The role of structured reporting and structured operation planning in functional endoscopic sinus surgery

Benjamin Philipp Ernst, Manuel René Reissig, Sebastian Strieth, Jonas Eckrich, Jan H. Hagemann, Julia Döge, Christoph Matthias, Haralampos Gouveris, Johannes Rübenthaler, Roxanne Weiss, Wieland H. Sommer, Dominik Nörenberg, Thomas Huber, Philipp Gonser, Sven Becker, Matthias F. Froelich

1 Department of Otorhinolaryngology, University Medical Center Mainz, Mainz, Rhineland-Palatinate, Germany, 2 Department of Otorhinolaryngology, University Hospital Bonn, Bonn, North Rhine-Westphalia, Germany, 3 Department of Radiology, LMU University Hospital, Munich, Bavaria, Germany, 4 Department of Otorhinolaryngology, University Hospital Frankfurt, Frankfurt, Hessen, Germany, 5 Department of Radiology and Nuclear Medicine, University Medical Center Mannheim, Mannheim, Baden-Wuerttemberg, Germany, 6 Department of Otorhinolaryngology, Head and Neck Surgery, University of Tübingen Medical Center, Tübingen, Baden-Wuerttemberg, Germany

* benjamin.ernst@unimedizin-mainz.de

Abstract

Computed tomography (CT) scans represent the gold standard in the planning of functional endoscopic sinus surgeries (FESS). Yet, radiologists and otolaryngologists have different perspectives on these scans. In general, residents often struggle with aspects involved in both reporting and operation planning. The aim of this study was to compare the completeness of structured reports (SR) of preoperative CT images and structured operation planning (SOP) to conventional reports (CR) and conventional operation planning (COP) to potentially improve future treatment decisions on an individual level. In total, 30 preoperative CT scans obtained for surgical planning of patients scheduled for FESS were evaluated using SR and CR by radiology residents. Subsequently, otolaryngology residents performed a COP using free texts and a SOP using a specific template. All radiology reports and operation plannings were evaluated by two experienced FESS surgeons regarding their completeness for surgical planning. User satisfaction of otolaryngology residents was assessed by using visual analogue scales. Overall radiology report completeness was significantly higher using SRs regarding surgically important structures compared to CRs (84.4 vs. 22.0%, p < 0.001). SOPs produced significantly higher completeness ratings (97% vs. 39.4%, p < 0.001) regarding pathologies and anatomical variances. Moreover, time efficiency was not significantly impaired by implementation of SR (148 s vs. 160 s, p = 0.61) and user satisfaction was significantly higher for SOP (VAS 8.1 vs. 4.1, p < 0.001). Implementation of SR and SOP results in a significantly increased completeness of radiology reports and operation planning for FESS. Consequently, the combination of both facilitates surgical planning and may decrease potential risks during FESS.
Introduction

Functional endoscopic sinus surgery (FESS) represents the gold standard in the surgical management of paranasal sinus disease [1, 2]. Three-dimensional high-resolution computed tomography (CT) scans are required for any surgical approach to treat both chronic and acute rhinosinusitis, particularly with potentially occurring complications [3, 4]. Prior to surgery, CT scans are indispensable to determine the extent of FESS as well as to identify anatomical structures with an increased risk regarding catastrophic complications. Such complications may include injuries of the anterior skull base, the orbit, optic nerve or internal carotid artery with potential lethal bleedings, ischemic stroke or need for blood transfusions [5–9]. Especially in the era of powered instruments such as microdebriders, a profound understanding of the anatomy is of utmost importance, as these particular instruments can cause severe complications when handled without sufficient care [10, 11]. Therefore, a solid preoperative knowledge of the anatomy using radiological and surgical knowledge is key for any successful interdisciplinary surgical treatment planning which may prevent premature revision surgery [12]. Additionally, the accessibility of CT scans sets the foundation towards performing image-guided surgery by using intraoperative navigation [13].

Despite major improvements in the quality of CT scans making it possible to address a wide variety of diseases and anatomical variances in great detail, radiologists and otolaryngologists have grossly different perspectives on these scans [4, 14]. Whereas radiologists mainly focus on the extent and the effects of the disease, otolaryngologists are also very much interested in anatomical variances to plan surgical approaches [15]. In addition, residents in training, both in radiology and otolaryngology, often struggle which anatomical structures which have to be considered in reporting and operation planning and how to grade them [16, 17]. Conventional CT checklists have been implemented in many otolaryngology departments to give residents some sort of guidance. Nevertheless, these checklists usually exist in analogous form. Therefore, they are frequently abandoned after initial implementation as they are not directly integrated into the clinical workflow [18].

Structured reporting (SR) has been advocated for various diagnostic modalities in radiology as well as in otolaryngology and other specialties with impact on treatment decisions and interdisciplinary communication [19–25]. The main benefit, especially for residents in training, is the standardization of the content and terminology which is known to improve report quality and time efficiency when compared to conventional reporting (CR) [19–21]. Additionally, the implementation of structured operation planning potentially reduces the risk of missing key structures during the planning process. This may be due to the fact that structured reporting templates can highlight important features as well as pertinent negative findings within predefined checklists [26, 27]. Consequently, SR and SOP may also promote the learning curve of younger radiologists and otolaryngologists in training [28].

Overall, the aim of this study was to perform a comparative analysis of the completeness of CT reports and surgical plannings using SR and SOP, respectively, to the conventional approaches (e.g. CR and COP) which may have the potential to improve treatment decisions and patient outcome in the long term.

Materials and methods

Study design and study sample

This study was designed to evaluate the impact of structured reporting as well as structured operation planning in the process of the surgical management of chronic rhinosinusitis. Therefore, n = 30 consecutive preoperative CT scans of adult patients (m = 17, w = 13, mean
Structured reporting and operation planning in sinus surgery

Table 1. Demographics and characteristics of the study sample.

| Characteristics                                    | Value                                      |
|----------------------------------------------------|--------------------------------------------|
| Number of patients included                        | 30                                         |
| Age at surgery (mean ± SD)                         | 41.4 ± 12.8 years (range: 23–58 years)     |
| Gender                                             | Male: n = 17 Female: n = 13                 |
| Indication for functional endoscopic sinus surgery | Chronic rhinosinusitis with polyposis: n = 20 |
|                                                   | Chronic rhinosinusitis without polyposis: n = 10 |
| Number of participating otolaryngology residents   | 6                                          |
| Years of residency                                 | 4.5 ± 0.9 (range: 4–6 years)               |

Ethics approval and consent to participate

Ethics approval was obtained by the Institutional Review Board (Ethik-Kommission der Landesärztekammer Rheinland-Pfalz. Reference number: 2018–13225). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Oral and written patient information was given by the examining physician. Written informed consent was obtained prior to the examination.

Sample size calculation

As previously described in the literature, the number of patients needed was calculated based on the anticipated effect size when comparing the percentage of CRs/COPs with 80%
completeness or higher to SRs/SOPs. We assumed that 45% of CRs/COPs would have very high completeness ratings (i.e. of 80% or higher), considering the report completeness of other head and neck ultrasound imaging studies as shown in the literature [19–21]. Additionally, we estimated that completeness ratings would go up to 80% by using SRs/SOPs. The power was set to 80% with a significance level of \( \alpha = 0.05 \). Using these parameters, the minimum number of reports required for the study was calculated to be \( n = 58 \) (29 reports in each group).

**Evaluation of radiological reports and operation plannings**

Collectively, 60 anonymized reports (30 SRs and CRs each) were independently analyzed for completeness (i.e. reporting of critical anatomy and pathology) by a board-certified radiologist and an otolaryngologist. Additionally, an evaluation template was implemented in order to standardize the analysis.

Following this, 60 anonymized operation plannings (30 SOPs and COPs each) were also evaluated for completeness (i.e. identification of critical anatomical structures and disease as well as determination of the extent of the procedure) by two board-certified otolaryngologists with a high expertise in FESS based on an evaluation checklist. Due to the free text structure of COPs which contain handwritten plannings, readability was subjectively assessed using a five-point Likert scale. Time expenditure for each type of planning was also recorded and compared.

Otolaryngology residents were asked for their opinions regarding practicability (question 1), usefulness in everyday practice (question 2), improvement in report-quality (question 3), time efficiency (question 4), justification of additional time needed (question 5) as well as benefits for inexperienced physicians being trained in FESS (question 6) of both types of planning by applying a ten-point visual analogue scale.

**Statistical analysis**

Data are reported as the mean percentage of the greatest possible outcome (i.e. percentage of maximum completeness, etc.), mean time needed to complete the report (seconds) and mean VAS values ± SD. Wilcoxon signed-rank test for paired nominal data was used to compare operation planning evaluations and questionnaire findings while Mann-Whitney test for unpaired data was used to compare radiology reports. A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using Prism 8 (GraphPad Software, Inc., San Diego, CA, USA).

**Results**

**Analysis of radiological reports**

Radiological reports, both CR and SR, were completed by radiology residents. Compared to CRs, SRs showed a significantly higher overall completeness level for all categories (84.4 vs. 22.0%, \( p < 0.001 \), Fig 1a).

In particular, SRs were more complete in regard to description of nasal septum (100 vs. 0%, \( p < 0.001 \)), middle nasal meatus (85.8 vs. 3.3%, \( p < 0.001 \)), maxillary sinus (95.6 vs. 62.2%, \( p < 0.001 \)), ethmoid sinus (82.7 vs. 24.3%, \( p < 0.001 \)), and frontal sinus (75 vs. 33.3%, \( p < 0.001 \)). Additionally, the anterior skull base (98.3 vs. 1.7%, \( p < 0.001 \)) and the absence of potential masses (70 vs. 13.3%, \( p < 0.001 \)) were reported more frequently. Concerning classifications, SRs had a higher level of completeness in regard to the Keros classification (83.3 vs. 0%, \( p < 0.001 \)) and the Lund-Mackay Score (73.3 vs 0%, \( p < 0.001 \)). These results are summarized in Fig 1b.
Analysis of operation plannings

Surgical planning of FESS, by both COP and SOP, was performed by otolaryngology residents who were assigned to assist or to perform (under supervision of a board-certified otolaryngologist) each FESS procedure by using the preoperative CT scans for surgical planning. When compared to mostly handwritten COPs, SOPs showed a significantly better readability (100 vs. 62%, \( p < 0.001 \)). Analysis revealed significantly higher overall completeness ratings for SOP when compared to COP (97 vs. 39.4%, \( p < 0.001 \)). In detail, SOPs received significantly superior ratings in respect to the nasal septum (100 vs. 56.7%, \( p < 0.001 \)), the middle nasal meatus (96.7 vs. 54.2%, \( p < 0.001 \)), the ethmoid infundibulum (92.5 vs. 50%, \( p < 0.001 \)) and the maxillary sinus (93.3 vs. 44.7%, \( p < 0.001 \)). In addition, the ethmoid sinus (99.2 vs. 33.3%, \( p < 0.001 \)) and the sphenoid sinus (93.9 vs. 30%, \( p < 0.001 \)) were documented more completely using SOP. Potential masses in the paranasal sinuses (100 vs. 15%, \( p < 0.001 \)) and particularly the Keros classification of the anterior skull base (100 vs. 40%, \( p < 0.001 \)) were considered significantly more reliably using SOP as well. Evaluation of time needed to plan the operation shows a tendency towards a better time efficiency for SOPs without reaching significance level (148 s vs. 160 s, \( p = 0.61 \)). A comprehensive presentation of operation planning analysis is shown in Fig 2.

User satisfaction

In total, the questionnaire showed a significant preference for SOPs by all participating otolaryngology residents (8.1 vs. 4.1, \( p < 0.001 \)). In detail, the use of SOP was rated to be usable in everyday practice (7.8 vs. 3.7, \( p = 0.035 \)), to improve the quality of preoperative planning (8.8 vs. 4.0, \( p = 0.038 \)) and to have a favorable time efficiency (7.2 vs. 3.5, \( p = 0.04 \)). Additionally, residents thought that any extra time spent on SOP was justified compared to COP (8.2 vs. 3.3, \( p = 0.038 \)). All other questions revealed a positive tendency towards a preference of SOP without reaching the level of significance. A detailed analysis of questionnaires is shown in Fig 3.
Discussion

FESS has been proven as an effective surgical treatment of refractory chronic conditions of paranasal sinuses and, therefore, represents the surgical gold standard in these cases [29]. While technical developments that lead to modern FESS procedures have improved the surgical efficacy even further [30–32], the influence of structured approaches in radiology reports and pre-treatment surgical plannings have not been studied comprehensively. Yet, precise imaging and accurate reporting of findings are generally found to be relevant for therapy.

Fig 2. Analysis of readability, time efficiency and completeness of structured and conventional operation plannings. Structured operation plannings (SOP) reveal a significantly superior readability and overall completeness when compared to conventional operation planning (COP, a). Evaluation of time needed to plan the operation shows a tendency towards a better time efficiency for SOPs without reaching significance level (b). Analysis of detailed completeness levels of relevant anatomical features for FESS plannings outlines significantly higher completeness ratings for all analyzed items when compared to COP (c). n.s. = not significant, *** p < 0.001.

https://doi.org/10.1371/journal.pone.0242804.g002

Fig 3. Analysis of user satisfaction. User satisfaction analysis reveals a significantly superior overall satisfaction when using structured operation planning (SOP) when compared to conventional operation planning (COP). In detail, SOP received significantly higher ratings concerning everyday practice (Q2), quality improvement (Q3) and time efficiency (Q4). In case of additional time needed for SOP, users thought that this additional time was likely to be well spent (Q5). The items practicability (Q1) and training effect (Q6) showed a tendency toward better ratings for SOP without reaching significance level. * p < 0.05.

https://doi.org/10.1371/journal.pone.0242804.g003
planning. Furthermore, detailed planning of surgery can increase confidence, boost the learning curves of residents in training and reduce complications during and after surgery [33, 34].

The main finding of our study outlines an added value of a structured approach to radiology reporting in combination with structured surgical planning to improve treatment decisions. In summary, structured data acquisition did indeed lead to superior completeness, both for information collected by otolaryngology and radiology residents. This may very well be due to the fact that radiologists and otolaryngologists often focus on quite different aspects when evaluating CT scans of the paranasal sinuses [15, 35, 36]. Whereas radiologists mainly evaluate CT scans for potential pathologies and their consecutive extent (e.g. signs and extent of chronic rhinosinusitis), otolaryngologists usually reflect CT scans in terms of a surgical approach considering the pathological findings [37]. Interestingly, implementation of SOP caused otolaryngology residents to consider potentially dangerous structures such as the lamina papyracea and particularly the anterior skull base and its asymmetries as described by the Keros classification (100 vs. 31.3%, p = 0.0007) significantly more often. While these results clearly demonstrate superior completeness ratings of SOPs, the insufficient completeness of COPs may be due to the fact that the SOP template queries all structures for every operation planning while unremarkable findings may not be reported using COPs due to a lack of necessity. Consequently, while important structures are actually considered by otolaryngology residents for each and every surgery, this may be underrepresented in COP documentation. Nevertheless, without proper documentation, the chance to miss an atypical critical structure in the surgical planning process, which may lead to intraoperative complications, is increased. Additionally, the surgical approach to the frontal sinus was described significantly more frequent which may very well reduce the rate of revision surgery due to insufficient drainage of the frontal sinus [38, 39]. As described by Stammberger et al., the uncapping the egg technique to the frontal recess and sinuses requires thorough preparation in order to identify ethmoidal cells protruding into the frontal sinus [40]. If planned insufficiently, dissection of only the lower portion of such cells will not provide sufficient drainage of the frontal sinus and consequently will fail to resolve the frontal sinus disease.

Structure and content of radiology reports of paranasal sinuses in terms of surgical therapies may be unclear to radiologists, and in particular for inexperienced residents, even though these scans are performed as part of the surgical planning [15, 35, 36]. Therefore, the creation of specific structured reporting templates may also enhance interdisciplinary discussion and may provide common grounds for exchange transmission of information [4]. The template used in this study was carefully designed in consideration of the current guidelines by a team of board-certified otolaryngologists and radiologists with a special expertise in FESS and head and neck radiology, respectively. In this process, anatomical structures that are of central importance for radiological reporting and FESS were identified and their interdisciplinary importance was discussed to implement all necessary information for detailed and accurate surgical planning. In this course, an interdisciplinary approach to preoperative reporting and planning of FESS was established. This may be highly desirable not only from a surgical perspective, but also from radiologists’ point of view in order to maximize the clinical value of their reports leading to higher satisfaction of referring physicians. Additionally, it decreases the risk that atypical anatomical structures, which may be concealed by extensive paranasal sinus disease, are missed, both by radiologists and otolaryngologists, and therefore compromised during surgery [41–43].

These results are in line with previously reported findings on structured reporting for imaging: In radiology, structured reporting has shown superior results in terms of report completeness, quality and time efficiency when compared to conventional free-text reporting [22, 44]. Therefore, structured reporting is recommended by leading societies [45, 46]. Additionally,
the utilization of structured reporting for pathology reports did lead to better patient management and outcomes [47] and showed beneficial effects in the setting of ENT sonography reporting [19–21]. While several studies report higher completeness, better readability, advantages in information extraction and educational benefits [19–24, 44, 48–50], sometimes a too rigid structure is claimed to be an obstacle for experienced readers in diagnostic imaging [51]. However, the results presented in this study show a comparable time investment towards surgical planning regarding both approaches. Due to the fact that the pre-existing CRs that had been created during the daily clinical practice, no information was available regarding the time needed to finish the report. Such being the case, no statement can be made concerning differences in time efficiency between CR/SR of paranasal sinus CTs. Also, structured reporting templates are now offering more flexible solutions and allowing the utilization of pre-defined text elements that can help to reduce orthographic mistakes as they are based on expert-reviewed text components [45]. This may also enhance report quality in the era of telemedical approaches which often suffer from non-native speaking reporting physicians [52–54]. Additionally, most of the recent publications have dismissed the problem of impaired radiology reports due to too rigorous structures which may be attributed to enhanced information technologies incorporated into SR templates [19–21].

The results presented in this study have to be interpreted in the context of its design: First, the results of this study are based on treatment planning for only one surgical procedure, namely FESS. As the surgical approach varies noticeably depending on the pathological pattern and the department’s internal standard and expertise, structured therapy planning may be of a very high importance in order to increase standardization. This may secondly lead to an increased scientific comparability of radiological findings as well as surgical planning, especially in the context of multicenter studies [55, 56]. Therefore, generalization of the results to other surgical procedures should only be done with great care. Additionally, the operation planning was carried out by residents in training, which does not represent the standard of care of board-certification. Second, imaging reporting of paranasal sinuses is a very suitable application for structured reporting in comparison to other diagnostic procedures with a higher degree of variability of pathological findings, like for example an MRI scan for unclear vertigo. In addition, structures to be reported may be valued significantly different by radiologists and otolaryngologists. In consequence, SR may be a valuable tool to ensure standardization while enabling the necessary variability. Third, while implementation of SR/SOP resulted in a significant increase of completeness, this study did not evaluate correctness of the reports. Therefore, no statement concerning the impact of SR/SOP on report content accuracy can be made. This has to be evaluated in future studies. Fourth, since participating Otolaryngology residents used the same CT scans for corresponding SOPs and COPs, potential bias due to testing or learning effects cannot be ruled out. A sequence of creating COPs before SOPs was chosen in order to reduce bias since, unlike SOPs, COPs do not offer any feedback to the user. Consequently, potential training effects are minimized to greatest possible extent. Additionally, residents prepared SOPs and COPs before the operation to reduce potential bias that may arise from additional knowledge acquired from intraoperative findings. Since there were only \( n = 6 \) residents with a sufficient experience in FESS procedures available at the University Medical Center Mainz, each resident prepared 5 corresponding SOPs/COPs within this study. By assigning residents one after the other, potential bias due to learning effects cannot be ruled out but are minimized since a greatest possible time interval between assignments may blur details used within SOPs. Finally, further analyses in other patient collectives, other healthcare systems and other treatment modalities may be needed to validate the findings presented in this study.
Conclusions
Implementation of SR and SOP results in a significantly increased completeness of radiologic reports and operation planning in the surgical management of paranasal sinus disease. Consequently, the combination of both may enhance the learning curve, both in radiology and otorhinolaryngology, and decrease potential risks during endoscopic sinus surgery in rhinology centers.

Supporting information
S1 Fig. Flowchart of the structured radiology reporting and structured operation planning structures.
(TIF)
S2 Fig. Screenshot of structured reporting template. For full decision tree, refer to S1 Table.
(TIF)
S3 Fig. Screenshot of structured operation planning template. For full decision tree, refer to S1 Table.
(TIF)
S1 Table. Key features of the structured reporting template.
(DOCX)
S2 Table. Key features of the structured operation planning template.
(DOCX)
S3 Table. Supporting raw data evaluated in this study.
(XLSX)

Acknowledgments
The authors thank Ben Braun for language editing.

Author Contributions
Conceptualization: Benjamin Philipp Ernst, Sebastian Strieth, Wieland H. Sommer, Sven Becker, Matthias F. Froelich.
Data curation: Benjamin Philipp Ernst, Manuel René Reissig, Jonas Eckrich, Matthias F. Froelich.
Formal analysis: Benjamin Philipp Ernst, Manuel René Reissig, Jonas Eckrich, Matthias F. Froelich.
Investigation: Benjamin Philipp Ernst, Manuel René Reissig, Jonas Eckrich, Jan H. Hagemann, Julia Döge, Haralampos Gouveris, Johannes Rüenthaler, Roxanne Weiss, Dominik Nörenberg, Thomas Huber, Philipp Gonser, Sven Becker, Matthias F. Froelich.
Methodology: Benjamin Philipp Ernst, Philipp Gonser, Matthias F. Froelich.
Project administration: Benjamin Philipp Ernst, Sebastian Strieth, Matthias F. Froelich.
Resources: Benjamin Philipp Ernst.
Software: Benjamin Philipp Ernst, Wieland H. Sommer.
Supervision: Benjamin Philipp Ernst, Christoph Matthias, Matthias F. Froelich.
Validation: Benjamin Philipp Ernst, Matthias F. Froelich.

Visualization: Benjamin Philipp Ernst, Matthias F. Froelich.

Writing – original draft: Benjamin Philipp Ernst, Jonas Eckrich, Haralampos Gouveris, Johannes Rübenthaler, Roxanne Weiss, Dominik Nörenberg, Sven Becker, Matthias F. Froelich.

Writing – review & editing: Benjamin Philipp Ernst, Sebastian Strieth, Haralampos Gouveris, Johannes Rübenthaler, Dominik Nörenberg, Sven Becker, Matthias F. Froelich.

References

1. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology. 2020; 58(Suppl S29):1–464. Epub 2020/02/23. https://doi.org/10.4193/Rhin.20.600 PMID: 32077450.

2. Higgins TS, Lane AP. Chapter 12: Surgery for sinonasal disease. Am J Rhinol Allergy. 2013; 27 Suppl 1:S42–4. Epub 2013/06/05. https://doi.org/10.2500/aja.2013.27.3793 PMID: 23711040.

3. Levine CG, Casiano RR. Revision Functional Endoscopic Sinus Surgery. Otolaryngol Clin North Am. 2017; 50(1):143–64. Epub 2016/11/28. https://doi.org/10.1016/j.otc.2016.08.012 PMID: 2788911.

4. Mistry SG, Strachan DR, Loney EL. Improving parasellar sinus computed tomography reporting prior to functional endoscopic sinus surgery—an ENT-UK panel perspective. J Laryngol Otol. 2016; 130(10):962–6. Epub 2016/10/25. https://doi.org/10.1017/S0022215116008902 PMID: 27774925.

5. Grevers G. Anterior skull base trauma during endoscopic sinus surgery for nasal polyposis preferred sites for iatrogenic injuries. Rhinology. 2001; 39(1):1–4. Epub 2001/05/09. PMID: 11340688.

6. Ledderose GJ, Stelter K, Betz CS, Enghard AS, Ledderose C, Leunig A. Cerebrospinal fluid leaks during endoscopic sinus surgery in thirty-two patients. Clin Otolaryngol. 2017; 42(5):1105–8. Epub 2016/03/21. https://doi.org/10.1111/coa.12870 PMID: 28317322.

7. Lum SG, Husain S, Ismail MR, Toh CJ, et al. Internal carotid artery injury during endonasal sinus surgery: our experience and review of the literature. Acta Otorhinolaryngol Ital. 2019; 39(2):130–6. Epub 2019/02/13. https://doi.org/10.14639/0392-100X-1312 PMID: 30745587.

8. Wu H, Shen T, Chen J, Yan L. Long-term therapeutic outcome of ophthalmic complications following endoscopic sinus surgery. Medicine (Baltimore). 2016; 95(38):e4896. Epub 2016/09/24. https://doi.org/10.1097/MD.0000000000004896 PMID: 27661034.

9. Povolotskiy R, Cerasiello SY, Siddiqui SH, Baredes S, Hsueh WD. Anemia and blood transfusion requirements in endoscopic sinus surgery: A propensity-matched analysis. The Laryngoscope. 2020; 130(6):1377–82. Epub 2019/08/17. https://doi.org/10.1002/lary.28228 PMID: 31488668.

10. Worden CP, Clark CA, Senior AK, Schlosser RJ, Kimple AJ, Senior BA. Modeling Microdebrider-Mediated Ophthalmic Damage: A Word of Caution in Endoscopic Sinus Surgery. Rhinol Online. 2019; 2:44–9. Epub 2019/09/19. https://doi.org/10.4193/RHINOL.19.004 PMID: 31531416.

11. Baban MIA, Mirza B, Castelnuovo P. Radiological and endoscopic findings in patients undergoing revision endoscopic sinus surgery. Surg Radiol Anat. 2020. Epub 2020/02/07. https://doi.org/10.1007/s00276-020-02427-5 PMID: 32025784.

12. Reiner BI, Knight N, Siegel EL. Radiology reporting, past, present, and future: the radiologist’s perspective. J Am Coll Radiol. 2007; 4(5):313–9. Epub 2007/05/01. https://doi.org/10.1016/j.jacr.2007.01.015 PMID: 17467614.

13. Deutschmann MW, Yeung J, Bosch M, Lysack JT, Kingstone M, Kilty SJ, et al. Radiologic reporting for parasellar sinus computed tomography: a multi-institutional review of content and consistency. The Laryngoscope. 2013; 123(5):1100–5. Epub 2013/04/27. https://doi.org/10.1002/lary.23906 PMID: 23619621.

14. Braun T, Betz CS, Ledderose GJ, Havel M, Stelter K, Kuhnel T, et al. Endoscopic sinus surgery training courses: benefit and problems—a multicentre evaluation to systematically improve surgical training.
Structured reporting and operation planning in sinus surgery
35. Error M, Ashby S, Oriandi RR, Alt JA. Single-Blind Prospective Implementation of a Preoperative Imaging Checklist for Endoscopic Sinus Surgery. Otolaryngol Head Neck Surg. 2018; 158(1):177–80. Epub 2017/09/20. https://doi.org/10.1177/0194599817731740 PMID: 28925320.

36. Yao CM, Fernandes VT, Palmer JN, Lee JM. Educational value of a preoperative CT sinus checklist: a resident’s perspective. J Surg Educ. 2013; 70(5):585–7. Epub 2013/09/11. https://doi.org/10.1016/j.jsurg.2013.02.009 PMID: 24016368.

37. Ramakrishnan Y, Zammit-Maempel I, Jones NS, Carrie S. Paranasal sinus computed tomography anatomy: a surgeon’s perspective. J Laryngol Otol. 2011; 125(11):1141–7. Epub 2011/09/09. https://doi.org/10.1017/S0022215111001988 PMID: 21968844.

38. Huang BY, Lloyd KM, DelGaudio JM, Jablonowski E, Hudgins PA. Failed endoscopic sinus surgery: spectrum of CT findings in the frontal recess. Radiographics. 2009; 29(1):177–95. Epub 2009/01/27. https://doi.org/10.1148/rg.291085118 PMID: 19168844.

39. Valdes CJ, Bogado M, Samaha M. Causes of failure in endoscopic frontal sinus surgery in chronic rhinosinusitis patients. Int Forum Allergy Rhinol. 2014; 4(6):502–6. Epub 2014/03/13. https://doi.org/10.1002/alr.21307 PMID: 24616299.

40. Stammberger H. Uncapping the Egg: The Endoscopic Approach to Frontal Recess and Sinuses: Endo-Press; 2004.

41. Tuncyurek O, Garces-Descovich A, Jaramillo-Cardoso A, Duran EE, Cataldo TE, Poylin VY, et al. Structured versus narrative reporting of pelvic MRI in peripheral fistulizing disease: impact on clarity, completeness, and surgical planning. Abdom Radiol (NY). 2019; 44(3):811–20. Epub 2018/12/07. https://doi.org/10.1007/s00261-018-1858-8 PMID: 30519819.

42. Johnson AJ, Chen MY, Swan JS, Applegate KE, Littenberg B. Cohort study of structured reporting compared with conventional dictation. Radiology. 2009; 253(1):74–80. Epub 2009/08/28. https://doi.org/10.1148/radiol.2531090138 PMID: 19709993.

43. Frasad R, Chen B. Imaging Evaluation of the Head and Neck Oncology Patient. Cancer Treat Res. 2018; 174:59–86. Epub 2018/02/13. https://doi.org/10.1007/978-3-319-65421-8_5 PMID: 29435837.

44. Norenberg D, Sommer WH, Thasler W, D’Haese J, Rentsch M, Kolben T, et al. Structured Reporting of Rectal Magnetic Resonance Imaging in Suspected Primary Rectal Cancer: Potential Benefits for Surgical Planning and Interdisciplinary Communication. Invest Radiol. 2017; 52(4):232–9. Epub 2016/11/20. https://doi.org/10.1097/RLI.0000000000000336 PMID: 27861230.

45. European Society of R. ESR paper on structured reporting in radiology. Insights Imaging. 2018; 9(1):1–7. Epub 2018/02/21. https://doi.org/10.1007/s13244-017-0588-8 PMID: 29460129.

46. Bosmans JM, Neri E, Ratib O, Kahn CE Jr. Structured reporting: a fusion reactor hungry for fuel. Insights Imaging. 2015; 6(1):129–32. Epub 2014/12/06. https://doi.org/10.1007/s13244-014-0368-7 PMID: 25476598.

47. Sluijter CE, van Workum F, Wiggers T, van de Water C, Visser O, van Slooten HJ, et al. Improvement of Care in Patients With Colorectal Cancer: Influence of the Introduction of Standardized Structured Reporting for Pathology. JCO Clin Cancer Inform. 2019; 3:1–12. Epub 2019/05/10. https://doi.org/10.1200/CC I.18.00104 PMID: 31070983.

48. Sabel BO, Plum JL, Czihal M, Lottspeich C, Schonleben F, Gabel G, et al. Structured Reporting of CT Angiography Runoff Examinations of the Lower Extremities. Eur J Vasc Endovasc Surg. 2018; 55 (5):679–87. Epub 2018/04/09. https://doi.org/10.1016/j.ejvs.2018.01.026 PMID: 29627139.

49. Sahni VA, Silveira PC, Sainani NI, Khorasani R. Impact of a Structured Report Template on the Quality of MRI Reports for Rectal Cancer Staging. AJR Am J Roentgenol. 2015; 205(3):584–8. Epub 2015/08/22. https://doi.org/10.2214/AJR.14.14053 PMID: 26295645.

50. Schoppe F, Sommer WH, Schmidutz F, Armbruster M, Paprottka KKJ, et al. Structured reporting of x-rays for atraumatic shoulder pain: advantages over free text? BMC Med Imaging. 2018; 18(1):20. Epub 2018/07/05. https://doi.org/10.1186/s12880-018-0262-8 PMID: 29970014.

51. Weiss DL, Langlotz CP. Structured reporting: patient care enhancement or productivity nightmare? Radiology. 2008; 249(3):739–47. Epub 2008/11/18. https://doi.org/10.1148/radiol.2493080988 PMID: 19011178.

52. Matsumoto M, Koike S, Kashima S, Awai K. Geographic Distribution of Radiologists and Utilization of Teleradiology in Japan: A Longitudinal Analysis Based on National Census Data. PLoS One. 2015; 10(9):e0139723. Epub 2015/10/01. https://doi.org/10.1371/journal.pone.0139723 PMID: 26421721.

53. Ranschaert ER, Binkhuysen FH. European Teleradiology now and in the future: results of an online survey. Insights Imaging. 2013; 4(1):93–102. Epub 2012/12/19. https://doi.org/10.1007/s13244-012-0210-z PMID: 23247775.
54. Ross P, Sepper R, Pohjonen H. Cross-border teleradiology-experience from two international teleradiology projects. Eur J Radiol. 2010; 73(1):20–5. Epub 2009/11/17. https://doi.org/10.1016/j.ejrad.2009.10.016 PMID: 19914019.

55. Pinto Dos Santos D, Baessler B. Big data, artificial intelligence, and structured reporting. Eur Radiol Exp. 2018; 2(1):42. Epub 2018/12/06. https://doi.org/10.1186/s41747-018-0071-4 PMID: 30515717.

56. Pinto Dos Santos D, Brodehl S, Baessler B, Arnhold G, Dratsch T, Chon SH, et al. Structured report data can be used to develop deep learning algorithms: a proof of concept in ankle radiographs. Insights Imaging. 2019; 10(1):93. Epub 2019/09/25. https://doi.org/10.1186/s13244-019-0777-8 PMID: 31549305.