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Using Gastrografin to manage adhesive small bowel obstruction: A nonrandomized controlled study with historical controls

Patients with adhesive small bowel obstruction who were treated with Gastrografin had a shorter hospital stay and were less likely to undergo surgical intervention than patients who did not receive the treatment.

ABSTRACT

Background: A standardized protocol for managing adhesive small bowel obstruction using diatrizoate meglumine and diatrizoate sodium (Gastrografin) was implemented at Vancouver General Hospital. Our study assessed whether this protocol improved the quality of patient care.

Methods: A nonrandomized controlled study was conducted. Two groups of patients were studied: a preimplementation group (historical control) and a postimplementation group that received the Gastrografin protocol. The primary outcome was length of hospital stay. Secondary outcomes included rate of successful conservative management, need for surgery, time to resolution of the obstruction, time to surgery, readmission to hospital, rate of complications or mortality, and patient satisfaction.

Results: The study included 122 patients (n = 82 preimplementation; n = 40 postimplementation). In the postimplementation group, length of hospital stay was shortened (adjusted mean difference: -3.209 days; 95% CI, -5.772 to -0.645; *P* = 0.015), successful conservative management was higher (odds ratio: 3.354; 95% CI, 1.129-12.600; *P* = 0.044), and need for surgery was lower (odds ratio: 0.237; 95% CI, 1.129-12.600; *P* = 0.034) compared with the preimplementation group. Patients in the postimplementation group were generally satisfied with their care.

Conclusions: The implementation of a standardized protocol using Gastrografin for managing adhesive small bowel obstruction was associated with improved quality of patient care.

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Background

Adhesive small bowel obstruction (ASBO) is one of the most common and significant complications after abdominal surgery,[1-5] with an incidence rate as high as 2.4%.[1] Adhesions are abnormal fibrous bands between organs and/or tissues that are normally separated. They are considered to be the pathological manifestation of peritoneal healing following surgery.[6,7] It is estimated that 93% of patients who undergo abdominal surgery will develop some postoperative adhesions.[8] In most cases, the adhesions do not translate into clinical symptoms; however, they can lead to serious complications, such as ASBO.

It is estimated that more than 300 000 emergency surgeries to treat ASBO are performed in the United States every year.[4] In the United Kingdom, small bowel obstruction is the indication for 37.3% of emergency laparotomies.[5] For patients who require hospital admission, the average hospital stay is 7 days, and the in-hospital mortality rate is 3%.[1] Small bowel obstruction also has a high recurrence rate.[9] Additionally, ASBO has been associated with a high financial burden. A study conducted in the Netherlands from 2013 to 2015 estimated the average cost of hospital admission and surgical treatment at €16 000.[10]

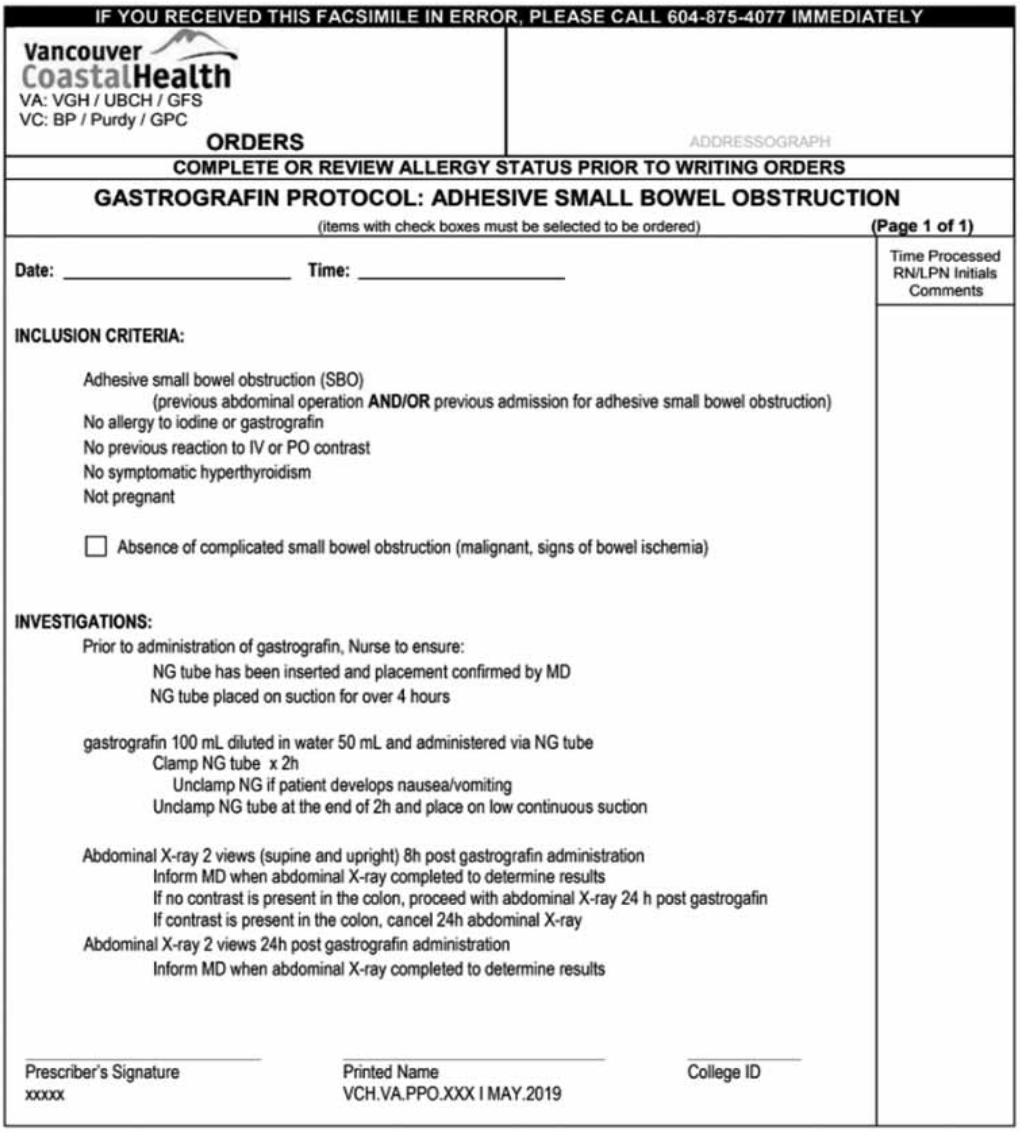
The management of ASBO remains a challenge. Peritonitis, strangulation, or bowel ischemia are the typical indications for urgent surgery.[11,12] The treatment of patients

depends on the clinical judgment of the surgeon[13] and typically consists of intravenous fluid rehydration, fasting, and nasogastric tube decompression.[13,14]

Diatrizoate meglumine and diatrizoate sodium (Gastrografin) is a water-soluble contrast agent that can be used for visualization by X-ray or CT scan, and thus serves an important diagnostic function. However, Gastrografin can be helpful as a therapeutic agent as well. Due to a strong osmotic effect, it causes a shift of water into the lumen of the bowel, thereby facilitating the passage of stool, reducing edema of the intestinal wall, and helping resolve intestinal obstruction.[15] This dual function has been proven in multiple studies, systematic reviews, and meta-analyses.[15-23] As a diagnostic agent, the appearance of Gastrografin on an abdominal radiograph within 24 hours of administration is highly predictive of nonoperative resolution of obstruction.[16] As a therapeutic agent, Gastrografin reduces the time to resolution of the obstruction[15,17,18,21,22] and reduces the need for surgery.[17,18,20,22-24] Furthermore, Gastrografin has been proven safe. It does not increase morbidity or mortality.[16-18]

The diagnostic and therapeutic value of Gastrografin shortens the length of hospital stay,[15-23] which in turn leads to improvements in hospital efficiency, health care utilization, quality of health care, and patient satisfaction. Standard use of Gastrografin in ASBO patients has resulted in a tenfold cost reduction in overall inpatient care.[19] As a result, since 2013, the World Society of Emergency Surgery has recommended the routine use of Gastrografin for the diagnosis of ASBO and as part of the nonoperative treatment.[13]

In June 2019, a standardized protocol using Gastrografin for the management of patients with ASBO was implemented at Vancouver General Hospital (VGH) **[Figure 1]**. The aim of our study was to determine whether this protocol has improved the quality of patient care. Improved quality of care has been defined as shortened length of hospital stay, increased rate of successful conservative management, reduced need for surgery, shortened time to resolution of the obstruction, shortened time to surgery, reduced surgical complications, and patient satisfaction.



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ORDERS

ADDRESSOGRAPH

COMPLETE OR REVIEW ALLERGY STATUS PRIOR TO WRITING ORDERS

GASTROGRAFIN PROTOCOL: ADHESIVE SMALL BOWEL OBSTRUCTION

(items with check boxes must be selected to be ordered) (Page 1 of 1)

Time Processed
RN/LPN Initials
Comments

Date: _____ Time: _____

INCLUSION CRITERIA:

Adhesive small bowel obstruction (SBO)
(previous abdominal operation **AND/OR** previous admission for adhesive small bowel obstruction)
No allergy to iodine or gastrografin
No previous reaction to IV or PO contrast
No symptomatic hyperthyroidism
Not pregnant

☐ Absence of complicated small bowel obstruction (malignant, signs of bowel ischemia)

INVESTIGATIONS:

Prior to administration of gastrografin, Nurse to ensure:
NG tube has been inserted and placement confirmed by MD
NG tube placed on suction for over 4 hours

gastrografin 100 mL diluted in water 50 mL and administered via NG tube
Clamp NG tube x 2h
Unclamp NG if patient develops nausea/vomiting
Unclamp NG tube at the end of 2h and place on low continuous suction

Abdominal X-ray 2 views (supine and upright) 8h post gastrografin administration
Inform MD when abdominal X-ray completed to determine results
If no contrast is present in the colon, proceed with abdominal X-ray 24 h post gastrogafin
If contrast is present in the colon, cancel 24h abdominal X-ray
Abdominal X-ray 2 views 24h post gastrografin administration
Inform MD when abdominal X-ray completed to determine results

Prescriber's Signature
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Printed Name
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College ID

FIGURE 1. Gastrografin protocol for adhesive small bowel obstruction.

Methods

We conducted a single-centre, observational, nonrandomized controlled study with historical controls. The study was approved by the University of British Columbia Clinical Research Ethics Board and the Vancouver Coastal Health Research Institute. Two groups were studied: a retrospective preimplementation group (i.e., prior to implementation of the protocol) and a prospective postimplementation group managed with the standardized protocol. The preimplementation group was used as the historical control.

We included patients 18 years of age or older who had a primary diagnosis of ASBO. This was defined as adhesions being the most likely cause of obstruction based on the final CT scan report by the attending radiologist. Patients admitted to general surgery from November 2017 until October 2018 were included in the preimplementation group; those admitted from July 2019 until November 2019 were included in the postimplementation group.

We excluded patients who were in need of immediate surgery (peritonitis, strangulation, bowel ischemia, and closed-loop obstruction) based on clinical signs and CT scans. We also excluded those who were treated with surgery initially without a trial of conservative

management. Patients with possible causes of a small bowel obstruction other than adhesions seen on CT were also excluded.

For the preimplementation group, management was dependent on the clinical judgment of the surgical team on call. In the postimplementation group, the Gastrografin protocol for ASBO was followed if the patient met the inclusion criteria.

Patient data were collected prospectively and were de-identified and stored in password-protected and encrypted computers. Baseline characteristics consisted of age, gender, and Charlson Comorbidity Index (CCI). We calculated the CCI value for each patient to categorize comorbidities. This is a combined age–comorbidity index that estimates 10-year survival.[25] The primary outcome measured was length of hospital stay, defined as the number of days from the patient's admission date to their discharge date. The secondary outcome measures were rate of successful conservative management; need for surgery; time to resolution of the obstruction; time to surgery; readmission to hospital; rate of surgical complications, aspiration, or mortality; and patient satisfaction. Multivariate linear regression models were created to estimate the mean difference in continuous variables between the two groups, while adjusting for age, gender, and CCI. The effect measure applies additively as an adjusted mean difference. Multivariate logistic regression models were created to estimate the multiplicative odds ratios of the categorical variables, while adjusting for age, gender, and CCI. Statistical significance was defined as a P value < 0.05. Although the models were all multivariate, only the results pertaining to the effect of postimplementation or preimplementation group were selected. We used RStudio and Microsoft Excel for our analyses.

To gather feedback prospectively on the quality of care patients in the postimplementation group received during their stay in hospital for ASBO treatment, the validated Canadian Patient Experiences Survey on inpatient care was used.[26] The patients completed the survey on paper prior to discharge or over the phone after discharge. Ethical consent was obtained prior to administering the survey.

Results

The study included 122 patients: 82 in the preimplementation group and 40 in the postimplementation group. The mean (SD) age was 68 (16) years, and 59.0% of the patients were female. There were no statistical differences in the baseline characteristics between the two groups.

Overall, the postimplementation group had a significantly shorter mean length of hospital stay than the preimplementation group (4.15 days versus 7.22 days; P = 0.007).

Primary outcome

Overall, the postimplementation group had a significantly shorter mean length of hospital stay than the preimplementation group (4.15 days versus 7.22 days; P = 0.007). The result remained significant after adjusting for age, gender, and CCI: length of stay of patients in the postimplementation group was on average 3.21 days shorter than that of patients in the preimplementation group (95% CI, -5.722 to -0.645; P = 0.015).

Secondary outcomes

Successful conservative management

More patients were treated successfully with conservative management in the postimplementation group than in the preimplementation group, but the difference was not statistically significant (90.0% versus 74.7%; P = 0.083). However, after adjusting for age, gender, and CCI, patients in the postimplementation group had significantly higher odds of being treated successfully with conservative management compared to patients in the preimplementation group (odds ratio: 3.354; 95% CI, 1.129-12.600; P = 0.044).

Need for surgery

Fewer patients in the postimplementation group required surgery compared to patients in the preimplementation group, but the difference was not statistically significant (7.5% versus 22.9%; P = 0.066). However, after adjusting for age, gender, and CCI, patients in the postimplementation group had significantly lower odds of needing surgery compared to patients in the preimplementation group (odds ratio: 0.237; 95% CI, 1.129-12.600; P = 0.034).

Time to resolution of the obstruction

The mean time from admission to resolution of the obstruction was significantly shortened for patients in the postimplementation group who were treated successfully with conservative management (1.74 days versus 2.77 days; P = 0.019). However, the difference was not significant after adjusting for age, gender, and CCI (adjusted mean difference: -1.059; 95% CI, -2.164 to -0.919; P = 0.06).

Time to surgery

There was no statistically significant difference in time to surgery between the two groups (3.17 days versus 3.66 days; P = 0.688). This persisted after adjusting for age, gender, and CCI (adjusted mean difference: -0.104 days; 95% CI, -4.547-0.910; P = 0.961).

Readmission to hospital

Fewer patients in the postimplementation group than in the preimplementation group needed readmission to hospital within 30 days of initial discharge, but the difference was not statistically significant (3.1% versus 10.1%; P = 0.433). There also was no significant difference between the two groups in the odds of being readmitted (odds ratio: 0.320; 95% CI, 0.017-1.909; P = 0.295).

Complications and mortality

Overall, there were no statistically significant differences in the rate of surgical complications, aspiration, or mortality between the two groups. No patients in the postimplementation group suffered from aspiration events. In the adjusted analysis, the odds ratios were not statistically significant.

Patient satisfaction

In the postimplementation group, 52.5% of patients (n = 21) rated their overall experience

during their admission with a mean grade of 8.5 on a scale from 0 to 10, where 0 was the worst hospital experience possible and 10 was the best. The measure "hospital stay helpful" received a mean grade of 9.2 out of 10, where 0 was "not helped at all" and 10 was "helped completely." Patients generally found that they were treated with courtesy and respect by doctors, and that doctors listened carefully to them and explained things in a way they could understand. Seventy-five percent of the patients said they would recommend VGH to their friends and family **[Figure 2]**.

Discussion

Length of hospital stay was significantly different between our two study groups: patients who received Gastrografin were discharged home 3 days sooner than patients who did not. This could be partially attributed to the higher odds of patients in the postimplementation group receiving successful nonoperative management. Our finding is in line with results reported in the literature.[15-23] The most significant difference in length of hospital stay between a control group and study group treated with Gastrografin was recorded in an open-label randomized controlled trial by Di Saverio and colleagues (7.8 days versus 4.7 days, respectively; $P < 0.05$).[22] By contrast, Scotté and colleagues suggested that no benefit was gained from Gastrografin administration in patients with ASBO in terms of length of hospital stay and need for surgery.[27] However, the authors set a cutoff period of 48 hours for the decision to perform surgery, as opposed to the 72-hour period recommended by the World Society of Emergency Surgery.[13] We believe that the earlier cutoff point may have resulted in a higher rate of surgical management, which in turn could have resulted in an increased length of hospital stay in patients who received Gastrografin. Additionally, Scotté and colleagues did not use a standardized protocol for Gastrografin.

The reduced length of hospital stay in the postimplementation group in our study may also have been due to the shortened time to resolution: patients in the postimplementation group had their nasogastric tube removed 1 day earlier than those in the preimplementation group. However, this difference was not significant after adjusting for age, gender, and CCI, possibly because the sample size of the subgroup of patients who did not undergo surgery was small.

The level of satisfaction with the quality of health care received by patients with ASBO has not been studied extensively in the literature. We measured this by using the Canadian Patient Experiences Survey on inpatient care.[26] Previous studies that used similar surveys have shown that surgical patients had a significantly higher satisfaction rate than medical patients.[28] Our results could be useful as a baseline or control for future studies in quality improvement that use our tailored patient survey, with questions specifically related to the patients' condition in hospital and the treatment they received.

A major strength of our study is our demonstration of the value of using a protocol-based approach. To our knowledge, none of the published randomized controlled trials and systematic reviews on the use of Gastrografin had such a standardized protocol. Zielinski and colleagues conducted a prospective cohort study that compared the outcomes of patients managed on- and off-protocol using Gastrografin;[20] however, their protocol was optional and based on surgeon discretion. Another prospective cohort study by Weiss and colleagues also had a protocol, but it was initiated in only a portion of their patient population, not universally.[19] Long and colleagues conducted a more recent study that included a protocol using Gastrografin,[23] but the study was based on a retrospective review only.

Study limitations and recommendations

The sample size of our postimplementation group was small, mainly because of a time limitation in our data collection. This could explain why we did not find statistically significant differences between the two groups for all outcomes measured. Despite the limited sample size, our results are promising.

We recommend that a shared multi-institutional data registry be created so more data on more outcomes can be collected. Also, feedback about the protocol and its implementation should be gathered from the multidisciplinary surgical team so another survey can be developed and targeted toward the nursing staff.

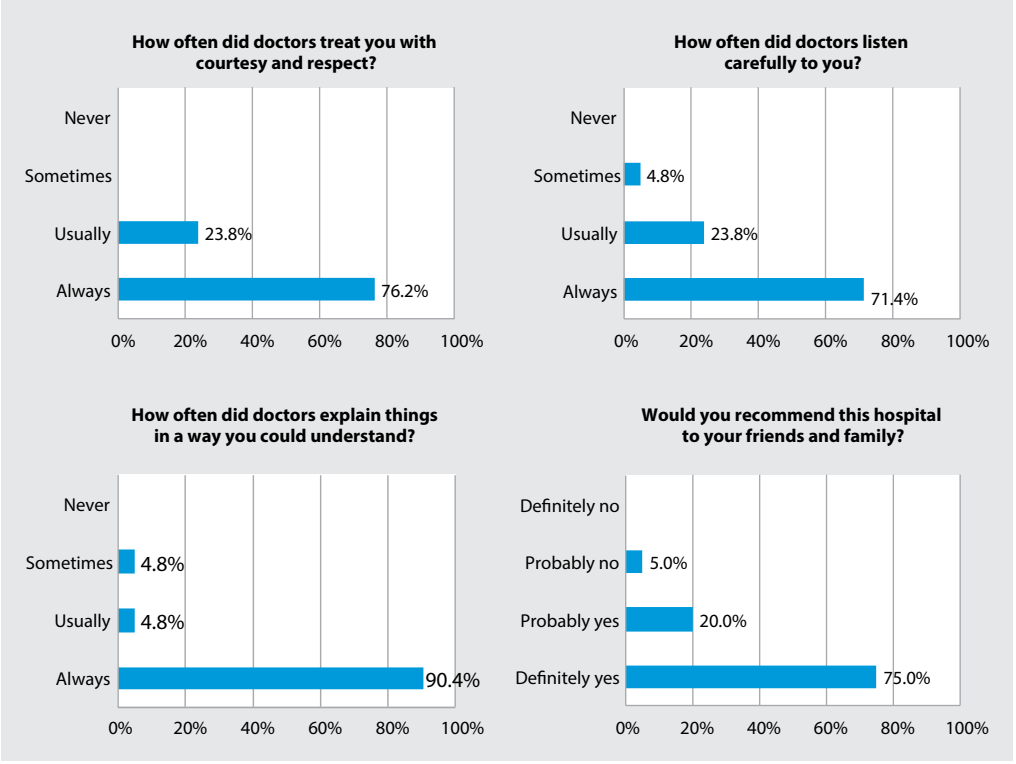

FIGURE 2. Patient satisfaction among the postimplementation group.[26]

Conclusions

An institutional standardized protocol using Gastrografin in the management of adhesive small bowel obstruction was associated with improved quality of patient care at Vancouver General Hospital. Most importantly, patients who received Gastrografin had a shorter hospital stay and were less likely to undergo surgical intervention. Patients were satisfied with the care they received. This study provided valuable benchmark data for further multi-institutional research. However, variability in the length of hospital stay, time to resolution of obstruction, and time to surgery should be further explored to identify the potential for improvement in patient care. ■

Competing interests

None declared.

Most importantly, patients who received Gastrografin had a shorter hospital stay and were less likely to undergo surgical intervention. Patients were satisfied with the care they received.

References

1. ten Broek RPG, Issa Y, van Santbrink EJP, et al. Burden of adhesions in abdominal and pelvic surgery: Systematic review and met-analysis. BMJ 2013;347:f5588.
2. Scott JW, Olufajo OA, Brat GA, et al. Use of national burden to define operative emergency general surgery. JAMA Surg 2016;151:e160480.
3. Sperry J, Cohen MJ. Acute obstruction. Surg Clin North Am 2014;94:77-96.
4. Scott FI, Osterman MT, Mahmoud NN, Lewis JD. Secular trends in small-bowel obstruction and adhesiolysis in the United States: 1988-2007. Am J Surg 2012; 204:315-320.
5. National Emergency Laparotomy Project Team. Fourth patient report of the National Emergency Laparotomy Audit (NELA). London: Royal College of Anaesthetists; 2018. Accessed 1 December 2020. www.hqip.org.uk/wp-content/uploads/2018/11/The-Fourth-Patient-Report-of-the-National-Emergency-Laparotomy-Audit-October-2018.pdf.
6. Vrijland WW, Jeekel J, van Geldorp HJ, et al. Abdominal adhesions: Intestinal obstruction, pain, and infertility. Surg Endosc 2003;17:1017-1022.
7. Duron J-J. Postoperative intraperitoneal adhesion pathophysiology. Colorectal Dis 2007;9 Suppl 2:14-24.
8. Menzies D, Ellis H. Intestinal obstruction from adhesions—how big is the problem? Ann R Coll Surg Engl 1990;72:60-63.
9. Foster NM, McGory ML, Zingmond DS, Yo, C. Small bowel obstruction: A population-based appraisal. J Am College Surg 2006;203:170-176.
10. Krielen P, van den Beukel BA, Stommel MWJ, et al. In-hospital costs of an admission for adhesive small bowel obstruction. World J Emerg Surg 2016;11:49.
11. Fevang BT, Jensen D, Svanes K, Viste A. Early operation or conservative management of patients with small bowel obstruction? Eur J Surg 2002;168:475-481.
12. Zielinski MD, Eiken PW, Bannon MP, et al. Small bowel obstruction—who needs an operation? A multivariate prediction model. World J Surg 2010;34:910-919.
13. ten Broek RPG, Krielen P, Di Saverio S, et al. Bologna guidelines for diagnosis and management of adhesive small bowel obstruction (ASBO): 2017 update of the evidence-based guidelines from the world society of emergency surgery ASBO working group. World J Emerg Surg 2018;13:24.
14. Köstenbauer J, Truskett PG. Current management of adhesive small bowel obstruction. ANZ J Surg 2018;88:1117-1122.
15. Assalia A, Schein M, Kopelman D, et al. Therapeutic effect of oral Gastrografin in adhesive, partial small-bowel obstruction: A prospective randomized trial. Surgery 1994;115:433-437.
16. Abbas SM, Bissett IP, Parry BR. Meta-analysis of oral water-soluble contrast agent in the management of adhesive small bowel obstruction. Br J Surg 2007;94:404-411.
17. Branco BC, Barmparas G, Schnüriger B, et al. Systematic review and meta-analysis of the diagnostic and therapeutic role of water-soluble contrast agent in adhesive small bowel obstruction. Br J Surg 2010;97:470-478.
18. Ceresoli M, Coccolini F, Catena F, et al. Water-soluble contrast agent in adhesive small bowel obstruction: A systematic review and meta-analysis of diagnostic and therapeutic value. Am J Surg 2016;211:1114-1125.
19. Weiss A, Sood D, Greenway SE, Tomassi M. Value of Gastrografin in adhesive small bowel obstruction. Langenbeck's Arch Surg 2017;402:1233-1239.
20. Zielinski MD, Haddad NN, Cullinane DC, et al. Multi-institutional, prospective, observational study comparing the Gastrografin challenge versus standard treatment in adhesive small bowel obstruction. J Trauma Acute Care Surg 2017;83:47-54.
21. Burge J, Abbas SM, Roadley G, et al. Randomized controlled trial of Gastrografin in adhesive small bowel obstruction. ANZ J Surg 2005;75:672-674.
22. Di Saverio S, Catena F, Ansaloni L, et al. Water-soluble contrast medium (Gastrografin) value in adhesive small intestine obstruction (ASIO): A prospective, randomized, controlled, clinical trial. World J Surg 2008; 32:2293-2304.
23. Long S, Emigh B, Wolf JS, et al. This too shall pass: Standardized Gastrografin protocol for partial small bowel obstruction. Am J Surg 2019;217:1016-1018.
24. Ishizuka M, Shibuya N, Takagi K, et al. Gastrografin reduces the need for additional surgery in postoperative small bowel obstruction patients without long tube insertion: A meta-analysis. Ann Gastroenterol Surg 2018;3:187-194.
25. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. J Clin Epidemiol 1994;47:1245-1251.
26. Canadian Institute for Health Information. Canadian patient experiences survey: Inpatient care procedure manual. Ottawa: CIHI; 2019. Accessed 1 December 2020. www.cihi.ca/sites/default/files/document/cpes-ic-procedure-manual-2019-en-web.pdf.
27. Scotté M, Mauvais F, Bubenheim M, et al. Use of water-soluble contrast medium (Gastrografin) does not decrease the need for operative intervention nor the duration of hospital stay in uncomplicated acute adhesive small bowel obstruction? A multicenter, randomized, clinical trial (Adhesive Small Bowel Obstruction Study) and systematic review. Surgery 2017;161:1315-1325.
28. Schmocker RK, Vang X, Cherney Stafford LM, et al. Involvement of a surgical service improves patient satisfaction in patients admitted with small bowel obstruction. Am J Surg 2015;210:252-257.