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Implementation of an adhesive small bowel obstruction protocol using low-osmolar water soluble contrast and the impact on patient outcomes☆

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ABSTRACT

Background: Small bowel obstruction (SBO) is a common condition leading to numerous hospital admissions and operations. Standardized care of adhesive SBO patients has not been widely implemented in hospital systems.
Methods: A prospective cohort of SBO patients was compared to a historical cohort of SBO patients after implementation of a SBO protocol using evidence-based guidelines and Omnipaque, a low-osmolar water soluble contrast. Patients without a history of abdominal surgery were excluded and data was collected through chart review.
Results: Univariate analyses demonstrated a decrease in both LOS by 1.35 days and in the proportion of patients receiving surgery (37% vs 25%; $p < 0.05$). There was a decrease in time to surgery, rate of SBR, and rate of complications, yet an increase in readmission, although these findings were not statistically significant.
Conclusions: Utilizing an evidence-based SBO protocol can lead to shorter LOS and may result in fewer operations for adhesive SBO patients.

Introduction

Small bowel obstruction (SBO) is a common condition leading to surgical consultation and admission to US hospitals accounting for 15% of acute surgical admissions.[1] In the US, there are over 300,000 hospitalizations for SBO and an additional 300,000 SBO adhesiolysis surgeries are performed per year in adults.[2] SBO accounts for more than 2.3 billion dollars in healthcare expenditures.[3] The most common SBO etiologies in Western society are adhesions, malignancy, hernia, and Crohn's disease.[4–7] Peritoneal adhesions account for 50–80% of all bowel obstructions.[8] Standardizing the care for this large population holds promise to ensure best practices, efficient care, and reduce hospital costs.

Strategies for the management of small bowel obstructions (SBO) have changed significantly over the years. Non-operative medical management has become the mainstay of treatment for most small bowel obstructions. However, there are situations in which surgery is indicated. These situations must be identified early on in order to prevent bowel ischemia and necrosis, which result in increased morbidity and mortality. Guidelines for the management of SBO have recently been published which provide a foundation for early identification of patients unlikely to resolve with medical therapy. Both the Bologna Guidelines[9] and the Eastern Association for the Surgery of Trauma guidelines[10] promote the use of water-soluble contrast challenge (WSCC) in patients without signs of strangulation or peritonitis, persistent vomiting, or CT signs of bowel ischemia. Both guidelines recommend administration of contrast any time after admission up to 48 h after initiation of medical management. There is good evidence that a WSCC can effectively predict the need for surgery in adhesive SBO and reduce length of hospital stay (LOS).[9] Complete bowel obstructions can be identified with the potential to reduce time to operation for those who will require an operation.[9] It is less conclusive if this intervention can reduce the overall need for surgery. Also, it has not been determined if there is a reduction of small bowel resection

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and postoperative complications with this reduction in the time to operation. Furthermore, there is wide range of length of time of nasogastric tube (NGT) decompression, timing of contrast administration, and follow up xrays. Also, utilization of a low-osmolar contract such as Omnipaque within a protocol has not been evaluated despite it being suggested by the American College of Radiology when there is an aspiration risk.[11] Therefore, we predicted that designing and implementing specific guidelines for the identification and management of adhesive SBO would improve standardization of practice and improve patient outcomes across our patient population.

The impetus for the development of the protocol was to improve standardization of the management of patients admitted to with SBO. Prior to the protocol implementation, there was substantial variability in the care of patients presenting with SBO as each of our providers utilized imaging modalities differently. Also, there was a lack of consensus on when and how to utilize contrast. We developed our protocol to provide this standardization.

Our protocol (Fig. 1) was developed utilizing the current practice guidelines, specifically incorporating a WSCC. The protocol provides a management algorithm based upon clinical and diagnostic criteria. The first step is diagnosis based upon a history, physical exam, laboratory values and an abdominal series. Findings suggestive of intestinal ischemia and absolute indications for operative management include peritonitis on exam, free intraperitoneal air on plain films, and/or irreducible hernia. Relative indications that are concerning though less specific include elevated lactate, fever, tachycardia, severe pain, focal tenderness, and leukocytosis >15,000. Included in indications for CT scan are those patients who meet some relative indications but are not felt to necessitate urgent operative intervention, those with no history of abdominal surgery nor any hernias noted on exam, and those in which the diagnosis of small bowel obstruction is in doubt. If it is determined there is no evidence of ischemia, non-operative management with a nasogastric tube (NGT), fluid and electrolyte resuscitation, urine output monitoring and serial abdominal exams are implemented. At 12-h post-NGT placement, if there is improvement in abdominal symptoms, the abdominal exam, and/or decreasing nasogastric output, yet obstipation continues, a WSCC is performed. The WSSC study is ordered as a bolus of 50 ml of Omnipaque orally or down the nasogastric tube (NGT) with clamping of the NGT for 6 h. A KUB x-ray is obtained at 6 h after contrast administration. Failure of non-operative management is defined by: persistent abdominal pain and/or distension, NG drainage volume greater than 500 cc in 24 h on hospital day three, fever at 48–72 h, WBC greater than 10,000, any findings of intestinal ischemia, or no evidence of contrast in the colon by 24 h after administration. In the case of failure of non-operative management operative management is considered.

The aim of this study was to determine the rate of completion of the Adhesive SBO protocol in Acute Care Surgery patients and to evaluate the impact of the new protocol on LOS, rate of resolution of SBO with non-operative management, time to operation, rate of complications, rate of small bowel resection (SBR), rate of small bowel ischemia, and rate of readmission within 30 days utilizing the low-osmolar contrast Omnipaque. We hypothesized that the new protocol would be completed in 75% of patients, that the LOS and time to operation would decrease, the rate of SBO resolution with non-operative management would increase, and the rate of readmission within 30 days, the rate of SBR, and the rate of complications in operative patients would remain unchanged.

Methods

A prospective cohort of patients after the implementation of our institution's Adhesive SBO Protocol was compared to a historical cohort of patients prior to implementation of the protocol. All patients admitted to the Acute Care Surgery service were evaluated for both inclusion and exclusion criteria. The historical cohort included patients admitted from January 1, 2012 until December 31, 2014. January 1, 2015 until June 30, 2015 was utilized as an implementation period for the new protocol, with no data collected during that time. During the implementation period there were no other protocols implemented, there were no changes to staff coverage of the service, and there were no other initiates introduced to reduce hospital length of stay. The prospective cohort included patients admitted from July 1, 2015 until January 31, 2017. All patients with a diagnosis of SBO were included, and all patients without a history of prior abdominal surgery were excluded. We used the low-osmolar agent Omnipaque because it is the only available water-soluble contrast at our institution. Low-osmolar agents have reduced risk of aspiration pneumonitis.

Data

An IRB-approved retrospective chart review was completed for both the historical and prospective cohorts. Data points collected included: medical record number, age, gender, admitting diagnosis, discharge diagnosis, co-morbidity conditions (current oral steroid use, active cancer, diabetes mellitus, hypertension, cardiac disease, congestive heart failure, current smoking, chronic obstructive pulmonary disease, end-stage renal disease, acute renal failure, and obesity), date and time of discharge, date and time of admission, time from admission to oral contrast order, time from admission to surgery, presence or absence of small bowel resection or ischemia, complications, presence of contrast in colon after 6 and 24 h (demonstrated on KUB), and readmission within 30 days.

Statistical analysis

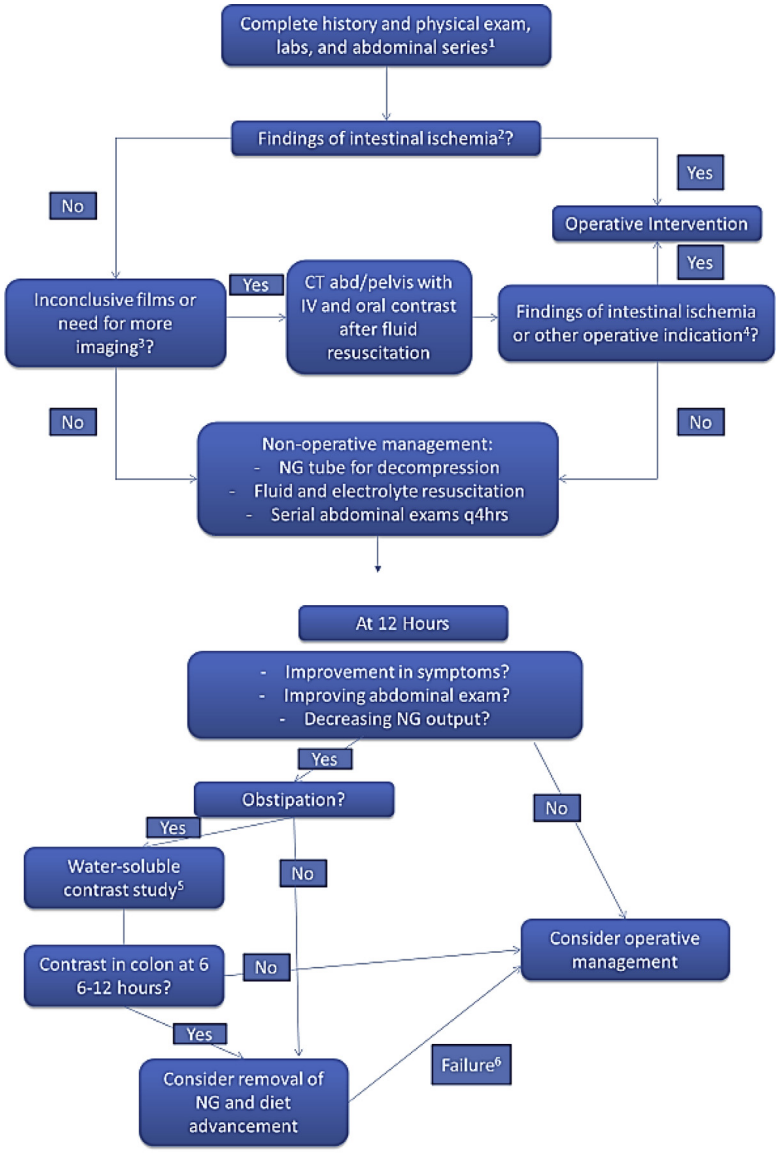
Protocol completion rate of the prospective cohort was determined by percentage of patients receiving water-soluble oral contrast. Patients in the prospective cohort that did not receive the Adhesive SBO protocol were not included in the univariate analyses. Univariate analyses were completed comparing the historical cohort to the protocol cohort for LOS, presence of surgery, time to operation, SBR rate in operative patients, small bowel ischemia rates in operative patients, and readmission within 30 days. A p-value of less than 0.05 was used to determine statistical significance.

Results

A total of 124 patients met the criteria for the historical cohort. 80 of those patients were female and 44 were male. The mean age was 62.52. A total of 117 patients met the criteria for the protocol cohort. 65 of those patients were female and 52 were male. The mean age was 59.87. There was no statistical difference between age ($p = 0.302$) or gender ($p = 0.158$) in the study (Table 1).

Implementation of the Adhesive SBO protocol was completed in 81.2% percent of patients. A 95% CI was used with a range of 74.1%–88.3%. There was no statistical significance for rate of implementation of the protocol ($p = 0.121$) in the study.

The mean LOS in the historical cohort was 6.34 days, with a median of 4.75 days. The mean LOS in the protocol cohort was 4.42, with a median of 2.75. There was a statistically significant decrease in LOS of 1.59 days ($p < 0.001$). The rate of readmission after 30 days for the historical cohort was 7.26%, compared to 11.97% of patients for the protocol cohort. This increase in rate of readmission by 4.71% was not statistically significant ($p = 0.214$). The number patients receiving operations in the historical cohort was 47 or 37.9%,



[1]Labs to include CBC with differential, basic chemistry panel, and serum lactate. Abdominal series should include an upright film, supine film, and a view of the diaphragms

[2]Findings suggestive of intestinal ischemia and absolute indications for operative management include peritonitis on exam, free intraperitoneal air on plain films, and/or irreducible hernia. Relative indications that are concerning though less specific include elevated lactate, fever, tachycardia, severe pain, focal tenderness, and leukocytosis > 15,000.

[3]Indications for CT scan include patient who meet some relative indications above but are not felt to necessitate urgent operative intervention, those with no history of abdominal surgery NOR any hernias noted on exam, and those whom abdominal series does not clearly make the diagnosis of small bowel obstruction

[4]CT findings predictive of intestinal ischemia and/or predictive of ultimately requiring operative intervention in SBO include free intraperitoneal fluid, mesenteric edema, poor or absent bowel wall enhancement, pneumatosis intestinalis, mesenteric/portal venous air, mesenteric vascular "whirl sign," bowel wall thickening, high-grade obstruction, and lack of fecalization of the small bowel

[5]Order 50 ml of Omnipaque to be given through NGT. Do not dilute. Order a KUB timed for 6 hours after the administration of the contrast. (Be sure to remove in the order the instructions to call radiology). If no contrast in the colon at 6 hours may repeat KUB in another 6 hours.

[6]Indications include persistent abdominal pain and/or distension, NG drainage volume >500cc/24hrs on hospital day #3, fever at 48-72 hours, WBC > 10,000, or any findings described in notes 2 and 4 above

Fig. 1. Adhesive SBO management protocol.

Table 1
Demographics for all patients.

Statistics	Historical Cohort	Protocol Cohort	P-value
Age			
	124	117	0.302
mean (stderr)	62.52 (1.35)	59.87 (1.45)	
median (IQR)	62.00 (53.50–72.50)	62.00 (51.00–69.00)	
Sex			
	124	117	0.156
Female	80 (64.52%)	65 (55.56%)	
Male	44 (35.48%)	52 (44.44%)	

compared to 15 patients receiving operations or 12.82%. This decrease in rate of operations by 25.08% was statistically significant ($p < 0.001$) in the study (Table 2-1).

The mean time to operation in the historical cohort was 1.89 days, with a median of 1 day. The mean time to operation in the protocol cohort was 2.95 days, with a median of 2.25 days. This increase in time to operation by 1.06 days was not statistically significant ($p = 0.113$) in the study (Table 2-2).

The number of complications in patients receiving surgery in the historical cohort was 8, or 17.02%. The number of complications in patients receiving surgery in the protocol cohort was 3, or 20%. This increase in complication rate of 2.98% was not statistically significant ($p = 0.793$). The number of SBR performed in the historical cohort was 15, or 31.91% of patients receiving surgery. The number of SBR performed in the protocol cohort was 2, or 13.33% of patients receiving surgery. This decreased rate of SBR by 18.58% was not statistically significant ($p = 0.160$) in the study (Table 3).

Discussion

Our findings aligned with our first hypothesis in that the new Adhesive SBO protocol using a low-osmolar water soluble contrast medium was completed in approximately 75% of patients (actual completion rate 81.2% with 95% CI ranging 74.1–88.3%). Our findings aligned with our second hypothesis in that the LOS decreased in patients receiving the Adhesive SBO protocol. The decrease in LOS by 1.59 days was statistically significant. Also, in alignment with our second hypothesis was the statistically significant decrease in rate of operations with the new protocol, a decrease of 25.08% of patients. This finding can be interpreted as more patients receiving the new adhesive SBO protocol had resolution of the SBO with non-operative management. Our findings differed in that the time to operation increased by 1.06 days, rate of readmission increased by 4.71%, rate of SBR decreased by 18.58%, and the rate of complications decreased by 2.98%, though these findings were not statistically significant.

Table 2-1
Hypothesis II (All Patients).

	Historical Cohort	Protocol Cohort	P-value
Length of Stay			
Non-missing	124	117	**<.001**
mean (stderr)	6.34 (0.48)	4.42 (0.42)	
median (IQR)	4.75 (3.25–7.63)	2.75 (1.75–5.50)	
Readmission within 30 days			
Non-missing	124	117	0.214
No	115 (92.74%)	103 (88.03%)	
Yes	9 (7.26%)	14 (11.97%)	
Surgery Received			
Non-missing	124	117	**<.001**
No	77 (62.10%)	102 (87.18%)	
Yes	47 (37.90%)	15 (12.82%)	

Table 2-2
Hypothesis II (Patients Who Received Surgery).

	Historical Cohort	Protocol Cohort	P-value
Time to Surgery			
Non-missing	47	15	0.113
mean (stderr)	1.89 (0.27)	2.95 (0.84)	
median (IQR)	1.00 (0.50–3.00)	2.25 (1.75–3.00)	

Based upon previous studies, a decreased LOS and a decreased number of operations with implementation of a protocol that included a WSCC was expected.[9] The findings met this expectation and were found to be statistically significant. Increased rates of readmission have also been described, as was the case in our study, though not significant.[9] Some unexpected findings include a decreased rate of complications in patients receiving surgery and a decreased rate of SBR, though these were not significant. Also unexpected was the increased time to operation, as the opposite was expected with the new protocol. A possible explanation is the theorized therapeutic effect of a WSCC, which could improve partial SBO and have no effect on complete obstructions or obstructions with more adhesions.[12] Overall, the new protocol led to few operations, shorter length of stay, few complications, few rates of SBR, and increased rate admissions and times to operation.

Limitations

This study was not without its limitations. The method of a retrospective chart review could have been improved with a prospective, randomized control trial of patients with two management groups: one receiving the new adhesive SBO protocol and one receiving traditional management. The longitudinal timeframe with historical data beginning in 2012 and the most recent protocol cohort from 2017 allows for the advancement of surgical techniques, which may have influenced the data. Finally, readmission in 30 days could have been skewed due to poor patient follow-up or readmission to different inaccessible hospital systems.

While we had a nearly 80% compliance rate of the protocol, it was not 100%. As with all protocols, it takes education, dissemination of information, and consistent follow through to get physicians, advanced practice providers, and nurses to standardize practice. To improve compliance over time we added the protocol to our policies and procedures website, monthly resident orientation, and presented it at the department of surgery grand rounds. However, our practice is at an academic medical center where we have resident physicians rotating through the service on a monthly basis. Therefore, re-education and communication needed to be completed frequently. Because of this rotation of providers, we were unable to get 100% compliance with the protocol.

Table 3
Hypothesis III (Patients Who Received Surgery).

Small Bowel Resection	Historical Cohort	Protocol Cohort	P-value
Complications			
Non-missing	47	15	0.793
No	39 (82.98%)	12 (80.00%)	
Yes	8 (17.02%)	3 (20.00%)	
Small Bowel Resection			
Non-missing	47	15	0.160
No	32 (68.09%)	13 (86.67%)	
Yes	15 (31.91%)	2 (13.33%)	

Conclusions

The new Adhesive SBO protocol was completed in most patients admitted to the Acute Care Surgery service with a diagnosis of SBO standardizing care utilizing an evidence-based protocol with low-osmolar water soluble contrast. This demonstrates good standardized management of patients with an adhesive SBO diagnosis at our institution. With continued use of this protocol, it is reasonable to expect increasing rates of protocol adherence over time. The value of the low-osmolar water soluble contrast protocol is obvious as it led to a statistically significant decreased number of operations and shorter length of stay for adhesive SBO patients. If implemented in other hospital systems, a required adhesive SBO protocol could lead to better patient management and care. Subsequent studies are needed to assess the outcomes after adhesive SBO protocol implementation at other institutions.

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Conflicts of interest

The Authors of this article have no conflicts of interest.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.amjsurg.2018.08.003.

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