JAMA Surgery | Original Investigation | ASSOCIATION OF VA SURGEONS

Delayed Diagnosis of Anastomotic Leak and Failure to Rescue After Colon Resection

Samantha L. Savitch, MD; Kiran H. Lagisetty, MD; Pasithorn A. Suwanabol, MD, MS

Invited Commentary

Supplemental content

IMPORTANCE Anastomotic leak remains a leading cause of morbidity and mortality following colon resection. There is increasing evidence to suggest that failure to rescue (FTR), defined as death after a complication, is the culmination of a series of cascading events, which may be exacerbated by delays in diagnosis. Timely identification and management of anastomotic leaks may represent a crucial strategy for reducing FTR after colon resection.

OBJECTIVE To determine whether delayed diagnosis of anastomotic leak is associated with FTR following colon resection.

DESIGN, SETTING, AND PARTICIPANTS This cohort study used the Veterans Affairs Surgical Quality Improvement Program dataset from 2004 to 2023 to assess the rate of FTR after postoperative organ space surgical site infection (OSSI) among patients who underwent colon resection at a Veteran Affairs hospital. Data were analyzed from September 1, 2024, to December 13, 2025.

EXPOSURE Colon resection.

MAIN OUTCOMES AND MEASURES FTR rate after diagnosis of OSSI. OSSI was used as a surrogate for anastomotic leak and categorized as delayed (occurring after a sepsis diagnosis) or early (before or without a sepsis diagnosis). FTR rate after delayed or early OSSI diagnosis was compared. Multivariable logistic regression was performed to identify factors associated with FTR after OSSI.

RESULTS Of 39 175 patients (37 228 males [95.0%] and 1947 females [5.0%]; mean [SD] age, 65.3 [11.1] years) included in the analysis who underwent colon resection, 219 were Asian (0.6%) individuals, 6386 were Black (16.3%) individuals, 1820 were Hispanic (4.7) individuals, 24 612 were White (62.8%) individuals, and 6138 were individuals of other or unknown race and ethnicity (15.7%). The indication for resection was colon cancer in 17 067 patients (43.6%), diverticular disease in 4678 (11.9%), inflammatory bowel disease in 658 (1.7%) and colitis, ischemia, or other indication in 16 772 (42.8%). OSSI was diagnosed in 1227 patients (3.1%); of these diagnoses, 381 (31.1%) were delayed and 846 (68.9%) were early. On multivariable analysis, those with delayed OSSI had a significantly higher mean (95% CI) number of total discrete complications compared with those with early OSSI (3.0 [2.9-3.2] vs 1.7 [1.6-1.8], $P < .001$), higher probability of reoperation (62.1% vs 40.3%, $P < .001$), longer mean (95% CI) length of stay (22.6 [20.4-24.8] days vs 17.6 [16.5-18.7] days, $P < .001$), and higher probability of FTR (7.8% vs 2.2%, $P < .001$). Probability of FTR was 6.7% higher in patients who developed sepsis (8.1%) compared with those who never developed sepsis (1.4%).

CONCLUSIONS AND RELEVANCE Findings of this study suggest that FTR after OSSI, which served as a proxy for anastomotic leak, was associated with delayed diagnosis, not the leak itself. Early identification of leaks and avoidance of progression to sepsis could reduce FTR rates. Quality initiatives aimed at earlier identification and timely and appropriate management of anastomotic leak may improve the mortality associated with colon resection.

JAMA Surg. doi:10.1001/jamasurg.2025.6551
Published online February 11, 2026.

Author Affiliations: Department of Surgery, University of Michigan Health System, Ann Arbor (Savitch); Department of Surgery, Ann Arbor Veterans Affairs Healthcare System, Ann Arbor, Michigan (Lagisetty, Suwanabol); Center for Health Outcomes and Policy, University of Michigan, Ann Arbor (Suwanabol).

Corresponding Author: Samantha L. Savitch, MD, University of Michigan, 1500 E Medical Center Dr, 2110 Taubman Center, SPC 5346, Ann Arbor, MI 48109 (sasavitc@med.umich.edu).

Despite substantial advancements in surgical technique and perioperative care, anastomotic leak remains a leading cause of morbidity and mortality following colon resection.[1,2] Failure to rescue (FTR), defined as death following a complication, has emerged as a key target for improving surgical outcomes. Increasing evidence suggests that FTR is not solely the consequence of a single complication but rather the culmination of a series of cascading events.[3,4] In the case of anastomotic leaks, these events often include the progression to sepsis and multisystem organ failure,[5,6] both of which are exacerbated by delays in diagnosis. Therefore, timely identification and management of anastomotic leaks may represent a crucial strategy for reducing FTR in this patient population.

Prior studies have demonstrated that FTR following organ space surgical site infections (OSSIs) may be altered by multiple factors, including patient comorbidities, clinician response times, and hospital resources.[7,8] However, it remains unknown whether delays in diagnosing OSSI substantially contribute to FTR. Given that the most common cause of sepsis following colon resection is anastomotic leak,[6,9] a diagnosis of anastomotic leak after the onset of sepsis likely reflects missed or delayed identification earlier in the clinical course. While timely recognition is a fundamental principle in the management of anastomotic leak, the clinical implications of diagnostic delay for FTR are unclear. Existing studies are often limited by the lack of granularity in defining timing of complications, making it difficult to determine whether delays in diagnosis are directly associated with patient outcomes.

In this context, we conducted a study leveraging a dataset that captures the timing and sequence of postoperative complications with a level of detail not previously available. Specifically, we sought to determine if delayed diagnosis of anastomotic leak is associated with FTR following colon resection. By examining the relationship between timing and outcomes, we aim to provide critical insights into whether early identification of anastomotic leaks can mitigate the risk of mortality. Findings from this study may inform strategies to optimize postoperative surveillance, enhance early detection, and ultimately improve FTR rates among patients undergoing colon resection.

Key Points

Question Is delay in detection of anastomotic leak after colon resection associated with failure to rescue?

Findings In this cohort study of the Veterans Affairs Surgical Quality Improvement Program that included 39 175 patients who underwent colon resection, probability of failure to rescue (ie, death after a complication) was significantly higher in patients who had delayed diagnosis of anastomotic leak (that is, leak after the onset of sepsis) compared with those who had a leak identified before sepsis developed.

Meaning These findings suggest early identification of anastomotic leak and timely and appropriate management may improve the mortality associated with colon resection.

Methods

Data Source

This cohort study was deemed exempt from review by the Ann Arbor Veterans Affairs Institutional Review Board and the informed consent requirement was waived because deidentified data were used. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline was followed.

The Veterans Affairs (VA) Surgical Quality Improvement Program (VASQIP) noncardiac dataset is a quality assurance activity–derived national registry that includes all noncardiac surgical procedures performed at 144 VA centers across the US. VASQIP collects demographic, preoperative, operative, and 30-day perioperative outcomes data on more than 100 000 noncardiac surgical procedures performed annually.

Study Population

We queried the VASQIP noncardiac dataset for patients who underwent a colon resection between 2004 and 2023. Patients were identified using *Concurrent Procedural Technology (CPT)* codes for a segmental, subtotal, or total colon resection. *International Classification of Diseases, Ninth Revision* and *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* codes were used to classify patients as having a diagnosis of colon cancer, inflammatory bowel disease, diverticular disease, or other indication (eTable 1 in Supplement 1). Patients were excluded if they were younger than 18 years of age, underwent resection without reanastomosis (ie, Hartmann procedure, colectomy with end ileostomy), or underwent a rectal or anal resection. Race categories were self-selected from a list of database options and included Alaska Native, American Indian, Asian or Pacific Islander, Black, White, unknown, and declined to answer. Ethnicity categories included Hispanic or non-Hispanic. For the purposes of analysis, the other category included Alaska Native, American Indian, unknown, and declined to answer. Race and ethnicity data were included to characterize the sample and not analyzed further.

Perioperative Outcomes and Failure to Rescue

Rates of 30-day postoperative outcomes were assessed. The number of days from date of the surgical procedure to each postoperative outcome was used to determine the sequence of postoperative outcomes. For the purposes of analysis, OSSI was used as a surrogate for anastomotic leak, as it is the most common etiology of organ space infections following colon resection.[10] OSSI was further categorized as delayed OSSI, defined as diagnosis of OSSI occurring on the same day as or subsequent to diagnosis of sepsis or septic shock, or early OSSI, defined as any OSSI that occurred either at least 1 day prior to sepsis or septic shock or without sepsis or septic shock. FTR was defined as death within 30 days of a surgical procedure in patients who experienced an OSSI.

Table 1. Patient Characteristics

Characteristic	No. (%) All patients (n = 39 175)	No OSSI (n = 37 948)	OSSI (n = 1227)	P value
Age, mean (SD)	65.3 (11.1)	65.3 (11.1)	64.4 (11.1)	.01
Sex				
Female	1947 (5.0)	1893 (5.0)	54 (4.4)	.35
Male	37 228 (95.0)	36 055 (95.0)	1173 (95.6)	
Race and ethnicity[a]				
Asian	219 (0.6)	210 (0.6)	9 (0.7)	.18
Black	6386 (16.3)	6214 (16.4)	172 (14.0)	
Hispanic	1820 (4.7)	1768 (4.7)	52 (4.2)	
White	24 612 (62.8)	23 819 (62.8)	793 (64.6)	
Other or unknown[b]	6138 (15.7)	5937 (15.7)	201 (16.4)	
Recent (within 12 mo) smoker	11 453 (29.2)	11 041 (29.1)	412 (33.6)	<.001
Alcohol use	3625 (9.3)	3512 (9.3)	113 (9.2)	.96
Selected comorbidities[c]				
Pulmonary	9158 (23.4)	8847 (23.3)	311 (25.3)	.10
Cardiac	27 042 (69.0)	26 200 (69.0)	842 (68.6)	.75
Neurologic	3480 (8.9)	3378 (8.9)	102 (8.3)	.48
Kidney	578 (1.5)	24 (2.0)	554 (1.5)	.16
Vascular	1208 (3.1)	1167 (3.1)	41 (3.3)	.60
Anemia	20 111 (51.3)	19 465 (51.3)	646 (52.6)	.35
Diabetes				
Oral agent	5937 (15.2)	5756 (15.2)	181 (14.8)	.91
Insulin-dependent	3992 (10.2)	3865 (10.2)	127 (10.4)	
Coagulopathy	4994 (16.3)	4792 (16.2)	202 (20.4)	<.001
Liver dysfunction	2764 (8.6)	2672 (8.6)	92 (8.8)	.75
Nutritional deficiency	8161 (24.4)	7823 (24.2)	338 (31.4)	<.001
Recent steroid use (within 30 d preoperatively)	981 (2.5)	935 (2.5)	46 (3.5)	.01
Functional status[d]				
1	36 550 (93.3)	35 434 (93.4)	1116 (91.0)	.01
2	1925 (4.9)	1839 (4.8)	86 (7.0)	
3	696 (1.8)	671 (1.8)	25 (2.0)	
4	4 (0.0)	4 (0.0)	0 (0.0)	
Indication for surgery				
Colon cancer	17 067 (43.6)	16 593 (43.7)	474 (38.6)	<.001
Inflammatory bowel disease	658 (1.7)	615 (1.6)	43 (3.5)	
Diverticular disease	4678 (11.9)	4521 (11.9)	157 (12.8)	
Other	16 772 (42.8)	16 219 (42.7)	553 (45.1)	
Emergency case	3188 (8.1)	3034 (8.0)	154 (12.6)	
Facility type[e,a]				
Ambulatory procedure center basic	47 (0.1)	46 (0.1)	1 (0.1)	.09
Ambulatory procedure center advanced	27 (0.1)	27 (0.1)	0 (0.0)	
Inpatient standard	413 (1.1)	400 (1.1)	13 (1.1)	
Inpatient intermediate	8312 (21.2)	8089 (21.3)	223 (18.2)	
Inpatient complex	30 376 (77.5)	29 386 (77.4)	990 (80.7)	

Abbreviation: OSSI, organ space surgical site infection.

[a] Percentages may not total 100 due to rounding.

[b] Other race or ethnicity included Alaska Native, American Indian, unknown, and patient declined to answer.

[c] These comorbidities are reported due to clinical relevance. Pulmonary comorbidities included dyspnea, pneumonia, chronic obstructive pulmonary disease, and ventilator dependence. Cardiac comorbidities included angina, congestive heart failure, myocardial infarction, hypertension, and prior cardiac intervention. Neurological comorbidities included stroke, transient ischemic attack, and hemiplegia. Kidney comorbidities included dialysis and kidney failure. Vascular comorbidities included peripheral vascular disease and rest pain. Nutritional deficiency was defined as albumin below the reference range.

[d] Functional status was characterized on a score from 1 to 4 with 1 defined as independent, 2 as partially dependent, 3 as totally dependent, and 4 as unknown.

[e] As designated by the Veterans Health Adminstration.[11]

Statistical Analysis

Descriptive and comparative analyses of patient demographics and treatment regimens were performed using χ^2 test for categorical variables, *t* test with unequal variance for normally distributed continuous variables, and Mann-Whitney test for continuous variables with skewed distribution. Multivariable logistic and linear regression with average marginal effects were performed to identify factors associated with 30-day outcomes and postoperative FTR. These analyses were adjusted for age, sex, race and ethnicity, indication for surgical procedure (colon cancer, inflammatory bowel disease, diverticular disease, or other), receipt of cancer-related treat-

Table 2. Unadjusted Postoperative Outcomes in Patients With Early vs Delayed OSSI

Outcome	OSSI		P value
	Early (n = 846)	Delayed (n = 381)	
No. of complications, mean (SD)	1.7 (1.1)	3.0 (1.3)	<.001
Time to diagnosis of OSSI, mean (SD), d	10.2 (26.0)	11.4 (6.6)	.40
Failure to rescue, No. (%)	19 (2.3)	26 (6.8)	<.001
Return to operating room, No. (%)	341 (40.3)	237 (62.2)	<.001
Hospital length of stay, mean (SD), d	17.4 (14.1)	22.9 (21.8)	<.001

Abbreviation: OSSI, organ space surgical site infection.

Table 3. Adjusted Postoperative Outcomes in Patients With Early vs Delayed OSSI

Outcome	OSSI		P value
	Early (n = 846)	Delayed (n = 381)	
No. of total complications, mean (95% CI)	1.7 (1.6-1.8)	3.0 (2.9-3.2)	<.001
Failure to rescue, % probability (95% CI)	2.2 (1.5-3.0)	7.8 (5.4-10.1)	<.001
Return to operating room, % probability (95% CI)	40.3 (35.1-45.4)	62.1 (57.2-67.1)	<.001
Hospital length of stay, mean (95% CI), d	17.6 (16.5-18.7)	22.6 (20.4-24.8)	<.001

Abbreviation: OSSI, organ space surgical site infection.

ment, functional status, alcohol abuse, smoking status, recent steroid use (within 30 days preoperatively), emergency status, and 27 preoperative comorbidities. Functional status was characterized on a score from 1 to 4 with 1 defined as independent, 2 as partially dependent, 3 as totally dependent, and 4 as unknown. Preoperative nutritional deficiency was defined as preoperative albumin less than the reference range. All regressions were performed with clustered SEs at the hospital level to account for variation across hospitals. Additional sensitivity analyses were performed evaluating the absence of other infectious complications, inpatient complications, facility complexity, and sidedness of resection. $P < .05$ was considered statistically significant. All statistical analysis was performed using Stata 18 (StataCorp, LLC).

Results

A total of 39 175 patients (37 228 males [95.0%] and 1947 females [5.0%]; mean [SD] age, 65.3 [11.1] years) underwent colon resection at 116 VA hospitals during the study period. Of these patients, 219 were Asian (0.6%) individuals, 6386 were Black (16.3%) individuals, 1820 were Hispanic (4.7) individuals, 24 612 were White (62.8%) individuals, and 6138 individuals (15.7%) were of other or unknown race and ethnicity. The indication for resection was colon cancer in 17 067 patients (43.6%), diverticular disease in 4678 (11.9%), inflammatory bowel disease in 658 (1.7%) and colitis, ischemia, or other indication in 16 772 (42.8%). Additional patient characteristics are shown in **Table 1**.[11]

Of our cohort, 8007 patients (20.4%) developed at least 1 postoperative complication, and 1227 patients (3.1%) were diagnosed with OSSI at some point in the 30 days postoperatively. The mean (SD) time to diagnosis of an OSSI was 10.6 (21.9) days. Patients who developed OSSI were more likely to be current or recent smokers, have a diagnosis of inflammatory bowel disease, have preoperative nutritional deficiency, have recent steroid use, have coagulopathy, and undergo an emergency operation (Table 1). Among patients with OSSI, FTR occurred in 45 (3.7%). The rate of FTR was significantly lower in patients whose only postoperative complication was OSSI (5 of 494 [1.0%]) compared with OSSI and other complications (40 of 733 [5.5%], $P < .001$). On multivariable regression, OSSI was not independently associated with FTR (odds ratio [OR], 1.41; 95% CI, 0.95-2.10; $P = .09$).

Diagnosis of OSSI was delayed in 381 patients (31.1%). Patients with early or delayed OSSI were similar with regard to preoperative demographics and comorbidities (eTable 2 in Supplement 1). Compared with those with an early OSSI diagnosis, patients with delayed OSSI had significantly higher rates of FTR and reoperation, as well as a higher mean number of total complications and longer hospital length of stay (LOS; **Table 2**). For those diagnosed with OSSI during the inpatient hospitalization, these results for early compared with delayed OSSI were consistent (eTable 3 in Supplement 1). On univariable analysis, probability of FTR was 4.6% higher for delayed OSSI compared with early diagnosis of OSSI, with significantly higher odds of FTR in patients with delayed OSSI (OR, 3.19; 95% CI, 1.89-5.38; $P < .001$). After adjusting for preoperative variables, the probability of FTR was 5.5% higher with delayed OSSI (OR, 5.13; 95% CI, 2.82-9.32; $P < .001$) compared with early OSSI. Adjusted probability of reoperation, total number of complications, and LOS were also higher with delayed OSSI (**Table 3**). The overall rate of OSSI was higher in patients undergoing left-sided resections compared with right-sided resections (225 of 6081 [3.7%] vs 243 of 7912 [3.1%]; $P = .04$), but rate of delayed OSSI was higher in right-sided resections (85 of 243 [35.0%] vs 56 of 225 [24.9%]; $P = .02$). FTR from delayed OSSI was similar between left-sided and right-sided resections (8 of 56 [14.3%] vs 5 of 85 [5.9%]; $P = .09$). Patients treated at inpatient complex facilities had lower rates of delayed OSSI (290 of 990 [29.3%]) compared with other facility types (91 of 237 [38.4%]; $P = .01$) but similar rates of FTR following delayed OSSI (16 of 290 [5.5%] vs 10 of 91 [11.0%]; $P = .07$).

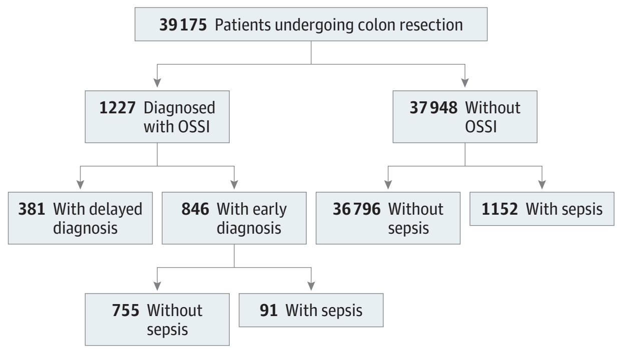
As sepsis can be secondary to other infectious etiologies in addition to OSSI, we conducted a sensitivity analysis of patients who did not have another infectious complication (pneumonia, urinary tract infection, superficial surgical site infection, or deep surgical site infection) diagnosed 30 days postoperatively. Of the 1227 patients with OSSI, 163 (13.2%) had another infectious complication. Among the 1064 patients who did not have another infectious complication, the adjusted rate of FTR for delayed OSSI was significantly higher than the rate of FTR for early OSSI (7.4% [95% CI, 5.2-9.6] vs 2.5% [95% CI, 1.7-3.2]; *P* < .001).

Of the 1227 patients with OSSI, 472 (38.5%) had a diagnosis of sepsis, and 91 (19.3%) had sepsis diagnosed after or at the same time as diagnosis of the OSSI. A total of 964 patients (78.6%) with OSSI had either OSSI or sepsis diagnosed as the initial complication. Among the 472 patients with both sepsis and OSSI, FTR occurred in 34 (7.2%). Unadjusted and adjusted FTR rates were similar between patients who developed sepsis before vs after an OSSI diagnosis (unadjusted rates: sepsis diagnosed first, 26 of 381 [6.8%]; OSSI diagnosed first, 8 of 91 [8.8%]; *P* = .51; adjusted rates: sepsis diagnosed first, 7.6% [95% CI, 5.3-9.9] vs OSSI diagnosed first, 7.9% [95% CI, 4.2-11.6]; *P* = .91). Among patients with OSSI who never developed sepsis (755 of 1227 [61.5%]), FTR occurred in 11 (1.5%). On multivariable analysis, probability of FTR after OSSI was 6.7% higher in patients who developed sepsis (8.1%) compared with those who never developed sepsis (1.4%). Development of sepsis was an independent risk factor for FTR after OSSI (OR, 10.08; 95% CI, 4.28-23.78; *P* < .001). The **Figure** shows a flowchart of patients who developed OSSI, sepsis, or both. Patients who did not have an OSSI but developed sepsis had a higher FTR rate (184 of 1152 [16.0%]) than those who had an OSSI. The rates of postoperative cardiac, pulmonary, and kidney complications were significantly higher among the 1152 patients who had sepsis of some other cause (86 [7.5%], 559 [48.5%], and 316 [27.4%], respectively compared with the 472 who had sepsis associated with an OSSI (18 [3.8%], 170 [36.0%], and 102 [21.6%], respectively [*P* < .05]).

Post Hoc Subanalysis of Nonemergent Cases

Due to the frequency of perforation and peritonitis being the impetus for emergency operations, which could be a possible etiology of sepsis and may confound the use of OSSI as a surrogate for anastomotic leak, we performed a post hoc analysis of patients who only underwent nonemergency surgical procedures. A total of 35 987 patients (91.1%) underwent a nonemergency surgical procedure, of whom 1073 (3.0%) developed an OSSI. Of these patients, 341 (31.8%) had delayed OSSI and 732 (68.2%) had early OSSI. Among 1073 patients with an OSSI, FTR occurred in 32 (3.0%). Compared with those with early OSSI, patients with delayed OSSI had significantly higher rates of FTR (8 of 732 [1.1%] vs 24 of 341 [7.0%]; *P* < .001) and reoperation (296 of 732 [40.4%] vs 213 of 341 [62.5%]; *P* < .001), as well as a higher mean (SD) number of total complications (1.63 [1.0] vs 3.0 [1.3]; *P* < .001) and longer LOS (16.5 [13.3] days vs 22.4 [22.0] days; *P* < .001). On univariable analysis, the probability of FTR was 6.0% higher with delayed OSSI (7.0%) compared with early OSSI (1.1%; OR, 6.85; 95% CI, 3.34-14.03; *P* < .001). After adjusting for preoperative variables, the probability of FTR was 6.7% higher with delayed OSSI (8.0%) than with early OSSI (1.3%; OR, 9.89; 95% CI, 4.52-21.65; *P* < .001). Adjusted probability of reoperation (early: 40.9%; 95% CI, 35.3-46.4; delayed: 62.5%, 95% CI, 57.2-67.8; *P* < .001), total number of complications (early: 1.7, 95% CI, 1.6-1.7; delayed: 3.0; 95% CI, 2.8-3.1; *P* < .001), and LOS (early: 16.8 days; 95% CI, 15.7-17.9; delayed: 21.7 days; 95% CI, 19.3-24.0; *P* < .001) were also higher with delayed OSSI.

Figure. Flowchart of Patients Who Developed Organ Space Surgical Site Infections (OSSIs), Sepsis, or Both



Discussion

In this national cohort study of veterans undergoing colon resection, we found that delayed diagnosis of OSSI, which was used herein as a surrogate for anastomotic leak, was independently associated with higher rates of FTR, reoperation, and prolonged hospitalization. The presence of sepsis, rather than OSSI alone, was associated with mortality, underscoring the importance of timely recognition and intervention. Our study is unique in its ability to assess the sequence of complications surrounding OSSI and highlights a critical insight: it is not only the occurrence of a complication but the timing of its diagnosis and management that is associated with postoperative survival.

It has been previously established that sepsis is a risk factor for FTR following anastomotic leak after colon resection.[12] There are multiple other complications that can lead to sepsis, such as pneumonia and urinary tract infections, that are common in this population and may play a role in poor outcomes. Our analysis shows that even in the absence of any other infectious complication in the 30 days postoperatively, FTR is significantly higher when OSSI is identified after the onset of sepsis. Thus, our study builds on existing literature suggesting that postoperative mortality often arises from the consequences of an earlier complication, rather than a single event.[3,13] This sequence frequently includes progression from leak to sepsis and multiorgan failure, especially when diagnosis is delayed.[5,6] Multiple prior studies have demonstrated that FTR is more common in patients experiencing multiple complications[3,13,14]; however, few studies have had access to data with sufficient granularity to capture the temporal sequence of complications. Those that had access to such data found that both the type and timing of the index complication are key.[15-17] By leveraging VASQIP data we found evidence that delays in leak recognition play a critical role in the development of downstream complications and mortality.

Our findings reinforce prior literature suggesting that successful rescue is less about preventing complications and more about recognizing and managing them effectively.[18] Although anastomotic leak is regarded as a devastating complication, it is increasingly recognized that a leak itself does not always lead to poor outcomes; rather, it is the presence of sepsis or other severe illness that is often the proximal cause of death.[5] This is supported by our findings that patients who do not develop sepsis associated with a leak had a significantly lower FTR rate. A recent study by Grönroos-Korhonen et al[19] found that anastomotic leaks diagnosed later in the postoperative period following colorectal operations are more likely to have another complication before the diagnosis of a leak and that the presence of an earlier complication is associated with increased FTR after a leak diagnosed at any time. Our results complement these findings by explicitly classifying OSSI when it is diagnosed relative to sepsis and demonstrating that it is the sequence of diagnosis as opposed to the postoperative day of diagnosis that is associated with FTR. This distinction has important clinical implications. Avoiding all leaks may not be feasible given their multifactorial etiology (eg, surgical technique, patient comorbid conditions, microbiome) and association with disease severity.[2,20,21] However, our findings suggest that early detection and appropriate management of leaks may reduce progression to sepsis and prevent mortality. The challenge, therefore, lies in identifying which patients are at highest risk and ensuring rapid evaluation and escalation of care when clinical deterioration occurs.

Prior work has shown that hospitals with high rescue rates succeed not by avoiding complications entirely, but by deploying timely, coordinated responses when complications occur.[22,23] A shift in efforts toward early detection of complications has been previously suggested as a method for improving FTR,[24] a notion supported by our finding that the FTR rate is significantly decreased if OSSI was diagnosed before other complications arise. Targeted interventions aimed at early complication recognition, such as daily team huddles, use of early warning systems, standardized escalation pathways, and multidisciplinary response teams, may therefore improve outcomes after leak. Within the VA system, team training and communication-focused interventions are associated with improved outcomes across perioperative settings.[25,26] Applying similar strategies to anastomotic leak management—particularly early detection and structured escalation—could meaningfully improve mortality after colon resection.

Early diagnosis of anastomotic leak can be achieved through a high index of suspicion, particularly in patients who deviate from expected recovery pathways. Clinical triggers such as persistent ileus, unexplained tachycardia, abdominal pain, electrolyte disturbances, or neutrophilia should prompt early diagnostic imaging,[27-29] especially in patients with known risk factors for FTR, including advancing age, poor functional status, immunosuppression, or cardiopulmonary disease.[7,8,30] Protocolized surveillance or decision support tools to guide reimaging and escalation may help standardize care and avoid diagnostic delay.[28] It should be noted that that there is no consensus regarding optimal timing, modality, or frequency of postoperative imaging for leak detection.[31-35] Universal early imaging is neither practical nor cost-effective, but more refined approaches based on dynamic risk stratification may improve yield. Future studies may explore how physiologic data and machine learning algorithms can identify patients at the highest risk for delayed diagnosis and guide clinical decision-making in real time.

Limitations

This study has a few limitations to that should be addressed. First, we used OSSI as a surrogate for anastomotic leak, which may introduce misclassification and underestimation. However, leak is the most common etiology of OSSI following colon resection,[10,36] and OSSI has been used as a proxy in other studies.[37,38] Second, the VASQIP dataset lacks granular data on postoperative management, including radiographic confirmation of leak, interventions performed as a result, and time to treat. Nevertheless, these data are unique in their ability to identify the sequence of events, which offers insights not possible with other datasets. Third, given the deidentified nature of VASQIP data, we were unable to confirm that data was accurately coded and extracted, though the VASQIP dataset is rigorously checked during the extraction process to ensure accuracy. Finally, this analysis reflects care at VA hospitals, which may differ in structure and resources from other health care settings. Furthermore, the population at the VA is less heterogeneous than the rest of the US, which limits the generalizability of the results. Despite these drawbacks, the VA's national reach, standardized data collection, and ability to track temporal sequences of events provide unique advantages over other data sources.

Conclusions

This cohort study found that delayed diagnosis of OSSI is associated with FTR following colon resection. These findings underscore the need for timely recognition and coordinated management of anastomotic leak. Efforts to improve outcomes should focus not only on prevention, but also on building systems that support early detection and rapid intervention—ultimately translating into better survival for patients undergoing any operative intervention.

ARTICLE INFORMATION

Accepted for Publication: December 14, 2025.

Published Online: February 11, 2026. doi:10.1001/jamasurg.2025.6551

Author Contributions: Dr Swanabol had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Concept and design: Savitch, Suwanabol.
Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Savitch, Suwanabol.
Critical review of the manuscript for important intellectual content: All authors.
Statistical analysis: Savitch, Suwanabol.
Obtained funding: Suwanabol.
Administrative, technical, or material support: Lagisetty, Suwanabol.
Supervision: Lagisetty, Suwanabol.

Conflict of Interest Disclosures: Dr Savitch reported receiving grants from the National Institute on Aging during the conduct of the study. Dr Lagisetty reported receiving grants from Atricure outside the submitted work. No other disclosures were reported.

Disclaimer: The contents of this article are solely the responsibility of the authors and do not necessarily represent the official position, policy, or views of the National Institute on Aging, National Institutes of Health, or Department of Veterans Affairs.

Meeting Presentation: Findings of this study were presented at the 2025 Association of VA Surgeons Annual Meeting; April 6, 2025: Atlanta, Georgia.

Data Sharing Statement: See Supplement 2.

REFERENCES

1. Turrentine FE, Denlinger CE, Simpson VB, et al. Morbidity, mortality, cost, and survival estimates of gastrointestinal anastomotic leaks. *J Am Coll Surg*. 2015;220(2):195-206. doi:10.1016/j.jamcollsurg.2014.11.002

2. Chiarello MM, Fransvea P, Cariati M, Adams NJ, Bianchi V, Brisinda G. Anastomotic leakage in colorectal cancer surgery. *Surg Oncol*. 2022;40:101708. doi:10.1016/j.suronc.2022.101708

3. Massarweh NN, Anaya DA, Kougias P, Bakaeen FG, Awad SS, Berger DH. Variation and impact of multiple complications on failure to rescue after inpatient surgery. *Ann Surg*. 2017;266(1):59-65. doi:10.1097/SLA.0000000000001917

4. Hatchimonji JS, Swendiman RA, Kaufman EJ, et al. Multiple complications in emergency surgery: identifying risk factors for failure-to-rescue. *Am Surg*. 2020;86(7):787-795. doi:10.1177/0003134820934400

5. Hyman NH, Osler T, Cataldo P, Burns EH, Shackford SR. Anastomotic leaks after bowel resection: what does peer review teach us about the relationship to postoperative mortality? *J Am Coll Surg*. 2009;208(1):48-52. doi:10.1016/j.jamcollsurg.2008.09.021

6. Choudhuri AH, Uppal R. Predictors of septic shock following anastomotic leak after major gastrointestinal surgery: an audit from a tertiary care institute. *Indian J Crit Care Med*. 2013;17(5):298-303. doi:10.4103/0972-5229.120322

7. Spence RT, Hirpara DH, Doshi S, Quereshy FA, Chadi SA. Will my patient survive an anastomotic leak? predicting failure to rescue using the modified frailty index. *Ann Surg Oncol*. 2021;28(5):2779-2787. doi:10.1245/s10434-020-09221-y

8. Bakker IS, Grossmann I, Henneman D, Havenga K, Wiggers T. Risk factors for anastomotic leakage and leak-related mortality after colonic cancer surgery in a nationwide audit. *Br J Surg*. 2014;101(4):424-432. doi:10.1002/bjs.9395

9. Mulita F, Liolis E, Akinosoglou K, et al. Postoperative sepsis after colorectal surgery: a prospective single-center observational study and review of the literature. *Prz Gastroenterol*. 2022;17(1):47-51. doi:10.5114/pg.2021.106083

10. Biondo S, Kreisler E, Fraccalvieri D, Basany EE, Codina-Cazador A, Ortiz H. Risk factors for surgical site infection after elective resection for rectal cancer. a multivariate analysis on 2131 patients. *Colorectal Dis*. 2012;14(3):e95-e102. doi:10.1111/j.1463-1318.2011.02798.x

11. VHA invasive procedure complexity for surgical programs. Veteran Health Administration. Accessed December 12, 2025. https://www.va.gov/health/surgery/

12. Wells CI, Baraza W, O'Grady G, Bissett IP. 'Failure to rescue' from anastomotic leak following colorectal cancer resection: an observational study from a binational registry. *Colorectal Dis*. 2025;27(10):e70262. doi:10.1111/codi.70262

13. Krell R, Sheetz K, Nagendran M, Mullard AJ, Ghaferi AA. Failure to rescue: the impact of multiple sentinel complications. *J Am Coll Surg*. 2013;217(3)(suppl):S106. doi:10.1016/j.jamcollsurg.2013.07.244

14. Roussas A, Masjedi A, Hanna K, et al. Number and type of complications associated with failure to rescue in trauma patients. *J Surg Res*. 2020;254:41-48. doi:10.1016/j.jss.2020.04.022

15. Chen VW, Portuondo J, Massarweh NN. Association between type of index complication and outcomes after noncardiac surgery. *Surgery*. 2024;176(3):857-865. doi:10.1016/j.surg.2024.04.033

16. Portuondo JI, Mehl SC, Shah SR, et al. Association between index complication and outcomes after inpatient pediatric surgery. *J Pediatr Surg*. 2022;57(9):1-8. doi:10.1016/j.jpedsurg.2022.03.014

17. Sheetz KH, Krell RW, Englesbe MJ, Birkmeyer JD, Campbell DA Jr, Ghaferi AA. The importance of the first complication: understanding failure to rescue after emergent surgery in the elderly. *J Am Coll Surg*. 2014;219(3):365-370. doi:10.1016/j.jamcollsurg.2014.02.035

18. Portuondo JI, Shah SR, Singh H, Massarweh NN. Failure to rescue as a surgical quality indicator: current concepts and future directions for improving surgical outcomes. *Anesthesiology*. 2019;131(2):426-437. doi:10.1097/ALN.0000000000002602

19. Grönroos-Korhonen MT, Koskenvuo L, Mentula PJ, Sallinen VJ. Failure to rescue in early versus late severe anastomotic leakage after colorectal surgery: a population-based multicenter study. *Ann Surg*. 2025. doi:10.1097/SLA.0000000000006864

20. Pickleman J, Watson W, Cunningham J, Fisher SG, Gamelli R. The failed gastrointestinal anastomosis: an inevitable catastrophe? *J Am Coll Surg*. 1999;188(5):473-482. doi:10.1016/S1072-7515(99)00028-9

21. Kitaguchi D, Ito M. Optimal anastomotic technique in rectal surgery to prevent anastomotic leakage. *Ann Coloproctol*. 2023;39(2):97-105. doi:10.3393/ac.2022.00787.0112

22. Sheetz KH, Dimick JB, Ghaferi AA. Impact of hospital characteristics on failure to rescue following major surgery. *Ann Surg*. 2016;263(4):692-697. doi:10.1097/SLA.0000000000001414

23. Burke JR, Downey C, Almoudaris AM. Failure to rescue deteriorating patients: a systematic review of root causes and improvement strategies. *J Patient Saf*. 2022;18(1):e140-e155. doi:10.1097/PTS.0000000000000720

24. Smith ME, Wells EE, Friese CR, Krein SL, Ghaferi AA. Interpersonal and organizational dynamics are key drivers of failure to rescue. *Health Aff (Millwood)*. 2018;37(11):1870-1876. doi:10.1377/hlthaff.2018.0704

25. Neily J, Mills PD, Young-Xu Y, et al. Association between implementation of a medical team training program and surgical mortality. *JAMA*. 2010;304(15):1693-1700. doi:10.1001/jama.2010.1506

26. Neily J, Mills PD, Lee P, et al. Medical team training and coaching in the Veterans Health Administration; assessment and impact on the first 32 facilities in the programme. *Qual Saf Health Care*. 2010;19(4):360-364. doi:10.1136/qshc.2008.031005

27. Alsaleh A, Pellino G, Christodoulides N, Malietzis G, Kontovounisios C. Hyponatremia could identify patients with intrabdominal sepsis and anastomotic leak after colorectal surgery: a systematic review of the literature. *Updates Surg*. 2019;71(1):17-20. doi:10.1007/s13304-019-00627-2

28. den Dulk M, Noter SL, Hendriks ER, et al. Improved diagnosis and treatment of anastomotic leakage after colorectal surgery. *Eur J Surg Oncol*. 2009;35(4):420-426. doi:10.1016/j.ejso.2008.04.009

29. Bellows CF, Webber LS, Albo D, Awad S, Berger DH. Early predictors of anastomotic leaks after colectomy. *Tech Coloproctol*. 2009;13(1):41-47. doi:10.1007/s10151-009-0457-7

30. Tevis SE, Carchman EH, Foley EF, Heise CP, Harms BA, Kennedy GD. Does anastomotic leak contribute to high failure-to-rescue rates? *Ann Surg*. 2016;263(6):1148-1151. doi:10.1097/SLA.0000000000001409

31. Gessler B, Eriksson O, Angenete E. Diagnosis, treatment, and consequences of anastomotic leakage in colorectal surgery. *Int J Colorectal Dis*. 2017;32(4):549-556. doi:10.1007/s00384-016-2744-x

32. Hirst NA, Tiernan JP, Millner PA, Jayne DG. Systematic review of methods to predict and detect anastomotic leakage in colorectal surgery. *Colorectal Dis*. 2014;16(2):95-109. doi:10.1111/codi.12411

33. Nicksa GA, Dring RV, Johnson KH, Sardella WV, Vignati PV, Cohen JL. Anastomotic leaks: what is the best diagnostic imaging study? *Dis Colon Rectum*. 2007;50(2):197-203. doi:10.1007/s10350-006-0708-x

34. Kornmann VNN, Treskes N, Hoonhout LHF, Bollen TL, van Ramshorst B, Boerma D. Systematic review on the value of CT scanning in the diagnosis of anastomotic leakage after colorectal surgery. *Int J Colorectal Dis*. 2013;28(4):437-445. doi:10.1007/s00384-012-1623-3

35. Doeksen A, Tanis PJ, Wüst AFJ, Vrouenraets BC, van Lanschot JJB, van Tets WF. Radiological evaluation of colorectal anastomoses. *Int J Colorectal Dis*. 2008;23(9):863-868. doi:10.1007/s00384-008-0487-z

36. Fry DE. The prevention of surgical site infection in elective colon surgery. *Scientifica (Cairo)*. 2013;2013:896297. doi:10.1155/2013/896297

37. Scarborough JE, Schumacher J, Kent KC, Heise CP, Greenberg CC. Associations of specific postoperative complications with outcomes after elective colon resection: a procedure-targeted approach toward surgical quality improvement. *JAMA Surg*. 2017;152(2):e164681. doi:10.1001/jamasurg.2016.4681

38. Reinke CE, Showalter S, Mahmoud NN, Kelz RR. Comparison of anastomotic leak rate after colorectal surgery using different databases. *Dis Colon Rectum*. 2013;56(5):638-644. doi:10.1097/DCR.0b013e31827886db