RESEARCH ARTICLE

Complications and postoperative ileus in laparoscopic versus open colectomy: A retrospective cohort study [version 1; peer review: 1 approved with reservations, 1 not approved]

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Abstract

Background: Postoperative complications are a major concern after colorectal surgery, and can lead to an increased burden on patients and the healthcare system. Complications include postoperative ileus (POI) and prolonged postoperative ileus (PPOI). There are well-established risk factors and potential modifiable risk factors that affect the incidence of POI and PPOI, including invasive techniques, operative difficulty, perioperative blood loss, and delayed mobilization. We compared the incidence of POI, PPOI, and other postoperative complications between laparoscopic colectomy and open colectomy.

Methods: This retrospective review investigates 120 patients who underwent either laparoscopic or open colectomy in King AbdulAziz University Hospital in Jeddah, Saudi Arabia, between January 2016 and June 2019. Data were collected from patients' electronic medical records. Patients were classified into laparoscopic and open colectomy groups. The main outcomes of interest were POI, PPOI and the overall complication rate. These outcomes were calculated and compared between the two groups.

Results: The overall incidence of POI and PPOI was 4.2% and 15%, respectively. There was a higher incidence of POI in the laparoscopic approach group (7.2% vs. 1.5%, $P=0.03$); however, the incidence of PPOI was higher in the open approach group (20% vs. 9.1%, $P=0.03$). The open surgery group showed a higher rate of overall complications ($P=0.001$). The mean estimated blood loss was lower in the laparoscopy group (139.09 ± 145.83 vs. 343.85 ± 307.78 mL; $P<0.001$). Significant earlier mobilization was observed in the laparoscopic group (3.12 ± 1.77 vs. 5.39 ± 3.48 days; $P<0.001$).

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Conclusion: The incidence of PPOI was significantly different depending on the surgical approach; however, the laparoscopy group tolerated regular diet earlier and had better outcomes regarding postoperative complications. The laparoscopic approach was associated with earlier ambulation and was more cost-effective based on the length of the hospital stay. Further randomized studies are required to confirm superiority of the laparoscopic approach in terms of postoperative recovery.

Keywords

postoperative ileus, postoperative complications, colectomy, laparoscopy, laparotomy

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Introduction

Postoperative complications are often inevitable following abdominal surgeries. They range from altered postoperative recovery which does not require medical intervention, to life-threatening conditions requiring intensive care management and may lead to mortality.^{1,2} Among these complications, postoperative ileus (POI) is still the most common postoperative problem causing delays in patient discharge, while anastomotic leak is considered the most important factor that leads to readmission within 30 days.³ Along with other complications, POI and anastomotic leak contribute heavily to the economic burden on the healthcare system.³ The incidence of POI across extensive studies was found to range from 10% to 30%, leading to a 29% increase in the length of stay (LOS) in the hospital.^{4,5} The term ileus refers to the disability of gastrointestinal peristalsis, which is characterized by absent or decreased peristalsis that results in the accumulation of digestive secretions leading to intolerance to oral feeding, abdominal distention, abdominal pain, failure to pass flatus, absence of bowel movement, nausea, and vomiting. These complications increase the risk of aspiration pneumonia, malabsorption, and anastomosis leakage.⁴ Normally, the functionality of the small intestine returns within 24–48 hours postoperatively, while the colon requires 48–72 hours of recovery.⁶

In Saudi Arabia, data on surgical outcomes and the differences between laparoscopic and open approaches in terms of postoperative ileus are scarce. Our goal was to evaluate the incidence of POI and prolonged postoperative ileus (PPOI) as well as postoperative complication rates between the two different approaches, following colorectal surgery in our institution. This was with a view to assessing the potential contributing factors.

Methods

Setting and patient population

We conducted a retrospective cohort study at King AbdulAziz University Hospital (KAUH), a tertiary center in Jeddah, Saudi Arabia. Data of 134 adult patients who underwent colectomy for colorectal cancer from January 2016 to June 2019 were collected from the electronic medical database and reviewed. Patients were divided into two groups, laparoscopy, and laparotomy approach. A total of 14 patients were excluded due to their conversion from laparoscopy to open surgery. The final population size was 120.

Ethics statement

This study was approved by the Institutional Review Board of KAUH in 2019 (ref. 145-19). The need for obtaining patient consent was waived by the IRB.

Inclusion and exclusion criteria

All adult patients aged > 18 years that were diagnosed with non-metastatic colon or rectal cancer and who had undergone operation were extracted from the hospital's data base and included. Key search terms were laparoscopic/open right or left colectomy, laparoscopic/open low anterior resection, laparoscopic/open total colectomy, laparoscopic/open subtotal colectomy, laparoscopic/open abdominoperineal resection and laparoscopic/open total coloproctectomy. Patients were classified into two groups according to the surgical approach used: either laparoscopic colectomy; or open colectomy. Patients who had laparoscopic conversion to open, i.e. surgeries which started with laparoscopy that ended up being laparotomy were excluded. In addition, patients with disseminated cancer, concurrent procedure, or sepsis (in the form of peritonitis) were excluded from the study to avoid confounders. Patients with incomplete records were also excluded from the analysis of that particular entity.

Definition of variables

The data collected included demographic information (age, sex, Body Mass Index, comorbidities) as well as preoperative variables including diagnosis, neoadjuvant therapy, comorbidities, and previous abdominal surgeries. Intraoperative variables were also documented, including the American Society of Anesthesiologists (ASA) score, use of epidural anesthesia, colorectal procedure, approach (laparoscopy or open), stoma formation, estimated blood loss, blood transfusion, and procedure duration. All patients received a clear liquid diet 24 h after the operation and subsequently progressed to a regular diet. After the regular diet was tolerated and bowel movements returned to normal, the patient was discharged.

Postoperative variables included the type of analgesia, vomiting, abdominal distention, time of mobilization, time until clear and regular diets were tolerated, and the day of the first bowel movement. The length of hospital stay, from the time of operation until patient discharge, was also recorded. Readmission within 30 days and postoperative complications were assessed based on the Clavien–Dindo score.⁷ POI was defined as the absence of first flatus and intolerance of an oral intake within three days, postoperatively, and PPOI was defined as the delayed passage of flatus with intolerance of an oral intake for more than three days, postoperative.⁸

Statistical methods

Statistical analysis was performed using **IBM SPSS Statistics** Version 21.0. Mean $\pm$ standard deviation was used to describe the numerical data. Patient treatment and outcome related variables were represented as percentages and frequencies of the total population. Comparisons and the relationships between the groups were made using independent t-test, chi-square test, and bivariate correlation. The results were considered significant where the two-tailed P value ≤ 0.05 .

Results

A total of 120 patients that were diagnosed with colorectal cancer who underwent different colonic procedures were included in this study (see *Underlying data*²³). The patients' baseline characteristics are presented in **Table 1**. Patients were divided into two groups: the laparoscopic approach group, 55 patients (45.8%); and the open approach group, 65 patients (54.2%). The age of the patients ranged from 22 years to 90 years, with a mean (SD) age of 61.36 ± 13.85 years. The patients were predominantly male (60%), and most of the cohort had colon cancer (67.5%). Over half of the patients were either overweight or obese (65%), and a third had diabetes mellitus (33.3%). Most patients were of ASA class 2 or 3 (92.5%).

Regarding operative variables, the majority were elective procedures (77.5%) and most had anastomoses (74.2%) (**Table 2**). Most patients did not require blood transfusion, and among those who did, the average number of units transfused was 1.75 (SD, 0.46).

Table 3 presents the postoperative outcomes including postoperative complications, POI, and PPOI in both the laparoscopic and the open approaches. The incidence of POI and PPOI in the study group was 4.2% and 15%, respectively. There was a higher incidence of POI in the laparoscopic approach (7.2% vs. 1.5%, $P = 0.03$); however, the incidence of PPOI was higher in the open approach (20% vs. 9.1%, $P = 0.03$). The mean time of first bowel movement in the laparoscopic and open approaches were 3.13 ± 2.13 vs. 3.94 ± 2.65 days; $P = 0.09$). Patients with previous abdominal surgeries showed no difference in PPOI compared to those with no previous surgeries ($P = 0.33$). The operative duration was greater in the laparoscopy approach group (403.16 ± 133.73 vs. 277.34 ± 123.39 min; $P < 0.001$) along with less bleeding compared to the open approach group (139.09 ± 145.83 vs. 343.85 ± 307.78 mL; $P < 0.001$). Regular diet was tolerated earlier in the laparoscopy approach group than in the open approach group (5.44 ± 2.7 vs. 8.94 ± 6.64 days; $P < 0.001$). Mobilization was also observed earlier in the laparoscopic approach (3.12 ± 1.77 vs. 5.39 ± 3.48 days; $P < 0.001$).

Regarding the incidence of postoperative complications, 59% of patients had no complications, while 41% had varying degrees of complications. The open approach showed a higher rate of complications—37 patients (56.9%), compared to 11 patients (20%) in the laparoscopic group. According to the Clavien–Dindo score, this difference was statistically significant (**Table 3**).

Furthermore, the LOS was longer in the open approach compared to the laparoscopic approach (14.52 ± 10.47 vs. 8.24 ± 4.29 days; $P < 0.001$). Patients with anastomotic leak had a longer LOS (23.86 ± 9.5 vs. 10.85 ± 8.17 days; $P < 0.001$). General and epidural anesthesia was used for most patients (98 [81.7%]), while the remaining patients received general anesthesia only (22 [18.3%]). No significant difference was found between patients with POI and PPOI in the use of epidural or general anesthesia ($P = 0.24$).

Discussion

Addressing the incidence of POI and PPOI is essential for determining the risk factors associated with these complications and can therefore help in decreasing their occurrence. In our study, the incidences of POI and PPOI following colorectal surgery were 4.2% and 15%, respectively, while the literature demonstrates that the incidence of POI is 10–30% and the incidence of PPOI is 2–54%.^{4,5,9}

Previous studies have demonstrated that the risk factors for POI and PPOI include more invasive approaches, operative difficulty, older age, perioperative blood loss, and delayed mobilization.^{10,11} Our analysis showed that the open approach was associated with a significantly higher incidence of PPOI than the laparoscopic approach. In the literature, the open approach was identified as an independent risk factor for the development of an ileus.⁹ At the same time, most of the patients with POI, which is a less severe form of ileus, were in the laparoscopic group. These results are more likely explained by the inflammatory and neurological responses to surgical trauma and increased requirements for narcotics, which are more pronounced in the open approach group.^{12,13} It has been suggested that adherence to protocols of enhanced recovery after surgery could potentially decrease the incidence of POI. These protocols that recommend minimally invasive procedures, early ambulation, and early feeding.¹⁴

Table 1. Distribution of patients according to their characteristics, body mass index (BMI) categories, comorbidities, previous abdominal surgery, and diagnosis.

Variable	No. (%)
Age (years) (mean $\pm$ SD)	61.36 $\pm$ 13.85
Operative approach	
Laparoscopy	55 (45.8)
Open	65 (54.2)
Gender	
Male	72 (60.0)
Female	48 (40.0)
Smoking	
Current smoker	9 (5.7)
Non-smoker	93 (77.5)
Ex-smoker	13 (10.8)
Unknown	5 (4.2)
BMI categories	
Underweight	5 (4.2)
Normal weight	37 (30.8)
Overweight	47 (39.2)
Obese	31 (25.8)
Mean BMI (mean $\pm$ SD) kg/m ²	27.21 $\pm$ 5.5
Comorbidity	
DM	40 (33.3)
HTN	45 (37.5)
Hyperlipidemia	16 (13.3)
Heart disease	9 (7.5)
CLD	1 (0.8)
COPD	1 (0.8)
CKD	2 (1.7)
Thyroid disorder	8 (6.7)
Asthma	1 (0.8)
CVA	5 (4.2)
Previous abdominal surgery	
Colorectal surgeries	8 (6.7)
Cholecystectomy	6 (5.0)
Appendectomy	5 (5.0)
Hernia repair	6 (4.2)
OBS\GY	5 (5.0)
None	89 (74.2)
Diagnosis	
Colon cancer	81 (67.5)
Rectal cancer	21 (17.5)
Colorectal cancer	18 (15.0)

BMI, body mass index; SD, standard deviation; DM, diabetes mellitus; HTN, hypertension; CLD, chronic liver disease; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; CVA, cerebrovascular accident; OBS/GY, obstetrics and gynecology.

Table 2. Distribution of patients according to their operative data.

Variable	No. (%)
Surgery timing	
Elective	93 (77.5)
Emergency	27 (22.5)
Type of colonic surgery	
Total colectomy	1 (0.8)
Right hemi-colectomy	26 (21.7)
Left hemi-colectomy	42 (35.0)
Subtotal colectomy	5 (4.2)
Abdominoperineal resection	9 (7.5)
Low anterior resection	34 (28.3)
Total proctocolectomy	3 (2.5)
Anastomoses	
Yes	89 (74.2)
No	31 (25.8)
Stoma formation	
Yes	58 (48.3)
No	62 (51.7)
Type of stoma	
End colostomy	21 (17.5)
End ileostomy	10 (8.3)
Diverting colostomy	3 (2.5)
Diverting ileostomy	24 (20.0)
None	62 (51.7)
Epidural anesthesia	
Yes	98 (81.7)
No	22 (18.3)
ASA score	
I	6 (5.0)
II	63 (52.5)
III	48 (40.0)
IV	2 (1.7)
V	1 (0.8)
Required blood transfusion	
Yes	27 (22.5)
No	93 (77.5)
Mean number of required units (mean $\pm$ SD)	0.46 $\pm$ 1.75

ASA, American Society of Anesthesiologists; SD, standard deviation.

Previous studies,^{2,10,14} including a cross-sectional study conducted in 2013 in Isfahan, Iran,⁶ have found that the occurrence of ileus is directly associated with the duration of the surgical procedure. However, the Iranian study solely focused on the duration of the operation, rather than the type of surgical approach used.⁶ In our analysis, the duration of laparoscopic colectomy was significantly longer than that of the open procedure; however, this did not lead to an increase in the incidence of PPOI. Another study that observed 295 patients who underwent laparoscopic colectomy for colorectal cancer, also found that the duration of the operation has little impact on POI and PPOI.¹⁵ Some studies speculate that the

Table 3. Distribution of patients according to type of approach.

Variable	Laparoscopic (n = 55)	Open (n = 65)	P value
Age (years)	59.38 ± 14.35	63.03 ± 13.29	-
BMI	27.58 ± 5.14	26.82 ± 5.70	0.57
ASA score			
I	3 (5.5%)	3 (4.6%)	0.35
II	33 (60.0%)	30 (46.2%)	
III	19 (34.5%)	29 (44.6%)	
IV	0	2 (3.1%)	
V	0	1 (1.5%)	
Procedure time (min)	403.16 ± 133.73	277.34 ± 123.39	<0.001
Estimated blood loss (ml)	139.09 ± 145.83	343.85 ± 307.77	<0.001
Stoma formation			
Yes	28 (48.3%)	30 (51.7%)	0.60
No	27 (43.5%)	35 (56.5%)	
Passing of first flatus (postoperative day)	3.13 ± 2.13	3.94 ± 2.65	0.09
Tolerance of clear liquid (days)	2.38 ± 1.52	3.77 ± 2.76	0.001
Tolerance of regular diet (days)	5.44 ± 2.70	8.94 ± 6.65	<0.001
Mobilization (days) ^b	3.12 ± 1.70	5.39 ± 3.48	<0.001
Length of hospital stay (days)	8.24 ± 4.29	14.52 ± 10.47	<0.001
POI	4 (7.2%)	1 (1.5%)	0.03
Prolonged POI	5 (9.1%)	13 (20.0%)	0.03
Post-OP complications ^a			
SSI	3 (12.5%)	21 (87.5%)	<0.001
Anastomosis leak	2 (28.6%)	5 (71.4%)	0.34
Pneumonia	0 (0.0%)	2 (100%)	0.19
UTI	1 (20.0%)	4 (80.0%)	0.23
DVT	0 (0.0%)	1 (100%)	0.35
Atelectasis	1 (25.0%)	3 (75.0%)	0.39
Dindo classifications			
No complications	44 (61.1%)	28 (38.9%)	0.001
Grade I	3 (37.5%)	5 (62.5%)	
Grade II	2 (12.5%)	14 (87.5%)	
Grade III	1 (11.1%)	8 (88.9%)	
Grade IV	5 (38.5%)	8 (61.5%)	
Grade VI	0 (0.0%)	2 (100%)	

^aSome patients had more than one complication.^bSome data are missing.

BMI, body mass index; ASA, American Society of Anesthesiologists; POI, postoperative ileus; SSI, surgical site infection; UTI, urinary tract infection; DVT, deep vein thrombosis; PPOI, prolonged postoperative ileus.

longer duration of the laparoscopic approach is due to the limited range of motion and flexibility of instruments, in addition to the two-dimensional view and the dependence on surgeon skill.¹⁶ However, we do not agree with that statement in view of ongoing innovations, and the early exposure of trainees to laparoscopic surgery. There is the potential risk of bias, however, as it may be the case that more advanced disease that requires open surgery and multi-organ resection could contribute to prolonged operative time, POI, and PPOI.

In terms of intraoperative complications, studies have shown that the higher the estimated blood loss, the higher the risk of developing POI. This is explained by the stimulation of the sympathetic stress response and its inhibition of bowel motility.¹⁷ Many studies state that the open approach results in more blood loss and blood transfusions than the laparoscopic approach.^{18,19} Our results have also shown a significant difference in blood loss between open surgery and laparoscopy (343.85 vs. 152.73 mL). The significant increase in bleeding in the open approach may have occurred due to the larger surgical incision. However, this could also be influenced by the fact that more advanced disease that requires major resection would be associated with more blood loss and a higher rate of transfusion.

Regarding the postoperative hospital course, our results have shown a significant earlier tolerance of regular diet in the laparoscopy group compared to the open group (5.44 vs. 8.94 days). This may be due to less trauma during the operation and the release of less amounts of stress hormones, allowing for early bowel recovery.¹⁸ Patients who underwent laparoscopy showed earlier ambulation (3.12 vs. 5.39 days) because of the small surgical incision and less pain. Early mobilization in the laparoscopy group also helped to stimulate bowel function. Similar results on early regular diet tolerance and early mobilization in the laparoscopy group were observed in other studies.¹²

The laparoscopic approach was associated with a significantly lower risk of overall complications and this supports our point of view.¹³ Furthermore, our study has shown that the Clavien–Dindo score was lower in the laparoscopy group than in the open group. A recent study showed that the most common surgical complication is surgical site infection (SSI), while POI is the third most common complication.²⁰ In our study, the most frequent complications were POI and PPOI, followed by SSI. With regard to LOS, we found that it was shorter in the laparoscopy group compared to the open group. This was similar to the findings of a recent retrospective cohort study performed in the United States, which investigated both surgical approaches and robotic surgery, and showed that robotic and laparoscopic surgeries had shorter LOS than the open approach.²¹ In addition, a better quality of life was observed in patients that underwent laparoscopic colectomy in a randomized controlled trial.²²

The study's main limitations were its retrospective nature, small number of patients, and the lack of standardized definitions of POI and PPOI. These results are limited to a small population in a single tertiary center, therefore not necessarily applicable to the general population and definitive conclusions cannot be made. Further studies with a larger sample size, involving multiple colonic diseases, are required to address this issue.

Conclusion

The incidence of both POI and PPOI were significantly influenced by the surgical approach used. The laparoscopic approach showed better postoperative mobilization and tolerance to regular diet. However, overall complications were more frequent in the open approach. Our suggestion for future studies is to address more extensive pre- and postoperative measures aimed at decreasing the incidence of POI, PPOI, and other complications of colorectal surgeries.

Data availability

Underlying data

Zenodo: Complications and postoperative ileus in laparoscopic versus open colectomy: A retrospective cohort study.
<http://doi.org/10.5281/zenodo.4730346>.²³

This project contains the following underlying data:

- raw data.xlsx
- CODING FOR REASEARCH VARIABLES.docx

Data are available under the terms of the [Creative Commons Attribution 4.0 International license](#) (CC-BY 4.0).

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Mario Trejo-Avila

Department of Colorectal Surgery, Hospital General Dr. Manuel Gea González, Calzada de Tlalpan, Mexico City, 4800, Mexico

This is a retrospective cohort study. I have several comments to this manuscript:

Abstract:

- The aim of the study is lacking.
- In the conclusion, I think its not appropriate to include that "the laparoscopic approach was more cost-effective". This was not the aim of the study, it should not be part of the conclusion.

Methods:

- The aim of the study is ambiguous. It should be clear whether the aim is the incidence of postoperative ileus or postoperative complications.
- I suggest to add a paragraph regarding primary and secondary outcomes, with their respective definitions.
- Regarding the inclusion criteria, including all the procedures is misleading. One should expect higher complications rates (and higher ileus incidence) after a total colectomy or after a pelvic procedure in comparison to a right colectomy (which is by definition less invasive).

Results:

- In table 1, there are patients with colon and rectal cancers, but what patients where included as "colorectal cancer"?
- Including elective vs. emergency surgery is misleading. It is expected to have higher complications rates after emergency resections.

- Why the Inclusion of an ASA-V patient that by definition is a moribund patient?
- It should be explained the reason why patients after open surgery mobilize later than laparoscopic patients.
- It is confusing why patients in the laparoscopic group have better tolerance of clear liquids and regular diet (less days) but the incidence of POI is higher in that group. Please explain this.
- In Table 3 the percentages presented for postoperative complications are confusing. SSI rates of 87.5%? Anastomotic leaks 71.4? And 100% of DVT?

Discussion:

- The limitation section of the study is incomplete. There are more flaws in this study that need to be mentioned.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Partly

Are sufficient details of methods and analysis provided to allow replication by others?

Partly

If applicable, is the statistical analysis and its interpretation appropriate?

Partly

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Colon and Rectal Surgery

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 28 May 2021

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Hefzi Alratrout

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In general, this is an interesting topic with nice results, however, I do have a few minor comments and suggestions:

1. Concerning the article's name: I think it would be more convenient to remove postoperative ileus from the title, and just say: Complications in laparoscopic versus open... etc. Or say: postoperative morbidities in laparoscopic versus open... etc.- Because postoperative ileus is among postoperative complications, and is considered a morbidity.
2. Regarding the results of POI and PPOI: PPOI is any POI that extends beyond 3 days, thus, logically the numbers and percentages of PPOI are less than POI because some patients will resolve their postoperative ileus. However, in this article the numbers of POI is more than PPOI. Did they inverse the numbers? or when they say PPOI what they really mean is late onset of postoperative ileus?

Again, good article and worth publishing after correction and clarification of those 2 points.

Thank you.

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: General, digestive and Colorectal surgeon.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 18 Jun 2021

nadim malibary, King Abdulaziz University, Jeddah, Saudi Arabia

Dear reviewer, thank you for your time and effort.

Regarding your first point, we can't argue that Ileus is not a post operative complication. The purpose of this project was comparing POI and PPOI between 2 surgical approaches, and we had to mention other morbidities too, hence the broader title.

For the second point, PPOI are patients who had persistent ileus beyond 3 days, and in our tables are not considered POI. Meaning that POI patients are only the patients whose POI was resolved during the 3-day period, and if it takes longer, they are counted as PPOI. We had a bigger number of PPOI than POI in our cohort.

Regards

Competing Interests: None

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