

Evolution of acute care surgery in a general surgery department during the COVID-19 pandemic and comparison with a historical cohort

Evolución de la cirugía urgente en un servicio de cirugía general durante la pandemia de COVID-19 y comparación con una cohorte histórica

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Abstract

Background: Acute care surgery decreased during the first wave of the COVID-19 pandemic. **Objective:** To study the evolution of acute care surgery and its relationship with the pandemic severity. **Method:** Retrospective cohort study which compared patients who underwent acute care surgery during the pandemic to a control group. **Results:** A total of 660 patients were included (253 in the control group, 67 in the first-wave, 193 in the valley, and 147 in the second wave). The median daily number of acute care surgery procedures was 2 during the control period. This activity decreased during the first wave (1/day), increased during the valley (2/day), and didn't change in the second wave (2/day). Serious complications were more common during the first wave (22.4%). A negative linear correlation was found between the daily number of acute care surgery procedures, number of patients being admitted to the hospital each day and daily number of patients dying because of COVID-19. **Conclusions:** Acute care surgery was reduced during the first wave of the COVID-19 pandemic, increased during the valley, and returned to the pre-pandemic level during the second wave. Thus, acute care surgery was related to pandemic severity, with fewer surgeries being performed when the pandemic was more severe.

Keywords: Acute care surgery. COVID-19. SARS-CoV-2. Pandemic.

Resumen

Antecedentes: La cirugía urgente disminuyó durante la primera ola de la pandemia de COVID-19. **Objetivo:** Estudiar la evolución de la cirugía urgente y su relación con la gravedad de la pandemia. **Método:** Estudio de cohortes retrospectivo que compara los pacientes intervenidos de forma urgente durante la pandemia con un grupo control. **Resultados:** Se incluyeron 660 pacientes (253 en el grupo control, 67 en primera ola de la pandemia, 193 en el periodo valle y 147 en la segunda ola). La mediana del número de cirugías urgentes fue de 2 (intervalo intercuartílico: 1-3) durante el periodo control, disminuyó durante la primera ola (1/día), aumentó durante el valle (2/día) y no se modificó en la segunda ola (2/día). Las complicaciones mayores fueron más comunes durante la primera ola (22.4%). Se encontró una correlación lineal negativa entre el número de procedimientos quirúrgicos urgentes diarios y el número de ingresos hospitalarios y fallecimientos diarios por COVID-19. **Conclusiones:** La cirugía urgente se redujo durante la primera ola,

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aumentó durante el periodo valle y volvió a niveles prepandémicos durante la segunda ola. Además, la cirugía urgente se relaciona con la gravedad de la pandemia, ya que se realizaron menos cirugías urgentes durante el periodo de mayor gravedad de la pandemia.

Palabras clave: Cirugía urgente. COVID-19. SARS-CoV-2. Pandemia.

Introduction

During the COVID-19 pandemic, hospitals had to prioritize resources to treat patients infected with SARS-CoV-2, leading to the cancellation or postponement of numerous elective surgical procedures^{1,2}. However, the situation was different when considering urgent surgical activity (USA). Urgent surgeries can sometimes be delayed or avoided using alternative treatments such as antibiotic therapy or percutaneous drainage³⁻⁵. However, some patients require procedures that cannot be postponed, regardless of the pressure hospitals may have gone through during the pandemic.

The impact COVID-19 had on urgent surgical procedures has been analyzed by numerous authors^{1,4,6-8}. Some studies have also examined the reduced USA described during the first wave of the pandemic compared to a control period⁹⁻¹². However, the evolution of USA during the pandemic, including the number of surgeries performed, the characteristics of the patients undergoing surgery, and postoperative complications, has not been studied yet. Additionally, there are no data on the possible relationship between the severity of the pandemic throughout different stages and the number of urgent surgical procedures performed.

Therefore, the objective of this study was to analyze the evolution of USA during the COVID-19 pandemic. We examined the number of daily surgical procedures, the main characteristics of the patients, and all complications recorded across different periods of the pandemic. We also explored the potential relationship between USA and the severity of the pandemic.

Method

We conducted a retrospective cohort study of patients who underwent urgent surgery in a tertiary-level general surgery unit of a Spanish hospital. Procedures performed as a complication of elective surgeries were excluded from the study. Four different study periods were defined based on the evolution of the pandemic: a pre-pandemic control period (Period C: from March 1 through July 1, 2019), first wave (Period

1W: from March 13 through April 4, 2020), second wave (Period 2W: from October 7 through December 5, 2020), and a valley period between the 2 waves (Period V: from April 30 through July 22, 2020). The periods of the first and second waves were defined based on the higher incidence rate of SARS-CoV-2 infection, while the valley period was defined by the lower rate of COVID-19 after the first wave, based on data from our region.

Data on the demographic characteristics, clinical variables, details of the surgical procedure, length of stay, postoperative morbidity (grouped according to the Clavien-Dindo classification)¹³, and mortality were obtained from the patients' electronic health records. Information on the pandemic (daily diagnoses, deaths, and hospital admissions due to COVID-19) was obtained from hospital and regional government records¹⁴. Data were recorded in a Microsoft Excel® database and analyzed using Stata® statistical software (version 13.1, StataCorp, TX, United States).

The Shapiro-Wilk test was used to analyze the normality of quantitative variables. Quantitative variables were expressed as median and interquartile range (IQR), and the qualitative ones as absolute numbers and percentages. The Kruskal-Wallis range or the Mann-Whitney U test were used to compare quantitative variables, while the chi-square test or Fisher's exact test were used, as appropriate, to compare the qualitative ones. P values < 0.05 were considered statistically significant. To analyze the relationship between the severity of the pandemic (daily number of diagnosed patients, deaths, or hospital admissions due to COVID-19) and the daily number of urgent surgical procedures, Pearson's correlation coefficient was used.

All procedures were performed in full compliance with the ethical standards of our center, the National Research Committee, and the 1964 Declaration of Helsinki and further amendments. Written informed consent was not deemed necessary for this type of study. The study was approved by our Institutional Review Board (Code 2021/173) and conducted in full compliance with STROCCS criteria¹⁵. The study was registered in the Chinese Clinical Trials Registry (Code: ChiCTR2100047785).

Results

A total of 660 patients were included in the study, 253 of whom (38.33%) underwent surgery during Period C, 67 (10.15%) during Period 1W, 193 (29.24%) during Period V, and 147 (22.27%) during Period 2W. The median daily number of urgent surgical procedures performed was 2 (IQR, 1-3) during the Period C, 1 (IQR, 0-2; $p = 0.003$) during Period 1W, 2 (IQR, 2-4; $p = 0.047$) during the Period V, and 2 (IQR, 1-4; $p = 0.172$) during Period 2W (Fig. 1).

Among the patients, 371 (56.2%) were men, and the median age was 58.1 years (IQR, 40.3-72.5). According to the American Society of Anesthesiologists (ASA) classification, 303 (45.8%) fell into ASA I, 162 (24.6%) into ASA II, 162 (24.6%) into ASA III, and 33 (5.0%) into ASA IV. Arterial hypertension, diabetes mellitus, dyslipidemia, and ischemic heart disease were diagnosed in 189 (28.6%), 68 (10.3%), 135 (20.4%), and 99 (15.0%) patients, respectively. Patients were slightly healthier (ASA I and II) during Periods 1W (70.1%) and V (77.2%) compared to Periods C (66.4%) and 2W (68.7%), although the differences reported were not statistically significant ($p = 0.092$).

The most common diagnoses requiring surgery were acute appendicitis (337 patients, 51.1%), acute cholecystitis (155 patients, 23.5%), and intestinal obstruction (43 patients, 6.5%). The median surgical time was 65.0 min (IQR, 35.0-90.0). A total of 395 (59.9%), 250 (37.9%), and 15 (2.3%) patients required laparoscopic approach, open surgeries, and conversion from laparoscopic to open procedures, respectively.

The patients' main characteristics from each period are shown on table 1. Figure 2 compares the most common diagnoses requiring surgery in each period. The median length of stay was 5 days (IQR, 3-9). Shorter lengths of stay were reported during Periods 2W and V (5 days [IQR, 3-11] in the Period C, 4 days [IQR, 2-11] during Period 2W, 4 days [IQR, 2.5-7] during Period V, and 4 days [IQR, 2-8] during Period 2W, respectively; $p = 0.069$).

As shown on figure 3, major complications (Clavien-Dindo grades III-V) were reported in 92 patients (13.9%). Table 2 compares the complications observed across the different study periods. Morbidity was higher during the first wave with a higher rate of major complications: 37 (14.6%), 15 (22.4%), 16 (8.3%), and 24 (16.3%) patients experienced major complications during Periods C, 1W, V, and 2W, respectively ($p = 0.019$).

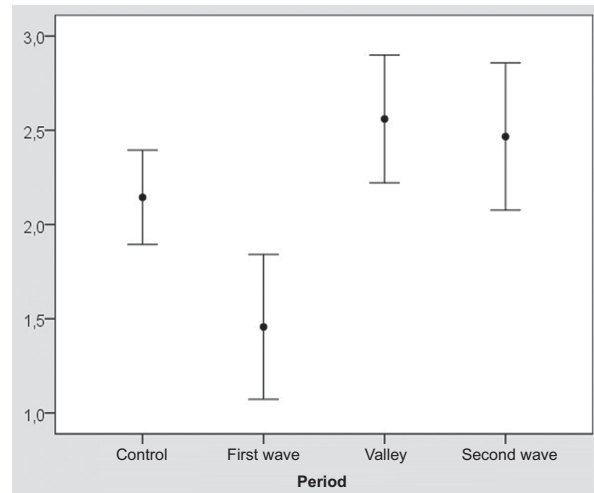


Figure 1. Mean and 95% confidence interval of the daily number of urgent surgeries performed during each study period.

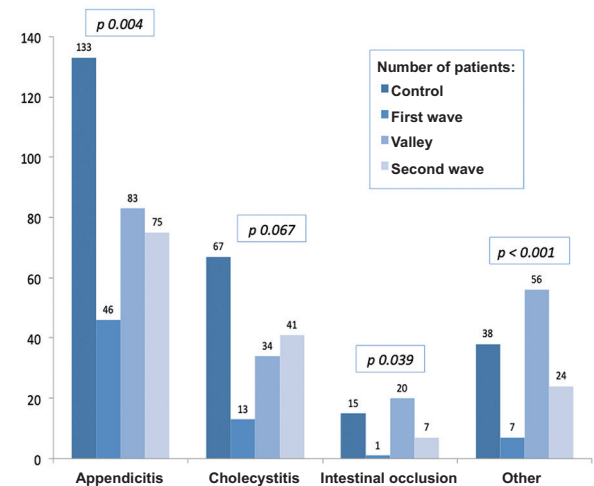


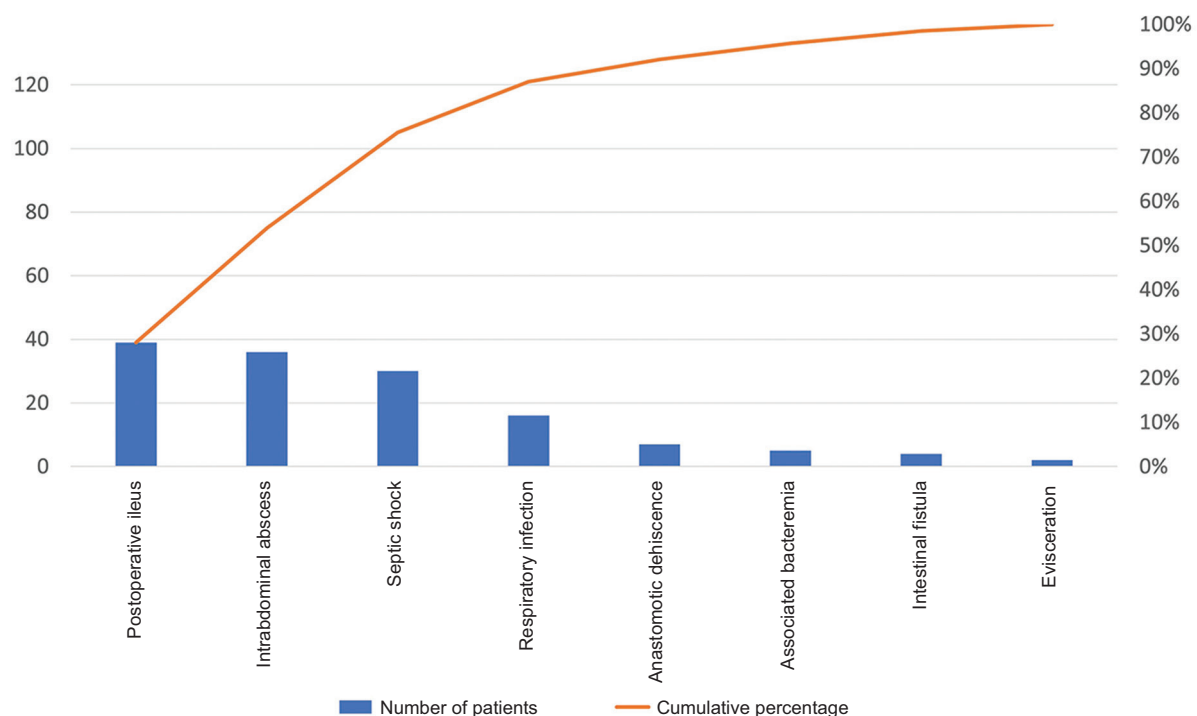
Figure 2. Comparison of the most common diagnoses requiring surgery in each study period.

Over the 30-day postoperative period, 24 patients (3.6%) died, 16 of these (2.4%) did so during the first postoperative week. No statistically significant differences were seen in the 30-day mortality rate among the 4 study periods (Table 2) ($p = 0.827$). Additionally, 110 patients (16.7%) were admitted to the intensive care unit (ICU) after surgery, with a mean ICU stay of 3 days (IQR, 2-7). No statistically significant differences were reported in the percentage of patients admitted to the ICU ($p = 0.675$) or in the duration of the ICU stay ($p = 0.485$) among the study periods.

Table 1. Comparison of the main characteristics of patients included in each study period

	Control (n = 253)	1 st wave (n = 67)	Valley (n = 193)	2 nd wave (n = 147)	p
Sex (n, % men)	151 (59.7%)	34 (50.8%)	101 (52.3%)	85 (57.8%)	0.336
Age (median, IQR)	58.4 (40.4-74.7)	58.5 (40.7-71.5)	53.1 (35.4-69.7)	59.9 (45.8-72.4)	0.045
ASA (n, % III-IV)	85 (33.6%)	20 (29.9%)	44 (22.8%)	46 (31.3%)	0.092
Hypertension (n, %)	75 (29.6%)	13 (19.4%)	49 (25.4%)	52 (35.4%)	0.066
Diabetes (n, %)	19 (7.5%)	6 (9.0%)	16 (8.3%)	27 (18.4%)	0.004
Ischemic heart disease (n, %)	48 (19.0%)	2 (3.0%)	25 (12.9%)	24 (16.3%)	0.009
Dyslipidemia (n, %)	56 (22.1%)	8 (11.9%)	36 (18.7%)	35 (23.8%)	0.185
Laparoscopic approach (n, %)	142 (56.1%)	37 (55.2%)	123 (63.7%)	93 (63.3%)	0.403

ASA: Classification of the American Society of Anesthesiologists; IQR: interquartile range.

**Figure 3.** Pareto diagram showing the number of patients and the cumulative percentage of the most frequent complications.

The median daily number of patients diagnosed with COVID-19 was 28.5 (IQR, 15.8-43.5) during Period 1W, 0 (IQR, 0-1) during Period V, and 113.0 (IQR, 65.8-150.8) during Period 2W ($p < 0.001$). Also, the median number of daily COVID-19-related deaths was different among the study periods: 2 during Period 1W (IQR, 0-4.3), 0 during Period V (IQR, 0-0), and 1 in during Period 2W (IQR, 0-4) ($p < 0.001$). Finally, the median daily number of hospital admissions due to COVID-19 was 5 during

Period 1W (IQR, 2.3-13), 0 during Period V (IQR, 0-1), and 7 during Period 2W (IQR, 5-9) ($p < 0.001$).

There was a negative linear correlation between the daily number of urgent surgeries and the number of daily COVID-19 hospital admissions (Pearson's correlation coefficient, -0.17 ; 95% confidence interval [CI], -0.31 to -0.02 ; $p = 0.024$) and the number of daily COVID-19-related deaths (Pearson correlation coefficient: -0.13 ; 95%CI, -0.27 to 0.01 ; $p = 0.067$).

Table 2. Comparison of the different postoperative complications diagnosed during each study period

	Control (n = 253)	1 st wave (n = 67)	Valley (n = 193)	2 nd wave (n = 147)	p
Length of stay (median, IQR)	5 (3-11)	4 (2-11)	4 (2.5-7)	4 (2-8)	0.069
Some complication (n, %)	69 (27.3%)	23 (34.3%)	34 (17.6%)	39 (26.5%)	0.022
Major complications (n, %)	37 (14.6%)	15 (22.4%)	16 (8.3%)	24 (16.3%)	0.019
Postoperative mortality (n, %)	10 (4.0%)	3 (4.5%)	5 (2.6%)	6 (4.1%)	0.827
ICU admission (n, %)	45 (17.8%)	11 (16.4%)	27 (14.0%)	27 (18.4%)	0.675
Intra-abdominal infection (n, %)	12 (4.7%)	7 (10.5%)	7 (3.7%)	10 (6.8%)	0.154
Evisceration (n, %)	1 (0.4%)	1 (1.5%)	0 (0%)	0 (0%)	0.236
Bacteremia (n, %)	2 (0.8%)	0 (0%)	3 (1.6%)	0 (0%)	0.352
Paralytic ileus (%)	16 (6.3%)	6 (9.0%)	5 (2.6%)	12 (8.2%)	0.095
Respiratory infection (n, %)	7 (2.8%)	3 (4.5%)	4 (2.1%)	2 (1.4%)	0.547
Septic shock	9 (3.6%)	5 (7.5%)	7 (3.6%)	9 (6.1%)	0.376

IQR: interquartile range; ICU: intensive care unit.

However, no significant correlation was seen between the number of urgent surgeries performed and the daily number of COVID-19 diagnoses (Pearson's correlation coefficient, 0.02; 95%CI, -0.13 to 0.16; $p = 0.830$).

Discussion

The main finding of our study was that the number of urgent surgical procedures decreased during the first wave of the COVID-19 pandemic, increased during the valley period, and remained unchanged during the second wave. This confirms that USA changed throughout the pandemic. Across the first wave, we saw a significant increase in the number of appendectomies performed, but fewer cholecystectomies, with the latter trend continuing during the valley period. Also, more complications were seen during the first wave likely because patients delayed visiting the ER, thus leading to developing more severe conditions. We also found an inverse relationship between the severity of the pandemic and the number of urgent surgical procedures eventually performed.

Several authors have already demonstrated that USA dropped during the first wave of the pandemic⁹⁻¹². However, the impact the second wave and the valley period had on the USA is still to be elucidate. The main finding of our study is that the median daily number of urgent surgical procedures dropped from 2 procedures during the control period to just 1 during the first wave ($p = 0.003$). However, this reduction was not seen during Periods V or 2W.

The reasons for this drop in USA during the pandemic have not been studied extensively. Most authors suggest that patients may have been afraid of getting COVID-19 while visiting the ER, thus leading to delayed visits. This delay could explain the decreased USA reported in case some of these patients improved without surgical treatment^{9-12,16}. Over time, patients may lose that fear of the virus, which would explain the increased number of procedures performed during the valley period and the return to higher levels during the second wave of the pandemic. Another possible explanation for the USA evolution could have been the different way of life occurred during the pandemic, especially during the strict lockdown of the first wave. This hard lockdown may explain the reduced incidence rate of certain life-style-related urgent surgeries performed during the first wave, such as high-fat intake-related acute cholecystitis¹⁷. However, these changes were not observed during the second wave of a more relaxed confinement.

When we analyzed the most common diagnoses requiring surgery throughout the different periods, we saw a significant increase in the number of appendectomies performed during the first wave (66.7% of all procedures performed during this period) and a decrease in other conditions. We also found a decline in the number of cholecystectomies performed, a trend that went on during the valley period. However, no changes were reported in the number of cholecystectomies performed during the second wave of the pandemic. Two factors could explain this finding: firstly, as discussed before,

the lifestyle changes occurred during the first wave may have reduced the rate of acute cholecystitis; secondly, it could very well be that numerous patients with cholecystitis were managed non-surgically, as observed by Ielpo et al.¹⁸ in a survey conducted in Spain.

Also, patients operated during the first wave and valley period were generally healthier than those operated during the second wave and the control period. This may be because patients with comorbidities tried to avoid visiting hospitals out on fear of COVID-19 infection. The severity of the pandemic was also related to the evolution of USA. The daily number of urgent surgical procedures kept a close correlation with the severity of the pandemic. Therefore, more patients being admitted to the hospital or died due to COVID-19 equaled fewer urgent surgeries were being performed. However, no association was found between USA and the daily number of COVID-19 diagnoses, likely due to the lack of diagnostic testing performed during the first wave of the pandemic.

Major complications were more common during the first wave of the pandemic ($p = 0.019$). Considering the reduced USA during the first wave, this growth in the number of major complications could be explained by delayed diagnoses following the patients' fear of seeking emergency care during the pandemic^{10,19}. Health authorities conducted information campaigns to encourage people to seek medical help when necessary²⁰. Therefore, these campaigns were probably effective, and patients probably became aware of the importance of seeking professional care if they had a health issue. Therefore, the absence of a reduced USA during the second wave of the pandemic could be attributed to the effectiveness of these campaigns and the development and implementation of safe health care pathways in emergency services. No significant mortality differences were found throughout the pandemic.

The main limitation of this study is its retrospective design, which may add information biases. However, most of the variables analyzed are objective and properly recorded in electronic health records. Another possible limitation is that the pandemic was still ongoing at the time of the study. Additionally, assessing the severity of the pandemic is challenging. We tried to analyze the number of patients diagnosed with COVID-19, but changes in diagnostic testing availability made it impossible to compare the incidence rate of COVID-19 during the first and second waves. Therefore, we studied the severity of the pandemic using more objective data, such as the number of patients who died or were

hospitalized with the virus. Finally, another limitation is that we chose a pre-pandemic period to compare the characteristics of urgent procedures, and it may not correspond exactly with the same seasons as the different periods of the pandemic. This could add bias due to seasonal variation in urgent surgeries. Nevertheless, urgent activity at our center remains relatively stable throughout the year, and the control period selected adequately represents the yearly trend. Hence, we deemed it unnecessary to collect a control period for each pandemic study period.

Conclusions

USA decreased during the first wave of the COVID-19 pandemic, increased during the valley period, and returned to pre-pandemic levels during the second wave. Additionally, we saw that USA was associated with the severity of the pandemic, with fewer surgeries being performed when pandemic severity increased. The main diagnoses requiring urgent surgery changed across the different periods of the pandemic. Finally, complications were more common during the first wave, although no mortality differences were reported.

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Conflicts of interest

None reported.

Ethical disclosures

Protection of human subjects and animals in research. The authors declare that no experiments were performed on humans or animals for this study.

Patients' data protection. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

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