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Evaluation des Mehrwerts von strukturierter Befundung in der Radiologie

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I. Abkürzungsverzeichnis

SR: structured report

FTR: free text report

RSNA: Radiological Society of North America

ESR: European Society of Radiology

ISCD: International Society for Clinical Densitometry

DXA: dual-energy x-ray absorptiometry exam

CTPA: CT pulmonary angiogram for pulmonary embolism

II. Publikationsliste

Während meiner Tätigkeit als Doktorandin an der Klinik und Poliklinik für Radiologie, Klinik der Ludwig-Maximilians-Universität München, sind unter Betreuung von Prof. Dr. med. Wieland Sommer und Dr. med. Franziska Galié folgende wissenschaftliche Arbeiten veröffentlicht worden:

Structured reporting has the potential to reduce reporting times of dual-energy x-ray absorptiometry exams [1]

Su Hwan Kim*, Lara M. Sobez*, Judith E. Spiro, Adrian Curta, Felix Ceelen, Eric Kampmann, Martin Goepfert, Raphael Bodensohn, Felix G. Meinel, Wieland H. Sommer, Nora N. Sommer and Franziska Galié

BMC Musculoskeletal Disorders 21, 248 (2020)

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Impact Faktor 2019: 2,05

*geteilte Erstautorenschaft

Creating high-quality radiology reports in foreign languages through multilingual structured reporting [2]

L. M. Sobez*, S. H. Kim*, M. Angstwurm, S. Störmann, D. Pförringer, F. Schmidutz, D. Prezzi, C. Kelly-Morland, W. H. Sommer, B. Sabel, D. Nörenberg, M. Berndt, F. Galié

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III. Einleitung / Introduction

III.1 The Importance of High-Quality Radiology Reports

A radiology report describes, interprets and documents the results of a radiological exam. According to the Radiological Society of North America (RSNA), “The clinical report is an essential part of the service that radiologists provide to patients” and “it is of utmost importance that the report be uniform, comprehensive, and easily understood” [3].

In practice a clinician requests a radiological exam in hopes of answering a clinical question. After the exam is performed, the radiologist is faced with describing, interpreting the results and answering the clinical question, so the clinician can draw the correct consequences for the patient’s treatment. Thus “radiology reports are vital for patient care as referring physicians depend upon them for deciding appropriate patient management” [4].

However, communicating the results of an exam is apparently easier said than done. Hospital clinicians in the UK gave a mean rating of 7 out of 10 (95% CI: 6.5-7.5) for content and 6.7 (95% CI: 6.2-7.2) for clarity of the reports they receive [5]. In another international survey of clinicians and general practitioners by Bosmans et al. 71.8% (513 of 714) of clinicians were satisfied with the radiology reports they receive. 22.5 % (109 of 707) of clinicians had trouble understanding what the radiologist wanted to convey and 26.8% (74 of 276) of general practitioners thought that radiologists frequently present simple things in a complicated way. Only 50.1% (356 of 710) agreed to the statement that the language of radiology reports is mostly clear to clinicians [6].

Inadequate communication of results has also repeatedly been found to be a leading cause of patient harm and litigation against radiologists [7-10]. A nationwide survey of radiologists in the United States found that inadequate communication of results was the third most common cause of malpractice suits against radiologists, after error in diagnosis and procedural complications [9].

In recent years the radiological community has therefore come to recognize that not only drawing the correct conclusions from an exam is important, but also how these results are communicated. A search for the optimal report type has ensued.

Traditionally radiology reports are free-text narratives [4]. Depending on the training and individual preferences of the radiologist these reports differ greatly in length, style and content. This can compromise clarity and make it difficult for referring physicians to find relevant information for optimal patient care [4, 11-13]. One author went so far as to compare lengthy and verbose radiology reports to the absurdity of presenting laboratory results in prose instead of as an itemized list [14].

In order to better meet the demands of referring physicians several surveys on their preferences have been conducted. This research has shown that the majority of referring physicians would rather receive itemized or structured reports (SRs) than free-text reports (FTRs) [5, 6, 15-17].

III.2 Structured Reporting

Structured reporting is a form of radiology reporting that was developed to improve the quality of radiology reports by means of standardization.

Types of Structured Reporting

Weiss et al. [18] differentiate three types of SRs:

The first uses a structured format with headings such as “Impression” or “Conclusion” which facilitate information gain. Most radiology reports nowadays fulfil these criteria. The second is so called “itemized reporting” with certain information appearing in a reliable order rather than buried in prose, making it easier to locate pertinent information [18]. This standardized structure serves as a checklist, so no relevant areas are forgotten [19]. The third type known as “fully structured” reporting also uses standardized language from a standard lexicon. Standardized language can contribute clarity, comprehensibility and also better comparability of reports for data mining and research [19].

Advantages of Structured Reporting

Many advantages of structured reporting over free-text reporting have been found.

Completeness

Structured reporting can lead to more complete reports, since the radiologist is reminded to report on each relevant area as if he or she were following a checklist [20-24]. One study comparing SRs and FTRs of cervical spine CT examinations, showed a statistically significant decrease in missed non-fracture findings due to the use of a structured reporting template [22]. Likewise Quattrocchi et al. reviewed 3000 lumbar spine MRIs and found that the SRs contained clinically significant extraspinal findings, that had not been mentioned in the FTRs for 28.5% of the patients [23].

On the other hand some authors argue that looking more at templates for structured reporting and less at the actual exams (“eye-dwell”) could potentially lead to an increase in missed findings [18]. In an older study from 2009 structured reporting resulted in less complete and accurate reports [25], leading the authors to conclude that not every form of structured reporting will lead to higher completeness and each method should be investigated individually.

Clarity and Comprehensibility

Another advantage of structured reporting, which is frequently mentioned by referring physicians is the better comprehensibility of SRs [26]. While one study from 2005 found that neither reading time nor information recall by medical students were affected positively by SRs [27], several recent studies have shown that structured reporting can in fact increase comprehensibility [26, 28-30]. For example, in a study by Ghoshhajra et al. referring clinicians better understood the degree of coronary artery stenosis in SRs than in FTRs [28]. In a 2017 study nearly 150 clinicians were asked to read CT angiography, CT abdomen, CT thorax and brain MRI reports and then answer multiple choice questions without being able to go back to the reports. Here SRs led to significantly higher average rate of critical diagnosis recall, 82.7% versus 65.1% for FTRs [30]. The use of standardised terminology in structured reporting also reduces ambiguity [19, 31].

Automated Data Mining

An additional very important advantage of structured reporting is the possibility of mining reports for research, teaching and other purposes [19]. It is much easier to perform specific searches for common data elements in SRs due to the standardization of sections, content and terminology [32]. This is important because as the RSNA puts it, “to take full advantage of the benefits that information technology provides in medicine, radiology reports should be readable to humans and machines alike” [3].

Clinical Consequences

The question whether these numerous advantages have a real impact on patient care has been examined by several studies. Among other benefits, structured reporting has been shown to improve tumour staging and the assessment of resectability for pancreatic and rectal carcinoma [4, 33-35]. The clinical value of SRs has also been rated significantly higher by referring physicians in studies comparing SRs and FTRs for shoulder x-ray, staging of diffuse large B-cell lymphoma, videofluoroscopy and CT Angiography of the Lower Extremities [21, 26, 29, 36].

Overall Quality

Likewise, the overall report quality of SRs has also been shown to be significantly higher compared to FTRs in multiple studies. This effect has further been shown for a wide variety of exams including standardized exams [21, 37], as well as highly complex exams such as tumour staging for hepatocellular carcinoma [38].

The State of Structured Reporting

In light of these many positive effects of structured reporting on report quality and patient care, the broad consensus is that structured reporting can be beneficial and should be advanced, despite some remaining controversy.

Among others the RSNA seeks to promote structured radiology reporting “as a means of providing consistent, organized, and clear communication of radiologic results” [39]. To further this cause, the RSNA reporting initiative created an online open-access library containing hundreds of structured reporting templates called RadReport.

Following suit, the European Society of Radiology (ESR) also recently wrote that structured reporting is an endorsed development and “wide adoption of structured reporting is of critical importance for providing referring physicians and ultimately patients with the best quality of service” [19].

Despite this pronounced support, a nationwide survey of 265 radiologists in 2015 in the United States found that only 51% used structured reporting regularly and 33% rarely used it [40]. In Italy 56% of 1159 radiologists surveyed in 2016 never used structured reporting at work even though 87.0% were in favour of implementing it [41].

Although there is ample evidence that structured reporting can improve the quality of radiology reports, it seems it still hasn't found its way into clinical practice as much as one might expect.

III.3 Research Goal

With the discrepancy of slow implementation of structured reporting despite favourable research in mind, the goal of the two studies presented here was to further evaluate certain advantages and disadvantages of structured reporting compared to free-text reporting that have not yet been studied satisfactorily.

III.3.1 Structured Reporting's Impact on Productivity

A frequently voiced concern about structured reporting is that it might lead to less productivity [18] and this could well be one of the main reasons why structured reporting has not yet been implemented more [31, 40, 42]. The theory is that the time required to design structured reporting templates, adjusting to this new way of reporting and being bound to their rigid structure may all lead to loss of productivity [4]. Another negative impact of structured reporting could be that radiologists might spend more time looking at the template rather than the exam, also impeding workflow and possibly even leading to more missed findings [8].

However, there has been very little actual research conducted on the consequences for productivity due to structured reporting.

The few studies on this effect have mainly focused on differences in reporting times because report timeliness is very highly valued by referring clinicians [43, 44] and it is an important measure of productivity in radiology departments [45].

One study found slightly increased data entry times for ultrasounds due to structured reporting [46]. Others have shown reduced reporting times [47] or reduced audio dictation times but unchanged total radiologist time per study [48]. This limited amount of contradictory literature and the importance of report timeliness for optimal patient care, highlights the need for further research [26].

III.3.2 Assessing the Quality of Multilingual Structured Reports

The second research goal was to explore the benefits of a new potential application for structured reporting, which is creating reports in foreign languages. Creating reports in foreign languages is possible thanks to the development of structured reporting templates. These templates automatically generate a report from user entries in point and click menus and can theoretically be translated into any desired language. For example, a radiologist might click on “no pneumothorax” and the template is pre-set to automatically insert the sentence “There is no evidence of pneumothorax” into the report. However, one could also just as well pre-set the template to enter the German translation of this sentence into the report if “no pneumothorax” is selected by the radiologist. This way of generating reports in foreign languages has a major advantage over creating a free-text report in one language and then subsequently machine translating it, because there is a limited amount of entries the user can make, and the according sentences need to be pre-set correctly only once. Thus, it is much easier to avoid inept translations and make sure that whatever entry the user makes, the syntax and terminology of the translation will be appropriate.

In recent years, a few authors have implemented multilingual structured reporting and illustrated its possible use in international teleradiology and international research cooperation [49, 50]. These are two fields that could bring immense benefits for patient care.

International research cooperation is especially important when dealing with rare conditions, since there might not be enough cases to conduct viable national studies. Stramare et al. demonstrated this meaningful application of multilingual structured reporting, by using it to translate Italian radiology reports of patients with sarcomas, thereby making their imaging findings available for international research on this rare condition [49].

International Teleradiology can also bring benefits to patient care by providing diagnostic radiology services to patients in areas where there might be a lack of doctors in general or a lack of expertise on rarer findings. These two important fields, international teleradiology and international research cooperation, both face one major obstacle, the language barrier between countries, which multilingual structured reporting can help to overcome.

Patients who are hospitalized abroad, could also receive reports in their native language, helping them and their doctors back home understand their condition more quickly.

Despite these many beneficial applications, multilingual structured reporting has not yet been studied satisfactorily. One of the few studies only compared the consistency of main findings between conventional reports and reports created with multilingual structured reporting, but not the overall quality or referrer satisfaction [50], the other didn't investigate report quality at all [49]. To guarantee that patients can truly benefit from multilingual structured reporting, further research on the feasibility of such international projects and the ensuing report quality is necessary.

IV. Forschung / Research

IV.1 The Potential of Structured Reporting to Reduce Reporting Times of Dual-energy X-ray Absorptiometry Exams

This section includes content published in the paper *The Potential of Structured Reporting to Reduce Reporting Times of Dual-energy X-ray Absorptiometry Exams* published in BMC Musculoskeletal Disorders by S.H. Kim, L.M. Sobez et al. in 2020 [1].

Goal

The goal of this study was to further evaluate the impact of structured reporting on the productivity of radiologists.

Methods

Unlike other studies on this subject we chose to investigate a highly standardized exam type, dual-energy x-ray absorptiometry (DXA) for better comparability. The reason for this is that reporting time is directly influenced by the comprehensiveness and content of a report. By choosing a highly standardized exam, with very similar content in FTRs and SRs, it is possible to avoid confounding the impact of structured reporting on reporting times with differences due to varying report content.

Two radiology residents and two final-year medical students retrospectively created FTRs and SRs of DXA. They measured reporting time from first viewing the exam until saving the final report. 48 randomly selected DXA reports were sent to 2 referring physicians to evaluate report quality.

Results

In total, 104 DXA reports (FTRs and SRs) were created and the quality of 48 randomly chosen reports was evaluated by referring physicians. Reporting times of SRs by both radiology residents and medical students were significantly shorter with median reporting times of 2.7 minutes (residents: 2.7, medical students: 2.7) for SRs and 6.1 minutes (residents: 5.0, medical students: 7.5) for FTRs.

The overall report quality of SRs was rated significantly higher than FTRs ($p < 0.001$). 96% of SRs received high or very high-quality ratings compared to 79% of FTRs.

The ease of information gain from SRs was rated significantly better than from FTRs ($P < 0.001$). SRs were perceived to answer the clinical question significantly better than FTRs ($p < 0.007$). In the follow up survey both referring clinicians stated they would rather receive SRs of DXA than FTRs.

In conclusion structured reporting of DXA can lead to higher productivity by reducing reporting times, while at the same time improving report quality.

Contribution

My contribution to this study was designing the study together with my doctoral thesis supervisor and academic supervisor. I retrospectively selected suitable DXA exams from a search in our institutional radiology information system. Assisting our participants during the training-phase which served to review the principles of DXA exams and to get accustomed to the online reporting template was also part of my work. I designed and conducted a follow-up survey among our participants who had created the reports. I also conducted a literature survey on the most important qualities of a radiology report. Based on these results I developed a standardized evaluation sheet for the rating of report quality by the referring clinicians. Further important contributions were evaluation and interpretation of results, writing substantial sections of our paper and later revising it.

IV.2 The Quality of Radiology Reports Created in Foreign Languages through Multilingual Structured Reporting

This section includes content published in the paper *Creating high-quality radiology reports in foreign languages through multilingual structured reporting* published in *European Radiology* by L.M. Sobez, S.H. Kim et al. in 2019 [2].

Goal

The goal of this study was to investigate the quality of reports created in foreign languages with multilingual structured reporting templates.

Methods

Multilingual structured reporting templates allow radiologists to report in their mother tongue and then switch the report language to another language automatically. Using these templates, German and English-speaking radiologists created SRs in both languages. Templates for three different exam types were implemented (intensive care chest x-ray, shoulder x-ray specifically for degenerative processes and CT pulmonary angiogram for pulmonary embolism (CTPA)). German clinicians used a standardized questionnaire to evaluate the report quality of German SRs by English-speaking radiologists and German SRs by German radiologists. The completeness, clarity, succinctness, language utilization and clinical value of reports were assessed.

Results

There was no significant difference in quality between German SRs by English-speaking radiologists and German SRs by German radiologists and both predominantly received very high or high overall quality ratings.

Similarly, no significant difference in comprehensibility or clinical value were found between the reports of German and English-speaking radiologists.

However, SRs by German radiologists received significantly better ratings for overall quality, than FTRs by German radiologists.

This study shows that multilingual structured reporting templates can be used to create high-quality radiology reports in foreign languages.

Contribution

My contribution to this study was designing the study together with my doctoral thesis supervisor. Translating the CTPA and shoulder x-ray templates and developing a multilingual chest x-ray template were my responsibility. I also retrospectively selected suitable patients from a search in our institutional radiology information system. The standardized questionnaire for report quality evaluation previously employed in the DXA study on reporting times was also refined. In this study developing and conducting a follow-up survey among the referring clinicians on their opinions of structured reporting was another part of my work. Further contributions were data management, evaluation and interpretation of results, writing substantial parts of the paper and later revising it.

V. Zusammenfassung

V.1 Englische Zusammenfassung

In recent years there has been an effort by radiologists around the world to improve the quality of their reports, in order to better suit the needs of referring clinicians and increase their value for patient care. Structured reporting has emerged as a method for creating higher quality reports due to standardized language, uniform format and content. Multiple studies have found numerous advantages of structured reporting over conventional FTRs such as completeness, clarity, ease of information extraction, clinical value and the possibility of datamining [19-23, 26, 28, 29]. However, structured reporting is still not in regular widespread use today [40, 41].

This research work's goal is to further investigate potential advantages and disadvantages of structured reporting that have not been studied satisfactorily. The objective of the first study is to investigate one of the main concerns of radiologists with structured reporting, which is that it may lead to a loss of productivity. The second study examines a new application of structured reporting, which is creating high quality reports in foreign languages and could bring immense benefits for patient care by enabling international research cooperation and providing world-wide radiology services via international teleradiology.

The first study, comparing the reporting times of structured and free-text DXA exams, showed that SRs required significantly less time to compose and they received significantly higher ratings in overall quality, ease of information extraction and clinical value by referring clinicians. Therefore, structured reporting can in fact increase productivity in DXA reporting, while at the same time improving quality [1].

In the second study English-speaking radiologists created reports in German with multilingual structured reporting templates, that automatically generated German reports from their English entries. The three different exam types included in the study are chest x-ray, shoulder x-ray and CT pulmonary angiogram for pulmonary embolism. These reports by English-speaking radiologist were compared to reports created with the same templates by Germans. No significant differences in overall report quality,

comprehensibility or clinical value were found between these two groups. Both received high quality and very high-quality ratings by referring clinicians in most cases. This study shows that multilingual structured reporting templates can be used to create high-quality radiology reports in foreign languages [2].

My contribution to this research work was partial study design, selecting the patient collective, developing a standardized questionnaire to evaluate report quality and designing and conducting follow up surveys among the participating radiologists and clinicians. Furthermore, I was responsible for data management, presentation and interpretation of results, composing substantial sections of the publications and finally the revision of the papers.

V.2 Deutsche Zusammenfassung

In den letzten Jahren hat es ein weltweites Bestreben von Radiologen gegeben die Qualität ihrer Befunde zu erhöhen, um den Bedürfnissen der zuweisenden Kliniker besser gerecht zu werden und ihren Wert für die Patientenversorgung zu steigern. Die strukturierte Befundung hat sich als eine Methode herausgebildet, die mittels standardisierter Terminologie, Gliederung und einheitlichem Inhalt, zu Befunden höherer Qualität führen kann. Mehrere Studien haben zahlreiche Vorteile der strukturierten Befundung gegenüber Freitext-Befunden gezeigt, wie höhere Vollständigkeit, Verständlichkeit, einfachere Informationsgewinnung, größerer klinischer Nutzen und die Möglichkeit von Datamining [19-23, 26, 28, 29]. Dennoch wird die strukturierte Befundung noch nicht flächendeckend und regelmäßig im klinischen Alltag angewendet [40, 41].

Diese Forschungsarbeit hat das Ziel weitere Vor- und Nachteile der strukturierten Befundung, die noch nicht ausreichend erforscht wurden, zu untersuchen. Zielsetzung der ersten Studie ist es, eines der häufigsten Bedenken von Radiologen zur strukturierten Befundung, die geringere Produktivität, unter die Lupe zu nehmen. Die zweite Studie beschäftigt sich mit einer neuen Anwendung der strukturierten Befundung, der Möglichkeit qualitativ hochwertige Befunde in fremden Sprachen zu erstellen. Diese Anwendung könnte einen beachtlichen Vorteil für die weltweite Patientenversorgung bringen, indem sie internationale Forschungszusammenarbeit und eine flächendeckende radiologischer Versorgung durch internationale Teleradiologie ermöglicht.

In der ersten Studie zeigte der Vergleich der Befundungszeiten von strukturierten und Freitext-Befunden von DXA Untersuchungen, dass strukturierte Befunde signifikant geringere Befundungszeiten benötigen. Außerdem wurde ihre Gesamtqualität, die Informationsgewinnung und ihr klinischer Nutzen, von zuweisenden Klinikern signifikant besser bewertet. Daraus lässt sich schließen, dass strukturierte Befundung bei DXA Untersuchungen eine Zunahme der Produktivität bewirken und gleichzeitig zu einer Zunahme der Qualität führen kann [1].

In der zweiten Studie wurden deutsche Befunde durch englischsprachige Radiologen erstellt. Dies geschah mit Hilfe von multilingualen strukturierten Befundungstemplates, die aus den englischen Eingaben automatisch deutsche Befunde generierten. Es wurden drei verschiedene Bildgebungsarten in diese Studie eingeschlossen. Röntgen-Thorax, Schulter Röntgen und CT Angiographie bei Verdacht auf Lungenembolie. Die Befunde von englischsprachigen Radiologen wurden mit Befunden verglichen, die von deutschen Radiologen mit denselben Templates erstellt wurden. Es zeigten sich keine signifikanten Unterschiede in der Gesamtqualität, der Verständlichkeit oder dem klinischen Nutzen zwischen diesen beiden Gruppen. Beide erhielten überwiegend gute bis sehr gute Bewertungen durch zuweisende Kliniker. Diese Studie belegt, dass es möglich ist mit multilingualen strukturierten Befundungstemplates qualitativ hochwertige Befunde in Sprachen zu erstellen, die man selbst nicht beherrscht [2].

Mein Beitrag zu dieser Forschungsarbeit umfasste das gemeinsame Studiendesign, die Auswahl des Patientenkollektivs, die Entwicklung eines standardisierten Bewertungsbogens für die Befundqualität und die Durchführung einer Nachbefragung der teilnehmenden Befunder und Kliniker. Darüber hinaus war ich für das Datenmanagement, die Darstellung und Interpretation der Ergebnisse, die Verfassung von wesentlichen Abschnitten der Veröffentlichungen und schlussendlich die Überarbeitung der Paper verantwortlich.

VI. Veröffentlichungen

VI.1 Structured Reporting has the Potential to Reduce Reporting Times of Dual-energy X-ray Absorptiometry Exams

VI.2 Creating High-quality Radiology Reports in Foreign Languages Through Multilingual Structured Reporting

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