

SAGES research agenda in gastrointestinal and endoscopic surgery: updated results of a Delphi study

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Abstract

Background Research in gastrointestinal and endoscopic surgery has witnessed unprecedented growth since the introduction of minimally invasive techniques in surgery. Coordination and focus of research efforts could further advance this rapidly expanding field. The objective of this study was to update the SAGES research agenda for gastrointestinal and endoscopic surgery.

Methods A modified Delphi methodology was used to create the research agenda. Using an iterative, anonymous web-based survey, the general membership and leadership

of SAGES were asked for input over three rounds. Initially submitted research questions were reviewed and consolidated by an expert panel and redistributed to the membership for priority ranking using a 5-point Likert scale of importance. The top 40 research questions of this round were then redistributed to and re-rated by members, and a final ranking was established. Comparisons were made between membership and leadership responses.

Results 283 initially submitted research questions were condensed into 89 distinct questions, which were rated by 388 respondents to determine the top 40 questions. 460 respondents established the final ranking of these 40 most important research questions. Topics represented included training and technique, gastrointestinal, hernia, GERD, bariatric surgery, and endoscopy. The top question was, “How do we best train, assess, and maintain proficiency of

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For the SAGES Research Committee.

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surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?" 28 % of responders were leadership and the rest general members with the majority of ratings (73 %) being similar between the groups. While SAGES leadership rated the majority of questions (89 %) lower, they rated nonclinical questions higher compared with general membership.

Conclusions An updated research agenda for gastrointestinal and endoscopic surgery was developed using a systematic methodology. This agenda may assist investigators and funding organizations to concentrate their efforts in the highest research priority areas and editors and reviewers in assessing the merit and relevance of scientific work.

Keywords Delphi process · Endoscopic surgery · Gastrointestinal surgery · Priority setting · Research agenda · Survey · SAGES

Research in gastrointestinal and endoscopic surgery has witnessed unprecedented growth since the introduction of minimally invasive techniques in surgery but research efforts remain uncoordinated and unfocused. The coordination and focus of these research efforts could further advance the impact of this rapidly expanding field. Given that funding for research endeavors is increasingly scarce and grants remain highly competitive, coordination of research efforts may be of great value to the surgical community and patients as it directs research efforts to the areas of highest need for improved understanding and supportive evidence for our practices. A research agenda that is "au courant" can help achieve this goal as it can guide investigator efforts and allocation of limited resources by funding agencies to the most pressing areas. To guide investigators and funding agencies, the research committee of SAGES developed and published a research agenda in 2007 [1]. This agenda, which was created using a systematic methodology, based on the Delphi process, informed the research community of the top 40 research priorities in the field of gastrointestinal and endoscopic surgery based on input from the SAGES membership. Since that time, the field has continued to evolve with innovations occurring in a variety of areas such as endoscopy, advanced minimally invasive surgery, instrumentation, and patient management. The introduction of new technologies and techniques generates new research questions about their value, effectiveness, cost-effectiveness, and other outcome metrics, which require scientifically valid answers. Given the constant changes in our environment, an updated research agenda for gastrointestinal and endoscopic surgery is needed.

The objective of this study was to update the SAGES research agenda for gastrointestinal and endoscopic surgery using a modified Delphi methodology. We further sought

to assess whether research priorities differed between SAGES leadership and SAGES members, and to examine the degree to which SAGES has been funding research projects that fit these priorities

Methods

A modified Delphi method was used for this study [2, 3], similar to the one used by Urbach et al. [1] for the creation of the initial SAGES research agenda in 2007. In brief, this involves a formal group process originally developed by the RAND Corporation to assess long-term trends in science and technology, and their anticipated effects on society [4]. It has been used extensively in the medical field to determine appropriate treatments, facilitate directions in technological innovation, and establish research agendas [5–8]. Key components to a Delphi process include anonymity, iteration, controlled acquisition of feedback, and analytic aggregation of responses. Similar to the first SAGES research agenda, three rounds were employed to obtain this updated agenda. A web-based, anonymous survey was distributed to the SAGES membership listserv for all rounds of this survey. At the time of distribution in 2011–2012, the SAGES listserv included approximately 5,300 functional email accounts. In round 1, the SAGES membership was requested to submit up to five important and answerable research questions in gastrointestinal and endoscopic surgery. The submitted questions were collected, collated, and collapsed by a review panel to eliminate redundancy and establish uniform clarity of topics described where applicable. Nine members of the SAGES Research Committee formed this review panel, consisting of practicing surgeons from the United States and Canada whose interests span endoscopy, laparoscopy, emerging technologies, and a variety of clinical areas. In round 2, the collated questions were redistributed to the entire SAGES membership to be ranked using a priority Likert scale from 1 (lowest) to 5 (highest). Average ratings submitted during round 2 were calculated and the top 40 research questions, along with their mean priority rating, were sent back to the entire membership for round 3. A final priority ranking using the same scale was requested and these new rankings formed the final updated research agenda. The relationship of round 2 compared with round 3 rankings was assessed using Spearman's correlation to establish rating agreement between rounds.

To assess whether research question rankings were influenced by leadership status within the SAGES organization and how closely the leadership represented their constituents, we targeted two distinct groups with our surveys: the first group (leadership, $N = 470$ at the time of

the survey) consisted of individuals who were members of the SAGES Board or its Committees, whereas the second group (membership) included the rest of the SAGES membership. The ratings of these two groups from rounds 2 and 3 were compared using a Mann–Whitney *U* test to assess if any differences existed. A *p* value <0.05 was considered significant. In addition, the rankings of the questions were compared between the groups; a ranking difference >5 was considered significant and >10 highly different. To assess the impact of the initial SAGES research agenda [3] on grant funding by SAGES, we reviewed the titles of all grants awarded by SAGES from 2008 to 2013 (after publication of the 2007 research agenda) and assessed their relevance to the top 40 research questions of the initial agenda.

Results

In round 1, 261 respondents submitted 283 research questions, which were then consolidated into 89 distinct research questions. These questions covered a broad range of topics and were grouped into eight categories that included gastrointestinal and biliary pathology, bariatric surgery, foregut/GERD, hernia, training and education, endoscopy, technology, and other (Table 1). In round 2, 388 respondents ranked these 89 questions by priority and the top 40 questions were determined (two questions tied for 40th place). In this round, ratings ranged between 3.55 and 4.02 in the 5-point Likert scale. Forty-one questions were sent to the SAGES membership in round 3 and 460 members responded. The final ranking order of the top 40 research questions was created based on the ratings received, which ranged between 3.20 and 4.04 (Table 2). The majority of the research questions (*n* = 31) were

clinical and 9 were nonclinical (most related to training and education). The top-rated research question was, “How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?” With the exception of this top question, all other questions were rated lower on round 3 than on round 2 (overall ratings 3.48 ± 0.19 vs. 3.74 ± 0.12 , respectively; *p* < 0.001). Nevertheless, the ratings of rounds 2 and 3 were highly correlated (*r* = 0.75; *p* < 0.01).

The SAGES leadership comprised 42, 29, and 28 % of the responders for rounds 1, 2, and 3, respectively. The SAGES leadership response rates were significantly higher than those of members in all rounds (Table 3). SAGES leadership ratings differed significantly (*p* < 0.05) for 34 of the 129 total questions (26 %) of rounds 2 and 3. Specifically, in round 2 ratings differed significantly for 19 of 89 (21 %) questions, the majority of which (*n* = 17) were rated lower by SAGES leadership compared with membership. In round 3, ratings differed significantly between leadership and general membership for 15 of 40 questions (37 %), with the majority (*n* = 14) receiving again lower priority scores by SAGES leadership. Overall SAGES leadership ratings were significantly lower for the top 40 questions compared with membership ratings (3.38 ± 1 vs. 3.52 ± 1 , respectively, *p* < 0.001) (Table 4). Nevertheless, SAGES leadership rated higher the nonclinical questions compared with SAGES membership (3.69 ± 1 vs. 3.59 ± 1 , respectively; *p* = 0.005), while the opposite was true for clinical questions (3.29 ± 1.1 vs. 3.5 ± 0.9 , respectively; *p* < 0.001). On the other hand, nonclinical versus clinical question ratings were different for SAGES leadership (3.69 ± 1 vs. 3.29 ± 1.1 , respectively; *p* < 0.001) but not for membership (3.59 ± 1 vs. 3.5 ± 0.9 , respectively, *p* = ns). Further, 18 research questions received similar rankings by the two groups (≤ 5 point difference in ranking order), 12 different (>5 but ≤ 10 difference in rankings), and 10 highly different (>10 point difference in ranking order).

Eight of the final top ten questions had no statistically significant difference in ratings when comparing leadership to general membership (Table 4). The two top-ten questions that differed significantly were “What are the optimal quality and outcome measures for new MIS techniques?” which was the only question that was rated higher by SAGES leadership and “What is the ideal surgical approach to recurrent GERD after failed fundoplication?”, which was rated significantly lower. The top ten questions for SAGES leadership and membership are shown in Tables 5 and 6, respectively; they included five common questions and five different questions.

Review of SAGES research grants administered from 2008 to 2013 demonstrated that 14 of the 35 (40 %) grants specifically addressed top 40 research questions from the 2007 SAGES Delphi study.

Table 1 Top 40 research questions by category

	Forced categorization	Loose categorization
Technique and technology	7	10
Hernia	7	7
Foregut/GERD	6	10
Training/education	5	5
Bariatric surgery	5	6
Endoscopy/NOTES	5	6
Gastrointestinal/biliary	4	6
Other	1	1

Forced categorization refers to question assignment to only one category, i.e., even if they would fit into more than one they were assigned to the most relevant only; loose categorization refers to assignment of questions to any category they fit in

Table 2 Top 40 research questions

Rank	Question	Round 2 rating	Round 3 rating
1	How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?	3.97 ± 0.9	4.04 ± 0.9
2	What are the optimal quality and outcome measures for new MIS techniques?	4.02 ± 0.8	3.91 ± 0.8
3	What are the indications for and outcomes of metabolic surgery?	3.93 ± 1	3.83 ± 1
	What patient factors (e.g., obesity, weight loss, genetic), hernia factors (e.g., size), and technical factors (e.g., extra-peritoneal placement of mesh, permanent fixation, defect closure) are associated with recurrence and other complications after ventral hernia repair?	3.90 ± 0.9	3.83 ± 0.9
5	What is the efficacy of endoscopic ablation of Barrett's esophagus, who is the best candidate for this treatment, and how should reflux be managed afterwards?	3.82 ± 0.9	3.66 ± 0.9
6	What patient and technical factors predict failure of laparoscopic fundoplication for GERD and paraesophageal hernia repair?	3.95 ± 0.9	3.65 ± 0.9
	What is the ideal surgical approach to recurrent GERD after failed fundoplication?	3.82 ± 0.9	3.65 ± 0.9
8	What is the best method for incorporating new techniques and technology for surgeons of variable levels of experience or training?	3.89 ± 0.9	3.61 ± 1.1
	What physiological and hormonal changes occur following bariatric surgery?	3.82 ± 1	3.61 ± 0.9
	What is the impact of poor ergonomic position during surgery on surgeon health and how can ergonomics be optimized in the OR?	3.72 ± 1	3.61 ± 1
11	What are the costs associated with the introduction of new technologies and how can they be minimized?	3.75 ± 1	3.59 ± 1
12	Is mesh always required for adequate abdominal wall hernia repair, and what is the optimal synthetic mesh?	3.87 ± 0.9	3.58 ± 1
13	What are the optimal neoadjuvant, adjuvant and surgical therapies for gastrointestinal cancers?	3.69 ± 1.1	3.56 ± 1
14	What is the impact of simulation training on patient outcomes?	3.79 ± 1	3.54 ± 1
15	Can prosthetic permanent mesh be used safely in contaminated procedures and if so what type?	3.68 ± 1	3.51 ± 1
16	What are the indications for and outcomes of sleeve gastrectomy and gastric plication for the treatment of morbid obesity?	3.83 ± 1	3.49 ± 1.1
	Can patient outcomes be improved through the implementation of a competency-based assessment for progression during training and for maintenance of certification?	3.55 ± 1	3.49 ± 1
18	What are the comparative advantages of laparoscopic and open surgery for the treatment of benign, malignant, and reoperative surgery (colon and rectal, component separation, inguinal hernia, pancreatic)?	3.81 ± 0.9	3.48 ± 1
19	What are the benefits of minimally invasive approaches to rectal cancer, including transanal endoscopic microsurgery (TEM)?	3.63 ± 1	3.46 ± 1
20	Does prosthetic reinforcement of the crural repair reduce the risk of recurrence following laparoscopic hiatal hernia repair and which is the ideal type of prosthesis?	3.86 ± 0.9	3.45 ± 1
	What are the best modalities and techniques to visualize the biliary tree before and during surgery and do they prevent common bile duct injuries?	3.86 ± 0.9	3.45 ± 1
22	How can complications after bariatric surgery be prevented and how can they be best managed once they occur?	3.73 ± 1.1	3.44 ± 1
	What is the role of laparoscopy in the treatment and prevention of postoperative adhesions, bowel obstruction, and other small bowel complications?	3.55 ± 1	3.44 ± 1
24	What is the most effective and cost-efficient (optimal) simulator-based curriculum for resident training?	3.74 ± 0.8	3.43 ± 1
25	What are the indications, risks, and outcomes of revisional surgery for weight regain after bariatric surgery and which is the best procedure?	3.76 ± 1	3.42 ± 1.1
26	Has the fundamentals of laparoscopic surgery (FLS) program had a positive impact on clinical outcomes?	3.61 ± 0.9	3.41 ± 1
27	What patient factors (e.g., obesity, weight loss, genetic) and technical factors (closure technique, use of SILS) are associated with the development of incisional hernia?	3.67 ± 0.9	3.40 ± 1
	What is the best treatment for gastrointestinal fistulae?	3.61 ± 1	3.40 ± 1
29	What are the indications for and outcomes of advanced endoscopic procedures and stents for the treatment of benign and malignant conditions?	3.58 ± 0.9	3.38 ± 0.9
30	What are the complications associated with long-term use of PPIs?	3.70 ± 1	3.33 ± 1.1
31	What is the optimal pre-op work-up, surgical technique, and post-op management of GERD patients for different clinical conditions?	3.66 ± 1	3.32 ± 1
32	Which conditions are best treated with endoscopic, transabdominal, or hybrid surgical approaches?	3.75 ± 1	3.31 ± 1
	What are the optimal treatments for esophageal cancer and what are the predictors of outcomes?	3.64 ± 0.9	3.31 ± 1

Table 2 continued

Rank	Question	Round 2 rating	Round 3 rating
34	What are the biological consequences of prosthetic mesh implantation?	3.61 ± 1	3.30 ± 1
35	What are the optimal technique and outcomes of per oral endoscopic myotomy (POEM) for the treatment of achalasia, and how do they compare to endoscopic dilation and laparoscopic myotomy?	3.61 ± 1	3.29 ± 1
36	What are the indications for and outcomes of endoscopic procedures for weight loss and how do they compare with traditional surgical approaches?	3.67 ± 1	3.28 ± 1
37	Which is the best technique for the repair of common bile duct injury?	3.67 ± 1	3.25 ± 1
38	What are the indications for and outcomes of endoluminal antireflux therapy, and which endoluminal procedure has the best results?	3.65 ± 0.9	3.24 ± 1
	What are the indications for and comparative advantages of endoscopic polypectomy and endoscopic mucosal resection for the treatment of mucosal lesions?	3.57 ± 0.9	3.24 ± 1
40	Is quality of life improved after ventral hernia repair?	3.72 ± 1	3.20 ± 1

Table 3 Response rates to each survey round

	Overall (%) N = 5,300	Leader (%) N = 470	Member (%) N = 4,830	p value
Round 1 N = 261	4.9	24	3.1	<0.01
Round 2 N = 388	7.3	24	5.7	<0.01
Round 3 N = 460	8.8	27	6.8	<0.1

Discussion

An updated research agenda for gastrointestinal and endoscopic surgery was developed using a systematic methodology. The modified Delphi process used to establish this agenda is optimal in that the opinions of a large group of participants are weighted equally as compared with a consensus in-person process where typically a few influential participants tend to prevail and determine the final outcomes. In addition, the process is structured and transparent and adds validity to the results.

The top 40 research questions submitted and ranked by the SAGES leadership and membership are presented in this paper and span a broad range of topics such as training, endoscopy, hernia, GERD, bariatric surgery, technique and technology, and gastrointestinal topics. Compared to the initial SAGES research agenda published in 2007, topics such as gastroesophageal reflux disease and bariatric surgery remain well represented among the top research questions but topics such as hernia and surgical education are more prominent. The top-rated question “How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?” replaced the previous top-rated question

from 2007: “What is the best treatment (antireflux surgery, endoluminal therapy, or medication) for GERD?”

This focused research agenda in gastrointestinal and endoscopic surgery highlights important knowledge deficits and may assist researchers in the field in concentrating their efforts by strategically establishing their research programs in the areas of highest need. Further, it may assist reviewers and journal editors in assessing the merit of scientific submissions in light of the perceived need. In addition, this agenda may help funding organizations in allocating limited grant resources to the areas of most need and interest. Importantly, through all these mechanisms, such a research agenda, may push the field of gastrointestinal and endoscopic surgery forward by promoting coordinated efforts and limiting redundancy.

In an effort to assess the impact of the initial SAGES research agenda [1] on grants awarded by SAGES, the grants allocated by the SAGES Research Committee from 2008 to 2013 were reviewed and their relevance to the initial agenda examined. We found that 40 % of the awarded grants during this time period addressed specific research agenda questions, suggestive of an impact of the agenda on funding. Efforts to accomplish this have included reference of the agenda in the instructions to authors for SAGES grant submissions and its consideration during the grant review process. In some respects, the actual rate achieved may appear suboptimal. Multiple reasons may account for this, including limited awareness of the agenda by investigators, awarding grants primarily on their scientific merit (relevance to the agenda currently plays a minor role in the overall assessment), and the ever evolving NOTES and bariatric procedures that have altered the surgical theater. This latter reason highlights the recognized need for an updated research agenda as it represents a snapshot of current research leaving behind the antiquated research interests. This current study also supports the need

Table 4 SAGES leadership versus SAGES general membership Round 3 ratings and rankings of top 40 questions

Overall rank	Leader rank	Member rank	Question	Leader rating and rank	Member rating and rank	<i>p</i> value
1	1	1	How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?	4.08 ± 0.8	4.01 ± 0.9	ns
2	2	2	What are the optimal quality and outcome measures for new MIS techniques?	4.06 ± 0.8	3.84 ± 0.8	0.01
3	3	4	What are the indications for and outcomes of metabolic surgery?	3.85 ± 0.9	3.82 ± 1	ns
	4	3	What patient factors (e.g., obesity, weight loss, genetic), hernia factors (e.g., size), and technical factors (e.g., extra-peritoneal placement of mesh, permanent fixation, defect closure) are associated with recurrence and other complications after ventral hernia repair?	3.80 ± 0.8	3.84 ± 0.9	ns
5	5	8	What is the efficacy of endoscopic ablation of Barrett's esophagus, who is the best candidate for this treatment, and how should reflux be managed afterwards?	3.69 ± 0.9	3.64 ± 0.9	ns
6	11	7	What patient and technical factors predict failure of laparoscopic fundoplication for GERD and paraesophageal hernia repair?	3.56 ± 0.9	3.69 ± 0.9	ns
	16	6	What is the ideal surgical approach to recurrent GERD after failed fundoplication?	3.46 ± 1	3.7 ± 0.9	0.008
8	7	12	What is the best method for incorporating new techniques and technology for surgeons of variable levels of experience or training?	3.63 ± 0.8	3.60 ± 0.9	ns
	14	10	What physiological and hormonal changes occur following bariatric surgery?	3.52 ± 1	3.64 ± 1	ns
	13	9	What is the impact of poor ergonomic position during surgery on surgeon health and how can ergonomics be optimized in the OR?	3.52 ± 1.1	3.64 ± 1.1	ns
11	10	13	What are the costs associated with the introduction of new technologies and how can they be minimized?	3.57 ± 0.9	3.59 ± 1.1	ns
12	15	11	Is mesh always required for adequate abdominal wall hernia repair, and what is the optimal synthetic mesh?	3.51 ± 0.9	3.61 ± 1	ns
13	34	5	What are the optimal neoadjuvant, adjuvant and surgical therapies for gastrointestinal cancers?	3.13 ± 1	3.72 ± 1	<0.001
14	6	21	What is the impact of simulation training on patient outcomes?	3.68 ± 1	3.48 ± 1.1	ns
15	19	15	Can prosthetic permanent mesh be used safely in contaminated procedures and if so what type?	3.38 ± 1.1	3.56 ± 1	ns
16	22	18	What are the indications for and outcomes of sleeve gastrectomy and gastric plication for the treatment of morbid obesity?	3.33 ± 0.9	3.55 ± 1	0.03
	9	25	Can patient outcomes be improved through the implementation of a competency-based assessment for progression during training and for maintenance of certification?	3.59 ± 1.1	3.45 ± 1.1	ns
18	23	16	What are the comparative advantages of laparoscopic and open surgery for the treatment of benign, malignant and reoperative surgery (colon and rectal, component separation, inguinal hernia, pancreatic)?	3.28 ± 0.9	3.55 ± 1	0.01
19	30	14	What are the benefits of minimally invasive approaches to rectal cancer, including transanal endoscopic microsurgery (TEM)?	3.19 ± 0.9	3.57 ± 1	<0.001
20	17	23	Does prosthetic reinforcement of the crural repair reduce the risk of recurrence following laparoscopic hiatal hernia repair and which is the ideal type of prosthesis?	3.43 ± 0.9	3.46 ± 1	ns
	18	22	What are the best modalities and techniques to visualize the biliary tree before and during surgery and do they prevent common bile duct injuries?	3.38 ± 1	3.47 ± 1.1	ns
22	27	19	How can complications after bariatric surgery be prevented and how can they be best managed once they occur?	3.23 ± 1	3.53 ± 1	0.004
	33	17	What is the role of laparoscopy in the treatment and prevention of postoperative adhesions, bowel obstruction, and other small bowel complications?	3.14 ± 1	3.55 ± 1	<0.001

Table 4 continued

Overall rank	Leader rank	Member rank	Question	Leader rating and rank	Member rating and rank	<i>p</i> value
24	8	34	What is the most effective and cost-efficient (optimal) simulator-based curriculum for resident training?	3.59 ± 1	3.36 ± 1.1	0.04
25	21	27	What are the indications, risks, and outcomes of revisional surgery for weight regain after bariatric surgery and which is the best procedure?	3.34 ± 1	3.44 ± 1	ns
26	12	33	Has the fundamentals of laparoscopic surgery (FLS) program had a positive impact on clinical outcomes?	3.54 ± 1	3.36 ± 1.1	ns
27	24	26	What patient factors (e.g., obesity, weight loss, genetic) and technical factors (closure technique, use of SILS) are associated with the development of incisional hernia?	3.26 ± 1	3.45 ± 1	ns
	36	20	What is the best treatment for gastrointestinal fistulae?	3.07 ± 1	3.53 ± 1	<0.001
29	25	29	What are the indications for and outcomes of advanced endoscopic procedures and stents for the treatment of benign and malignant conditions?	3.26 ± 0.9	3.43 ± 0.9	ns
30	38	28	What are the complications associated with long-term use of PPIs?	3.04 ± 1.1	3.44 ± 1.1	<0.001
31	37	30	What is the optimal pre-op work-up, surgical technique, and post-op management of GERD patients for different clinical conditions?	3.06 ± 1	3.42 ± 0.9	<0.001
32	26	35	Which conditions are best treated with endoscopic, transabdominal, or hybrid surgical approaches?	3.23 ± 0.9	3.33 ± 1	ns
	39	24	What are the optimal treatments for esophageal cancer and what are the predictors of outcomes?	2.92 ± 1	3.46 ± 1	<0.001
34	35	31	What are the biological consequences of prosthetic mesh implantation?	3.08 ± 1.1	3.38 ± 1	<0.001
35	20	39	What are the optimal technique and outcomes of per oral endoscopic myotomy (POEM) for the treatment of achalasia, and how do they compare to endoscopic dilation and laparoscopic myotomy?	3.36 ± 1	3.26 ± 1	ns
36	28	36	What are the indications for and outcomes of endoscopic procedures for weight loss and how do they compare with traditional surgical approaches?	3.2 ± 0.9	3.31 ± 1.1	ns
37	40	32	Which is the best technique for the repair of common bile duct injury?	2.92 ± 0.9	3.37 ± 1.1	<0.001
38	29	38	What are the indications for and outcomes of endoluminal antireflux therapy, and which endoluminal procedure has the best results?	3.2 ± 1	3.28 ± 1	ns
	32	37	What are the indications for and comparative advantages of endoscopic polypectomy and endoscopic mucosal resection for the treatment of mucosal lesions?	3.16 ± 1	3.28 ± 0.9	ns
40	31	40	Is quality of life improved after ventral hernia repair?	3.18 ± 0.9	3.2 ± 1	ns

to capture important changes in the perceived research needs in the field [9].

The comparison of the research questions submitted by leaders and members of the organization revealed several interesting findings. SAGES leaders rated the importance of the majority of questions in general lower compared with members with one exception: nonclinical questions, mainly comprised of research questions related to training and policy, were rated significantly higher by leaders than members. A possible explanation for this finding is that leaders may be more likely to originate from academic institutions with focus on training compared with members who may be practicing surgeons in their majority and thus more interested in clinical issues. This finding may also reflect the leadership's responsibility as representatives of SAGES to train and provide their members with needed policies. On the

other hand, the top two questions were the same for both members and leaders and the ranking order of the majority of the top 10 (90 %) and top 20 questions (65 %) did not differ significantly (defined as <5 ranking order difference per question) between them indicating that the SAGES leadership accurately represents their constituents.

Limitations of this study include a limited response rate to our three surveys (4.9–8.8 %). Electronic surveys to a large participant pool, however, are known to have low response rates in the literature. Further, the response rate of the SAGES leadership was significantly higher (24–27 %) and the overall response rates in this study were very similar to the initial Delphi study (388 vs. 397 responders for round 2 and 460 vs. 385 for round 3, respectively). Another limitation of this process is the potential for influence by the reviewer panel, particularly when reviewing and consolidating the

Table 5 Top 10 SAGES leadership questions

Leadership rank	Question	Leader rating
1	How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?	4.08 ± 0.8
2	What are the optimal quality and outcome measures for new MIS techniques?	4.06 ± 0.8
3	What are the indications for and outcomes of metabolic surgery?	3.85 ± 0.9
4	What patient factors (e.g., obesity, weight loss, genetic), hernia factors (e.g., size), and technical factors (e.g., extra-peritoneal placement of mesh, permanent fixation, defect closure) are associated with recurrence and other complications after ventral hernia repair?	3.80 ± 0.8
5	What is the efficacy of endoscopic ablation of Barrett's esophagus, who is the best candidate for this treatment, and how should reflux be managed afterwards?	3.69 ± 0.9
6	What is the impact of simulation training on patient outcomes?	3.68 ± 1
7	What is the best method for incorporating new techniques and technology for surgeons of variable levels of experience or training?	3.63 ± 0.8
8	What is the most effective and cost-efficient (optimal) simulator-based curriculum for resident training?	3.59 ± 1
	Can patient outcomes be improved through the implementation of a competency-based assessment for progression during training and for maintenance of certification?	3.59 ± 1.1
10	What are the costs associated with the introduction of new technologies and how can they be minimized?	3.57 ± 0.9

Table 6 Top 10 SAGES membership questions

Rank	Question	Member rating
1	How do we best train, assess, and maintain proficiency of surgeons and surgical trainees in flexible endoscopy, laparoscopy, and open surgery?	4.01 ± 0.9
2	What are the optimal quality and outcome measures for new MIS techniques?	3.84 ± 0.8
	What patient factors (e.g., obesity, weight loss, genetic), hernia factors (e.g., size), and technical factors (e.g., extra-peritoneal placement of mesh, permanent fixation, defect closure) are associated with recurrence and other complications after ventral hernia repair?	3.84 ± 0.9
4	What are the indications for and outcomes of metabolic surgery?	3.82 ± 1
5	What are the optimal neoadjuvant, adjuvant and surgical therapies for gastrointestinal cancers?	3.72 ± 1
6	What is the ideal surgical approach to recurrent GERD after failed fundoplication?	3.7 ± 0.9
7	What patient and technical factors predict failure of laparoscopic fundoplication for GERD and paraesophageal hernia repair?	3.69 ± 0.9
8	What is the efficacy of endoscopic ablation of Barrett's esophagus, who is the best candidate for this treatment, and how should reflux be managed afterwards?	3.64 ± 0.9
	What is the impact of poor ergonomic position during surgery on surgeon health and how can ergonomics be optimized in the OR?	3.64 ± 1.1
	What physiological and hormonal changes occur following bariatric surgery?	3.64 ± 1

initially submitted research questions. The collation of initially submitted questions arguably could dilute or refocus the original intent. Nevertheless, the review panel used consensus when collating the questions and made every effort to preserve the questions' intent. In addition, the panel was diverse in that it consisted of a multi-national group from a variety of clinical backgrounds and research interests, which adds to the validity of this process. Further, reducing redundancy, combining, and clarifying the questions are requirements of the Delphi process. On occasion this resulted

in combining two questions into one research question, such as "What are the indications for and outcomes of metabolic surgery?"

In conclusion, an updated research agenda for gastrointestinal and endoscopic surgery was developed using a systematic methodology. This research agenda may enhance the ability of investigators and funding organizations to focus attention to areas most likely to advance the field and by editors and reviewers to assess the merit and relevance of scientific contributions.

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