Technical skills of endoscopic sinus surgery for performance assessment using the Delphi methodology

Mads Juhl Guldager[1], Steven Arild Wuyts Andersen[1], Jacob Melchiors[1], Emmanuel Prokopakis[2], Claire Hopkins[3], Christian von Buchwald[1]

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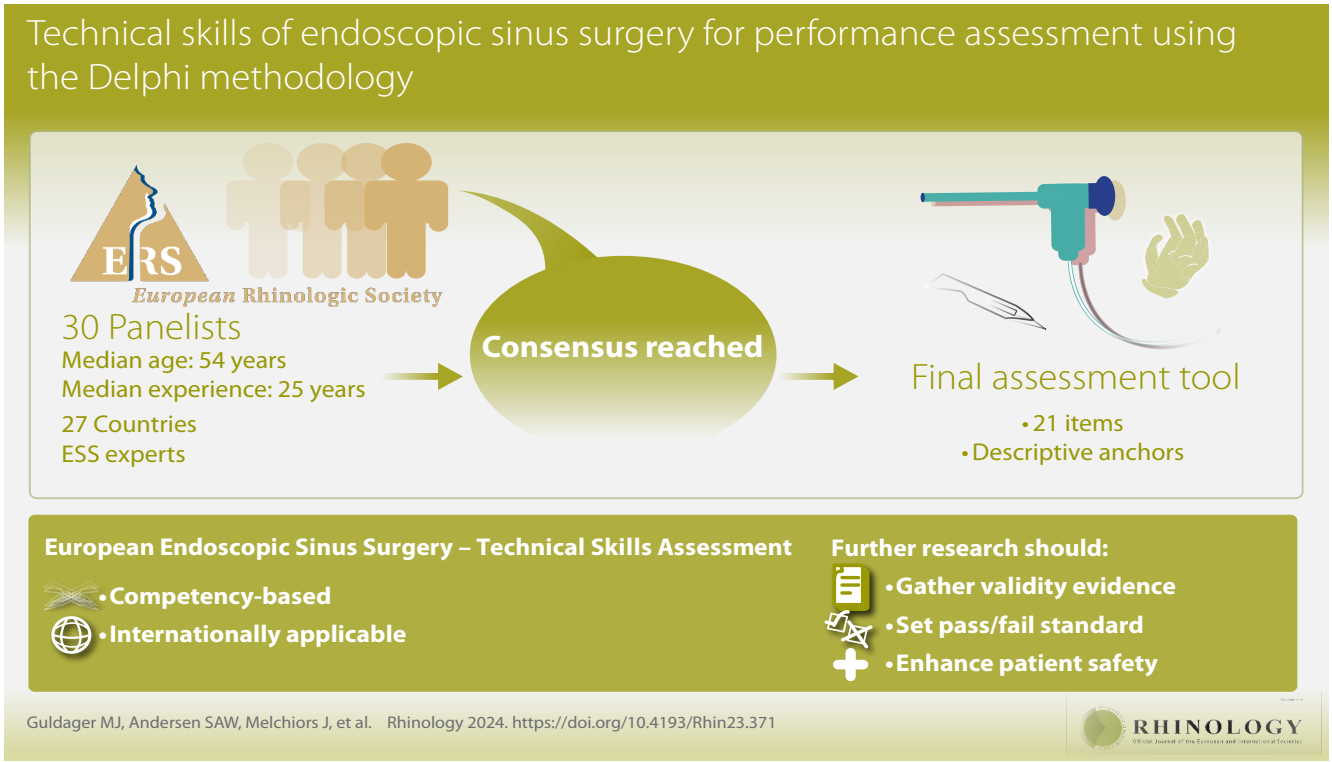

Abstract

Background: In surgical residency, competence has traditionally been defined by a specified number of surgical procedures. Modern advances in medical education and surgical fellowships have challenged this approach. It is widely accepted that a definition of a skill set, enabling a systematic, competency-based assessment is mandatory in surgical education.

Methodology: We conducted an international Delphi study with panelists from the European Rhinologic Society, representing 27 countries. Through four rounds, the panel reached consensus on the phrasing of an assessment tool-, for the technical skills of endoscopic sinus surgery (ESS).

Results: Thirty panelists participated throughout the study. The median age of the panelists was 54 years (range 31-66 years) with a median experience of 25 years (range 6-40 years). All were experts in the field of endoscopic sinus surgery. Consensus was reached. The final assessment tool consists of 21 items with descriptive anchors.

Conclusion: The assessment tool, European Endoscopic Sinus Surgery – Technical Skills Assessment (EE-TSA), enables a competency-based approach to acquiring and maintaining essential elements of endoscopic sinus surgery. The international Delphi panel makes the tool internationally applicable. Further research should gather validity evidence for EE-TSA, enhancing the assessment of ESS by setting a pass/fail-standard ultimately improving surgical outcomes and patient safety.

Key words: education, medical, rhinology

Introduction

In surgical residency, competency is traditionally achieved by performing a fixed number of surgical procedures. Technological advances rendered this approach to surgical training rather obsolete. In this context, several other factors should be borne in mind; a trend towards shorter workweeks, increasing demand for operating room efficiency, and diminishing time available for supervision compared to the number of residents to train. These factors all lead to a decreased exposure to surgery for surgical trainees. Modern-day surgical education further calls for evidence-based training curricula that ensure surgical skills acquisition with a focus on patient safety [1]. To accommodate this, simulation-based training for basic surgical technical skills is increasingly implemented [2,3].

The first step in developing a competency-based training curriculum is to define the basic technical skills of the surgical procedure. The next step is to ensure that assessment is structured, applicable in clinical and educational setting, and supported by validity evidence [4].

For endoscopic sinus surgery (ESS), current literature lacks a broad internationally-based consensus on what constitutes essential technical skills in relation to training and assessment. ESS is performed close to vital structures such as the brain, carotid arteries, orbit, and optic nerves. This complex anatomy and pathology display considerable anatomical variation between individuals/patients. Performance in ESS is further challenging because the surgeon needs to create a three-dimensional mental map of the surgical field based on two-dimensional imaging and split cognitive attention between the patient, endoscope, instruments, personnel, and in cases of computer-assisted surgery, the navigation equipment.

In defining a modern training curriculum in ESS, we first need to identify the essential skills of this procedure, and then frame these skills in relation to a structured tool for competency assessment. This will then enable surgical educators to develop evidence-based training curricula and establish a pass/fail standard level for competency in the procedure [2,5]. Previous studies have identified essential skills in relation to ESS in a single institutional setting or among only a few surgeons [6,7].

In defining what constitutes essential skills for assessment, we wanted broad consensus and therefore used the Delphi-methodology [8]. This has previously been employed in medical education [9–11]. The method first described by Norman Dalkey and Olaf Helmer, derives its name from the oracle of Delphi. It is especially suited for reaching consensus on complex and not-easily definable subjects - in this case, what constitutes important skills of the ESS procedure across different surgical traditions [12].

To achieve maximal generalizability and potential worldwide implementation of the final assessment tool, we recruited a panel of internationally well-recognized rhinologists through the European Rhinologic Society (ERS). Consequently, we developed this structured performance assessment for essential technical skills of ESS based on an international consensus.

Materials and methods

Participants and setting

As our target procedure for assessment, we chose ESS performed on adults by otorhinolaryngologists for the indication of acute or chronic rhinosinusitis not resolving with medical treatment. The surgery is performed with the intent of gaining access to, and establishing sufficient ventilation of- and drainage from, all paranasal sinuses. Therefore, we defined our content experts as surgical rhinologists in the field of otorhinolaryngology and members of the European Rhinologic Society (ERS). We invited the authors of the 2020 European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS2020) guidelines with surgical expertise as panelists as these can be considered key opinion leaders and content experts in the field of ESS.

In developing an assessment tool for essential technical skills of ESS, we used the Delphi methodology and a priori planned four rounds of questionnaires to obtain consensus on content (Figure 1). The study was conducted from August 2022 to June 2023 using an online survey program (Google Forms©, Google, Alphabet, CA, USA). We allowed panelists a minimum of four weeks to complete each questionnaire and sent reminders after three weeks. The Delphi steering committee (i.e., the author group) was blinded to the identity of panelists throughout the study.

Round 1: Brainstorming phase

In the first round, panelists were asked to list everything they deemed as essential technical skills of ESS with the defined goal of "gaining access to and establish sufficient drainage from- and ventilation of, all paranasal sinuses". The input was free text, and any given number of items could be listed. At the end of Round 1, the steering committee merged items and eliminated redundancy. Duplicate items and non-technical skills such as "knowledge of anatomy" (cognitive skill) or "quality of exposure" were removed.

Round 2: Prioritization

The resulting list was sent to the panelists, who were asked to rate the relevance of each item using a 5-point Likert scale (1 = Unimportant, 3 = Not important or unimportant, 5 = Really important). For each item, the panelists had the option to add any comments in free text. All items receiving a 4 or 5 by at least 80% of panelists were included as items for Round 3. Based on comments and suggestions by panelists and discussion in the

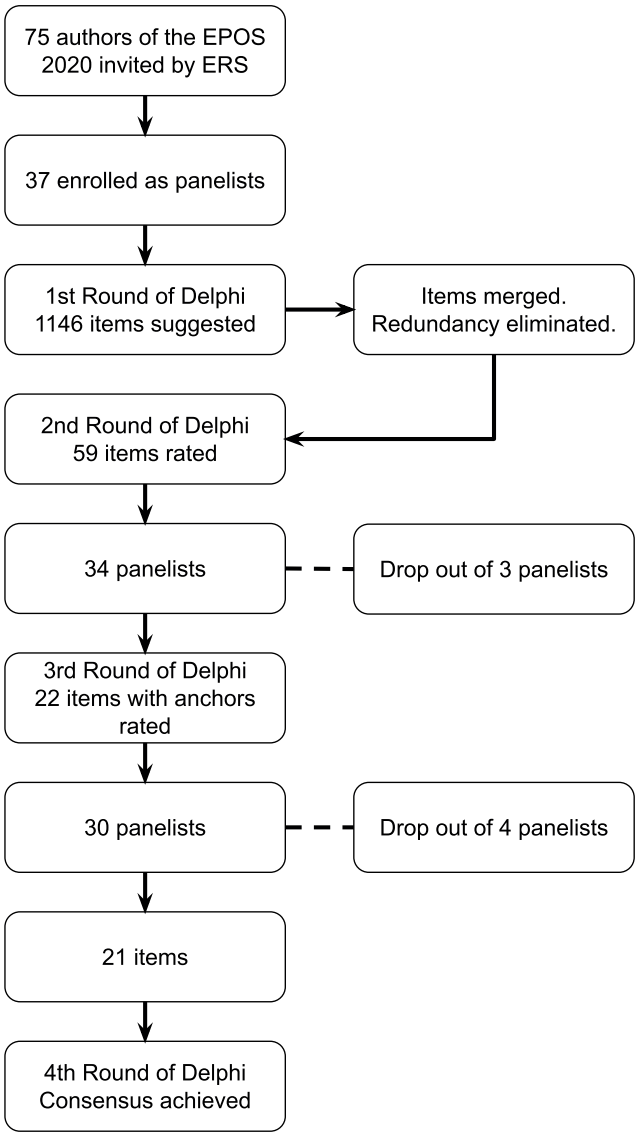

Figure 1. Schematic showing the process of the Delphi study.

Delphi steering committee, items were further merged. For each resulting item, the steering committee suggested descriptive anchors for the assessment using a 5-point Likert scale, with 1 for the Unsatisfactory performance, 3 for Average performance, and 5 for Masterly performance, as well as N/A if not applicable (for example if the frontal sinus is absent or if no anatomical variants compromise access or visualization).

Round 3: Refinement

This proposed assessment tool with the Likert scale rating and anchors was sent to the panelists for Round 3 for rating the relevance of the items and free text comments on the proposed description of each item and anchors for assessment. Again, all items receiving a 4 or 5 by at least 80% of panelists were included as items for the final round. Minor adjustments were finally made by the steering committee based on provided comments.

Table 1. Demographics of the panelists in the study.

	Median	Range
Age (years)	54	(31-66)
Years of experience	25	(6-40)
	Male	**Female**
Sex	30	7

27 Countries represented: Austria, Belgium, Brazil, Canada, Croatia, Czech Republic, Denmark, Egypt, Greece, Israel, Libya, Malaysia, Malta, North Macedonia, The Netherlands, New Zealand, Poland, Portugal, Romania, Russia, Serbia, Slovenia, Spain, Switzerland, Turkey, United Kingdom, The United States of America.

Round 4: Consensus

In the final round, panelists were asked to reply to our mail if they did not find the final assessment tool acceptable for evaluating essential technical skills of ESS. The assessment tool was finalized and named the European Endoscopic Sinus Surgery – Technical Skills Assessment (EE-TSA).

Ethics

No ethical review is required under Danish regulation for a questionnaire study. Panelists consented to participation by responding to the invitation for the study in the first questionnaire.

Results

The secretary of the ERS contacted 74 authors of the EPOS2020 guideline, and who regularly perform ESS and are members of the European Rhinological Society. Thirty-seven panelists accepted the invitation to participate. Demographics are presented in Table 1. Of the invited panelists not participating in the study, 29 were male and eight were female.

In Round 1 (Brainstorming phase), a total of 1,146 free text items for technical skills essential when gaining access to, and establishing sufficient drainage from- and ventilation of the paranasal sinuses, were suggested. By eliminating duplicates, excluding non-technical skills, and merging similar items, the steering committee reduced the entire list of 1,146 free text suggestions to 59 unique items.

Of these 59 items, 39 items were assigned a 4- or 5-point score for importance by >80% of the panelists in Round 2 (Prioritization). Based on free text feedback and recommendations from the panelists, the steering committee further reduced and merged the 39 items ending up with 22 merged items for the next round. For example, "Secure ergonomic positioning for the surgeon with the best possible height of operating table" and "Secure ergonomic positioning for the surgeon, including relaxed shoulder and elbow flexed at approximately 90 degrees"

were merged into the item "Ergonomic positioning for the surgeon with the best possible height of the operating table facilitating relaxed shoulders and elbows flexed at an angle with the best possible comfort, to enable keeping the instruments steady and minimizing tremors".

In Round 3 (Refinement), the preliminary assessment tool based on the 22 items was presented to the panelists for the rating of the relevance of items and anchors. Of the 22 items, 21 received a rating of the relevance of 4 or 5 points by >80% of the panelists and thus one item was further eliminated (frontal sinus: establish drainage and secure it by opening 30% larger than needed because of postoperative stenosis). Items from the 2nd and 3rd round are presented in Appendix 2.

In Round 4 (Consensus), panelists were asked to confirm that the final assessment tool containing 21 items was acceptable, and consensus was achieved.

Discussion

We achieved consensus on essential technical skills of ESS with the goal of gaining access to and establishing sufficient drainage from- and ventilation of all paranasal sinuses. Based on these essential items, we constructed a structured assessment tool, EE-TSA, consisting of 21 items with each item rated using a 5-point Likert scale with descriptive anchors for the extremes and middle values (Appendix 1).

The assessment of technical skills in the field of otorhinolaryngology -- head and neck surgery -- has been discussed for many years. In recent years, multiple studies have sought to identify technical skills using Delphi methodology. To the best of our knowledge, only two studies have sought to identify the technical skills in ESS using a Delphi methodology [6,7]. In a study by Lin et al. [7] from 2009, a modified Delphi approach with continuous revision from local rhinologists, and visiting faculty was performed. The Delphi process was not further detailed. Identified items were clumped into eight identifiable and assessable tasks. Afterwards this checklist was complemented by creating a global rating scale modified from Reznick. Certain items from this study recurred in our study, such as instrument handling and flow of operation [7]. In the 2012-study by Marglani et al. [6], a modified Delphi-process was used to develop a global rating of endoscopic surgical skills. Similar items such as "instrument visualization endoscopically" also found it important to keep instruments in view during the surgery, though many items not ESS specific were listed. Again, details on the Delphi panel or the process was not specified [6].
In 2008, Syme-Grant, White and McAleer published an ESS competence assessment tool developed by a modified Shea and Fortna's approach for deriving assessment scales [13]. The first draft for the tool was developed by the authors and then modified based on feedback from 19 national panelists in a single questionnaire [5].
In a traditional Delphi process, a central author group or focus panel defines the initial elements based on personal experience and a literature review [12]. This has been described as a potential weakness of the traditional Delphi process. To minimize this risk and potential for author bias, we used a modified Delphi process with the additional "Brainstorming phase" as the first round as has previously been described [11]. By adding this round, the panelists were able to freely define the procedure as it fit within their experience. Through this Delphi study, we chose to apply a consensus-based approach. Items scoring a 4 or 5 by at least 80% of panelists were included for the next round. This method ensured that only items with high consensus among the panelists progressed, while outliers did not affect the process.

There were several limitations to this study. Only half of the experts invited by the ERS accepted to participate in the study. As the experts were invited by the ERS secretariat, we do not know why some of the invited experts declined the offer. Though the ERS has a global outreach, we did end up with a disproportionate representation of nations located within the European continent. We had a limited drop-out of seven panelists. It has previously been described that increasing the panel size above 30 rarely improves the results, and this study still met the recommended amount of panelists (15–30)[14,15]. Through the rounds, we observed saturation in answers when approximately half of the panelists had answered. In regard to identifying and engaging panelists, we deem it a strength that the initial process was initiated via the ERS.

Endoscopic sinus surgery is being performed by surgeons in different specialties, i.e., otorhinolaryngologists, neurosurgeons, and ophthalmologists. In this study, we focused on ESS in the context of otorhinolaryngology. Its application in other specialties, such as ophthalmologists performing, for example dacryocystorhinostomy or neurosurgeons performing endoscopic skull-base surgeries, may be limited. Though rhinologists perform a wide array of surgeries, we chose to focus on primary surgery on adults for benign, inflammatory lesions in the nasal cavity and paranasal sinuses. We did not include revisions, skull base surgery, or procedures on the lacrimal gland-, or orbit, as achieving consensus on this wider array of complicated cases is influenced by multiple factors such as anatomical alterations, spread of the disease, and patient history. The role and indication of surgery in acute rhinosinusitis is controversial, though we have developed this tool within the scope of when surgery is needed in the setting of acute rhinosinusitis without compli-

cations (i.e. intraorbital or intracranial involvement). This study aimed at developing an assessment tool for training of ESS and deemed it beyond the scope of this present study to achieve consensus in these complicated cases (revisions, malignancy). The assessment tool addresses the technical skills of ESS, though assessing the procedure with the tool requires an experienced surgeon. Each case varies depending on pathology and anatomical variants, which means different aspects in the assessment will vary as well. Therefore, no definitive statement is listed, for example, for when anatomical variants should be corrected, visualization should be optimized with an angled scope, or when access to a sinus is not properly achieved. Like any surgery, it is mandatory to recognize non-technical skills e.g., communication, decision-making, situational awareness, and anatomical knowledge. The nose and paranasal sinuses are frequent sites of anatomical variants which may predispose to surgical complications if not acknowledged. Sound anatomical knowledge and meticulous appraisal of radiological imaging is essential prior ESS.

The Delphi method derives its strength and generalizability from its panel members. Composing a panel with internationally acknowledged experts is important in achieving solid consensus. The purpose of the study was to achieve an agreement, among profound surgical experts, on what constitutes proper performance of a common procedure. We aimed to develop an assessment tool that would be applicable internationally and independent of local traditions and dogmas. We expect the study to have a significant impact, due to the profound experience of the panelists, with a median of 25 years of experience as well as the international width, as 27 countries were represented. The panelists being anonymous to each other as well as to the central author group allows for a broad consensus and eliminates the possibility of an academic leader implementing a personal agenda.

By creating an assessment tool, we have enabled supervisors and trainees to evaluate and track the advancement of the procedure. By applying an evidence-based strategy to acquiring ESS skills, it becomes evident which aspects of the procedure demand additional attention before performing surgery independently. When validity evidence has been gathered for the assessment tool, supervisors will have a structured, evidence-based method at their disposal for assessing technical skills involved in ESS.

Future research should aim to gather validity evidence for the assessment tool in the process of developing a modern, competency-based training curriculum for fellowships in rhinology. In collecting validity evidence for the tool, examining various groups of proficiency, cut-offs for minimum competence should be determined. In establishing training curriculums with cadavers, sheep heads, printed models, or virtual reality, we expect EE-TSA can support the investigation of skill transfer from a training modality to real patients. This evidence-based approach will improve skill acquisition and retention thereby improving patient safety and the quality of ESS being performed.

Conclusion

We have developed a structured assessment tool for technical skills in ESS (EE-TSA) based on a broad international consensus and a high number of content experts. The EE-TSA is based on consensus using a 4-round Delphi process. The final tool consists of 21 items rated using a Likert scale with descriptive anchors. This enables its use for competency-based training of ESS and implementation into the surgical curriculum by surgical educators and trainees to improve the quality of training and ESS. We recommend that further validity evidence for the EE-TSA be gathered, and the pass/fail score defined.

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Authorship contribution

MG, SAWA, JM, EP, CvB. designed the study. MG carried out the study. Input was processed by the central author group MG, SAWA, JM and CvB. MG wrote the manuscript. All authors provided critical feedback on the manuscript.

Conflict of interest

No conflicts of interest.

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Mads Guldager
Department of Otolaryngology
Head and Neck Surgery and Audiology
Rigshospitalet
University Hospital of Copenhagen
Denmark.

Tel: +45 - 3545 6033
E-mail: madsguldager@mail.com

Mads Juhl Guldager[1], Steven Arild Wuyts Andersen[1], Jacob Melchiors[1], Emmanuel Prokopakis[2], Claire Hopkins[3], Christian von Buchwald[1]

[1] Department of Otolaryngology, Head and Neck Surgery and Audiology, Rigshospitalet, University Hospital of Copenhagen, Denmark

[2] Department of Otorhinolaryngology-Head and Neck Surgery, School of Medicine, University of Crete, Greece

[3] ENT Department, Guy's Hospital, London, United Kingdom

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SUPPLEMENTARY MATERIAL

Appendix 1. Assessment tool with identified essential skills of endoscopic sinus surgery.

#1 Ergonomic position of the surgeon. Best possible height of operating table to ensure relaxed shoulders. Elbows flexed comfortably, promoting stability for holding instruments firmly and reducing tremors.

1	2	3	4	5
Position inhibiting comfort. Grip insufficient. Tremor.		Occasionally discomfort and/or inadequate grip. Brief instances of tremor.		Comfortable position. Firm grip. No tremor.

#2 Secure visualization of the operative field by applying decongestant before – and during the procedure. Keep the surgical field dry by establishing hemostasis

1	2	3	4	5
No decongestant applied. Compromised visualization.		Insufficient application of decongestant, rinsing, and/or hemostasis		Sufficient rinsing and application of decongestant. Good hemostasis. Clear and unhindered visualization

#3 Secure sufficient overview and only engage the instrument when it is in the visual field.

1	2	3	4	5
Insufficient overview.		Suboptimal overview. Momentarily, the instrument slips out of view while engaged		Sufficient overview. Good visualization of the engaged instrument.

#4 Utilize an angled endoscope when standard 0°-endoscope fails to provide sufficient visualization.

1	2	3	4	5	N/A
Limitation not acknowledged.		Partial limitation due to the choice of angled endoscopes.		No limitation. Optimal use of angled endoscopes.	

#5 Continuous progression/flow throughout the procedure

1	2	3	4	5
Extended periods with no progression		Temporary periods with no progression.		Continuos progression/flow

#6 Gently handle healthy mucosa and preserve when possible. Especially regarding mucosa on the lateral side of the middle turbinate, lateral side of the frontal drainage pathway, lateral lamella of the cribriform plate, and at the olfactory region

1	2	3	4	5
Unnecessary mucosa damage. Careless handling.		Partial unnecessary resection and/or damage. Momentarily careless handling.		Gently handling healthy mucosa, while preserving as much as possible.

#7 Within the procedural boundaries, establish proper access to involved sinuses, securing clearance and ventilation.

1	2	3	4	5
Access not established. Clearance not achieved.		Moderate access to some sinuses. Partial clearance achieved		Proper access to all involved sinuses securing sufficient clearance.

Nasal cavity

#8 Correct anatomical variants when compromising access or visualization (*e.g. septum deviation, septal spur, concha bullosa etc.*).

1	2	3	4	5	N/A
Anatomical variants not corrected resulting in compromised access and/or visualization.		Anatomical variants are partially corrected but visualization and/or access are still compromised.		Anatomical variants are corrected enabling access and visualization.	

Nasal polyps not removed.	Nasal polyps partially removed.	Nasal polyps removed.

#10 Ensure mobilization of the middle turbinate when necessary. Avoid unnecessary destabilization. If required, a high fracture of the middle turbinate should be avoided.

1	2	3	4	5	N/A
Necessary mobilization not achieved or unnecessary destabilization.		Mobilization is partially assured.		Good mobilization. No unnecessary destabilization.	

Maxillary sinus

#11 Identification and assessment of the middle meatus, infundibulum, and natural ostium.

1	2	3	4	5
Not identified		Insufficient assessment.		Sufficient assessment.

#12 Visualization and removal of the relevant part of the uncinate process while keeping instruments medially. Awareness of the periorbita and lacrimal sac when using angled instruments and/or back-biter.

1	2	3	4	5
The uncinate process is not removed. Non-cautious handling of instruments.		Incomplete removal of the uncinate process. Partial caution when handling the instruments.		Complete removal of the uncinate process. Cautious maneuvering of instruments.

Ethmoid sinus

#13 Remove the ethmoid bullae by entering the face of the bullae with an inferior-medial approach. Avoid leaving unnecessary remnants.

1	2	3	4	5
Ethmoid bullae not removed		Partially removal of the ethmoid bullae.		Complete removal of the ethmoid bullae without leaving unnecessary remnants.

#14 Identify and avoid damage to the lamina papyracea. Examine an uncertain relation to the orbit by gently pressing the eyeball.

1	2	3	4	5
Lamina papyracea not identified. Risk of damage. Fails to assess relation to the orbit.		Uncertain identification of lamina papyracea		Lamina papyracea identified and/or relation to the orbit confirmed

#15 When advancing to the posterior ethmoid: Identify the basal lamella keeping instruments medially and inferiorly.

1	2	3	4	5
Basal lamella not identified.		Uncertain identification of the basal lamella. Limited access to posterior ethmoid.		Basal lamella identified. Sufficient access to the posterior ethmoid.

Sphenoid sinus

#16 Identify and visualize the natural sphenoid ostium. When within the scope of the procedure, unite the natural sphenoid ostium with the transethmoidal access.

1	2	3	4	5
Sphenoid ostium not identified		Limited identification of the sphenoid ostium.		Sphenoid ostium sufficiently identified and visualized

#17 Access the sphenoid sinus by enlarging the natural ostium in an inferior/medial approach: exercise caution, respecting the internal carotid artery, and optic nerve.

1	2	3	4	5	N/A
Access to sphenoid sinus was not achieved. Non-cautious behavior.		Partially performing an inferior and medial approach. Occasional non-cautious behavior.		Inferior/medial approach is performed while exercising caution.	

Frontal sinus

#18 Expose the frontal recess. Remove the Agger nasi- and cells of the frontoethmoidal recess when present.

1	2	3	4	5
Frontal recess not exposed. Cells not removed.		Partial exposure of recess. Partial removal of cells		Full exposure of frontal recess and complete removal of cells.

#19 Enlarge the opening to the frontal sinus. Do not mistake frontal recess with supraorbital cells when present.

1	2	3	4	5	N/A
Recess not enlarged. Not cautious regarding supraorbital cells.		Partial enlargement. Brief focus on supraorbital cells.		Correctly enlarges frontal recess. Cautious regarding supraorbital cells.	

#20 When using instruments, the orientation should be with consideration of the: cribriform plate, lamina papyracea, anterior ethmoidal artery, and slope of the skull base.

1	2	3	4	5
Non-cautious instrument handling.		Momentarily non-cautious instrument handling.		Maintain constant caution in instrument handling.

#21 Visualization of the posterior wall of the frontal sinus.

1	2	3	4	5	N/A
Posterior wall is not visualized		Posterior wall is partially visualized		Posterior wall is sufficiently visualized	

Appendix 2. Delphi process. Mean-score and percentage of ratings at or above 4 for the 2nd and 3rd round.

Round 2 – Prioritization. The 59 items with mean-score and percentage of ratings at 4 or above.

Item	Mean-score (1-5)	Percentage of ratings ≥4 (%)
1. CT-scan of nose and sinuses, not older than 1 year	4.18	78.79
2. Position patient in anti-Trendelenburg with head elevated 15-20 degrees	4.15	78.79
3. Secure ergonomic positioning for the surgeon with best possible height of the operating table	4.91	100
4. Secure ergonomic positioning for the surgeon including: relaxed shoulders and elbow flexed at approximately 90 degrees	4.27	81.82
5. Avoid tremor	4.45	93.94
6. Continuous progression during the procedure	4.30	87.88
7. Only engage instrument when it is in the visual field	4.67	93.94
8. Gently handle and preserve healthy mucosa when possible	4.82	100
9. Within the boundaries of the procedure, secure: Proper access of the sinuses	4.85	100
10. Within the boundaries of the procedure, secure: Proper clearance of the sinuses	4.45	96.97
11. Enlargement of the sinus ostia should not exceed more than two-thirds of the original size	2.97	27.27
12. Assure all sinuses are connected	3.30	42.42
13. Avoid stripping mucosa, especially on: The lateral side of the frontal drainage	4.58	93.94
14. Avoid stripping mucosa, especially on: Fovea ethmoidalis	4.03	78.79
15. Avoid stripping mucosa, especially on: Lateral lamella of the cribriform plate	4.61	93.94
16. Avoid stripping mucosa, especially on: Lamina papyracea	3.45	48.48
17. Avoid leaving bare bone	4.00	72.73
18. Local analgesia before the operation – Sphenopalatine ganglion block	2.58	21.21
19. Local analgesia before the operation – Infiltration analgesia of the superior turbinate	2.55	15.15
20. Local analgesia before the operation – Infiltration analgesia along the middle turbinate	2.82	27.27
21. Local analgesia before the operation – Topical analgesia	3.73	54.55
22. Decongestion before – and during the procedure	4.82	96.97
23. Rinsing before – and during the operation	4.30	81.82
24. Establish and secure hemostais in the surgical field	4.94	100
25. In a primary standard surgery for benign lesions – Anterior-posterior approach	3.76	45.45
26. In a primary standard surgery for benign lesions – Posterior-anterior approach	3.15	24.24
27. Use angled scope when visualization with 0 degrees scope is not possible	4.70	93.94
28. In establishing space for the procedure, perform endoscopic septoplasty when needed	4.30	84.85
29. Visualization and removal of any present nasal polyps	4.18	87.88
30. Identify concha bullosa and remove if needed	4.18	90.63
31. Identification of the olfactory cleft	4.27	78.79
32. Visualization and partially removal of the uncinate process not injuring the periorbita/orbit	4.79	100
33. Visualization of the middle meatus	4.70	96.97
34. Visualization and dilation of natural – and if present – accessory ostia	4.12	78.79
35. Remove the ethmoidal bullae – without leaving any remnants – by a medial-inferior approach thereby avoiding damage to the orbit	4.52	90.91
36. Confirm relation to the orbit by gently pressing the eyeball	4.42	90.91
37. Assure mobilization of the middle turbinate without destabilizing it. Minimize reduction.	4.27	84.85
38. Identify and avoiding damage to the lamina papyracea	4.73	100
39. Identify the anterior and posterior ethmoidal arteries: Before surgery	4.45	90.91
40. Identify the anterior and posterior ethmoidal arteries: Only during surgery when supraorbital cells are present	3.82	66.67

Item	Mean-score (1-5)	Percentage of ratings ≥4 (%)
41. When addressing the posterior ethmoid: Identify the basal lamella staying medially and inferiorly	4.39	87.88
42. Identify the sphenoid spatium as endpoint of the ethmoidectomy	4.30	81.82
43. Identify natural sphenoid ostia. If relevant enlarge ostia depending on pathology – and if necessary unify natural and transethmoidal ostia	4.36	90.91
44. If relevant – resect inferior portion of the superior turbinate leaving superior part intact	3.85	66.67
45. Remove polyps at the sphenoid-ethmoidal recess	4.45	100
46. When in the sphenoid sinus do inferior/medial first to expose roof. Avoid sphenopalatine branhces.	4.45	93.94
47. Avoid carotids and optic nerve	4.94	100
48. Remove uncinate – especially superior portion and avoid orbital trauma and dura lesions	4.61	90.91
49. Expose space of Agger nasi cell. Removal of Agger nasi and cells anterior to beak	4.48	90.91
50. Make an axillary flap if taking out some of the frontal beak	3.09	33.33
51. Expose the middle turbinate mucosa superiorly. Removal of intercepted frontal cell. Remove part of middle turbinate if necessary, minimizing reduction as much as possible	3.70	63.64
52. Assess if removal of the ethmoid bullae is necessary. If removed: Avoid damage to the anterior ethmoidal artery	4.48	90.91
53. Temporarily preserve the ethmoid bullae as an anatomical landmark when addressing the frontal sinus	3.61	60.61
54. Adequate exposure of the frontal sinus	4.42	90.91
55. Expose frontal recess – take care not to mistake with supraorbital recess. Identify suprabullar and frontoethmoidal cells if present	4.58	93.94
56. Dilation of frontal recess through the resection of frontoethmoidal cells	4.39	90.91
57. Direction of tools should be away from lamina papyracea, skull base and anterior ethmoidal artery	4.70	90.91
58. Identify and widen natural ostium while preserving mucosa. Establish drainage and open 30% larger than needed in view of post-operative stenosis	4.33	87.88
59. Identification of the posterior wall	4.48	96.97

Round 3 – Refinement.

Item	Mean-score (1-5)	Percentage of ratings ≥4 (%)
1. Ergonomic positioning for the surgeon with the best possible height of the operating table facilitating relaxed shoulders and elbows flexed at an angle with the best possible comfort, to enable keeping the instruments firm and minimize tremors.	4.43	90
2. Secure visualization of the operative field by decongesting before - and during the procedure as well as keeping the surgical field dry by establishing hemostasis	4.70	96.67
3. Secure sufficient overview and only engage the instrument when it is in the visual field.	4.53	90
4. Use an angled endoscope when visualization is limited using a standard 0°-endoscope	4.23	83.33
5. Continuous progression throughout the procedure	4.17	83.33
6. Gently handling healthy mucosa and preserving it when possible. Especially regarding mucosa on the lateral side of the frontal drainage pathway, lateral lamella of the cribriform plate, and at the olfactory region	4.77	100
7. Within the boundaries of the procedure, establishes proper access, securing relevant clearance of the sinuses.	4.53	90
8. Correct anatomical variants when compromising access or visualization (i.e. septum deviation etc.).	4.30	86.67
9. Visualization and removal of nasal polyps, if present	4.50	93.33
10. Assure mobilization of the middle turbinate when needed. Avoiding unnecessary destabilization.	4.43	90
11. Identification and assessment of the middle meatus.	4.73	96.67

Item	Mean-score (1-5)	Percentage of ratings ≥4 (%)
12. Visualization and removal of the uncinate process while keeping instruments medially. Awareness of the periorbita when using angled instruments and/or back-biter	4.70	96.67
13. Remove the ethmoid bullae by an inferior-medial approach. Avoid leaving any remnants.	4.43	93.33
14. Identify and avoid damage to the lamina papyracea. Examine the relation to the orbit by gently pressing the eyeball.	4.69	90
15. When advancing to the posterior ethmoid: Identify the basal lamella keeping instruments medially and inferiorly.	4.63	96.67
16. Identify the natural sphenoid ostium. When within the scope of the procedure, unite the natural sphenoid ostium with the transethmoidal access.	4.37	83.33
17. Access to the sphenoid sinus, enlarging the opening in an inferior/medial approach: exercise caution, respecting the internal carotid artery, and optic nerve.	4.73	96.67
18. Expose the frontal recess. Remove Agger nasi- and cells of the frontoethmoidal recess when present.	4.50	90
19. Enlarge the opening to the frontal sinus. Do not mistake frontal recess with supraorbital cells when present.	4.40	90
20. When using tools, the movement should be with consideration of the: lamina papyracea, anterior ethmoidal artery, and slope of the skull base.	4.77	100
21. Establish drainage and secure it by opening 30% larger than needed because of postoperative stenosis.	4.20	73.33
22. Visualization of the posterior wall of the frontal sinus.	4.43	86.67