Management of adhesive small bowel obstruction: A distinct paradigm shift in the United States

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BACKGROUND: Recent studies show that early operative intervention in patients who fail nonoperative management of adhesive small bowel obstruction (ASBO) is associated with improved outcomes. The purpose of this study was to determine the trend in practice pattern and outcomes of patients with ASBO in the United States.

METHODS: Data from the National Inpatient Sample data (2003–2013) were extracted for analysis and included patients (age ≥18 years) who were discharged with primary diagnosis codes consistent with ASBO. We analyzed the data to examine changes in mortality and hospital length of stay in addition to any trends in rate and timing of operative interventions.

RESULTS: During the study period, 1,930,289 patients were identified with the diagnosis of ASBO. Over the course of the study period, the rate of operative intervention declined (46.10–42.07%, $p = 0.003$), and the timing between admission and operative intervention was significantly shortened (3.09–2.49 days, $p < 0.001$). In addition, in-hospital mortality rate decreased significantly (5.29–3.77%, $p < 0.001$). In the multiple logistic regression analysis, the relative risk of mortality decreased by 5.6% per year (odds ratio, 0.944; 95% confidence interval, 0.937–0.951; $p < 0.001$). Hospital length of stay decreased from 10.39 to 9.06 days ($p < 0.001$).

CONCLUSION: Over the last decade, fewer patients with ASBO were managed operatively, whereas those requiring an operation underwent one earlier in their hospitalization. Although further studies are warranted, our results suggest that recent changes in practice pattern may have contributed to improved outcomes. (*J Trauma Acute Care Surg.* 2019;86: 383–391. Copyright © 2018 American Association for the Surgery of Trauma.)

LEVEL OF EVIDENCE: Therapeutic study, level IV.

KEY WORDS: Adhesive small bowel obstruction; management; outcome; trends.

Adhesive small bowel obstruction (ASBO) continues to be one of the most common emergency surgical conditions in the United States and other developed countries. Disease burden and respective operative costs remain elevated in recent reports.[1–3] While the majority of patients with ASBO can be managed nonoperatively, delays in surgical management during cases of strangulation or complete obstruction are significantly associated with increased mortality and major complications.[4,5] Therefore, multiple attempts have been made in previous prospective and retrospective studies to propose models that can reliably predict the need for an emergent operation for ASBO.[6–8] Nonetheless, the basic tenets of managing the patient with ASBO have not changed for decades and include bowel rest, decompression of the stomach, and rehydration with intravenous fluids while monitoring for signs of peritonitis, strangulation, or bowel ischemia.[9] Nonetheless, in instances of complicated clinical presentations, efforts toward further clarifying the decision between operative and nonoperative management are critical.

With recent advances in resolution, speed, and availability, the use of computed tomography (CT) is currently recommended in patients with suspected ASBO.[10] In addition to its diagnostic ability, a combination of specific CT findings associated with strangulation and clinical signs can be used to predict which patient may require an emergent operation.[7,8,11–13] Conversely, patients without clinical and radiographic signs of strangulation/bowel ischemia may follow a separate path toward nonoperative management; in these patients, the diagnostic and potentially therapeutic use of water-soluble contrast followed by serial abdominal radiographs has been proposed.[14–16] The results from a recent multicenter study suggest that the management of ASBO using water-soluble contrast is significantly associated with a lower rate of operative intervention and shorter hospital length of stay (HLOS) compared with conventional management.[17] Thus, an increasing number of institutions have developed and implemented a protocol for the management of ASBO adopting an initial clinical evaluation with CT and subsequent water-soluble contrast challenge.[18,19]

To date, scarce data exist regarding the nationwide trend in the management of ASBO and patient outcomes. The purpose of this study was to examine whether there are any recent changes in practice patterns and patient outcomes of patients with ASBO in the United States. We hypothesized that there would be significant trends toward less frequent but early operative interventions over the last decade. In addition, we hypothesized that we would observe significant trends toward improved patient outcomes.

PATIENTS AND METHODS

Study Design and Patient Selection

This is a population-based, retrospective cohort study using the National Inpatient Sample (NIS), a nationwide hospital discharge database organized under the federal Healthcare Cost and Utilization Project. First started in 1988, the NIS continues to release updates on an annual basis, capturing 20% of the approximately 37 million annual nationwide discharges. Each update reports information regarding patient demographics, preexisting conditions, hospital demographics, and identified patient diagnostic and procedural codes. Diagnostic and procedure codes for each patient are provided using the *International Classification of Diseases, Ninth Edition, Clinical Modification* (*ICD-9-CM*). National discharge estimates are determined through sampling weights provided by the NIS database. The weighting algorithm provides reliable estimates for national volumes of a given diagnosis or procedure and updates regularly through every database redesign-iteration.[20,21] All aspects of this study including use of the NIS database have been approved by the Institutional Review Board of the University of Southern California.

The NIS covers all patients, regardless of insurance status, and provides a large sample size including rare diagnoses, uncommon procedures, and unique patient populations. For this study, data from 2003 to 2013 were compiled and retrospectively reviewed. Patients younger than 18 years of age were excluded using data filters. The *ICD-9-CM* diagnostic codes 560.81 and 560.89 were used to select the subset of patients with a discharge diagnosis of ASBO. Patients within this filtered group were categorized in the surgery group if they possessed an *ICD-9-CM*

procedural code of either 54.11, 54.19, 54.51, 54.59, 45.61, 45.62, 45.63, 45.90, or 45.91. Patients in the Surgery group with an *ICD-9-CM* procedural code of either 45.61, 45.62, 45.63, 45.90, or 45.91 were further subcategorized to having a procedure for bowel resection. Patients who fulfilled the diagnostic inclusion criteria but possessed neither of the surgically labeled procedural codes were categorized in the no surgery group.

Statistical Analysis

The counts of inpatient discharge were weighted using sampling weights provided by the NIS database to generate a reliable estimate of nationwide discharges for patients with ASBO. A Charlson comorbidity index was calculated based on *ICD-9-CM* diagnostic codes provided by Quan et al.[22] Univariate analysis comparing patient demographics, preexisting conditions, patient demographics, and hospital variables between the operative and nonoperative group was performed. For continuous or discrete variables, a Student *t* test was used. For categorical variables, a Fisher exact test or χ^2 analysis was used as appropriate. Trends in practice pattern and outcomes over time were analyzed using a linear regression, and a *p* value was calculated from the slope of the line of best fit. Clinically significant patient- and hospital-level covariates (age, sex, Charlson comorbidity index, primary payment methods, year of admission, hospital teaching status, hospital bed size, hospital region) were included and adjusted for in a logistic regression model for multivariable analysis. A *p* value of <0.05 was considered significant. All statistical analyses were calculated using STATA 13.0 (StataCorp LP, College Station, X).

RESULTS

Patient and Hospital Characteristics

From 2003 to 2013, a total of 1,930,289 patients were found to fit our inclusion and exclusion criteria (Fig. 1). Of those, 863,465 patients (44.73%) underwent surgical procedures for ASBO. Patient baseline demographics in the operative group and nonoperative group were compared in Table 1. Patients who received surgical management were found to be significantly younger (62.97 vs. 63.94 years, $p < 0.001$) and predominantly female (61.99% vs. 57.31%, $p < 0.001$). Preexisting conditions such as congestive heart failure, obesity, and fluid and electrolytes disorders were found more common in patients with surgical management. In contrast, patients with other preexisting conditions including liver disease, metastatic cancer, and other neurological disorders were more common in the nonoperative group; however, univariate analysis of total preexisting conditions revealed no statistical significance (2.37 vs. 2.35, $p = 0.891$). Hospital characteristics such as large bed size (62.62% vs. 61.59%, $p < 0.001$), nonteaching status (56.11% vs. 55.33%, $p < 0.001$), and urban locations (87.25% vs. 86.89%, $p = 0.002$) were also found to be significantly increased in patients receiving surgical management.

Rate and Timing of Surgical Interventions for ASBO

Table 2 demonstrates the rate and timing (days from hospital admission) of surgical interventions for ASBO in each year.

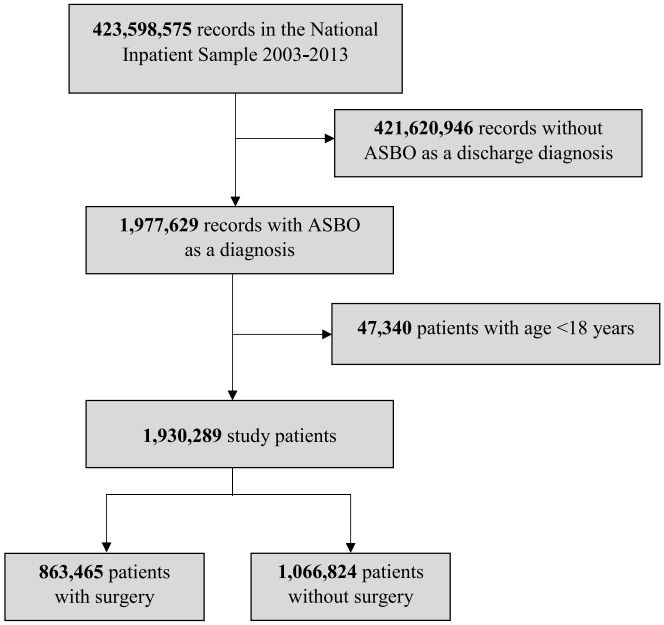

Figure 1. Patient selection diagram.

The number of patients who underwent surgical interventions decreased from 46.10% in 2003 to 42.07% in 2013. Using logistic regression, each 1-year increase was significantly associated with a 1.1% decrease in the rate of surgical intervention (odds ratio [OR], 0.989; 95% confidence interval [CI], 0.986–0.992; $p < 0.001$). In the patients who underwent surgical interventions, the average days from admission to operation shortened from 3.09 days to 2.49 days ($p < 0.001$). Out of all patients who underwent surgical intervention, the rate of immediate surgery, defined as surgery within 24 hours of admission, increased from 24.09% in 2003 to 33.26% in 2013. Surgery within 24 and 72 hours of admission each also saw a significant steady 1-year increase (OR, 1.032 per year; 95% CI: 1.027–1.038, $p < 0.001$ and OR, 1.026 per year; 95% CI, 1.022–1.031; $p < 0.001$). In contrast, the rate of operative intervention leading to bowel resection was found to have a significant decrease in prevalence every year (OR, 0.995 per year; 95% CI, 0.991–0.999; $p = 0.023$).

Patient Outcomes

In-hospital mortality rate and average HLOS in each year are shown in Table 3. Overall, the rate of in-hospital mortality decreased from 5.29% in 2003 to 3.77% in 2013. Over the study period, patients were found to have a 5.6% yearly decrease in in-hospital mortality rate (OR, 0.944 per year; 95% CI, 0.937–0.951; $p < 0.001$). Similarly in both operative and nonoperative subgroups, each increase in year brought lowers rates of in-hospital mortality (OR, 0.944 per year; 95% CI, 0.935–0.954; $p < 0.001$ and OR, 0.948 per year; 95% CI, 0.939–0.957; $p < 0.001$). The average HLOS decreased from 10.39 to 9.06 days ($p < 0.001$). Patients in the operative group were found to have increased lengths of stay compared with the nonoperative group (7.34 vs. 12.80 days, $p < 0.001$). However, patients with and without surgical interventions overall

TABLE 1. Patient and Hospital Characteristics

Variables	Nonoperative Group (n = 1,066,824)	Operative Group (n = 863,465)	*p*
Age, mean (SD)	63.94 (0.04)	62.94 (0.04)	<0.001
Female sex, n (%)	610,653 (57.31)	534,747 (61.99)	<0.001
Race, n (%)			<0.001
White	671,064 (75.66)	533,942 (75.18)	
Black	101,423 (11.43)	97,092 (13.67)	
Hispanic	68,520 (7.73)	46,858 (6.60)	
Asian or Pacific Islander	21,454 (2.42)	14,065 (1.98)	
Native American	3,902 (0.44)	2,892 (0.41)	
Other	20,624 (2.33)	15,338 (2.16)	
Preexisting comorbidities, n (%)			
AIDS	1,561 (0.15)	1,239 (0.14)	0.674
Alcohol abuse	20,722 (1.95)	17,391 (2.02)	0.119
Deficiency anemia	188,350 (17.74)	142,947 (16.63	<0.001
Chronic blood loss anemia	18,832 (1.77)	14,068 (1.64)	0.001
Combined anemia	204,302 (19.24)	155,397 (18.08)	<0.001
Rheumatoid arthritis/collagen vascular disease	26,136 (2.46)	20,499 (2.38)	0.117
Congestive heart failure	80,192 (7.55)	73,130 (8.51)	<0.001
Chronic pulmonary disease	170,301 (16.04)	152,967 (17.79)	<0.001
Coagulopathy	34,883 (3.28)	35,303 (4.11)	<0.001
Depression	102,263 (9.63)	72,863 (8.48)	<0.001
Diabetes uncomplicated	155,409 (14.63)	114,055 (13.27)	<0.001
Diabetes with chronic complications	21,267 (2.00)	14,667 (1.71)	<0.001
Drug abuse	16,969 (1.60)	13,041 (1.52)	0.064
Hypertension	489,003 (46.05)	388,685 (45.22)	<0.001
Hypothyroidism	115,425 (10.87)	89,609 (10.42)	<0.001
Liver disease	24,986 (2.35)	16,055 (1.87)	<0.001
Lymphoma	8,874 (0.84)	6,380 (0.74)	0.001
Fluid and electrolyte disorders	387,234 (36.46)	341,721 (39.75)	<0.001
Metastatic cancer	117,997 (11.11)	679,814 (7.89)	<0.001
Other neurological disorders	67,582 (6.36)	46,032 (5.35)	<0.001
Obesity	63,642 (5.99)	58,835 (6.84)	<0.001
Paralysis	24,293 (2.29)	12,235 (1.42)	<0.001
Peripheral vascular disorders	49,320 (4.64)	51,753 (6.02)	<0.001
Psychoses	33,105 (3.12)	25,450 (2.96)	0.004
Pulmonary circulation disorders	16,401 (1.54)	15,581 (1.81)	<0.001
Renal failure	74,398 (7.01)	56,316 (6.55)	<0.001
Solid tumor w/o metastasis	37,747 (3.55)	24,648 (2.87)	<0.001
Peptic ulcer disease (no bleeding)	1,006 (0.09)	1,039 (0.12)	0.014
Valvular disease	38,599 (3.63)	36,384 (4.23)	<0.001
Weight loss	110,934 (10.45)	126,797 (14.75)	<0.001
Primary payment method, n (%)			<0.001
Medicare	584,257 (54.85)	447,007 (51.86)	
Medicaid	80,356 (7.54)	57,928 (6.72)	
Private insurance	335,345 (31.48)	299,419 (34.74)	
Self-pay	35,348 (3.32)	31,869 (3.70)	
No charge	4,212 (0.40)	3,651 (0.42)	
Other payment	25,678 (2.41)	22,101 (2.56)	
Median household income, n (%)			<0.001
0–25th percentile	188,589 (23.91)	157,592 (25.09)	
26–50th percentile	194,119 (24.62)	161,862 (25.77)	
51–75th percentile	200,175 (25.38)	158,029 (25.16)	
76–100th percentile	205,716 (26.09)	150,718 (23.99)	
Hospital level variables			

Continued next page

TABLE 1. *(Continued)*

Variables	Nonoperative Group (n = 1,066,824)	Operative Group (n = 863,465)	*p*
Bed size of hospital, n (%)			<0.001
Small	139,078 (13.09)	104,969 (12.22)	
Medium	269,052 (25.32)	216,255 (25.17)	
Large	654,521 (61.59)	538,078 (62.62)	
Hospital location setting, n (%)			0.002
Rural	113,315 (13.11)	91,375 (12.75)	
Urban	751,086 (86.89)	625,178 (87.25)	
Region of hospital, n (%)			<0.001
Northeast	240,972 (22.59)	164,286 (19.03)	
Midwest	242,117 (22.70)	205,175 (23.76)	
South	363,742 (34.10)	322,085 (37.30)	
West	219,993 (20.62)	171,920 (19.91)	
Teaching status of hospital, n (%)			<0.001
Nonteaching	478,265 (55.33)	402,037 (56.11)	
Teaching	386,136 (44.67)	314,516 (43.89)	

AIDS, acquired immune deficiency syndrome.

stayed fewer days in the hospital during the course of the study period.

DISCUSSION

In this study using a large national database, we reported several important findings to suggest significant trends in the management of ASBO and patient outcomes. While patients less frequently undergo operative interventions for ASBO, the timing of operation has shifted earlier in their hospital stay. Approximately one third of operative interventions were performed within 24 hours after the admission, increased from one quarter in previous years. The in-hospital mortality in ASBO patients with and without operative intervention significantly decreased over the study period. Similarly, the length of hospital stay trended down regardless of operative intervention. To our knowledge, this is one of the largest studies in the modern era to report the contemporary management of ASBO and patient outcomes.

One of the most significant findings we observed in this study was the trend toward earlier operation for ASBO. A longstanding dilemma surgeons have faced for centuries is on the management of ASBO, particularly (1) whether to operate and (2) when to operate. In the past, a mandatory surgical intervention was considered as the mainstay of treatment for ASBO. This practice pattern is well-represented in the motto, "Never let the sun rise or set on a small bowel obstruction." However, it has been recently reported that up to 70% of patients with SBO were managed nonoperatively at 13 hospitals across North America, all of which participated in the American College of Surgeons National Surgical Quality Improvement Program.[23] On the other hand, a failure to identify the patient with strangulated ASBO and subsequent bowel ischemia is associated with the significant delay in surgical interventions. In these cases, the mortality rate was reported to be as high as 40% in previous literature.[24]

The ultimate goal in the management of ASBO is to identify patients who require an operation and then operate early in their hospital stay. Any delay in surgical intervention, even more than 24 hours after admission, is significantly associated with higher mortality and complication rate.[4] Multiple studies from the 20th century have challenged to create the best model to predict the need for surgical interventions using clinical and laboratory variables without success.[25] In many cases, the experienced surgeon's gestalt may not be sufficiently accurate or reliable. In the last decade, an increased number of studies have focused on the utility of CT features in addition to clinical symptoms and signs to achieve the aforementioned goals in the management of ASBO.[6–9,11,26] Zielinski et al.[6,7] created a prediction model including clinical and CT signs in a retrospective study, then conducted a prospective study to validate their model. They found that 86% of patients with all three variables including clinical symptoms and CT features (obstipation, lack of small bowel feces sign, and mesenteric edema) required surgical exploration, with 29% of these explorations demonstrating strangulation. Another recent (2011–2013) prospective observational study from three US trauma centers also identified one clinical symptom (no flatus) and two CT findings (free fluid, high-grade obstruction) were identified as significant predictors for early operation in ASBO patients who underwent a trial of nonoperative management.[11] With the presence of these three variables being positive, 56% of patients required an early operation. Of note, the median days from admission to operation among three participating centers was 1.5 days. Furthermore, the median length of stay in patients successfully managed nonoperatively was 2 days.

There are an increasing number of institutions where the use of water-soluble contrast in a trial of nonoperative management of ASBO is standard practice. In a recent multi-institutional study of water-soluble contrast for ASBO, 11 (79%) of 14 participating institutions had previously implemented the water-soluble contrast challenge for the management of ASBO. There was also a significantly lower rate of operative exploration in the water-soluble contrast group (20.8% vs. 49.0%, $p < 0.0001$) and a significant trend toward lower operative rate, the latter of which

TABLE 2. Trends in Surgical Management for ASBO From 2003 to 2013

Outcomes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total no. patients (weighted)	152,625	161,124	167,796	174,849	181,832	193,160	189,839	182,888	185,176	170,380	170,620
Patients with surgery, %	70,355 (46.10)	74,041 (45.95)	77,264 (46.05)	83,059 (47.50)	80,574 (44.31)	87,492 (45.30)	87,091 (45.88)	82,490 (45.11)	78,340 (42.31)	70,970 (41.65)	71,780 (42.07)
Patients with bowel resection, %	22,798 (14.94)	23,683 (14.70)	24,646 (14.69)	27,292 (15.61)	25,888 (14.24)	28,265 (14.63)	28,485 (15.00)	27,238 (14.89)	26,557 (14.34)	23,810 (13.97)	24,145 (14.15)
Mean days to surgery	3.09	2.98	2.86	2.77	2.66	2.66	2.64	2.65	2.66	2.59	2.49
Surgery <24 h, %	16,879 (24.09)	18,852 (25.57)	20,536 (26.73)	22,801 (27.58)	22,636 (28.24)	25,810 (29.64)	27,065 (31.27)	25,754 (31.42)	23,719 (30.43)	22,885 (32.48)	23,700 (33.26)
Surgery <72 h, %	36,160 (51.61)	38,943 (52.81)	41,948 (54.61)	45,880 (55.50)	44,555 (55.59)	50,197 (57.65)	52,240 (60.36)	49,322 (60.17)	46,105 (59.14)	44,300 (62.87)	45,130 (63.34)

TABLE 3. Trends in Patient Outcomes From 2003 to 2013

Outcomes	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
In-hospital mortality											
Total patients, %	8,053 (5.29)	8,494 (5.27)	8,413 (5.02)	8,678 (4.96)	8,537 (4.70)	8,712 (4.51)	8,625 (4.55)	7,649 (4.18)	7,819 (4.23)	6,865 (4.03)	6,430 (3.77)
Surgery patients, %	4,095 (4.99)	4,469 (5.13)	4,452 (4.92)	4,481 (4.88)	4,625 (4.57)	4,586 (4.34)	4,355 (4.24)	4,012 (4.00)	4,368 (4.10)	3,870 (3.89)	3,585 (3.63)
No surgery patients, %	3,958 (5.65)	4,024 (5.44)	3,961 (5.13)	4,197 (5.05)	3,911 (4.86)	4,125 (4.72)	4,270 (4.91)	3,636 (4.41)	3,451 (4.41)	2,995 (4.22)	2,845 (3.96)
Mean HLOS											
Total patients, d	10.39	10.25	10.17	10.19	9.84	9.87	9.73	9.66	9.32	9.22	9.06
Surgery patients, d	13.53	13.40	13.27	13.07	12.82	12.73	12.63	12.58	12.40	12.27	12.02
No surgery patients, d	7.70	7.57	7.53	7.57	7.45	7.50	7.28	7.26	7.05	7.05	6.91

may be contributed by an increase in the administration of water-soluble contrast.[17] This algorithm includes administration of water-soluble contrast via nasogastric tube, and then serial abdominal radiographs are taken every 4 to 6 hours. The indication for surgical intervention is usually defined as a failure to pass contrast to the ascending colon within 8 to 24 hours.[15] The benefits of this protocol are twofold: serial radiographs follow the passage of contrast and can help diagnose whether the patient has a complete obstruction in an objective fashion. The second potential benefit is therapeutic from the contrast's high osmolarity that facilitates decrease in edema of the small intestine and help relieve intraluminal pressure. While this protocol helps guide the surgeon, the most important decision is to determine, within 24 to 48 hours, whether to a patient with ABSO requires an operation.

To date, little has been described about recent changes in the practice patterns and patient outcomes for ASBO in population-based studies. Our study clearly demonstrates an improved survival of patients with ASBO in the United States over the last decade. In the United Kingdom, Peacock et al[27] reported the data from the National Emergency Laparotomy Audit, a nationwide surgical quality improvement program database in England and Wales. Between December 2013 and November 2015, 31.3% of emergency laparotomies with either adhesiolysis or bowel resection for SBO were performed less than 24 hours after admission. The overall 30-day mortality was 7.2% in their cohort. Behman et al.[28] conducted a retrospective population-based study using a Canadian administrative database to evaluate the trends in the management of ASBO from 2005 to 2014. While their study also showed a significant increase in the proportion of patients who underwent surgery within 1 day, the proportion of patients who underwent surgery overall increased significantly.

There are several limitations to our study. First, the NIS database is an administrative database, thus not structured for the use in research. Although the database includes a large number of patients discharged from the US hospitals, limited clinical data are available to be adjusted in the multivariable analysis. There are several important factors associated with patient outcomes in ASBO, including previous history of abdominal surgeries, previous admissions for ASBO, severity grades, and primary admitting service (surgery vs. others).[29,30] For that reason, this study focused on describing the trends in practice pattern and patient outcomes.[31] Furthermore, we determined to include ASBO patients between 2003 and 2013, as we believe that water-soluble contrast have been more commonly used for ASBO in the United States since the early 2000s, although this period can be arbitrary.[14,15,32] Second, we were unable to evaluate the impact of laparoscopic procedures. The utility of laparoscopic procedure for ASBO remains controversial.[33,34] We believe that the NIS database is not suitable to perform the analysis to compare patient outcomes between different treatment options because of limitations of the database. Third, significant trends observed in our study may not apply to each surgeon- and hospital-level across the country. Significant disparities in the practice pattern and outcome may still exist in ASBO.[35] Finally, we would like to emphasize that the results of this study should not interpreted as if the change in practice patterns have improved the outcome of patients with ASBO. There are several factors, including recent advances in initial resuscitation, medical optimization of patients with comorbidities, and postoperative care in the intensive care unit, all of which may have contributed to these improved patient outcomes.

CONCLUSIONS

The results of this study suggest that there has been a significant paradigm shift in the management of ASBO from 2003 to 2013. We observed an overall decrease in the number of patients who underwent an operative intervention but a shift to intervention earlier during hospitalization. At the same time, in-hospital mortality and HLOS have significantly improved. Further studies are warranted whether recent changes in practice pattern are associated with improved patient outcomes.

DISCLOSURE

The authors declare no conflicts of interest.

AUTHORSHIP

Corresponding author: Matsushima; study concept, design: Matsushima, Sabour, Park, Strumwasser, Inaba, Demetriades; data collection and analysis: Matsushima, Sabour, Park; writing: Matsushima, Sabour; critical revision: Park, Strumwasser, Inaba, Demetriades.

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DISCUSSION

Martin D. Zielinski, M.D. (Rochester, Minnesota): Good morning. Drs. Rotondo and Reilly, Publication and Program Committee, thank you for the opportunity to discuss this outstanding paper. Dr. Matsushima, thank you for highlighting the care of small bowel obstruction patients.

My interest in this field was actually due to a delayed diagnosis of a strangulation obstruction as a chief resident, and that really drove me into doing some research in this area, because I knew there must be a better way to manage small bowel obstruction patients which the authors have successfully highlighted.

They present a secondary analysis of the National Inpatient Sample and have studied non-operative versus operative management of adhesive small bowel obstruction in the setting of increasing national trends to use small bowel obstruction protocols, which heavily rely on CT imaging and Gastrografin challenge protocols.

They hypothesize that there would be trends towards less frequent operations, but that the operations would be earlier in the patients' critical course.

To answer their questions, the NIS was utilized from 2003 to 2013, and identified nearly two million patients. Of these patients, almost half of them underwent operative exploration.

They were able to show multiple improvements over that decade in terms of mortality, lesser rates of bowel resection, and lesser durations of stay.

The authors also highlighted, however, that there was no ability to proscribe a cause and effect relationship with these improvements in clinical outcomes to the protocols, but their results certainly are intriguing. This was really a quite well-done paper, so I only have a few questions:

Why did you choose the years 2003 – 2013? The Gastrografin challenge has been around since the early 1990's, and the push to move small bowel obstruction protocols really was coming in in the late 2000's. I would also bet that there would be a continued and probably even stronger national trends to further support your hypothesis after 2013.

Secondly, why didn't you stratify for hospital characteristics, particularly the ones with differences such as bed size and teaching status?

This study highlights the inability to really use some of these national databases designed for purposes other than quality and research. For instance, we have no idea which hospitals are using small bowel obstruction protocols, and how many more protocols were implemented in these institutions across the country throughout the study period.

Really, to me, there are two major takeaways from this paper. First, the clinical protocols for emergency general surgery diseases will likely become more commonplace, and hopefully improve patient outcomes in the next years and decades;

And secondly, that we need a reliable national data source that captures both operatively and non-operatively managed patients, that also contains data points specific to disease processes to allow us to control for disease severity, physiologic status, and hospital parameters, instead of relying on billing databases to drive our research. With this more specific information, we as a community of emergency surgeons can determine the cause and effect this and other similar protocols will have to further improve patient care. Thank you.

David Harrington, M.D. (Providence, Rhode Island): Thank you. The rate of surgery of 40 percent was a shocker to me, and I was wondering if you could give us some information as to whether those were immediate operations – people came in with, you know, compromised bowel and went to surgery – and how many of those were, kind of, failure of management, meaning, detected later. That would be an important distinction for me.

Kimberly A. Davis, M.D., M.B.A. (New Haven, Connecticut): Thank you very much for your excellent presentation and an interesting study. A number of papers have previously demonstrated that the type of surgery performed is more likely to be linked to lengths of stay and outcomes, so can you give us some insight as to how many of these patients underwent their surgeries laparoscopically versus via more traditional open techniques? Thank you.

Kazuhide Matsushima, M.D. (Los Angeles, California): Dr. Zielinski, thank you so much for your kind and invaluable comments. We certainly acknowledge your contribution to this area. Please let me start to address your questions first.

In terms of a study period, I agree, the Gastrografin challenge has been around since 1990's, but we felt that the surgeons in the U.S. became familiar with the Gastrografin study in early 2000, that's why we chose the 2003. I know it's an arbitrary number, so that's one of the limitations.

The second question regarding the hospital level characteristics, we did control in our logistical regression model; however, like I briefly mentioned, I can imagine there is a significant variations in terms of management of small bowel obstruction between institutions, so that's something we have to address in future studies.

The rate of operative intervention – 46 percent in 2003 – it's higher than described; however, I think the rate of successful non-operative management – 70-80 percent – in previous literature, is based on the data at institutions with a high-volume of patients with small bowel obstruction; however, if you include entire hospital across the country, the rate of operating intervention can be increased, such as 45-50 percent.

The question regarding laparoscopic surgery, which is another hot topic in adhesive small bowel obstruction, we did increase ICD-9 code for laparoscopic procedures, such as lysis of adhesions. I don't have an exact number, but in the previous study, the use of laparoscopic surgery has been increasing significantly in the last ten years, so I would think the number would be much higher in the last ten years.

Thank you so much.

