



## Unexpected complicated appendicitis in the elderly diagnosed with acute appendicitis<sup>☆</sup>



Navpreet K. Dhillon<sup>a</sup>, Galinos Barmparas<sup>a</sup>, Ting-Lung Lin<sup>a, b</sup>, Rodrigo F. Alban<sup>a</sup>,  
Nicolas Melo<sup>a</sup>, Audrey R. Yang<sup>a</sup>, Daniel R. Margulies<sup>a</sup>, Eric J. Ley<sup>a, \*</sup>

<sup>a</sup> Department of Surgery, Division of Trauma and Critical Care, Cedars-Sinai Medical Center, Los Angeles, CA, USA

<sup>b</sup> Department of Surgery, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan

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### ABSTRACT

**Background:** This study determined the prevalence of complicated appendicitis in elderly patients diagnosed preoperatively with uncomplicated appendicitis.

**Methods:** Patients with a preoperative diagnosis of uncomplicated appendicitis at an academic hospital from 11/2013 to 05/2017 were reviewed. Patients  $\geq 65$  years were compared to those younger. Pathology reports were categorized as either uncomplicated or complicated (COMP). The primary outcome was the prevalence of COMP appendicitis.

**Results:** The prevalence of COMP appendicitis increased with age after 20 years with an abrupt increase after 65 years. Patients  $\geq 65$  years were more likely to have COMP appendicitis (48.1% vs. 15.5%; OR: 5.1;  $p < 0.01$ ) and prolonged stays (3.8 vs. 2.3 days;  $p < 0.01$ ).

**Conclusion:** Nearly half of elderly patients had pathologic confirmation of complicated appendicitis despite no preoperative clinical or radiographic suspicion for complicated appendicitis. Nonoperative management of acute appendicitis in the elderly may not be appropriate due to the high rate of unexpected complicated appendicitis.

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## Background

Appendicitis represents a significant burden to the emergency general surgery volume within the United States.<sup>1</sup> Within the last decade, there has been an increasing trend to treat acute appendicitis with nonoperative management alone.<sup>2</sup> Proponents argue that this strategy is not only a safer alternative to surgery, but may also prevent further complications.<sup>3</sup> Other recent studies, however, question these earlier findings and cite prolonged hospital length of stay and in-hospital complications in those patients who are managed nonoperatively.<sup>4</sup> Furthermore, a recently published large national retrospective study has demonstrated that nonoperative

management was associated with increased readmissions and overall cost of care.<sup>5</sup> Another large study shows that nearly a quarter of patients treated with antibiotics initially recurred within one year and 40% within five years.<sup>6</sup> Despite these recent data, nonoperative management may appear to be a viable option to many providers.

Elderly patients often have co-morbidities and physical conditions that make them less than ideal surgical candidates, swaying providers to pursue a nonoperative approach when managing appendicitis. Patients with complicated appendicitis (COMP) are at a higher risk of failure from nonoperative management.<sup>7</sup> Given differences in how elderly patients present,<sup>8</sup> this patient population may have a higher risk of COMP although this risk is unknown.

We sought to quantitate the risk of COMP in elderly patients, specifically in the subset of patients that appeared to clinically have uncomplicated appendicitis, in order to determine if nonoperative management was a suitable alternative in this patient population. We hypothesized that the risk of COMP would be higher among elderly patients when compared to their younger counterparts.

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\* Corresponding author. Cedars-Sinai Medical Center Department of Surgery, 8700 Beverly Blvd, Suite 8215NT, Los Angeles, CA, 90048, USA.

E-mail addresses: [Navpreet.Dhillon@cshs.org](mailto:Navpreet.Dhillon@cshs.org) (N.K. Dhillon), [Galinos.Barmparas@cshs.org](mailto:Galinos.Barmparas@cshs.org) (G. Barmparas), [Ting-Lung.Lin@cshs.org](mailto:Ting-Lung.Lin@cshs.org) (T.-L. Lin), [Rodrigo.Alban@cshs.org](mailto:Rodrigo.Alban@cshs.org) (R.F. Alban), [Nicolas.Melo@cshs.org](mailto:Nicolas.Melo@cshs.org) (N. Melo), [aryang08@gmail.com](mailto:aryang08@gmail.com) (A.R. Yang), [Daniel.Margulies@cshs.org](mailto:Daniel.Margulies@cshs.org) (D.R. Margulies), [Eric.Ley@cshs.org](mailto:Eric.Ley@cshs.org) (E.J. Ley).

## Methods

A retrospective review was conducted of all patients undergoing an appendectomy from November 2013 to May 2017 at a large urban medical center. The medical center includes academic surgeons as well as non-academic, private surgeons from various practices, resulting in variability with respect to preoperative assessments and postoperative management. Surgeons belonging to the acute care surgery service adhere to a protocol wherein young, healthy males forego additional imaging if the clinical suspicion for acute appendicitis is high. In addition, patients with acute non-perforated or non-gangrenous appendicitis are immediately discharged after surgery from the post anesthesia care unit.<sup>9</sup>

For the purposes of this study, patients who underwent an interval appendectomy or an appendectomy for a reason other than appendicitis, such as for an oncologic resection, were excluded. Notes were reviewed for further selection. Individuals who had suspected acute appendicitis were included for review, while those with a clinical suspicion for complicated appendicitis were excluded. Patients with exam findings consistent with peritonitis were also excluded. Additionally, when available, patients who had imaging findings showing free fluid, a phlegmon, or an abscess were removed from analysis.

Data collection included patient demographics, American Society of Anesthesiologists (ASA) classifications, preoperative imaging results, and antibiotic use. Notes were reviewed for time to presentation from symptom onset and white blood cell count on admission. Pathology reports were categorized as either uncomplicated, which included either nonperforated or suppurative appendicitis, or complicated (COMP), which included either perforated, necrotizing, or gangrenous appendicitis. Outcomes data included hospital length of stay, readmissions, and mortality. Patients  $\geq 65$  years, who were defined as elderly (ELD), were compared to those who were younger (NELD). The primary outcome was the prevalence of COMP appendicitis based on pathology.

Data are summarized as percentages for categorical variables

and means with standard deviations (SD) or medians with interquartile range (IQR) for continuous variables. Categorical variables were compared using Pearson  $\chi^2$  or Fisher's exact test whereas comparisons of continuous variables were conducted using a Student's *t*-test or Mann-Whitney *U* Test, where appropriate. A *P* value of  $<0.05$  was considered statistically significant. Odds ratios and mean differences with their respective 95% confidence intervals (CIs) were calculated.

All statistical analysis was performed using IBM SPSS statistics for Windows, version 25 (IBM Corp., Armonk, N.Y., USA). This study was approved by Cedars-Sinai Medical Center's Institutional Review Board; the requirement for informed consent was formally waived.

## Results

From November 2013 to May 2017, 1242 patients were identified who met the inclusion criteria of having undergone an appendectomy for suspected acute appendicitis. The mean age of the study population was  $38.6 \pm 13.6$  years (Table 1). Fifty-two (4.2%) patients were at least 65 years old and were defined as being ELD. ELD and NELD were similar with respect to sex (50.0% vs. 53.6%,  $p = 0.61$ ) and body mass index ( $26.4 \pm 5.2$  vs.  $25.8 \pm 5.6$ ,  $p = 0.16$ ). ELD were more likely to be either an ASA Class II (67.3% vs. 48.7%,  $p < 0.01$ ) or Class III (25.0% vs. 6.8%,  $p < 0.01$ ) compared to their younger counterparts.

ELD often presented to the hospital later after symptom onset (time to presentation  $> 24$  h 71.4% vs. 55.1%,  $p = 0.04$ ) although the white count on admission was similar in both cohorts ( $11.5 \pm 5.2$  vs.  $12.5 \pm 4.4$ ,  $p = 0.11$ ). ELD patients were more likely have a preoperative computerized tomography scan (90.4% vs. 71.8%,  $p < 0.01$ ).

Upon review of pathology reports, ELD patients were significantly more likely to have COMP appendicitis compared to NELD (48.1% vs. 15.5%; OR (95% CI): 5.1 (2.9–8.9);  $p < 0.01$ ) (Table 2). The incidence of some degree of perforation in the specimen was similarly higher in ELD patients (40.4% vs. 8.7%; OR (95% CI): 7.2 (4.0–12.9);  $p < 0.01$ ) although the risk of gangrene or necrosis

**Table 1**  
Comparison of elderly and non-elderly patients.

Characteristic	All (n = 1242)	ELD (n = 52)	NELD (n = 1190)	P-value
Age, y	$38.6 \pm 13.6$	$67.4 \pm 1.7$	$37.3 \pm 12.5$	$<0.01$
Male, %	664 (53.5%)	26 (50.0%)	638 (53.6%)	0.61
BMI, kg/m <sup>2</sup>	$25.8 \pm 5.6$	$26.4 \pm 5.2$	$25.8 \pm 5.6$	0.16
ASA Class I	532 (42.8%)	4 (7.7%)	528 (44.4%)	$<0.01$
ASA Class II	615 (49.5%)	35 (67.3%)	580 (48.7%)	$<0.01$
ASA Class III	94 (7.6%)	13 (25.0%)	81 (6.8%)	$<0.01$
ASA Class IV	1 (0.1%)	0	1 (0.1%)	$>0.99$
Time to presentation $> 24$ h, % <sup>a</sup>	661 (55.8%)	35 (71.4%)	626 (55.1%)	0.04
WBC on presentation, $\times 10^9/L$	$12.5 \pm 4.4$	$11.5 \pm 5.2$	$12.5 \pm 4.4$	0.11
Patients with preoperative CT, %	902 (72.6%)	47 (90.4%)	855 (71.8%)	$<0.01$
Received preoperative antibiotics, %	1009 (81.2%)	43 (82.7%)	966 (81.2%)	0.93
Received intraoperative antibiotics, %	1001 (80.6%)	47 (90.4%)	966 (81.2%)	0.14
Received postoperative antibiotics, %	579 (46.6%)	34 (65.4%)	545 (45.8%)	$<0.01$

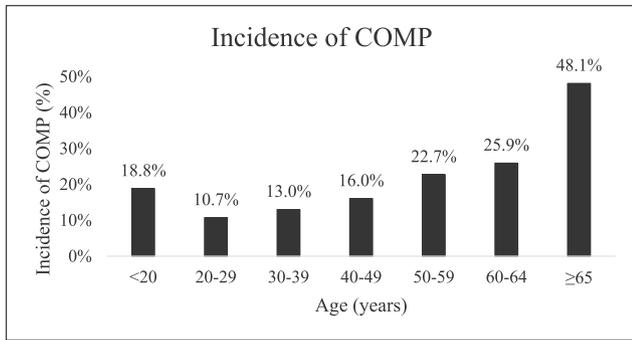
ASA, American Society of Anesthesiologists; BMI, body mass index; CT, computed tomography; ELD, elderly; NELD, non-elderly; WBC, white blood cell.

<sup>a</sup> Among 1185 patients with documentation.

**Table 2**  
Comparison of pathology reports.

	All (n = 1242)	ELD (n = 52)	NELD (n = 1190)	Odds Ratio (95% CI)	P-value
Uncomplicated, %	1033 (83.2%)	27 (51.9%)	1006 (84.5%)	0.2 (0.1–0.3)	$<0.01$
Complicated, %	209 (16.8%)	25 (48.1%)	184 (15.5%)	5.1 (2.9–8.9)	$<0.01$
Perforated, %	124 (10.0%)	21 (40.4%)	103 (8.7%)	7.2 (4.0–12.9)	$<0.01$
Gangrenous/Necrotic, %	106 (8.5%)	6 (11.5%)	100 (8.4%)	1.4 (0.6–3.4)	0.44

CI, confidence interval; ELD, elderly; NELD, non-elderly.



**Fig. 1.** Prevalence of COMP by age. COMP, complicated appendicitis.

(11.5% vs. 8.4%; OR (95% CI): 1.4 (0.6–3.4);  $p = 0.44$ ) was similar compared to NELD. The prevalence of COMP below 20 years was 18.8% (Fig. 1). This rate decreased to 10.7% for individuals between 20 and 29 years. The prevalence increased with each decade in a stepwise-fashion, with an abrupt increase to 48.1% for individuals at least 65 years-old.

ELD patients often had longer hospital stays ( $3.8 \pm 3.6$  vs.  $2.3 \pm 2.0$  days,  $p < 0.01$ ) with a mean difference of 1.5 days (Table 3). Readmission rates (5.8% vs. 4.9%,  $p = 0.74$ ) and mortality (0% vs. 0.1%,  $p > 0.99$ ) did not differ. When comparing ELD with COMP to NELD with COMP, there was a trend for prolonged hospital LOS among ELD with COMP although this did not reach statistical significance ( $4.7 \pm 3.8$  vs.  $3.7 \pm 3.2$  days,  $p = 0.06$ ) (Table 4). Again, readmission rates and mortality did not differ.

**Discussion**

Despite the increasing trend to treat acute appendicitis non-operatively nationwide,<sup>10</sup> there is sparse literature about the appropriateness of this management strategy in the elderly patient. By using histopathologic confirmation of the type of appendicitis, we found that elderly patients were five more times likely to have complicated appendicitis compared to their younger counterparts. Specifically, these patients were more likely to have some degree of perforation at the time of surgery. These data question the use of nonoperative management in elderly patients.

Nonoperative management may be appropriate in select patient

populations, such as in a subset of children<sup>11</sup> or adults meeting certain scoring criteria.<sup>12</sup> However, broader application may be hazardous. One common criticism is the potential to miss an appendiceal malignancy without obtaining a specimen.<sup>13</sup> Another is the high risk of recurrent appendicitis with nearly half recurring within five years<sup>6</sup> and further complications with longer-term follow up.<sup>14</sup> The role of nonoperative management should be questioned in older patients, even if they appear to be suitable candidates for nonoperative management.

Elderly patients pose a unique challenge to the acute care surgeon. Contributing factors include co-morbid conditions, frailty, and delays in seeking treatment and subsequent diagnosis.<sup>15,16</sup> These factors can often result in misdiagnosis,<sup>17</sup> leading to higher morbidity and mortality in this patient population.<sup>18</sup> Despite the fact that elderly patients were more likely to have preoperative imaging performed, there appeared to be some level of discordance between preoperatively suspected uncomplicated appendicitis and postoperatively pathologic confirmation of COMP. This likely is because any degree of perforation, gangrene, and/or necrosis on pathology was classified as COMP by study design, and as such, may not have been radiographically appreciated preoperatively. Histopathologic confirmation was used in lieu of surgeon interpretation from the operative report in order to provide an objective measure of the prevalence of COMP, as other literature has shown that surgeon interpretation is often unreliable.<sup>19</sup> Data regarding the clinical significance of microscopic COMP is lacking in the literature, and as such, there is little to support the safety of nonoperative management in microscopic perforations. Further investigation is required to understand the clinical implications of microperforations.

There are several limitations that should be noted with regards to this study. First, this is a retrospective study limited to a single institution. The ability to select patients with presumed uncomplicated appendicitis based on physician assessments and physical exam findings was heavily dependent upon the level of documentation which is difficult to verify. A patient who appeared to have benign findings on exam based on documentation may in fact have exhibited signs of peritonitis on presentation. In addition, there likely is significant variability in provider practice patterns, which may lead to how patients are diagnosed and ultimately outcomes such as hospital length of stay. The degree of perforation, gangrene, or necrosis could not be assessed from the available pathology reports, which otherwise may have been able to further stratify patients. A historical cohort could not be used for

**Table 3**  
Outcomes among elderly and non-elderly patients.

	All (n = 1242)	ELD (n = 52)	NELD (n = 1190)	Mean Difference (95% CI)	P-value
Hospital LOS	2.3 ± 2.1	3.8 ± 3.6	2.3 ± 2.0	1.5 (0.9–2.1)	<0.01
	All (n = 1242)	Elderly (n = 52)	Non-Elderly (n = 1190)	Odds Ratio (95% CI)	P-value
Readmission	61 (4.9%)	3 (5.8%)	58 (4.9%)	1.2 (0.4–3.9)	0.74
Mortality	1 (0.1%)	0	1 (0.1%)	0	>0.99

CI, confidence interval; ELD, elderly; LOS, length of stay; NELD, non-elderly.

**Table 4**  
Outcomes differences among elderly and non-elderly with complicated appendicitis.

	All (n = 209)	ELD with COMP (n = 25)	NELD with COMP (n = 184)	Mean Difference (95% CI)	P-value
Hospital LOS	3.8 ± 3.3	4.7 ± 3.8	3.7 ± 3.2	1.0 (–0.4–2.4)	0.06
	All (n = 209)	ELD with COMP (n = 25)	NELD with COMP (n = 184)	Odds Ratio (95% CI)	P-value
Readmission	22 (10.5%)	2 (8.0%)	20 (10.9%)	0.7 (0.2–3.3)	>0.99
Mortality	0	0	0	0	>0.99

CI, confidence interval; ELD, elderly; LOS, length of stay; NELD, non-elderly.

comparison due to limitations in the previous electronic medical record at our institution. Importantly, due to the limited sample size among elderly patients, we were not able to show any significant differences in complications when stratified in accordance to the Clavien-Dindo classification system. Similarly, no meaningful trends could be discerned among patients who were discharged from the post anesthesia care unit. Despite these limitations, the rate of COMP appeared to be unusually higher in the elderly compared to their younger counterparts.

## Conclusion

Nearly half of elderly patients had pathologic confirmation of complicated appendicitis despite no preoperative clinical or radiographic suspicion for complicated appendicitis. Nonoperative management of acute appendicitis in the elderly may not be a safe strategy to employ due in part to the high rate of unexpected complicated appendicitis.

## Author contributions

**Study conceptions and design:** Navpreet K Dhillon MD, Galinos Barmparas MD, Eric J Ley MD.

**Acquisition of data:** Navpreet K Dhillon MD, Ting-Lung Lin MD, Rodrigo F Alban MD, Nicolas Melo MD.

**Analysis and interpretation of data:** Navpreet K Dhillon MD, Audrey R Yang BS, Daniel R Margulies MD.

**Literature Review:** Navpreet K Dhillon MD, Ting-Lung Lin MD, Audrey R Yang BS.

**Drafting of Manuscript:** Navpreet K Dhillon MD, Ting-Lung Lin MD, Audrey R Yang BS.

**Critical revision:** Galinos Barmparas MD, Rodrigo F Alban MD, Nicolas Melo MD, Daniel R Margulies MD, Eric J Ley MD.

## Conflicts of interest

The authors have no conflicts of interest to report and have received no financial support in relation to this manuscript.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2019.08.013>.

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