



Impact of Covid-19 pandemic on volume and surgeon professional fees generated by emergency general surgery procedures

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Abstract

Introduction The COVID-19 pandemic has changed the dynamics of healthcare in the USA. In early 2020, most states issued orders to stop non-emergent elective surgeries. This contracted the overall revenue generated by the hospital systems. The impact of COVID-19 pandemic on volume has not been well studied but effects on surgeon professional fees generated remains unexplored. The goal of this study was to assess if COVID-19 pandemic has affected surgeon professional fees and revenues generated from emergency general surgeries.

Methods This is a retrospective review to compare surgical case volume in 2019 and 2020. We obtained our data from a tertiary care referral center database. Data were collected from February to April of 2019 and 2020, corresponding to the duration of statewide ban on non-emergent surgical cases. We used the most reported current procedural terminology (CPT) Code for each surgical procedure to calculate the surgeon professional fees generated. We calculated the percentage difference in surgeon professional fees between 2019 and 2020 for comparison.

Results There was a statistically significant decrease in daily emergent operations between 2019 and 2020 time periods (6.13/day vs 4.64/day). There was a statistically significant decrease in hospital admissions for appendicitis, cholecystitis, diverticulitis, skin and soft tissue infections, small bowel obstruction and GI bleed. Additionally, a statistically significant decrease in number of appendectomy, cholecystectomy, sigmoid colectomy with anastomosis, small bowel resection, operation for incarcerated and reducible hernia procedures was observed. There is a decline in surgeon professional fees generated in 2020 compared to 2019 for all emergent surgeries. When compared to 2019, we observed an increase of 238 more inquests in February to April of 2020, which is the same time period when we noticed a significant decrease in hospital admissions and procedures for emergency general surgery.

Conclusion The COVID-19 pandemic has negatively impacted surgical case volumes in 2020 compared to 2019. This includes both emergent and non-emergent cases. There is a need for more broad cost analysis which considers hospital expenditures and cost benefit analysis.

Keywords COVID-19 · Emergency general surgery admissions · Surgery · Revenue · Pandemic · Economic impact

The SARS-CoV-2 pandemic has put significant stress on the healthcare system in the USA. Since the beginning of the pandemic hospitals across the nation have formulated different strategies to reallocate their resources [1]. One

strategy was halting elective surgical procedures, and there was an expected decline in revenue generation. Tonna et al. reported in their retrospective cohort analysis, using insurance claim data, that cancellation of elective cases involving

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the musculoskeletal, cardiovascular, and digestive system accounted for the largest loss of hospital gross revenue [2].

As awareness of the COVID-19 pandemic spread, and social isolation mandates were enforced by different states, patients tended to avoid seeking medical care. A decline in Emergency Department (ED) visits for reasons other than respiratory tract infections has been reported by multiple studies [3–5]. Giannouchos et al. reported that this decline in ED visits was particularly noticeable in non-medically urgent conditions [4]. Westgrad et al. used data from a level 1 trauma center and reported a decline in ED visits for syncope, cerebrovascular accidents, urolithiasis, abdominal and back pain, and this trend was more prominent in pediatric and elderly population [5]. More recently, Lund et al. reported a decrease in 65% of emergency general surgeries during the COVID-19 governmental restrictions [6].

General surgery cases that were emergent were expected to continue during COVID-19 pandemic. In current literature, there are limited studies evaluating the incidence of emergency general surgeries during COVID-19. However, surgeon professional fees from emergent surgical cases during COVID-19 remains unexplored. The goal of this study was to retrospectively evaluate surgeon professional fees generated from emergency general surgery cases at a major tertiary referral center and to analyze the economic impact of cancellation of procedures on the hospital system during the COVID-19 pandemic.

Methods

We performed a retrospective review of de-identified data from a tertiary care referral center database. During February to April of 2020, there was a statewide ban in Texas on non-emergent surgical cases. Data were obtained for the most common emergency general surgery admission diagnoses and procedures performed from February to April of 2019 and 2020. Using International Classification of Diseases (ICD) 9 and ICD 10 codes, we retrospectively

calculated the number of general surgery diagnoses such as appendicitis, cholecystitis, diverticulitis, skin & soft tissue infections (SSTI), small bowel obstruction, gastrointestinal bleeding, and incarcerated hernia (Table 1). We used the reported current procedural terminology (CPT) Code to obtain the number of procedures performed for appendectomy, cholecystectomy, sigmoid colectomy with colostomy (Hartmann's Procedure), sigmoid colectomy with anastomosis, skin & soft tissue debridement, enterolysis, resection of small intestine, endoscopic procedures for gastrointestinal bleeding, incarcerated hernia repair, and reducible hernia repair (Table 2). The control group for comparison was designated as February to April of 2019, which is the time period before COVID-19 pandemic when there was no mandated statewide ban on surgical procedures.

After obtaining the volume of emergency general surgery diagnoses and procedures for February to April of 2019 and 2020, we translated the data into monetary units. To analyze the economic impact of COVID-19 on emergency general surgery, we used the Centers for Medicare & Medicaid Services (CMS) database. Using the CMS website and database, we obtained the work relative value unit (RVU) for each of the procedures. CMS defines work RVU as the relative time and intensity associated with providing a service and equals approximately 50% of the total payment [7]. The RVUs become the payment rate through the application of a dollar multiplier known as the conversion factor. For the year 2019 and 2020, the Medicare physician fee schedule (MPFS) was \$36.04 and \$36.09, respectively, for general surgery procedures. By multiplying the work RVU with MPFS, we obtained the physician monetary fee for each of the procedures for 2019 and 2020. We then multiplied this by the volume of the procedures to obtain the surgeon professional fees for 2019 and 2020. These professional fees were used to calculate surgeon revenue lost during the COVID-19 pandemic.

With the help of Harris County Deputy Chief Medical Examiner, we were able to obtain and access the data on the volume of inquests during our study periods in 2019 and

Table 1 ICD 9 and ICD 10 codes for the most common general surgery diagnoses

Diagnosis	ICD code
Appendicitis	K35-38, K35.80, K36, K37, K38
Cholecystitis	K81.0, K81.A1, K81.A2, K81.9, K81.1, K81.2, K80.00, K80.10, K80.12, K80.13, K80.01, K80.11, K90.19, K80.40, K80.41, K80.42, K80.43, K80.45, K80.47 K80.5
Diverticulitis	K57.0, K57.01, K57.2, K57.21, K57.33, K57.4, K57.8, K57.81
Skin and soft tissue infections (SSTI)	M72.6, M35.4, M31, M31.8, M31.9, I96, M79.9, M79.89
Small bowel obstruction	K56.51, K56.60, K56.69, K91.31, K50.812, K50.012
GI bleed	K25.2, K25.4, K29.71, K22.11, K92.2, I85.1, I85.11, I86.4, K50.911, K51.411, K51.911, K92.81
Incarcerated hernia	K40.0, K40.01, K40.31, K41.00, K41.01, K41.30, K42.0, K43.0, K43.3, K41.31, K43.6, K44.0, K45.0, K46.0

Table 2 CPT codes for the most common emergency general surgery procedures

Procedure	CPT code
Appendectomy	44950, 44955, 44960, 44970
Cholecystectomy	47562, 47563, 47564, 47600, 47605, 47610, 47612, 47620
Sigmoid colectomy with colostomy	44141, 44143, 44144, 44146, 44147, 44206, 44213
Sigmoid colectomy with anastomosis	44140, 44145, 44204, 44207, 44208, 44626
Skin and soft tissue debridements	11004, 11005, 11006, 11008, 11043, 11044
Enterolysis	44005, 44180
Resection of small intestine	44120, 44121, 44202
Endoscopic procedures for bleeding	43227, 43255, 44366, 44378, 44391, 45317, 45335, 45382, 46614
Incarcerated hernia repair	49496, 49501, 49507, 49521, 49553, 49557, 49561, 49566, 49572, 49582, 49587, 49653, 49655, 49657, 49492
Reducible hernia	49495, 49500, 49505, 49520, 49550, 49555, 49560, 49565, 49570, 49580, 49585, 49652, 49654, 49656, 49491

2020. Harris County is where the Houston Methodist Hospital is located. An inquest is defined as an inquiry into the circumstances surrounding a person's death. The purpose of the inquest is to determine the identity of the deceased, and to investigate how, when, and where they died.

For statistical analysis we used the two-sample T-test with equal variances, two-sample Wilcoxon rank sum test and Poisson regression to answer the research question: whether there are differences in emergency case volumes across different procedures between two-time periods (2019 and 2020). A p value < 0.05 was considered statistically significant.

Results

From February to April of 2019 control group, we collected data on 2751 admission diagnoses for appendicitis, cholecystitis, diverticulitis, SSTI, small bowel obstruction, gastrointestinal bleeding, and incarcerated hernia. Covid-19 pandemic group was from February to April of 2020, which had a total of 2109 admission diagnoses. There was a statistically significant decrease (i.e., p value < 0.05) in hospital admissions for the 2020 time period for appendicitis, cholecystitis, diverticulitis, SSTI, small bowel obstruction, gastrointestinal

bleeding, and incarcerated hernia (Table 3). Due to the small sample size for incarcerated hernia diagnosis ($n = 68$ and 48), there was no statistical difference observed between the two-time periods.

From February to April of 2019 control group, we collected data on 2148 emergency general surgery procedures such as appendectomy, cholecystectomy, sigmoid colectomy with colostomy, sigmoid colectomy with anastomosis, endoscopic procedure for gastrointestinal bleeding, small bowel resection, incarcerated hernia repair, reducible hernia repair, and skin and soft tissue debridement. In comparison, the 2020 time period had a total of 1201 emergency general surgery procedures, which equates to an absolute decrease of 947 cases during the COVID-19 time period. There was a statistically significant decrease (i.e., p value < 0.05) in the volume of emergency general surgery procedures for the 2020 time period for appendectomy, cholecystectomy, sigmoid colectomy with anastomosis, small bowel resection, incarcerated hernia repair, and reducible hernia repair (Table 4). We did not observe a statistically significant decrease in 2020 for sigmoid colectomy with colostomy, endoscopic procedures for gastrointestinal bleeding, and skin and soft tissue debridement.

From February to April of 2019 control group, we collected surgeon professional fees data on 2177 emergency

Table 3 Descriptive statistics for the number of hospital admissions by time period

Admission diagnosis	Number of admissions		Daily average Admissions		p value
	2019 (n)	2020 (n)	2019 (\bar{x})	2020 (\bar{x})	
Appendicitis	331	249	4.36	3.41	0.0085
Cholecystitis	596	463	7.64	6.01	0.0009
Diverticulitis	93	53	1.9	1.43	0.0268
SSTI	460	337	6.13	4.64	< 0.001
Small bowel obstruction	478	362	6.13	4.64	< 0.001
GI bleed	725	597	2.86	3.06	< 0.001
Incarcerated Hernia	68	48	1.58	1.23	0.1840

Bold values indicate statistically significant p value < 0.05

Table 4 Descriptive statistics for the volume of emergent cases by time period

Procedure	Number of procedures		Daily avg of procedures		<i>p</i> value
	2019 (<i>n</i>)	2020 (<i>n</i>)	2019 (\bar{x})	2020 (\bar{x})	
Appendectomy	318	242	4.24	3.14	0.0013
Cholecystectomy	678	425	8.69	5.52	< 0.001
Sigmoid colectomy with colostomy	37	29	1.23	1.32	0.8995
Sigmoid colectomy with anastomosis	201	109	3.65	2.42	0.0015
Endoscopic procedure for bleeding	51	31	1.38	1.35	0.5436
Small bowel resection	35	17	1.35	1	0.0124
Incarcerated hernia repair	84	34	40	24	0.0121
Reducible hernia repair	564	181	9.56	4.11	< 0.001
Skin and soft tissue debridement	180	133	2.81	2.46	0.2989

Bold values indicate statistically significant *p* value < 0.05

general surgery procedures such as appendectomy, cholecystectomy, sigmoid colectomy with colostomy, sigmoid colectomy with anastomosis, SSTI, enterolysis, resection of small intestines, endoscopic procedure for gastrointestinal bleeding, incarcerated hernia repair, and reducible hernia repair. In comparison, the 2020 time period had a total of 1215 emergency general surgery procedures that were analyzed for surgeon professional fees. Table 5 shows that all of the emergency general surgery procedures in 2020

resulted in decreased surgeon revenues when compared to the control time period from 2019. The total surgeon professional fees generated from February 2019 to April 2019 was \$1,073,333 and from February 2020 to April 2020 was \$591,621, which accounts for a difference of \$481,711 or 44.88% decrease in surgeon professional fees.

Table 6 shows the volume of inquests in Harris County during our study periods in 2019 and 2020. There was an increase in the number of inquests in February to April

Table 5 Physician revenue generated by emergency general surgery cases in 2019 and 2020

Procedure	# of Cases 2019	# of Cases 2020	Work RVU	MPFS 2019 (\$36.04)	MPFS 2020 (\$36.09)	Physician Revenue 2019 (\$)	Physician Revenue 2020 (\$)	Revenue lost (%)
Appendectomy	318	242	9.45	340.58	341.05	108,303.80	82,534.22	- 23.79
Cholecystectomy	678	425	10.47	377.33	377.86	255,829.32	160,591.48	- 37.23
Sigmoid Colectomy with colostomy	37	29	27.79	1001.53	1002.94	37,056.48	29,085.29	- 21.51
Sigmoid colectomy with anastomosis	201	109	33.99	1224.97	1226.70	246,218.77	133,710.20	- 45.69
Skin & Soft Tissue Infections (SSTI)	180	133	13.10	472.11	472.78	84,980.20	62,879.61	- 26.01
Enterolysis	29	14	18.46	665.28	666.22	19,293.17	9327.10	- 51.66
Resection of small intestine	35	17	20.82	750.33	751.39	26,261.69	12,773.69	- 51.36
Endoscopic procedure for bleeding	51	31	3.56	128.30	128.48	6543.26	3982.89	- 39.13
Incarcerated hernia repair	84	34	15.38	554.28	555.06	46,559.63	18,872.18	- 59.47
Reducible hernia repair	564	181	11.92	429.59	430.19	242,286.54	77,864.90	- 67.86
Total	2177	1215	164.94	5944.298	5952.685	1,073,333	591,621.6	- 44.88

Table 6 Coroner data from Harris County showing volume of inquests

	Volume of inquests	
	2019	2020
February	581	635
March	668	701
April	570	721
TOTAL	1819	2057

of 2020, with a total number of inquests being 2057 in the 2020 time period. This was an increase of 238 more inquests when compared to the time period in 2019.

Discussion

While elective surgical procedures saw a noticeable decline in volume during the early phase of the COVID-19 pandemic, similar effect on emergency general surgery procedures and hospital admissions was observed at Houston Methodist Hospital, which is a major tertiary care referral center. This trend is consistent across medical specialties [5]. This study demonstrates that the COVID-19 pandemic has led to a reduction in the number of emergency surgical procedures (Table 4) performed and a decrease in hospital admissions (Table 3) for high acuity emergency general surgery conditions. This is in line with other studies showing a decline in the number of patients seeking medical care for non-COVID-19-related causes as evident by, for example, reductions in US cardiac catheterization laboratory STEMI activations and significant drops in non-coronavirus-related ER visits across multiple institutions nationally [8]. In addition, other studies have shown a decline in outpatient ED

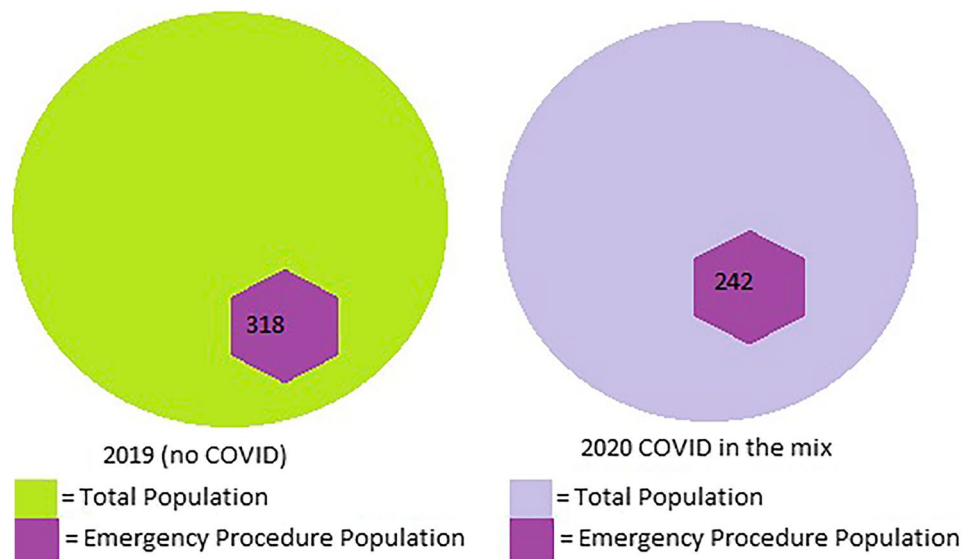
visits for syncope, cerebrovascular accidents, urolithiasis, and abdominal and back pain [4, 5]. These studies also report decreased visits for pediatric and elderly population.

Potential causes for this observed decline in hospital admissions and procedures may be multifactorial, ranging from fear of contracting COVID-19, to restrictions caused by social distancing and stay-at-home orders. In addition, the mandates issued by state and local governments limiting elective surgeries may have further contributed to this decline as healthcare practitioners may have opted for conservative treatment of illnesses that may have otherwise been treated surgically prior to the pandemic [9, 10].

Figure 1 highlights a decrease in volume of one of the most common emergency general surgery cases, an appendectomy. COVID-19 is the independent variable (binary: yes for 2020, no for 2019) and emergent appendectomy case volume is the dependent variable. The green and light-purple shaded circles are the “same” population from the catchment area for the hospital system. There were no new facilities nor any reasons to assume that the catchment area populations in 2019 versus 2020 are different at all. They are the same population at risk for acute appendicitis and the need for an emergency appendectomy surgery. Thus mathematically, the total population can be held constant between the two-time periods. Even despite having the same at-risk population as depicted in the pie charts, there were 72 fewer appendectomy surgeries in the time period we studied which was statistically significant ($p < 0.0013$).

In terms of severity of illness, the authors also noted that surgical patients during the COVID-19 pandemic had more extensive disease and more likely to be hemodynamically unstable. McLean et al. stated that patients during the COVID lockdown were more likely to present with gastrointestinal perforation and hemodynamic instability [11].

Fig. 1 Appendectomy cases in February to April 2019 and February to April 2020



Similarly in our study, there was a statistically significant decrease in the number of cases for sigmoid colectomy with anastomosis as opposed to with colostomy ($p = 0.0015$) between 2019 and 2020, because we believe many of the patients in 2020 presented with more extensive diverticulitis and septic shock. In the setting of Hinchey IV diverticulitis with septic shock, most surgeons would advocate for a colostomy instead of a primary anastomosis during sigmoid colectomy. In 2019 before the COVID-19 pandemic, patients were more likely to present to the hospital earlier in the disease process resulting in less severity of illness and more hemodynamic stability, which would favor a case with an anastomosis.

As less people were being admitted to the hospital for surgical emergencies and procedures, we investigated Harris County, which is the county of the hospital, public records to determine if there were more deaths at home. We were able to analyze the volume of inquests during our study periods. We observed a rise in the number of inquests in February to April of 2020, which is the same time period when we noticed a significant decrease in hospital admissions and procedures for emergency general surgery. We do not have the data for the etiologies of their deaths, so it is not possible to draw any major conclusions from this data. It is possible that some of these patients may have died at home from diagnoses that are amendable to emergency general surgery. We hope to continue our work with Harris County Deputy Chief Medical Examiner to learn more about the home deaths observed during our study period as well as post-pandemic time period.

This observed delay in seeking care when needed can have future implications for our healthcare systems. Patients may present later in the course of their disease with more serious symptoms that increase morbidity and mortality. McLean et al. reported that post-COVID lockdown, patients presenting to the hospital were significantly older, frailer, and significantly more likely to present with gastrointestinal cancer, obstruction, and perforation [11]. In addition, attention should be paid to the cost implications of treating a more severe course of a disease that could have been managed successfully and promptly with earlier intervention. Furthermore, the delay in preventative care, such as colonoscopy screenings and mammograms, may further exacerbate the long-term public health consequences of this pandemic [10–17]. Prior studies have shown that patients' perception of severity of symptoms, and even more so, the extent of perceived control over them, influence "reaction times". Such behavioral and perceptual factors may also play a role in the observed decline in seeking medical assistance and warrants further investigation.

Like all other studies, this current study also has limitations. First, this was a retrospective study and has all the usual limitations of this study design. Second, this study is based

on calculated and expected CPT reimbursements, which often are not applicable to actual reimbursements, particularly with uninsured patients. Third, this study focuses on procedural volume and reimbursements. This study does not account for any billing related to non-operative management of surgical diagnoses and does not account for billing of critical care days, all which impact revenue generation for the hospital. Fourth, this study does not include data on possible post-pandemic surge in surgical volume. However in future studies, the authors are interested in investigating the post-pandemic time period (after May 2020) to learn the cost of the pandemic shut-downs resulting in lives lost, decreased reimbursements, and higher cost of care to treat delayed surgical complications.

COVID-19 pandemic placed tremendous burdens on the healthcare system and affected the overall economy, including hospital revenues. This study shows that there was a loss in surgeon professional fees for all emergency general surgery procedures within a three-month time period during the COVID-19 pandemic in 2020, when compared to the same three-month period a year before (Table 5). These surgeon professional fees are an indicator of revenue generated by the hospital, and we do acknowledge that the decrease in revenue to the hospital far exceeds that when compared to the surgeon's professional fees. In 2020, at our hospital, we saw a 44.88% loss in surgeon revenue from emergency general surgery procedures. A reduction of revenue or professional fees of this magnitude can have ripple effects in terms of obtaining adequate resources within the hospital including hiring new personnel to help during the pandemic.

In conclusion, this Covid-19 pandemic has led many patients to delay seeking medical assistance for various reasons which has negative public health ramifications. To lessen this burden, public health officials and hospital administrations should reassure the public that health care facilities are ready and equipped to deliver urgent/emergent care in a safe, timely, and effective manner. Educational efforts aimed at encouraging the public to seek needed medical and surgical care in a timely fashion at symptom perception and interpretation can have long and lasting positive effects that can be applied to future public health challenges.

Declarations

Disclosures Dr. Aman Ali, Dr. Asad Shaikh, Dr. Mahnoor Zia, Dr. Nima Maghami, and Dr. Daniel J. Bonville have no conflicts of interest or financial ties to disclose.

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