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Perception of radiology reporting efficacy by neurologists in general and university hospitals

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AIM: To investigate how neurologists perceive the value of the radiology report and to analyse the relation with the neurologists own expertise in radiology and the level of subspecialisation of radiologists.

MATERIALS AND METHODS: A web-based survey was distributed to neurologists. The level of subspecialisation was assessed by the percentage of fellowship-trained radiologists and the percentage of radiologists that were members of the Dutch Society of Neuroradiology.

RESULTS: Most neurologists interpret all computed tomography (CT) and magnetic resonance imaging (MRI) studies themselves, and their self-confidence in making correct interpretations is high. Residents gave higher scores than neurologists for "Radiologist report answers the question" (p=0.039) and for "Radiologist reports give helpful advice" (p=0.001). Neurologists from university hospitals stated more frequently that the report answered their questions than neurologists from general hospitals (p=0.008). The general appreciation for radiology reports was higher for neurologists from university hospitals than from general hospitals (8.2 versus 7.2; p=0.003). Radiologists at university hospitals have a higher level of subspecialisation than those at general hospitals.

CONCLUSION: Subspecialisation of radiologists leads to higher quality of radiology reporting as perceived by neurologists. Because of their expertise in radiology, neurologists are valuable sources of feedback for radiologists. Paying attention to the clinical questions and giving advice tailored to the needs of the referring physicians are opportunities to improve radiology reporting.

Introduction

Efficacy in radiology can be studied at different levels. Traditionally, radiologists focus on making correct diagnoses and trying to optimise the images they use. This

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corresponds to, respectively, level 2 (diagnostic accuracy efficacy) and level 1 (technical efficacy) in the hierarchical model as described by Thornbury *et al.*[1] In the last decade, the focus has shifted to the added value of radiology for the referring physician and for patient outcome. This means that radiologists should pay attention to the higher levels of that model: diagnostic thinking efficacy (level 3), therapeutic efficacy (level 4), and patient outcome efficacy (level 5). The highest level of this model is societal efficacy (level 6). At present, this impact on society is very relevant for radiologists because of limited budgets in healthcare and the trend towards value-based reimbursement instead of volume-based pricing.[2,3] Therefore, quality improvement and cost-effectiveness should be considered together.

The radiology report is the main communication vehicle between radiologists and referring physicians. A high-quality report is essential to be of added value for the patient and society. In order to be useful in decision-making, the content of the report should be tailored to the needs of the clinician.[4] The term 'actionable reports' fits here, as it describes a practice in which the report facilitates an action of the referring physician based on the imaging findings.[5,6]

The quality of the reporting practice varies with the experience of the radiologist. In double reading of chest computed tomography (CT) examination reports, subspecialised chest radiologists make more clinically important corrections than other second readers.[7] Lindgren *et al.* advocate reinterpretation of abdominal imaging studies by radiologists with abdominal subspecialty if any potentially important finding is reported or in patients with known or suspected cancer, trauma, and/or infection.[8] Both studies indicate the value of subspecialisation. At the European Congress of Radiology (ECR) in 2015, the topic "General radiologist versus subspecialist radiologist" was discussed. One of the messages from this discussion was that subspecialisation is relevant for improved patient care. The proportion of subspecialty-trained radiologists varies between institutions.[9] In academic and large general hospitals, dedicated teams of, for instance, fellowship-trained neuroradiologists perform all neuroradiology reporting, while in smaller hospitals less or no subspecialisation exists.[10]

The question is whether the perceived value of the radiology reports has a relationship with the degree of subspecialisation of the radiologist and/or with the expertise of the neurologist. The expertise of the neurologist is relevant because communication always depends both on sender and receiver.

To realise improvements in reporting, it is necessary to know how radiology reports are valued by referring physicians, as they know the value of reports for patient care. Feedback from referring physicians is not a common practice, although it may reveal useful information[11] in addition to peer feedback among radiologists themselves.[12]

Assuming that subspecialisation leads to better radiology, the present study was undertaken to assess whether this also leads to a higher perceived value of the radiology report. Even though the assessment of an opinion leads to subjective results, it is important to assess because physicians base their decisions on patient management to a high degree on their confidence in the radiology report.

The hypotheses in the present study were (1) a higher level of specialisation of radiologists correlates with a higher perceived value of the report by referring neurologists and (2) a higher level of expertise of neurologists correlates with a lower perceived value of the report of radiologists. The purpose of the present study was to compare the value of the radiology report, as perceived by neurologists, between general hospitals and university hospitals, to relate this to the expertise of neurologists with radiology, and to identify items to improve the value of the radiologists report.

Materials and methods

An anonymous web-based survey with both closed and open questions was developed using Google Forms. The questions were grouped into categories of "Personal information", "Expertise in radiology", "Confidence in reading CT and magnetic resonance imaging (MRI) examinations", and "Opinions about the radiology reports". The survey is provided in the Electronic Supplementary Material. The survey was part of a broader project concerning the development and implementation of feedback systems to improve radiology services,[13] and an international comparison of neuroradiology expertise and the availability of radiology services.

The neurology departments of two university hospitals and 13 general hospitals in the Netherlands were invited to participate by telephone. The contacts at these hospitals sent an email to all neurologists and residents in neurology in their hospital requesting the completion of the questionnaire. A reminder was sent after 2 weeks. Data collection in the general hospitals was performed in November 2014 and in the university hospitals in December 2014. Data were collected anonymously. Approval of the Medical Research Ethics Committee was not required as this survey does not fall under the scope of the Medical Research Involving Human Subjects Act.

All neurologists in both university and general hospitals were board certified and members of the Dutch Society for Neurology. Training to become a Board-registered neurologist takes 6 years. Eight university hospitals and seven large regional hospitals in the Netherlands are licensed for the full training programme, which includes a 1-year exchange internship between them. One of these seven large regional hospitals belonged to the group of 13 general hospitals in the present study, but no residents of this hospital participated. Therefore, all residents in the present study worked in the two participating university hospitals.

The level of subspecialisation in neuroradiology was determined for both the university hospitals and the general hospitals by the percentage of radiologists with a membership of the Dutch Society for Neuroradiology and the percentage of certified fellowship-trained (a 2-year

programme) neuroradiologists in a department. The membership committee of the Dutch Society for Neuroradiology admits new members based on their motivation, the percentage of their weekly work in the field of neuroradiology, and their continuous medical education in neuroradiology over the past 5 years. A manual search of the membership list of the Radiological Society of the Netherlands was performed for all the hospitals that participated in this study. The level of subspecialisation was compared between university hospitals and general hospitals with Fisher's exact test.

In the survey, the participating neurologists and neurology residents were asked to give information about their expertise with radiology and to give a general impression of the neuroradiology reports of the radiologists group at their own hospital, irrespective of the reporting style.

Statistical analysis was performed using IBM SPSS Statistics software version 23. For the questions on self-confidence of the neurologist and about the value of the radiologist report, the Mann–Whitney test was used to test the differences between subgroups (A–B and C–D) whereby: A, neurologists at university hospitals; B, neurologists at general hospitals; C, all neurologists (university hospitals and general hospitals); and D, residents at university hospitals.

Results

Fifty (29%) of the 170 invited Dutch neurologists or neurology residents completed the online survey: 19 out of 82 (23%) neurologists from 12 general hospitals participated, and 15 neurologists and 16 neurology residents from two university hospitals (together 31 out of 88; 35%). No difference was observed in participation between general and university hospitals (chi-squared test; $p=0.085$).

The female-to-male ratio was 1.08: 1, and the average age was 41 years (SD 10.4). One respondent indicated that the survey was completed on behalf of the whole group ($n=6$). The data of this respondent were used only once in the database. The neurologists ($n=10$) of one large general hospital collectively decided not to participate.

Subspecialisation of radiologists

In total 51 radiologists worked in the two participating university hospitals and 66 radiologists in the 12 participating general hospitals. Significantly more radiologists from the university hospitals were member of the Dutch Society for Neuroradiology, compared to radiologists from the general hospitals, (29.4% versus 10.6%; $p=0.016$). Furthermore, neuroradiologists in the university hospitals were significantly more often fellowship-trained than those in the general hospitals (17.6% versus 1.5%; $p=0.002$). A total of 90% of all participating fellowship-trained radiologists worked in a university hospital. In the university hospitals, >90% of all neuroradiology reporting was done by neuroradiologists. These radiologists spent >75% of their time on neuroradiology.

Expertise in neuroradiology among neurologists

Table 1 demonstrates the expertise of the neurologists with radiology, both semi-objective (the number of imaging examinations requested and read every week) and subjective (a self-reported confidence score). Both groups of neurologists were equally confident in reading brain CT, brain MRI, and lumbar spine MRI examinations (Table 1). Residents were significantly less confident in reading brain CT, brain MRI and lumbar spine MRI examinations than neurologists ($p=0.007$, $p=0.001$, and $p=0.001$, respectively).

Perceived value of the radiologist report

Compared to neurologists, residents stated more frequently that the radiology report answered their questions ($p=0.039$, Table 2). Furthermore, neurologists from university hospitals stated more frequently that the report answered their questions than neurologists from general hospitals ($p=0.008$, Table 3). Residents responded more frequently that the radiology report gave useful advice than the neurologists (87.6% of residents scored 4 or 5; 82.4% of neurologists scored 3 or 4; $p<0.001$, Table 2), but no difference was observed between neurologists in general and university hospitals (Table 3).

Furthermore, the general appreciation for the radiology reports was lower for neurologists than for residents (7.65 versus 8.31; $p=0.030$, Table 2), and higher for neurologists from university hospitals than for neurologists from general hospitals (8.20 versus 7.21; $p=0.003$, Table 3).

Discussion

Subspecialisation of radiologists

The level of subspecialisation among radiologists was higher in university hospitals. The actual percentage of radiology cases read by subspecialised radiologists is probably even higher than the determined percentages of fellowship-trained radiologists and percentages of membership in the Dutch Society for Neuroradiology. In both university hospitals, the workload is distributed among subsections according to subspecialty. This means that the vast majority of neuroradiology cases are read by or supervised by neuroradiologists. With a supposed equal distribution of radiologists among subsections (such as neuroradiology, abdominal radiology, chest radiology, etc.), the determined 17.6% of all radiologists with fellowship training means that essentially all neuroradiologists were fellowship trained.

Experience of neurologists

Feedback on radiology reports actually measures the difference between the perceived quality and the expected quality.[14] Because background and experience have an impact on expectations, it makes sense to measure these expectations in a study to assess perceived quality. Branco *et al.* investigated the expectations of neurologists,

Table 1
The experience of neurologists and residents with radiology.

	Neurologists (n=34)			Residents (n=16)	p-Value
	A. University hospitals	B. General hospitals	C. Total	D. University hospitals	A–B/C–D
Number of requested CT examinations weekly, n (%)					
Less than 5	10 (66.7)	5 (26.3)	15 (44.1)	1 (6.3)	
5–10	3 (20)	5 (26.3)	8 (23.5)	12 (75)	
10–20	1 (6.7)	8 (42.1)	9 (26.5)	3 (18.8)	
More than 20	1 (6.7)	1 (5.3)	2 (5.9)	0	
Number of requested MRI examinations weekly, n (%)					
Less than 5	7 (46.7)	0	7 (20.6)	5 (31.3)	
5–10	4 (26.7)	9 (47.4)	13 (38.2)	9 (56.3)	
10–20	3 (20)	9 (47.4)	12 (35.3)	2 (12.5)	
More than 20	1 (6.7)	1 (5.3)	2 (5.9)	0	
Percentage of self-read cases, n (%)					
0-25%	0	0	0	2 (12.5)	
25-50%	0	0	0	0	
50-75%	2 (13.3)	0	2 (5.9)	1 (6.3)	
75-100%	13 (86.7)	19 (100)	32 (94.1)	13 (81.3)	
Self-confidence in reading brain CT examinations					
Mean	8.40	8.74	8.59	7.88	0.26/0.007
Median	8	9	9	8	
SD	0.828	0.733	0.783	0.806	
Self-confidence in reading brain MRI examinations					
Mean	7.80	8.0	7.91	7	0.63/0.001
Median	8	8	8	7	
SD	1.014	0.882	0.933	0.516	
Self-confidence in reading lumbar spine MRI examinations					
Mean	7.53	8.3	7.97	6.50	0.07/0.001
Median	7	9	8	7	
SD	1.125	1.157	1.193	1.265	

$p<0.05$ was considered significant.

Table 2
Perceived value of the radiologists' reports: residents versus neurologists.

	Residents (n=16)	Neurologists (n=34)	p-Value
Radiologist reports answer questions, n (%)			
1 (disagree)	0	0	0.039
2	0	2 (5.9)	
3 (neutral)	1 (6.3)	4 (11.8)	
4	6 (37.5)	19 (55.9)	
5 (agree)	9 (56.3)	9 (26.5)	
Radiologist reports are understandable, n (%)			
1 (disagree)	0	0	0.503
2	0	0	
3 (neutral)	0	3 (8.8)	
4	10 (62.5)	14 (41.2)	
5 (agree) Non response	5 (31.3)	17 (50.0)	
	1 (6.3)	0	
Radiologist reports give helpful advice, n (%)			
1 (disagree)	0	1 (2.9)	<0.001
2	0	3 (8.8)	
3 (neutral)	2 (12.5)	15 (44.1)	
4	9 (56.3)	13 (38.2)	
5 (agree) Non response	5 (31.3)	0	
	0	1 (2.9)	
Agreement with radiologist reports, n (%)			
1 (disagree)	0	0	0.389
2	0	1 (2.9)	
3 (neutral)	0	5 (14.7)	
4	15 (93.8)	24 (70.6)	
5 (agree)	1 (6.3)	4 (11.8)	
Appreciation score of radiologist reports (1–10)			
Median	8	8	0.030
Mean	8.31	7.65	
SD	0.873	0.950	

$p<0.05$ was considered significant.

neurosurgeons, and psychiatrists when requesting brain MRI examinations for their patients.[15] They reported that "Understanding the particularities of the different medical practices involving brain imaging may help neuroradiologists to improve the quality of their service." In addition to this, the present study indicates that neurologists have considerable high self-confidence in reading CT or MRI examinations. This implies that neurologists see themselves as imaging professionals. This knowledge can help radiologists to treat their customers as equal partners with their own specific expertise.

In both the university and general hospitals, the vast majority of neurologists read all cases of MRI and CT examinations themselves. Hence, radiologists should realise that neurologists are not only interested in the reports, but also in the images. Therefore, it makes sense to refer to specific images in radiology reports because reports enriched by images are believed to improve communication.[16]

Perceived value of radiology reporting

Dutch neurologists are familiar with the 10-point grading system used in the present survey.[17] The median appreciation scores for radiology reporting were 7 at the general hospitals and 8 at the university hospitals, corresponding, respectively, to the qualitative descriptions "very satisfactory" and "good". This confirms the first hypothesis of the present study that a higher level of specialisation of

Table 3
Perceived value of the radiologists' reports: neurologists at university hospitals versus general hospitals.

	University hospitals (n=15)	General hospitals (n=19)	p-Value
Radiologist reports answer questions, n (%)			
1 (disagree)	0	0	0.008
2	0	2 (10.5)	
3 (neutral)	0	4 (21.1)	
4	8 (53.3)	11 (57.9)	
5 (agree)	7 (46.7)	2 (10.5)	
Radiologist reports are understandable, n (%)			
1 (disagree)	0	0	0.918
2	0	0	
3 (neutral)	0	3 (15.8)	
4	8 (53.3)	6 (31.6)	
5 (agree) Non response	7 (46.7)	10 (52.6)	
Radiologist reports gives helpful advice, n (%)			
1 (disagree)	0	1 (5.3)	0.632
2	1 (6.7)	1 (5.3)	
3 (neutral)	8 (53.3)	2 (10.5)	
4	5 (33.3)	7 (36.8)	
5 (agree) Non response	1 (6.7)	8 (42.1)	
	0	0	
Agreement with radiologist reports, n (%)			
1 (disagree)	0	0	0.051
2	0	1 (5.3)	
3 (neutral)	1 (6.7)	4 (21.1)	
4	10 (66.7)	14 (73.7)	
5 (agree)	4 (26.7)	0	
Appreciation score of radiologist reports (1–10)			
Median	8	7	0.003
Mean	8.20	7.21	
SD	0.676	0.918	

$p<0.05$ was considered significant.

radiologists correlates with a higher perceived value of the report by referring neurologists, and even though the differences are small they are significant.

Furthermore, the second hypothesis that a higher level of expertise of the neurologist correlates with a lower perceived value of the report of radiologists, is accepted because the residents in the present study, who are less experienced, were less self-confident in reading radiology cases and gave a significantly higher score for radiology report.

Dickerson *et al.* reported that ratings of neurologists on a five-point Likert scale where 2.2 (+/- 1.2 standard deviation [SD]) for "This report was easy to understand" in non-template reports and 3.2 (SD 1.3) in template reports. The overall quality for non-template reports on a five-point scale was 2.3 (SD 1.0) and for template reports was 3.2 (SD 0.9).[18] These scores seem lower than those of the present study, but the studies cannot be compared because of a difference in methodology. In the study of Dickerson *et al.*, the ratings were given for 20 selected reports, whereas the ratings in the present study were for reporting practices in general.

Improving reporting

Previous reports state that referring physicians value radiology reports less when radiologists do not address the clinical questions.[19,20] In the present study, the lower score for this item in the general hospitals demonstrates that this is an opportunity for improvement. To better answer the clinical questions, radiologists have to include the clinical information and questions in the report and answer these questions in the conclusion. A reporting template serves as a reminder for these items[4,21] and is appreciated by referring physicians.[18] In contrast to the present study that was focussed on the content of the report regardless of reporting style, a study by Sadigh *et al.* focussed on the satisfaction score of the referring physician on the structure of the report.[22] They reported a score of 5.1 on a scale from 1 (worst) to 7 (best) for text-only reports, and 80% of their respondents believed that interactive image- and data-embedded reports would be an improvement to the current text-only reports.

Giving helpful advice in the report is the second item for improvement that can be learned from the present study. Because residents gave a significantly higher score for this item than neurologists, this advice should be tailored to the needs of the referring physician.

Improvement by feedback

In addition to the opportunities to improve reporting, the results of the present study indicate chances to improve by giving feedback. The majority of neurologists and residents in university hospitals and neurologists in general hospitals scored 4 on a five-point scale for agreement with the radiology report. This level of agreement is within the range reported by Fu *et al.*[23] In that study in a specialised setting, the inter-rater agreement between two orthopaedic spine surgeons and four musculoskeletal radiologists for reporting findings on spinal MRI examinations ranged from 54.6% to 95%.[23] These inter-rater agreements were determined in a point-by-point comparison between each possible pair of reviewers and were averaged across all reviewer pairs. In addition to the relatively high scores for agreement with the radiology reports, the neurologists read almost all their requested CT and MRI cases, and they had high self-confidence in doing this. These findings indicate that neurologists are valuable sources for feedback for radiologists, in addition to peer feedback from radiologists.[24,25]

Limitations

The present study had several limitations. The response to the survey was low (29%) but was in the same range as a study on response rates to web-based surveys among physicians.[26] In that study, the neurologist response rate after the first reminder was 34.5%. More reminders could have been beneficial, as they found an increase in responses of 43.1% and 46.6%, respectively.[26] The major reason for non-response in that study was that there were too many survey requests and not enough time to complete them. This might also have been the case in the present study, but no information is available regarding the non-responders.

The design of the study was in some way suboptimal, because the neurologists were asked to provide feedback

only on the reports of their "own" radiologists as a group and did not have the opportunity to rate each radiologist individually. In the free-text comments, four neurologists indicated that major variations existed between the quality of the reports of the different radiologists in their own general hospital. In their opinion, the subspecialised neuroradiologists produced much better reports than the general radiologists. In the general hospitals with both general and subspecialised radiologists, this might have influenced the results because of a higher average score due to the better perceived quality of the reports of the subspecialised radiologists. Because of the limited level of subspecialisation in general hospitals, this bias is assumed to be minor.

Future projects

Improved consistency in reporting can be achieved by quality initiatives.[27] Examples of quality initiatives are developing working agreements with referring physicians to formulate essential information for imaging requests and radiology reports, implementing structured reporting to improve the quality of the reports, peer feedback among radiologists,[28] and a feedback system for referring physicians. The results of the present study are the first step towards implementation of continuous or periodical feedback from referring physicians, and measuring its effect could be a valuable tool to increase the diagnostic quality of reports. Repetitive evaluation is necessary in the Plan–Do–Check–Act cycle, as has been explained in several recent papers.[27,29–31] Feedback can make reports more patient-centred and improve diagnostic accuracy of reporting by peer review.[24,25,32,33]

Conclusion

The quality of radiology reporting as perceived by neurologists was more than sufficient in general hospitals and good in university hospitals, where a higher level of subspecialisation of radiologists exists. Because of their expertise in radiology, neurologists are valuable sources of feedback for radiologists. To understand the clinically important and unimportant aspects, good communication and feedback between radiologists and referring physicians is of great importance. Paying attention to the clinical questions and giving advice tailored to the needs of the referring physicians are opportunities to improve radiology reporting.

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