Systemic sclerosis and small bowel obstruction: a comprehensive analysis of outcomes using the TriNetX global health database

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Abstract

Systemic sclerosis (SSc) can lead to small bowel obstruction (SBO) through progressive smooth muscle atrophy and fibrosis, causing hypoperistalsis. Despite its clinical relevance, data on SBO outcomes in SSc remain limited. This study evaluates these outcomes using a large multi-institutional database.

This retrospective cohort study utilized TriNetX global research network. Adults ≥ 18years were categorized into two cohorts: those with both SBO and SSc (Cohort A) and those with SBO alone (Cohort B). Outcomes assessed over a 20-year period (2005- 2025) included all-cause mortality, sepsis, malnutrition, venous thromboembolism (DVT/PE), gastrointestinal (GI) bleeding, bowel perforation, small intestinal bacterial overgrowth (SIBO), inpatient hospitalizations, and use of total parenteral nutrition (TPN). Propensity score matching was used to balance baseline demographic and clinical characteristics.

After matching, 2,323 patients were included in each cohort. Cohort A had higher all-cause mortality (30% *vs.* 20%; Relative Risk (RR) 1.46, $p < 0.001$) and reduced 5-year-survival (61% *vs.* 73%; $p< 0.001$). SSc patients were more likely to develop malnutrition (RR 1.64, $p< 0.0001$), and sepsis (RR 1.24, $p < 0.001$). While absolute risks of DVT/PE and GI bleeding were similar, cumulative incidence was higher in Cohort A. No significant differences were observed in the risk of bowel perforation, SIBO, or TPN use. SSc had more hospitalizations (mean 8 *vs.* 7; $p =0.003$).

Patients with SSc and SBO had significantly worse outcomes, including higher mortality, malnutrition, sepsis, and greater healthcare utilization. These findings underscore the need for heightened surveillance and proactive management in this high-risk population.

Keywords: Systemic sclerosis; Small bowel obstruction; Gastrointestinal dysmotility; Survival analysis; Propensity score matching.

INTRODUCTION

Systemic sclerosis (SSc) is a multisystem autoimmune disease characterized by microvascular injury, immune activation, and progressive fibrosis of the skin and internal organs[1,2]. Gastrointestinal (GI) involvement is among the most frequent systemic manifestations, affecting up to 90% of patients and contributing substantially to morbidity and mortality[1,2]. Recent systematic reviews indicate that while the entire GI tract may be affected, small intestinal involvement is particularly prominent, as smooth muscle atrophy, myenteric plexus dysfunction, and progressive fibrosis impair motility, driving malnutrition, severe disability, and, in advanced cases, small bowel obstruction (SBO) [3-6].

SBO in SSc may arise from a spectrum of pathophysiologic mechanisms, including hypoperistalsis, pseudo-obstruction, and fixed fibrotic strictures[6]. Contemporary evidence suggests that small bowel dysmotility is not only prevalent but also serves as a key predictor of poor prognosis and reduced quality of life[3,4]. Recurrent or chronic obstruction leads to malnutrition, sepsis, bacterial overgrowth, and repeated hospitalizations, all of which worsen long-term outcomes[7,8]. Despite its clinical significance, data characterizing the burden and outcomes of SBO in SSc remain limited. Most existing evidence comes from small cohorts or single-center reports and lacks direct comparison with SBO in the general population[9-11.]

Given these knowledge gaps, this study aims to characterize the clinical outcomes of SBO in patients with SSc using a large, multi-institutional database. We compared in-hospital morbidity, mortality, length of stay, and healthcare resource utilization between patients with SSc and those with SBO in the absence of SSc. We hypothesized that SSc-associated SBO would be associated with higher complication rates, prolonged hospitalization, and increased mortality, reflecting the combined effects of systemic inflammation, intestinal fibrosis, and severe motility impairment inherent to SSc. Understanding the clinical trajectory of SBO in patients with SSc is crucial for risk stratification, facilitating earlier recognition of complications, and guiding decisions regarding surgical versus conservative management strategies. In addition, identifying factors associated with poor outcomes may help clinicians anticipate the need for nutritional support, antimicrobial prophylaxis, or targeted interventions aimed at improving gut motility and minimizing recurrent obstruction.

MATERIAL & METHODS

Data collection

This retrospective cohort study utilized TriNetX Global health Research Network, a global federated health research platform providing de-identified electronic health record data from 146 large healthcare organizations (HCOs). This network aggregates data from approximately 117 million patients across diverse clinical settings, including academic university hospitals and specialty practices[12]. TriNetX complies with the Health Insurance Portability and Accountability Act (HIPAA) and maintains an Information Security Management System (ISMS) certified to the ISO 27001:2013 standard[12]. As the platform provides de-identified, aggregated data in accordance with the HIPAA Privacy Rule (45 CFR §164.514[a]), this study was determined to be non-human subjects research and was exempt from Institutional Review Board (IRB) review. Data for this analysis was retrieved on May 24, 2025[12].

Study Population

We identified adult patients (≥18 years) with a documented diagnosis of small bowel obstruction (SBO) between 2005 and 2025 using the ICD-10-CM (International Classification of Diseases, 10th Revision, Clinical Modification) code K56.6. Cohort A included patients with a diagnosis of SBO and a concurrent or prior diagnosis of SSc defined by ICD-10-CM code M34, whereas cohort B included patients with a diagnosis of SBO but no recorded diagnosis of SSc at any time in their medical history.

The index event was defined as the first recorded occurrence of SBO within the 20-year study period. To ensure the capture of incident outcomes, a follow-up window was established starting one day after the index event and extending for 1,825 days (5 years). Patients were excluded if they met the index criteria more than 20 years ago to ensure contemporary clinical relevance.

Outcome Measures

Clinical outcomes were identified using ICD-10-CM and CPT (Current Procedural Terminology) codes. Primary outcomes included:

- **Mortality:** All-cause mortality tracked during the follow-up period.
- **Acute Complications:** Sepsis, gastrointestinal bleeding, and nontraumatic bowel perforation.
- **Nutritional and Chronic Impact:** Malnutrition, small intestinal bacterial overgrowth (SIBO), and the requirement for total parenteral nutrition (TPN).
- **Healthcare Utilization:** Frequency of inpatient hospitalizations (Visit Type: IMP)

Statistical Analysis and Propensity Score Matching

To address potential confounding and selection bias, 1:1 Propensity Score Matching was performed using a neighbor-matching algorithm with a greedy approach as described in supplementary data. Cohorts were balanced on the following baseline covariates recorded prior to the index event:

- **Demographics:** Age, sex, race, and ethnicity.
- **Comorbidities:** Hypertensive diseases, metabolic disorders, diabetes mellitus, obesity, chronic kidney disease, and chronic lower respiratory diseases.
- **Medication History:** Use of immunosuppressants, sympathomimetics, and parasympatholytics.

Post-matching comparability was assessed using Standardized Mean Differences (SMD), with an SMD < 0.1 considered indicative of successful balance (Table I).

For categorical outcomes, we calculated Risk Ratios (RR), Risk Differences (RD), and Odds Ratios (OR) with 95% Confidence Intervals (CI). Time-to-event data were analyzed using Kaplan–Meier survival curves, with differences between cohorts evaluated via the log-rank test. Cox proportional hazards models were used to estimate Hazard Ratios (HR). For healthcare utilization counts (hospitalizations and SIBO encounters), we employed a number-of-instances analysis using two-sample t-tests to compare mean event frequencies. A two-sided p-value < 0.05 was used to denote statistical significance (Table II & Figure 2).

RESULTS

Baseline Characteristics and Propensity Score Matching

A total of 2, 455 adults with coexisting systemic sclerosis and small bowel obstruction were identified (Cohort A), alongside 620, 485 adults with SBO without SSc (Cohort B). Following 1:1 propensity score matching (PSM), 2,323 patients remained in each cohort. Baseline demographic characteristics, comorbidities, and medication profiles were well-balanced post-matching, with standardized mean differences (SMD) < 0.1 for all included covariates (Table I). The mean age at index for both cohorts was 62 years (SD ±14.4 for Cohort A; ±16.6 for Cohort B), and the majority of participants were female (78% in Cohort A; 79% in Cohort B).

Primary Outcome: All-Cause Mortality

Patients with SSc-associated SBO (Cohort A) demonstrated a significantly higher risk of all-cause mortality compared to matched controls (30% vs. 20%; RR 1.46, 95% CI 1.32–1.62; $p < 0.001$). Kaplan-Meier survival analysis confirmed significantly reduced 5-year survival in the SSc cohort (61% vs. 73%; log-rank $p < 0.001$) (Figure 1). The adjusted hazard ratio (HR) for mortality was 1.54 (95% CI 1.37–1.74), indicating a 54% higher risk of death over the 5-year follow-up period for patients with underlying SSc.

Secondary Outcomes

Malnutrition was significantly more prevalent in the SSc cohort (20% vs. 12%; RR 1.64, 95% CI 1.40–1.92; $p < 0.001$). Time-to-event analysis showed a markedly higher cumulative incidence of malnutrition over 5 years (HR 1.75, 95% CI 1.48–2.08; log-rank $p < 0.001$). The use of total parenteral nutrition (TPN) was rare and did not differ between groups (0.4% vs. 0.4%; $p = 0.99$). Sepsis occurred more frequently in patients with SSc (14% vs. 11%; RR 1.24, 95% CI 1.04–1.47; $p = 0.015$), with a higher cumulative hazard over time (HR 1.30, 95% CI 1.08–1.56; log-rank $p = 0.005$). While the crude risk of venous thromboembolism (DVT/PE) was not statistically significant (7% vs. 5%; $p = 0.086$), survival analysis revealed a significantly higher cumulative incidence in the SSc cohort (HR 1.32, 95% CI 1.03–1.69; log-rank $p = 0.030$).

Gastrointestinal bleeding showed a similar pattern; while the risk difference was not significant ($p = 0.081$), the cumulative 5-year hazard was significantly higher for the SSc cohort (HR 1.33,

95% CI 1.03–1.71; log-rank p = 0.029). Bowel perforation rates were identical (2.0% vs. 2.0%; p = 0.918).

There was no significant difference in the mean instances of small intestinal bacterial overgrowth (SIBO) encounters (5.37 vs. 4.98; p = 0.292). However, patients with SSc experienced a significantly higher burden of healthcare utilization, with a higher mean number of inpatient hospitalizations during the follow-up period (8.1 vs. 6.8; p = 0.003) (Figure 2 & Table II).

DISCUSSION

This large-scale, multi-institutional cohort study provides robust evidence that small bowel obstruction (SBO) in systemic sclerosis (SSc) constitutes a distinct, high-risk clinical phenotype. Our analysis of over 620,000 patients across 146 healthcare systems demonstrates that, after rigorous propensity score matching, SSc patients with SBO experience significantly higher all-cause mortality, a greater long-term burden of malnutrition and sepsis, and increased healthcare utilization compared to the general SBO population. While prior research has focused extensively on esophageal dysmotility and gastroparesis, this study fills a critical gap by quantifying the longitudinal consequences of SBO in SSc[3-5]. Our findings suggest that SBO is not merely an incidental gastrointestinal manifestation but a sentinel event, a clinically meaningful turning point in the SSc disease trajectory that warrants proactive, interdisciplinary management.

A primary consideration in interpreting these data is the inherent heterogeneity of intestinal obstruction within the SSc population. The ICD-10 coding utilized in this study (K56.6) likely captures a spectrum of pathology ranging from true mechanical SBO, often secondary to adhesions or strictures, to chronic intestinal pseudo-obstruction (CIPO), which arises from severe myogenic and neurogenic dysmotility. In SSc, these two entities are frequently indistinguishable at presentation, and CIPO can often mimic the clinical and radiographic features of mechanical blockage. Consequently, our observed outcomes likely reflect a mixed population.

This potential misclassification carries significant implications for long-term prognosis. Patients with CIPO-predominant obstruction are prone to recurrent episodes and chronic functional decline, whereas those with purely mechanical events may face unique surgical risks. By encompassing both entities, our results may provide a more realistic “real-world” assessment

of the SSc-SBO burden, highlighting a population that suffers from high rates of recurrence and readmission regardless of the underlying obstructive mechanism.

The observed 54% increase in the 5-year hazard of mortality among SSc patients suggests that the physiological impact of SBO in this population is profound and persistent. This elevated risk likely stems from interrelated pathophysiological mechanisms, including progressive collagen deposition and microvascular injury involving the intestinal smooth muscle and myenteric plexus[9,10]. Unlike the general population, where SBO is often a mechanical event, the SSc-affected intestine suffers from reduced peristaltic capacity and compromised vascular reserve[13]. This predisposes the bowel to ischemia and necrosis under obstructive stress, even when intraluminal pressures are only moderately elevated. Furthermore, the high prevalence of intestinal dysbiosis and small intestinal bacterial overgrowth (SIBO) in SSc can exacerbate mucosal inflammation, blunting the gut's resilience to acute obstructive episodes[14,15].

A key finding of our study is the disproportionately high burden of malnutrition in the SSc-SBO cohort, which affected one-fifth of patients and progressed longitudinally over the 5-year follow-up. While malnutrition is a recognized complication of SSc due to malabsorption and dysmotility, our data suggest that an episode of SBO may act as a catalyst for nutritional decline[16-18]. The requirement for prolonged bowel rest and the metabolic stress of obstruction likely accelerate pre-existing dysmotility and mucosal dysfunction. Critically, our results imply that nutritional assessment in these patients should not be confined to the acute hospitalization phase but must remain a long-term management priority. Proactive nutritional support and early intervention may be necessary to interrupt the cycle of chronic debility and immune compromise following an SBO event.

The significantly increased risk of sepsis in our SSc-SBO cohort underscores the fragility of the intestinal mucosal barrier in scleroderma. Previous studies have demonstrated that SSc-related mucosal dysfunction predisposes patients to bacterial translocation even in the absence of obstruction[19,20]. When obstruction occurs, the resulting ischemia and increased intraluminal pressure further weaken epithelial integrity, facilitating systemic microbial dissemination[21]. Furthermore, the common use of immunosuppressive therapies in SSc may mask early signs of infection, delaying life-saving treatment[22]. These findings argue for a lower threshold for diagnostic evaluation and antimicrobial therapy in SSc patients presenting with obstructive symptoms.

The increased frequency of inpatient hospitalizations observed in this study points to a substantial burden on both the patient and the healthcare system[23]. This pattern of healthcare use is likely driven by recurrent partial obstructions and chronic functional decline rather than isolated acute crises. As SSc survival continues to improve due to better management of pulmonary and renal complications, the absolute number of patients at risk for SBO-related morbidity will likely increase.

Clinical Implications

Small bowel obstruction in systemic sclerosis appears to be associated with a high-risk clinical state that requires a fundamental shift in current management protocols. While this study identifies a strong association between SBO and increased mortality, clinicians should interpret these findings with the understanding that SBO may serve as a sentinel marker for advanced systemic disease severity as much as an independent driver of morbidity. Consequently, the onset of obstructive symptoms should prompt not only acute intervention but also a comprehensive re-evaluation of the patient's overall SSc disease status, including screening for worsening pulmonary, cardiac, or renal involvement. The observed association with higher risk of sepsis and mortality may warrant lower threshold for hospitalization and the early initiation of broad-spectrum antimicrobial therapy, especially in patients receiving immunosuppressive therapy where inflammatory signs may be less apparent. Clinicians must maintain an intensified index of suspicion for mucosal barrier breakdown and subsequent bacterial translocation, regardless of whether the obstruction is mechanical or functional. Surgical decision-making remains exceptionally complex in this population due to the inherent reduced tissue resilience and impaired wound healing of the scleroderma-affected bowel. Although conservative management is often the initial preference, our findings may suggest that a prolonged wait-and-see approach may be detrimental in selected patients. These observations highlight the potential value of early and frequent coordination between rheumatologists, gastroenterologists with expertise in motility disorders, and surgical teams individualize management decisions while balancing operative risks against the possibility of bowel ischemia or systemic complications. Furthermore, the enduring and progressive nature of malnutrition observed in these patients can indicate that nutritional support should be prioritized as a long-term management pillar rather than a transient inpatient concern. This requires early nutritional consultation upon admission and the establishment of scheduled post-discharge follow-ups to monitor for malabsorption and determine the potential need for enteral or parenteral supplementation. Rheumatologists should also proactively counsel patients with known

gastrointestinal involvement on the early recognition of obstructive symptoms to facilitate timely intervention.

Study Strengths and Limitations

A key strength of this study is the utilization of a large and diverse patient population sourced from real-world data across 146 healthcare systems, which significantly enhances the generalizability of the findings to broader clinical practice. The extended five-year follow-up period provided a robust framework for assessing long-term cumulative risks, while the implementation of propensity score matching effectively minimized confounding across a wide array of demographic and clinical variables, thereby strengthening internal validity.

However, several limitations must be acknowledged. As with any large-scale database study, there is a potential for diagnostic coding misclassification inherent in electronic health record data. Specifically, while the ICD-10 code K56.6 is categorized as unspecified obstruction, it likely captures a heterogeneous population within the SSc cohort, including both mechanical small bowel obstruction and chronic intestinal pseudo-obstruction (CIPO). Because CIPO is a functional rather than mechanical etiology characterized by recurrent episodes, its inclusion may influence the interpretation of results regarding hospitalization frequency and long-term prognosis.

Furthermore, the TriNetX platform lacks granular details regarding systemic sclerosis-specific variables, such as clinical subtypes (limited versus diffuse), disease duration, and the presence of extra-intestinal manifestations (such as interstitial lung disease, pulmonary hypertension, or cardiac involvement), all of which could represent sources of residual confounding. While propensity score matching was robust for general clinical variables, the absence of these SSc-specific markers introduces the possibility of residual confounding. It is possible that SBO acts as a marker for more advanced systemic disease severity rather than being an entirely independent driver of mortality. Consequently, causal interpretations should be tempered. Future research incorporating granular imaging, manometry, or operative data is necessary to definitively differentiate outcomes between mechanical and functional obstruction and to further disentangle the independent impact of SBO from the overall systemic disease burden. Despite these constraints, the consistency and magnitude of the observed associations over an extended period strengthen the overall confidence in these findings.

CONCLUSION

In summary, small bowel obstruction in systemic sclerosis is associated with a severe clinical burden and a heightened risk of long-term complications. Recognition of SBO as a high-risk state should prompt early multidisciplinary involvement, including rheumatology, gastroenterology, and nutrition services. Future prospective research is needed to better phenotype these patients using manometry or advanced imaging to distinguish between mechanical and pseudo-obstructive processes and to evaluate whether early prokinetic therapy or targeted microbiome interventions can improve survival and quality of life in this vulnerable population.

From a research perspective, these results highlight an urgent need for prospective trials evaluating the efficacy of prokinetic therapies and microbiome-directed strategies in preventing recurrence. Future investigations should prioritize the identification of serologic or imaging biomarkers capable of predicting which individuals are at the highest risk for small bowel obstruction, thereby allowing for the development of standardized care pathways and earlier preventative strategies tailored specifically to the systemic sclerosis population.

Tables and Figures

Table I. Baseline characteristics of all patients included in the study after propensity score matching

Variable	Cohort A: SSc + SBO (n=2,323)	Cohort B: SBO only (n=2,323)	p-value	Std Diff
Age				
Current age, mean ± SD	69 ± 14.1	69 ± 16.1	0.852	0.005
Age at index, mean ± SD	62 ±14.4	62 ± 16.6	0.890	0.004
Sex				
Male, N (%)	438 (19%)	413 (18%)	0.343	0.028
Female, N (%)	1,821 (78%)	1,842 (79%)	0.451	0.022
Race				
White, N (%)	1,420 (61%)	1,409 (61%)	0.741	0.010
Black/African American, N (%)	447 (19%)	460 (18%)	0.630	0.014
Hispanic/Latino, N (%)	87 (4%)	80 (3%)	0.581	0.016
Not Hispanic/Latino, N (%)	1,638 (71%)	1,631 (70%)	0.822	0.007
Unknown, N (%)	488 (21%)	493 (21%)	0.857	0.005
Co-morbidities				
Hypertension, N (%)	1,492 (64%)	1,476 (64%)	0.625	0.014
Metabolic disorders, N (%)	1,644 (71%)	1,655 (71%)	0.722	0.010
Diabetes, N (%)	538 (23%)	524 (23%)	0.625	0.014
Obesity, N (%)	529 (23%)	529 (23%)	1	<0.001
Chronic respiratory disease, N (%)	930 (40%)	915 (39%)	0.653	0.013
CKD / AKI, N (%)	790 (34%)	784 (34%)	0.852	0.005
Medication				
Immune suppressants, N (%)	617 (27%)	598 (26%)	0.526	0.019
Sympathomimetics, N (%)	934 (40%)	966 (42%)	0.340	0.028
Parasympatholytics, N (%)	769 (33%)	778 (34%)	0.779	0.008

SSc=Systemic Sclerosis; SBO=Small Bowel Obstruction; SD= Standard Deviation; N=Number; %=Percentage; CKD/AKI=Chronic/Acute Kidney Injury/Disease

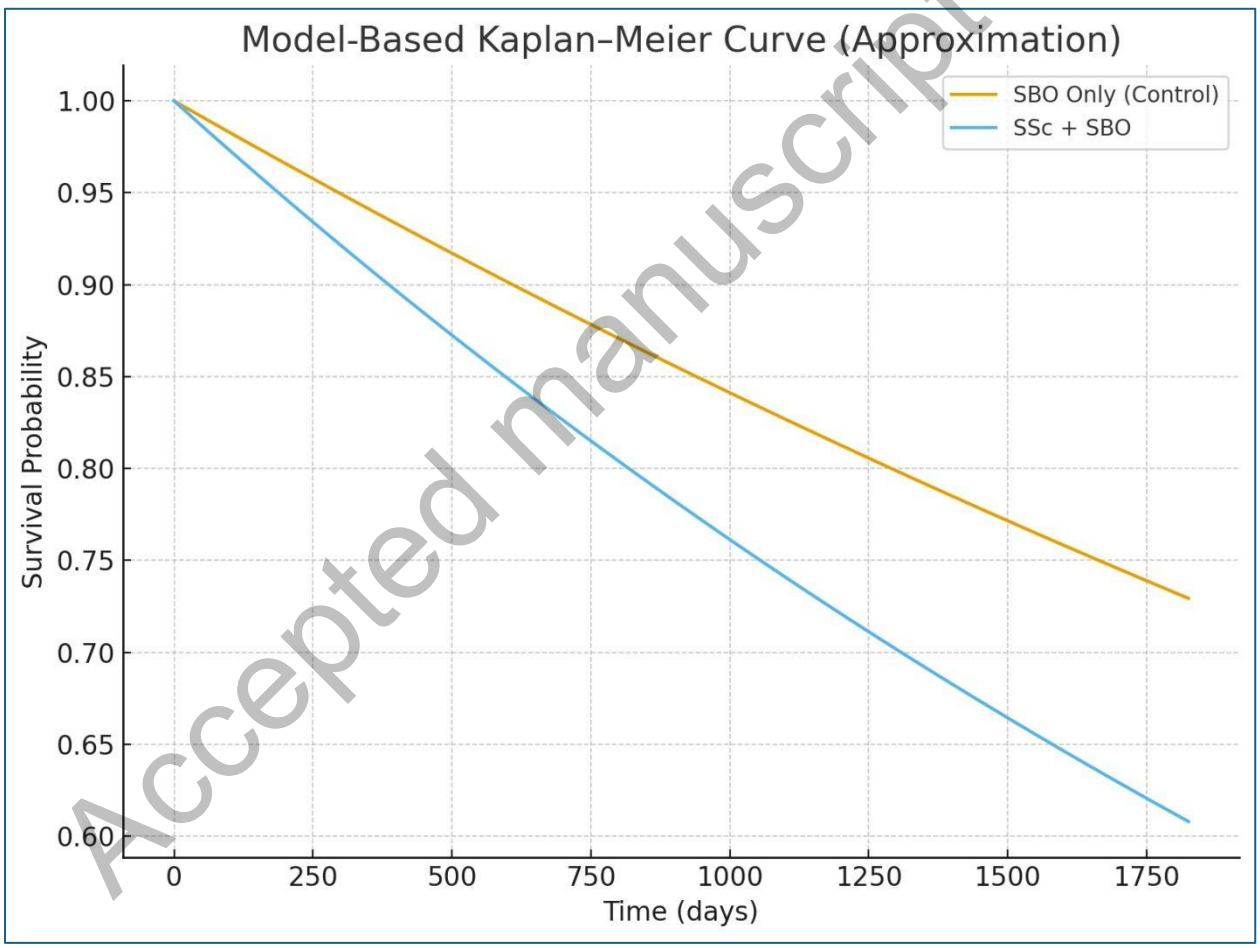

Figure 1 - Kaplan-Meier 5-year survival analysis of all-cause mortality following small bowel obstruction (SBO) in patients with and without systemic sclerosis (SSc). *This shows significantly reduced survival among patients with SSc-associated SBO compared with those with SBO alone*

Table II. Summary of Clinical Outcomes Following Small Bowel Obstruction in Patients With and Without Systemic Sclerosis.

Outcome	Cohort A (SSc + SBO)	Cohort B (SBO only)	Effect Estimate	95% CI	p-value	Notes
SIBO (mean instances)	n=2,323; mean 5.37 (SD 8.05)	n=2,323; mean 4.98 (SD 8.07)	t = 1.055	-	0.292	No significant difference
Malnutrition						
Risk, % (n)	20% (317/1,601)	12% (226/1,873)	RR = 1.64	1.40–1.92	<0.001	Higher risk in SSc
5-year Survival	71%	83%	HR = 1.75	1.48–2.08	<0.001	KM χ^2 = 42.753
Sepsis						
Risk, % (n)	14% (255/1,872)	11% (210/1,907)	RR = 1.24	1.04–1.47	0.015	Higher risk in SSc
5-year Survival	79%	84%	HR = 1.30	1.08–1.56	0.005	KM χ^2 = 7.991
DVT/PE						
Risk, % (n)	7% (134/2,000)	5% (114/2,102)	RR = 1.24	0.97–1.57	0.086	Not significant
5-year Survival	89%	92%	HR = 1.32	1.03–1.69	0.030	KM χ^2 = 4.736
Gastrointestinal bleeding						
Risk, % (n)	7% (132/2,038)	5% (109/2,094)	RR = 1.24	0.97-1.60	0.081	Not significant
5-year Survival	89%	92%	HR = 1.33	1.03–1.71	0.029	KM χ^2 = 4.773
Bowel perforation						
Risk, % (n)	2% (45/2,249)	2% (44/2,247)	RR = 1.02	0.68–1.54	0.918	No difference
5-year Survival	97%	97%	HR = 1.05	0.69–1.59	0.811	KM χ^2 = 0.057
Need for Total parenteral nutrition						
Risk, % (n)	0.4% (10/2,318)	0.4% (10/2,319)	RR = 1.00	0.42–2.40	0.999	No difference
5-year Survival	100%	100%	HR = 0.99	0.06–15.79	0.993	KM χ^2 = 0.000
Inpatient Hospitalizations	mean 8.12 (SD 12.69)	mean 6.80 (SD 10.89)	t = 2.962	-	0.003	Higher in SSc

SSc=Systemic Sclerosis; SBO=Small Bowel Obstruction; CI=Confidence Interval; SIBO= Small Intestinal Bacterial Overgrowth; DVT=Deep Venous Thrombosis; PE=Pulmonary Embolism; n=Number; t=Test Statistics; HR=Hazard ratio; RR=Relative risk; SD=Standard Deviation; KM=Kaplan-Meier survival analysis; %=Percentage

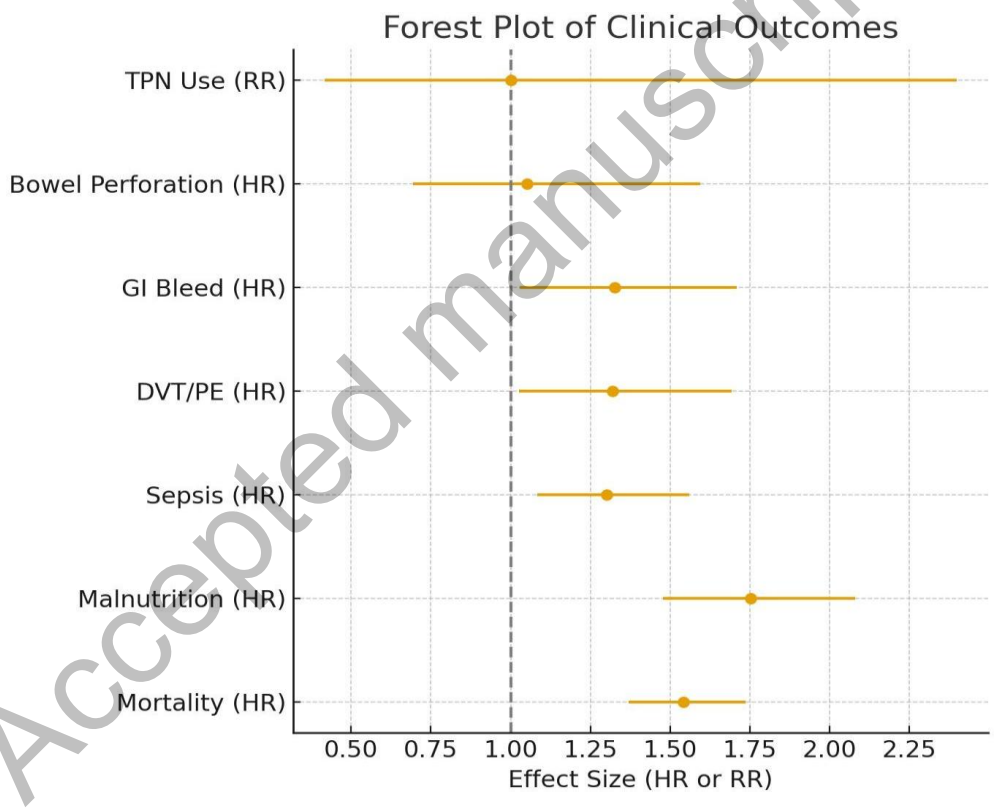

Figure 2: Forest plot showing adjusted hazard ratios (HR) and relative risks (RR) for clinical outcomes in small bowel obstruction (SBO) patients with and without systemic sclerosis *This shows significant increase risks of mortality, malnutrition, sepsis, venous thromboembolism, and gastrointestinal bleeding compared with matched SBO controls, while risks of bowel perforation and TPN use remain similar. TPN use=Total Parenteral Nutrition use; GI Bleed=Gastrointestinal Bleed; DVT/PE=Deep Vein Thrombosis/Pulmonary Embolism; HR=Hazard ratio; RR=Relative risk*

SUPPLEMENTARY DATA

Supplementary Table I: Diagnostic and procedural codes used in the study

Outcome / Variable	Code System	Code
Systemic Sclerosis (SSc)	ICD-10-CM	M34
Small Bowel Obstruction (SBO)	ICD-10-CM	K56.6
Primary & Secondary Outcomes		
All-cause Mortality	Vital Status	Deceased
Malnutrition	ICD-10-CM	E40–E46
Sepsis	ICD-10-CM	A41.9
Deep Vein Thrombosis (DVT)	ICD-10-CM	I82.40
Pulmonary Embolism (PE)	ICD-10-CM	I26
Gastrointestinal Bleeding	ICD-10-CM	K92.1
Bowel Perforation	ICD-10-CM	K63.1
Total Parenteral Nutrition (TPN)	SNOMED	225372007
Inpatient Hospitalization	HL7 Visit Type	IMP
Small Intestinal Bacterial Overgrowth (SIBO)*	UMLS	1013711

**In the absence of a discrete ICD-10-CM code for SIBO during the study period, SIBO-related encounters were identified using the TriNetX-mapped UMLS term 1013711. This proxy aggregates clinical instances and procedural data indicative of bacterial overgrowth.*

Supplementary Table II: Baseline Characteristics Before Propensity Score Matching

Variable	Cohort A: SSc + SBO (n=2,323)	Cohort B: SBO only (n=2,323)	p-value	Std Diff
Age				
Current age, mean ± SD	68.7 ± 14.1	67.9 ± 17.3	0.019	0.053
Age at index, mean ± SD	62.4 +/- 14.4	61.7 +/- 17.9	0.067	0.042
Sex				
Male, N (%)	438 (20%)	264,413 (46%)	<0.001	0.588
Female, N (%)	1,821 (78%)	299,045 (52%)	<0.001	0.596
Race				
White, N (%)	1,420 (61%)	352,225 (61%)	0.630	0.010
Black/African American, N (%)	447 (19%)	75,394 (13%)	<0.001	0.171
Hispanic/Latino, N (%)	87 (4%)	28,341 (5%)	0.011	0.056
Not Hispanic/Latino, N (%)	1,638 (71%)	365,107 (63%)	<0.001	0.163
Unknown, N (%)	262 (1%)	103,071 (18%)	<0.001	0.184
Co-morbidities				
Hypertension, N (%)	1,492 (64%)	244,120 (42%)	<0.001	0.456
Metabolic disorders, N (%)	1,644 (71%)	260,416 (45%)	<0.001	0.544
Diabetes, N (%)	538 (23%)	104,455 (18%)	<0.001	0.128
Obesity, N (%)	529 (23%)	93,036 (16%)	<0.001	0.171
Chronic respiratory disease, N (%)	930 (40%)	113,163 (20%)	<0.001	0.461
CKD / AKI, N (%)	790 (34%)	104,282 (18%)	<0.001	0.372
Medication				
Immune suppressants, N (%)	617 (27%)	24,462 (4%)	<0.001	0.651
Sympathomimetics, N (%)	934 (40%)	141,262(24%)	<0.001	0.345
Parasympatholytics, N (%)	769 (33%)	116,699 (20%)	<0.001	0.298

SSc=Systemic Sclerosis; SBO=Small Bowel Obstruction; SD= Standard Deviation; N=Number; %=Percentage; CKD/AKI=Chronic/Acute Kidney Injury/Disease

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