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Development of S.Tool: An electronic diary for assessing bowel symptoms after rectal cancer surgery

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ABSTRACT

Introduction: Rectal cancer treatment has improved survival, but postoperative bowel dysfunction, known as Low Anterior Resection Syndrome (LARS), significantly impacts Quality of Life. However, current assessment tools lack granularity to assess all LARS symptoms. Therefore, this study developed a mobile application (S.Tool), designed to be patient-friendly and easy to interpret, tailored to monitor LARS.

Materials and methods: This study followed eight phases: 1) literature review, 2) internal expert group, 3) pre-Delphi patient focus group, 4) international Delphi Survey (conducted in two rounds in Dutch and English with five stakeholder-groups including colorectal surgeons, radiation and medical oncologists, pelvic floor physiotherapists, colorectal clinical nurse specialists and patients), 5) post-Delphi patient focus group, 6) consensus meeting, 7) forward-backward translation, and 8) development of the application. Descriptive statistics, percentages and median (range), were used to present the data.

Results: A total of 122 participants, including 22 patients, participated in the international Delphi survey. Of these, 103 (84%) completed the first round and 97 (80%) the second round. After the Delphi rounds, 25 items were included in the bowel diary, 10 excluded and 8 discussed in the consensus meeting. Based on feedback from the post-Delphi patient focus group, the consensus meeting decided to include 6 of the 8 discussed items, resulting in 31 items. These guided the development of the S.Tool application.

Conclusion: The S.Tool application is an innovative, multidisciplinary bowel diary for assessment and follow-up of patients with LARS. It generates visual summaries shareable with healthcare professionals to support clinical decision-making and personalized care.

1. Introduction

Colorectal cancer is the third most common cancer, with approximately 35% of cases located in the rectum [1,2]. Multimodal treatment (radio-chemotherapy and radical surgery) of rectal cancer has improved local control and long-term survival over the years [3]. Given the improved survival rates, postoperative gastrointestinal function and related Quality of Life (QoL) have gained importance [4]. A wide spectrum of bowel symptoms, including variable bowel function, altered stool consistency, increased frequency, urgency, incontinence and emptying difficulties, collectively impact QoL. These symptoms and consequences have been summarized in an international consensus

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definition [5] known as Low Anterior Resection Syndrome (LARS) [6–11].

Given that approximately 80% of patients experience severe and invalidating symptoms one month post-surgery and about 60% still have these symptoms after two years, it is crucial to assess all LARS symptoms in every patient and tailor individual care accordingly [12]. Unfortunately, to date, a comprehensive evaluation to identify the different aspects of LARS is lacking, leading to inadequate diagnostics, follow-up and management of symptoms.

Only three questionnaires specifically assess LARS [13–15]: the Low Anterior Resection Syndrome-score (LARS score) [16], the Memorial Sloan-Kettering Cancer Center Bowel Function Instrument (MSKCC-BFI) [17] and the Colorectal Functional Outcome (COREFO) [18] questionnaire. The LARS score is the most used tool to assess bowel symptoms after rectal cancer surgery due to its effectiveness in reflecting the impact on QoL, defining severity categories and its ease of use, as it consists of only five questions [13]. However, it has limitations. The score may overestimate the impact on QoL and appeared insensitive to evacuatory dysfunction [19]. Furthermore, because LARS symptoms are also common in the general population, the LARS score exhibited high sensitivity but low specificity [20,21]. These issues question the LARS score's effectiveness as a single tool [19,22]. While it might have served as a useful screening instrument, it lacks the nuance and granularity required to accurately evaluate bowel dysfunction following rectal cancer treatment or the outcomes of therapeutic interventions [3,14,22].

Furthermore, questionnaires are prone to recall bias and may miss day-to-day variations in bowel symptoms [23–25]. A real-time electronic bowel diary, as recommended by current guidelines, can mitigate this issue [26–28]. However, available diaries often focused on fecal incontinence only, while LARS involves a broader range of symptoms [26,29–37]. Therefore, the present study developed the S.Tool mobile application, a patient-friendly, easy-to-interpret bowel diary tailored to LARS.

2. Materials and methods

A systematic approach was used to develop a bowel diary, taking into account the latest evidence and expert opinions [5]. The research was conducted following eight phases: 1) Literature review; 2) Internal expert group; 3) Pre-Delphi patient focus group; 4) International Delphi Survey; 5) Post-Delphi patient focus group; 6) Final consensus meeting; 7) Forward-backward translation; and 8) Development of the mobile application.

1. Literature review (Phase 1)

A literature review was conducted by two independent reviewers on PubMed for studies published between 2003 and 2023, using keywords and MeSH terms such as diary, bowel movement, stool, fecal incontinence, bowel symptoms, feces and defecation as outlined in Appendix 1. Only articles mentioning a bowel diary in the full text were included. Additionally, manual screening was conducted for studies indexed with the MeSH term ‘LARS’, due to its international definition only being established in 2020 [38]. However, none of these studies were included, as they did not provide a detailed bowel diary.

From the included articles, the same two reviewers extracted items used in the bowel diaries. In addition, questionnaires assessing bowel symptoms from the included articles were reviewed to identify any additional items not previously listed.

2. Internal expert group (Phase 2)

An interdisciplinary team—three colorectal surgeons, a pelvic floor physiotherapist, a dietitian, a liaison psychologist and three colorectal nurse specialists from University Hospitals Leuven (UZ Leuven, Belgium)—reviewed item clarity found in literature (phase 1), identified missing items and determined stakeholders for the Delphi Survey.

3. Pre-Delphi patient focus group (Phase 3)

A total of ten Dutch-speaking patients who had undergone rectal cancer surgery at UZ Leuven were recruited for the pre-Delphi patient focus group [39]. To ensure a diverse representation in terms of age, gender and LARS severity, a clinical nurse specialist selected the patients based on their medical records. The researcher then contacted the selected patients to invite them to participate in the focus group, which took place at UZ Leuven for 2 hours and was conducted in two parts. First, patients discussed expectations for the new bowel diary and challenges with current symptom tracking. In the second part, they reviewed the 43 items that had been revised by the internal expert group (phase 2), clarifying unclear ones with additional explanations and/or visuals and identifying any missing items. The semi-structured script of this patient focus group can be found in Appendix 5.

4. International Delphi Survey (Phase 4)

Given the complexity of LARS and the need for thorough insights from multiple stakeholders including healthcare professionals and patients, the Delphi method was found most suitable for selecting relevant items [40–42].

This Delphi Survey, available in Dutch and English, consisted of two rounds [40–42]. Each of the five international stakeholder groups, included at least 10 to 18 participants: 1) colorectal surgeons; 2) radiation and medical oncologists; 3) pelvic floor physiotherapists; 4) colorectal clinical nurse specialists; and 5) patients [42]. Medical stakeholders were selected from established international panels of experts. Furthermore, patients were recruited from UZ Leuven and different (inter)national patient associations.

Participants were initially emailed to confirm their willingness to join the Delphi Survey. After confirmation, they received the questionnaire for round one to rate each item's relevance using a 1-9 Likert scale, where 1 represented ‘Not relevant’ and 9 indicated ‘Essential’. Stakeholders could also suggest additional items. A priori decision rules were set for item inclusion and exclusion. An item was included if at least 67% of each stakeholder group rated it between 7 and 9, indicating high priority. Conversely, an item was excluded if at least 67% of each stakeholder group rated it between 1 and 3, or if at least 67% of three or more stakeholder groups rated it between 1 and 3 and less than 15% rated it between 7 and 9, indicating low priority. Items not meeting these criteria were reassessed in round two, using the same Likert scale. In round two, participants received their individual score per item as well as the median score for each stakeholder group per item. Following each round, the scientific committee, consisting of one representative from each stakeholder group, reviewed the process and discussed the decision rules if needed [38].

5. Post-Delphi patient focus group (Phase 5)

Patients who took part in the pre-Delphi patient focus group were invited to join the post-Delphi focus group, provided that they had participated in the Delphi survey. The post-Delphi group discussed the included and excluded items, as well as those items for which no consensus was reached after the second round of the Delphi Survey. To ensure that patient perspectives were adequately considered, the patient focus group was held separately from the consensus meeting. This separation was necessary because patients faced challenges in expressing opinions in the presence of healthcare professionals and due to language barriers [38]. Their feedback was then presented at the consensus meeting. The semi-structured script used to guide this patient focus group is provided in Appendix 5.

6. Final consensus meeting (Phase 6)

An online consensus meeting was held for medical stakeholders who completed one Delphi round to finalize bowel diary items. Polling was used to review items that did not meet the inclusion and exclusion criteria after the two Delphi rounds.

7. Forward-backward translation (Phase 7)

The original English items were translated into Dutch using a forward–backward translation procedure. Two independent native Dutch speakers translated the items into Dutch, after which a native English speaker, blinded to the original version, back-translated them into English. Discrepancies between the original and back-translated versions were discussed and resolved by consensus, resulting in a Dutch version. Subsequently, the Dutch version was translated into French using a similar forward–backward translation procedure. To ensure cross-linguistic validity, the translations focused on preserving conceptual meaning over literal wording, following WHO and EORTC guidelines [43,44]. As a result, in the next phase (Phase 8), the app will be developed in three languages: Dutch, English, and French.

8. Development of the mobile application (Phase 8)

Following final consensus on item selection in Phase 6, relevant answer categories were identified through literature review in Phase 1. These options were discussed with patients from the post-Delphi focus group, who gave input on answer categories and completion frequency (per toilet visit, daily, or weekly). Based on their input, a proposed structure for the application was developed and subsequently reviewed by the same internal expert group involved in Phase 2. Technical development of the mobile application was then initiated, informed by both patient feedback and expert validation.

Data analysis

Descriptive statistics including percentages and median (range) were presented.

Ethical approval

Ethical approval for this study was granted by the University Hospitals Leuven (S68746) and the study protocol was registered on ClinicalTrials.gov (NCT06274190).

3. Results

The results follow the eight development phases previously described in the Materials and methods section as outlined in Fig. 1.

1 Literature review

After the exclusion of 366 articles, 316 full-text articles were included in the final analysis (Fig. 2).

From these, 42 items were compiled from bowel diaries and one additional item was derived from questionnaires: 'Level of activity prior to fecal loss'. In total, 43 potential items for the bowel diary were identified.

2. Internal expert group

The interdisciplinary team at UZ Leuven reviewed the potential items from the literature, rephrased three for clarity, added three and removed three. They also identified stakeholders for the Delphi Survey: colorectal surgeons, oncologists, pelvic floor physiotherapists, colorectal nurse specialists and patients.

3. Pre-Delphi patient focus group

The participating patients had a mean age of 57 years, ranging from 33 to 73 years. Furthermore, the group comprised seven women and three men. The mean time since their surgery was three years, ranging from one to five years and the mean LARS score at time of the focus group was 22 out of 42, with a range from 0 to 39.

Firstly, patients expressed a need for a user-friendly bowel diary that provides insight into bowel symptoms, progression and risk factors. They suggested merging two items into one, clarifying three, adding explanation and figures for another three and adding a new item on 'Influence of diet or beverages on bowel movements,' noting foods and drinks triggered symptoms.

4. International Delphi Survey

A total of 122 participants from 19 countries were willing to participate the Delphi Survey, including 88 healthcare professionals (mean age 47 years; 37 males (42%) and 51 females (58%)) and 22 patients (mean age 54 years; 10 males (45%) and 12 females (55%)) participated in round one and/or two. Of these, 103 (84%) participants completed the first round and 97 (80%) completed the second round (Fig. 3). Both overall completion rates exceeded the required rate of 70% for each round [41]. Participant characteristics are detailed in Table 1 and geographic details are provided in Appendix 2.

After the first Delphi round, 12 out of 43 items were included in the bowel diary based on the a priori decision rules, but no items were excluded. Therefore, the scientific committee acknowledged overly strict a priori decision rules and revised the exclusion criteria: an item would be excluded if less than 67% of each stakeholder group assigned a score between 7 and 9 (Appendix 3). Due to the revised exclusion criteria, nine items were excluded. However, the scientific committee re-evaluated three in the second round – 'the level of activity prior to defecation' and 'to fecal loss' and 'the presence of bloating during the day' - because 50-55% of the patients rated them as high priority. As a result, 12 items were included, 6 items were excluded and 25 items proceeded to the second round.

In round two, the scientific committee reviewed additional stakeholder-suggested items, but concluded that they were already covered by the existing ones. Again, no items met the a priori exclusion items, so the revised exclusion criterion and a new inclusion criterion -requiring relevance from four out of five stakeholder groups-were applied (Appendix 3). Consequently, 13 items were included, 4 excluded and 8 lacked consensus. Appendix 4 provides bar charts of item ratings from rounds 1 and 2.

5. Post-Delphi patient focus group

In total, eight patients participated in the post-Delphi focus group. Patients received the Delphi results and discussed the eight unresolved items, concluding that two should be excluded. The first, 'size of bowel movement per defecation', initially received high prioritization from patients, who explained that larger-sized bowel movements gave them a greater sense of security and reduced unexpected toilet visits. However, after discussion they concluded that this item was redundant, as it is already addressed by other items, such as 'sense of incomplete evacuation per defecation'. The second item, 'fear of painful defecation', was excluded because patients reported not experiencing or fearing painful defecation. The remaining six items, which patients considered important for inclusion, address 'the number of false defecation alarms per day', 'the location of pain', 'the need for digital stimulation', 'the need for splinting or vaginal/perineal (counter)pressure' and 'fear of eating related to bowel symptoms'. Finally, five patients proposed reinstating the excluded item 'Presence of bloating during the day' into the bowel diary, as they occasionally experienced this symptom.

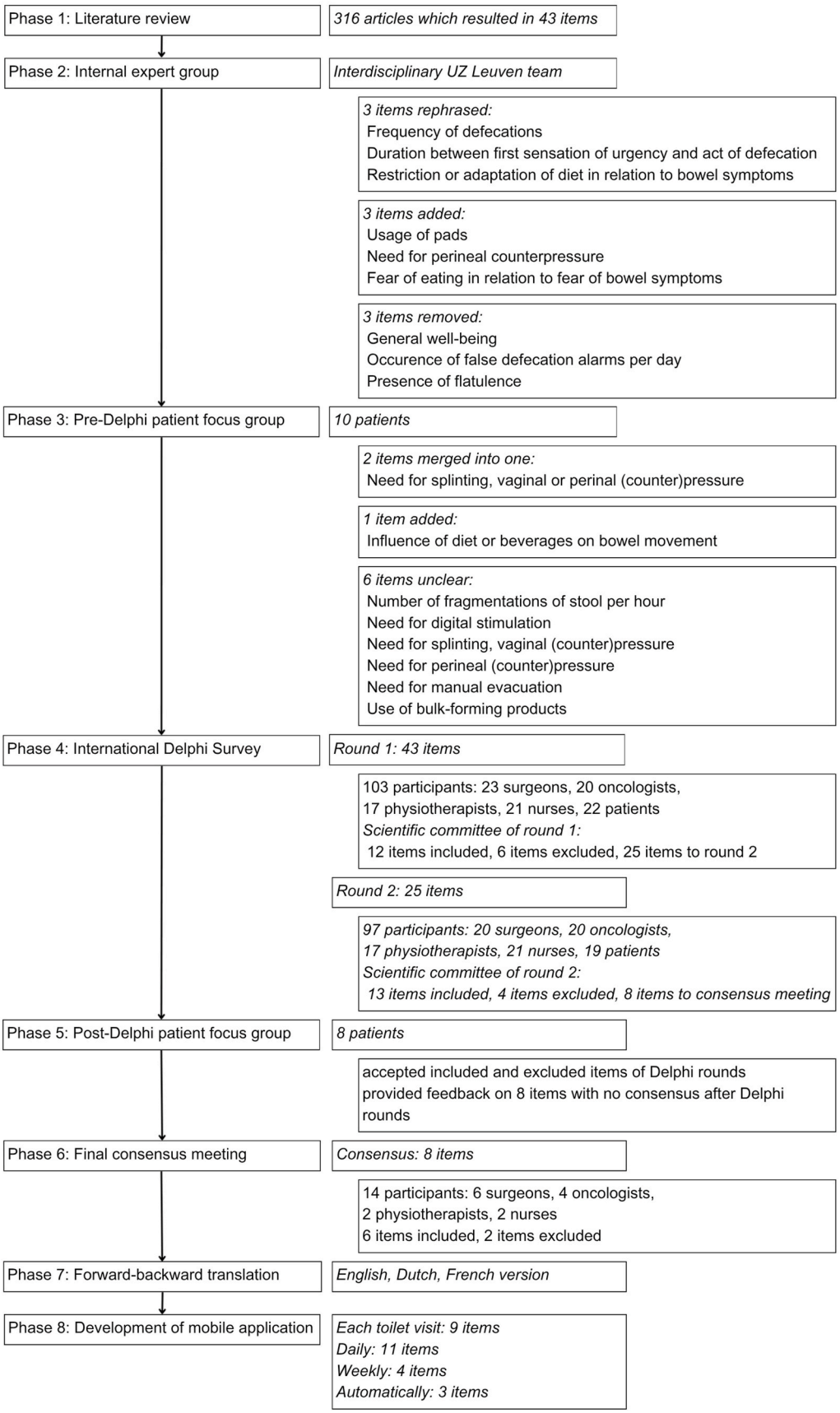

Fig. 1. Study flow.

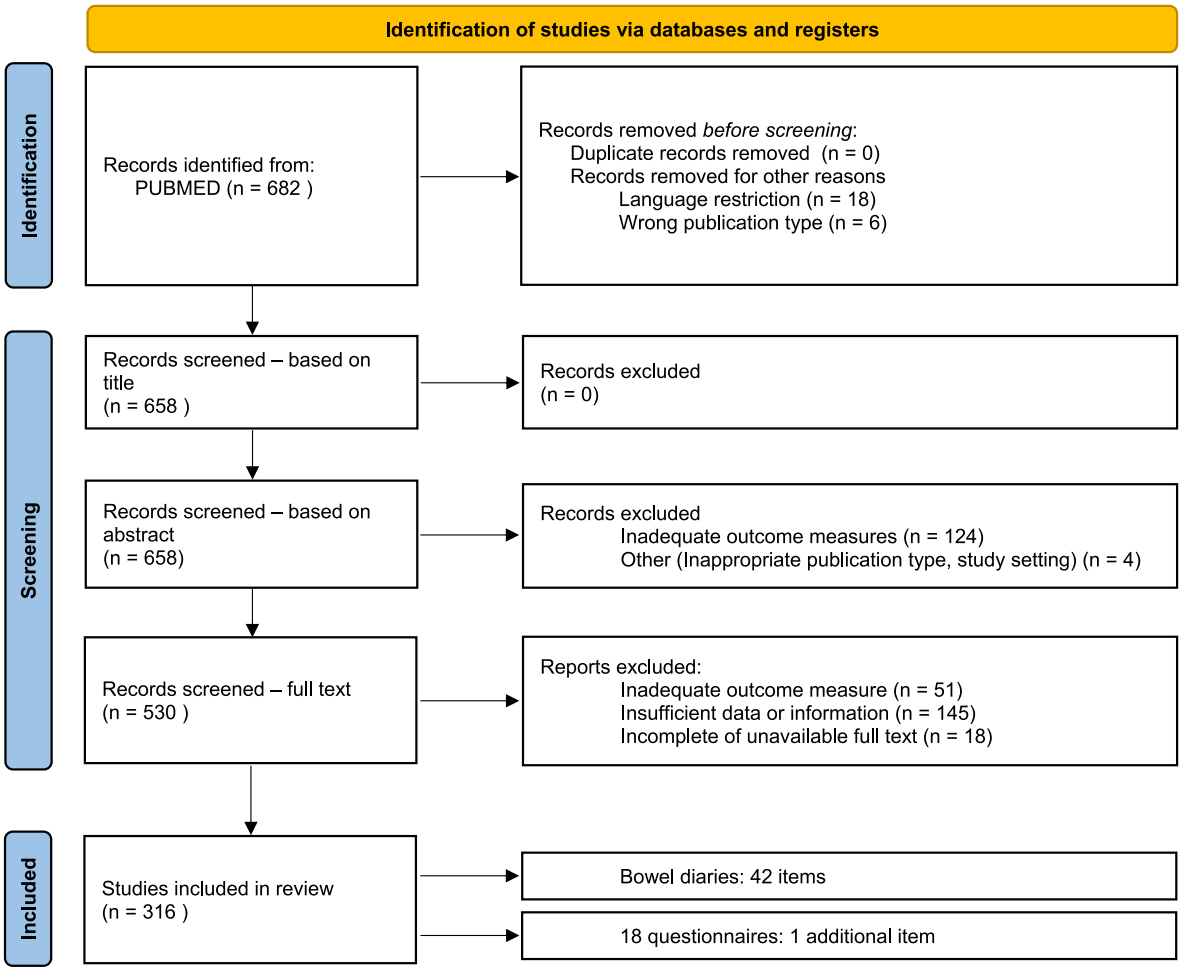

Fig. 2. Prisma flow diagram.

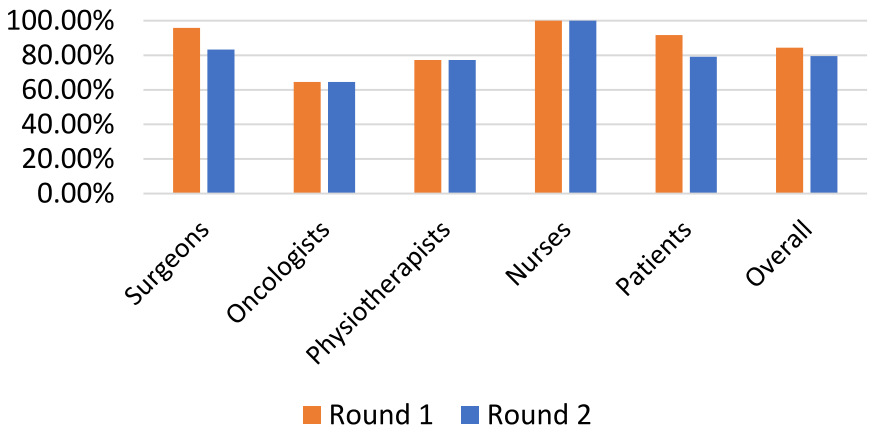

Fig. 3. Response rate of the international Delphi Survey.

6. Final consensus meeting (8 items)

A total of 14 participants attended the online consensus meeting: six colorectal surgeons, two medical oncologists, two radiation oncologists, two pelvic floor physiotherapists and two colorectal clinical nurse specialists. These participants largely aligned with the post-Delphi patient perspectives, except for the item 'Presence of bloating during the day'. They concluded that this item should not be included in the bowel diary, as less than 67% of each stakeholder group rated it high priority. The final list of 31 included and 10 excluded items is shown in Table 2.

Table 1
Baseline characteristics of the Delphi Survey participants.

Round	Health care professionals	Patients
	N = 88	N = 22
	1 + 2	1 + 2
Gender (%)		
Male	42	45
Female	58	55
Age (%)		
30-39	26	14
40-49	38	14
50-59	25	45
60-69	11	18
70-79	0	9
Type of hospital/practice (%)		
Academic hospital	66	
General hospital	28	
Private hospital	1	
Private practice	5	
Years of experience		
Median (range)	10(2-30)	
Years since surgery		
Median (range)		2,5(0,3-6,0)
(Neo)adjuvant therapy		
Chemoradiotherapy (%)		59
Chemotherapy (%)		23
None (%)		18
Temporary stoma (%)		77
Previously used a paper bowel diary (%)		59

7. Forward-backward translation

For both the Dutch and French versions, the two independent forward translations showed only minor differences, which were resolved through discussion between the translators. The subsequent backward translations confirmed that the original meaning of the items had been preserved.

8. Development of the mobile application

Table 3 presents the items with their corresponding answer categories, as determined by the post-Delphi patient focus group and the internal expert group. The resulting mobile application, S.Tool (Scientific Stool Tool), includes four types of data entry: at each toilet visit, patients complete nine questions, which can be entered retrospectively for the current and previous day. Daily items, accessible from 6:00 p.m. until the following day, consist of eleven questions. Weekly items, available on Sundays and Mondays, comprise four questions. In addition, the app automatically derives three variables based on patient input. Furthermore, within the application, patients can access additional explanations and illustrative visuals by clicking on the '?' icon next to each item, which clarifies professional terminology and symptom descriptions. The operational interface of the application is provided in Appendix 6. The app also generates visual outputs, including graphs and summary reports, which can be shared with healthcare professionals to facilitate clinical follow-up. The graphical outputs are presented in Appendix 7. More information is available at: www.stoolapp.be.

Table 2
Final list of included and excluded items based on international Delphi Survey.

Items included in the bowel diary	Round 1	Round 2	Consensus Meeting
Frequency of defecations	X		
Nightly defecation	X		
Color of stool per defecation	O		
Size of the bowel movement per defecation	?	?	O
Stool consistency per defecation	X		
Consistency of each fecal loss episode	?	X	
Smell of the stool	O		
Awareness of each fecal loss episode	X		
Number of soiling episodes	?	X	
Usage of pads	?	X	
Number of pads per day	?	O	
Size of each used pad	O		
Degree of urgency per defecation	X		
Duration between first sensation of urgency and act of defecation	?	X	
The number of false defecation alarms per day	?	?	X
Presence of pain	?	X	
Location of pain	?	?	X
Intensity of pain	?	X	
Level of activity prior to each defecation	?	O	
Level of activity prior to fecal loss	?	O	
Restriction or adaptation of diet in relation to bowel symptoms	X		
Presence of bloating during the day	?	O	
Presence of nausea during the day	O		
Presence of vomiting during the day	O		
Lack of appetite	O		
Presence of rectal bleeding	?	X	
Number of fragmentations of stool per hour	X		
Duration of defecation	?	X	
Need for digital stimulation	?	?	X*
Need for splinting, vaginal or perineal (counter)pressure	?	?	X*
Need for manual evacuation	?	?	X*
The influence of diet or beverages on bowel movement	?	X	
Use of laxatives	?	X	
Use of anti-diarrea medication	X		
Use of bulk-forming products	X		
Use of (water)enemas or colonic irrigation	?	X	
Need to strain per defecation	?	X	
Sense of incomplete evacuation per defecation	X		
Frequency of flatus incontinence	?	X	
Fear of painful defecation	?	?	O
Fear of eating in relation to fear/avoidance of bowel symptoms	?	?	X
Impact of bowel problems on activities of daily living	X		
Satisfaction with bowel function in general	X		
Included items	12	13	6
Excluded items	6	4	2
To next round	25	8	0

X: Item is included in the bowel diary; O: Item is excluded from the bowel diary; ?: Item is re-evaluated in the next round; *: Item will be integrated into the response options of the item 'Need to strain per defecation'

4. Discussion

This study developed the S.Tool mobile application, a comprehensive and patient-centered bowel diary designed for monitoring Low Anterior Resection Syndrome (LARS) after rectal cancer surgery. A rigorous methodology was employed, integrating patient perspectives and utilizing the Delphi method with two rounds involving 122 participants from five international stakeholder groups [5]. The study identified 31 essential items that were incorporated into the S.Tool mobile application.

Table 3
Items with answer categories and app-derived variables in the S.Tool mobile application.

Log a new toilet visit		
Stool Consistency	Choose the type on the scale that best corresponds to the consistency of your stool.	Bristol Stool Scale
Fecal incontinence	Have you had fecal incontinence?	Yes; No
Consistency of fecal loss*	Choose the type on the scale that best corresponds to the consistency of fecal loss.	Bristol Stool Scale
Soiling episodes	Have you had a smear of feces in your underwear, pants, or pad?	Yes; No
Degree of urgency	Do you have such a strong urge to open your bowels that you had to rush to the toilet?	No urgency; Slight urgency; Moderate urgency; Severe urgency
Need to strain	How hard do you have to strain to pass bowel movements?	Normal; Hard; Very hard requiring interventions
Straining intervention*	Which intervention did you need?	Digital stimulation; Splinting, vaginal or perineal (counter)pressure; Manual evacuation
Incomplete evacuation	Do you have an incomplete bowel movement, like you do not finish?	Yes; No
Duration of defecation	How many minutes do you spend in the lavatory?	<5 min; 5-10 min; 10-20 min; 20-30 min; More than 30 min
Fill in the daily questionnaire		
False defecation alarms per day	Do you feel like you need to open your bowels, but it won't come out?	Never/rarely; Sometimes: < half the time; Usually: > half the time; Always
Presence of pain	Do you have pain?	Yes; No
Location of pain*	Where did you have the most pain?	Abdomen; Anal; Skin
Intensity of pain*	Rate the level of your pain.	NRS scale 0-10 (0: No pain; 5: Moderate pain; 10: Worst possible pain)
Flatus	Do you ever have occasions when you cannot control your flatus (wind)?	Never/rarely; Sometimes: < half the time; Usually: > half the time; Always
Fear of eating	Did you have fear of eating due to concerns about bowel symptoms?	Yes; No
Influence of diet or beverages	Indicate which foods or beverages have affected your bowel movements.	Selection from expandable food categories (drinks, vegetables, fruits, other food)
Medication or dietary supplements	Have you taken any medication or dietary supplements for bowel symptoms?	Yes; No; If yes: patient selects medication from predefined list; App categorizes as anti-diarrheal, laxatives, or bulk-forming
Colonic irrigation	Did you use enemas or colonic irrigation?	Yes; No
Daily impact	How would you score the impact of your bowel problems on your activities of daily living?	NRS scale 0-10 (0: No impact; 5: Moderate impact; 10: Heavy impact)
General satisfaction	How satisfied are you with your bowel function in general?	NRS scale 0-10 (0: Very dissatisfied; 5: Moderately satisfied; 10: Very satisfied)
Fill in the weekly questionnaire		
Awareness of each fecal loss*	Did you leak, without being aware of it at first, during the past week?	Never/rarely; Sometimes: < half the time; Usually: > half the time; Always
Usage of pads	Have you used a pad or anal plug in the past week?	Yes; No
Rectal bleeding	Have you experienced blood loss during your bowel movements in the past week?	Yes; No
Restriction or adaptation of diet	Over the last week, how often have you restricted the amount or type of food you eat because of your bowel problems?	Never; 1-3 days/week; 4-6 days/week; Daily
Variables automatically derived by the app		
Frequency of defecations		
Frequency of nightly defecation		
Number of fragmentations of stool per hour		

Items marked with an asterisk (*) are conditional items that appear in the app only if relevant.

Various questionnaires are used for assessing LARS, but they have disadvantages. Firstly, these questionnaires reflect the patient's current state rather than changes from baseline [24,25]. Secondly, they typically miss day-to-day variations in bowel symptoms [23]. To address these limitations, guidelines highlight the need for prospective electronic bowel diaries [26–28]. These diaries allow patients to record each bowel movement and stool leakage in real-time, serving as a reference method [15]. Building on this need, our study identified 31 items for developing a bowel diary. These items cover all bowel symptoms and consequences outlined in the LARS definition [5], including 3 related to stool frequency, 5 to fecal incontinence, 3 to urgency, 1 to stool consistency, 7 to emptying difficulties, 3 to pain, 4 to medication, 3 to eating and 2 to quality of life.

To assess how the comprehensive bowel diary compares to existing tools, literature on previous bowel diaries was reviewed and analyzed against the LARS definition. Of the ten articles that detailed the content of their bowel diary in a diverse population, six assessed fecal incontinence [26,29,31,33,34,37], while four addressed issues such as female anorectal dysfunction [30], vaginal reconstructive surgery [32], defecation habits [45] and constipation [36]. None of the existing bowel diaries evaluated all components of the LARS definition, whereas the aforementioned items included the broad range of symptoms and consequences of rectal cancer treatment. Additionally, only two diaries included dietary considerations [30,33]. Consequently, this item was also added by the patients in our patient focus group. Moreover, the need for manual maneuvers were mentioned in just two studies [30,45]. Furthermore, medication use was assessed in nine out of ten articles, though only briefly [26,29–32,34,36,37,45].

4.1. Clinical implications

As highlighted in the management guidelines for low anterior resection syndrome (LARS) by Christensen et al. (2021), patients with LARS are often treated as a single entity, despite presenting with distinct symptom profiles—such as fecal incontinence, fragmentation/clustering, and constipation—each driven by different underlying mechanisms and requiring tailored treatment strategies [3]. To address this, specific care pathways have been developed for these clinical profiles: e.g. fecal incontinence may be managed with loperamide, fragmentation and clustering with soluble fibers or bulking agents, and emptying difficulties with enemas, while physiotherapy can help improve stool frequency and continence [3,46].

Current assessment tools, such as the LARS score, lack sufficient granularity to capture the full spectrum of postoperative bowel dysfunction or to evaluate the outcomes of these targeted interventions. By providing a more detailed and structured assessment of individual symptoms, the development of this digital app offers a clinically meaningful tool: it can guide personalized treatment decisions, monitor patient responses to specific therapies, and facilitate high-quality research on the effectiveness of individual interventions, ultimately

addressing critical gaps in LARS management.

A major strength of this study was the development of the mobile application (S.Tool) to assess all LARS-related symptoms and consequences following. Additionally, the methodology is robust, involving eight distinct phases and ensuring early inclusion of patients in the diary's development. The study also benefits from a broad range of opinions gathered from five different international stakeholder groups and achieved high response rate in both Delphi rounds. A limitation of the current study was that the bowel diary comprises a large number of items (31 items), which may contribute to participant burden and incomplete data. To address this, items were distributed across toilet visits, daily and weekly entries with three variables automatically calculated by the app. The intuitive navigation and electronic format further ease completion. Future research (currently in progress) will focus on the evaluation of app usability in a balanced group (age, educational level, level of bowel complaints …) of 10 patients using the System Usability Scale (SUS) and semi-structured interviews. Consequently, to support scale development and evaluation of the psychometric properties of the application, a large group of patients will be recruited to complete the application for 14 consecutive days. Hence, item reduction to identify and eliminate redundant items, exploratory factor analysis and confirmatory factor analysis will be applied. Finally, psychometric properties (reliability, internal consistency, construct, convergent and divergent validity and responsiveness) will be evaluated.

In conclusion, this study identified 31 items forming the basis of the S.Tool application for evaluating all LARS-related symptoms and consequences. The S.Tool captures the full spectrum of the LARS definition and additional aspects such as diet, evacuation techniques and medication. The robust methodology, which involved (inter)national stakeholder groups, including patients and achieved high response rates, supports the validity of the findings.

Author's contribution

LL, ADH, EC, EMC, HV, and IG conceived the study. LL, LD, HV, and IG collected the data. LL, ADH, EC, AW, GB, KH, GR, JD, LD, ND, AD, HV, and IG analyzed and interpreted the data. LL, ADH, EC, and IG drafted the manuscript. All authors have reviewed the manuscript and approved the final draft.

Ethical approval

The study was approved by the Ethics Committee of the University Hospitals Leuven on April 10, 2024 (approval number: S68746) and the study protocol was registered on ClinicalTrials.gov (NCT06274190). The study was conducted in accordance with the approved protocol and ethical standards of the Declaration of Helsinki of 1964 and later amendments. Informed consent was obtained by providing patients with detailed information about the study. If they agreed to participate, they signed the consent form. Once signed, patients could withdraw from the study at any time.

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Declaration of interest statement

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Given his role as Associate Editor, Albert Wolthuis had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to another journal editor.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejso.2026.111755.

Data availability

All data generated or analyzed during this study are included in this article. Further inquiries can be directed to the corresponding authors.

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