Postoperative ileus: in search of an international consensus on definition, diagnosis, and treatment

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Abstract

Purpose Postoperative ileus (POI) is a frequent complication after abdominal surgery; nonetheless, it remains poorly defined. Our aim was to achieve an international consensus among leading colorectal surgeons on definition, prevention, and treatment of POI.

Methods Thirty-five experts from five continents participated in a three-round Delphi process. Round 1 contained open-ended questions on POI and postoperative nausea and vomiting (PONV). Round 2 included closed-ended questions. Round 3 measured agreement on a 5-point Likert scale. Consensus was defined when items were rated as agree or strongly agree by at least 70 % of the experts.

Results Experts reached following consensus: POI is a temporary inhibition (86 %) of gastrointestinal motility after surgical intervention due to non-mechanical causes (89 %) and prevents sufficient oral intake (96 %). Abdominal distension/tenderness are the most relevant clinical signs (71 %). Nasogastric tube placement is not mandatory (78 %) but can be removed without previous clamping (81 %)/gastrointestinal contrast study (100 %). Preventive measures are recommended to decrease the risk of POI (96 %): narcotic sparing analgesia (89 %) and fluid optimization (74 %). Treatment of

POI should include stimulation of ambulation (96 %) and stop of opioids (74 %). Total parenteral nutrition is recommended from the 7th day without sufficient oral intake (81 %). There was no consensus on the ranking of POI's symptoms, on the imaging modality of choice for the diagnosis of POI, neither on the difference between POI and PONV.

Conclusions This Delphi study achieved consensus on the definition, relevant clinical signs, prevention, treatment, and supportive care of POI. Areas of non-consensus were identified (necessity and modality of radiologic imaging to establish the diagnosis, difference between POI and PONV), giving opportunity for further research.

Keywords Postoperative ileus · Ileus · Delphi method · PONV · Postoperative nausea and vomiting · Consensus

Introduction

The definition of postoperative ileus (POI) is heterogeneous and for this reason, its reported incidence, diagnostic algorithm, prevention and therapeutic measures underlie wide variation [1]. POI is often described as a pathologic pattern of gastrointestinal (GI) motility occurring after any type of major surgery, with increased length of stay [2]. Typical signs and symptoms are inability to tolerate oral diet, nausea, vomiting, absence of effective bowel movements, abdominal distention, and discomfort [3]. As a consequence, POI temporarily alters the quality of life and imposes a great economic burden to the health-care systems, with an estimated annual cost in the USA between \$0.75 and 1.5 billion [4, 5].

Due to its high prevalence and debilitating effect, and in the era of enhanced recovery, studies on etiology, risk factors, and treatment of POI are in the focus of medical literature. On the other hand, distinction between postoperative nausea and

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vomiting (PONV), a physiologic period of gastrointestinal dysmotility following abdominal surgery and POI varies arbitrarily among studies [6–8]. Consensual distinction or merging of those clinical entities according to precise criteria, such as their occurrence in the postoperative course or the hierarchy of their symptoms seems to be necessary. Homogenization of the definitions of these frequent postoperative complications would help to identify primary end-points for future prospective studies targeting the optimization of the management of patients presenting POI.

The aim of the present study was to achieve an international consensus among leading colorectal surgeons on the definition, prevention, and treatment of postoperative ileus using the Delphi method.

Material and methods

A three-round Web-based Delphi approach was used in this consensus process. The Delphi technique is an iterative process used to collect and distill the judgments of a group of experts to reach consensus on specific questions or issues [9]. Fiore et al. used the technique to define discharge criteria after colorectal surgery—their paper served as model for the design of the current study [10]. Delphi research involves completion of structured questionnaires interspersed with summary and feedback derived from previous responses [11]. Experts remain anonymous to each other during the process. Advantages of the Delphi over usual consensus methods are the (a) non-necessity of face-to-face meetings enabling the sharing of personal views without embarrassment and (b) the possibility to simultaneously survey experts from all around the world to find a consensus [12, 13]. The original Delphi method was developed in the 1950s for a US sponsored military project, and since, it has been widely used for similar studies in health care [14, 15] and surgery [16, 17].

Expert nomination and recruitment

Surgical program directors, chairmen of colorectal surgery departments, and academic surgeons with publications involving POI were identified using the 2013 Yearbook of the Fellow of the American Society of Colon and Rectal Surgeons, the European Society of Colorectal Surgeon member list and the Pubmed database. They were deemed as “experts.”

To ensure the international standpoint to this consensus, a panel of 35 experts with 10 experts from North and South America, 10 from Asia/Oceania, and 15 from Europe was targeted. A recruitment letter in English was sent via e-mail providing a brief outline of the project and its objectives. If invited experts did not respond to the invitation within 4 weeks, a reminder was sent out. Based on the same selection

criteria, further experts were invited if no answer came in the next 4 weeks or the expert declined to participate in the study. The recruitment process was continued until a total of 35 experts from the 3 geographic areas agreed to participate in the study. A positive response to the recruitment letter served as informed consent.

Delphi process

In all 3 rounds, questionnaires were sent by e-mail via secured web-link. A password-protected, Web-based interface was used for creating, publishing and analyzing surveys (SurveyMonkey®, Palo Alto, CA, USA). Before the start of the first round, the questionnaire was pilot tested among all ($n = 33$) physicians of the Department of Visceral Surgery of the University of Lausanne. Minor changes in structure and word use were made in response to their feedback. Experts were given 3 weeks to respond to each round. A reminder to complete the questionnaire was sent at 4 weeks and repeated three times by 3 weeks intervals. An interval of 6 weeks between rounds was used to summarize the data and develop the next questionnaire.

The round 1 questionnaire included ten open-ended questions (Table 1). Responses obtained in round 1 were summarized in a Microsoft Excel table. A qualitative thematic analysis was jointly performed by all authors of the study; similar patterns in the answers were simplified to keywords and grouped in separate columns. The round 2 consisted of closed-ended questions, such as yes/no questions, multiple choice questions, or ranking. Questions were grouped in sets, corresponding to each of the open-ended questions of round 1. Each question challenged the acceptance of an item/items mentioned by at least two experts in round 1. Room for comments was provided at the end of each set.

In the third and final round, structured results and comments obtained to round 2 questions was provided and experts were asked to rank their agreement on each item by the use of a 5-point Likert scale (1, strongly disagree; 2, disagree; 3, neither agree nor disagree; 4, agree; 5, strongly agree). They could change their own round 2 ranks in light of their colleagues' responses and arguments. Room for comments was again provided at the end of each set.

Data analyses

Data were analyzed by using descriptive statistics. Mean ranks, standard deviation, and percentage agreement obtained for each question was calculated with the use of the SurveyMonkey online interface and Microsoft Excel. Consensus was defined when at least 70 % of the experts in round 3 agreed or disagreed (i.e., they rated either 4 or 5 or 1 or 2 on the Likert scale, respectively) [18]. In round 3, the means of mean Likert scores per item per geographic region

Table 1 Round 1 questions and respective answers mentioned by at least two experts

How would you define postoperative ileus (POI)?	Lack of effective bowel movements, reference on timing, nausea/vomiting, no mechanical obstruction, necessity of an NG tube, prevents oral intake
Which elements of the clinical examination do you find relevant for the diagnosis of POI?	Abdominal distension, nausea/vomiting, pain, auscultation
Which features of the gastrointestinal transit would you consider relevant for the diagnosis of POI?	Absence of gas/stool, impaired food tolerance, nausea/vomiting, delay in normal bowel function
Which radiologic imaging technique do you use to establish the diagnosis of POI?	No radiologic exam, abdominal X-ray, abdominal X-ray + CT if needed, abdominal CT alone, water-soluble contrast agent
How would you specify postoperative nausea and vomiting (PONV)?	Nausea/vomiting, medication (anesthesia) induced, occurs in the first 24 h–48 h postoperatively
How do you differentiate PONV and POI?	Abdominal distension in POI, duration of PONV: 1 day, no bowel function impairment in PONV
What are your indications for the placement of a nasogastric (NG) tube in patients with POI?	Vomiting, vomiting more than twice, abdominal distension/discomfort
On which criteria do you rely to remove the nasogastric tube in patients with POI?	Gas/stool, amount/24 h less than 1000/500 ml, no abdominal distension, clamping test
Do your patients receive prophylactic medication to prevent POI? Which are those?	No, metoclopramid, ondansetron, dexamethasone, narcotic sparing analgesia, alvimopan
How do you treat POI? (Please explain in detail)	NG tube, wait and see, total parenteral nutrition, stop opioids, metoclopramid, neostigmine, mobilization, ondansetron

POI postoperative ileus, NG nasogastric, CT computed tomography, PONV postoperative nausea and vomiting

were compared by the Chi-square goodness-of-fit statistical test for independence.

Results

Expert recruitment

A total of 61 experts were initially invited, and finally, 35 experts (10 from the Americas, 10 from Asia/Oceania, and 15 from Europe) did agree to participate in the study (Fig. 1). Due to the high rate of non-responders and refusals, recruitment of the experts took more time than initially planned (4 months versus 1 month). All experts were able to communicate effectively in English. The rate of included experts completing each round was 69 % ($n = 24$), 80 % ($n = 28$), and 80 % ($n = 28$) in the 1st, 2nd, and 3rd rounds, respectively.

Round 1

The thematic analysis of the responses obtained in round 1 identified items that were mentioned by at least two experts per question and are listed in Table 1.

Round 2

The round 2 questionnaire was based on the answers obtained in round 1. The answers are presented in [Online resource 1](#)

and were used to create the round 3 questionnaire. Most relevant comments were: POI is a transient inhibition of GI motility in response to surgical trauma and resolves without surgical intervention; bowel sounds are irrelevant in the diagnosis of POI; POI is a subset of PONV; PONV is part of POI;

Fig. 1 Consort flowchart of experts' recruitment and participation

exacerbating factors for PONV are opioid analgesics, intraperitoneal surgery, degree of bowel manipulation, and hypokalemia; appearance of bowel sounds and feeling of hunger pains is an indication of nasogastric (NG) tube removal.

Round 3

The questions and answers are presented in Fig. 2 and Online resource 2. Consensus was obtained in 20 items from a total of 57 (35 %). The definition, diagnosis, and treatment of POI in light of the results of this consensus research are listed in Table 2. Most relevant comments were: an expected temporary ileus is physiologic after surgery; flatus may be present with small bowel ileus; POI might recover earlier than the passage of gas/stool; POI is primarily a clinical diagnosis, investigations are indicated only if some complication is suspected; PONV is immediate and within hours of surgery; PONV is exacerbated by motion and frequently coincides with narcotic dose; NG tube is indicated for physical exam of gastric distention, abdominal distention, intractable nausea, vomiting one to two times; the use of laxatives is accepted but has never been studied; and antiemetic drugs do not treat POI. The means $\pm$ standard deviations of the mean Likert scores per item per geographic region were 3.09 ± 0.88 for America, 3.18 ± 0.66 for Asia/Oceania, and 3.28 ± 0.68 for Europe. There was no significant difference between mean rankings per item between America and Asia/Oceania ($p = 0.6$) and America and Europe ($p = 0.11$); however, differences in experts' rankings between Asia/Oceania and Europe was at the limit of statistical significance ($p = 0.049$).

Discussion

This Delphi study has provided partial consensus on the definition, prevention, and treatment of POI. The expert panel of leading colorectal surgeons from 5 continents, representing 23 countries agreed on the definition of POI, on its most relevant clinical signs and on key steps of preventive and therapeutic measures. Geographic localization did not seem to impede the consensus building process. Lack of consensus remained on the necessity and on the modality of radiologic imaging for the diagnosis of POI and on the difference between POI and PONV. The panel was rather well engaged in the Delphi process, reflected by the high response rates. In light of these factors, the consensual items gained from the Delphi process (Table 2) bear validity within the international academic surgical community.

Definition of POI

Experts agreed that POI prevents oral intake, that it occurs temporarily after a surgical intervention, and is due to non-mechanical causes. The most relevant clinical signs were abdominal distension and tenderness, and in third position, absence of normal bowel sounds. Experts did not differentiate POI and prolonged POI.

A systematic review on the definition of POI including 52 trials, found that the most frequently used criteria to establish the diagnosis of POI were the passage of flatus (83 %) and stool (79 %), ability to tolerate an oral diet (28 %), and presence of bowel sounds (13 %) [2]. Based on these findings and on a global survey, Vather et al. suggest the terminology “postoperative ileus” until the 3rd PO day when passage of flatus/stool and tolerance of an oral diet is not experienced.

Fig. 2 Percentage agreement/disagreement in round 3 (red line, threshold of consensus). **a** Definition of postoperative ileus. **b** Diagnosis of postoperative ileus. **c** Difference between postoperative

ileus and postoperative nausea and vomiting. **d** Indications for nasogastric tube placement and removal. **e** Prevention of postoperative ileus. **f** Treatment of postoperative ileus

Fig. 2 (continued)

From the 4th day they advocate to use “prolonged postoperative ileus” with the following specifics: nausea/vomiting, inability to tolerate an oral diet over last 24 h, absence of flatus over last 24 h, abdominal distention and radiologic confirmation.

Choice of imaging modality in the diagnosis of POI

Experts failed to reach consensus on the radiologic exam of choice and also on its necessity at all.

Abdominal X-ray, abdominal computed tomography (CT), gastrointestinal contrast studies, the combination of these and no imaging were all favored by some experts. According to the literature, any of these approaches is defensible [19]. A systematic review of 11 articles on POI found no single clinical manifestation to have a significant correlation with the decision to obtain X-ray films [20]. It states that abdominal CT is the most accurate modality to distinguish mechanical

bowel obstruction from POI, and water soluble-contrast agent study is reliable in the diagnosis of POI when clinical signs and abdominal X-ray are inconclusive.

Definition of postoperative vomiting and nausea

Experts did not reach consensus on the difference between POI and PONV.

The most often mentioned differentiating items were the onset, the abdominal distention, and the bowel movements. Some suggested that these two entities were the same; some said that POI was part of PONV or vice-versa. Based on the Society for Ambulatory Anesthesia 2014 consensus guidelines [21], PONV is not limited to the first 24 h after surgery. Its etiology is multi-factorial, including patient-related factors (female gender; younger age; non-smoker; history of PONV) and environmental factors (postoperative opioids; general anesthesia; emetogenic

Fig. 2 (continued)

Table 2 Consensus on the definition, diagnosis, prevention, and treatment of postoperative ileus

		Agreement (%)
The definition of POI	• Temporary inhibition of gastrointestinal motility after a surgical intervention	86
	• Due to non-mechanical causes	89
	• Prevents sufficient oral intake	96
The definition of PONV	• Can occur during the entire postoperative period	74
	• Exacerbated by opioid analgesics, intraperitoneal surgery, bowel manipulation and hypokalemia	85
	• Differentiation of PONV from POI is controversial	— ^a
Diagnosis of POI	• Most relevant clinical signs: (1) abdominal distension, (2) abdominal tenderness, (3) absence of normal bowel sounds	71
	• No consensus on the imaging modality of choice, neither on its necessity	— ^a
Indications of nasogastric tube placement and removal in POI	• Abdominal distension/discomfort and vomiting (no consensus on the main criterion)	60/48
	• NG tube can be removed without previous clamping or previous gastrointestinal contrast study	81
		100
Prevention of POI	• Preventive measures are recommended to decrease the risk of POI	96
	• Narcotic sparing analgesia	89
	• Fluid optimization	74
	• Dexamethasone and laxatives should not be used for POI prevention	70/81
Treatment of POI	• Stimulation of ambulation/mobilization	96
	• Stop of opioids	74
	• Nasogastric tube placement is not mandatory	78
	• Neostigmine should not be used	78
	• Total parenteral nutrition is recommended in POI from the 7th day without sufficient oral intake	81

POI postoperative ileus, NG nasogastric, PONV postoperative nausea and vomiting

^a No consensus

surgery: cholecystectomy, laparoscopy, gynecologic procedures). In this study, experts agreed that PONV can occur at any time during the postoperative period and is exacerbated by opioid analgesics, intraperitoneal surgery, bowel manipulation and hypokalemia. Gentle tissue handling by laparoscopic surgery is a valid preventive measure for POI, but has not been shown effective in PONV [22, 23]. Hypochloremic, hypokalemic, metabolic alkalosis on presentation was proved to correlate to the number of episodes of postoperative emesis only in infants diagnosed with pyloric stenosis [24]. Its significance in the general surgical population needs further analysis.

Prevention of POI

Consensus was obtained on the use of narcotic sparing analgesia and fluid optimization. Experts also agreed that dexamethasone and laxatives should not be used for the prevention of POI.

Experts agreed that preventive measures are necessary to decrease the risk of POI. Some experts suggested the use of ondansetron, metoclopramid, chewing gum and magnesium. Concerning the pathophysiology, an inflammatory response to surgical trauma is considered as the main trigger of POI – its severity correlated in several studies with the level of circulating cytokines [20]. Immunologic response to surgery deteriorates the barrier function of the gut, allowing bacterial dislocation, stimulates immunocytes to decompose the extra-cellular matrix and enhances inflammation via the activation of mechanosensitive ion channels in the bowel wall [25]. Opioids can cause nausea and POI by modulating the transmission of peripheral and central nervous systems, leading to the inhibition of gastric emptying and to non-propulsive contraction of the GI smooth muscles, predominantly via the μ -receptors [3]. The experts' opinion was in concordance with the recent guidelines and systematic reviews: the use of non-steroidal anti-inflammatory drugs and narcotic-sparing analgesia (for example, epidural

Table 3 List of experts

Name	Affiliation	Region
Nancy Baxter	Department of Surgery at St. Michael's Hospital, Toronto, Canada	America
George J. Chang	The University of Texas MD Anderson Cancer Center, Houston, Texas, USA	America
Conor Delaney	Department of Surgery, University Hospitals Case Medical Center, OH, USA	America
James Fleshman	Dept. of Surgery, Washington University Medical School in St. Louis, Missouri, USA	America
Andreas M. Kaiser	Division of Colorectal Surgery, University of South Carolina, South Carolina, USA	America
Hermann P. Kessler	Colorectal Surgery, Cleveland Clinic, Florida, USA	America
David W. Larson	Colon and Rectal Surgery, Mayo Clinic, Rochester, MN, USA	America
Rodrigo O. Perez	Colorectal Surgery, University of São Paulo, Sao Paulo, Brazil	America
Anthony J. Senagore	General Surgery, Central Michigan University, Michigan, USA	America
Eric Weiss	Colorectal Surgery, Cleveland Clinic, Florida, USA	America
Faris Al Aswad	General Surgery, NMC Specialty Hospital, Dubai, UAE	Asia/Oceania
Ian Bisset	Colorectal Surgery, University of Auckland, New Zealand	Asia/Oceania
Peter WG. Carne	Colorectal Surgery, Monash University, Victoria, Australia	Asia/Oceania
Ho-Kyung Chun	Dept. of Surgery, Sungkyunkwan University, Seoul, South Korea	Asia/Oceania
Sayandev Dasgupta	Dept. of Surgery, Woodlands Medical Centre, Kolkata, India	Asia/Oceania
Alexander Engel	Academic Surgery, University of Sydney, Australia	Asia/Oceania
Andrew G. Hill	Colorectal Surgery, University of Auckland, New Zealand	Asia/Oceania
Hannan Jafri	Pediatric Surgery, South Point Hospital, Chittagong, Bangladesh	Asia/Oceania
Wai-Lun Law	Division of Colorectal Surgery, The University of Hong Kong	Asia/Oceania
Sanjay Marwah	Dept. of Surgery, Postgraduate Inst. of Medical Sciences, Rohtak, India	Asia/Oceania
Wilhelm Bemelman	Dept. of Surgery, University of Amsterdam, The Netherlands	Europe
Paolo Delrio	Dept. of Surgical Science, University of Parma, Italy	Europe
Daniel Dindo	Dept. of Surgery, Stadtspital Triemli, Zürich, Switzerland	Europe
Eloy Espin	Dept. of Surgery, Universitat Autònoma de Barcelona, Spain	Europe
Alois Fürst	Dept. of Surgery, Caritas-Krankenhaus St. Josef, Regensburg, D	Europe
Ethem I. Gecim	Dept. of Surgery, Ankara University School of Medicine, Turkey	Europe
Søren Laurberg	Dept. of Surgical Gastroenterology, Aarhus University, Denmark	Europe
Olle Ljungqvist	Dept. of Surgery, Örebro University Hospital, Sweden	Europe
Yves Pannis	Dept. of Colorectal Surgery, Beaujon Hospital, Clichy, France	Europe
Stefan Post	Dept. of Surgery, University of Heidelberg, Mannheim, Germany	Europe
Harald Rosen	Dept. of Surgery, Danube Hospital-SMZ-Ost, Vienna, Austria	Europe
Emmanuel Tiret	Dept. of Surgery, Saint-Antoine Hospital, Paris, France	Europe
Petr Tsarkov	Dept. of Colorectal and Pelvic Floor Surgery, Russian Academy of Medical Sciences, Moscow	Europe
Arne Wibe	Dept. of Cancer Research, Norwegian University of Science and Technology, Trondheim, Norway	Europe
Des Winter	Dept. of Surgery, St Vincent's University Hospital, Dublin, Ireland	Europe

analgesia for open procedures) proved to reduce the time of bowel function recovery [26, 27]. As a cardinal point of prevention, physiologic research also supports the aim for “zero fluid balance” in the perioperative phase, to avoid intestinal edema and electrolytic disturbances, and as a consequence, gut dysfunction [28]. With regards to pharmacologic agents for the prevention of POI, a Cochrane Review investigated 15 prokinetic substances and found only one (alvimopan, a selective μ -receptor antagonist) with a reproducible clinical benefit [29]. Recent trials showed significantly faster bowel function recovery with magnesium and chewing gum use [30, 31].

Indications of nasogastric (NG) tube placement and removal

This study did not identify one main indication for NG tube placement in POI.

However, several acceptable indications were sustained by experts. Abdominal distension/tenderness and vomiting >500 ml were the most popular ones, while intractable nausea was also mentioned. Consensus was achieved on the non-necessity of clamping test and gastrointestinal contrast series before NG tube removal. Forty percent of the experts would remove NG tube when the patient feels hunger. There are no

published algorithms for NG tube placement and removal. Van Bree et al. performed a statistical analysis to evaluate the predictive value of different indicators in a prospective study where colonic transit was scintigraphically assessed from postoperative day 1 to 3 [32]. They concluded that tolerance of solid food and defecation, but not time to first flatus, best indicates recovery of GI transit.

Treatment of POI

The experts reached consensus on stimulation of ambulation, cessation of opioids and administration of parenteral nutrition from the 7th day without sufficient oral intake in patients with POI.

NG tube placement was not deemed mandatory; however, it is a basic measure to decompress the small bowel, to comfort the patient and to reduce the risk of bronchoaspiration. These measures are consistent with an evidence-based recommendation on the management of POI, published in 2013 [33]: ambulate regularly (Grade C); pain relief with paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs); Tramadol, opiates in reserve (Grade A); parenteral nutrition after 7 days (Grade A). Other therapeutic interventions failed to obtain consensus. Of note, 63 % of experts would not make any changes in the medication of patients presenting POI and would wait spontaneous recovery. Water-soluble contrast agents can be used as diagnostic tool and therapeutic attempt at the same [34], but only one third of experts supported their utility. Ondasentron, erythromycin and metoclopramid were mentioned by some experts, without achieving consensus—on the other hand, these products have never been proved to foster POI recovery [3]. Neostigmine is a parasympathomimetic drug that acts as a reversible acetylcholinesterase inhibitor. Some studies have shown modest effectiveness in treating acute colonic pseudo-obstruction, but the clinical usefulness of neostigmine in postoperative patients may be limited by adverse effects including abdominal cramps, excess salivation, vomiting, and bradycardia [35]. Experts in this study agreed that neostigmine is not to be used to alleviate POI. In the literature, various clinical end-points of POI have been used, making difficult to compare the efficacy of therapeutic interventions.

Strengths and limitations

The study has some limitations. First, we set the level of agreement for consensus at only 70 %. However, there is great variability among Delphi studies on the rule to determine consensus. Setting a percentage level of agreement between 51 and 80 % before the commencement of the study is an accepted practice [36, 37]. Secondly, we invited 35 colorectal surgeons as experts and therefore might have missed view-points of non-colorectal surgeons and/or anesthesiologists who are

also involved in the management of PONV and POI. The number of experts that represents an adequate sample in a Delphi study remains unknown. The quality of expert panel, rather than its size guarantees probably better representativeness. 35 experts from 5 continents provided a variety of opinions with international relevance. We realize, however, that the selection of the experts who were initially invited to participate ($n = 61$) was somewhat arbitrary and might be a source of bias. The main strengths of this study were diversity of nationalities in the panel, truly representing a world experience. The experts were active and engaged with the Delphi, reflecting their interest in the topic. The possibility of leaving comments at the end of each sub-topic was appreciated and used by experts. The comments to the 2nd round were included in the 3rd questions and happened to be subjected to consensus. The use of online interface was user-friendly and allowed real-time communication.

Implications and future research

This Delphi study confirms that recent evidence-based recommendations for the treatment of POI are widely supported by international experts. The consensual items of the study may guide decision-making in daily practice whereas the identified areas of controversy may be subject of future research. The study provides a practical definition of POI, suggests preventive measures and therapeutic steps for the general surgical population, including precise indication of parenteral nutrition or NG tube placement/removal. The concept of multimodal rehabilitation after surgery aims to shorten the postoperative recovery and hospital stay and to cut complication-related costs [38]. POI and PONV are among the most frequent complications following abdominal surgery: they prevent oral intake and ambulation and delay discharge.

Conclusion

This consensus research established a definition for POI and adopted measures to prevent, diagnose, and treat it. Accordingly, POI occurs temporarily after a surgical intervention due to non-mechanical causes and prevents sufficient oral intake. Prophylaxis should include narcotic sparing analgesia and fluid optimization; whereas treatment should rely on stimulation of ambulation and opioid withdrawal. The consensual definition may support further studies on POI by improving homogeneity among them and thus improving the quality of research in this field. The preventive and therapeutic measures obtained in this Delphi may guide clinicians in the establishment of multimodal caremaps and in the choice of therapeutic options for patients presenting with POI. This study may contribute to future observational cohort studies to validate these consensual findings. Areas of remaining controversy consist

of the difference of PONV and POI and the imaging modality of choice for POI (if necessary at all).

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Acquisition of data: D Gero, O Gié

Analysis and interpretation of data: D Gero, O Gié, M Hübner, D Hahnloser

Drafting of manuscript: D Gero, D Hahnloser

Critical revision of manuscript: O Gié, M Hübner, N Demartines, D Hahnloser

Compliance with ethical standards

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Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

- Wolthuis AM, Bislenghi G, Fieuws S, de Buck van Overstraeten A, Boeckxstaens G, D'Hoore A (2016) Incidence of prolonged postoperative ileus after colorectal surgery: a systematic review and meta-analysis. *Color Dis* 1:O1–O9
- Vather R, Trivedi S, Bissett I (2013) Defining postoperative ileus: results of a systematic review and global survey. *J Gastrointest Surg* 5:962–972
- Holte K, Kehlet H (2000) Postoperative ileus: a preventable event. *Br J Surg* 11:1480–1493
- Asgeirsson T, El-Badawi KI, Mahmood A, Barletta J, Luchtefeld M, Senagore AJ (2010) Postoperative ileus: it costs more than you expect. *J Am Coll Surg* 2:228–233
- Vather R, O'Grady G, Bissett IP, Dinning PG (2014) Postoperative ileus: mechanisms and future directions for research. *Clin Exp Pharmacol Physiol* 5:358–370
- Lee SY, Park KJ, Ryoo SB, HK O, Choe EK, Heo SC (2014) Early postoperative small bowel obstruction is an independent risk factor for subsequent adhesive small bowel obstruction in patients undergoing open colectomy. *World J Surg* 11:3007–3014
- Doorly MG, Senagore AJ (2012) Pathogenesis and clinical and economic consequences of postoperative ileus. *Surg Clin North Am* 2:259–272
- Kranke P, Thompson JP, Dalby PL, et al. (2015) Comparison of vestibitant with ondansetron for the treatment of breakthrough postoperative nausea and vomiting after failed prophylaxis with ondansetron. *Br J Anaesth* 3:423–429
- Hsu CC, Sandford BA (2007) The Delphi technique: making sense of consensus. *Practical Assessment, Research & Evaluation* 10:1–8
- Fiore JF Jr, Bialocerkowski A, Browning L, Faragher IG, Denehy L (2012) Criteria to determine readiness for hospital discharge following colorectal surgery: an international consensus using the Delphi technique. *Dis Colon rectum* 4:416–423
- Murphy MK, Black NA, Lamping DL, et al. (1998) Consensus development methods and their use in clinical guideline development. *Health Technol Assessment* 2:1–88
- Jones J, Hunter D (1995) Consensus methods for medical and health services research. *BMJ* 311:376–380
- Hasson F, Keeney S, McKenna H (2000) Research guidelines for the Delphi survey technique. *J Adv Nurs* 32:1008–1015
- Roberts DM, Yates C, Megarbane B, et al. (2015) Recommendations for the role of extracorporeal treatments in the management of acute methanol poisoning: a systematic review and consensus statement. *Crit Care Med* 2:461–472
- Swamy M, Venkatachalam S, McLachlan J (2014) A Delphi consensus study to identify current clinically most valuable orthopaedic anatomy components for teaching medical students. *BMC Med Educ* 14:230
- Dijkstra FA, Bosker RJ, Veeger NJ, van Det MJ, Pierie JP (2015) Procedural key steps in laparoscopic colorectal surgery, consensus through Delphi methodology. *Surg Endosc* 9:2620–2627
- Jacobs M, Henselmans I, Macefield RC, et al. (2014) Delphi survey to identify topics to be addressed at the initial follow-up consultation after oesophageal cancer surgery. *Br J Surg* 13:1692–1701
- Bonrath EM, Grantcharov TP (2015) Contemporary management of paraesophageal hernias: establishing a European expert consensus. *Surg Endosc* 8:2180–2195
- Sandrasegaran K, Maglinte DD (2015) Imaging of small bowel-related complications following major abdominal surgery. *Eur J Radiol* 3:374–386
- Wu Z, Boersema GS, Dereci A, Menon AG, Jeekel J, Lange JF. (2014) [Clinical endpoint, early detection, and differential diagnosis of postoperative ileus: a systematic review of the literature](#). *Eur Surg Res*, 3–4:127–138.
- Gan TJ, Diemunsch P, Habib AS, et al. (2014) Consensus guidelines for the management of postoperative nausea and vomiting. *Anesth Analg* 1:85–113
- Shussman N, Brown MR, Johnson MC, Da Silva G, Wexner SD, Weiss EG (2013) Does nasogastric tube decompression get used less often with laparoscopic and hand-assisted compared with open colectomy? *Surg Endosc* 12:4564–4568
- Sirivanasandha P (1995) Postoperative nausea vomiting (PONV): influence of bowel manipulation during intraabdominal surgery. *J Med Assoc Thai* 10:547–553
- St Peter SD, Tsao K, Sharp SW, Holcomb GW, Ostlie DJ (2008) Predictors of emesis and time to goal intake after pyloromyotomy: analysis from a prospective trial. *J Pediatr Surg* 11:2038–2041
- Wehner S, Vilz TO, Stoffels B, Kalf JC (2012) Immune mediators of postoperative ileus. *Langenbeck's Arch Surg* 4:591–601
- Gustafsson UO, Scott MJ, Schwenk W, et al. (2013) Guidelines for perioperative care in elective colonic surgery: enhanced recovery after surgery (ERAS((R))) society recommendations. *World J Surg*, 2:259–284.
- Pöpping DM, Elia N, Van Aken HK, et al. (2014) Impact of epidural analgesia on mortality and morbidity after surgery: systematic review and meta-analysis of randomized controlled trials. *Ann Surg* 6:1056–1067
- Lobo DN (2004) Fluid, electrolytes and nutrition: physiological and clinical aspects. *The Proceedings of the Nutrition Society* 3:453–466
- Traut U, Brügger L, Kunz R, et al. (2008) Systemic prokinetic pharmacologic treatment for postoperative adynamic ileus following abdominal surgery in adults. *Cochrane Database Syst Rev* 1:CD004930
- Shariat Moharari R, Motalebi M, Najafi A, et al. (2013) Magnesium can decrease postoperative physiological ileus and postoperative pain in major non laparoscopic gastrointestinal surgeries: a randomized controlled trial. *Anesth Pain Med* 1:e12750

31. van den Heijkant TC, Costes LM, van der Lee DG, et al. (2015) Randomized clinical trial of the effect of gum chewing on postoperative ileus and inflammation in colorectal surgery. *Br J Surg* 3:202–211
32. van Bree SH, Bemelman WA, Hollmann MW, et al. (2014) Identification of clinical outcome measures for recovery of gastrointestinal motility in postoperative ileus. *Ann Surg* 4:708–714
33. Vather R, Bissett I (2013) Management of prolonged post-operative ileus: evidence-based recommendations. *ANZ J Surg* 5:319–324
34. Branco BC, Barmbaras G, Schnuriger B, Inaba K, Chan LS, Demetriades D (2010) Systematic review and meta-analysis of the diagnostic and therapeutic role of water-soluble contrast agent in adhesive small bowel obstruction. *Br J Surg* 4:470–478
35. Zeinali F, Stulberg JJ, Delaney CP (2009) Pharmacological management of postoperative ileus. *Can J Surg* 2:153–157
36. Elledge RO, McAleer S (2015) Planning the content of a brief educational course in maxillofacial emergencies for staff in accident and emergency departments: a modified Delphi study. *Br J Oral Maxillofac Surg* 2:109–113
37. Nagpal K, Arora S, Abboudi M, et al. (2010) Postoperative handover: problems, pitfalls, and prevention of error. *Ann Surg* 1:171–176
38. Fesharakizadeh M, Taheri D, Dolatkah S, Wexner SD (2013) Postoperative ileus in colorectal surgery: is there any difference between laparoscopic and open surgery? *Gastroenterol Rep (Oxf)* 2:138–143