




Management and short-term outcomes of patients with small bowel obstruction in Denmark: a multicentre prospective cohort study

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Abstract

Aims The optimal management of small bowel obstruction (SBO) remains a matter of debate and treatment varies internationally. In Denmark, a more surgically aggressive strategy has traditionally been used, but to what extent patient outcomes differ from international reports is unknown. This study aimed to describe the current management and outcomes of patients admitted with SBO in Denmark.

Methods This was a prospective cohort study conducted at six acute hospitals in Denmark over a 4-month period. Patients aged ≥ 18 years with a clinical or radiological diagnosis of SBO were eligible. Primary outcomes were 30 day morbidity and mortality rates.

Results 316 patients were included during the study period. The median age was 72 years and 56% were female. Diagnosis was made by computed tomography (CT) in 313 patients (99.1%), with the remaining three diagnosed clinically. Non-operative management was the initial strategy in 152 patients (48.1%) and successful in 119 (78.3%). Urgent surgery was performed in the remaining 164 (51.9%), with a laparoscopic approach used in 84 patients (51.2%). The entire cohort had a 30 day mortality rate of 7.3% and a 30 day morbidity rate of 17.1%.

Conclusions The management of SBO in Denmark differs markedly to previous international reports, with an almost ubiquitous use of CT for diagnosis and a high proportion of patients undergoing urgent surgery. Despite higher rates of surgery, patient outcomes are broadly similar to reports of more conservative strategies, perhaps due to a reduction in delayed operations.

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Keywords Small bowel obstruction · Peri-operative outcomes · Emergency general surgery

Introduction

Small bowel obstruction (SBO) is a common surgical emergency, accounting for 15–20% of all acute general surgical admissions and is associated with a mortality rate of up to 10% [1–3]. However, far from being a single disease entity, the patient population presenting with SBO is diverse both in terms of their underlying aetiology, comorbidities and the severity of their clinical presentation, which presents challenges in determining the optimal management of this condition [4, 5]. The most critical decision to be made is between operative and non-operative management. In some cases, the decision is made for the clinician, with evidence of peritonitis, bowel ischaemia or perforation being examples of clear indications for acute surgical intervention [6]. However, when these signs are absent, as they are in the majority

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of patients with SBO, determining which course of action is best for each patient can be challenging.

Adhesions are the most common cause of SBO and, in the absence of the aforementioned indications for acute intervention, non-operative management has a success rate in excess of 70% [7, 8]. Given this high rate of success and the association of operative intervention with higher risks of short-term complications and death, current guidelines recommend a trial of non-operative management in stable patients [6, 9]. However, for the 30% of patients in whom non-operative management fails, the risks of death are higher still [10]. To further complicate matters, recent studies suggest that, in contrast to the old surgical dogma, operative treatment of SBO may actually reduce the incidence of further episodes in the future [11, 12]. As such, the clinician must choose between a non-operative strategy, which may allow surgery to be avoided altogether but risks more severe complications if it fails, and an operative strategy, which is associated with more short-term risks but potential long-term benefits.

Given these uncertainties, it is no surprise that variation in the management of SBO on national and international levels has been reported [13, 14]. Despite these variations, a non-operative approach remains the predominant strategy internationally, with between 70 and 80% of patients managed in this fashion [12, 13, 15]. However, in Denmark, an operative approach has traditionally been favoured, although there is limited data as to what proportion of patients are treated operatively and to what extent patient outcomes differ from those observed internationally. Whilst the National Acute Surgical Database provides national level data on survival outcomes in Denmark, these include all patients with acute abdominal presentations and are not stratified according to specific diagnoses [16].

The aims of this study were to describe the current management and short-term outcomes of patients with SBO in Denmark, to identify prognostic factors for complications and mortality, and to identify potential aspects of treatment which may be improved.

Methods

This was a multicentre prospective cohort study performed at six acute hospitals in Zealand, the most populous island in Denmark with approximately 2.3 million inhabitants. The study is reported according to STROBE guidelines [17]. Patients aged ≥ 18 years with a radiological or clinical diagnosis of SBO were eligible for inclusion. Patients admitted with SBO within 30 days of a previous abdominal operation were excluded. The original inclusion period was from 22/02/2021 to 21/05/2021 but was extended until 18/06/2021 due to lower than anticipated recruitment. This study was

registered on clinicaltrials.gov (NCT04750811) and the study protocol is provided in the supplementary material. Approval for the study was provided by the Danish Data Protection Agency (P-2021-70) and consent was obtained from all participating patients.

Clinicopathological data were retrieved from electronic patient records and entered in a pseudoanonymised format into a secure REDCap database housed by Region Hovedstaden, which was only accessible to the study team. Clinicopathological variables of interest included age, sex, American Society of Anesthesiologists (ASA) grade, performance status, Charlson comorbidity index (CCI), cause of SBO, type of patient (inpatient versus new admission), and inflammatory markers at the time of diagnosis. The mode of diagnosis was recorded as well as the use of radiological investigations and water-soluble contrast. Operative data included operative approach, conversion rates, operative duration, the number and type of iatrogenic injuries, as well as bowel resections and stoma formation. Patients were stratified into 3 groups for further analyses according to their treatment: operative, where the initial strategy was an urgent operation performed within 6 h of diagnosis; non-operative, where patients were successfully treated with a non-operative strategy; and failed non-operative, where a non-operative strategy was unsuccessful and patients then proceeded to surgery.

Follow-up was conducted in person during admission and using electronic patient records following patient discharge. All hospitals in Zealand use the same system for electronic patient records, allowing readmissions in any of the hospitals in this region to be identified. Furthermore, electronic patient records in Denmark are automatically updated in the case of a patient's death, allowing 30-day and 90-day mortality rates to be calculated with certainty. Data were checked for completeness by the principal investigator (HGS) and validated by the local investigators for each centre (TKJ, JJ, IL, LBJN, APS, MAT).

The primary study endpoints were 30-day morbidity and mortality rates. 30-day morbidity was defined as any complication with a Clavien–Dindo grade > 2 . Secondary endpoints included 90-day mortality rate, major complications (defined as unplanned high dependency/step down unit or intensive care unit (HDU/ICU) admission, 30-day morbidity $>$ Clavien Dindo grade 2 or 30-day mortality), the proportion of patients undergoing operative versus non-operative management and the success rate of non-operative management. Descriptive statistics comparing clinicopathological demographics between groups were performed using the Chi-square test for categorical data and the Kruskal–Wallis test for continuous data.

To identify prognostic factors for short- and medium-term adverse events, univariable and multivariable logistic regression analyses were performed. The outcomes for these

analyses were major complications (which as described above is a composite including the study's primary end-points) and 90-day mortality. The following factors were investigated for both outcomes and were chosen a priori: age, sex, ASA grade, performance status, CCI, patient type (inpatient versus new admission), aetiology, presence of acute kidney injury (AKI) on admission and treatment strategy (operative versus non-operative versus failed non-operative). The results of the logistic regression analyses are presented as odds ratios (OR) with 95% CI. All analyses were performed using SPSS version 25.0 (IBM, Armonk, New York, USA).

Results

Patient characteristics

A total of 319 patients were identified during the study period. Three patients were subsequently excluded as they did not meet the inclusion criteria, leaving a final cohort of 316 patients. No patients were lost to follow-up within 90-days. The median age of the entire cohort was 72 years (interquartile range (IQR) 57–79), 56% of patients were female and 87% were new admissions. Most patients had undergone at least one previous abdominal operation (77.8%, 246 patients) although the majority had no previous episodes of SBO requiring admittance to hospital (70.9%, 224 patients). Computed tomography scan was performed in 313 patients (99.1%), with the diagnosis of SBO made clinically in the remaining 3. No other radiological modalities were used in the primary diagnosis of SBO. Clinico-pathological demographics according to the initial treatment strategy are shown in Table 1. Histograms of the aetiology of SBO are shown in Fig. 1 with further details provided in Supplementary Table 1.

Urgent surgery

164 (51.9%) patients underwent urgent surgery. A laparoscopic approach was used in 84 of these patients (51.2%), with conversion to open surgery necessary in 42 (50%). There was no statistically significant difference in the number of previous operations performed in patients undergoing open versus laparoscopic surgery for SBO ($p=0.059$). However, patients in the laparoscopic group had a lower rate of previous open surgery ($p=0.006$, Fig. 2). When considering only those patients with adhesional SBO ($n=178$), a total of 77 patients (43.3%) underwent urgent surgery, with a laparoscopic approach used in 37 (48.1%) and a conversion rate of 43.2% (16 patients). Of these 77 patients, 42 had a single band adhesion (54.5%).

Iatrogenic injuries occurred in 44 patients (26.8%) (24 serosa lesions, 17 full thickness enterotomies, 3 lesions of other structures (1 bladder, 1 small bowel mesentery, 1 inferior epigastric vein) and were more common in patients undergoing open surgery than those in whom laparoscopy was attempted (40% versus 14.3%, $p<0.001$). Similarly, in those patients undergoing laparoscopy, iatrogenic injuries were more common in those requiring conversion to open surgery (26.2% versus 4.8%, $p=0.013$). However, no significant difference in the rates of bowel resections was noted between the open and laparoscopic groups (28.8% versus 28.6%, $p=0.980$).

A total of 16 patients in the operative group had malignant SBO, of whom five underwent stoma formation (31.3%) and four underwent an internal bypass (25.0%). Stomas were formed in a further five patients who had non-malignant SBO (3.4%). Despite radiological and clinical suspicion of SBO, no evidence of obstruction was found in six patients in the immediate surgery group who underwent diagnostic laparoscopy (3.7%).

Non-operative management

152 patients (48.1%) underwent an initially non-operative strategy. These patients were more likely to have undergone multiple previous operations when compared to those undergoing urgent surgery (Table 1). Water-soluble contrast was given to 138 patients (90.8%), with the decision to give water-soluble contrast made within 6 h of diagnosis in 124 (81.6%). Non-operative management was successful in 119 patients (78.3%), with one patient dying due to aspiration before resolution of SBO. Non-operative management was abandoned in the remaining 32 patients and most often within 24 h of the initiation of treatment (19/32, 59.4%). Non-operative management was abandoned after more than 72 h in 5 patients (15.6%). No significant difference in the proportion of patients receiving water-soluble contrast was noted between those undergoing successful versus unsuccessful non-operative management (90.8% versus 87.5%, $p=0.624$).

Patients in whom non-operative management was unsuccessful were more likely to have more severe comorbidities (as demonstrated by ASA grade, performance status and CCI), more likely to be inpatients and more likely to have a malignant cause of obstruction (Table 1). These patients were also more likely to undergo open surgery than patients selected to urgent operation (68.8% versus 48.8%, $p=0.039$) and had a longer median operative duration (122 versus 88 min, $p=0.012$) (Table 2). However, neither the rates of iatrogenic injuries nor bowel resections

Table 1 Clinicopathological demographics of patients with small bowel obstruction stratified according to the initial treatment strategy

	Treatment group			P value
	Non-operative	Operative	Failed non-operative	
Number of patients	120	164	32	–
Male: female	45:75	84:80	10:22	0.022
Median age in years (IQR)	67 (56–77)	73 (56–79)	74 (64–80)	0.062
ASA grade				
1	10 (8.3)	27 (16.5)	3 (9.4)	0.014
2	53 (44.2)	67 (40.9)	10 (31.3)	
3	55 (45.8)	59 (36.0)	14 (43.8)	
≥4	2 (1.7)	11 (6.7)	5 (15.6)	
Performance status missing				
0	54 (45.0)	81 (49.4)	11 (34.4)	0.008
1	24 (20.0)	49 (29.9)	8 (25.0)	
2	29 (24.2)	26 (15.9)	6 (18.8)	
≥3	12 (10.0)	7 (4.3)	7 (21.9)	
Missing	1 (0.8)	1 (0.6)	0 (0)	
Median CCI (IQR)	4 (2–6)	4 (2–5)	5 (3–7)	0.013
Patient type				
New	108 (90.0)	145 (88.4)	22 (68.8)	0.005
Inpatient	12 (10.0)	19 (11.6)	10 (31.3)	
Suspected perforation*	0 (0)	4 (2.4)	0 (0)	0.153
Suspected ischaemia*	0 (0)	29 (17.7)	1 (3.1)	<0.001
Signs of peritonitis	2 (1.7)	17 (10.4)	1 (3.1)	0.009
qSOFA ≥2	1 (0.8)	2 (1.2)	1 (3.1)	0.586
Median WCC (IQR)	10.3 (7.9–14.0)	9.8 (7.5–13.1)	11.4 (9.4–13.4)	0.175
Median CRP (IQR)	9 (4–38)	11 (4–47)	23 (6–38)	0.097
Median lactate (IQR)	1.1 (0.9–1.6)	1.2 (0.8–1.7)	1.3 (0.8–1.9)	0.809
AKI on admission [§]	16 (13.8)	40 (25.8)	9 (30.0)	0.030
Number of previous operations				
0	8 (6.7)	51 (31.1)	11 (34.4)	<0.001
1	33 (27.5)	56 (34.1)	6 (18.8)	
2	23 (19.2)	33 (20.1)	9 (28.1)	
≥3	56 (46.7)	24 (14.6)	6 (18.8)	
Number of previous SBO				
0	60 (50.0)	142 (86.6)	22 (68.8)	<0.001
1	19 (15.8)	11 (6.7)	7 (21.9)	
2	19 (15.8)	4 (2.4)	1 (3.1)	
≥3	22 (18.3)	7 (4.3)	2 (6.3)	

Numbers in parentheses refer to percentages unless otherwise stated

Bold represents statistically significant results

IQR interquartile range, ASA American Society of Anesthesiologists, CCI Charlson Comorbidity Index, qSOFA quick sequential organ failure assessment, WCC white cell count, CRP c-reactive protein, AKI acute kidney injury, SBO small bowel obstruction

*Suspected on computed tomography scanning

[§]Data missing for 4 patients in the non-operative group, 9 patients in the operative group and 2 patients in the failed non-operative group

were significantly higher in the failed non-operative group. Of note, four patients (12.5%) in the failed non-operative group were found to have closed loop obstructions. Each

of these patients had been diagnosed by CT scanning, with only one reported to have suspicion of a closed loop obstruction.

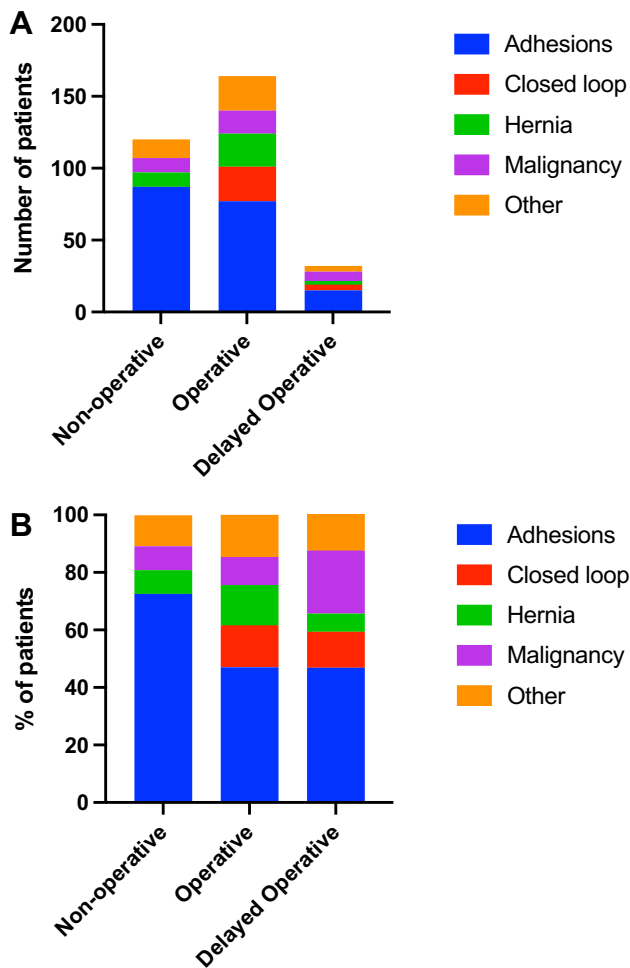


Fig. 1 Etiologies of small bowel obstruction stratified according to initial treatment strategy presented as **A** absolute numbers and **B** proportion of patients in each group

Morbidity and mortality

The overall mortality rate was 7.3% (23 patients) at 30 days and 12.3% (39 patients) at 90-days. The overall 30-day morbidity rate (Clavien–Dindo grade > 2) was 17.1% (54 patients). Morbidity and mortality rates stratified by treatment strategy are summarised in Table 3. Patients in the failed non-operative group had significantly higher rates of unplanned HDU/ICU admission, 30-day morbidity and 90-day mortality when compared with the other groups. The lowest rates of morbidity were seen in the non-operative group, which also had lower rates of medical complications than the other groups. Univariable (Supplementary Table 2) and multivariable analyses (Table 4) were performed to identify prognostic factors for major complications and 90-day mortality. ASA grade and performance status were both independently prognostic for major complications along with the presence of AKI on admission (OR 3.04

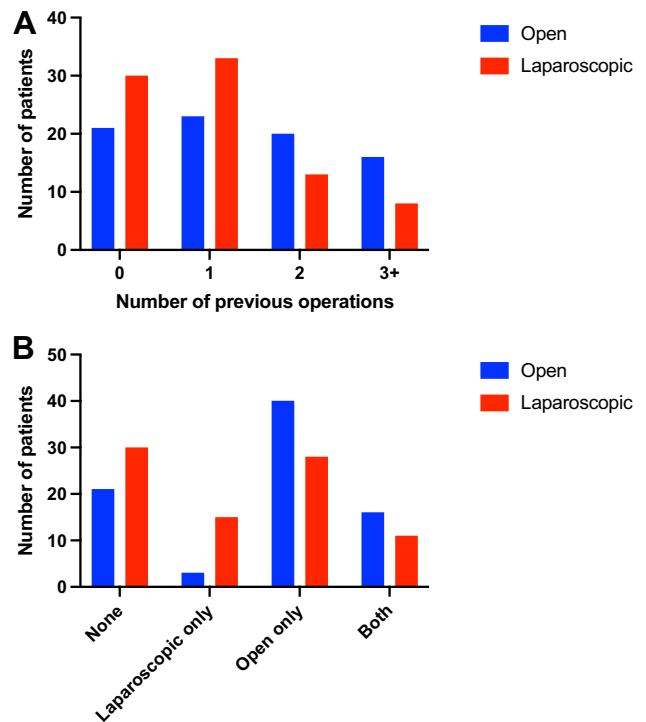


Fig. 2 The previous surgical history of patients undergoing urgent operations for small bowel obstruction. **A** The number of previous operations in those undergoing subsequent open or laparoscopic surgery for small bowel obstruction. **B** The type of previous operations in those undergoing subsequent open or laparoscopic surgery for small bowel obstruction

(1.40–6.66), $p=0.005$) and operative management (OR 3.69 (1.42–9.56), $p=0.007$). ASA grade was also prognostic for 90-day mortality along with a malignant cause for SBO (OR 6.88 (1.86–25.41), $p=0.004$).

Discussion

This study provides a snapshot of the current management of patients with SBO in Denmark and has identified several ways in which this differs from international trends. The most striking difference is in the proportion of patients undergoing urgent operation, which at 50% is substantially higher than reported rates from other nations. In the prospective NASBO study from the UK, less than 30% of patients underwent urgent operation, and even lower rates have been reported from retrospective studies including patients from USA, Canada, Italy, South Africa and Romania [13–15, 18]. Given that surgical management of SBO has previously been found to be associated with increased risks of short-term complications when compared with non-operative treatment, one may expect that a more aggressive surgical policy would be associated with increased peri-operative morbidity and

Table 2 Operative characteristics of patients undergoing immediate or delayed surgery for small bowel obstruction

	Treatment group		P value
	Operative	Failed non-operative	
Number of patients	164	32	–
Type of surgery			
Open	80 (48.8)	22 (68.8)	0.039
Laparoscopic	84 (51.2)	10 (31.2)	
Conversion to open (rate)	42 (50)	8 (80)	0.085
Iatrogenic injury			
No	120 (73.2)	22 (68.8)	0.609
Serosa lesion	24 (14.6)	7 (21.9)	0.534
Enterotomy	17 (10.4)	2 (6.3)	
Other organ	3 (1.8)	1 (3.1)	
Bowel resection	47 (28.7)	8 (25.0)	0.674
Indication for bowel resection			
Non-viable bowel	23 (48.9)	1 (12.5)	0.207
Malignancy	7 (14.9)	2 (25.0)	
Stenosis	6 (12.8)	1 (12.5)	
Iatrogenic	5 (10.6)	3 (37.5)	
Other	6 (12.8)	1 (12.5)	
Palliative stoma or bypass*	9/16	6/7	0.172
Stoma – other [§]	5 (3.4)	2 (8.0)	0.278
Operative duration	88 (49–125)	122 (81–151)	0.012

Numbers in parentheses refer to percentages unless otherwise stated

Bold represents statistically significant results

*Only including patients with malignant obstruction

[§]As a percentage of patients without malignant obstruction

mortality rates [13]. It is, therefore, of great interest to see that these outcomes in the current study are broadly comparable to those achieved with more conservative strategies. The NASBO study, which in contrast to the current study excluded patients treated with palliative intent, reported a 30-day mortality rate of 6.6% and a major complication rate of 14.4% [13]. Although mortality rates as low as 2% have been reported from other retrospective studies, direct comparisons are limited by the fact that these studies only included patients with adhesional SBO [14, 15, 18].

One possible explanation for the comparable short-term outcomes of the current study may be found in the proportion of patients who undergo urgent versus delayed operation. In the current study, delayed operations following unsuccessful non-operative management (failed non-operative group) accounted for less than 20% of the total number of patients undergoing operative treatment for SBO. In contrast, such delayed operations accounted for more than 40% of all operations performed in the NASBO study [13].

Corresponding differences were noted in the success rate of non-operative management, which at almost 80% in the current study is 10% higher than that observed in the NASBO study. Although operative management is far from necessary in all patients with SBO, it is clear that if an operation is needed, the best outcomes are achieved if it is performed early [10, 13, 14]. Although direct comparisons to other study cohorts should be made with caution, it may be that the more aggressive surgical strategy described in the current study captures more of those patients in whom non-operative management is likely to fail, which in turn reduces the number of patients undergoing delayed operations.

In addition to the high rate of immediate operations, the current study also identified widespread use of laparoscopic surgery in the management of SBO. Laparoscopy was attempted in more than half of the patients undergoing immediate operation, which is far above the rates reported in international observational studies and also represents an increase from a previous Danish study, in which laparoscopy was attempted in less than 15% of patients with SBO [13, 19, 20]. The role of laparoscopy in the management of SBO remains contentious, with some reports of increased rates of iatrogenic injuries when compared with open surgery [19]. However, in appropriately selected patients, potential benefits include shorter length of stay, reduced post-operative pain and reduced peri-operative morbidity [21, 22]. Indeed, in a recent randomised controlled trial comparing open and laparoscopic surgery in patients presumed to have a band adhesion, a laparoscopic approach was associated with fewer complications, a quicker recovery and a conversion rate of 25% [23]. Although the conversion rate in the current study was higher at 50%, patients in whom laparoscopy was attempted had a lower rate of iatrogenic injuries and a similar rate of bowel resections compared to those undergoing open surgery. As such, these results add to a body of the evidence suggesting that a laparoscopic approach is safe and beneficial in selected patients with SBO.

Another important finding of the current study is the almost ubiquitous use of timely CT scan in the diagnosis of SBO. This can be explained by the success and subsequent adoption of acute care bundles in Denmark for the management of patients with acute high-risk abdominal conditions [24]. Designed to improve the diagnosis and treatment of patients with perforated, ischaemic or obstructed bowels, these bundles have been shown to reduce 30-day mortality from these conditions from 20 to 15% [24]. A key component of these bundles is access to on-demand CT scans to be performed within 2 h of request. Not only was CT performed in almost all patients in the current study, but no other radiological modalities were used in diagnosis, demonstrating that these pathways are well integrated into everyday clinical practice. Patient selection is a major challenge in the management of SBO and early access to definitive

Table 3 Morbidity and mortality in patients with small bowel obstruction stratified according to treatment strategy

	Treatment group			P value
	Non-operative	Operative	Failed non-operative	
Number of patients	120	164	32	–
30-day morbidity				
Any	18 (15.0)	58 (35.4)	15 (46.9)	<0.001
CD > 2	10 (8.3)	36 (22.0)	8 (25.0)	0.005
Medical complications				
Any	13 (10.8)	33 (20.1)	11 (34.4)	0.005
Respiratory	5 (4.2)	9 (5.5)	2 (6.3)	0.262
UTI	1 (0.8)	2 (1.2)	1 (3.1)	
Thromboembolic	1 (0.8)	1 (0.6)	0 (0)	
Surgical complications				
Any	–	35 (21.3)	3 (9.4)	0.117
Anastomotic leak	–	3/40 (7.5)	0/5 (0)	0.526
Bleeding	–	6 (3.7)	0 (0)	0.588
Superficial SSI	–	4 (2.4)	1 (3.1)	
Deep SSI	–	5 (3.0)	1 (3.1)	
Superficial dehiscence	–	7 (4.3)	1 (3.1)	
Full dehiscence	–	9 (5.5)	0 (0)	
Re-admission with SBO	6 (5.0)	8 (4.9)	4 (12.5)	0.215
Unplanned HDU/ICU adm	2 (1.7)	15 (9.1)	4 (12.5)	0.016
30-day mortality	6 (5.0)	12 (7.3)	5 (15.6)	0.121
90-day mortality	11 (9.2)	18 (11.0)	10 (31.3)	0.003
Median length of stay (IQR)	3 (2–6)	6 (4–11)	9 (6–17)	<0.001

Numbers in parentheses refer to percentages unless otherwise stated

Bold represents statistically significant results

CD Clavien Dindo grade, UTI urinary tract infection, SSI surgical site infection, SBO small bowel obstruction, HDU high dependency unit, ICU intensive care unit, IQR interquartile range

cross-sectional imaging is an invaluable resource. Not only is CT scan capable of accurately identifying the cause of SBO, but it can also determine the presence/absence of strangulation, may be of use in predicting the likely success or failure of non-operative management and may help stratify suitable patients to a minimally invasive surgical approach [25–27].

The liberal use of CT scan may in part explain the higher rates of surgical intervention and lower rates of non-operative failure in the current study by allowing better stratification of patients at an earlier time point. However, it is more likely that the more surgically aggressive strategy described in the current study is due to differences in surgical dogma. ‘Never let the sun rise or set on a patient with small bowel obstruction’ was the historical mantra, when urgent operations in this patient group were more commonplace due to the fear of subsequent bowel ischaemia. Attitudes have since changed in many other nations, where the default approach is often non-operative management unless a clear indication for urgent surgery is present. However, in Denmark, the change in approach has not been so marked, with an urgent operation remaining the preferred treatment option

unless a clear contra-indication is present, for example a multi-operated patient without suspicion of bowel ischaemia or perforation.

A potential criticism of a more surgically aggressive strategy is that it may subject patients in whom non-operative management may have been successful to the risks of an operation that may have been avoidable. In keeping with previous studies, an urgent operation was an independent prognostic factor for major complications, alongside higher ASA grade, poorer performance status and the presence of AKI on admission [13–15]. Whilst these findings may appear to support this criticism, it should be noted that each of these factors may also be indicative of a more critically unwell patient, at risk of poorer outcomes regardless of their initial treatment strategy. However, it should also be noted that although the short-term outcomes of the whole cohort from the current study are similar to those achieved with more conservative strategies, the most relevant outcome to each patient is their own. It is impossible to say how many of the patients who underwent an urgent operation in the current study could have been successfully treated non-operatively. Similarly, it is unknown how many patients, who did not

Table 4 Multivariable analyses of prognostic factors for major complications and 90-day mortality in patients with small bowel obstruction

	Major complications		90-day mortality	
	OR (95% CI)	<i>P</i> value	OR (95% CI)	<i>P</i> value
Age	0.98 (0.95–1.01)	0.153	0.99 (0.95–1.03)	0.538
Sex	0.89 (0.44–1.80)	0.741	1.75 (0.67–4.54)	0.252
ASA				
1	0.03 (0.00–0.25)	0.001	0.20 (0.14–2.78)	0.230
2	0.05 (0.01–0.23)	< 0.001	0.05 (0.01–0.32)	0.002
3	0.10 (0.03–0.40)	0.001	0.23 (0.06–0.89)	0.033
4	Reference	–	Reference	–
Performance status				
0	0.16 (0.04–0.61)	0.008	0.16 (0.03–1.05)	0.056
1	0.38 (0.12–1.23)	0.108	0.61 (0.15–2.41)	0.477
2	0.34 (0.10–1.09)	0.069	0.42 (0.11–1.56)	0.196
3	Reference	–	Reference	–
CCI	0.96 (0.79–1.17)	0.658	1.19 (0.95–1.48)	0.134
Patient type				
New	Reference	–	Reference	–
Inpatient	1.91 (0.76–4.80)	0.167	0.94 (0.30–2.92)	0.915
Aetiology				
Adhesions	Reference	–	Reference	–
Closed loop	1.50 (0.42–5.43)	0.535	1.07 (0.18–6.37)	0.938
Hernia	1.23 (0.43–3.48)	0.703	0.85 (0.19–3.85)	0.836
Malignancy	0.93 (0.26–3.38)	0.913	6.88 (1.86–25.41)	0.004
Gallstone ileus	2.31 (0.34–15.65)	0.393	8.19 (0.98–68.63)	0.053
Other	0.85 (0.24–2.94)	0.794	0.65 (0.11–3.70)	0.626
AKI on admission	3.04 (1.40–6.66)	0.005	1.19 (0.43–3.27)	0.737
Treatment group				
Non-operative	Reference	–	Reference	–
Operative	3.69 (1.42–9.56)	0.007	1.26 (0.41–3.91)	0.691
Failed non-operative	3.08 (0.87–10.92)	0.081	2.90 (0.74–11.44)	0.128

Bold represents statistically significant results

ASA American society of anesthesiologists, CCI Charlson comorbidity index, AKI acute kidney injury

have a clear indication for urgent surgery, had a preference for one treatment strategy over the other. Future studies to investigate patient perspectives of the management of SBO would be of great interest.

Although treatment strategies for patients with SBO may vary, an international constant is the difficulty in choosing the right treatment at the right time for an extremely heterogeneous group of patients. The respective risks and benefits of operative and non-operative strategies differ between individual patients in both their likelihood and their relevance. Operative management would appear to reduce the risks of future recurrence of SBO, which may be of upmost relevance to a fit, young patient but of lesser importance to a frail, comorbid patient, who is at greater risk of post-operative complications [11]. Similarly, the risks of adhesiolysis increase with the number of previous operations and differ substantially between patients who have undergone multiple laparotomies and those presenting with their first

episode of SBO after previous laparoscopy [28]. In reality, the decision as to which strategy is best needs to be made on a case-by-case basis in light of the patient's own wishes, previous surgical history, comorbidities and the severity of their clinical presentation. However, standardisation of diagnostic pathways for patients with suspected SBO may allow this decision-making process to be optimised. The early and liberal use of CT for diagnosis, with standardised reporting of not only the presence or absence of indicators for immediate surgery but also of factors that may predict the success or failure of non-operative management, should be a key component in such pathways. By maximising the utility of the available diagnostic tools in this fashion, not only should it be possible to quickly and accurately identify those patients who are in need of urgent surgical intervention, but also to provide a more personalised estimation of the risks and benefits of conservative management in those who are not.

The authors recognise the limitations of this study. Whilst it was a multicentre study, it only represents hospitals from one region in Denmark and may not necessarily be representative of national practice. In addition, this study was conducted during the ongoing COVID-19 pandemic. The pandemic has made a global impact on healthcare and the practice observed during this time may not be fully representative of previous management patterns [29]. In addition to these limitations, it will be of interest to investigate the long-term impacts of the initial management of SBO in these patients. Long-term follow-up is planned for this patient cohort at 1-, 3- and 5-year time points where patterns of recurrence and mortality will be recorded, which will be of particular interest in the 224 patients who presented with their 1st episode of SBO during this study.

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Data availability Data-sharing requests will be considered by the DASBO trial steering committee upon written request to the corresponding author. If agreed, deidentified participant data will be made available, subject to a data-sharing agreement.

Declarations

Conflict of interest None of the authors have conflicts of interest to declare.

Ethical approval This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Danish Data Protection Agency (P-2021–70) and consent was obtained from all participating patients.

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