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Consensus priority research questions in gastrointestinal and endoscopic surgery in the year 2020: results of a SAGES Delphi study

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Abstract

Introduction The objectives of this study were to identify consensus priority research questions according to members of the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES), and to explore differences in priorities according to specific membership subgroups.

Methods A modified Delphi study was conducted including active members of SAGES. An initial list of research questions was compiled by members of 26 SAGES Committees and Task Forces, and was further refined by the SAGES Delphi Task Force. The questions were divided into five research categories: (1) Surgical Outcomes; (2) Education, Training, and Simulation; (3) Health Services Research; (4) New Technology; and (5) Artificial Intelligence. Delphi respondents were asked to rank each question with regards to its importance in the field of gastrointestinal and endoscopic surgery (1—low; 5—high). "Priority" was defined as a single-round mean score of ≥ 3.5, and "consensus" as a single-round standard deviation < 1.0. Subgroup analyses were performed according to a priori selected respondent characteristics.

Results The total number of respondents for each round was: Round 1 ($n=407$); Round 2 ($n=569$); Round 3 ($n=273$). In each round, the majority of respondents were male (Round 1: 77.4%; Round 2: 77.1%; Round 3: 76.7%), self-identified as academic (vs. community) surgeons (Round 1: 57.1%; Round 2: 61.1%; Round 3: 60.2%), and practiced in North America (Round 1: 71.8%; Round 2: 70.8%; Round 3: 75.9%). A total of 29 out of 122 research questions met criteria for both "priority" and "consensus"—Surgical Outcomes, $n=6$; Education, Training, and Simulation, $n=9$; Health Services Research, $n=5$; New Technology, $n=5$; and Artificial Intelligence, $n=4$.

Conclusions Consensus priority research questions in gastrointestinal and endoscopic surgery were identified across five different research categories. These results can provide direction and areas of interest for funding and investigation for future studies.

Keywords Surgical research · Research questions · SAGES research agenda · Delphi process

The ability for surgeons to produce high-quality research has markedly expanded over the past several decades. Once

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described as "comic opera" by the Editor of *The Lancet*, [1] surgical research has transformed into a collaborative, productive, and highly respectable output. Studies have demonstrated exponential increases in the quantity and quality of publications emanating from general surgeons [2–4], driven mainly by systematic reviews and randomized controlled trials. Surgical trainees are also spending more time in the pursuit of research skills and graduate degrees [5, 6], suggesting a continued growth in the number of future surgeon-scientists. Despite this, research funding awarded to academic surgeons relative to their non-surgical colleagues has declined, and failure to publish surgical research remains problematic. [7–9].

Thus, it is important to identify key research questions to help surgeons focus their research efforts on topics that are of greatest importance to both clinicians and patients. With the introduction of new technology and treatment paradigms, the fields of gastrointestinal and endoscopic surgery are rapidly evolving. In 2007, a Delphi study of Society of American Gastrointestinal and Endoscopic Surgery (SAGES) members was conducted to identify key research questions within gastrointestinal and endoscopic surgery [10]. An updated list of questions was generated using a similar methodology in 2014 [11]. Given the ongoing innovation in the practice and training in the field of gastrointestinal and endoscopic surgery, an update to the key research questions was warranted.

The objectives of this study were (1) to identify research questions of greatest importance to the members of SAGES using a modified Delphi method, and (2) to examine differences in priorities regarding research questions between different membership subgroups. We also sought to compare the results of this modified Delphi study with the 2007 [10] and 2014 [11] publications, to explore how research priorities have changed over time.

Materials and methods

Selection of research categories

The SAGES Delphi Task Force (SDTF) was formed in September 2019, as a subgroup of the SAGES Research and Career Development Committee (RCDC), to lead this initiative and update the society's research priorities. One of the authors (R.G.) began by performing a review of research granting agencies, surgical societies, and high-impact surgical journals to generate a broad list of eleven research categories: Surgical Outcomes, New Technologies, Diagnostic Accuracy, Health Economics, Artificial Intelligence, Population Health, Education Simulation and Surgical Training, Professionalism and Diversity, Basic Science, Translational Research, and Health Services Research. A Nominal Group Technique (NGT) was then used to review the eleven research categories during an in-person meeting of the SAGES RCDC (November 2019) and identify the top five most relevant research categories to the SAGES membership. In general, the NGT tries to answer a single nominal question by sharing ideas amongst a group of individuals in a round-robin format. A facilitator records ideas and then organizes them in such a way that they are easily summarized and presented back to the group. Participants can then engage in a discussion until all ideas are saturated, after which a vote is held to terminate the process [12]. In our case, NGT participants were asked to rank each research category from 1 to 9 on its importance to the membership of SAGES. The top five selected research cat

egories were: (1) Surgical Outcomes; (2) New Technologies; (3) Education, Simulation, and Surgical Training; (4) Artificial Intelligence; (5) Health Services Research.

Initial set of research questions

We invited members of 26 clinical and non-clinical (e.g. research, education) SAGES committees and task forces to submit up to three research questions of greatest importance within each of the five research categories. The SAGES committees and task forces cover the entire breadth of gastrointestinal and endoscopic surgery. Rather than soliciting research questions from *all* SAGES members (as had been done in previous Delphi studies), we felt that committee members, many of whom are academic leaders in their respective disciplines, would generate a comprehensive list of the most current and pertinent research questions.

A total of 287 questions were submitted. The SDTF reviewed this list of questions during a 2-day in-person meeting in February 2020. Similar questions within and across research categories were combined, duplicates were removed, and questions were re-worded into an answerable format. This process resulted in 122 unique research questions across the five research categories: (1) Surgical Outcomes, $n=31$; (2) New Technologies, $n=25$; (3) Education, Simulation, and Surgical Training, $n=21$; (4) Artificial Intelligence, $n=24$; (5) Health Services Research, $n=24$.

Modified Delphi study

The 122 unique research questions were submitted to all active members and candidate members of SAGES for rating using an online survey and a modified Delphi method. Medical student members of SAGES were not included. The modified Delphi method was chosen to allow for the inclusion of a diverse group of respondents without geographic constraints. It maintains complete anonymity of respondents, which not only prevents undue influence by a few dominant

members of the group, but also permits the modification of responses over multiple iterations [12].

The online survey was created using Survey Gizmo © and was distributed via email and social media platforms. The survey included questions on respondent characteristics, such as demographic (age, sex), occupational (years in practice, type of practice, subspecialty), and geographic (continent of primary practice) information. In Round 1 of the Delphi study (April 2020), respondents were asked to rank each of the 122 research questions on their importance in the field of gastrointestinal and endoscopic surgery (1—low; 5—high). The survey was open for four weeks. Reminders were sent out at the two-week mark, and periodically thereafter. The means and standard deviations for the rank of each question were calculated. "Priority" for a given research question was defined as a single-round mean score of ≥ 3.5. "Consensus" for a given research question was defined as a single-round standard deviation < 1.0. Questions which met the pre-defined threshold for "priority" and "consensus" in Round 1 were removed from future rounds of the Delphi and were selected for inclusion in the final list of questions.

All research questions which did not meet the pre-defined threshold for "consensus" and "priority" in Round 1, were distributed in Round 2 of the Delphi (June 2020). Each research question contained its mean score ± standard deviation rating from Round 1. An identical process for ranking and analysis of questions was used. Research questions which did not meet the threshold for "priority" and "consensus" in Round 2 were re-presented to the membership of SAGES in the 3rd and final round of the Delphi study (August 2020). There was no requirement for respondents to complete each round of the Delphi study, thus each round had a unique pool of individual respondents. The following rule was used to terminate the Delphi study for any single research category: five or more questions met the "consensus" and "priority" definition, or a maximum of three Delphi rounds were conducted.

Data analysis

Respondent characteristics were described for each round of the Delphi. Categorical variables were presented as frequencies with proportions, and continuous variables as means with standard deviation. The final list of research questions that met "priority" and "consensus" criteria were presented in descending order (mean score ± standard deviation) across all five research categories. For each round of the Delphi study, inter-rater agreement within each individual research category was calculated using an intra-class correlation (ICC) coefficient (two-way, random effects model using average score measurements). Subgroup analyses chosen a priori were performed to compare mean scores of priority research questions among three respondent characteristics: sex (male vs. female), years in independent surgical practice (< 10 years vs. ≥ 10 years), and type of practice (academic vs. community). All statistical analyses were performed with R v3.5.1.

Results

The total number of respondents for each round of the Delphi study was as follows: Round 1 ($n = 407$); Round 2 ($n = 491$); Round 3 ($n = 249$). In each round, the majority of respondents were male (Round 1: 77.1%; Round 2: 77.2%; Round 3: 76.7%) and had a mean age of close to 45 years-old (Round 1: 46.1 ± 10.6; Round 2: 47.6 ± 10.1; Round 3: 46.6 ± 11.8). Most respondents self-identified as academic surgeons (Round 1: 57.7%; Round 2: 61.2%; Round 3: 60.2%) and reported practicing in North America (Round 1: 72.7%; Round 2: 70.9%; Round 3: 75.9%). The majority of respondents completed a clinical fellowship (Round 1: 73.0%; Round 2: 71.1%; Round 3: 67.9%), the most common being Minimally Invasive Surgery and Bariatric Surgery (Table 1). Approximately 40% of respondents were SAGES leadership (past / present board member or active committee / task force member) (Round 1: 43.5%; Round 2: 35.8%; Round 3: 43.9%), while the remainder were general or candidate members. All respondent characteristics across the three Delphi rounds are presented in Table 1.

In Round 1, six research questions met "priority" and "consensus" criteria within the Surgical Outcomes category, thus satisfying the pre-defined rule to terminate the Delphi study for this research category. Two questions met "priority" and "consensus" criteria within the Education, Simulation, and Surgical Training category. One question met "priority" and "consensus" criteria within Health Services Research. After Round 2 and 3 of the Delphi, 20 additional questions met "priority" and "consensus" criteria (Fig. 1). Artificial Intelligence was the only research category with less than five questions that met "priority" and "consensus" criteria. In total, 29 research questions met "consensus" and "priority" criteria (Table 2). Inter-rater agreement within each research category was excellent (Table 3).

On subgroup analysis, there were several significant differences between male and female respondents. Male respondents rated two questions of greater importance; one regarding advanced endoscopic skills (3.84 ± 0.93 vs. 3.46 ± 1.12, $p = 0.0031$) and another regarding decision algorithms for high-risk colorectal anastomoses (3.72 ± 0.96 vs. 3.41 ± 0.88, $p = 0.0043$) (Supplementary Table 1). Less experienced surgeons (< 10 years of independent practice) rated questions focusing on the impact of video-based assessment on surgical outcomes (3.97 ± 0.88 vs. 3.75 ± 0.97, $p = 0.012$) and enhanced recovery (4.05 ± 0.86 vs. 3.77 ± 0.99, $p = 0.0025$) higher versus their more

Table 1 Respondent characteristics

	Round 1 $n=407$	Round 2 $n=491$	Round 3 $n=249$
Age, mean (SD)	46.1 (10.6)	47.6 (10.1)	46.6 (11.8)
Male sex, *n* (%)	314 (77.1)	379 (77.2)	191 (76.7)
Years in independent practice, mean (SD)	13.5 (10.0)	15.0 (12.4)	13.6 (11.8)
≥ 10 years, *n* (%)	234 (57.5)	291 (59.2)	138 (55.4)
< 10 years, *n* (%)	173 (42.5)	200 (40.8)	111 (45.6)
Type of practice, n (%)	–	–	–
Academic	235 (57.7)	300 (61.2)	150 (60.2)
Community	172 (42.3)	191 (38.8)	99 (39.8)
Continent of practice, *n* (%)	–	–	–
North America	296 (72.7)	348 (70.9)	189 (75.9)
Other	111 (27.3)	143 (29.1)	60 (24.1)
Fellowship, *n* (%)[a]	–	–	
None	110 (27.0)	142 (28.9)	80 (32.1)
MIS	206 (50.6)	231 (47.0)	116 (46.6)
Bariatric	95 (23.3)	108 (22.0)	55 (22.1)
Advanced Gastrointestinal	73 (17.9)	87 (17.7)	43 (17.3)
Flexible Endoscopy	50 (12.3)	64 (13.0)	36 (14.5)
Foregut	44 (10.8)	61 (12.4)	32 (12.9)
Colorectal	39 (9.6)	58 (11.8)	29 (11.6)
Hepatobiliary	22 (5.4)	32 (6.5)	12 (4.8)
Surgical Oncology	17 (4.2)	31 (6.3)	14 (5.6)
Other[b]	53 (13.0)	59 (12.0)	31 (12.5)
Type of SAGES member, *n* (%)	–	–	–
Leadership—past or present board member	33 (8.1)	43 (8.8)	28 (11.2)
Leadership—active committee or task force	144 (35.4)	136 (27.0)	79 (31.7)
General member	185 (45.5)	248 (50.5)	109 (43.8)
Candidate member	45 (11.1)	64 (13.0)	33 (13.3)

[a]percentages sum to more than 100, as respondents were allowed to select multiple completed fellowships

[b]includes Trauma Surgery, Acute Care Surgery, Pediatric Surgery, Breast Surgery, Thoracic Surgery, Transplant Surgery, Vascular Surgery, or other

SD standard deviation, *MIS* Minimally Invasive Surgery, *SAGES* Society of American Gastrointestinal and Endoscopic Surgeons

experienced colleagues. Conversely, more experienced surgeons rated a question regarding artificial intelligence and decision-making for patient safety (4.04 ± 0.85 vs. 3.62 ± 0.84, $p < 0.001$) higher than their less experienced colleagues (Supplementary Table 2). Likewise, academic surgeons were also more interested in the impact of video-based assessment on surgical outcomes (3.92 ± 0.85 vs. 3.70 ± 1.07, $p = 0.012$). Community surgeons rated higher questions concerning effectiveness of hands-on courses in transfer to practice (4.05 ± 0.93 vs. 3.67 ± 0.99, $p < 0.001$) and SAGES initiatives for continued education, such as ADOPT and the Master's Programs (3.68 ± 0.89 vs. 3.44 ± 0.96, $p < 0.0079$) (Supplementary Table 3).

In the 2007 and 2014 Delphi studies, the top 40 research questions were presented, respectively. Among the 29 research questions which met "consensus" and "priority" criteria in the *current* study, six questions addressed the same research topics as questions from 2007 and/or 2014. Four research questions were present in all three Delphi studies. The individual research topics identified in the current 2020 study, as well as 2007 and/or 2014 studies, are listed in Table 4.

Discussion

The practice of surgery has vastly evolved over the past decade, including advancements in surgical technology, perioperative care, and resident training, amongst others. Likewise, there has been an increased number of surgeon-scientists

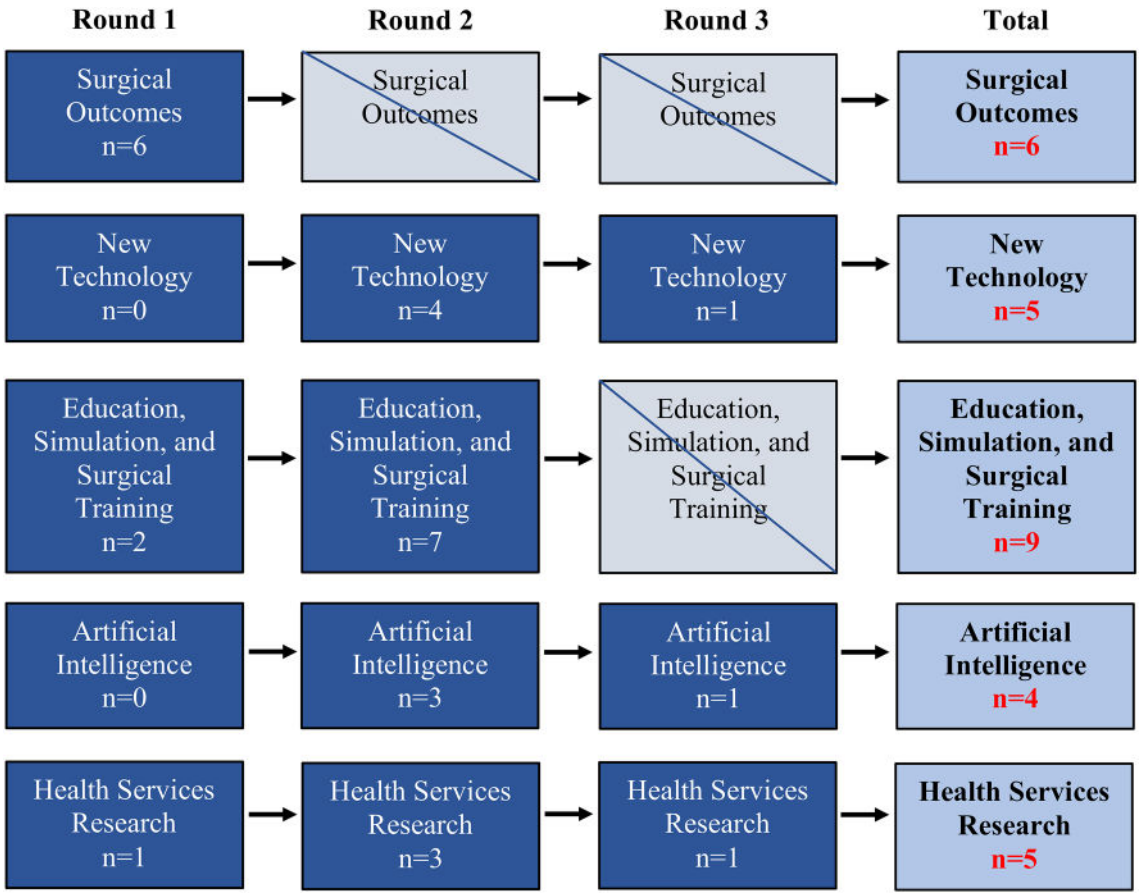

Fig. 1 Number of research questions meeting "consensus" and "priority" criteria in each round of the Delphi

entering the workforce possessing the necessary skills and motivation to produce high-quality research [13, 14]. SAGES, whose mission it is to innovate, educate, and collaborate to improve patient care, can help surgeons identify research questions which are of greatest importance in the field of gastrointestinal and endoscopic surgery.

In the current study, we used a modified online web-based Delphi method to survey the SAGES membership to identify 29 consensus priority research questions in the field of gastrointestinal and endoscopic surgery. We used the modified Delphi method to maximize participation among a geographically diverse group of surgeons, with greater than one-quarter of respondents in each round practicing outside of North America. Similar to previous Delphi studies from SAGES, a five-point Likert scale was used to rate questions according to their perceived importance in the field of gastrointestinal and endoscopic surgery. However, there are several notable differences in methodology between our study and the 2007 [10] and 2014 [11] studies. Rather than list the top 40 research questions irrespective of individual rating, we aimed to identify research questions that met criteria for both "consensus" and "priority", to better focus researchers on the most important questions. We used a single-round mean score of ≥ 3.5 to define "priority" according to the dispersion of the highest rated questions from the 2007 and 2014 Delphi studies [10, 11]. Furthermore, 70% agreement is often used to classify binary statements as important in Delphi methodology [15]. We also solicited an equal number of questions within each of the five selected research categories, in order to provide respondents with a wide variety of questions for rating. An NGT method was used to identify the most relevant research categories to the SAGES membership. Likewise, the final list of questions was stratified according to research category so that readers could more easily narrow in on their respective interests.

In comparing the results of the current study to those of the 2007 and 2014 SAGES Research Agendas, we identified several research topics that remained a priority in this society over the last 15 years. For instance, the optimal surgical treatment of patients with gastroesophageal reflux disease and obesity continues to be of importance to SAGES members. This is likely in part due to the considerable overlap between minimally-invasive and endoscopic surgery with upper gastrointestinal surgery, as highlighted in

Table 2 Consensus priority questions by research category

Research Question	Mean score (SD)
Surgical Outcomes	
1.How do modifiable risk factors (obesity, tobacco abuse, etc.) affect surgical outcomes?	4.17 (0.96)
2.What is the optimal treatment for obesity?	4.01 (0.99)
3.What is the most effective treatment option for: a) GERD alone; b) hiatal hernia with GERD; c) esophageal dysmotility with GERD and/or hiatal hernia?	3.94 (0.96)
4.What is the optimal education tool to engage patients in their care?	3.82 (0.99)
5.Does reporting surgeon outcomes have a measurable effect on patient outcomes?	3.71 (0.99)
6.How are risk prediction tools currently used in surgical practice?	3.50 (0.97)
Education, Training, and Simulation	
7.How can we best utilize video-based education and coaching to adopt new techniques?	4.11 (0.83)
8.What is the best method to teach newer techniques/technology to surgeons already in practice (including those in international, low resource, or community settings)?	3.90 (0.99)
9.What is the impact of video-based assessment on the surgeon's clinical outcomes?	3.84 (0.98)
10.How effective are hands-on courses in transfer to practice?	3.81 (0.98)
11.How much training is needed to acquire proficiency in advanced techniques (e.g. flexible endoscopy, robotics)?	3.80 (0.98)
12.What are the advanced endoscopic skills required of general surgeons?	3.76 (0.99)
13.How can we utilize courses and webinars to disseminate new technologies to residency programs?	3.69 (0.99)
14.Can competency in laparoscopic and robotic simulation be accurately correlated with operative autonomy and competency in patients?	3.60 (0.98)
15.How can we effectively teach and evaluate new technologies through current SAGES mechanisms (ADOPT, Master's Program, etc.)?	3.52 (0.94)
Health Services Research	
16.Which elements of enhanced recovery pathways have the greatest impact on outcomes?	4.12 (0.93)
17.Does enhanced recovery after surgery benefit all patient populations or are there outliers where there is decreased benefit or harm?	3.88 (0.95)
18.Do standardized prehabilitation programs improve outcomes of elective surgical procedures, and which patients benefit the most?	3.87 (0.93)
19.How does centralizing care in specialized centers affect patient access to care?	3.84 (0.95)
20.What is the relationship between surgical innovation and health care quality and costs?	3.78 (0.93)
New Technology	
21.How can we decrease the rate of staple line leaks with new technology?	4.20 (0.85)
22.What outcomes are important to measure after the implementation of new technology?	4.05 (0.84)
23.During cholecystectomy, do visualization techniques (near infra-red cholangiography, white light and IOC) prevent bile duct injury?	3.78 (0.99)
24.Should there be standards of interoperability (set by industry or physician groups) for new surgical devices, platforms, artificial intelligence, and data collection programs?	3.77 (0.99)
25.What are the clinical advantages of near-infrared fluorescence in laparoscopy?	3.60 (0.97)
Artificial Intelligence	
26.How can artificial intelligence be used to help with preoperative and intraoperative decision-making for patient safety?	3.85 (0.87)
27.How can artificial intelligence be used in training and education to improve competency?	3.79 (0.95)
28.Can artificial intelligence assist in recognition of pathology in endoscopy?	3.78 (0.99)
29.Can an algorithm be developed to support decision-making regarding the management of high-risk colorectal anastomoses?	3.64 (0.96)

SD standard deviation, *GERD* gastroesophageal reflux disease, *ADOPT* acquisition of data for outcomes and procedure transfer, *IOC* intraoperative cholangiogram

the fellowships completed by the Delphi respondents. However, it also underscores the challenge of treating patients with these diseases and the unanswered questions that remain. SAGES has also been at the forefront of surgical education and simulation research, and questions pertaining to teaching new surgical techniques and the measurement of operative proficiency remain paramount. A recent non-SAGES Delphi study aimed at determining priorities in surgical simulation research highlighted many of the same questions [16], including their highest ranked question

Table 3 Inter-rater agreement for each research category across all three Delphi rounds

Research Category	Round 1[a]	Round 2[a]	Round 3[a]
Surgical Outcomes	0.96	/	/
New Technologies	0.95	0.97	0.96
Education, Simulation, and Surgical Training	0.95	0.96	/
Artificial Intelligence	0.94	0.95	0.94
Health Services Research	0.95	0.97	0.05

[a]Values correspond to intra-class correlation coefficients

concerning the correlation between competency in simulation with proficiency in practice. Our study also emphasized several *novel* research topics, which reflect a new era of surgical practice and training. For example, several questions focused on video-based learning and the dissemination of knowledge through modern educational platforms (e.g. webinars, SAGES programs). Furthermore, there was an entire section dedicated to research questions on artificial intelligence, which is increasingly being incorporated into surgical research. [17].

The results of this study have potential to help surgeons, academics and researchers in several ways. First, the research questions identified in this study may be used to generate hypotheses for future grant submissions, both within the SAGES Research Grant competition and to national and international granting agencies. As part of the evaluation process for new grant submissions, SAGES places added value on those research questions which align with the goals and priorities of the membership [18]. Therefore, this study may be highly informative for those planning to submit research grants to SAGES within the coming years. The questions within this study were also conceived by individual task force and committee members, most of whom are affiliated with notable subspecialty societies. Thus, these research questions are likely to reach broad interest outside of SAGES as well. In addition to being considered for research funding, studies addressing these research questions may be of increased interest to peer-reviewed surgery journals, such as Surgical Endoscopy. A recent systematic review reported that 27% of registered surgical randomized controlled trials were never published, and the authors hypothesized that considerable research waste may arise through the pursuit of low-priority research questions [19]. Finally, this output represents the views and opinions of SAGES membership. For members looking to start new educational and/or collaborative initiatives—particularly within individual SAGES task forces and committees—the research questions identified within this study can be used as a foundation for future work.

The strengths of this study lie in its robust Delphi methodology and clinical relevance to modern-day gastrointestinal and endoscopy surgery; however, there are limitations as well. First, we limited questions according to pre-selected research categories, which may have narrowed the scope of our results. While the research categories selected for this study were the outcome of a NGT process involving members of the SAGES RCDC, questions pertaining to basic science, for example, may still have been of interest to SAGES members. Second, in an effort to present a wide range of questions from all categories, we terminated the Delphi for any given research category after five or more consensus priority research questions were identified. This may have precluded additional questions from meeting criteria for "priority" and "consensus" on subsequent rounds, where applicable (e.g. Surgical Outcomes). Finally, while the number of respondents was similar to previous Delphi studies, it represents a small proportion of SAGES members

Table 4 Priority research topics identified in both the 2007 and/or 2014 Delphi study and the 2020 Delphi study

Research Question	2007 Delphi	2014 Delphi	2020 Delphi
What is the best treatment for GERD?	⊗	⊗	⊗
What is the best treatment for obesity?	⊗	⊗	⊗
What is the best method to teach surgeons new techniques in gastrointestinal and endoscopic surgery?	⊗	⊗	⊗
How do we best measure operative proficiency and does it correlate with clinical outcomes?	⊗	⊗	⊗
What new devices/technology can we use to decrease anastomotic leak?	⊗		⊗
How should new technologies be introduced into surgical practice and should there be standards of operability?	⊗		⊗
What is the relationship between surgical innovation and new technology and healthcare cost?		⊗	⊗
What are the best techniques and new technologies to prevent bile duct injuries?		⊗	⊗

GERD gastroesophageal reflux disease

overall; thus, the results may not be generalizable to the entire society.

Conclusions

Consensus priority research questions in gastrointestinal and endoscopic surgery were identified across five different research categories. These results can provide direction and areas of interest for funding and investigation for future studies.

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Declarations

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