Received: 9 January 2024 | Revised: 26 March 2024 | Accepted: 4 April 2024

DOI: 10.1002/ags3.12806

AGSurg Annals of Gastroenterological Surgery Open Access WILEY

ORIGINAL ARTICLE

Effects of the COVID-19 pandemic on short-term postoperative outcomes of emergency surgery for gastroduodenal perforation: A nationwide study in Japan based on the National Clinical Database

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Funding information
the Ministry of Health, Labour and Welfare Research on Emerging and Re-emerging Infectious Diseases and Immunization, Grant/Award Number: JPMH21HA2011

Abstract

Aim: To examine the potential negative effects of the COVID-19 pandemic on short-term postoperative outcomes of emergency surgery for gastroduodenal perforation in Japan.

Methods: A total of 7973 cases of gastroduodenal perforation from 2019 to 2021 were retrieved from the National Clinical Database (NCD), which includes >95% of surgical cases in Japan. Data were analyzed nationally and in subgroups for subjects in areas with high infection levels (HILs). Postoperative 30-d mortality, surgical mortality, and complications (Clavien–Dindo (CD) grade ≥3) were examined. Months were considered to have significantly high or low mortality or complication rates, if the 95%

confidence interval (CI) of the standardized mortality (morbidity) ratio (SMR) does not contain 1.

Results: Nationally, data from 2019 vs 2020 and 2021 showed 30-d mortality of 175 (6.7%) vs 398 (7.4%), surgical mortality of 250 (9.5%) vs 537 (10.1%), and complications (CD ≥3) of 558 (21.2%) vs 1163 (21.8%). Among these data, the only significantly high SMR was found for complications in July 2020 (1.36 [95% CI: 1.001–1.80]). In areas with HILs, data from 2019 vs 2020 and 2021 indicated 30-d mortality of 91 (6.3%) vs 215 (7.3%), surgical mortality of 135 (9.4%) vs 294 (10.0%), and complications (CD ≥3) of 304 (21.1%) vs (23.1%). In these data, no month had a significantly high SMR.

Conclusion: The COVID-19 pandemic had few negative effects on outcomes after surgery for gastroduodenal perforation. These findings suggest that the emergency system for gastroduodenal perforation in Japan was generally maintained during the pandemic.

KEYWORDS
COVID-19, gastroduodenal perforation, National Clinical Database, postoperative short-term outcomes

1 | INTRODUCTION

The outbreak of COVID-19 had a variety of impacts not only on the social economy but also on the medical field. Hospitals had refrained from providing other medical services in order to treat patients infected with COVID-19. The patient refrained from visiting the outpatient clinic for fear of contracting COVID-19 at the hospital, and refrained from undergoing various medical examinations, including cancer screening,[1] with upper gastrointestinal endoscopy was withdrawn due to concerns about COVID-19 infection by aerosol transmission.

The number of endoscopy procedures decreased by 44% during the pandemic. As a result, the number of surgeries for early gastric cancer has decreased.[2] Emergency cases with diseases other than COVID-19 were treated as normal, but consultations in nonemergency cases were postponed, resulting in discontinuation or postponement of some surgeries,[3,4] with a consequent increase in the number of patients with advanced cancer. During the pandemic, mild cases of acute appendicitis decreased, whereas those with complicated appendicitis including abscess formation and perforation increased.[5] More patients with colorectal cancer complicated with occlusion and perforation due to large tumors.[6] Fewer patients with abdominal diseases visited emergency departments, patients were admitted to hospitals late, and delayed therapeutic intervention affected short-term postoperative outcomes.[7,8]

Gastroduodenal perforation is a common complication of gastroduodenal ulcer that occurs in ~5% of patients with gastroduodenal ulcer.[9] The number of patients with gastroduodenal ulcer has been reduced by advances in treatment, including drug therapy with proton pump inhibitors for elimination of *Helicobacter pylori* infections, but complications of perforation and bleeding remain due to increased use of nonsteroidal antiinflammatory drugs (NSAIDs), steroids, aspirin, and alcohol.[10–12] The lifetime risk of gastroduodenal perforation is 10% for untreated patients with gastroduodenal ulcer and 30%–50% in patients with perforation related to NSAIDs.[12,13] Perforation is also the cause of death in 70% of patients with gastroduodenal ulcer.[14]

Delayed diagnosis and treatment of gastroduodenal perforation can result in serious complications and sepsis. Therefore, early therapeutic intervention after onset is necessary,[10] and delayed intervention associated with the COVID-19 pandemic may have had negative effects on treatment outcomes. To our knowledge, no study has been reported that investigated the impact of the pandemic on the short-term postoperative outcome of gastroduodenal perforation, and here we report the results of the first study in Japan.

2 | METHODS

2.1 | Patients

Data from the National Clinical Database (NCD) in Japan were used as a basis for the study. The NCD was established by surgical societies in 2010 for the medical specialist qualification system, as a large-scale database that now includes >95% of surgical cases in Japan, with >1.5 million cases registered since 2016.[15] Therefore, data from the NCD reflect the outcomes of gastroduodenal perforation surgery in Japan. The subjects were patients with gastroduodenal perforation among those who had acute diffuse peritonitis (ADP) and underwent surgery from January 2019 to December 2021. The cause of peritonitis was gastrointestinal perforation, and the culprit sites were the stomach and duodenum. Patients aged <18 y old and those with elective surgery, missing values in observations, or

a disease other than gastroduodenal perforation were excluded. Only adults were included in the study to ensure a homogeneous population. The study was approved by the Ethics Committee of Tokyo Women's Medical University (approval no. 2022-0041) and the Japanese Society for Abdominal Emergency Medicine (approval no. 22-04). The work was supported by the Ministry of Health, Labour and Welfare Research on Emerging and Re-emerging Infectious Diseases and Immunization (Program Grant Number JPMH21HA2011).

2.2 | Outcomes

The outcomes were postoperative 30-d mortality, surgical mortality, and postoperative complications (Clavien–Dindo classification grade ≥3 [CD ≥3]). Surgical mortality was defined as overall 30-d mortality or in-hospital death within 90 days. Since evaluation in all patients may reduce the effect of the COVID-19 pandemic, we also evaluated patients in areas with high infection levels (HILs), in addition to analysis of all subjects. Thus, subgroup analyses were conducted in HIL and non-HIL areas. Based on a previous study, the HIL areas were Aichi, Chiba, Fukuoka, Hyogo, Kanagawa, Kyoto, Nara, Okinawa, Osaka and Saitama Prefectures, and Hokkaido and Tokyo Met. These regions were defined as HIL based on the cumulative number of infected people per population using the index for the degree of infection reported by Ikeda et al.[4]

2.3 | Statistical analysis

Statistical analysis was performed using the monthly standardized mortality (morbidity) ratio (SMR), which was calculated as the observed/expected mortality (morbidity). The expected mortality (morbidity) was obtained using logistic regression to evaluate factors associated with ADP identified in previous studies (age, sex, body mass index [BMI], American Society of Anesthesiologists [ASA] score, performance status [PS], activities of daily living [ADLs], sepsis, malignant tumor, acute renal failure, hypertension, chronic obstructive pulmonary disease [COPD], bleeding risk, long-term steroids, smoking, drinking, diabetes, leukocyte count, hemoglobin, platelet count, C-reactive protein [CRP], total bilirubin, creatinine, prothrombin time-international normalized ratio [PT-INR], activated partial thromboplastin time [APTT], laparoscopy, and emergency transport).[16] SMR is a metric of risk-adjusted mortality (morbidity) that is controlled by these risk factors. Months were considered to have significantly high or low mortality (morbidity) if the 95% confidence interval (CI) of the SMR does not contain 1. The trend of expected morbidity represents the fluctuation of the underlying overall risk of mortality or morbidity.

Data were compared by *t*-test, chi-square test, and Mann–Whitney *U* test, with significance defined as a two-sided $P < 0.05$. R v. 4.1.2 (2021; R Foundation for Statistical Computing, Vienna, Austria) was used for all calculations.

3 | RESULTS

3.1 | Patient characteristics

Of 47 084 patients with ADP who underwent surgery between January 2019 and December 2021, 7973 patients with gastroduodenal perforation were included in the study. The excluded patients were <18 y old ($n = 655$), underwent elective surgery ($n = 3371$), had missing values ($n = 1564$), and had a disease other than gastroduodenal perforation ($n = 33\,521$) (Figure 1). In subgroup analyses, 4385 subjects lived in HIL areas and 3588 in non-HIL areas. Background factors are shown in Table 1. There was no significant difference in the mean number of cases per month in 2019 vs 2020 and 2021 for all subjects (219.0 vs 222.7, $P = 0.72$), subjects in HIL areas (119.8 vs 122.8, $P = 0.64$), and subjects in non-HIL areas (99.2 vs 99.9, $P = 0.89$). The overall postoperative 30-d mortality was 7.2% ($n = 573$), surgical mortality was 9.9% ($n = 787$), and postoperative complications (CD ≥3) occurred in 1721 subjects (21.6%). There was a significantly higher rate of complications in HIL areas than in non-HIL areas (986 (22.5%) vs 735 (20.5%) subjects, $P = 0.03$), but no significant difference in 30-d or surgical mortality.

3.2 | National data

In 2019 vs 2020 and 2021, postoperative 30-d mortality was 6.7% ($n = 175$) vs 7.4% ($n = 398$), surgical mortality was 9.5% ($n = 250$) vs 10.1% ($n = 537$), and the complication rate (CD ≥3) was 21.2% ($n = 558$) vs 21.8% ($n = 1163$). The only significantly high SMR was for complications in July 2020 (1.36 [95% CI: 1.001–1.80]) (Figure 2A–C).

3.3 | HIL and non-HIL prefectures

In HIL areas in 2019 vs 2020 and 2021, postoperative 30-d mortality was 6.3% ($n = 91$) vs 7.3% ($n = 215$), surgical mortality was 9.4% ($n = 135$) vs 10.0% ($n = 294$), and the complication rate (CD ≥3) was

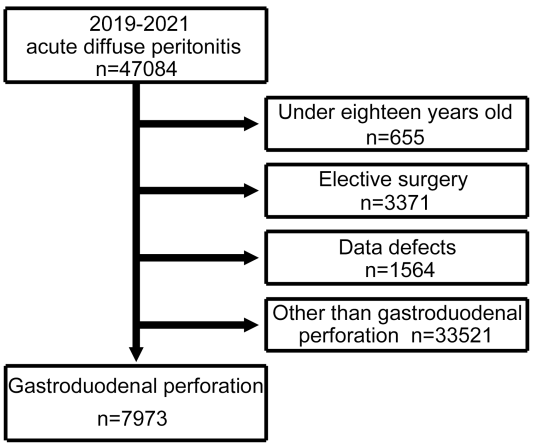

FIGURE 1 Flowchart of the patient selection process.

TABLE 1 Characteristics of patients.

	Overall	Prefectures with high infection levels	Prefectures without high infection levels	
n	7973	4385	3588	
Age (y) (%)				
<59	2075 (26.0)	1178 (26.9)	897 (25.0)	0.051
≥60, <64	676 (8.5)	340 (7.8)	336 (9.4)	
≥65, <69	972 (12.2)	534 (12.2)	438 (12.2)	
≥70, <74	1150 (14.4)	629 (14.3)	521 (14.5)	
≥75, <79	994 (12.5)	566 (12.9)	428 (11.9)	
≥80	2106 (26.4)	1138 (26.0)	968 (27.0)	
Sex (%)				
Male	5187 (65.1)	2868 (65.4)	2319 (64.6)	0.47
Female	2786 (34.9)	1517 (34.6)	1269 (35.4)	
Body mass index (BMI) (%)				
<18.5 kg/m^2	2088 (26.2)	1163 (26.5)	925 (25.8)	0.75
≥18.5, <25 kg/m^2	4774 (59.9)	2616 (59.7)	2158 (60.1)	
≥25 kg/m^2	1111 (13.9)	606 (13.8)	505 (14.1)	
ASA PS (%)				
ASA1	714 (9.0)	406 (9.3)	308 (8.6)	0.31
ASA2	3627 (45.5)	2012 (45.9)	1615 (45.0)	
ASA3–5	3632 (45.6)	1967 (44.9)	1665 (46.4)	
Independence in ADL (%)				
+	2110 (26.5)	1131 (25.8)	979 (27.3)	0.13
Sepsis (%)				
None	7088 (88.9)	3886 (88.6)	3202 (89.2)	0.44
Sepsis	445 (5.6)	244 (5.6)	201 (5.6)	
Septic shock	440 (5.5)	255 (5.8)	185 (5.2)	
Malignancy (%)				
+	474 (5.9)	249 (5.7)	225 (6.3)	0.27
Acute renal failure (%)				
+	242 (3.0)	138 (3.1)	104 (2.9)	0.52
Hypertension (%)				
+	2763 (34.7)	1441 (32.9)	1322 (36.8)	<0.001
COPD (%)				
+	234 (2.9)	132 (3.0)	102 (2.8)	0.66
Risk of hemorrhage (%)				
+	536 (6.7)	275 (6.3)	261 (7.3)	0.08
Long-term steroid use (%)				
+	223 (2.8)	114 (2.6)	109 (3.0)	0.24
Smoking (%)				
+	2696 (33.8)	1448 (33.0)	1248 (34.8)	0.10
Habitual alcohol consumption (%)				
+	2147 (26.9)	1144 (26.1)	1003 (28.0)	0.06
Diabetes mellitus (%)				
+	1234 (15.5)	695 (15.8)	539 (15.0)	0.31

TABLE 1 (Continued)

	Overall	Prefectures with high infection levels	Prefectures without high infection levels	
WBC count (%)				
<3500/μL	764 (9.6)	422 (9.6)	342 (9.5)	0.32
≥3500, <9000/μL	2834 (35.5)	1527 (34.8)	1307 (36.4)	
≥9000/μL	4375 (54.9)	2436 (55.6)	1939 (54.0)	
Hemoglobin (%)				
M: <13.5 g/dL, F: <11.5 g/dL	4063 (51.0)	2266 (51.7)	1797 (50.1)	0.03
M: ≥13.5 g/dL, ≤17.0 g/dL, F: ≥11.5 g/dL, ≤15.0 g/dL	3413 (42.8)	1873 (42.7)	1540 (42.9)	
M: >17.0 g/dL, F: 15 g/dL	497 (6.2)	246 (5.6)	251 (7.0)	
Platelets (%)				
<150 000	755 (9.5)	413 (9.4)	342 (9.5)	0.50
≥150 000, ≤350 000	5488 (68.8)	2999 (68.4)	2489 (69.4)	
>350 000	1730 (21.7)	973 (22.2)	757 (21.1)	
C-reactive protein (CRP) (%)				
≤0.1 mg/dL	1255 (15.7)	683 (15.6)	572 (15.9)	0.68
>0.1 mg/dL, ≤1.0 mg/dL	1615 (20.3)	869 (19.8)	746 (20.8)	
>1.0 mg/dL, ≤5.0 mg/dL	1590 (19.9)	888 (20.3)	702 (19.6)	
>5.0 mg/dL, ≤10.0 mg/dL	974 (12.2)	549 (12.5)	425 (11.8)	
>10.0 mg/dL	2539 (31.8)	1396 (31.8)	1143 (31.9)	
Total bilirubin (%)				
≤1.0 mg/dL	6519 (81.8)	3569 (81.4)	2950 (82.2)	0.34
>1.0 mg/dL	1454 (18.2)	816 (18.6)	638 (17.8)	
Creatinine (%)				
≤1.0 mg/dL	4741 (59.5)	2646 (60.3)	2095 (58.4)	0.08
>1.0 mg/dL	3232 (40.5)	1739 (39.7)	1493 (41.6)	
PT-INR (%)				
<0.9	222 (2.8)	124 (2.8)	98 (2.7)	0.23
≥0.9, ≤1.1	4985 (62.5)	2700 (61.6)	2285 (63.7)	
>1.1	2375 (29.8)	1334 (30.4)	1041 (29.0)	
Unknown	391 (4.9)	227 (5.2)	164 (4.6)	
APTT (%)				
<30 s	3028 (38.0)	1713 (39.1)	1315 (36.6)	0.053
≥30 s, ≤40 s	3798 (47.6)	2029 (46.3)	1769 (49.3)	
>40 s	718 (9.0)	407 (9.3)	311 (8.7)	
Unknown	429 (5.4)	236 (5.4)	193 (5.4)	
Laparoscopic surgery (%)				
+	2591 (32.5)	1549 (35.3)	1042 (29.0)	<0.001
Ambulance transportation (%)				
+	4939 (61.9)	2754 (62.8)	2185 (60.9)	0.08
30-d mortality (%)				
	573 (7.2)	306 (7.0)	267 (7.4)	0.43
Surgical mortality (%)				
	787 (9.9)	429 (9.8)	358 (10.0)	0.77
Complications (CD≥3) (%)				
	1721 (21.6)	986 (22.5)	735 (20.5)	0.03

(Continues)

TABLE 1 (Continued)

	Overall	Prefectures with high infection levels	Prefectures without high infection levels	
Postoperative hospital stays, days (median [IQR])				
	18 [12, 35]	19 [12, 36]	18 [12, 34]	0.07

Abbreviations: ADL, activities of daily living; APTT, activated partial thromboplastin time; ASA PS, American Society of Anesthesiologists physical status; CD, Clavien–Dindo classification grade; COPD, chronic obstructive pulmonary disease; IQR, interquartile range; PT-INR, prothrombin time-international normalized ratio; WBC, white blood cell.

21.1% ($n=304$) vs 23.1% ($n=682$). There was no significantly high SMR for any of these parameters in any month. In non-HIL areas, these data were 7.1% ($n=84$) vs 7.6% ($n=183$) for 30-d mortality, 9.7% ($n=115$) vs 10.1% ($n=243$) for surgical mortality, and 21.3% ($n=254$) vs 20.1% ($n=481$) for complication rate. SMR was significantly high for surgical mortality in July 2019 (1.79 [95% CI: 1.06–2.83]) and significantly low for complications in October 2021 (0.52 [95% CI: 0.24–0.99]) (Figures S1 and S2, Appendices S1–S3).

4 | DISCUSSION

During the COVID-19 pandemic in 2020 and 2021, there were no month with a significantly high SMR for 30-d death or surgical mortality, and only July 2020 had a significantly high SMR for complications (CD ≥3). Similar results were found in HIL areas, with no month with a significantly high SMR for 30-d mortality, surgical mortality, or complications. These findings show that the expanding COVID-19 pandemic had little effect on postoperative short-term outcomes of gastroduodenal perforation.

Almost all patients with gastroduodenal ulcer perforation underwent emergency surgery. The Japanese Society of Gastroenterology (JSGE) guidelines describe the indication for early surgery in cases with perforation, including those with a long time after perforation, massive ascites, a full stomach, age over 70 y, general disorder, and unstable vital signs. The guidelines recommend surgery for patients who do not improve with conservative therapy for 24 h based on symptoms or images.[17] Gastrectomy is performed for patients with giant gastric ulcer or malignant ulcer or those who cannot undergo omental patch closure, whereas peritoneal lavage of the perforated hole plus an omental patch is recommended for other patients.[9,17] Laparoscopic surgery has become more common due to advantages of less pain for 24 h after surgery, reduced wound infection, and a shorter hospital stay. However, a meta-analysis showed that short-term outcomes of postoperative mortality, leaks of the suture repair, intraabdominal abscess, and reoperation did not differ between laparoscopic surgery and laparotomy.[18]

In patients with gastroduodenal perforation, food leak and digestive enzymes leak from the perforation site to the abdominal cavity, and this can cause chemical peritonitis, resulting in secondary bacterial peritonitis.[12,13] Consequently, patients often have sepsis and undergo surgery in poor general condition, resulting in high rates of postoperative complications and mortality.[19] Previous studies have found a 30-d and surgical mortality of 7%–30%, and postoperative complication rates of 18.5%–35%.[19–22] Various risk factors for morbidity and mortality of gastroduodenal perforation have been proposed.[22,23] The period until surgery is also related to morbidity and mortality; consequently, delayed therapeutic intervention is considered to be a risk factor.[23,24] Buck et al found that until the first 24 h after admission, each hour of delay in time to surgery increased 30-d mortality by 2.4%, and that the 30-d mortality following surgery at over 24 h after admission was 20%.[24]

The COVID-19 pandemic decreased the rate of emergency surgery, delayed therapeutic intervention, and may have had a negative effect on treatment outcomes.[7,8] A study in Spain indicated a significantly longer time for arrival in the emergency department after onset during the pandemic than prepandemic (71.0 vs 44.6 h) and a significantly higher postoperative complication rate during the pandemic (47.1% vs 34.7%).[7] A comparison of surgeries in Italy in March to May 2020 (during lockdown) and March to May 2019 (prepandemic) showed that 15.5% of patients delayed emergency department visits and that there was a significantly higher rate of postoperative complications during lockdown.[8]

In contrast to these studies, we found no difference in the number of surgeries in 2019 compared to 2020 and 2021 in this study, with no decrease in patients during the pandemic and no difference in treatment outcomes. Other studies using the NCD have found similar results for the effects of COVID-19. Thus, in patients who underwent distal gastrectomy for gastric cancer during the pandemic, there was a significantly high SMR only in October 2020 for 30-d mortality nationally, and for 30-d mortality and surgical mortality in HIL areas, suggesting little impact of the pandemic.[25] In a study of five common gastroenterological surgeries and ADP surgery, the number of patients treated for gastric/rectal cancer decreased during the pandemic, whereas there was no change in those with ADP surgery. The 30-d mortality, surgical mortality, and postoperative complications (CD ≥3) of 8.1%, 11.3%, and 25.6%, respectively, during the pandemic were similar to those before the pandemic.[26] There are no reports of the effects of COVID-19 on patients who underwent surgery for gastroduodenal perforation in countries other than Japan. We previously studied the effect of COVID-19 on colorectal perforation using NCD data and found that SMRs for 30-d mortality and postoperative complications (CD ≥3) were significantly high only in 2 mo in 2020 and 2021, while there was no significantly high SMR for postoperative death.[27] The previous and current findings show that the effects of the pandemic on outcomes of surgery for colorectal and gastroduodenal perforation were limited in Japan.

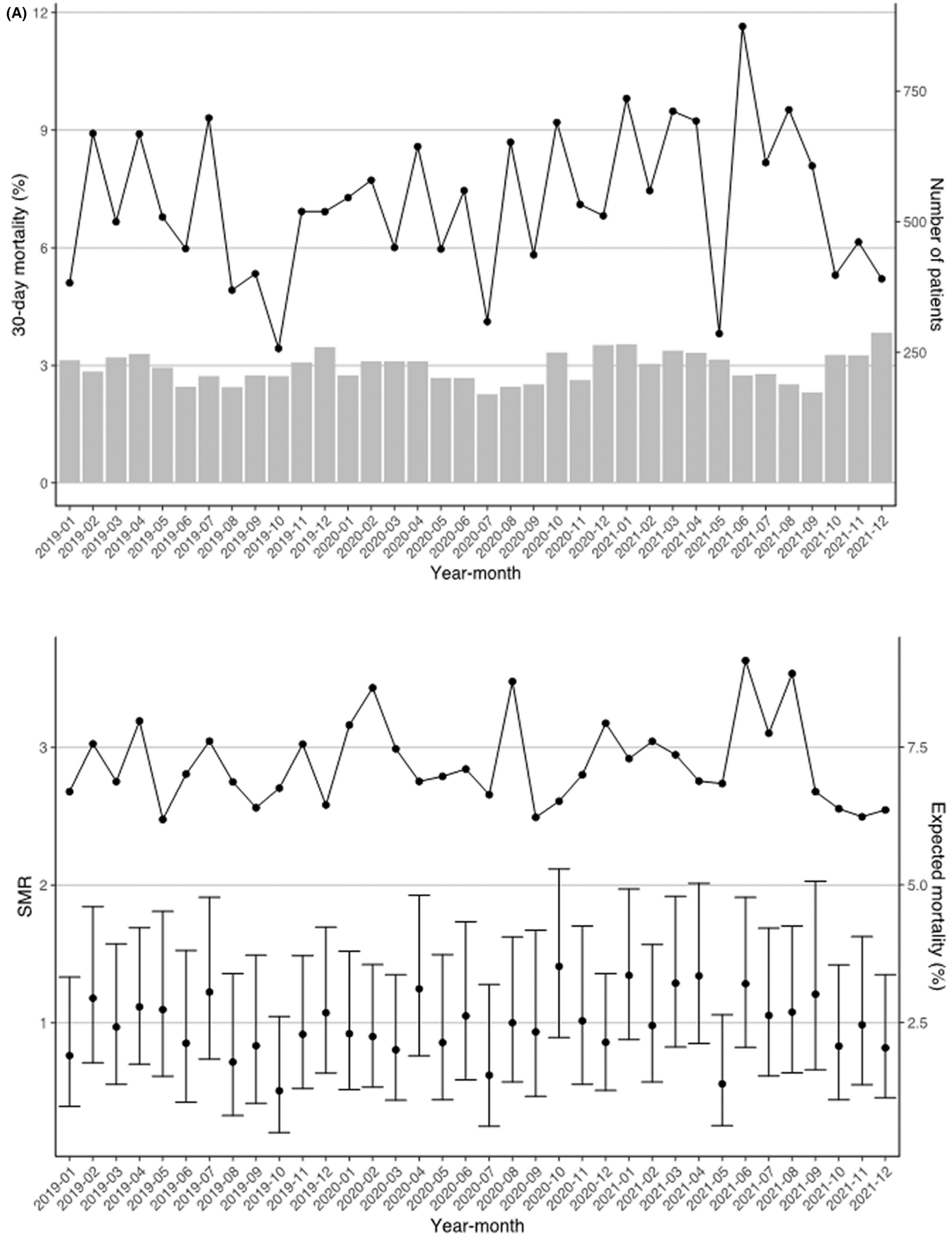

FIGURE 2 Standardized mortality (morbidity) ratio (SMR) by month for all subjects. (A) Top: 30-d mortality and number of patients. Bottom: SMR and expected mortality. (B) Top: surgical mortality and number of patients. Bottom: SMR and expected mortality. (C) Top: postoperative complications (Clavien–Dindo classification grade ≥3) and number of patients. Bottom: SMR and expected morbidity. → indicates months when the SMR was significantly higher.

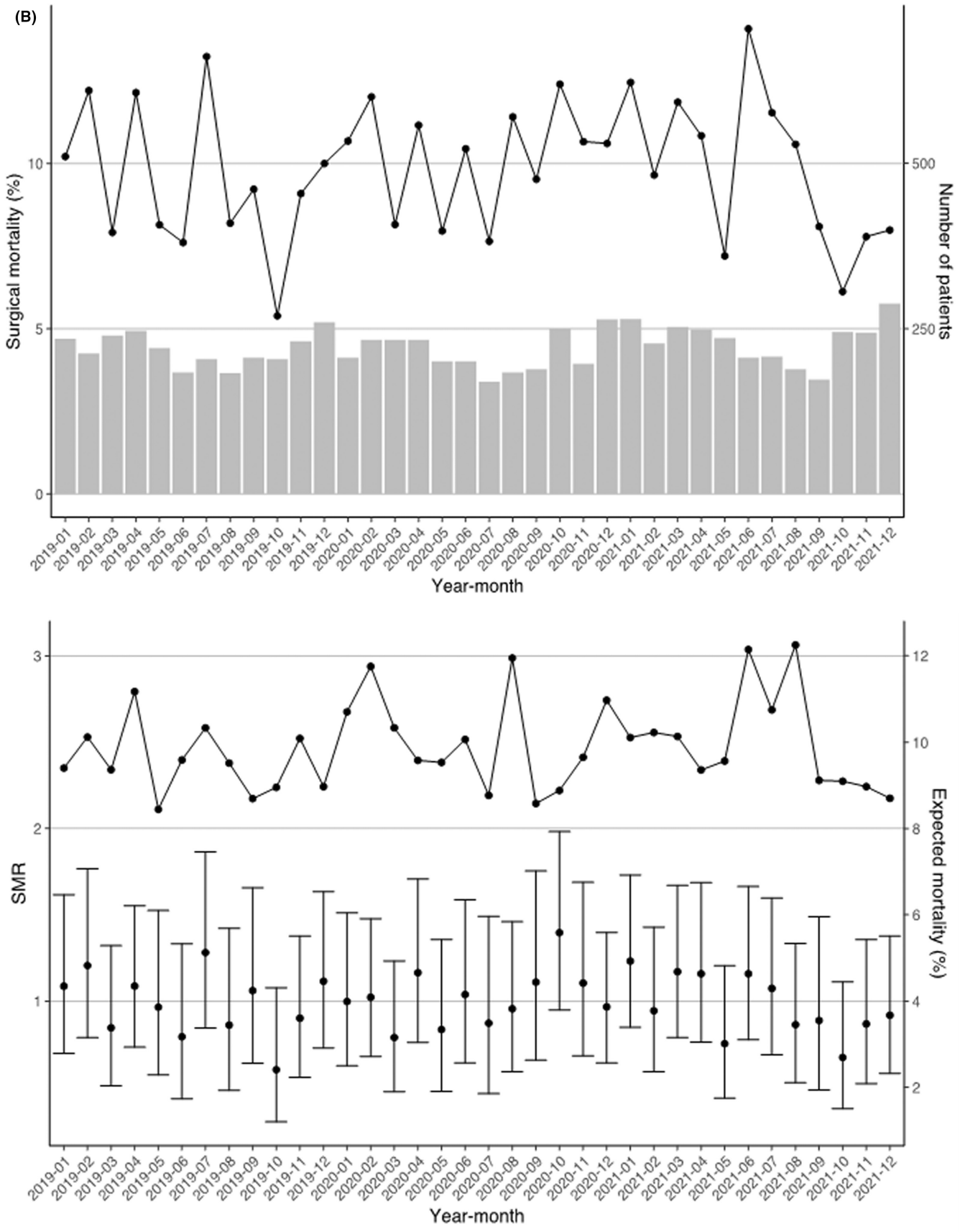

FIGURE 2 (Continued)

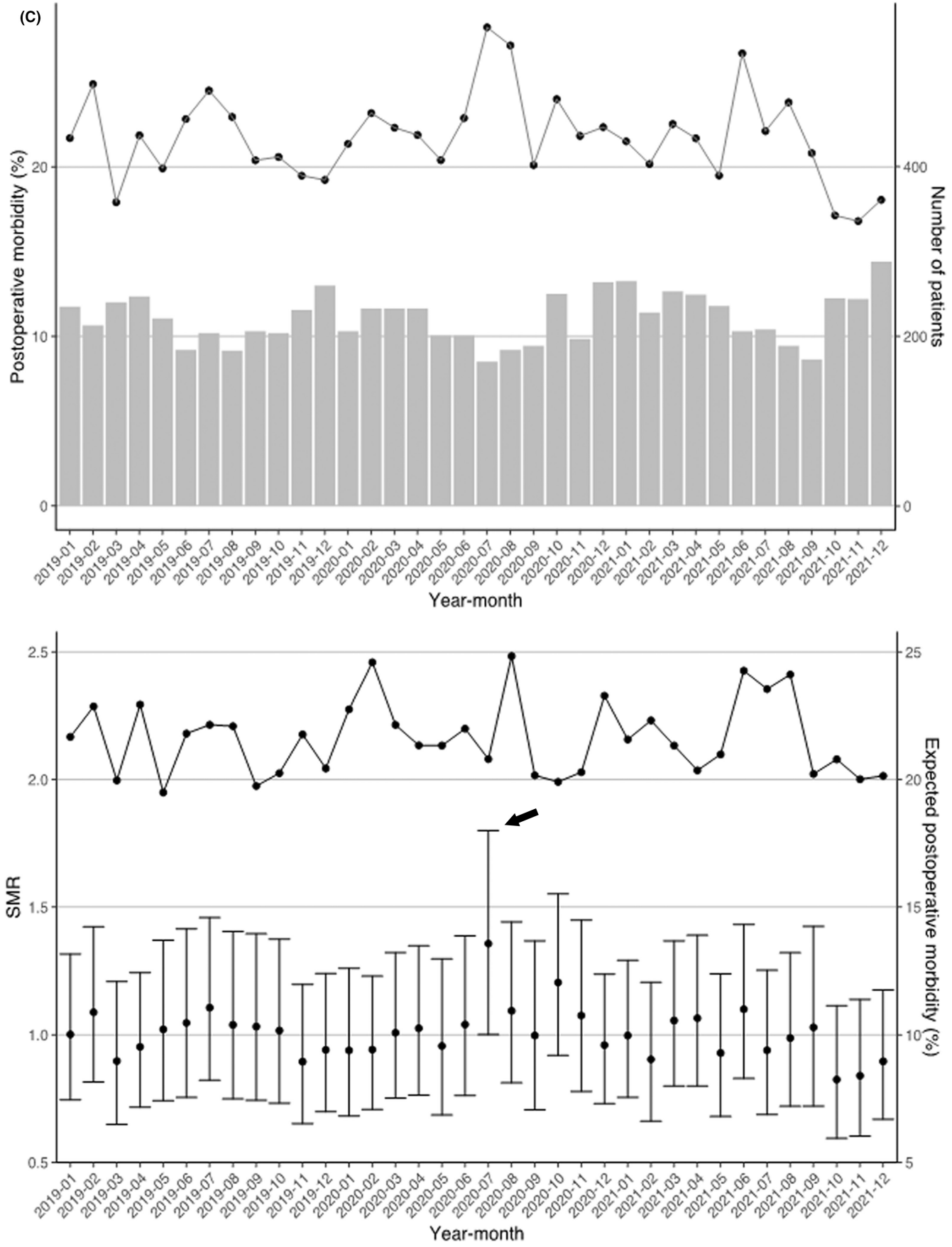

FIGURE 2 (Continued)

The absence of a change in surgeries for gastroduodenal perforation during the pandemic is due to there being no alternative to emergency surgery for most patients. Indications for conservative therapy in the JSGE guidelines are limited to cases with mild localized peritonitis within 24 h, onset at hunger, a stable condition without severe complications, a symptom of peritoneal irritation localized in the upper quadrant, and a small amount of ascites.[17] The Japan Surgical Society "Guidelines for performing surgical triage during the COVID-19 pandemic" indicate that emergency surgery should be limited to cases of disease level C, in which nonoperative treatment cannot be selected after careful consideration. This criterion is met by gastroduodenal perforation.[28] In this study, no changes in expected mortality and morbidity were observed due to the surge in the number of COVID patients. Thus, emergency surgery was considered to have been performed based on the same indications as before the infection outbreak, and no surgery was limited.

Gastroduodenal perforation is likely to complicate with sepsis and result in a serious condition. Most patients require care in the ICU after surgery. During the pandemic, many patients with COVID-19 infection required ICU management, and this may have influenced perioperative management for patients with gastroduodenal perforation. Thus, in this study we anticipated an effect on treatment outcomes of gastroduodenal perforation during the pandemic, but we found no difference in HIL areas and nationwide. The absence of a negative effect on outcomes reflects the systematic effort of surgery departments to provide appropriate surgical and perioperative management in Japan under difficult conditions with limited medical resources and staff.

The findings are also supported by the study of "weekend effect" for emergency services in Japan.[29] A comparison of therapeutic interventions between weekdays and the weekend (the so-called "weekend effect") revealed no difference in surgical mortality or in prognosis for patients with ADP admitted to the hospital at the weekend, which shows the maintenance of surgical quality in Japan. The study concluded that the absence of a "weekend effect" shows that medical service quality is maintained at night and during the weekend in Japan, despite the decreased staff and increased number of patients at the weekend.[29]

This study has several limitations. First, various factors are involved in treatment outcomes of gastroduodenal perforation. This study was conducted using risk-adjusted SMRs from which confounders were excluded as much as possible. However, the time from disease onset to therapeutic intervention, capacity and function of treatment facilities, ambulance availability, hospital access, admission restrictions, operating room use restrictions, medical staffing shortages, and quality of postoperative care, which are important risk factors for treatment outcomes, are not included in the NCD data. A delay in the start of treatment has a negative effect on outcomes of gastroduodenal perforation, and these outcomes might also be affected by the number of gastrointestinal surgeons and staff, and medical systems at night and during holidays. The absence of these data in the NCD may have reduced the accuracy of our assessment. Some patients with gastroduodenal perforation have moderate symptoms of peritonitis that can be treated with conservative therapy. It is difficult to elucidate outcomes from NCD data; however, outcomes of conservative therapy need to be assessed to clarify the effect of the pandemic on patients with gastroduodenal perforation. This is an issue for a further study.

Second, in 2020 and 2021 probably some patients with COVID-19 with gastroduodenal perforation were included, but the number of such patients is unclear and the effect on outcomes cannot be evaluated. Elective surgery may have had to be postponed for COVID-19-infected patients; however, surgery for gastroduodenal perforation is difficult to postpone, and patients with COVID-19 infection might have undergone surgery. COVID-19 infection has perioperative risks for serious complications and mortality,[30] and there is a need to examine the effects of COVID-19 infection on outcomes of gastroduodenal perforation. Third, the limited effect on treatment outcomes among COVID-19 patients and serious patients in Japan compared with those in other countries may be due to fewer limitations on medical treatment in Japan and a limited impact on emergency departments.[31]

5 | CONCLUSION

This study used data from the NCD, in which most surgeries in Japan are registered. Thus, the results include most surgeries for gastroduodenal perforation performed before and during the COVID-19 pandemic and the short-term outcomes in Japan. A significantly high SMR was found for complications in only 1 mo and there was no effect of the COVID-19 pandemic on postoperative outcomes. These findings suggest that the emergency service system for gastroduodenal perforation in Japan was maintained during the pandemic.

AUTHOR CONTRIBUTIONS

Study conception and design: Shimpei Ogawa, Hideki Endo, Masahiro Yoshida, Tomomitsu Tsuru, Michio Itabashi, and Hiroyuki Yamamoto. Data acquisition, Data analysis, and interpretation: Shimpei Ogawa, Hideki Endo, Masahiro Yoshida, Tomomitsu Tsuru, Michio Itabashi, Hiroyuki Yamamoto, Yoshihiro Kakeji, and Hideki Ueno. Article revision: all authors. Final article approval: all authors.

FUNDING INFORMATION

This work was supported by MHLW Research on Emerging and Re-emerging Infectious Diseases and Immunization (Program Grant Number JPMH21HA2011).

CONFLICT OF INTEREST STATEMENT

Hideki Endo and Hiroyuki Yamamoto are affiliated with the Department of Healthcare Quality Assessment at the University of Tokyo. The department is a social collaboration department supported by grants from the National Clinical Database, Intuitive Surgical Sarl, Johnson & Johnson K.K., and Nipro Co. Yuko Kitagawa is the Editor-in-Chief of Annals of Gastroenterological Surgery. Masaki Mori is an Emeritus Editor-in-Chief of Annals of Gastroenterological Surgery.

Yoshihiro Kakeji and Hideki Ueno are Associate Editors of Annals of Gastroenterological Surgery dealing with the lower digestive tract. The other authors declare no conflicts of interest for this article.

ETHICS STATEMENT

Approval of the research protocol: This study was approved by the Ethics Committee of Tokyo Women's Medical University (approval no. 2022-0041) and the Japanese Society for Abdominal Emergency Medicine (approval no. 22-04). Patients agreed to inclusion of their data in this study through presumed consent with opt-out through a Web page and/or a notice from each center.

Informed Consent: N/A.

Registry and the Registration No. of the study/trial: N/A.

Animal Studies: N/A.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Ogawa S, Endo H, Yoshida M, Tsuru T, Itabashi M, Yamamoto H, et al. Effects of the COVID-19 pandemic on short-term postoperative outcomes of emergency surgery for gastroduodenal perforation: A nationwide study in Japan based on the National Clinical Database. Ann Gastroenterol Surg. 2024;8:795–806. https://doi.org/10.1002/ags3.12806