

The radiological report

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Impact

Research

The radiological report is the main and most important output of the radiologist as it states the outcome of the performed examination in concordance to the condition of the patient and the suggested diagnosis. However, due to differences in reporting and report content, the value of the radiological report is not always the same. In addition, the reporting process is still the same as in the earliest days, despite suggested reporting improvements like structured reporting (SR) and standardization. Especially these two possible improvements are widely promoted by large radiological societies to increase the value of the radiological report.

As the radiological report is very important, it is necessary to know how the reporting process can be enhanced and why for instance SR is still not implemented in the full field of radiology. This might be caused by difficulties in implementation or full suitability in the whole field and perhaps a negative sentiment among the reporters.

In addition, we need to search for different solutions to improve radiological reporting as the quality of the radiological report is still not improved and SR might not the way to go. Natural Language Processing (NLP), by using Artificial Intelligence (AI), can also extract and analyze free text and might be a substitute for SR in order to improve report quality.

Relevance

This thesis highlights the ongoing search towards improving radiology reporting focusing on structured reporting and the use of NLP. In the first part of this thesis, it is shown that due to difficulties in definitions of SR and its interpretations, a bonanza of scientific papers appeared. Proper setting the definitions for structured reporting and standardized reporting (Chapter 2), will increase its understanding and will allow for more evidence-based research. This is especially important as the current research performed with structured reporting has a low evidence level (Chapter 3). The output

of most studies is beneficial for structured reporting, but this is mostly due to better implementation of standardized reporting and not due to the fact that structured reporting is implemented. These outcomes are important for future implementations and question the promotion of structured reporting by radiological societies, as high-level evidence-based research is still lacking.

NLP has been used in healthcare to structure free text data. As it can also structure free text radiological reports it can be a substitute for structured reporting in radiology. This thesis provides the evidence that in a pilot setting it is possible to extract the Tumor and Nodal (TN-stage) necessary for oncological staging of pulmonary carcinoma out of free text radiological (PET) CT reports according to the TumorNodeMetastasis (TNM) classification system (Chapters 4-6). In addition, and because NLP structures free text data, it is possible to use the separate data components in for instance the radiological report. When combining both applications of NLP it is possible to use the free text data in a structured format as well as add value to the report by adding the described oncological stage. Hereby, a graphical user interface (GUI) is suggested to be a vehicle to improve NLP-processes, as it can highlight NLP results in the reporting process (Chapter 5).

This research does also show that for implementing AI in radiological reporting not always a large amount of data is necessary, but that smaller data sets can suffice, especially when using a rule-based approach. A different advantage of this rule-based approach is that the workflow is known and can be adjusted easily. This is also true for changing the language of the algorithm as is shown in chapter 5. Because it is rule-based only the language needs to be adjusted instead of training the algorithm and its rules again in a different language. Especially this will make the rule-based approach interesting for future research.

Target population

First of all, this thesis is a message to the structured reporting community that the evidence for structured reporting is questionable and that they should look closer to the

reporting process in order to assess its different components. It is advisable to review the efforts done in concordance with the new definitions for structured reporting and standardization, as standardization of the report content alone seems sufficient. For future research it is important to implement studies to investigate in which cases the structured reporting format is beneficial and in which it is not.

Secondly this thesis is interesting for the radiology reporter as it is important to get more insights in the reporting process as well as getting more insights in the problem of inconsistent reporting. After all, there is still much to gain in enhancing the value of the radiological report, and perhaps the possible solutions are much easier than letting AI and PACS vendors do their magic. Nevertheless, PACS-vendors and NLP experts should cooperate in searching evidence, solutions and applications for free text mining. After all, it will be a real improvement in radiology reporting when structuring data and adding specific information is integrated in the PACS system. Especially we postulate that a GUI will increase the acceptability and understanding NLP dependent tools among radiology reporters.

Finally, if we look beyond radiology and where NLP tools can be implemented in daily clinical routine, it might assist with all kinds of administrative tasks that current healthcare is facing. NLP solutions than can be a problem solver to overcome administrative burdens and thereby allowing healthcare employees to use more time for patient care.

Future

The overall aim should be to combine the image information of the radiological examination into the radiological report and use this combined information to improve the final radiological report. The GUI should be the central point of interaction and text as well as image algorithms should assist to increase the value of the radiological report. This is something we are aiming for, probably since the discovery of the X-ray by Wilhelm Conrad Röntgen.