

# High complication rate among patients undergoing appendectomy in Ontario: a population-based retrospective cohort study

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**Background:** Appendectomy is a common emergency procedure. The risks have been reported in previous studies but often are limited to inpatient complications. The purpose of this study was to describe inpatient and outpatient rates of complications associated with appendectomy in a contemporary population-based cohort and explore factors associated with these complications.

**Methods:** We conducted a retrospective study using linked data for Ontario within ICES databases. Patients who underwent emergent appendectomy between 2009 and 2014 were included. The primary outcome was a complication (death, readmission, emergency department visit, lengthy [ $> 7$  d] hospital stay, percutaneous abscess drainage, reoperation or 1 of the predefined complication codes) occurring within 30 days of surgery. We used modified Poisson regression to identify predictors of complications.

**Results:** A total of 50 369 patients underwent emergent appendectomy over the study period, of whom 16 953 (33.7%) had a perforated appendix. Overall, 14 451 patients (28.7%) (8428 [25.2%] in the nonperforated group and 6023 [35.5%] in the perforated group) had at least 1 complication. The most common complication was an emergency department visit (7942 patients [15.8%]), followed by surgical site infection (4792 [9.5%]). Increasing age, female sex, rural residence, perforation status, daytime surgery and open surgical technique were associated with increased risk of complications.

**Conclusion:** We found a higher rate of complications after appendectomy than previously reported. The most common complication was presentation to the emergency department. Our definition of complications is more inclusive than in previous studies and provides a deeper understanding of complications after appendectomy.

**Contexte :** L'appendicectomie est une intervention urgente qui est courante. Les risques qui y sont associés ont déjà fait l'objet d'études, mais se limitent souvent aux complications perhospitalières. Cette étude avait pour but de décrire les taux de complications chez les patients durant et après leur hospitalisation pour appendicectomie dans une cohorte contemporaine basée dans la population et d'explorer les facteurs associés à ces complications.

**Méthodes :** Nous avons procédé à une étude rétrospective à partir des données reliées des bases de données de ICES pour l'Ontario. Les patients soumis à une appendicectomie urgente entre 2009 et 2014 ont été inclus. Le paramètre principal était la survenue d'une complication (décès, réadmission, consultation aux urgences, séjour hospitalier prolongé [ $> 7$  j], drainage d'abcès percutané, réintervention ou l'un des codes de complications prédéfinis) dans les 30 jours suivant la chirurgie. Nous avons utilisé la régression de Poisson pour identifier les facteurs prédictors de complications.

**Résultats :** En tout, 50 369 patients ont subi une appendicectomie urgente au cours de la période de l'étude, dont 16 953 (33,7 %) présentaient un appendice perforé. Globalement, 14 451 patients (28,7 %) (8 428 [25,2 %] dans le groupe ayant l'appendice non perforé et 6 023 [35,5 %] dans le groupe ayant l'appendice perforé) ont eu au moins une complication. La complication la plus fréquente a été une consultation aux urgences (7942 patients [15,8 %]), suivie de l'infection du site opératoire (4792 [9,5 %]). L'âge avancé, le fait d'être de sexe féminin, de vivre en milieu rural, un appendice perforé, la chirurgie effectuée durant le jour et la technique chirurgicale ouverte ont tous été associés à un risque accru de complications.

**Conclusion :** Nous avons observé un taux de complications post-appendicectomie plus élevé comparativement aux rapports précédents. La complication la plus fréquente était la consultation aux urgences. Notre définition du terme complications est plus inclusive que celle des précédentes études et permet une compréhension plus approfondie des complications post-appendicectomie.

The lifetime risk of appendicitis has been reported to be as high as 9%.<sup>1</sup> Appendectomy is one of the most common procedures performed by general surgeons, following only laparoscopic cholecystectomy and inguinal hernia repair.<sup>2</sup> Most appendectomy procedures are performed in an emergency setting for acute appendicitis. Appendectomy in patients suspected of having appendicitis has been a mainstay of treatment, and physicians intervene early to avoid the risks associated with perforation. The incidence of perforation of the appendix among those who undergo appendectomy is 25%–35%,<sup>1,3,4</sup> and perforation has been shown to increase the risk of postoperative complications. The complication rate is as high as 25% in patients with a perforated appendix, compared to 10% in similar patients without perforation.<sup>4</sup>

The risks of appendectomy have been assessed in large studies.<sup>4–7</sup> Prior Canadian publications are outdated.<sup>3,8</sup> Most contemporary studies describe short-term complications occurring during the index admission, with rates ranging from 4% to 26%. Typically assessed complications include surgical site and urinary tract infections, ileus, intra-abdominal abscess, bleeding and death;<sup>4–7</sup> however, these large studies did not evaluate several clinically relevant complications, such as lengthy hospital stay, emergency department visits and/or readmission to hospital. These are important to both the clinician and the patient, as they can account for increased hospital costs and resource use, and delayed return to normal activity and work. To our knowledge, a comprehensive evaluation of potential complications from appendectomy, including those occurring beyond the index hospital admission, has not been previously reported. The purpose of this study was to better delineate clinically relevant risks associated with appendectomy in a large contemporary population-based cohort.

## METHODS

### *Study cohort*

We conducted a population-based retrospective cohort study in Ontario, a province with a population of about 13.6 million and a single-payer universal health insurance program. The study cohort was identified by means of linked administrative data within ICES to identify all incident cases of appendicitis in patients who underwent emergency appendectomy between Apr. 1, 2009, and Feb. 28, 2015. Patients with appendicitis were identified by means of International Classification of Diseases diagnostic codes, Canadian Classification of Health Interventions procedure codes and Ontario Health Insurance Plan billing codes. Codes for laparoscopic appendectomy, other appendectomy and appendectomy for ruptured appendix were included.

We obtained patient, surgeon, diagnostic and treatment information through the linked data holdings contained

within ICES and accessed through ICES Queen's. These data holdings included the Canadian Institute for Health Information Discharge Abstract Database and National Ambulatory Care Reporting Service, the Ontario Health Insurance Plan, the Registered Persons Database and the ICES Physician Database. These data sets were linked by means of unique identifiers and analyzed at the ICES.

### *Measures and outcomes*

The primary outcome for this study was a complication occurring within 30 days of surgery. "Complication" was a composite outcome and included any of the following: death, readmission to hospital, emergency department visit, percutaneous drain insertion, reoperation, prolonged (> 7 d) postoperative index hospital stay or presence of 1 of the predefined complication diagnostic codes (Appendix 1, available at [canjsurg.ca/011517-a1](http://canjsurg.ca/011517-a1)). Secondary outcomes included operative time, length of stay and hospital costs. We calculated costs of the hospital stay using the resource intensity weight and case-mix severity of each patient's stay, identified from the Discharge Abstract Database.<sup>9</sup> Hospital costs were reported in 2015 Canadian dollars.

We examined several patient and clinical predictors of surgical complications, including age, income quintile and patient residence (urban v. rural), as found in the Registered Persons Database. We identified perforation status through Ontario Health Insurance Plan codes, and surgical technique (laparoscopic v. open surgery) through Canadian Classification of Health Interventions codes. We determined the time between presentation at triage and operative start time, and the time of day the procedure was performed using the Discharge Abstract Database and National Ambulatory Care Reporting Service databases. The time of appendectomy was defined as day (8 am–5 pm), evening (5 pm–12 am) or night (12 am–8 am).

### *Statistical analysis*

We used univariate analysis to estimate associations between predictors and surgical complications using modified Poisson regression model. Predictors of specific complications (readmission, emergency department visits, lengthy hospital stay, percutaneous drain insertion and reoperation) were estimated. We assessed differences in secondary outcomes (mean operative time, length of stay and costs of the hospital stay) using *t* tests. Statistical analysis was completed with SAS version 9.3 (SAS Institute).

## RESULTS

### *Study population*

A total of 50 369 patients underwent appendectomy performed by 778 surgeons during the study period. The

number of appendectomy procedures per surgeon over the study period ranged from 1 to 421 (median 54.5 [interquartile range 16.5–97.5]).

Patient demographic and clinical characteristics are summarized in Table 1 by complication status. There was an equal distribution of male and female patients within our cohort. The average age at appendectomy was 39.9 (standard deviation [SD] 16.5) years. Most patients (44 680 [88.7%]) were from an urban address. About a third (16 953 [33.6%]) had a perforated appendix at the time of surgery. Just over half (27 485 [54.6%]) underwent surgery

within 12 hours of presentation to the emergency department. Appendectomy most commonly occurred in the evening (28 255 patients [56.1%]). Most patients (40 991 [81.4%]) underwent laparoscopic appendectomy.

### Complication rates

A total of 14 451 patients (28.7%) had at least 1 predefined complication within 30 days of surgery (Table 2). Complications were more common among patients with a perforated appendix (6023 [35.5%]) than among those without

**Table 1. Baseline demographic and clinical characteristics of patients who underwent emergent appendectomy in Ontario, 2009–2014**

Characteristic	No. (%) of patients*		
	Total <i>n</i> = 50 369	No complications <i>n</i> = 35 918	Complications <i>n</i> = 14 451
Age, yr, mean $\pm$ SD	39.9 $\pm$ 16.5	38.4 $\pm$ 15.5	43.5 $\pm$ 18.0
Age group, yr			
18–30	18 288 (36.3)	13 922 (38.8)	4366 (30.2)
31–50	18 865 (37.4)	13 709 (38.2)	5156 (35.7)
51–70	10 681 (21.2)	7083 (19.7)	3598 (24.9)
$\geq$ 71	2535 (5.0)	1204 (3.4)	1331 (9.2)
Sex			
Female	25 313 (50.2)	17 503 (48.7)	7810 (54.0)
Male	25 056 (49.7)	18 415 (51.3)	6641 (46.0)
Sum of all Johns Hopkins ADGs, mean $\pm$ SD	5.9 $\pm$ 2.8	5.5 $\pm$ 2.6	6.9 $\pm$ 3.1
Sum of major Johns Hopkins ADGs, mean $\pm$ SD	1.6 $\pm$ 0.8	1.4 $\pm$ 0.7	1.9 $\pm$ 1.0
Neighbourhood income quintile			
1 (lowest)	9489 (18.8)	6550 (18.2)	2939 (20.3)
2	9727 (19.3)	6928 (19.3)	2799 (19.4)
3	9981 (19.8)	7122 (19.8)	2859 (19.8)
4	10 692 (21.2)	7644 (21.3)	3048 (21.1)
5 (highest)	10 243 (20.3)	7509 (20.9)	2734 (18.9)
Missing	237 (0.5)	165 (0.4)	72 (0.5)
Residence at time of appendectomy			
Urban	44 680 (88.7)	32 148 (89.5)	12 532 (86.7)
Rural	5668 (11.2)	3755 (10.4)	1913 (13.2)
Missing	21 (0.04)	15 (0.0)	6 (0.04)
Perforation status			
Nonperforated	33 416 (66.3)	24 988 (69.6)	8428 (58.3)
Perforated	16 953 (33.6)	10 930 (30.4)	6023 (41.7)
Time from triage to operating room, h, mean $\pm$ SD	13.6 $\pm$ 11.8	12.7 $\pm$ 9.2	18.5 $\pm$ 100.8
Time from triage to operating room, h			
< 6	7993 (15.9)	5806 (16.2)	2187 (15.1)
6–12	19 492 (38.7)	14 198 (39.5)	5294 (36.6)
> 12	22 122 (43.9)	15 500 (43.2)	6622 (45.8)
Missing	762 (1.5)	414 (1.2)	348 (2.4)
Time of appendectomy			
8 am–5 pm	15 638 (31.0)	10 914 (30.4)	4724 (32.7)
5 pm–12 am	28 255 (56.1)	20 361 (56.7)	7894 (54.6)
12 am–8 am	6476 (12.8)	4643 (12.9)	1833 (12.7)
Surgical technique			
Laparoscopic	40 991 (81.4)	30 310 (84.4)	10 681 (73.9)
Open	9378 (18.6)	5608 (15.6)	3770 (26.1)

ADG = Aggregated Diagnosis Group; SD = standard deviation.

\*Except where noted otherwise.

perforation (8428 [25.2%]) ( $p < 0.001$ ). The most common complication diagnostic codes were surgical site infection (4792 [9.5%]), cardiac complication (2767 [5.5%]), urinary tract infection (874 [1.7%]) and pneumonia (387 [0.8%]). These codes were identified during the index admission and any subsequent admission or emergency department visit(s). Notably, 2113 patients (4.2%) had a prolonged index hospital stay. A total of 686 patients (1.4%) required percutaneous drainage of an abscess, and 241 (0.5%) required an additional operation. Reoperation was most commonly performed to treat an intra-abdominal abscess (161/241 [66.8%]).

In all, 7942 patients (15.8%) re-presented to the emergency department, and 2074 (4.1%) were readmitted to hospital. Among those who re-presented to the emergency department, the median time between surgery and presentation was 4.5 (interquartile range 1.5–1.5) days.

Table 3 presents surgical outcomes stratified by complication status. Mean operative time was significantly longer among patients who subsequently experienced a complication than among those who did not (84.9 min [SD 69.8 min] v. 75.4 min [SD 76.9 min],  $p < 0.001$ ). The total length of stay

was longer and hospital costs were higher in the complication group than in the no-complication group ( $p < 0.001$  for both).

### Factors associated with complications

In univariate analysis, increasing age was associated with any complication, percutaneous drainage of an abscess, reoperation, readmission to hospital and lengthy hospital stay (Table 4). Compared to female patients, male patients were less likely to have a complication (relative risk [RR] 0.86, 95% CI 0.84–0.88) and to present to the emergency department (RR 0.83, 95% CI 0.79–0.86), and were more likely to require abscess drainage (RR 1.34, 95% CI 1.15–1.56). Rural patients were more likely than urban patients to have a complication (RR 1.20, 95% CI 1.16–1.25), to return to the emergency department (RR 1.36, 95% CI 1.29–1.44) and to have a prolonged hospital stay (RR 1.37, 95% CI 1.22–1.54), and were less likely to require abscess drainage (RR 0.72, 95% CI 0.55–0.95). Appendix perforation increased the risk of all assessed complications. Longer time from triage to surgery was associated with an increased risk of complications, readmission and prolonged hospital stay. Compared to operations performed in the evening and at night, those performed during the daytime were associated with a higher risk of any complication. Laparoscopic surgery reduced the risk of any complication, reoperation, lengthy hospital stay and emergency department visit.

### DISCUSSION

In this population-based study of appendectomy in a large contemporary cohort of patients in Ontario, the complication rate was high (28.7%), with surgical site infections, cardiac complications, urinary tract infections and pneumonia being the most common diagnoses. Emergency department visits within 30 days of surgery were common (15.8%); lengthy hospital stays (4.2%) and readmission to hospital (4.1%) occurred less frequently. Perforation status was the strongest predictor for the development of any complication. We also found that open appendectomy and female sex strongly predicted complications.

The complication rate in our study is much higher than rates reported in previously published series, especially in patients without perforation. Masoomi and colleagues<sup>4</sup>

**Table 2. Complications in 14 851 patients**

Complication	No. (%) of patients <i>n</i> = 50 369
Complication diagnostic category*†	
Cardiac	2767 (5.5)
Ileus/small bowel obstruction	871 (1.7)
Neurologic	60 (0.1)
Other	1927 (3.8)
Pulmonary embolism/deep vein thrombosis	104 (0.2)
Pneumonia	387 (0.8)
Respiratory	876 (1.7)
Surgical site infection	4792 (9.5)
Urinary tract infection	874 (1.7)
Lengthy hospital stay (> 7 d)	2113 (4.2)
Death	79 (0.2)
Emergency department visit	7942 (15.8)
Readmission	2074 (4.1)
Reoperation	241 (0.5)
Percutaneous drainage of abscess	686 (1.4)

\*Not all included patients received an additional complication diagnosis.  
†Some patients had more than 1 complication.

**Table 3. Surgical outcomes by complication status**

Outcome	Mean ± SD			<i>p</i> value
	Total	No complications	Complications	
Operating room time, min	78.2 ± 75.0	75.4 ± 76.9	84.9 ± 69.8	< 0.001
Length of stay (index admission), d	3.5 ± 4.2	2.8 ± 1.3	5.0 ± 7.3	< 0.001
Total length of stay (index admission and subsequent admission[s]), d	3.7 ± 4.6	2.8 ± 1.3	5.8 ± 7.8	< 0.001
Total cost of hospital stay(s), \$	5196 ± 7899	4176 ± 1292	7630 ± 14 106	< 0.001

SD = standard deviation.

**Table 4. Univariate analysis of the association between risk factors and any complication, percutaneous drainage of an abscess, reoperation, readmission, emergency department visit and lengthy hospital stay (> 7 d)**

Characteristic	RR (95% CI)					
	Any complication	Percutaneous drainage of abscess	Reoperation	Readmission	Emergency department visit	Lengthy stay
Age at appendectomy, yr						
18–30	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
31–50	1.15 (1.11–1.19)	1.34 (1.11–1.62)	1.44 (1.01–2.04)	1.13 (1.02–1.25)	0.98 (0.94–1.03)	1.92 (1.66–2.23)
51–70	1.41 (1.36–1.46)	1.64 (1.34–2.01)	1.84 (1.27–2.69)	1.35 (1.21–1.52)	1.01 (0.95–1.06)	4.76 (4.15–5.46)
≥ 71	2.20 (2.10–3.10)	1.57 (1.13–2.20)	4.16 (2.66–6.51)	2.02 (1.72–2.37)	1.13 (1.03–1.23)	15.29 (13.30–17.6)
Sex						
Female	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Male	0.86 (0.84–0.88)	1.34 (1.15–1.56)	1.08 (0.83–1.41)	0.96 (0.88–1.04)	0.83 (0.79–0.86)	1.07 (0.99–1.17)
Neighbourhood income quintile						
1	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
2	0.93 (0.89–0.97)	0.99 (0.78–1.25)	1.16 (0.77–1.75)	0.87 (0.76–1.00)	0.85 (0.79–0.90)	1.02 (0.90–1.17)
3	0.93 (0.89–0.97)	0.88 (0.69–1.12)	0.82 (0.52–1.27)	0.92 (0.81–1.05)	0.87 (0.81–0.92)	0.88 (0.77–1.00)
4	0.92 (0.88–0.96)	0.92 (0.73–1.16)	1.01 (0.67–1.53)	0.87 (0.76–0.99)	0.86 (0.81–0.92)	0.87 (0.76–0.99)
5	0.86 (0.83–0.90)	0.89 (0.70–1.13)	0.86 (0.56–1.33)	0.84 (0.74–0.96)	0.78 (0.73–0.83)	0.90 (0.79–1.03)
Missing	0.98 (0.81–1.19)	0.59 (0.15–2.38)	—	0.92 (0.50–1.70)	1.08 (0.83–1.40)	1.13 (0.64–1.97)
Residence						
Urban	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Rural	1.20 (1.16–1.25)	0.72 (0.55–0.95)	1.18 (0.79–1.75)	1.08 (0.95–1.23)	1.36 (1.29–1.44)	1.37 (1.22–1.54)
Missing	1.02 (0.52–2.00)	3.48 (0.51–23.6)	—	1.17 (0.17–7.91)	0.63 (0.17–2.36)	3.55 (1.25–10.10)
Perforation status						
Nonperforated	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Perforated	1.41 (1.37–1.45)	5.61 (4.72–6.66)	4.45 (3.33–5.94)	1.98 (1.82–2.16)	1.21 (1.16–1.26)	4.13 (3.77–4.51)
Time from triage to operating room, h						
< 6	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
6–12	0.99 (0.95–1.04)	1.05 (0.83–1.33)	0.94 (0.63–1.39)	1.09 (0.95–1.24)	0.93 (0.87–0.99)	1.09 (0.94–1.27)
> 12	1.09 (1.05–1.14)	1.24 (0.99–1.56)	0.93 (0.63–1.37)	1.21 (1.06–1.37)	0.96 (0.91–1.02)	1.94 (1.68–2.24)
Missing	1.67 (1.53–1.82)	1.23 (0.66–2.28)	3.00 (1.49–6.03)	1.74 (1.29–2.34)	1.18 (1.01–1.37)	8.29 (6.88–10.00)
Time of appendectomy						
8 am–5 pm	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
5 pm–12 am	0.93 (0.90–0.95)	0.81 (0.68–0.96)	1.26 (0.93–1.70)	0.91 (0.83–1.00)	0.91 (0.87–0.96)	0.76 (0.69–0.83)
12 am–8 am	0.94 (0.90–0.98)	1.42 (1.15–1.77)	0.59 (0.34–1.04)	0.93 (0.81–1.07)	0.93 (0.87–0.99)	0.91 (0.79–1.03)
Surgical technique						
Open	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)	1 (reference)
Laparoscopic	0.65 (0.63–0.67)	1.11 (0.91–1.36)	0.57 (0.42–0.76)	0.89 (0.77–0.95)	0.83 (0.79–0.87)	0.21 (0.20–0.23)

CI = confidence interval; RR = relative risk.

reviewed close to 3 million appendectomy procedures performed in the United States between 2004 and 2011 identified through the National Inpatient Sample and found that the overall complication rate was 11%, with complications occurring in 5%–10% of patients without perforation depending on the type of surgery (laparoscopic v. open), compared to the complication rate of 25.2% in nonperforated cases in our study. The data for their study were taken from discharge records and therefore did not include complications identified after discharge. The risk of surgical site infection was much higher in the present study than in the study by Masoomi and colleagues<sup>4</sup> (9.5% v. 0.4%–0.6%), whereas rates of urinary tract infection (1.7% v. 1.2%–1.5%) and death (0.2% v. 0.05%–0.6%) were sim-

ilar. The differences in surgical site infections may be due to differences in how these infections were defined.

Another large US study included 32 683 patients from the National Surgical Quality Improvement Program from 2005 to 2008.<sup>6</sup> This study showed a complication rate of 5.5%, with surgical site infections (4.1%) being the most common complication diagnosed. The mortality rate was 0.09%. Although complications that occurred up to 30 days after inpatient admission (as defined by the American College of Surgeons<sup>10</sup>) were included, the authors did not include readmission, presentation to the emergency department or prolonged hospital stays in their analysis. In a study from Taiwan that included 166 690 patients who underwent appendectomy between 2001 and 2008, the readmission rate



was 1.3%, compared to 4.1% in the current study.<sup>7</sup> Emergency department visits were not reported. These large studies showed that laparoscopic appendectomy was associated with decreased risk of complications, similar to our findings.

Presentation to the emergency department following discharge was the most common complication in our cohort (15.8%). A previous single-centre study in pediatric patients who underwent appendectomy for acute appendicitis from 2007 to 2010 showed similarly high rates of emergency department visits (18.9%).<sup>11</sup> Of these visits, 43% were for minor, potentially avoidable concerns.<sup>11</sup> In another single-centre study, Aiello and colleagues<sup>12</sup> assessed adult patients who underwent appendectomy over a 4-year period and found that 48% of postdischarge presentations to the emergency department were for pain issues and 13% were for minor wound issues. If these findings are true within our study population, there is an opportunity to decrease emergency department visits with better patient education and access to outpatient clinics.

### Strengths and limitations

The strength of our study is the more inclusive nature of how complications were defined in a contemporary cohort of patients undergoing surgical management of appendicitis. We included patients who had a diagnosed complication, those who re-presented to the emergency department, those who had a prolonged hospital stay and those who required a reintervention following surgery. This definition is more representative of the patient experience than existing definitions in the literature, which are often limited to the immediate index hospital admission.

Limitations include those inherent in large population-level studies, such as the risk of misclassification of diagnostic codes. In addition, precise details of the hospital course and clinical decision-making are not available in these administrative data sets. We assumed that the reasons for emergency department visits and/or readmission to hospital were for issues related to the surgery; however, patients may have had issues unrelated to this. The median time of presentation to the emergency department after surgery was 4.5 days. In addition, the study population was relatively young (mean age 39.9 yr). It therefore seems unlikely, although not impossible, that the emergency department visit was attributable to an unrelated problem. Consequently, the rate of emergency department visits and readmissions may have been overestimated, which would affect our study conclusions. Finally, given the lack of pathology reports, we were not able to identify patients who underwent appendectomy but did not actually have appendicitis.

### CONCLUSION

The present study shows that the rate of complications following appendectomy is higher than previously reported.

This elevated risk is largely a manifestation of the inclusive nature of complications included in our study. We found that emergency department visits occurred more frequently than any other complication assessed. Clinicians should be aware that many patients who undergo appendectomy return to the emergency department, and this may represent an opportunity for improvement in patient care.

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