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## COVID-19 PANDEMİYASI ŞƏRAİTİNDƏ TƏCİLİ CƏRRAHİ YARDIMIN XÜSUSİYYƏTLƏRİ

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Məqalədə COVID-19 pandemiyası şəraitində təxirəsalınmaz cərrahi yardımın xüsusiyyətlərini analiz etmək və müəyyənləşdirmək məqsədilə aparılmış tədqiqat işi haqqında məlumat verilmişdir. 3 №-li Poltava Dövlət Klinik Xəstəxanasına 2021-ci ilin iyun ayından sonrakı dövrdə COVID-19 infeksiyası ilə təxirəsalınmaz cərrahi müdaxilənin zəruriliyinə görə daxil olmuş 242 pasiyentin xəstəlik tarixi retrospektiv təhlil edilmişdir; 2019-cu ilin fevral ayından iyun ayına qədər təxirəsalınmaz cərrahi müdaxiləyə məruz qalmış pasiyentlər (COVID-19 infeksiyası olmayan pasiyentlər qrupu) müqayisə qrupuna daxil edilmişdir.

Aparılmış tədqiqat göstərmişdir ki, pandemiya dövründə ümumi vəziyyəti Amerika Anestezioloqlar Cəmiyyətinin təsnifatı üzrə 2-3-cü dərəcə kimi qiymətləndirilən pasiyentlər sayca üstünlük təşkil etmişdir ( $p < 0,0001$ ), cərrahlıq şöbələrində letal nəticələr işə pandemiya dövründə 6,2% olmuşdur. Pandemiya dövründə pasiyentlərdə COVID-19 fonunda koagulopatiya ilə əlaqəli olan ağırlaşmalara mezenterium arteriyalarının trombozu, aşağı ətraf arteriyalarının trombozu, perional venoz tromboz, tromboflebit) daha çox rast gəlinmişdir.

Müəlliflərin fikrincə, COVID-19 infeksiyaları pasiyentlərin operativ müdaxiləyə hazırlandığı dövrdə trombyaranmaya meyliyi və koagulopatiya törənməsi ehtimalı nəzərə alınaraq, antikoagulyantlardan istifadə etməklə profilaktika tədbirləri görülməlidir.

**Açar sözlər:** COVID-19 pandemiyası, təcili cərrahi yardım, koagulopatiya

**Ключевые слова:** пандемия COVID-19, экстренная хирургия, коагулопатия

**Key words:** COVID-19 pandemic, emergency surgery, cholecystectomy, coagulopathy

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## THE FEATURES OF EMERGENCY SURGICAL CARE DURING THE COVID-19 PANDEMIC

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**Summary.** The article presents the results of a study conducted to analyze and determine the characteristics of providing emergency surgical care in the context of the COVID-19 coronavirus infection.

A retrospective analysis of case histories of 242 patients with confirmed COVID-19 infection was conducted, who were admitted to the surgical department from February to June 2021 due to the need for emergency surgery. A comparative analysis was carried out with a group of patients who underwent emergency surgery from February to June 2019 (group without COVID-19 infection).

Emergency surgical care for patients in an infectious diseases hospital was one of the urgent problems during the pandemic of a new coronavirus infection COVID-19. The analysis showed that during the pandemic period, the number of patients with American Society of Anesthesiologists status 2-3 was significantly higher ( $< 0.0001$ ), and the mortality rate during the pandemic period in the surgical

department was 6.2%. During the pandemic, we detected the prevalence of patients with pathologies related to coagulopathy due to COVID-19 infection in the form of thrombosis of the mesenteric arteries, thrombosis of the arteries of the lower extremities, perianal venous thrombosis, and thrombophlebitis.

The tendency for thrombosis and the development of coagulopathy in patients with COVID-19 infection should be taken into account when preparing them for surgery and preventing thrombosis with the help of anticoagulants. Laparoscopic operations are safe for medical personnel, providing the compliance with sanitary and epidemiological requirements.

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#### List of abbreviations:

ACE2 – angiotensin-converting enzyme 2 receptor

ASA – American Society of Anaesthesiologists

CT – Computed tomography of the lungs

ESR – Sedimentation rate of erythrocytes

SARS – COV-2 - Severe acute respiratory syndrome coronavirus 2

#### Introduction

Emergency surgical care for patients in an infectious diseases hospital was one of the urgent problems during the pandemic of a new coronavirus infection COVID-19. During the pandemic, the burden on the surgical service has increased significantly [1]. However, Chinese scientists reported that along with increased postoperative morbidity and hospitalization in the intensive care unit, patients with COVID-19 also have an increase in mortality up to 20.5% [2]. In addition, patients with acute surgical pathology may have a concomitant asymptomatic COVID-19 infection that remains undetected until the patient has undergone surgery.

The world surgical communities (Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) [3], American College of Surgeons [4], Royal College of Surgeons of England [5]) have published joint recommendations for the work of the surgical service under these new conditions. The main provisions of the Temporary Guidelines were aimed at preventing the infection of medical personnel, and at developing principles for providing infected patients with medical care that cannot be postponed until the end of the pandemic.

**The objective of the study** was to analyze and determine the features of emergency surgical care in the context of the COVID-19 coronavirus infection pandemic at the General Surgery Department of Poltava City Clinical Hospital No. 3.

Before admission to the surgical department, each patient was tested for SARS-CoV-2. Due to the presence of the virus in body fluids and its spread by airborne droplets, the staff in the operating room used barrier gowns, FFP3 masks, and visors in accordance with the sanitary and epidemiological requirements of the hospital.

#### Materials and methods

We conducted a retrospective analysis of case histories of 242 patients with confirmed COVID-19 infection, admitted to the surgical department of Poltava Clinical Hospital No. 3 (Poltava, Ukraine) from February to June 2021 due to the need for emergency surgery. A comparative analysis was carried out with a group of patients who underwent emergency surgery from February to June 2019 (group without COVID-19 infection).

Over a period of 5 months in 2021, 97 emergency operations were performed at the Surgery Department during the COVID-19 pandemic. All scheduled operations were cancelled. Among the patients with surgical pathologies, there were 38 (39.2%) men and 59 (60.8%) women. The average age of patients was  $56.7 \pm 5.8$  years.

During the same period in 2019, 145 patients were operated on at the department, of which 66 (45.5%) were emergency cases. Among the emergency patients, there were 14 (21.2%) men and 52 (78.8%) women. The average age of patients with emergency pathology was  $54.3 \pm 13.6$  years.

The study was carried out in compliance with the basic provisions of the "Rules of ethical principles of scientific medical research with human participation", approved by the Declaration of Helsinki (1964-2013), ICH GCP (1996), EEC Directive No. 609 (dated 24.11.1986), Orders of the Ministry of Health of Ukraine No. 690 (dated 23.09.2009), No. 944 (dated 14.12.2009), No. 616

(dated 03.08.2012). All the participants were informed about the goals, organization, methods of examination and signed an informed consent to participate in the completely anonymous study.

In both groups, demographic and preoperative parameters such as age, sex, and physical condition were determined by ASA (American Society of Anaesthesiologists) [6]. We also collected data on comorbidities, postoperative diagnosis, abdominal surgery, disease severity, status, and postoperative complications. Comorbidities were assessed using the Charlson Comorbidity Index [7], and the ASA classification system (grades 1, 2–3, 4–5). For surgical complications, the Clavien-Dindo classification was used [8, 9].

In both groups of patients operated on for acute calculous cholecystitis, baseline laboratory tests were evaluated for the purpose of statistical analysis. The following parameters were taken into account: the number of leukocytes, erythrocyte sedimentation rate (ESR), fibrinogen, prothrombin index, creatinine, and urea.

Statistical processing of data samples was carried out using various packages of application programs “Excel” and “GraphPad Prism 5.0”.

The descriptive statistics were presented as the mean  $\pm$  standard error of the mean ( $M \pm m$ ). Quantitative values were presented in terms of the median (Me) and interquartile (25%-75%) range (Q1-Q3) of minimum (Min), and maximum (Max) values. These indicators were presented in terms of absolute values (n) and percentage (%). D'Agostina-Pearson's test (test K2) was used to evaluate the normalcy of distribution. To assess intergroup differences, a U-test was performed using the Mann-Whitney U-test and Student's t-test.

The values were considered statistically significant at  $p < 0.05$ .

## Results

Table 1 presents a comparative assessment of the physical condition of patients in both groups according to ASA.

A comparison of the physical condition of patients undergoing emergency surgery in the pre-pandemic and pandemic periods according to ASA showed that during the pandemic, the number of patients with ASA status 2-3 was significantly higher, which is explained by the presence of pneumonia, respiratory failure and coagulopathy in most patients. Mortality in the study period of the pandemic at the surgical department was 9.2%.

Comparative characteristics of the diagnoses of patients with emergency pathology in both groups are presented in Table 2.

Among patients with COVID-19, 13 (13.4%) were operated on for strangulated hernias: 11 patients with inguinal hernias and 2 patients with hernias of the anterior abdominal wall. In 12 cases, patients operated on for strangulated hernias were diagnosed with bilateral community-acquired pneumonia. In 2019, there were 7 emergency operations for strangulated hernias (10.6%): 4 cases of inguinal hernias and 3 patients with hernias of the anterior abdominal wall. The surgical technique and materials did not change during the pandemic: all patients underwent allohermioplasty with a mesh without tension according to Liechtenstein [10]. This technique is currently the preferred method for plastic reconstruction of inguinal hernias by most surgeons in the world [11]. No complications were observed in both groups.

In 4 patients, interventions were performed for acute intestinal obstruction against the background of viral pneumonia with the degree of damage to the lung parenchyma CT-3-4. In 2 cases, the obstruction was of an adhesive nature, and the adhesions were dissected laparoscopically. Two patients had acute intestinal

**Table 1.** A comparison of the physical condition according to ASA of patients undergoing emergency surgery in the pre-pandemic and pandemic periods

	Pre-pandemic period (n=145)	Pandemic period (n=97)	p-value
ASA score, n (%)			
ASA 1	57(39.3)	39(40.2)	0.8241
ASA 2-3	9 (9.2)	49 (50.5)	<0.0001
ASA 4-5	0	9 (9.2)	0.0002
Lethal outcome	0	9 (9.2)	0.0002

**Table 2.** Emergency room (ER) diagnoses; comparison of 2020 and 2019

Diagnosis according to ICD-10	2020 n= 97	% of total	2019 n= 66	% of total	P-value
K35 Acute appendicitis	5	5.2	23	34.85	< 0.0001
K40 Inguinal hernia	11	11.3	4	6.06	0.3712
K43 Hernia of the anterior abdominal wall	2	2.06	3	4.55	0.2552
K55.0 Thrombosis of mesenteric arteries	5	5.2	0	0	0.1091
K56.6 Acute intestinal obstruction, adhesive disease	5	5.2	2	3.0	0.2455
K61.2 Anorectal abscess	5	5.2	0	0	0.0626
K64 Perianal venous thrombosis	3	3.1	0	0	0.0113
K81 Cholelithiasis	32	32.9	30	45.45	0.0971
K85 Pancreatic necrosis	3	3.1	0	0	0.6568
I74.3 Thrombosis of lower limb arteries	2	2.06	0	0	0.0626
I80 Thrombophlebitis	9	9.3	0	0	0.1526
E11.2 Diabetic gangrene	4	4.1	0	0	0.0971
C54 Malignant neoplasms of the uterus	6	6.2	3	4.55	0.4166
N20 Ureteral stone	4	4.1	2	3.0	0.1526
N44 Testicular torsion	1	1.0	0	0	0.5158
Total	97		66		

obstruction with necrosis of the small intestine, which required resection of the necrotic section with side-to-side enteroanastomosis, and tubing of the small intestine with a nasogastric tube. All patients with intestinal obstruction were over 60 years of age. All patients were discharged with improvement.

Researchers have observed an increase in the number of patients with intestinal obstruction since the beginning of the quarantine due to the COVID-19 pandemic [12]. Several studies have suggested that this was facilitated by strict adherence to quarantine, as a result of which people were chained to their homes, their physical activity sharply reduced, and their diet changed. Patients without previous surgeries may experience adhesions, mainly caused by past infections. Abdominal COVID-19 infection and the prolonged prone position may play a role in the appearance of adhesions [13].

Five patients were admitted to the department with thrombosis of mesenteric vessels. All of them were diagnosed with bilateral polyseg-

mental pneumonia with respiratory failure of 2-3 degrees and ASA risk of 4-5 degrees. It is known that mortality in this group of patients exceeds 75% [14]. In our observation, patients were admitted with a clinical presentation of peritonitis, and total necrosis of the small intestine was detected during an emergency operation. All patients underwent thrombectomy from the superior mesenteric artery with resection of the small intestine. However, despite the prescription of anticoagulants in therapeutic doses and emergency treatment in the intensive care unit, all patients in the early postoperative period experienced rethrombosis and necrosis of the remaining part of the small intestine, and subsequently died.

Three patients were treated for acute destructive pancreatitis complicated by retroperitoneal phlegmon, fibrinous-purulent peritonitis, and sepsis. The diagnosis was confirmed by ultrasound and CT. In all cases, laparotomy, opening, debridement, and drainage of the phlegmon of the retroperitoneal space were

performed, followed by antibiotic therapy. According to the literature [15], acute necrotizing pancreatitis accounts for 10% of cases of acute pancreatitis. It is associated with higher mortality and usually develops 4 weeks after the onset of the disease. Consequently, the patients admitted to the department had not presented with complaints for quite a long time and were hospitalized in a neglected state with a risk level of III. All patients were discharged with improvement.

Eleven patients had thrombosis of the vessels of the lower extremities, 9 patients had thrombophlebitis, and 2 patients had arterial thrombosis. All of them underwent thrombectomy followed by anticoagulant and antibiotic therapy and were discharged for outpatient treatment. Several authors report that patients with acute COVID-19 are at high risk of thrombosis of various blood vessels due to hypercoagulability, blood stasis, and endothelial damage [16, 17]. Severe acute respiratory syndrome coronavirus (SARS-COV-2) is associated with clotting dysfunction that predisposes patients to an increased risk of both venous and arterial thromboembolism, worsening short-term morbidity and mortality [17].

Four patients were admitted to the department for gangrene of the lower extremities. All of them were diagnosed with polysegmental

pneumonia, Charlson comorbidity index 4-5, ASA 4. Two patients had diabetes mellitus, and the other two had no vasculopathy caused by COVID-19 coagulopathy. Toes of the lower extremities were amputated in two patients, and the foot was amputated in the other two patients. The patients were in the intensive care unit on artificial lung ventilation apparatus, but despite intensive treatment, respiratory failure increased and the patients died of the disease within a week after admission to the unit. Quite a few cases of gangrene development against the background of COVID-19 infection have been described [18, 19], which is interpreted as the development of coagulopathy for this infection.

In addition, in this study, we focused on the disease that was most often diagnosed at the Surgery Department of Poltava City Clinical Hospital No.2. Both in 2021 and 2019, it turned out to be acute cholecystitis against the background of calculous cholecystitis, which was an indication for emergency cholecystectomy.

Table 3 presents the comparative characteristics of laboratory tests of the patients who underwent emergency cholecystectomy in the pre-pandemic period and during the COVID-19 pandemic. The tests were conducted before the operation.

**Table 3.** Comparison of laboratory tests in patients undergoing emergency cholecystectomy in the pre-pandemic and pandemic periods

	Pre-pandemic period (n=30)	Pandemic period (n=32)	p-value
Age (years)	54.26±13.06	52.81±12.21	0.8216
Sex, n (%)			
Female	24 (80)	22 (68.75)	0.9057
Male	6 (20)	10 (31.25)	
Laboratory tests			
Leukocytes (×10 <sup>9</sup> /L)	8.15±2.3	9.38±3.67	0.5076
ESR (mm/h)	12.5±5.6	21.75±10.8	0.0018
Fibrinogen, g/l	3.32±0.85	4.52±1.1	<0.0001
Prothrombin index, %	96.63±11.99	136.77±23.36	<0.0001
Creatinine, mmol/l	72.17±8.93	95.72±25.74	0.0045
Urea, mmol/l	5.02±1.38	4.6±1.17	0.3002
ASA score, n (%)			
ASA 1	16 (53.3)	17 (53.1)	
ASA 2-3	14 (46.7)	15 (46.9)	
Charlson Comorbidity Index, %	3.62±1.54	3.63±1.83	0.0117
Length of hospital stay (days)	5.56±1.39	5.96±1.48	0.3634
30-day rehospitalization, n (%)	2 (6.66)	2 (6.25)	0.9604

Both groups of patients who were admitted to the clinic for acute cholecystitis and underwent emergency laparoscopic cholecystectomy did not have significant differences in terms of age, sex, comorbidity index, physical condition, and length of stay at the department.

During the COVID-19 pandemic, the severity of the disease in patients is much higher, therefore, the results of laboratory tests for acute inflammatory diseases, such as leukocytes and ESR, were expected to increase, because there may have been delayed hospitalizations of patients [20]. However, in our study, no significant differences were observed in leukocyte values between the pre-pandemic and pandemic periods, whereas ESR was significantly higher in patients with COVID-19.

As to the results of other laboratory tests, the increase in fibrinogen and prothrombin index in the group of patients with COVID-19 infection is noteworthy because it indicates an increased tendency for thrombosis and the development of coagulopathy [21]. Therefore, all patients in the pandemic period group received fraxiparine at a dose depending on the severity of the condition and coagulogram parameters.

An increase in creatinine in patients with COVID-19 is indicative of strained renal function due to direct viral cytopathic effects on the renal epithelium and podocytes, – a possible mechanism that is currently being discussed [22, 23].

### Discussions

A comparative analysis of patients undergoing emergency surgery in the pre-pandemic and pandemic periods showed that patients with the pathologies associated with coagulopathy due to COVID-19 infection prevailed in the pandemic period. These are thrombosis of the mesenteric arteries, thrombosis of the arteries of the lower extremities, perianal venous thrombosis, and thrombophlebitis. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is associated with clotting dysfunction that predisposes patients to an increased risk of both venous and arterial thromboembolism, worsening short-term morbidity and mortality [17].

The reason for the increased incidence of these pathologies is that the vascular endothelium is an important target for SARS-CoV-2 infection, therefore, vascular disorders are a

serious problem in COVID-19 [24]. Several histopathological studies revealed a direct viral infection of endothelial cells with evidence of their apoptosis, pyroptosis, and lymphocytic inflammation of the endothelium both in the lungs and in other organs [25].

It is known that the function of the vascular endothelium is to promote dilation of vessels, as well as fibrinolysis and anti-aggregation. Since the endothelium plays a significant role in the regulation of thrombosis [26], the hypercoagulability observed in COVID-19 indicates significant damage to the endothelium. Thus, according to M. Paz Ocaranza and J. Riquelme [27], the release of cytokines occurs because SARS-CoV2 is a single-stranded RNA coronavirus belonging to the Coronaviridae family (a genus of beta-coronavirus), which penetrates human cells by binding “spike protein” (S-protein) with angiotensin-converting enzyme 2 receptor (ACE2). It acts as the main receptor for SARS-CoV-2, which leads to inhibition of ACE2 and an increase in the expression of angiotensin II, which has pronounced vasoconstrictor properties and increases hypercoagulability due to the enhanced production of tissue factor and plasminogen activator inhibitor [28].

The second problem of patients during the pandemic is diabetic gangrene, which is also a consequence of the vasoconstrictor effect of increased angiotensin II under the influence of SARS-CoV-2. However, the neglect of the disease is a crucial issue due to patients' late visits to the clinic for fear of contracting COVID-19 infection. Other authors [29] have also observed the same reason for neglected cases in patients during the pandemic. Hence, immobilization due to quarantine, fear of this new virus, the delay associated with a patient's choice to stay at home until symptoms worsen, and an increase in the waiting time before receiving an exclusionary test for COVID-19 lead to prolonged illness and more severe diagnosis at admission.

The surgical strategy for acute cholecystitis during the COVID-19 pandemic has been debated for a long time as some authors report that patients who test positive for COVID-19 and undergo surgery experience poor clinical outcomes, such as increased mortality and pulmonary complications [30]. However, current guidelines recommend laparoscopic cholecys-

tectomy as the gold standard for the treatment of acute cholecystitis due to better outcomes in terms of mortality, morbidity, and postoperative hospital stay as compared to open cholecystectomy [31, 32, 33]. Therefore, we did not change the surgical tactics: all patients underwent laparoscopic cholecystectomy during the pandemic period.

As for laparoscopic emergency cholecystectomy, whose technique also did not change at the clinic during the pandemic period, there was no increase in perioperative complications as compared to the pre-pandemic period. There were minimal complications in this study according to the Clavien and Dindo scale in both groups. During the pandemic, only 2 patients had complications in the form of increased blood pressure, which required additional administration of medications; in the pre-pandemic period, 3 patients also had an increase in blood pressure after the surgery.

None of the medical professionals involved in operations contracted COVID-19 infection, which indicates the safety of laparoscopic abdominal operations during the pandemic period, providing the compliance with sanitary and epidemiological requirements.

#### Limitations

This is a retrospective, single-center study. The patient cohort was rather small. To reduce possible bias, we examined the exact time frame of 5 months in both 2019 and 2021. However, our results show that the two groups are well comparable, without any significant differences between the main pandemic and control group.

#### Conclusions

A comparative analysis of cases of emergency surgical care during the COVID-19 pandemic as contrasted with the pre-pandemic

period showed an increased number of diseases associated with vascular thrombosis in different parts of the body (mesenteric arteries, arteries and veins of the lower extremities, perianal veins) due to the impact of the SARS-CoV2 virus on the vascular endothelium and increased thrombosis among patients.

The severity of urgent laparoscopic emergency cholecystectomies during the pandemic did not increase compared to the previous year; postoperative complications were minimal.

In patients with COVID-19 infection, according to laboratory tests, there is a tendency for thrombosis and the development of coagulopathy, which should be taken into account when preparing for surgery and preventing thrombosis with the help of anticoagulants.

The safety-related resources at the clinic were in line with sanitary and epidemiological requirements, therefore, not a single surgeon contracted an infection.

The obtained results are important for the management of patients with COVID-19 infection in emergency surgical cases, as the coronavirus pandemic continues. In the tactics of managing patients with coronavirus infection and acute surgical pathology, no fundamental effective changes were found during the study. However, in the case of the comorbidity of acute surgical disease, COVID-19, and viral pneumonia of varying severity, it is necessary to take into account the increased risk of complications by bacterial and thromboembolic diseases. Based on our study, we can conclude that at the peak of the COVID-19 incidence, with an effective organization of surgical care in an infectious diseases hospital, it is possible to balance the reduction in surgical interventions (focusing on emergency surgeries) and the risk of infection of medical staff.

#### Compliance with Ethics Requirements:

„The authors declare no conflict of interest regarding this article”

„The authors declare that all the procedures and experiments of this study respect the ethical standards in the Helsinki Declaration of 1975, as revised in 2008(5), as well as the national law.“

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### ОСОБЕННОСТИ СКОРОЙ ХИРУРГИЧЕСКОЙ ПОМОЩИ В УСЛОВИЯХ ПАНДЕМИИ COVID-19

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**Резюме.** В статье представлены результаты исследования, проведенного с целью анализировать и определить особенности оказания неотложной хирургической помощи в условиях коронавирусной инфекции COVID-19.

Был проведен ретроспективный анализ медицинских карт 242 пациентов с подтвержденной инфекцией COVID-19, поступивших в хирургическое отделение Полтавской городской клинической больницы №3, с февраля по июнь 2021 г. в связи с необходимостью экстренного оперативного вмешательства. Сравнительный анализ проведен с группой пациентов, перенесших экстренную операцию в период с февраля по июнь 2019 г. (группа без инфекции COVID-19).

В результате проведенных исследований установлено, что в период пандемии количество больных со статусом American Society of Anesthesiologists 2-3 было достоверно выше ( $< 0,0001$ ), а летальность в период пандемии в хирургическом отделении составила 6,2%. В период пандемии выявлено преобладание пациентов с патологией, связанной с коагулопатией на фоне инфекции COVID-19, в виде тромбоза мезентериальных артерий, тромбоза артерий нижних конечностей, перианального венозного тромбоза, тромбоза флебитов.

По мнению авторов, следует учитывать склонность к тромбообразованию и развитию коагулопатии у пациентов с инфекцией COVID-19 при подготовке их к операции и профилактике тромбообразования с помощью антикоагулянтов.

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