and in 889/14,760 children treated by pediatric units (pooled risk ratio 1.79; 95%CI 1.26–2.54; $P = 0.001$) (Figure 2). There was evidence for considerable heterogeneity with an I^2 value of 90%. The funnel plot did not suggest publication bias.

Eight studies[8,11–17] (23,718 children) reported on wound infections. This complication occurred in 317/18,312 children treated by general surgery units versus 118/5406 children who were treated in pediatric surgery units (pooled risk ratio 1.25; 95%CI 0.64–2.44; $P = 0.52$) (Figure 3). There was substantial heterogeneity with an I^2 statistic of 63%. The funnel plot did not suggest publication bias.

Seven studies[8,11,12,14–17] (2691 children) reported on intra-abdominal collections. This complication occurred in 34/1443 children who were treated in general surgery units versus 32/1248 children who were treated in pediatric units (pooled risk ratio 1.24; 95%CI 0.47–3.25; $P = 0.66$). There was evidence for substantial heterogeneity with an I^2 statistic of 61%. The funnel plot was asymmetrical indicating possible publication bias.

Eight studies[8,11–17] (23,700 children) reported on readmissions. This occurred in 285/18,301 children treated in general surgery units versus 90/5399 children managed in pediatric surgery units (pooled risk ratio 1.62; 95%CI 0.85–3.06; $P = 0.14$). There was evidence for substantial heterogeneity with an I^2 statistic of 73%. The funnel plot did not suggest bias.

Three studies[11,13,14] (24,665 children) reported mortality. One of 19,863 children managed by general surgery units died versus 0/4802 managed by pediatric surgery units (pooled risk ratio 2.35; 95%CI 0.10–57.51; $P = 0.6$). It was not possible to general an I^2 statistic based upon these data. The funnel plot did not suggest bias.

Two studies[13,16] (21,430 children) reported on length of hospital stay. Children managed in general units (17,115 children) had shorter mean hospital stays compared with children managed in pediatric units (4315 children) (pooled mean difference −0.70 days; 95%CI −1.09 to −0.30; $P = 0.0005$). There was evidence for considerable heterogeneity with an I^2 statistic of 98%. The funnel plot did not suggest bias.

DISCUSSION

In our article, we examined the influence of surgical specialty on outcomes following pediatric appendicectomy procedures. We included 9 studies comprising 65,995 children and focused on patient important outcomes. We found that

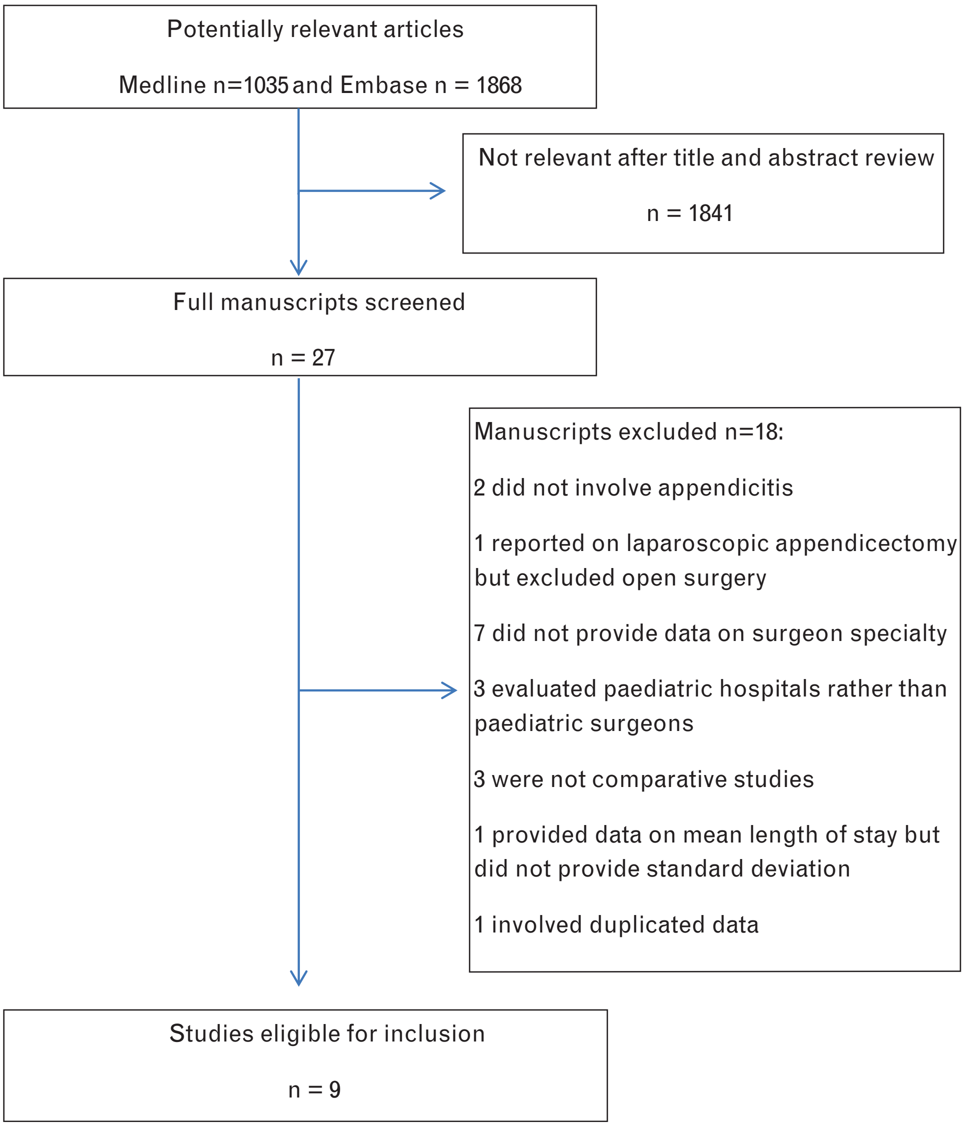

FIGURE 1. Results of the search.

children who were managed by general surgeons were more likely to have removal of a histologically normal appendix (pooled risk ratio 1.79; 95%CI 1.26–2.54; $P = 0.001$) and mean length of stay was significantly longer in children treated by pediatric surgeons (pooled mean difference 0.70 days; 95%CI 0.30 to 1.09; $P = 0.0005$) compared with those treated by general surgeons. There were no significant differences between the groups regarding wound infections, intra-abdominal collections, and readmission rates. We think that our findings are noteworthy because appendicectomy is the most common pediatric surgical emergency. Despite this, our findings must be interpreted with caution as our article is based entirely upon observational data.

Several noncausal factors may account for the observed difference in the negative appendicectomy rate. One possibility is that specialized pediatric units may have better access to high quality imaging. Four studies reported on the use of preoperative imaging[8,11,16,17] – 1 study found no difference in use of imaging,[11] 2 studies found that children who were managed by specialized pediatric surgical teams were more likely to have undergone ultrasound scanning.[8,17] The final study found similar overall use of imaging (computed tomography scanning and ultrasonography) across the groups but more use of computed tomography in the general surgery group.[16] Another possible explanation relates to the tendency for children with more severe disease to have been managed by pediatric surgical teams – in many of the included study rates of perforation and gangrene were higher in the pediatric surgery group (Table 2). Another possibility is that management in pediatric units may reflect enhanced processes of care. It is important to highlight that both groups in our article had acceptably low-negative appendicectomy rates (9.7% in the general surgery group versus 6% in the pediatric surgery group) but nonetheless any true improvement in this outcome is likely to be clinically meaningful. Regarding the difference in length of stay, we think that the difference we observed probably reflects the tendency for

TABLE 1. Characteristics of Included Studies

Study	Date Published	Design	Inclusion	Exclusion	Outcomes Reported	Specific Primary Outcome	Main Results
Alexander	2001	Retrospective multicenter cohort study	Consecutive children aged 17 years or younger who underwent emergency appendicectomy between March 1994 and December 1997	None specified	Number of imaging tests performed, operation type, complications, readmissions, and length of stay	No specified primary outcome	No difference in use of imaging. There was increased use of laparoscopy in the general surgeon group. No difference in complications or readmissions. In the subgroup of those with perforated appendicitis, there were fewer complications and shorter length of stay in the pediatric surgery group.
Emil	2007	Retrospective single center cohort study	Consecutive children aged younger than 18 years who were treated for appendicitis between January 2002 and April 2004	Interval appendicectomy cases were excluded	Complications, length of stay, hospital charges	Normal appendicectomy, readmissions, wound infections, length of stay were specified as primary outcomes	No difference in outcomes.
Somme	2007	Retrospective cohort study based upon hospital discharge data from Ontario, Canada	Children less than 19 years of age who had appendicetomy for appendicitis between 1993 and 2000	Incidental appendicectomy patients were excluded	Length of stay, wound infections, readmissions within 30 days, rate of negative appendix histology	No specified primary outcome	Negative appendicectomy rate was lower in the pediatric surgeon group although length of stay was longer. More perforated disease occurred in the pediatric surgery group.
Whisker	2009	Retrospective multicenter cohort study	Children aged younger than 16 years who had surgery for suspected appendicitis between January 2005 and September 2007	Incidental appendicectomies	Negative histology rate, incidence of perforated appendicitis, length of stay, complications	No specified primary outcome	Patients were younger and more frequently had perforations in the pediatric surgeon group. Laparoscopy was used more often and length of stay was longer in the pediatric surgeon group.
Collins	2010	Retrospective multicenter cohort study	Children aged from 6 to 15 years of age who had appendicectomy between 2004 and 2007	Elective, incidental or interval appendicectomy procedures were excluded	Preoperative pain scores, antibiotic prescription, operations after midnight, complications, readmissions	No specified primary outcome	More complications and readmissions occurred in the district general hospital cohort.

Study	Date Published	Design	Inclusion	Exclusion	Outcomes Reported	Specific Primary Outcome	Main Results
Mizrahi	2013	Retrospective multicenter cohort study	Consecutive appendicectomies for acute appendicitis performed in patients younger than 16 years of age between January 2008 and December 2009	Interval and incidental appendicectomies were excluded. Procedures carried by general surgery attending surgeons were excluded	Complications, readmissions, rate of negative histology, antibiotic use, length of stay	Morbidity and length of stay	Complication rates were similar. Length of stay was shorter in the general surgery group.
da Silva	2014	Retrospective single center cohort study	Consecutive children aged less than 16 years who underwent appendicectomy between January 2010 and December 2011	Incidental appendicectomy, removal of a histologically normal appendix, interval appendicectomy	Complications, length of stay, time from emergency department assessment to operating room, readmissions within 30 days	Complication rate	Overall complication rate was not different. Intra-abdominal abscesses occurred more frequently in the group treated by general surgeons. Other outcomes were not different.
Tiboni	2014	Prospective multicenter cohort study	Consecutive children less than 16 years who underwent appendicectomy for suspected appendicitis between May 2012 and June 2012	Interval or incidental appendicectomies were excluded	Negative appendicectomy rate, use of imaging preoperatively, use of laparoscopy, consultant involvement, 30 day adverse events including infections, readmissions and reinterventions	Normal appendicectomy rate	Negative appendicectomy rate was lower in the pediatric surgery group. Adverse event rates were similar.
Cheong	2014	Retrospective cohort study based upon hospital discharge data from all hospitals in Canada except for Quebec	Patients less than 18 years of age who had appendicectomy between 2004 and 2010	Elective admissions, incidental appendicectomies were excluded	Negative appendicectomy rate, rate of perforation, length of stay	No specified primary outcome	The study identified factors that were associated with each of the outcomes using regression analyses.

TABLE 2. Results from Included Studies

Study	Date Published	N General Surgery	Characteristics	Negative Histology	Length of Stay	Wound Infection	Intra-abdominal Abscess	Readmissions	Mortality	Other Complications	N Pediatric Surgery	Characteristics	Negative Histology	Length of Stay	Wound Infection	Intra-abdominal Abscess	Readmissions	Mortality	Other Complications	Study Quality Score
Alexander	2001	96	Mean age was 13 years (range 3–17 years); 65/96 were male; Simple appendicitis in 69/96. Perforated or gangrenous appendicitis in 27/96	3/96	Mean 1.7 days (range 1–6) for simple appendicitis and mean 8.6 days (range 1–31) for perforated disease	1/96	3/96	6/96 Timeframe was not specified	0/96	4/96 had small bowel obstruction	79	Mean age was 11 years (range 1–17 years). 48/79 were male; Simple appendicitis 45/79; Perforated or gangrenous appendicitis 34/79	2/79	Mean 2.1 days (range 1–8) for simple appendicitis and 5.4 days (range 1–20) for perforated disease	3/79	1/79.	1/79 Timeframe was not specified	0/79	0/79 had small bowel obstruction	20
Emil	2007	161	Mean age was 13.2 years (SEM0.2); 101/161 were male; Perforation or gangrene occurred in 53/161 cases	9/161	Mean 2.9 days; no SD available	2/152 (data were unavailable for the 9 cases with negative histology)	2/152 developed (data were unavailable for the 9 cases with negative histology)	5/152 (data were unavailable for the 9 cases with negative histology) Timeframe was not specified	N/A	N/A	304	Mean age was 8.3 years (SEM0.2); 172/304 were male; Perforation or gangrene was found in 154/304	13/304	Mean 3.74 days; No SD available	1/291 (data were unavailable for the 13 cases with negative histology)	2/291 (data were unavailable for the 13 cases with negative histology)	3/291 (data were unavailable for the 13 cases with negative histology) Timeframe was not specified	N/A	N/A	20
Somme	2007	19,503	Mean age was 12.8 years (SD 3.8); Perforation in 6241/19,503	2634/16,869	Mean length of stay was 3.2 days (SD2.4) (positive histology only)	266 (positive histology only)	N/A	192 required readmission within 30 days (positive histology only)	0/19,503	N/A	4516	Mean age was 10.5 years (SD3.6); Perforated appendicitis in 1481/4516	358/4516	4.1 days (SD 3.24) (positive histology only)	92 (positive histology only)	N/A	45 (positive histology only)	0/4516	N/A	19
Whisker	2009	264	Median age was 11.7 years (range 3–15 years); 156/264 were male; Perforated appendicitis in 48/264	52/264	Median length of stay 2 days (range 1–21 days)	11/264	5/264	22/264; Timeframe not specified	1/264	4/264 had bowel obstruction	207	Median age was 10.3 years (range 1–15 years); 143/207 were male; Perforated appendicitis in 77/207	8/207	Median length of stay was 5.5 days (range 1–21 days)	0/207	0/207	0/207	0/207	0/207	18
Collins	2010	196	Mean age was 11.9 (SD 2.2); Gangrenous or perforated appendicitis in 43/196	N/A	N/A	15/196	5/196	24/185 were readmitted within 6 months (data were unavailable for 11 patients)	N/A	5/196 were complicated by adhesions and wound dehiscence	206	Mean age was 11.9 years (SD 2.5); Gangrenous or perforated appendicitis in 86/206	N/A	N/A	4/206	5/206	9/199 were readmitted within 6 months (data unavailable for 7 patients)	N/A	1/206 was complicated by antibiotic associated diarrhea	17
Mizrahi	2013	246	Mean age was 10.4 years (SD 0.2); 185/246 were male	11/246	Mean 4 days (SD 0.2)	10/246	5/246	6/246 were readmitted within 30 days	N/A	N/A	157	Mean age was 9.8 (SD 0.2); 103/157 were male	7/157	Mean 4.5 days (SD 0.2)	4/157	5/157	7/157 were readmitted within 30 days	N/A	N/A	21

Study	Date Published	N General Surgery	Characteristics	Negative Histology	Length of Stay	Wound Infection	Intra-abdominal Abscess	Readmissions	Mortality	Other Complications	N Pediatric Surgery	Characteristics	Negative Histology	Length of Stay	Wound Infection	Intra-abdominal Abscess	Readmissions	Mortality	Other Complications	Study Quality Score
da Silva	2014	28	23/28 were aged between 10 and 15 years and 5/28 were aged 5 to 10 years; 9/28 were male; 7/28 perforated or gangrenous appendicitis; 21/28 had uncomplicated appendicitis	N/A	Median length of stay 3 days (IQR2–4)	2/28	3/28	2/28 were readmitted within 30 days	N/A	Reoperation was required in 4/28	66	11/66 were aged ≤ 5 years, 30/66 were aged between 5 and 10 years; 25 were between 10 and 15 years; 37/66 were male; 32/68 were documented as having either perforation or gangrene; 34/68 had uncomplicated appendicitis	N/A	Median length of stay was 4 days (range 3–7)	5/66	0/66	1/66 was readmitted within 30 days	N/A	Reoperation was required in 2/66 patients	20
Tiboni	2014	461	Median age was 12 years (range 4–15). 253/461 were male; 84/461 had gangrenous or perforated appendicitis	110/461	N/A	10/461	11/461	28/461	N/A	N/A	242	Median age was 10 years (range 1–15); 123/242 were male; 102/242 had gangrenous or perforated appendicitis	25/242	N/A	9/242	19/242	24/242	N/A	N/A	20
Cheong	2014	30,008	N/A	1841/30,008	N/A	N/A	N/A	N/A	N/A	N/A	9255	N/A	476/9255	N/A	N/A	N/A	N/A	N/A	N/A	19

IQR = interquartile range, N/A = not available, SD = standard deviation, SEM = standard error of the mean.

Study or Subgroup	General surgeons Events	General surgeons Total	Paediatric surgeons Events	Paediatric surgeons Total	Weight	Risk Ratio M-H, Random, 95% CI
Alexander 2001	3	96	2	79	3.4%	1.23 [0.21, 7.21]
Cheong 2014	1841	30008	476	9255	23.7%	1.19 [1.08, 1.32]
Emil 2007	9	161	13	304	10.2%	1.31 [0.57, 2.99]
Mizrahi 2013	11	246	7	157	8.9%	1.00 [0.40, 2.53]
Somme 2007	2634	16869	358	4516	23.6%	1.97 [1.77, 2.19]
Tiboni 2014	110	461	25	242	18.2%	2.31 [1.54, 3.46]
Whisker 2009	52	264	8	207	11.9%	5.10 [2.48, 10.49]
Total (95% CI)		**48105**		**14760**	**100.0%**	**1.79 [1.26, 2.54]**
Total events	4660		889			

Heterogeneity: Tau² = 0.13; Chi² = 62.80, df = 6 (P < 0.00001); I² = 90%
Test for overall effect: Z = 3.27 (P = 0.001)

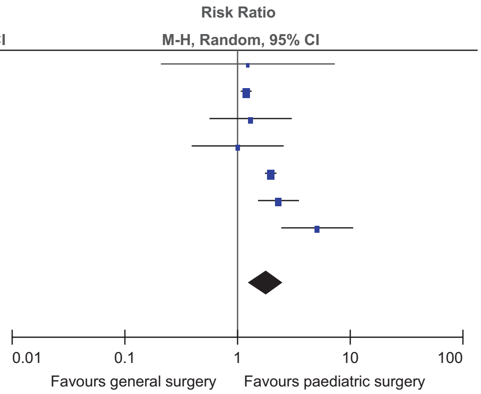

FIGURE 2. Forest plot for negative appendicectomy rate.

younger children and children with more severe disease (Table 2) to have been managed by pediatric surgical teams. Another consideration is that the shorter length of stay in the general surgery group may be a reflection of the higher negative appendicectomy rate in this group. However with the limited available summary data, it is not possible to explore these theories at present. It is noteworthy that we found no difference in wound infections, intra-abdominal infections, readmissions, and mortality even though our sample sizes for these outcomes were considerable.

The principle strength of our review is our exhaustive search strategy which included a detailed gray literature search. It yielded a large number of eligible studies and patients. We focused on patient important outcomes and we extracted and presented data on a wide range of important baseline factors. Regarding limitations, the main issue is the retrospective nature of most of the included studies. Only one involved prospective data collection.[8] Furthermore, no randomized data were available and therefore our review is prone to biases and confounding. We aimed to make this limitation as transparent as possible by reporting clearly on study characteristics and by including quality assessment scores (Table 2). We also wish to highlight that a large proportion of our data came from discharge registries[13,18] which are known to be prone to inaccuracies. Overall, these limitations limit the external validity of this article. Additionally, it is notable that our study evaluated surgeon specialization rather than institutional specialization.

We wish to encourage further research on outcomes in pediatric appendicitis. Randomized trials are unfeasible given the likely logistic difficulties and the large sample sizes that would be required for a trial to demonstrate superiority in relation to any outcome; therefore, we think that prospective multicenter appendicectomy registries represent the most feasible study design. Such databases will need to consider a range of baseline, predischarge and postdischarge factors in order to generate externally valid conclusions. We wish to emphasize the need to consider the effect of clustering in future studies – this is an often ignored source of bias in such studies (none of the studies in this article provided data on outcomes from individual surgeons).

CONCLUSIONS

We found that children who were managed by specialized pediatric surgery teams had lower rates of negative appendicectomy although mean length of stay was longer in this group. However, our article is based upon a group of heterogeneous and mostly retrospective studies, and therefore there is little

Study or Subgroup	General surgeons Events	General surgeons Total	Paediatric surgeons Events	Paediatric surgeons Total	Weight	Risk Ratio M-H, Random, 95% CI
Alexander 2001	1	96	3	79	6.6%	0.27 [0.03, 2.59]
Collins 2010	15	196	4	206	15.3%	3.94 [1.33, 11.67]
Da Silva 2014	2	28	5	66	10.5%	0.94 [0.19, 4.57]
Emil 2007	2	152	1	291	6.0%	3.83 [0.35, 41.89]
Mizrahi 2013	10	246	4	157	14.6%	1.60 [0.51, 5.00]
Somme 2007	266	16869	92	4158	24.7%	0.71 [0.56, 0.90]
Tiboni 2014	10	461	9	242	17.6%	0.58 [0.24, 1.42]
Whisker 2009	11	264	0	207	4.6%	18.05 [1.07, 304.57]
Total (95% CI)		**18312**		**5406**	**100.0%**	**1.25 [0.64, 2.44]**
Total events	317		118			

Heterogeneity: Tau² = 0.46; Chi² = 18.90, df = 7 (P = 0.009); I² = 63%
Test for overall effect: Z = 0.65 (P = 0.52)

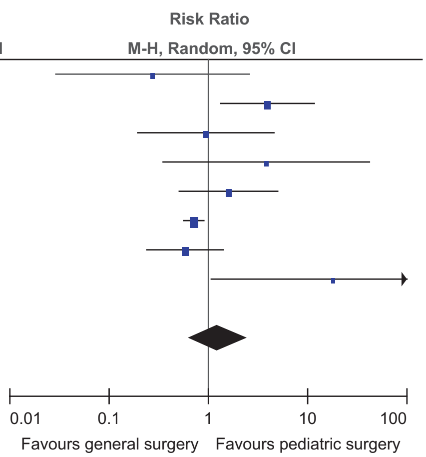

FIGURE 3. Forest plot for wound infections.

external validity. We wish to encourage future research through the use of large-scale prospective multicenter registries.

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