

General Surgery Admissions, Operations, and Patient Outcomes during the COVID-19 Pandemic

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Abstract

Background and Objectives: During the COVID-19 pandemic, hospitals were overwhelmed and non-COVID admissions were restricted due to national guidelines and decreased references. The aim of this study was to evaluate the collateral effect of the pandemic on general surgery admissions, operations, and patient outcomes. **Patients and Methods:** After the ethics committee approval for this retrospective descriptive study, all general surgery patients from February 23 to May 21, 2020, were compared with a similar timeframe in 2019. Time from symptom onset to admission, final diagnosis, and type of surgery was documented. Morbidity and mortality rate, intensive care unit (ICU) admission time, and total admission time were compared. **Results:** During the first COVID-19 surge, a 64% decrease in admissions was observed. The mean time from symptom onset to admission showed a significant delay of 1.2 days. Fewer patients were admitted to the ICU, but ICU admission time was longer. Total admission time and postoperative surgical and nonsurgical complications showed no significant difference. The rate of complicated appendicitis increased from 2.8% to 12.3% of total surgeries. A decrease in total trauma admissions was observed, but trauma operations remained unchanged, and penetrating trauma admissions had doubled. **Conclusion:** Although morbidity and mortality were not increased during the pandemic, increased time to admission, under triage of trauma patients, shortage of ICU beds, and a higher rate of complicated appendicitis portray the collateral effects of the pandemic on general surgery patient care. The increased number of penetrating injuries demands psychological support during home confinement. Efforts should be made to maintain maximal surgical care during pandemics.

Keywords: Admissions, COVID-19, general surgery, operations, outcome, pandemic

INTRODUCTION

Since February 2019, the COVID-19 pandemic is affecting nearly all health systems all over the world. Beginning in the Wuhan province of China, this pandemic has afforded over 6 million deaths until now. During the waves of the pandemic, health-care systems and hospital beds were overwhelmed with COVID-19 patients and many nonemergent patients were canceled or postponed. It seems that patients avoided

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the emergency department due to the fear of COVID-19 and presented later and with more advanced illnesses.^[1,2] Similarly, elective admissions declined due to decreased patient allocation from primary health centers and canceled diagnostic procedures.^[3] Finally, road traffic accidents changed due to national quarantine policies. At the beginning of the pandemic, questionnaires disclosed that most centers reported a decrease in trauma and surgical emergencies and some trauma hubs shifted to other hospitals.^[4] Another challenge during the COVID-19 pandemic was the significantly increased mortality of COVID-19 patients after general anesthesia. The mortality of COVID-19 patients after surgery is high and varies between 5.6% in asymptomatic COVID-19-positive patients to 27% in symptomatic patients.^[5-8] According to these data, a shift to nonoperative management of several surgical emergencies occurred, especially for the treatment of noncomplicated appendicitis and cholecystitis.^[4,9] National and internal guidelines requested a higher threshold for surgery during the pandemic, particularly in the elderly, and postponing of nonurgent procedures.^[9] During the first wave of the COVID-19 pandemic in Iran, our center was one of the first hospitals fully overwhelmed with COVID-19 patients. Members of different specialties were involved in the care of COVID-19 patients, admission of elective patients was stopped and all emergent, urgent, and semi-urgent non-COVID patients were hospitalized in one separate emergency ward. As the COVID patients filled all hospital wards and intensive care units (ICUs), the non-COVID ward was completely transferred to the nearest non-COVID hospital for 3 weeks. According to these major changes during the pandemic and the adverse effects they might have had on patient care, we decided to assess the spectrum of general surgery admissions, operations, and patient outcomes during the first COVID-19 wave in comparison to the similar timeframe in the year before.

PATIENTS AND METHODS

Ethics committee approval was attained for this retrospective descriptive study (ethics committee approval number: 140.115). All general surgery patients who underwent an operation from February 23, 2020, to May 21, 2020, were included in the study and compared with a similar timeframe in 2019. Surgical patients without surgery (e.g., acute pancreatitis) were also included. Demographic data including gender, age, and COVID-19 status were recorded. COVID-19 status was considered positive if the polymerase chain reaction (PCR) test was positive or if typical lung involvement was seen on a chest computed tomography scan. Time from symptom onset to admission, final diagnosis, and type of surgery was documented. Mortality and surgical complications were considered as primary endpoints. Total admission time, ICU admission time, and nonsurgical complications including pulmonary, renal, and hepatic failure were evaluated as secondary endpoints. Complications which were assumed to be a consequence of late presentation according to the

surgeon's opinion were recorded. Data analysis was performed using SPSS statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA). Chi-square test, Fisher's exact test, and logistic regression were used, and a $P < 0.05$ was considered statistically significant.

RESULTS

During the first COVID-19 surge from February 23, 2020, to May 21, 2020, 89 patients were admitted to the surgery ward. In a similar timeframe in 2019, 251 patients had been admitted, showing a 64% decrease in admissions. The mean age of patients was 35.65 ± 19.47 years in the COVID-19 era (Group 1) and 39.46 ± 21.76 in the year before (Group 2), showing no significant difference. In Group 1, 73% of patients, and in Group 2, 61.4% of patients were male. Eighteen patients (20.2%) in Group 1 were diagnosed with COVID-19 infection according to symptoms, imaging, and PCR test. The mean time from symptom onset to admission was 3.19 ± 3.76 days in Group 1 and 2.04 ± 1.85 days in Group 2, showing a significant delay (+1.15 days) in Group 1 ($P = 0.007$). During the COVID-19 pandemic, fewer patients were admitted to the ICU in comparison to the year before (9% vs. 20%, respectively), but ICU admission time was longer (9.87 days vs. 3.90 days, respectively). Total admission time showed no significant difference between the

Table 1: Demographic data and time to admission in general surgery patients during the COVID-19 pandemic (Group 1) and the year before (Group 2)

	Group 1	Group 2	P
Age (years), mean±SD	35.65±19.47	39.46±21.76	0.145*
Male, n (%)	65 (73.0)	154 (61.4)	0.065**
Time to admission (days), mean±SD	3.19±3.76	2.04±1.85	0.007*
ICU admission, n (%)	8 (9)	51 (20)	0.024**
ICU admission time (days), mean±SD	9.87±14.40	3.90±3.22	0.280*
Total admission time (days), mean±SD	4.58±9.85	4.19±4.41	0.610*

*Independent *t*-test, **Yates' Chi-square test (Yates' correction for continuity). SD: Standard deviation, ICU: Intensive care unit

Table 2: Surgical and nonsurgical complications and mortality in general surgery patients during the COVID-19 pandemic (Group 1) and the year before (Group 2)

	Group 1 (COVID era), n (%)	Group 2 (non-COVID), n (%)	P
Surgical complications	2 (2.2)	11 (4.4)	0.526*
Pulmonary complications	2 (2.2)	12 (4.8)	0.534*
Renal complications	8 (9)	22 (8.8)	1.0**
Hepatic complications	6 (6.7)	22 (8.8)	0.710**
Complications due to late admission	24 (27)	11 (4.4)	0.000**
Mortality	2 (2.2)	4 (1.6)	0.654*
Mortality due to late admission	1 (1.1)	8 (3.2)	0.455*

*Fisher's exact test, **Yates' Chi-square test (Yates' correction for continuity)

two groups [Table 1]. The rate of postoperative surgical and nonsurgical complications, including pulmonary, hepatic, and renal complications, showed no significant difference between the groups. However, complications which were assumed to be a consequence of late presentation were significantly higher during the COVID-19 pandemic [Table 2]. The final diagnosis of patients showed a remarkable decrease in trauma admissions. Blunt trauma admissions dropped from 60 patients to 10, but penetrating trauma admissions doubled during the pandemic. The rate of appendectomy showed no significant difference, but in the pandemic group, the rate of complicated appendicitis showed a noticeable increase from 2.8% to 12.3% [Tables 3 and 4]. COVID-19 era was associated with an increased risk for poor outcomes in comparison to a similar time 1 year before with a relative risk of 4.45. Similarly, age and time to admission were predicting factors for poor outcomes with a relative risk of 1.03 and 1.34, respectively [Table 5].

Table 3: Final diagnosis of general surgery patients during the COVID-19 pandemic (Group 1) and the year before (Group 2)

Final diagnosis	Group 1 (COVID era), n (%)	Group 2 (non-COVID), n (%)	P*
Acute appendicitis	23 (25.8)	68 (27.1)	0.002
Complicated appendicitis	11 (12.3)	7 (2.8)	
Acute cholecystitis	10 (11.2)	39 (15.5)	
Acute pancreatitis	1 (1.1)	5 (2.0)	
Perforated peptic ulcer	1 (1.1)	8 (3.2)	
Intestinal obstruction/perforation	7 (7.9)	15 (6.0)	
Hernias	6 (6.7)	19 (7.6)	
Perianal/diseases	6 (6.7)	15 (6.0)	
Pilonidal disease	5 (5.6)	8 (3.2)	
Multiple trauma	10 (11.2)	60 (23.9)	
Penetrating trauma	6 (6.7)	3 (1.2)	
Burns	0	2 (0.8)	
Other	3 (3.3)	2 (0.8)	

*Fisher's exact test (Fisher-Freeman-Halton test)

Table 4: Surgeries performed on general surgery patients during the COVID-19 pandemic (Group 1) and the year before (Group 2)

Operations	Group 1 (COVID era), n (%)	Group 2 (non-COVID), n (%)	P*
Appendectomy	34 (41)	75 (36.6)	0.345
Cholecystectomy	9 (10.8)	41 (20)	
Laparotomy	7 (8.4)	10 (4.9)	
Colostomy	0	4 (2)	
Herniorrhaphy	6 (7.2)	18 (8.8)	
Hemorrhoidectomy	2 (2.4)	4 (2)	
Abscess drainage	11 (13.3)	19 (9.3)	
Trauma surgery	13 (15.7)	32 (15.6)	
Thoracotomy	0	2 (1.0)	
Amputation	1 (1.2)	0	

*Fisher's exact test (Fisher-Freeman-Halton test)

DISCUSSION

We observed a noticeable decrease in surgery emergency ward admissions (64%) during the COVID-19 pandemic in comparison to the same timeframe in the year before. Similar results are reported from other centers worldwide. A large nationwide study in the USA reported a 48% decrease in total surgical procedures.^[10] Different countries observed a noticeable decrease in elective surgical procedures, mostly affecting the endocrine, maxillofacial, hand, and esthetic surgeries.^[10-13] Even a decrease in oncologic surgeries (up to 47%) and admissions for urgent surgeries (7%–35%) was observed, in part due to decreased patient allocation from primary health-care centers and patients avoiding hospitals during the lockdown.^[2,3,12,14] The observed decrease in admissions in our center (64%) was somewhat higher than other studies, probably due to the availability of other state and private hospitals in the city, which did not admit COVID-19 patients and therefore attracted more non-COVID patients during the pandemic. During the lockdown, a trend toward nonoperative management of inflammatory causes of the acute abdomen like appendicitis and cholecystitis was seen. Similarly, in our study, a significant decrease in the number of performed cholecystectomies was seen (41 operations vs. only 9 in the COVID era). Acute cholecystitis was usually managed nonoperatively during the pandemic and probably many symptomatic patients were treated with antibiotics or were operated on in other non-COVID hospitals. The absolute number of appendectomies did not decrease in our center during the pandemic, but a significant increase in complicated appendicitis was observed. Other studies showed a decrease in uncomplicated and an increase in complicated appendicitis even up to 42%.^[1,15]

Trauma admissions were also substantially affected by the pandemic. A 29%–67% decrease in trauma patients is reported, mostly not only due to decreased road traffic during the pandemic but also due to decreased admission of minor injuries.^[3,16,17] Increased ISS of patients during the pandemic is reported, which favors the under-triage of patients.^[18-20] In our center, trauma admissions decreased dramatically during the COVID era, but the performed operations showed a less severe decrease. Therefore, it is obvious an under-triage of trauma patients had occurred. Many minor injuries were apparently referred to other hospitals or not admitted at all. During the lockdown, we observed the admission of trauma patients in other “nontrauma” centers throughout the city, which was a matter of concern, as trauma patient management needs a high standard of care including experienced and trained personnel and a broad service of imaging and laboratory facilities, for example, availability of Focused Assessment with Sonography in Trauma (FAST) and blood products. This issue was the concern of all surgeons during the pandemic, considering also that referring patients from other centers to our hospital, if patients needed surgery, proceeded not quickly, and standardized, because referral of trauma patients was not routine in our city before the pandemic.

Table 5: Prognostic factors for poor outcome in general surgery patients during the COVID-19 pandemic and the similar time the year before (logistic regression)

	Poor prognosis ^a	Good prognosis	Crude P	Adjusted P	OR
Age	49.95±25.84	36.67±19.87	0.002	0.001	1.030 (1.013-1.047)
Time to admission	4.93±4.65	1.94±1.72	<0.001	<0.001	1.342 (1.169-1.540)
Year					
COVID-19 era	25 (54.3)	64 (21.8)	<0.001	<0.001	4.452 (2.106-9.409)
Non-COVID era	21 (45.7)	230 (78.2)			

^aDeath or complications related to delayed admission were considered a poor prognosis. OR: Odds ratio

Another outstanding result was the increased number of penetrating injuries during the pandemic. One example was a woman who was stabbed by her husband with a knife, which could be a reflection of the adverse psychological effects of the quarantine. Similarly, several studies showed a slight increase in penetrating injuries, especially self-harm and attempted suicide, probably due to restrictions and home confinement.^[16,20-23] Time from symptom onset to admission in our hospital had increased during the pandemic by more than 1 day. This delay in presentation is assumed to be the consequence of people's fear of getting infected with COVID-19 in hospitals. Delayed presentation is also reported in other studies.^[1] ICU admissions were decreased due to lack of availability, but ICU admission time was increased. These data are depicting obviously that only the most severely ill patients were transferred to the ICU and the remaining patients had no access to intensive care during the pandemic. Similarly, Hakeem *et al.* reported a 57% decrease in ICU admissions in Saudi Arabia.^[17] Other studies reported an unchanged ICU admission rate but decreased ICU length of stay during the pandemic.^[24] Mortality and morbidity of general surgery patients in our center showed no change during the pandemic. Only complications which were assumed to be the consequence of late presentation were increased in the pandemic group. One example was a patient with a perforated peptic ulcer with a very late presentation, who was reoperated due to intra-abdominal abscesses. Other studies report similar results. In the study of Aviran *et al.*, patients had later presentation, higher leukocyte count, creatinine, and C-reactive protein.^[2] However, paradoxically, almost all studies, including ours, did not show a statistically significant increase in overall morbidity or mortality during the pandemic.^[16,20,25] One study observed an increase in morbidity and postoperative complications, but not in reinterventions and mortality.^[1]

We also assessed the prognostic factors for poor outcomes (death or complications related to delayed admission) demonstrating that age, time to admission, and COVID era had an adverse prognostic effect. Patients in the COVID pandemic had a 4.4 times higher risk of having a poor prognosis, and a longer time to admission showed a relative risk of 1.3. Previous studies had warned about the risk of adverse prognosis when patients are deprived of surgical access as a collateral effect of the pandemic and proposed reorganization of surgical services.^[26]

CONCLUSION

During the pandemic, patients have been deprived of surgical access with the risk of a worse prognosis. Although morbidity and mortality were unchanged, increased time from symptom onset to admission, shortage of ICU beds, and a higher rate of complicated appendicitis portray the collateral effects of the pandemic on general surgery patient care. Total trauma admissions decreased not only due to road traffic restrictions but also under triage, putting patients at risk for missed injuries. The increased number of penetrating injuries is also worrying and demanding psychological support during home confinement. Efforts should be made to maintain maximal surgical care during the pandemic waves. As late presentation seems to be in part a result of the patient's fear of getting infected, creating separate centers for non-COVID patients might be necessary. The long-term effect of the pandemic due to the cancellation of elective procedures, including cancer screening and surgery, was not in the scope of our study and should be evaluated in future studies.

Limitations

One limitation of this study is the small number of patients from a single center. Many patients were admitted to other hospitals during the pandemic, which was not included in the study.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Cano-Valderrama O, Morales X, Ferrigni CJ, Martín-Antona E, Turrado V, García A, *et al.* Acute care surgery during the COVID-19 pandemic in Spain: Changes in volume, causes and complications. A multicentre retrospective cohort study. *Int J Surg* 2020;80:157-61.
2. Aviran E, Laks S, Benvenisti H, Khalilieh S, Assaf D, Aviran N, *et al.* The impact of the COVID-19 pandemic on general surgery acute admissions and urgent operations: A comparative prospective study. *Isr*

- Med Assoc J 2020;11:673-9.
- Abram J, Gasteiger L, Putzer G, Spraidner P, Mathis S, Hell T, *et al.* Impact of COVID-19 related lockdown on the frequency of acute and oncological surgeries-lessons learned from an Austrian university hospital. *Front Public Health* 2021;9:625582.
 - Cozza V, Fransvea P, La Greca A, De Paolis P, Marini P, Zago M, *et al.* I-ACTSS-COVID-19-the Italian acute care and trauma surgery survey for COVID-19 pandemic outbreak. *Updates Surg* 2020;72:297-304.
 - Ghosh S, John A, D'sa P, Kurian B, Ayodele P, Gadgil A. "Surgically treated COVID-19-positive trauma patients had a higher fatality rate"—A rural district general hospital's perspective in the United Kingdom. *Cureus* 2021;13:e18905.
 - Haffner MR, Le HV, Saiz AM Jr., Han G, Fine J, Wolinsky P, *et al.* Postoperative in-hospital morbidity and mortality of patients with COVID-19 infection compared with patients without COVID-19 infection. *JAMA Netw Open* 2021;4:e215697.
 - Carrier FM, Amzallag É, Lecluyse V, Côté G, Couture ÉJ, D'Aragnon F, *et al.* Postoperative outcomes in surgical COVID-19 patients: A multicenter cohort study. *BMC Anesthesiol* 2021;21:15.
 - Shanthanna H, Uppal V. Surgery during the COVID-19 pandemic. *Lancet* 2020;396:e74.
 - COVIDSurg Collaborative. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: An international cohort study. *Lancet* 2020;396:27-38.
 - Mattingly AS, Rose L, Eddington HS, Trickey AW, Cullen MR, Morris AM, *et al.* Trends in US Surgical Procedures and Health Care System response to policies curtailing elective surgical operations during the COVID-19 pandemic. *JAMA Netw Open* 2021;4:e2138038.
 - Covino M, Fulchignoni C, Pietramala S, Barbaliscia M, Franceschi F, Maccauro G, *et al.* One year of COVID-19: Lessons learned in a hand trauma center. *J Clin Med* 2022;11:2163.
 - McClelland PH, Cheng O, Hu J, Hunter JG, Winkler AC, Lee R, *et al.* Operative shutdown and recovery: Restructuring surgical operations during the SARS-CoV-2 pandemic. *J Surg Res* 2021;268:181-9.
 - Iyer S, Subramaniam S, Ravikumar B, Pai R, Satyapalan D, Moni M, *et al.* Recommendations for safely performing major head and neck surgery during the COVID-19 pandemic: Experience with implementation of a workflow. *J Maxillofac Oral Surg* 2020;19:630-7.
 - Pintado JF, Gibaja W, Vallejos RA, Rosas W, Guerra-Farfan E, Nuñez JH. How COVID-19 has affected emergent visits to a Latin-American trauma department: Experience at a Peruvian national trauma referral center. *Injury* 2020;51:2834-9.
 - Orthopoulos G, Santone E, Izzo F, Tirabassi M, Pérez-Caraballo AM, Corriveau N, *et al.* Increasing incidence of complicated appendicitis during COVID-19 pandemic. *Am J Surg* 2021;221:1056-60.
 - Giudici R, Lancioni A, Gay H, Bassi G, Chiara O, Mare C, *et al.* Impact of the COVID-19 outbreak on severe trauma trends and healthcare system reassessment in Lombardia, Italy: An analysis from the regional trauma registry. *World J Emerg Surg* 2021;16:39.
 - Hakeem FF, Alshahrani SM, Ghobain MA, Albabtain I, Aldibasi O, Alghnam S. The impact of COVID-19 lockdown on injuries in Saudi Arabia: Results from a level-I trauma center. *Front Public Health* 2021;9:704294.
 - Anwander H, Klingberg K, Gerber J, Bednarski P, Exadaktylos A, Müller M. Major trauma during COVID-19 in a level I trauma Centre in Switzerland – A cohort study comparing the years 2020 and 2019. *Swiss Med Wkly* 2021;151:33-4.
 - Çiftci AB. Injury mechanism, volume, and severity of general surgical trauma patients during COVID-19 lockdown. *Cureus* 2021;13:e15914.
 - Park J, Jung K, Kwon J, Moon J, Huh Y, Heo YJ, *et al.* Changes in the characteristics of trauma patients after the early COVID-19 outbreak: A retrospective study of a regional level 1 trauma center in Republic of Korea. *Medicine (Baltimore)* 2022;101:e28567.
 - Olding J, Zisman S, Olding C, Fan K. Penetrating trauma during a global pandemic: Changing patterns in interpersonal violence, self-harm and domestic violence in the Covid-19 outbreak. *Surgeon* 2021;19:e9-13.
 - Ghafil C, Matsushima K, Ding L, Henry R, Inaba K. Trends in trauma admissions during the COVID-19 pandemic in los Angeles County, California. *JAMA Netw Open* 2021;4:e211320.
 - Nia A, Popp D, Diendorfer C, Apprich S, Munteanu A, Hajdu S, *et al.* Impact of lockdown during the COVID-19 pandemic on number of patients and patterns of injuries at a level I trauma center. *Wien Klin Wochenschr* 2021;133:336-43.
 - Graulich T, Gerhardy J, Gräff P, Örgel M, Omar Pacha T, Krettek C, *et al.* Patient volume, diagnosis and injury mechanisms in a level 1 trauma center at the beginning of the COVID-19 pandemic in comparison to the mean of the 3 previous years: A retrospective, epidemiological evaluation of 4967 patients. *Unfallchirurg* 2020;123:862-9.
 - Yeates EO, Grigorian A, Schellenberg M, Owattanapanich N, Barmparas G, Margulies D, *et al.* Decreased hospital length of stay and Intensive Care Unit admissions for non-COVID blunt trauma patients during the COVID-19 pandemic. *Am J Surg* 2022;224:90-5.
 - Soreide K, Hallet J, Matthews JB, Schnitzbauer AA, Line PD, Lai PB, *et al.* Immediate and long-term impact of the COVID-19 pandemic on delivery of surgical services. *Br J Surg* 2020;107:1250-61.