Thieme

Structured Reporting in Clinical Routine

Strukturierte Befundung in der klinischen Routine

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ABSTRACT

Background The radiology report is the key component in the communication between radiologists and referring clinicians. Traditionally, reports are written as free text. Several studies have shown that structured reporting using dedicated report templates has a number of advantages compared to conventional reports. Therefore, many radiological societies have recommended the implementation of structured reporting in clinical routine.

Method In the meantime, collections of freely available templates have been presented and software solutions for structured reporting have been made commercially available. These allow for quality improvements in the written radiology report as they ensure that all relevant clinical information is included. Most vendors mainly supply proprietary report templates or allow users to create templates for their own institution. The German Radiological Society (DRG) has the goal of developing consensus-based, quality-assured report templates and providing them under a free license.

Results The DRG has developed its first consensus-based report templates and provides them at www.befundung.drg.de. Further report templates will be developed in close cooperation with the respective committees of the DRG and referring clinicians.

Conclusion Structured reporting allows for a significant improvement in the quality of written radiology reports. The use of report templates requires personal and technical changes to the reporting process itself. Radiology should face these challenges in its leading role in the application of modern IT-based solutions. Vendors are now encouraged to provide practical solutions.

Key Points:

- Structured reports have numerous advantages over conventional narrative reports.
- The German Radiological Society is developing consensus-based and quality assured report templates.
- Report templates are provided at www.befundung.drg.de under a free license.
- Vendors are now encouraged to provide solutions for the implementation of structured reporting.

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ZUSAMMENFASSUNG

Hintergrund Der radiologische Befundbericht ist das zentrale Mittel der Kommunikation zwischen Radiologen und Zuweisern. Traditionell wird dieser als Freitext verfasst. Aus zahlreichen Untersuchungen ist bekannt, dass eine strukturierte Befundung mit Nutzung entsprechender Befundvorlagen eine Vielzahl von Vorteilen gegenüber herkömmlichen Befundberichten aufweist. Zahlreiche radiologische Fachgesellschaften empfehlen daher die Implementierung einer strukturierten Befundung in der klinischen Routine.

Methode Inzwischen existieren bereits Sammlungen frei verfügbarer Befundvorlagen sowie kommerzielle Softwarelösungen zur strukturierten Befundung. Diese ermöglichen eine Verbesserung der Qualität radiologischer Befundberichte durch Nennung aller notwendigen klinischen Informationen. Die meisten Hersteller stellen vor allem proprietäre Befundvorlagen zur Verfügung oder erlauben dem Benutzer die

Erstellung institutionsspezifischer Befundvorlagen. Die Deutsche Röntgengesellschaft (DRG) hat sich zum Ziel gesetzt, qualitätsgesicherte konsensbasierte Befundvorlagen zu entwickeln und unter freier Lizenz zur Verfügung zu stellen.

Ergebnisse Die DRG hat erste konsensbasierte Befundvorlagen entwickelt und unter www.befundung.drg.de zur freien Verfügung gestellt. Weitere Befundvorlagen werden in enger Zusammenarbeit mit den entsprechenden Arbeitsgemeinschaften der DRG und zuweisenden Kollegen erarbeitet.

Schlussfolgerung Strukturierte Befundung ermöglicht eine deutliche Verbesserung der Qualität radiologischer Befundberichte für eine Vielzahl von Fragestellungen. Die Nutzung strukturierter Befundvorlagen bedingt jedoch eine Umstellung im persönlichen und technischen Befundungsprozess. In ihrer führenden Rolle in der Anwendung moderner IT-gestützter Lösungen sollte sich die Radiologie diesen Herausforderungen bewusst stellen. Softwarehersteller sind nun gefordert, praktische Lösungen anzubieten.

Introduction

Radiology is an integral part of the diagnosis and treatment of numerous diseases. From X-ray images of the chest and skeletal system to MRI scans of the liver and prostate, diagnostic radiology has become an essential part of the clinical routine. The trend toward personalized imaging-based medicine increasingly requires specialized knowledge in order to be able to answer the particular clinical questions of referring specialists. The majority of the communication with referring clinicians typically occurs via the report written by the radiologist. Describing and interpreting the imaging findings and providing the probability-based differential diagnosis are the radiologist's main responsabilities in this context.

Radiology reports are traditionally written as a free-form narrative. The variations in language use and vocabulary result in significant differences with respect to the form and content of the description and the evaluation of radiological findings. Less structured reporting may also result in important information for the further management of a patient being incomplete or difficult to understand in the report. Such information is then ultimately subsequently discussed and communicated in interdisciplinary meetings and tumor conferences in a time-consuming process. It would be desirable for all relevant information to be already provided in the primary report.

The goal of this review is therefore to provide an overview of current efforts to improve reporting, particularly with respect to the creation of structured reports using corresponding report templates. In addition, solutions that can already be used in the clinical routine are presented and discussed. Also, information on current and planned projects of the German Radiological Society (DRG) is provided.

Structured reporting

Publications evaluating and discussing radiology reports have been available since the 1980 s [1]. The goal of all of these publications was to define quality criteria for radiology reports, thereby helping to create high-quality reports. Many of the early publications were only theoretical considerations regarding the formulation of free-text reports and provided only minimal scientifically sound evidence [2, 3]. However, there was strong consensus already early on that both report completeness and clear formulations using terminology that is as uniform as possible are desirable. This has since been able to be confirmed by multiple surveys of radiologists and referring clinicians and is supported by corresponding evidence [4 – 7].

In 2007, the American College of Radiology (ACR) was one of the first major societies to publish results of an intersociety conference clearly calling for more structured reporting [8]. At the same time, the Radiological Society of North America (RSNA) developed and published the RadLex, a lexicon of standardized radiology terms [9]. In addition, a technical standard for structured radiology report templates was developed as part of a reporting initiative launched by the RSNA [10, 11]. This initial XML-based standard was ultimately replaced by an HTML-based standard at the initiative of IHE (Integrating the Healthcare Enterprise) and comprehensively described in the MRRT profile (Management of Radiology Report Templates) [12, 13]. In addition, this profile allows the integration of logic for reporting for radiologists so that automatic classifications and recommendations can be made as a function of individual input, for example [14, 15].

Numerous professional societies have since spoken out in favor or structured reporting [16 – 18]. The German Radiological Society has also addressed this topic and in 2016 defined it as a key project for the coming years.

The additional advantages of structured reports could be shown in various studies. For example, in oncology, there have been significant improvements in the quality of reports and the communication of findings. Therefore, it was able to be shown that the use of a report template based on defined criteria produced more complete and precise reports in patients with hepatocellular carcinoma (HCC) than conventional free-text reports [19]. Similar results have also been seen in the case of rectal and pancreatic cancer. Multiple studies were able to independently show that the use of structured report templates resulted in significant improvements in the comprehensibility and completeness of reports [20 – 22]. In a study on structured reporting in pancreatic cancer, the surveyed referring surgeons reported that only 25 – 42 % of narrative reports contained all findings relevant for surgical planning while an increase to 69 – 98 % was seen in the case of structured reports [22]. This was confirmed in other studies regarding reports on rectal cancer. The authors found that the use of a corresponding report template was able to increase the percentage of reports evaluated as optimal from 38 – 70 % [20] and the percentage of relevant information contained in the report from 38 – 98 % [21].

It was able to be shown even outside of oncology that structured reporting results in a relevant increase in quality. Reports for simple chest X-rays [23] as well as for complicated examinations like CT enterography [24], MRI examination of the shoulder [25], CT angiography of the pulmonary circulation [26] and MRI examination in multiple sclerosis [27] benefit greatly from the use of structured report templates. In all cases significantly more relevant information was contained in the corresponding reports and referring clinicians preferred the structured reports to the conventional free-text format.

Structured reporting could yield advantages even beyond the communication of findings. For example, the automatic communication of data regarding contrast agent or patient radiation exposure with subsequent integration in the report would be easy to achieve given the corresponding technical implementation [28, 29].

Despite all of these promising developments and the fact that some guidelines and certification procedures already require structured reporting, it has not yet become established in the clinical routine. A survey of Italian radiologists found that the majority of those surveyed had heard of structured reporting but only a minority of them regularly use it in their clinical work [30]. Reasons for this include the current lack of usable report templates and the minimal availability of software solutions for structured reporting.

Current implementation in the clinical routine

Radiology reports have always been structured to some extent. Structuring of the report according to "clinical data", "clinical problem", "findings", and "diagnosis" can be considered the most basic form of structuring. However, structured reporting entails more than this and requires additional structuring within the individual sections. An early solution that was implemented in radiology information systems (RIS) is the use of text modules. Today, this very simple solution is employed in numerous hospitals and practices and allows the use of reusable free-text modules that can be modified as needed.

A more structured form of reporting is the use of text modules based on established reporting systems with precisely defined terminology. The most well-known example of this is BI-RADS (Breast Imaging Reporting and Data System) which is already comprehensively used in the clinical routine [31]. For this concrete example, it was able to be shown that the use of IT-supported structured reporting has no disadvantages and increases the quality of reports [32]. There are similar reporting systems for other clinical problems, for example LI-RADS for hepatocellular carcinoma, lung-RADS for lung tumors, and TI-RADS for thyroid nodules.

Solutions are already commercially available for some of these reporting systems and have been integrated by the manufacturers in their RIS systems, for example (▶ **Fig. 1a**). Other manufacturers offer products for individual clinical problems independent of RIS systems that attempt to structure and thus support reporting by radiologists [33]. Mint Lesion (Mint Medical GmbH, Dossenheim) is one example (▶ **Fig. 1b**). This software supports reporting of examinations for oncological problems with respect to correct TNM classification and the evaluation of tumor response (for example in the study setting according to RECIST 1.1, Cheson criteria or RANO).

The fact that structured reporting can be practically implemented on a larger scale and for clinical problems for which structured reporting systems are currently not available has also already been able to be shown. In two published studies regarding the practical implementation of structured reporting for almost the entire clinical routine, report templates were integrated in language recognition software. As a result, over 90 % of all reports were structured at the end of the observation periods [34, 35]. The commercially available software SmartRadiology (Smart Reporting GmbH, Munich), which provides report templates for a number of different clinical problems, could potentially be used for this purpose (▶ **Fig. 1c**).

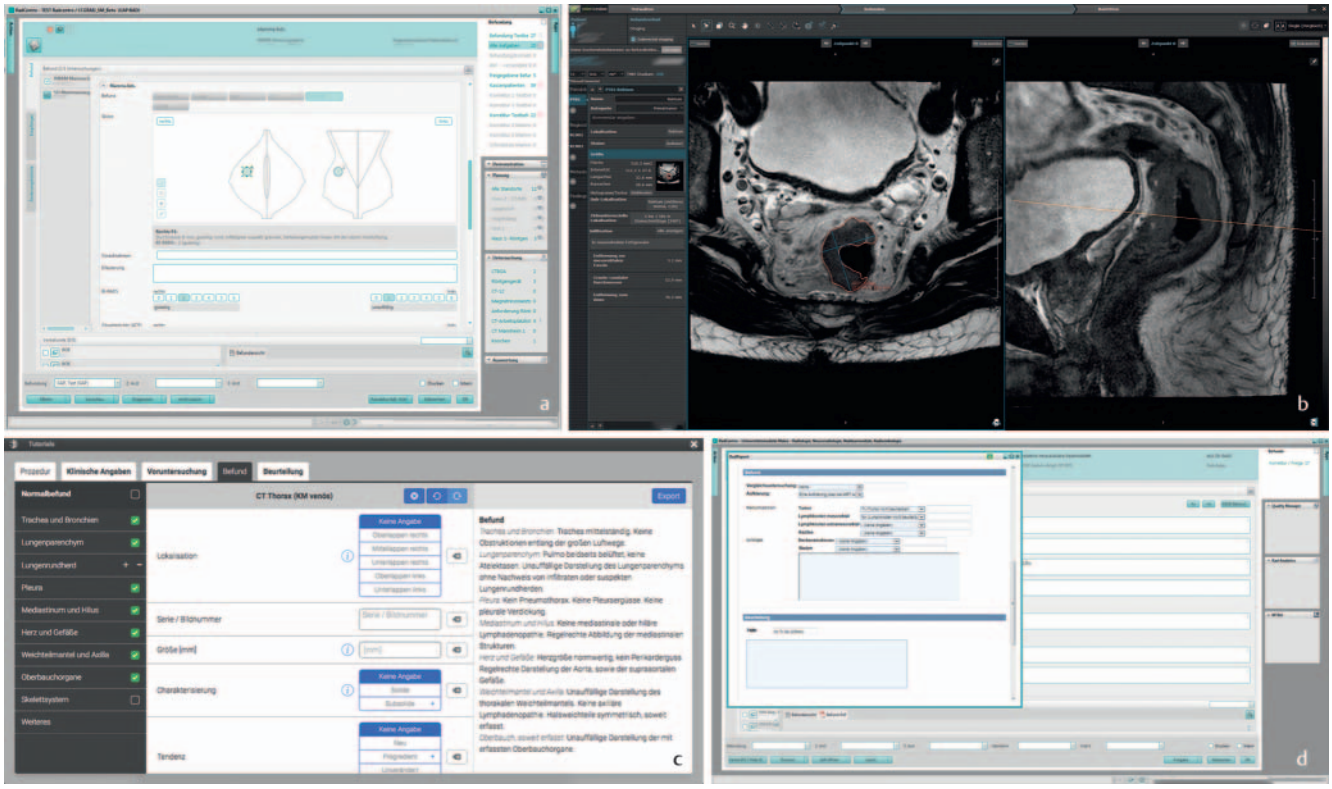
All currently available structured reporting products seem to have in common that either users must enter their own institution-specific report templates or the software manufacturer provides proprietary report templates. More generic approaches that make it possible to adopt and use report templates from the professional societies, such as the corresponding collection of the RSNA (www.radreport.org), have only been published as prototypes and are not widely used in the clinical routine [36]. However, the manufacturer i-Solutions Health GmbH, Mannheim in cooperation with DFC-Systems GmbH, Munich was able to include this generic application in their RIS solution (▶ **Fig. 1d**).

Limitations in routine use

The potential advantages of structured reporting have been sufficiently described in recent years, particularly the improvement in the quality of radiology reports and interdisciplinary communication [37]. There are many reasons for the continued lack of implementation of structured reporting in the clinical routine.

While standardized and structured reporting may be easy and simple to implement for numerous clinical problems, other radiological findings require greater flexibility. Although a report template can be useful, for example, for a preoperative staging examination, structured reporting can be used only on a limited basis in early postoperative situations in particular due to the wide range of possible findings. As a result, the percentage of unstructured free text will have to remain comparatively high in these cases.

The currently available report templates represent another significant limitation. Although there are already over 250 report templates on the website of the RSNA (www.radreport.org) and the website in cooperation with the ESR (open.radreport.org) that have been downloaded over 4.5 million times, they are primarily in English and can therefore only be used in Germany on a limited basis and are of heterogeneous quality. The templates available there are primarily suggestions from individual persons or groups. Only a small number of the templates were the result of a formal consensus process or were created in coordination with the corresponding clinical professional societies.



▶ **Fig. 1** **a** RIS-based reporting with BI-RADS, i-Solutions (i-Solutions Health GmbH, Mannheim) in this case. **b** Reporting for oncological cases with support for TNM and evaluation of tumor response, mint Lesion (Mint Medical GmbH, Dossenheim) in this case. **c** Structured reporting with Smart Radiology (Smart Reporting GmbH, München). **d** Generic platform for structured reporting (www.mrre.org), integrated in i-Solutions (i-Solutions Health GmbH, Mannheim in cooperation with DFC-Systems GmbH, München) in this case.

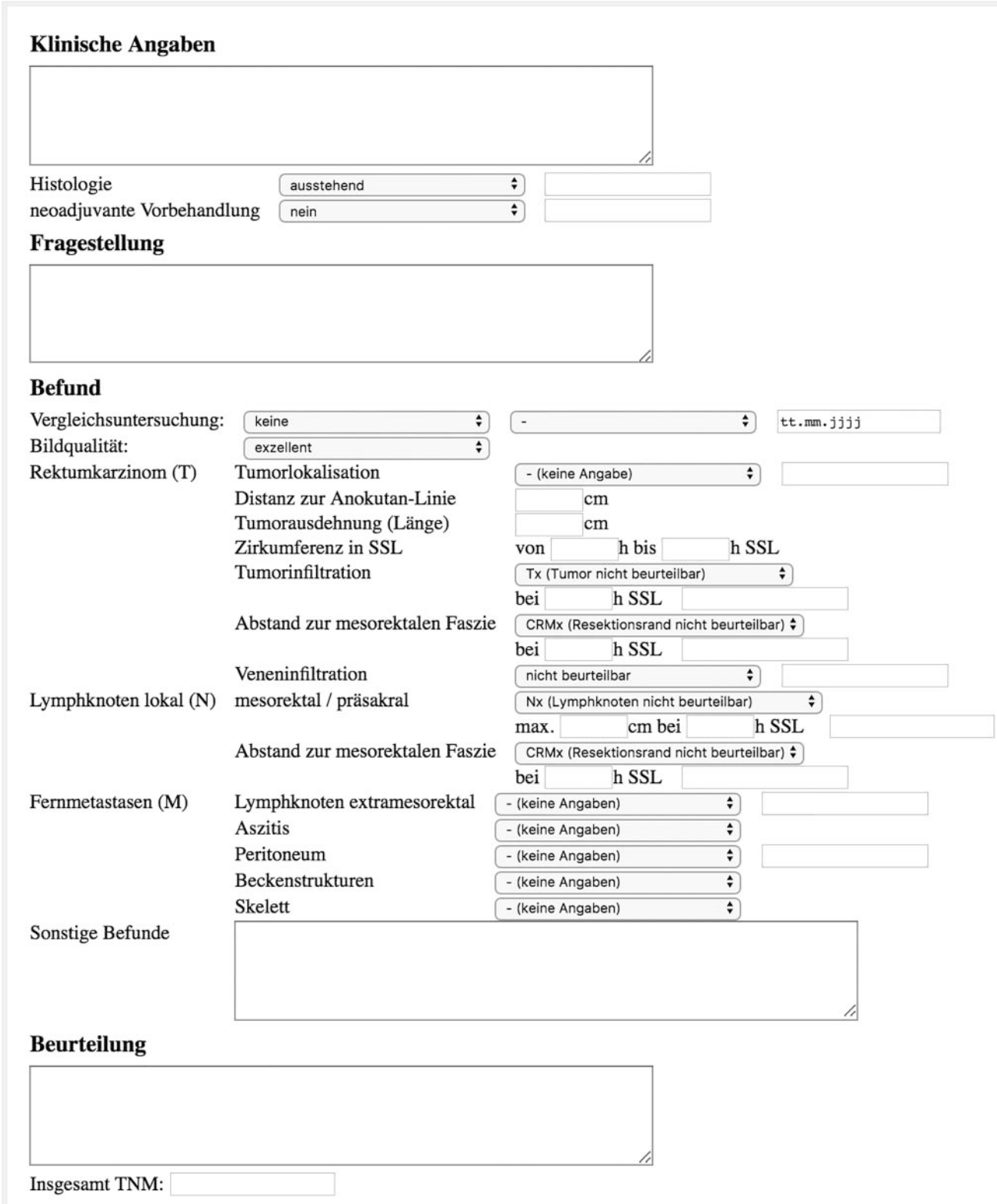
The lack of quality-assured German report templates has been addressed by the German Radiological Society and was recently defined as a key future project. AG Informationstechnologie (AGIT) in cooperation with the other work groups of the German Radiological Society has begun creating a comprehensive collection of quality-assured German report templates which are available via the website www.befundung.drg.de for free non-commercial use. The report templates, which are approved at consensus meetings, are intended to represent a minimum standard and should not contain any information that is irrelevant for referring clinicians but can be adapted or expanded to meet the needs of the particular facility or special wishes of referring clinicians (▶ **Fig. 2**). The templates should be checked regularly and updated as necessary in order to reflect the current state of scientific knowledge and the reality of care (▶ **Fig. 3**).

Interested users can already download these report templates and use them locally or process them with a free web-based tool (EasyRad, IFTM GmbH, Solingen) and copy the generated report via intermediate storage to their own RIS.

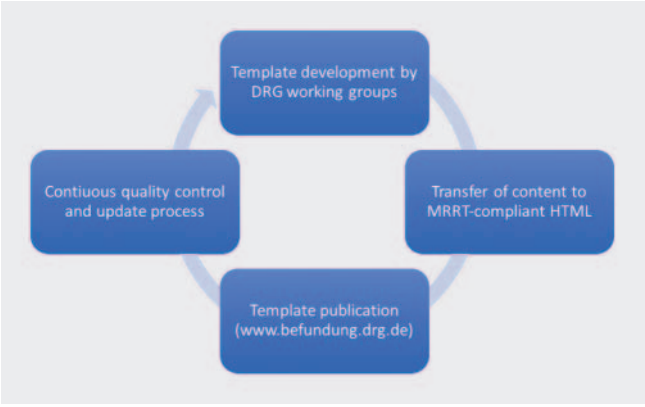
However, comprehensive use of structured reporting probably cannot be expected in the foreseeable future. Even though initial IT solutions for the implementation of structured reporting are available, there continues to be a lack of commercial products allowing efficient and simple use of the free report templates developed by the professional societies in the daily routine in radiology. Moreover, radiologists need to be willing to fundamentally change personal work practices in the reporting process. Furthermore, the concern regarding an increase in the time required for reporting is not without cause. Some studies on the topic indicate that radiologists feel that the use of report templates is restrictive and time-consuming [38, 39]. However, other studies were able to show that the use of corresponding templates for traumatological examination reporting did not have a significant effect on the time needed to create a report [40]. Particularly in situations in which a high percentage of normal findings are to be expected, report templates with corresponding default values result in a relevant time savings [34].

Outlook and potential

There is a vast amount of clinically relevant information in radiology reports but it is extremely difficult or even impossible to automatically extract this information from free-text reports. It would be theoretically conceivable to analyze reports with Natural Language Processing (NLP) and to then further process the information contained in the report. However, in addition to computational linguistic challenges, the problem that certain data is only contained in some reports is often encountered [41]. Structured reporting using corresponding templates could simplify data analysis due to the use of a primary computer-compatible format. It would also ensure that the same data is included in all reports.



▶ **Fig. 2** Example of an IHE-MRRE-compliant template, in this case for MRI in rectal cancer (similar templates can be found at http://www.befundung.drg.de).



▶ **Fig. 3** Process of development, publication and continued updating of the report templates.

Initial approaches to make information contained in reports usable or statistically analyzable have already been described for interventional radiology and areas in which standardized reporting systems, such as BI-RADS, are used [42, 43]. Therefore, databases could be filled during clinical use with structured and usually complete data, the analysis of which could be relevant for quality assurance as well as various research areas. As a result of the central role of radiology in almost all clinical pathways, it would be possible to analyze the prevalence and incidence of various pathologies as well as the disease course. This data could be analyzed on an anonymized nationwide basis, thereby helping to answer questions that could otherwise only be answered in larger studies.

Structured reporting with integration of data from other sources such as lab and pathology would open up even more interesting possibilities. Initial attempts to create structured reports in pathology have already been made in Norway [44]. If databases could be linked to such structured reports, the radiological assessment of a tumor could be automatically compared to the surgical specimen, for example, or interventional radiologists could receive automatic notification regarding CT-guided biopsies. However, the required interoperable interfaces and structured data recording in hospital information systems have not yet been sufficiently technically implemented.

Structured reporting could prove to be a key to further progress with respect to other current topics such as machine learning and artificial intelligence. Unstructured reports with inconsistencies are not suitable as a reliable collection of annotations, while a structured report could provide reliable and machine-readable annotations for all fields contained in the report template.

Conclusion

The radiology report is a central medium in the communication of findings with referring clinicians. The conventional narrative form has various limitations with respect to the quality of radiology reports and interdisciplinary communication that can be avoided by structured reporting using corresponding report templates.

The German Radiological Society therefore launched an initiative with the goal of providing free consensus-based and quality-assured German report templates in a manufacturer-independent format.

Software manufacturers now need to support this approach and provide flexible interoperable solutions in their IT systems.

Conflict of Interest

The authors declare that they have no conflict of interest.

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