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Inter-hospital variation in management of patients with small bowel obstruction in Denmark

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ABSTRACT

INTRODUCTION. Inter-hospital variation in the management of small bowel obstruction (SBO) has been described in other countries, but the extent to which similar variations exist in Denmark remains unknown. This study aimed to compare the management of SBO between hospitals in Denmark and identify potential areas for improvement

METHODS. This was a multicentre prospective study performed at six emergency hospitals. Patients aged ≥ 18 years with a diagnosis of SBO were eligible for inclusion. The primary study endpoints were the proportion of patients undergoing operative versus non-operative management, laparoscopic surgery versus open surgery and the success rate of non-operative management.

RESULTS. A total of 316 patients were included. No differences were noted in diagnostic pathways or operative versus non-operative management. However, variations were noted in compliance with peri-operative care bundles, ranging from 63.2% to 95.8%. The surgical approach also varied, with the use of laparoscopic surgery ranging from 20.7% to 71.0% ($p < 0.001$). Variations were also noted in duration of surgery (63-124 minutes, $p < 0.001$), time to re-introduction of normal diet and length of hospital stay (3-8.5 days, $p < 0.001$). No differences were observed in 30-day or 90-day mortality rates.

CONCLUSION. The management of SBO in Denmark is relatively standardised. Future efforts should focus on improving adherence to multidisciplinary peri-operative protocols, optimising patient selection for laparoscopic surgery and standardising nutritional therapy.

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Small bowel obstruction (SBO) accounts for up to 20% of all acute general surgical admissions [1]. The severity of the clinical presentation of SBO varies from simple obstruction to strangulation, with a risk of ischaemia and perforation. Patients presenting with SBO are diverse both in terms of SBO aetiology and their comorbidities and previous surgical history. This diversity presents challenges in determining the best management for each patient, with the options being surgical intervention or a non-operative strategy.

Variations in the management of SBO have been reported. Studies from Canada and the United Kingdom found variations in the diagnostic pathways and treatment strategies between hospitals [2, 3]. In recent years, acute care bundles (ACBs) have been introduced for patients admitted with suspected abdominal emergencies, including, but not limited to, SBO [4]. These bundles aim to reduce surgical stress and return patients to their physiological baseline with the intended benefits of reducing peri-operative morbidity and mortality as well as the length of hospital stay [5].

Although ACBs are now well integrated into clinical practice in many Danish hospitals, whether the management of patients with SBO differs between hospitals remains unknown. This study aimed to compare the diagnostic pathways, treatment strategies and short-term outcomes of patients admitted with SBO in hospitals in eastern Denmark and to identify potential areas for improvement.

METHODS

This multicentre prospective study was conducted at six hospitals (four in the Capital Region of Denmark and two in Region Zealand). The hospitals in Region Zealand also receive patients with SBO from a satellite surgical department on alternate days once the diagnosis has been established locally. All hospitals in the study use ACBs for patients with suspected SBO [4].

The study was reported according to the STROBE guidelines [6]. 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 inclusion period ran from 22 February 2021 to 18 June 2021. Study approval was provided by the Danish Data Protection Agency and consent was obtained from all participating patients. The outcomes of this patient cohort have recently been reported [7]. The present study focuses on variations between individual centres.

Clinicopathological data were retrieved from electronic patient records and entered into RedCap in a pseudo-anonymised format. The initial treatment strategy was defined as urgent operation or non-operative management awaiting spontaneous resolution. Patients were stratified into groups for further analyses according to the admitting hospital. Follow-up was conducted during admission and using electronic patient records following discharge. Each hospital uses the same electronic patient records system (Epic), allowing readmissions in both regions to be identified. Data completeness was checked by the principal investigator and validated by the local investigators for each centre.

The primary study endpoints were the proportion of patients undergoing operative versus non-operative management, the proportion of patients undergoing laparoscopic surgery versus open surgery and the success rate of non-operative management at each centre. Secondary endpoints were differences in diagnostic pathways, nutritional management and peri-operative outcomes. Thirty-day morbidity was defined as any complication with a Clavien-Dindo grade > 2, and 30-day morbidity rate was defined as the number of patients experiencing at least one such complication.

Descriptive statistics were performed comparing clinicopathological demographics between groups. Continuous

data were reported by the median and interquartile range. The χ^2 test was used for comparisons of categorical data. The one-way analysis of variance (ANOVA) test or the Kruskal-Wallis test was used for comparisons of parametric or non-parametric continuous data. A posthoc Bonferroni correction was applied due to the number of comparisons performed, with statistical significance defined as p values < 0.001. All analyses were performed using SPSS version 25.0.

Trial registration: NCT04750811.

RESULTS

A total of 316 patients were included. No patients were lost to follow-up. Patient age varied between individual centres (median 64-75 years), although this was not statistically significant. Similarly, no statistically significant differences were found between individual centres regarding female/male ratio, comorbidity, previous surgical history and previous SBO episodes (**Supplementary Figure 1** a01230057.R2-supplementary.pdf (ugeskriftet.dk)). Adhesions were the most common cause of SBO at each centre. The severity of clinical presentation appeared similar between the various hospitals (**Table 1**). Almost all patients were diagnosed with a computed tomography (CT) scan (313 patients, 99.1%), with no variation in the use of diagnostic imaging noted between hospitals.

TABLE 1 Clinical characteristics of patients with small bowel obstruction.

	HGH	HVH	BFH	ZUH	NH	SH	p value
Time since last meal, n (%)							0.003
< 24 hrs	65 (68.4)	58 (95.1)	38 (76.0)	31 (66.0)	35 (92.1)	23 (92.0)	
24-48 hrs	12 (12.6)	3 (4.9)	4 (8.0)	8 (17.0)	0	1 (4.0)	
> 48 hrs	9 (9.5)	0	7 (14.0)	8 (17.0)	2 (5.3)	1 (4.0)	
Unknown	9 (9.5)	0	1 (2.0)	0	1 (2.6)	0	
AKI on admission, n (%)	19 (20.0)	11 (18.0)	11 (22.0)	11 (23.4)	8 (21.1)	5 (20.0)	0.979
WCC, mean (range), × 10^9/l	10.7 (0.9-26.8)	11.7 (4.2-27.2)	9.3 (0.3-24.0)	11.1 (2.0-21.9)	11.9 (0.5-30.3)	10.4 (0.4-21.9)	0.224
CRP concentration, median (IQR), mg/l	6.0 (4.0-25.0)	12.0 (3.4-47.5)	12.0 (2.5-43.5)	21.0 (2.9-56.0)	6.0 (3.0-29.0)	34.0 (5.2-71.5)	0.281
Lactate concentration, median (IQR), mmol/l	1.3 (1.1-2.0)	1.0 (0.6-1.7)	1.3 (0.8-1.7)	0.9 (0.7-1.6)	1.2 (0.8-1.5)	1.1 (0.7-2.1)	0.061
qSOFA ≥ 2, n (%)	2 (2.1)	0	0	1 (2.1)	1 (2.6)	0	0.681
Suspected perforation, n (%)[a]	1 (1.1)	2 (3.3)	1 (2.0)	0	0	0	0.610
Suspected ischaemia, n (%)[a]	12 (12.6)	4 (6.6)	7 (14.0)	5 (10.6)	0	0	0.065
Signs of peritonitis, n (%)	12 (12.6)	4 (6.6)	2 (4.0)	1 (2.1)	0	1 (4.0)	0.051
Aetiology, n (%)							0.053
Adhesions	55 (57.9)	38 (62.3)	24 (48.0)	26 (55.3)	24 (63.2)	11 (44.0)	
Closed loop	13 (13.7)	4 (6.6)	2 (4.0)	0	5 (13.2)	4 (16.0)	
Hernia	12 (12.6)	2 (3.3)	10 (20.0)	6 (12.8)	4 (10.5)	1 (4.0)	
Malignancy	6 (6.3)	9 (14.8)	5 (10.0)	6 (12.8)	2 (5.3)	5 (20.0)	
Other	9 (9.5)	8 (13.1)	9 (18.0)	8 (17.0)	3 (7.9)	4 (16.0)	

AKI = acute kidney injury; BFH = Bispebjerg and Frederiksberg Hospital; CRP = C-reactive protein; HGH = Herlev and Gentofte Hospital; HVH = Hvidovre Hospital; IQR = interquartile range; NH = North Zealand Hospital; qSOFA = quick sequential organ failure assessment; SH = Slagelse Hospital; WCC = white cell count; ZUH = Zealand University Hospital.
a) Based on CT appearances.

Acute care bundles

Most patients were initially managed using ACBs (248 patients, 78.4%). However, the use of ACBs was more common in patients undergoing urgent operations than in patients undergoing non-operative management (87.8% versus 67.8%, p < 0.001). Significant differences were also noted in the proportion of patients managed with ACBs at each centre (63.2-95.8%, p < 0.001, **Figure 1**A). Furthermore, variations were seen in the proportion of patients who received all of the key initial interventions in these protocols (CT, broad spectrum intravenous antibiotics, nasogastric tube, arterial blood gas, urinary catheter, Figure 1B). Further details on the completion of each of these interventions are shown in **Supplementary Figure 2** a01230057.R2-supplementary.pdf (ugeskriftet.dk). Although still present, less variation in the use of these protocols was seen in patients undergoing urgent operations when compared with those managed non-operatively (Figure 1C and D). Finally, despite these variations, no between-centre differences were noted in the time from CT diagnosis to operation in patients undergoing urgent surgery (Figure 1E).

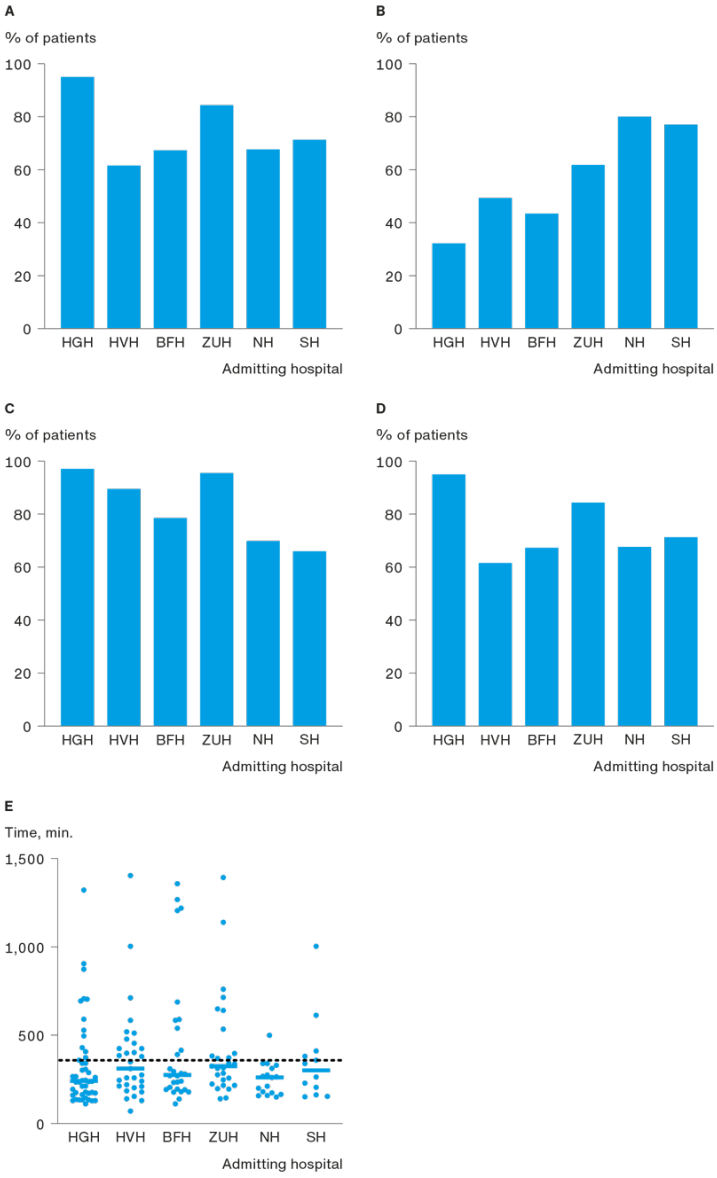

FIGURE 1 Adherence to multidisciplinary perioperative protocols in patients with small bowel obstruction. **A.** The proportion of patients initially managed with perioperative protocols at each centre. **B.** The proportion of patients in whom all initial key interventions were completed. **C.** The proportion of patients undergoing urgent operation who were managed with perioperative protocols at each centre. **D.** The proportion of patients treated non-operatively who were managed with perioperative protocols at each centre. **E.** The time from CT to start of surgery in patients undergoing urgent operation.

BFH = Bispebjerg and Frederiksberg Hospital; HGH = Herlev and Gentofte Hospital; HVH = Hvidovre Hospital; NH = Nordsjællands Hospital; SH = Slagelse Hospital; ZUH = Zealand University Hospital.
--- 6 hrs from CT diagnosis.

Treatment strategies

A total of 164 patients (51.9%) underwent urgent surgery, with 152 patients (48.1%) treated with an initial non-operative strategy. Statistically significant differences in the use of laparoscopic surgery between centres were noted (20.7-71.0%, $p < 0.001$). Similarly, significant differences in the median duration of surgery were noted (median 63-124 minutes, $p < 0.001$). Despite this, no corresponding differences were noted in conversion rates, iatrogenic injuries or bowel resections.

Most patients initially undergoing non-operative treatment received water-soluble contrast (WSC) (138 patients, 90.8%). However, significant differences were noted in the proportion of patients in whom the decision to give WSC was made within six hours of diagnosis (23.1-96.7%, p < 0.001). No significant between-centre variations were noted in the success rates of non-operative management (**Table 2**).

TABLE 2 Treatment and outcomes of patients admitted with small bowel obstruction.

	HGH	HVH	BFH	ZUH	NH	SH	p value
Urgent operation							
Patients, n (%)	48 (50.5)	31 (50.8)	29 (58.0)	27 (57.4)	17 (44.7)	12 (48.0)	-
Type of surgery:							< 0.001
Open, n_o (%)	19 (39.6)	9 (29.0)	23 (79.3)	18 (66.7)	6 (35.3)	5 (41.7)	
Initially laparoscopic, n_{li} (%)	29 (60.4)	22 (71.0)	6 (20.7)	9 (33.3)	11 (64.7)	7 (58.3)	
Conversion from laparoscopic to open, n_c (% of n_{li})	17 (58.6)	12 (54.5)	3 (50.0)	5 (55.6)	3 (27.3)	2 (28.6)	0.452
Iatrogenic injury, n (%)	12 (25.0)	7 (22.6)	13 (44.8)	8 (29.6)	3 (17.6)	1 (8.3)	0.152
Type of injury, n (%):							0.173
Serosa lesion	6 (12.5)	4 (12.9)	9 (31.0)	4 (14.8)	3 (17.6)	1 (8.3)	
Inadvertent enterotomy	6 (12.5)	3 (9.7)	3 (10.3)	2 (7.4)	0	0	
Other organ	0	0	1 (3.4)	2 (7.4)	0	0	
Bowel resection, n (%)	9 (18.8)	14 (45.2)	11 (37.9)	7 (25.9)	3 (17.6)	3 (25.0)	0.116
Operative duration, median (IQR), min.	72 (45-103)	96 (56-127)	124 (100-172)	73 (48-109)	63 (32-114)	114 (62-145)	< 0.001
Non-operative management, n (%)							
Patients	47 (51.6)	30 (49.2)	21 (42.0)	20 (42.6)	21 (55.3)	13 (52.0)	-
WSC given	44 (93.6)	29 (96.7)	18 (85.7)	18 (90.0)	19 (90.5)	10 (76.9)	0.376
Decision to give WSC < 6 hrs	44 (93.6)	29 (96.7)	13 (61.9)	16 (80.0)	19 (90.5)	3 (23.1)	< 0.001
Success rate	31 (66.0)	27 (90.0)	20 (95.2)	16 (80.0)	19 (90.5)	7 (53.8)	0.005
Abandonment within 24 hrs	11 (23.4)	2 (6.7)	0	4 (20.0)	3 (14.3)	0	0.044
Short-term outcomes							
30-day morbidity: CD > 2, n (%)	13 (13.7)	7 (11.5)	13 (26.0)	13 (27.7)	7 (18.4)	1 (4.0)	0.039
Unplanned HDU/ITU, n (%)	6 (6.3)	0	5 (10.0)	3 (6.4)	6 (15.8)	1 (4.0)	0.058
30-day mortality, n (%)	6 (6.3)	3 (4.9)	4 (8.0)	6 (12.8)	4 (10.5)	0	0.377
90-day mortality, n (%)	10 (10.5)	7 (11.5)	6 (12.0)	7 (14.9)	6 (15.8)	3 (12.0)	0.959
Length of stay, median (IQR), days	4.0 (2.0-7.0)	5.0 (3.0-8.5)	5.5 (3.0-17.0)	8.0 (4.0-18.0)	3.0 (2.0-7.8)	8.5 (4.3-12.8)	< 0.001

BFH = Bispebjerg and Frederiksberg Hospital; CD = Clavien-Dindo grade; HDU = high-dependency unit; HGH = Herlev and Gentofte Hospital; HVH = Hvidovre Hospital; IQR = interquartile range; ITU = intensive care unit; NH = North Zealand Hospital; SH = Slagelse Hospital; WSC = water-soluble contrast; ZUH = Zealand University Hospital.

Nutritional status and supplementation

Formal nutritional assessments were performed in 61 patients (19.3%); mostly after treatment had commenced (82.0%). No differences in the performance or timing of these assessments or in the use of parenteral nutrition were noted between centres (**Table 3**). Parenteral nutrition was often initiated after the start of treatment for SBO and was given for more than three days in most patients who received it. Interestingly, of the 47 patients who received parenteral nutrition, only 34 (72.3%) had undergone a formal nutritional assessment. The time from diagnosis to return to a full diet differed significantly between centres, with the proportion of patients fasting for more than five days after diagnosis ranging from 0.0% to 32.0% (p < 0.001).

TABLE 3 Nutritional status of patients admitted with small bowel obstruction.
The values are n (%).

	HGH	HVH	BFH	ZUH	NH	SH	p value
Patients	95	61	50	47	38	25	-
Formal nutritional assessment	21 (22.1)	14 (23.0)	7 (14.0)	11 (23.4)	7 (18.4)	1 (4.0)	0.288
Timing of nutritional assessment							0.570
At diagnosis	0	0	0	1 (9.1)	0	0	
Pre-therapy	6 (28.6)	2 (14.3)	1 (14.3)	1 (9.1)	0	0	
Post-therapy	15 (71.4)	12 (85.7)	6 (85.7)	9 (81.8)	7 (100)	1 (100)	
PN given	11 (11.6)	2 (3.3)	12 (24.0)	14 (29.8)	5 (13.2)	3 (12.0)	0.002
Timing of PN							0.600
Pre-therapy	3 (27.3)	0	1 (8.3)	3 (21.4)	0	1 (33.3)	
Post-therapy	8 (72.7)	2 (3.3)	11 (91.7)	11 (78.6)	5 (100)	2 (66.7)	
Duration of PN							0.218
< 48 hrs	0	0	0	3 (21.4)	1 (20.0)	0	
48-72 hrs	0	1 (50.0)	0	2 (14.3)	2 (40.0)	1 (33.3)	
> 72 hrs	11 (100)	1 (50.0)	12 (100)	9 (64.3)	2 (40.0)	2 (66.7)	
Time from diagnosis to enteral intake							< 0.001
< 24 hrs	22 (23.1)	35 (57.4)	8 (16.0)	12 (25.5)	9 (23.7)	7 (28.0)	
24-48 hrs	27 (28.4)	23 (37.7)	13 (23.0)	11 (23.4)	13 (34.2)	5 (20.0)	
48-72 hrs	12 (12.6)	2 (3.3)	9 (18.0)	9 (19.1)	8 (21.1)	3 (12.0)	
72-96 hrs	9 (9.5)	1 (1.6)	4 (8.0)	1 (2.1)	2 (5.3)	4 (16.0)	
> 96 hrs	23 (24.2)	0	16 (32.0)	12 (25.5)	4 (10.5)	6 (24.0)	
Unknown	2 (0.2)	0	0	2 (4.3)	2 (5.3)	0	

BFH = Bispebjerg and Frederiksberg Hospital; HGH = Copenhagen University Hospital Herlev and Gentofte; HVH = Hvidovre Hospital; NH = North Zealand Hospital; PN = parenteral nutrition; SH = Slagelse Hospital; ZUH = Zealand University Hospital.

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). No significant differences were noted in the 30-day or 90-day mortality rates between individual centres; and while greater variations were seen in 30-day morbidity rates and the number of unplanned high dependency/intensive care unit admissions, these were also not statistically significant. However, significant differences were noted in the length of stay (median 3-8.5 days, $p < 0.001$, Table 2).

DISCUSSION

Little variation was noted in the management of patients admitted to these different centres. Diagnostic pathways for patients with suspected SBO were particularly uniform, with CTs being the only imaging modality used. This contrasts to reports from other nations. In a study from the United Kingdom, almost 20% of patients with SBO underwent plain abdominal radiography as the only diagnostic imaging modality [3]. The value of a standardised diagnostic approach in managing this diverse patient group should not be underestimated. CT is not only capable of accurately identifying the cause of SBO but can also identify strangulated bowel, help stratify patients to minimally invasive surgical approaches and help predict the success of non-operative treatment [8-10].

Significant inter-centre variations were seen in the use and completion of ACBs in the initial management of patients with SBO, which may be a cause for concern. Interestingly, these differences did not seem to correlate with delays in surgical treatment or with morbidity and mortality outcomes. However, it should be noted that the present study did not include data regarding the intra- and post-operative components of these bundles; and, so, these associations, or lack thereof, should be interpreted with caution. Further focused studies regarding adherence to ACBs across different centres would be of interest, not only in patients with SBO but also in patients other abdominal emergencies.

Initial adherence to ACBs was particularly poor in patients with SBO who were managed non-operatively. Given that ACBs focus on optimising the management of patients undergoing major abdominal surgery, this may reflect selection bias introduced by the clinician, whereby ACBs are not activated in patients not thought to require or be able to tolerate surgery. Development of SBO-specific protocols, potentially within existing ACBs, may not only improve the rates of adherence but also standardise non-operative management of these patients.

Treatment strategies employed at each centre were also similar, with urgent operations being performed in most patients. Not only is the rate of urgent operations higher in Denmark than in other countries, but there also appears to be less variation in approaches between centres [2, 3, 11]. In a study from Canada, urgent operations were performed in < 15% of patients admitted with SBO, with rates of early surgical intervention ranging from 0% to 33% between centres 2. Interestingly, the same study also found evidence to suggest that hospitals with higher rates of early surgical intervention had lower rates of 30-day mortality. Given that other studies have demonstrated an association between early surgical intervention and reduced recurrence of adhesional SBO, it may well be that this approach has both short- and long-term benefits in appropriately selected patients [12, 13].

Significant variations were identified in the use of laparoscopic surgery between centres. It is beyond the scope of the present study to explain this variation with any certainty. Whilst there were no significant differences in aetiology or the severity of clinical presentation between centres, differences in surgical approach may reflect differences in the case mix at each hospital. It is possible that the thresholds for attempting laparoscopy vary between centres and further studies to identify which factors play a role in this decision-making process would be of interest. Laparoscopic surgery certainly has a role in patients with SBO and is associated with several benefits in appropriately selected patients, including reduced post-operative pain, reduced post-operative morbidity and a shorter length of stay [14-16]. The conversion rate from laparoscopic surgery in the present study was 50%; double that reported in other studies [16]. Whilst there was no difference in iatrogenic injuries or bowel resections between patients undergoing laparoscopic or open surgery, the high rate of conversion in the present study suggests that patient selection for a minimally invasive approach may be improved.

This study identified several other areas for potential improvement. Formal nutritional assessments were performed in less than 20% of patients included in this study, and the majority of assessments occurred after treatment had started. Significant variation in the time from diagnosis to the re-establishment of enteral nutrition was seen between hospitals; and a total of 61 patients (19.3%) in the present study went without enteral nutrition for at least five days. Patients with SBO are at high risk of malnutrition, which itself is associated with increased risks of morbidity and mortality [17, 18]. The findings highlight the need to standardise nutritional assessments and therapy in this patient group.

Differences were also noted in the timing of WSC in patients undergoing non-operative management. Current guidelines recommend that WSC is given at the start of a non-operative strategy to allow earlier identification of patients who will eventually require surgery [19]. Patients who undergo delayed operations are recognised to have poorer outcomes, with delays exceeding 72 hours being associated with an increased risk of 30-day mortality [20]. The study showed significant differences in length of stay, which ranged from a median of 3 to 8.5 days. The reasons for this are unclear and may be multifactorial.

The present study has several limitations. Whilst it was a multicentre study, it only represents hospitals from the eastern region of Denmark and may not necessarily be representative of current practice in the other Danish regions. Also, no power calculation was performed to ensure sufficient sample size. Finally, there was a risk of confounding by indication. This study was not randomised, and surgeons decided which patients should undergo urgent surgery or initially non-operative strategy according to their own clinical judgement.

CONCLUSION

The management of patients with SBO in eastern Denmark is relatively standardised. Although some variation in the adherence to ACBs was noted between centres, this was not accompanied by variations in short-term mortality. Potential areas for improvement include improving adherence to multidisciplinary peri-operative protocols, optimising patient selection for laparoscopic surgery and standardising nutritional assessments and therapy.

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