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## ■ Research Article

# Predictors of Postoperative Complications in COVID-19 Patients Undergoing Emergency Abdominal Surgery

## *Acil Abdominal Cerrahi Yapılan COVID-19 Hastalarında Postoperatif Komplikasyonların Öngördürücüleri*

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### Abstract

**Aim:** The rapid spread of COVID-19 worldwide has also caused an increase in the incidence of postoperative complications in surgical patients. Clearly, COVID-19 positivity may affect postoperative complications in patients undergoing emergency surgeries. This study aimed to evaluate the factors predictive of postoperative complications in COVID-19 patients undergoing emergency abdominal surgeries.

**Material and Methods:** Fifty-two patients who underwent emergency abdominal surgeries and tested positive for COVID-19 via a Polymerase Chain Reaction (PCR) test within 72 hours of the perioperative period were evaluated retrospectively.

**Results:** The median age of the patients included in the study was 50.5 years (range: 18–83 years). The 30-day mortality rate was 15.4%, while the postoperative complication rate was 23.1%. A significant correlation was found between postoperative complication status and age ( $p = 0.003$ ) and between postoperative complication status and preoperative hemoglobin levels ( $p = 0.001$ ). The evaluation of age and hemoglobin together showed a sensitivity of 91.7% and a specificity of 87.5% for postoperative complications ( $p < 0.001$ , AUC: 0.867). In addition, a negative correlation was found between preoperative hemoglobin levels and length of hospital stay ( $p < 0.001$ ).

**Conclusion:** COVID-19-positive patients who undergo emergency abdominal surgeries face a significant risk of postoperative complications. An advanced age and low hemoglobin levels may be predictors of postoperative complications in this group of patients.

**Keywords:** COVID-19; abdominal surgery; emergency surgery; postoperative complications

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## ÖZ

**Amaç:** COVID-19 dünya çapında hızla yayılması ve pandemi haline gelmesi, cerrahi hastalarda postoperatif komplikasyonların insidansında da artışa neden oldu. Acil ameliyata alınan hastalarda COVID-19 pozitifliğinin ameliyat sonrası komplikasyonları etkileyebileceği açıktır. Bu çalışmada acil abdominal cerrahi uygulanan COVID-19 hastalarında postoperatif komplikasyonlar için öngördürücü faktörlerin değerlendirilmesi amaçlanmıştır.

**Gereç ve Yöntemler:** Bu çalışmada acil abdominal cerrahi uygulanan ve perioperatif 72 saat içerisinde COVID-19 Polimeraz Zincir Reaksiyonu (PCR) testi pozitif sonuçlanan 52 hasta retrospektif olarak değerlendirildi.

**Bulgular:** Çalışmaya dahil edilen hastaların medyan yaşı 50.5'di (aralık: 18-83). 30 günlük mortalite oranı %15.4 olarak saptandı. Postoperatif komplikasyon oranı %23.1'di. Postoperatif komplikasyon durumu ile yaş ( $p=0.003$ ) ve preoperatif hemoglobin değeri ( $p=0.001$ ) arasında anlamlı bir ilişki saptandı. Yaş ve hemoglobinin birlikte değerlendirilmesinin postoperatif komplikasyonlar için sensitivitesinin %91.7, spesifitesinin %87.5 olduğu görüldü ( $p<0.001$ , AUC: 0.867). Ayrıca ameliyat öncesi hemoglobin değeri ile hastanede kalış süresi arasında negatif korelasyon saptandı ( $p<0.001$ ).

**Sonuç:** COVID-19 testi pozitif olan ve acil abdominal cerrahi uygulanan hastalar önemli bir postoperatif komplikasyon riski ile karşı karşıyadır. Bu hastalarda ileri yaş ve düşük hemoglobin düzeyleri postoperatif komplikasyonlar için öngördürücü olabilir.

**Anahtar Kelimeler:** COVID-19; abdominal cerrahi; acil cerrahi; postoperatif komplikasyonlar

## Introduction

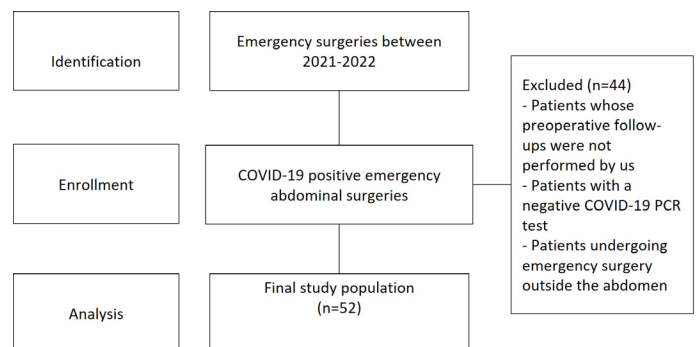
The global COVID-19 pandemic caused by the SARS-COV-2 virus has significantly disrupted patient follow-ups and treatments since 2020 [1], creating challenges for healthcare professionals and patients alike [2]. Despite the changes in lifestyle brought about by the pandemic, there has been no change in the incidence of emergency surgeries [3]. The performance of emergency surgeries in COVID-19-positive patients continues, but this situation brings high-level challenges for both patients and healthcare professionals [2]. Nevertheless, there is a need to continue conducting surgical procedures in order to resolve the emergency situations that threaten patients' lives [4].

COVID-19 infection can trigger an inflammatory response in the body [4], and the inflammation triggered by acute surgery can lead to multiple organ failure, increased mortality, and morbidity in COVID-19-positive patients [5]. For this reason, many studies have been conducted on perioperative morbidity and mortality in this group of patients [5, 6]. Studies including patients requiring emergency surgeries have found that individuals with an ongoing COVID-19 infection requiring surgeries have a higher risk of mortality and postoperative complications [3, 7].

Previous research has mostly focused on the early periods of the pandemic and the effects of COVID-19 infection on complications. Our study aims to contribute to the literature by evaluating the factors affecting the postoperative complications of COVID-19-positive patients who require emergency abdominal surgeries, and to emphasize the necessity of taking necessary precautions in patient follow-up for these factors.

## Material and Methods

Patients who underwent emergency abdominal surgeries in a tertiary health center between 2021 and 2022 were retrospectively evaluated. As part of COVID-19 measures, a preoperative COVID-19 Polymerase Chain Reaction (PCR) test was performed on all individuals undergoing surgical interventions. Patients who required emergency abdominal surgeries and whose COVID-19 diagnoses were confirmed through PCR tests within 72 h were included in the study. Those with negative COVID-19 PCR tests within the first 72 h and those whose preoperative follow-ups were not conducted by the researchers were excluded from the study (Figure 1). The patient population was classified into the postoperative complication-positive (PCP) or postoperative complication-negative (PCN) group, and these two groups were compared in terms of predictive factors. This study was approved by the XXX University Clinical Research Ethics Committee (Date: 08.05.2023, Decision No. 384). The study protocol is in accordance with the Declaration of Helsinki.



**Figure 1.** The sample collection scheme.

## Statistical Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences program (version 26.0, SPSS Inc., Chicago, IL, USA). In addition to descriptive statistical methods (medians, frequencies, and rates), the Mann–Whitney U test was used for the two groups' comparison. Fisher's exact test was adopted to compare qualitative data. Spearman's correlation analysis test was applied for the correlation between the numerical parameters. Binary logistic regression analysis was performed for predictive properties and efficacy. Diagnostic and predictive values were detailed using ROC analysis. A p value < 0.05 was considered statistically significant.

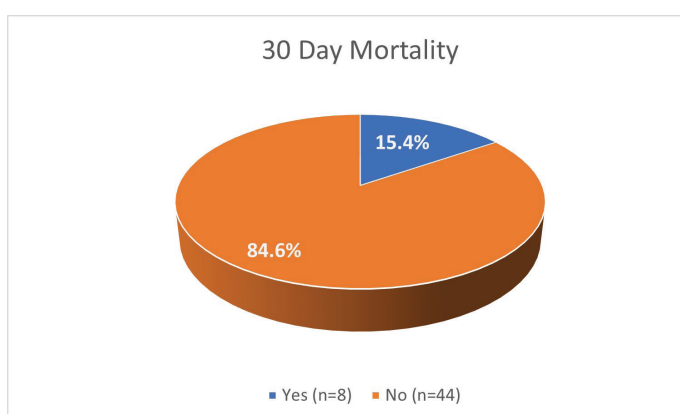
## Results

The median age of the 52 patients included in the study was 50.5 years (min:18–max:83) (Table 1). There were 31 males (59.6%) and 21 females (40.4%) in the patient population (Table 2). Eight patients (15.4%) died within 30 days postoperatively (Figure 2). Of these eight patients, four died from pulmonary complications, three from septic shock, and one from multiple organ failure on the basis of acute renal failure.

**Table 1.** General distribution properties of quantitative parameters

Parameters	Minimum	Maximum	Distribution †
Age (year)	18,00	83,00	50,5
Hemoglobin (g/dL)	8,00	16,30	12,45
WBC (K/ $\mu$ L)	3,10	27,10	8,86
CRP (mg/L)	1,31	415,00	32,90
D-dimer (mg/L)	,50	20,66	3,02
Hospitalization time (day)	1,00	29,00	4,50

† Variables are expressed as median (min-max) (IQR= Interquartile Range), WBC: White Blood Cell count, CRP: C-reactive protein



**Figure 2.** 30 Day Mortality

There were 12 patients (23.1%) in the PCP group and 40 (76.9%) patients in the PCN group. The patients in the two groups were evaluated for age, preoperative hemoglobin, white blood cell (WBC), C-reactive protein (CRP), and D-dimer parameters using the Mann–Whitney U test. Age was significantly different between the two groups ( $p = 0.003$ ). While there was no significant difference in terms of WBC ( $p = 0.704$ ), CRP ( $p = 0.161$ ), and D-dimer ( $p = 0.174$ ) levels, preoperative hemoglobin levels were significantly lower in the PCP group ( $p = 0.001$ ). The median length of hospitalization was 6.50 days (min:1–max:27) in the PCP group and 3.50 days (min:1–max:29) in the PCN group. However, there was no significant difference in the length of hospitalization between the two groups ( $p = 0.293$ ). In addition, there was no difference between the two groups in terms of the presence of pneumonia in the preoperative period ( $p = 0.336$ ) (Table 3).

**Table 2.** Summary of general distribution of preoperative characteristics

Parameters	Frequency (N)	%	
Preoperative features	Gender		
	Female	21	40.4%
	Male	31	59.6%
	ASA score		
	ASA 1	7	13.5%
	ASA 2	33	63.5%
	ASA 3	11	21.2%
	ASA 4	1	1.9%
	Presence of preoperative comorbidity		
	Cancer	20	38.5%
	Diabetes mellitus	14	26.9%
	Smoking	7	13.5%
	Hypertension	8	15.4%
	Chronic kidney disease	3	5.8%
COPD	3	5.8%	
Congestive heart failure	3	5.8%	
Coronary artery disease	3	5.8%	
Cerebrovascular disease	2	3.8%	

ASA: American Society of Anaesthesiologists, COPD: Chronic Obstructive Pulmonary Disease

There was a moderate negative correlation between preoperative hemoglobin levels and length of hospitalization, and it was found that the length of hospitalization was prolonged as preoperative hemoglobin levels decreased ( $p < 0.001$ ) (Table 4).

**Table 3.** Comparison of quantitative and categorical parameters between postoperative complication status

Parameters	POSTOPERATIVE COMPLICATION		p
	POSITIVE (n=12, 23.1%)	NEGATIVE (n=40, 76.9%)	
Median (min-max) <sup>a</sup>			
Age (year)	71 (23-83)	46 (23-83)	0,003
Hemoglobin (g/dL)	10.15 (8.00-13.40)	13.20 (8.30-16.30)	0.001
WBC (K/ $\mu$ L)	10.00 (4.90-27.10)	8.85 (3.10-25.60)	0.704
CRP (mg/L)	63.10 (11.20-415.00)	30.30 (1.31-210.00)	0.161
D-dimer (mg/L)	7.87 (0.88-20.66)	2.18 (0.5-4.04)	0.174
Hospitalization time (day)	6.50 (1-27)	3.50 (1-29)	0.293
Preoperative pneumonia, N (%)			
Positive	3 (25%)	5 (12.5%)	0,336 <sup>b</sup>
Negative	9 (75%)	35 (87.5%)	

WBC: White blood cell, CRP: C-reactive protein  
<sup>a</sup> Mann Whitney U test; variables are expressed as median (min-max) (IQR= Interquartile Range)  
<sup>b</sup> Fisher's exact test

**Table 4.** The correlation relationship between Hb levels, hospitalization time in COVID-19 patients undergoing abdominal surgery.

Two-tailed Correlation Analysis Model *		
	Hemoglobin (g/dL)	
	$\rho$	P *
Hospitalization time (day)	-0,547	<0,001

\* Spearman two-tailed correlation analysis  $\rho$ = Spearman's rho (correlation coefficient)

Each parameter with an effect profile on postoperative complications was evaluated using logistic regression analysis. An advanced age and low hemoglobin levels increased postoperative complications (OR = 1.065, 95% CI: 1.016–1.115, p = 0.008; and OR = 0.563, 95%CI: 0.386–0.822; p = 0.003, respectively) (Table 5). In the ROC analysis, age and hemoglobin levels were found to be predictive of postoperative complications (AUC: 0.783, 95% CI: 0.615–

0.952, p = 0.003; and AUC: 0.815, %95 CI: 0.665–0.964, P = 0.001, respectively). The cut-off values were determined as 65.5 years for age and 11.2 g/dL for hemoglobin levels (Figure 3, Table 6). In addition, the combined evaluation of age and hemoglobin was predictive of postoperative complications, with a sensitivity of 91.7% and a specificity of 87.5% (95% CI: 0.713–1.000, p < 0.001) (Figure 4, Table 7).

**Table 5.** An overview of the results of the logistic regression analysis for each parameter with an impact profile on postoperative complications

Faktör	POSTOPERATIVE COMPLICATION (Logistic Regression model regarding efficacy and prediction for postoperative complication)				
	B	-2LL	R <sup>2</sup> Nagelkerke	p	OR (95% CI)
Age (year)	0.063	46.663	0,253	0.008	1.065 (1.016-1.115)
Gender	-0.391	55.854	0.010	0.572	0.676 (0.175-2.620)
Hemoglobin (g/dL)	-0.574	44.106	0.314	0.003	0.563 (0.386-0.822)
WBC (K/ $\mu$ L)	0.055	55.228	0.027	0.324	1.056 (0.947-1.178)
CRP (mg/L)	0.006	37.658	0.089	0.176	1.006 (0.997-1.016)
D-dimer (mg/L)	0.349	10.704	0.440	0.20	1.418 (0.831-2.419)
Type of anesthesia					
	0.114	56.172	0.0002	0.924	1.121 (0.106-11.888)
Cancer	1.067	53.635	0.072	0.114	2.908 (0.773-10.936)
Diabetes mellitus	-1.667	52.993	0.092	0.12	0.189 (0.022-1.623)
Hypertension	0.847	55.169	0.029	0.302	2.333 (0.467-11.649)
Chronic kidney disease	2.054	53.408	0.079	0.107	7.800 (0.641-94.925)
COPD	2.054	53.408	0.079	0.107	7.800 (0.641-94.925)
Cerebrovascular disease	1.266	55.463	0.021	0.384	3.545 (0.205-61.381)

Since the distribution pattern is incompatible with the model, smoking, congestive heart failure, and coronary artery disease have been excluded from the regression analysis.

Reference category: Patients without postoperative complications. LL:Log Likelihood CI:Confidence Interval

OR: Odds Ratio, WBC: White Blood Cell Count, CRP: C-Reactive Protein, COPD: Chronic Obstructive Pulmonary Disease

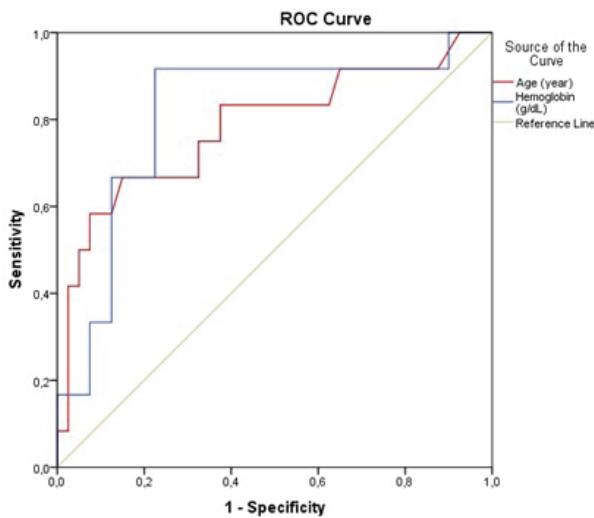


Figure 3. ROC analysis graph of age and Hemoglobin levels

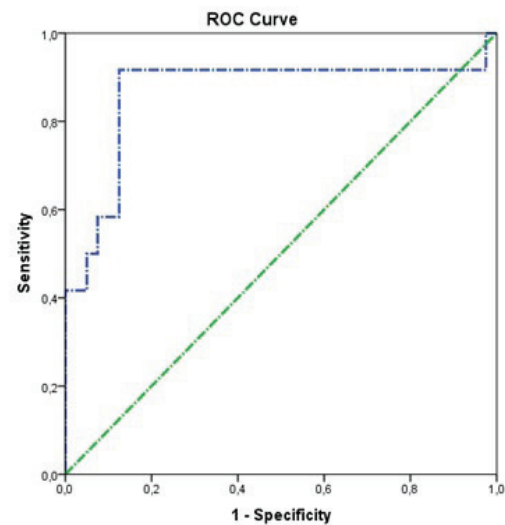


Figure 4. ROC analysis graph of the combination of age and hemoglobin parameters

**Table 6.** ROC analysis data of parameters for postoperative complication and predictive features

	AUC (%95 CI)	Cut-off <sup>a</sup>	p	Sensitivity (%)	Specificity (%)
Age (year)	0.783 (0.615-0.952)	65,5	0.003	66.7%	85.0%
Hemoglobin (g/dL) <sup>b</sup>	0.815 (0.665-0.964)	11,20	0.001	91.7%	77.5%

Reference category: Patients without postoperative complications  
AUC: Area under curve (eğri altında kalan alan). ROC: Receiver operating characteristic. CI: Confidence Interval  
<sup>a</sup> Decision is based on Youden J index.  
<sup>b</sup> Lower values are associated with positive status (complication).

**Table 7.** Predictive features and diagnostic values were investigated by combining age and Hemoglobin parameters.

	AUC (%95 CI)	Cut-off <sup>a</sup>	p	Sensitivity (%)	Specificity (%)
Age + Hemoglobin	0.867 (0.713-1.000)	0.277 <sup>b</sup>	<0,001	91.7%	87.5%

Reference category: Patients without postoperative complications  
AUC: Area under curve . ROC: Receiver operating characteristic. CI: Confidence Interval  
<sup>a</sup> Decision is based on Youden J index.  
<sup>b</sup> The predictive cut-off values obtained from the logistic regression (LR) model;  $\ln(p[x]/1-p[x]) = \text{Constant} + B1X1 + B2X2$  (B=LR coefficient, x=parameter, Constant=LR constant coefficient)

## Discussion

In this study, we aimed to determine the predictability of postoperative complications in the preoperative period of 52 COVID-19-positive patients who underwent emergency abdominal surgeries. We identified the preoperative factors that affected postoperative complications, including an advanced age and low preoperative Hb levels.

Many previous studies have reported that perioperative COVID-19 infection increases morbidity and mortality in patients undergoing major surgeries [8, 9]. In the COVID-Surg study, which included different types of surgeries, the mortality rate was 23.8% [10]. In studies conducted with different cohort groups, the mortality rate varied between

4.3% and 42.8% [11-14]. In the COVID-CIR study, which focused on emergency abdominal surgeries, the mortality rate was 12.6%, but this was not statistically significant [15]. In our study, the mortality rate was 15.4%, which was similar to that in previous studies. The postoperative complication rates also varied between 16.8% and 25.6% in similar studies [7, 8]. The postoperative complication rate in our study was 23.6%.

It has been reported that emergency surgeries performed in patients with perioperative COVID-19 positivity involve increased postoperative complications compared to elective surgeries [5, 7, 15]. However, subgroup analyses of these studies regarding the prediction of postoperative complications in COVID-19-positive patients undergoing major and emergency

abdominal surgeries are limited. In the COVIDSurg study, which included different types of surgeries, it was reported that a male gender, above 70 years of age, and emergency and major surgeries increase the adverse outcomes in COVID-19-positive patients [10]. Similarly, we found that an advanced age may be predictive of postoperative complications in patients who underwent emergency abdominal surgeries while being COVID-19 positive (AUC = 0.783, 95% CI: 0.615–0.952, cut-off: 65.5 years,  $p = 0.003$ , sensitivity: 66.7%, specificity: 85%).

It is well known that preoperative anemia generally worsens postoperative outcomes [16, 17]. However, we could not find any data in the literature on the effects of low hemoglobin levels on postoperative outcomes in COVID-19-positive patients who underwent emergency abdominal surgeries. In our study, low preoperative hemoglobin levels were found to be predictive of postoperative complications (AUC = 0.815, 95% CI: 0.665–0.964, cut-off: 11.2 g/dL,  $p = 0.001$ , sensitivity: 91.7%, specificity: 77.5%). In addition, there was a negative correlation between hemoglobin levels and hospitalization time ( $p < 0.001$ ;  $p = -0.547$ ). Although these findings support classical surgical knowledge, they are important in terms of emphasizing the need to focus on anemia in COVID-19-positive patients who undergo emergency abdominal surgeries.

In our study, we also showed that the evaluation of age and hemoglobin levels together can be a stronger predictor of postoperative complications in COVID-19-positive patients who undergo emergency abdominal surgeries (AUC = 0.867, 95% CI: 0.713–1.000,  $p < 0.001$ , sensitivity: 91.7%, specificity: 87.5%). This result can guide surgeons who will perform emergency abdominal surgeries on COVID-19-positive patients with advanced ages and low hemoglobin levels, as they may deal with postoperative complications.

This study has some limitations. First, it includes only one center experience, which may limit the generalizability of the results. However, it represents a homogeneous population base that can minimize selection bias. The retrospective design is a further limitation. In the study, positivity for COVID-19 was accepted according to nasopharyngeal RT-PCR performed within 72 h of the perioperative period. However, patients diagnosed with COVID-19 clinically and radiologically in other studies were also included [15]. There are also studies that define positive results of the COVID-19 test up to the postoperative 30th day as a perioperative COVID-19 infection [7]. Although these two conditions narrowed the population included in the study, they were necessary to determine the certainty of COVID-19 positivity during the operation.

## Conclusion

Surgeons should be mindful of postoperative complications when performing emergency abdominal surgeries in patients with COVID-19 infection. An advanced age and low hemoglobin levels are strong predictors of postoperative complications in this patient group. However, more comprehensive studies and subgroup analyses of existing studies are needed to confirm our hypothesis.

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## References

1. Bilinski A, Emanuel EJ. COVID-19 and Excess All-Cause Mortality in the US and 18 Comparison Countries. *Jama*, 2020; 324: 2100-2102.
2. Kasivisvanathan V, Lindsay J, Rakshani-Moghadam S, et al. A cohort study of 30 day mortality after NON-EMERGENCY surgery in a COVID-19 cold site. *International journal of surgery (London, England)*, 2020; 84: 57-65.
3. Jang M, Lee M, Lee G, Lee J, Choi K, Yu B. Changes in Injury Pattern and Outcomes of Trauma Patients after COVID-19 Pandemic: A Retrospective Cohort Study. *Healthcare (Basel)*, 2023; 11.
4. Toor SM, Saleh R, Sasidharan Nair V, Taha RZ, Elkord E. T-cell responses and therapies against SARS-CoV-2 infection. *Immunology*, 2021; 162: 30-43.
5. Pratha AR, Pustela MK, Kaniti VK, Shaik SB, Pecheti T. Retrospective analysis of outcome of COVID positive patients undergoing emergency surgeries for acute general surgical conditions. *International Surgery Journal*, 2023; 10: 432-436.
6. Hachiya K, Kawabata S, Nagai S, et al. Emergency Surgical Management of Lumbar Burst Fracture in a Patient with COVID-19: A Case Report. *Spine Surg Relat Res*, 2022; 6: 314-317.
7. Inzunza M, Romero C, Irrarázaval MJ, et al. Morbidity and Mortality in Patients with Perioperative COVID-19 Infection: Prospective Cohort in General, Gastroesophageic, Hepatobiliary, and Colorectal Surgery. *World J Surg*, 2021; 45: 1652-1662.
8. Deng JZ, Chan JS, Potter AL, et al. The Risk of Postoperative Complications After Major Elective Surgery in Active or Resolved COVID-19 in the United States. *Ann Surg*, 2022; 275: 242-246.
9. Doglietto F, Vezzoli M, Gheza F, et al. Factors Associated With Surgical Mortality and Complications Among Patients With and Without Coronavirus Disease 2019 (COVID-19) in Italy. *JAMA Surg*, 2020; 155: 691-702.
10. Nepogodiev D, Bhangu A, Glasbey JC, et al. Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *The Lancet*, 2020; 396: 27-38.

11. Knisely A, Zhou ZN, Wu J, et al. Perioperative Morbidity and Mortality of Patients With COVID-19 Who Undergo Urgent and Emergent Surgical Procedures. *Ann Surg*, 2021; 273: 34-40.
12. Guadalajara H, Muñoz de Nova JL, Fernandez Gonzalez S, et al. Patterns of acute surgical inflammatory processes presentation of in the COVID-19 outbreak (PIACO Study): Surgery may be the best treatment option. *Br J Surg*, 2020; 107: e494-e495.
13. Seeliger B, Philouze G, Cherkaoui Z, Felli E, Mutter D, Pessaux P. Acute abdomen in patients with SARS-CoV-2 infection or co-infection. *Langenbecks Arch Surg*, 2020; 405: 861-866.
14. González-Calatayud DM, Vargas-Ábrego DB, Gutiérrez-Uvalle DGE, et al. Observational study of the suspected or confirmed cases of sars COV-2 infection needing emergency surgical intervention during the first months of the pandemic in a third level hospital: Case series. *Ann Med Surg (Lond)*, 2020; 60: 149-154.
15. Osorio J, Madrazo Z, Videla S, et al. Analysis of outcomes of emergency general and gastrointestinal surgery during the COVID-19 pandemic. *Br J Surg*, 2021; 108: 1438-1447.
16. Fowler AJ, Ahmad T, Phull MK, Allard S, Gillies MA, Pearse RM. Meta-analysis of the association between preoperative anaemia and mortality after surgery. *Br J Surg*, 2015; 102: 1314-24.
17. Musallam KM, Tamim HM, Richards T, et al. Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study. *Lancet*, 2011; 378: 1396-407.