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ABDOMINAL RADIOLOGY

Subspecialization in radiology: effects on the diagnostic spectrum of radiologists and report turnaround time in a Swiss university hospital

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Abstract

Purpose To analyze the changes in the work profiles of radiologists and the reporting time after the implementation of professional subspecialization in the radiology department of a Swiss university hospital.

Methods In a retrospective analysis, the overall number of different radiologic examinations performed in the department of radiology of the largest Swiss university hospital was documented for 2014 and 2016 before and after the implementation of subspecialized reporting (subspecialities: abdominal, musculoskeletal, cardiothoracic, emergency, and pediatric imaging) in May 2015. For six selected radiologists, the number and types of reported examinations as well as the related radiology report turnaround times (RTATs) were analyzed in detail and compared between the two 1-year periods.

Results Overall, there was a significant increase of 10.3% in the total number of examinations performed in the whole department in 2016 compared with 2014. For four of the six radiologists, the range of different types of examinations significantly decreased with the introduction of subspecialized reporting ($p < 0.05$). Furthermore, there was a significant change in the subset of the ten most commonly reported types of examinations reported by each of the six radiologists. Mean overall RTATs significantly increased for five of the six radiologists ($p < 0.05$).

Conclusions Implementation of subspecialized reporting led to a change in the structure and a decrease in the range of different examination types reported by each radiologist. Mean RTAT increased for most radiologists. Subspecialized reporting allows the individual radiologist to focus on a special field of professional competence but can result in longer overall RTAT.

Keywords Subspecialization · Reporting time · Professional competence · Radiologists

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Introduction

A high degree of subspecialization among referring physicians from different clinical specialties has implications for radiologists in that it requires increasingly specialized diagnostic skills tailored to the specific needs of referrers [1, 2]. Referring physicians expect radiologic examinations to adhere to high technical standards and expect high-quality radiology reports to be available within a short time [3].

In this era of lower health care spending and reimbursement models mostly based on the payment of fixed amounts per service, efficient organization of examination and reporting workflow becomes essential for both hospital-based and office-based radiologists [4–6]. In Europe, radiology departments and practices organize reporting workflow by imaging modality such as computed tomography (CT), magnetic resonance imaging (MRI), mammography, and conventional radiography.

An alternative to general reporting is subspecialized reporting. With this option, reporting is organized by organ system such as abdomen, chest, musculoskeletal, and vascular system, and radiologists form teams focusing on the examination of one organ system with any imaging modality [7, 8]. Using subspecialized reporting, radiologists can develop in-depth skills and experience in a specific area, allowing them to better meet the needs of subspecialized referring physicians and ensuring consistently high reporting quality [9, 10]. In addition to improving quality, subspecialized reporting has the potential to also enhance reporting efficiency.

Based on these considerations, the radiologic department of a Swiss university hospital introduced an internal subspecialized examination and reporting system in mid-2015. The subspecialties defined were thoracic and cardiovascular imaging, abdominal and urogenital imaging (including mammography), musculoskeletal imaging, and emergency imaging.

In this study, we analyzed the effects of switching from general to subspecialized reporting on reporting workflow in a representative group of radiologists from our department who worked under both systems during the study period. Specifically, we investigated how the implementation of subspecialized reporting altered the range of types of examinations reported by individual radiologists and reporting efficiency in terms of reporting volumes and radiology report turnaround time (RTAT).

Materials and methods

We conducted an internal analysis in the radiology department of a Swiss university hospital to compare workflow before and after implementation of subspecialized reporting. This was done by comparing two calendar years, 2014 and 2016. Subspecialized reporting was introduced on May 1, 2015.

Before the introduction of subspecialized reporting in 2015, the radiologists selected for this analysis worked by imaging modality, i.e., CT, MRI, conventional radiography, and mammography. Under the general reporting system, a resident assigned to a given imaging modality generated a preliminary report. The preliminary report was then discussed with the staff or senior radiologist responsible for the respective modality and then finalized by the latter after any necessary editing (see Fig. 1).

With the introduction of the subspecialized reporting system, teams for different organ systems or body regions were formed, who worked independently of the imaging modality used for the examination. The subspecialties defined were thoracic and cardiovascular imaging, abdominal and urogenital imaging, musculoskeletal imaging, emergency imaging, and pediatric imaging. For reasons of internal organization, abdominal imaging included ear, nose and throat (ENT) imaging and mammography. Reporting workflow was adjusted accordingly, allowing both residents and senior radiologists, who finalized the reports, to focus on the respective subspecialized area (see Fig. 2).

To compare radiologists' reporting profiles before and after implementation of subspecialized reporting, we retrospectively analyzed the types of examinations, their numbers, and the corresponding radiology report turnaround times (RTATs) for a 1-year period of general reporting (2014) and a 1-year period of subspecialized reporting (2016). RTAT was defined as the interval from the end of the examination to finalization of the report.

For detailed analysis, six radiologists who worked in the department throughout the two 1-year periods under investigation were selected. The group of radiologists selected for analysis had to contribute at least 20% of the department's total reporting volume. Four of the six radiologists selected for this analysis were heads of the subspecialized radiologist teams formed when the new system was introduced in 2015.

For the six radiologists selected, we documented the different types of examinations reported by each of them including the number of reports generated for each examination type for the 1-year period of general reporting and the period of subspecialized reporting.

Only examinations performed during standard weekday (Monday through Friday) working hours, i.e., 8:00 a.m. to 5:00 p.m., were included. Examinations completed during off-hours were excluded. Also excluded were neuroradiologic examinations, which are performed by an organizationally independent unit of the radiology department. Finally, we only included types of examinations that were performed during both 1-year periods under investigation. Moreover, the analysis included only examinations for which a finalized report was available within 72 h. This

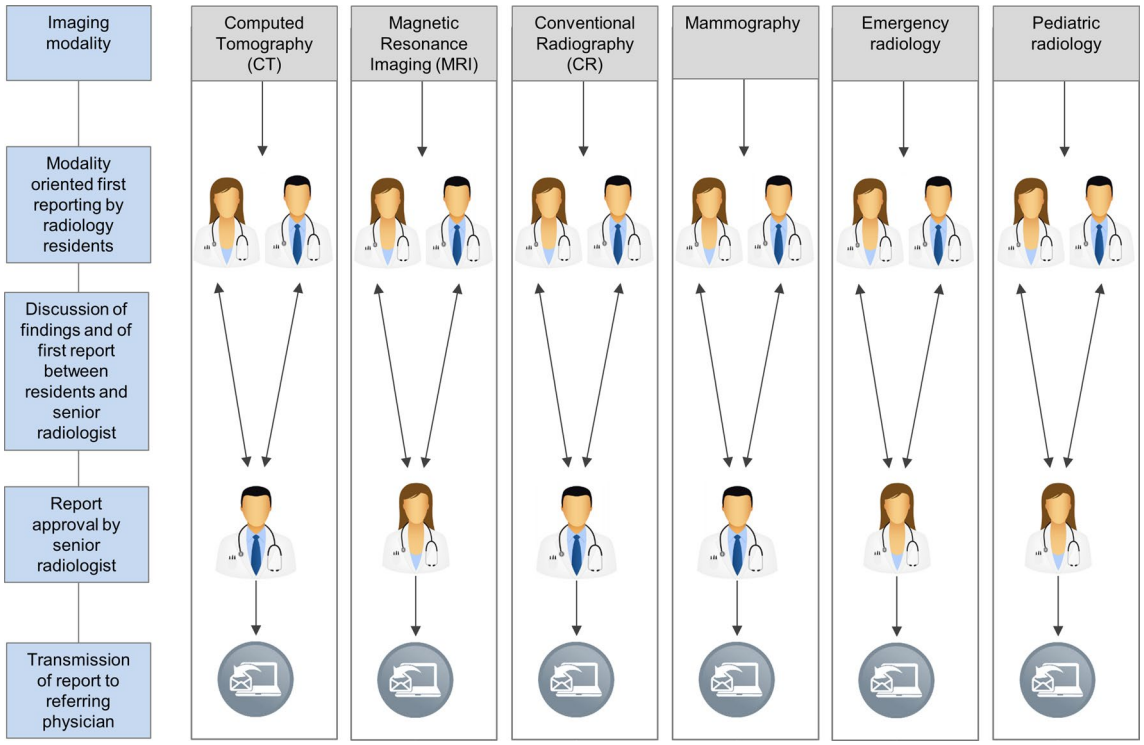

Fig. 1 Workflow of reporting *before* the introduction of subspecialized reporting. Reporting is strictly based on the different imaging modalities, i.e., CT, MRI, conventional radiography, and mammography. Under the general reporting system, residents assigned to a given imaging modality generate a preliminary report. The preliminary report is then discussed with the staff or senior radiologist responsible for the respective modality and then finalized by the latter after any necessary editing

was done to minimize effects of outliers or of imaging material only stored in the picture archiving and communication system (PACS) for documentation purposes on the calculation of average RTATs.

All data for the analysis were extracted from the radiology information system (RIS; Centricity RIS-i 4.2 Plus, GE Medical Systems, Milwaukee, WI, USA). The following data were recorded: type of examination, date of examination, end of examination, beginning and end of reporting time, and finalizer.

For each report, RTAT was calculated in minutes. RTAT was defined as the period from completion of the examination to the finalization of the report by the responsible radiologist. For comparison of RTATs before and after introduction of subspecialized reporting, the following classification was used: more than 2 h shorter with subspecialized reporting [− −], 1–2 h shorter with subspecialized reporting [−], no more than 1 h longer or shorter with subspecialized reporting [0], 1–5 h longer with subspecialized reporting [+], more than 5 h longer with subspecialized reporting [+ +].

Statistical analysis

The Cochran–Mantel–Haenszel test was used to test for significant differences in the number of different types of examinations following the introduction of subspecialized reporting for all six radiologists taken together. The Chi-square test was applied to analyze possible differences in the comparison of individual radiologists.

Changes in the range of examinations reported by each radiologist in terms of a shift toward a higher share of subspecialized imaging studies were assessed using a one-sided Cochran–Mantel–Haenszel test. The impact of subspecialized reporting on the range of types of imaging studies reported by each radiologist was assessed by the Chi-square test.

Whether subspecialized reporting had a significant effect on RTAT was tested for each radiologist using a two-tailed Mann–Whitney–Wilcoxon test and was based on an analysis of the subset of the 10 most common types of imaging studies reported by that radiologist in 2016.

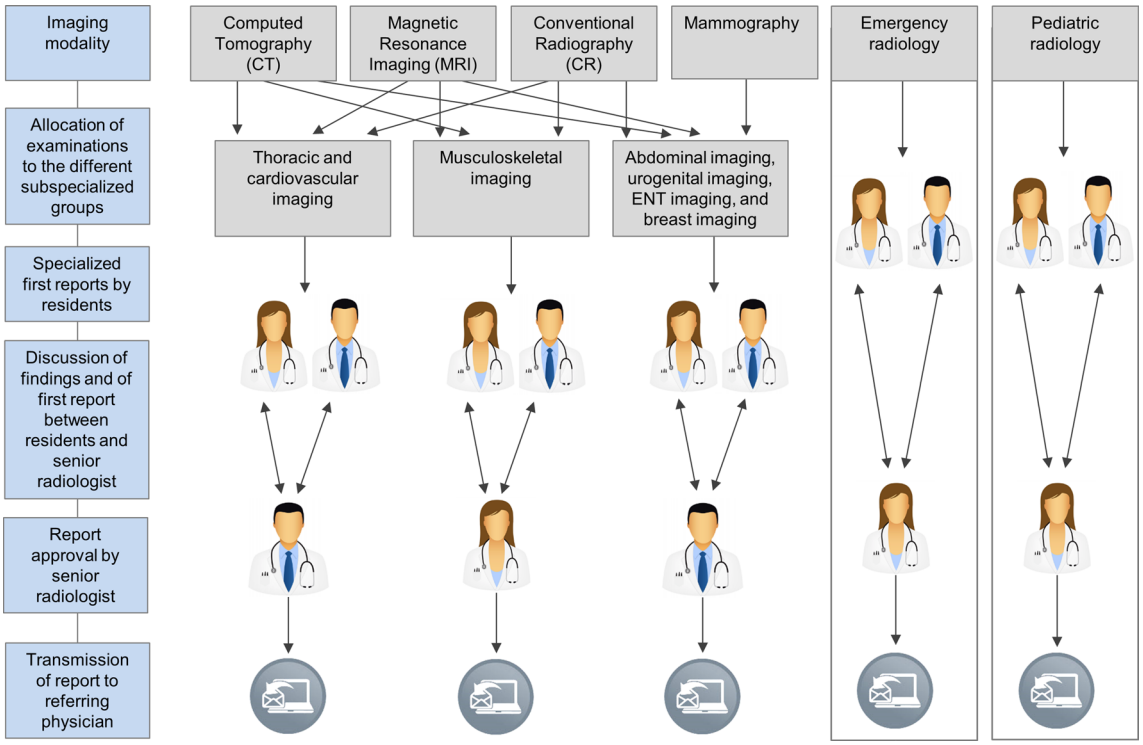

Fig. 2 Workflow of reporting *after* the introduction of subspecialized reporting. With the introduction of the subspecialized reporting system, teams for different organ systems or body regions were formed, who worked independently of the imaging modality used for the examination. The subspecialties defined were thoracic and cardiovascular imaging, abdominal and urogenital imaging (including ENT imaging and breast imaging), musculoskeletal imaging, emergency imaging, and pediatric imaging. Both residents and senior radiologists focus on the respective subspecialized area

Statistical significance was assumed for $p < 0.05$. All data were recorded and analyzed using Excel 2010 for Windows (Microsoft Corporation, Redmond, WA, USA). Statistical calculations were done using the "R" software (R Foundation for Statistical Computing, Vienna, Austria).

Results

We included a total of 67,585 reports from 2014 and 72,224 reports from 2016. During both 1-year periods, roughly 20% of the department's reporting volume was contributed by the six radiologists selected for detailed analysis (see Table 1). The proportion of reports finalized within the evaluated 72-h period was 97.8% in the full year before and 95.2% in the full year after implementation of a subspecialized reporting.

For each of the six radiologists, introduction of the subspecialized system led to an approximately 25% reduction in the range of examination types reported. The reduction was statistically significant for five of the six radiologists ($p < 0.05$, see Table 2).

This reduction was associated with an increase in the share of reports pertaining to the respective subspecialty for four of the six radiologists. For these four radiologists, 92–98% of their reporting volumes were accounted for by imaging studies in their respective subspecialties (see radiologists A, C, D, and F in Fig. 3). In contrast, there were no relevant changes in the proportion of subspecialized reports for radiologists B and E, for whom subspecialized reports

Table 1 Number of radiologic examinations performed by the radiology department as a whole and the six radiologists included in the present analysis during the two 1-year periods compared (general reporting system in 2014 vs. subspecialized reporting system in 2016)

Number of radiologic reports	2014 (Generalized reporting)	2016 (Subspecialized reporting)	Δ absolute	Δ (%)
Entire radiology department	67‘585	72‘224	4‘639	6.9
Six radiologists in study	14‘950	15‘174	224	1.5

Table 2 Number of types of imaging examinations reported by the six selected radiologists before (full year 2014) and after (full year 2016) introduction of subspecialized reporting

Radiologist	Year 2014	Year 2016	Δ absolute	Δ (%)	*p* value
A	105	74	−31	−30	<0.05
B	87	63	−24	−28	<0.05
C	82	54	−28	−34	<0.05
D	79	71	−8	−10	0.28
E	77	60	−17	−22	<0.05
F	60	43	−17	−28	<0.05

already accounted for 98 and 100%, respectively, of their overall reporting before introduction of the subspecialized reporting system.

In detail, subspecialized reporting led to the following changes in the distribution of examination types reported by each radiologist and RTATs. These data are based on the analysis of the subset of the 10 most common imaging studies reported by each radiologist (see Table 3).

Radiologist A

Radiologist A specialized in abdominal and urogenital imaging including breast and ENT imaging. Following introduction of subspecialized reporting, this radiologist's 10 most commonly reported types of examinations accounted for 78.1% of his/her overall reporting volume in his/her specialized area. RTATs were longer for 7 of the 10 most common types of examinations, and the difference was statistically significant for five of the seven examination types with longer RTATs ($p < 0.05$).

Radiologist B

Radiologist B specialized in emergency imaging. The 10 types of examinations most commonly reported by radiologist B in 2016 accounted for 66.4% of his/her total reporting. In this subset, RTATs were significantly shorter for 4 of the 10 examination types under the subspecialized reporting system ($p < 0.05$).

Radiologist C

Radiologist C specialized in thoracic and cardiovascular imaging. The 10 types of examinations most commonly reported by radiologist C in 2016 accounted for 94.3% of his/her total reporting. All 10 examination types of this subset had significantly longer RTATs after the introduction of subspecialized reporting ($p < 0.05$).

Radiologist D

Radiologist D specialized in musculoskeletal imaging. The 10 types of examinations most commonly reported accounted for 72.5% of this radiologist's total reporting volume. Subspecialized reporting resulted in longer RTATs, which was statistically significant for 8 of the 10 examination types of this subset ($p < 0.05$).

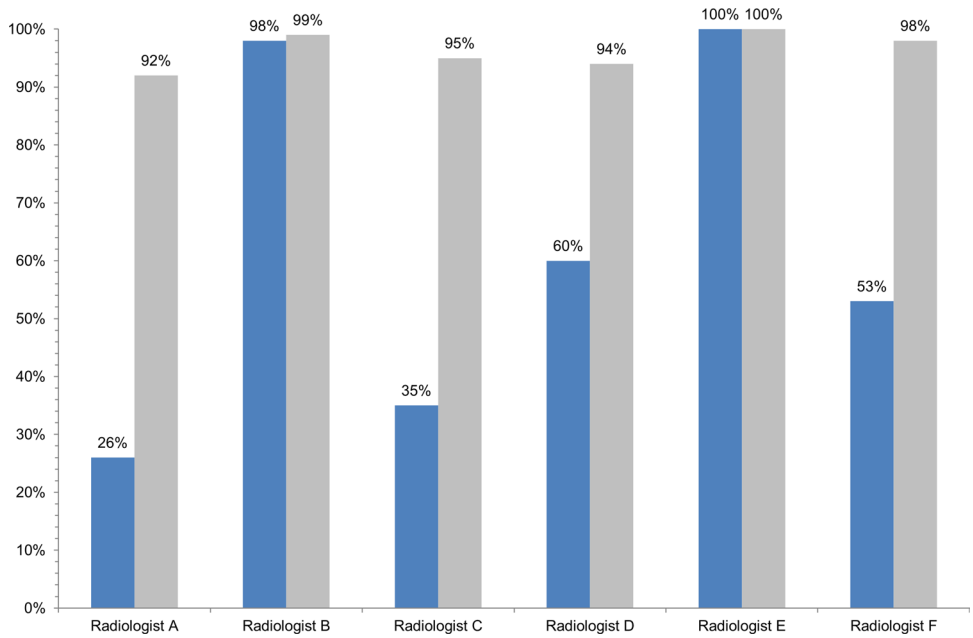

Fig. 3 Share of subspecialized reports before (2014, blue columns) and after (2016, gray columns) introduction of subspecialized reporting for the six radiologists included in the analysis (A to F)

Table 3 Ten most common types of examinations reported by radiologists A to F and their shares of the total reporting volumes of these radiologists following introduction of subspecialized reporting

Top 10 most common types of examinations of **radiologist A** during subspecialized reporting period		78.1%	Δ Ø reporting time	
			Symbol	*p* value
1.	Mammography	19.9%	+	< 0.05
2.	CT abdominal	13.9%	++	< 0.05
3.	CT chest and abdominal	8.6%	++	< 0.05
4.	CR abdominal	8.3%	+	< 0.05
5.	MRI abdominal	8.2%	+	< 0.05
6.	US breast	5.8%	+	0.21
7.	MRI pelvis	4.5%	+	0.08
8.	US abdominal	3.8%	−−	0.09
9.	VF esophagus	2.6%	−−	0.13
10.	MRI neck	2.5%	−	< 0.05
Top 10 most common types of examinations of **radiologist B** during subspecialized reporting period		66.4%	Δ Ø reporting time	
			Symbol	*p* value
1.	CR thorax	21.6%	0	< 0.05
2.	CR upper ankle joint	6.9%	0	0.18
3.	CR foot/calcaneus	6.8%	0	0.80
4.	CT angiography	6.5%	0	0.66
5.	CR hand	5.2%	−	< 0.05
6.	CR spine	4.8%	−	< 0.05
7.	CR shoulder	4.1%	−	< 0.05
8.	CR pelvis/sacrum	3.6%	−−	< 0.05
9.	CR knee	3.5%	0	0.65
10.	CR LODOX	3.4%	0	0.83
Top 10 most common types of examinations of **radiologist C** during subspecialized reporting period		94.3%	Δ Ø reporting time	
			Symbol	*p* value
1.	CR thorax	35.4%	++	< 0.05
2.	CT angiography	24.2%	++	< 0.05
3.	CT chest	11.1%	++	< 0.05
4.	CT chest and abdomen	5.7%	++	< 0.05
5.	CT heart	5.3%	++	< 0.05
6.	MRI chest	4.2%	++	< 0.05
7.	MRI abdominal	4.0%	++	< 0.05
8.	CT neck	1.9%	++	< 0.05
9.	CT abdominal	1.3%	+	< 0.05
10.	MRI pelvis	0.9%	++	< 0.05
Top 10 most common types of examinations of **radiologist D** during subspecialized reporting period		72.5%	Δ Ø reporting time	
			Symbol	*p* value
1.	CR pelvis/sacrum	16.3%	+	< 0.05
2.	CR spine	15.9%	0	0.77
3.	CR hand	9.3%	+	< 0.05
4.	CR shoulder	6.2%	++	0.06
5.	CR foot/calcaneus	6.2%	+	< 0.05
6.	CR skull	6.2%	+	< 0.05
7.	CR wrist	3.5%	+	< 0.05
8.	CR knee	3.3%	+	< 0.05
9.	CR upper ankle joint	3.3%	+	< 0.05

Table 3 (continued)

Top 10 most common types of examinations of **radiologist D** during subspecialized reporting period		72.5%	Δ Ø reporting time	
			Symbol	*p* value
10.	MRI arthrography	2.5%	+	< 0.05
Top 10 most common types of examinations of **radiologist E** during subspecialized reporting period		72.6%	Δ Ø reporting time	
			Symbol	*p* value
1.	US abdominal	19.9%	+	< 0.05
2.	US pelvis	15.9%	0	0.10
3.	US musculoskeletal	7.3%	0	0.14
4.	US skull/brain	6.9%	+	< 0.05
5.	CR pelvis	6.6%	0	0.75
6.	CR hand	4.5%	0	0.67
7.	CR forearm	4.0%	+	0.62
8.	CR elbow	2.9%	0	0.21
9.	US infant's hip (Graf)	2.7%	+	< 0.05
10.	CR knee	2.4%	0	0.26
Top 10 most common types of examinations of **radiologist F** during subspecialized reporting period		94.6%	Δ Ø reporting time	
			Symbol	p value
1.	CR abdominal/urography	36.7%	0	0.56
2.	CT abdominal	28.7%	+	< 0.05
3.	CT chest and abdomen	13.4%	+	< 0.05
4.	MRI pelvis	5.8%	− −	0.76
5.	US pelvis	2.7%	− −	0.33
6.	MRI neck	2.3%	+	0.40
7.	MRI kidneys	1.5%	+ +	< 0.05
8.	MRI abdominal	1.3%	+ +	< 0.05
9.	US abdominal	1.3%	−	0.67
10.	CT neck	0.9%	+	< 0.05

Effects on average radiology report turnaround times (RTATs) [symbol]: more than 2 h shorter with subspecialized reporting [− −], 1–2 h shorter with subspecialized reporting [−], no more than 1 h longer or shorter with subspecialized reporting [0], 1–5 h longer with subspecialized reporting [+], more than 5 h longer with subspecialized reporting [+ +]

CT computed tomography, *MRI* magnetic resonance imaging, *CR* conventional radiography, *US* ultrasonography, *VF* video fluoroscopy, *LODOX* Xmplar low-dose whole-body X-ray scanner

Radiologist E

Radiologist E specialized in pediatric radiology both before and after the introduction of subspecialized reporting. The 10 most commonly reported types of examinations accounted for 72.6% of the radiologist's overall reporting volume. RTATs were prolonged for 4 of the 10 most commonly reported types of examinations, and the difference was significant in three of the four cases ($p < 0.05$).

Radiologist F

Radiologist F specialized in abdominal, urogenital, and ENT imaging. The 10 most common types of examinations reported by this radiologist accounted for 94.6% of his/her total reporting volume. No clear trend regarding RTATs was apparent. For 6 of the 10 most commonly reported types of examinations, average RTATs were longer, and the difference was significant for five of the six examination types ($p < 0.05$).

The results for radiologists A through F taken together show that, for the 10 most commonly reported types of examinations reported by each radiologist under the subspecialized reporting system, RTATs were longer in 60% of instances, unchanged in 23%, and shorter in 17% (see Table 4).

Table 4 Distribution of changes in mean radiology report turnaround times (RTATs) by type of examination (10 most common types of examinations), frequencies, and shares of total reporting volumes for radiologists A–F

Δ RTAT after implementation of subspecialized reporting	Symbol	Frequency radiologist A–F	Share radiologist A–F (%)
More than 5 h longer	++	14	23.3
1–5 h longer	+	22	36.7
Up to 1 h longer/shorter	0	14	23.3
1–2 h shorter	−	5	8.3
More than 2 h shorter	−−	5	8.3

Discussion

Switching to a subspecialized reporting system in the radiology department of a Swiss university hospital was associated with the formation of subspecialized reporting teams instead of organizing reporting workflow by imaging modality. Our results show that, under the subspecialized reporting system, subspecialized reporting accounted for a greater share of radiologists' total reporting volumes. Surprisingly, this greater subspecialization did not result in overall shorter radiology report turnaround times. On the contrary, RTATs were in part even markedly longer after switching to subspecialized reporting.

These findings must be interpreted in light of an overall increase of approximately 7% in the department's total reporting volume, and this increase in workload also included the six radiologists selected for this study. The increase in imaging studies performed by our department is in agreement with general national and international data indicating a steady increase in radiologic examinations [11, 12].

As expected, the introduction of subspecialized reporting in 2016 led to a concentration on examinations of the respective subspecialties among the six radiologists included in our analysis in that the range of different examination types reported became smaller for all of them compared with 2014 (see Table 2). Reporting of a narrower range of examinations was especially conspicuous for radiologist A (who became head of the abdominal imaging team with the introduction of subspecialized reporting, 30% decrease) and radiologist C (head of the thoracic and vascular imaging team, 34% decrease).

As expected after switching to the new system, subspecialized reports accounted for a higher proportion of the total reporting volume (for examinations performed during standard weekday working hours) in 2016 compared with 2014. Subspecialized reports accounted for well over 90% of the total reporting volume for all staff, and even for over 95% of the volume for five of the six radiologists included in our analysis (see Fig. 3).

The concentration on specialized reporting was especially conspicuous for radiologist A. Here, the increase in subspecialized reporting was 66% compared with 2014. This high increase is attributable to the fact that, with his/her extensive expertise and experience, radiologist A covered nearly the complete range of imaging studies in his/her reporting activities under the earlier general reporting system; hence, the impact of subspecialization was especially marked. In contrast, the range of examination types reported by radiologist E (head of pediatric imaging before and after introduction of the new system) was nearly unchanged after the switch of systems. This is not surprising since pediatric radiology with its focus on examinations tailored to the specific needs of young patients already was a largely autonomous unit before the introduction of subspecialized reporting.

While a concentration on the defined subspecialties was expected, it was surprising that subspecialized reporting, rather than making reporting workflow more efficient, even resulted in longer RTATs for many types of examinations. A possible explanation is that a large proportion of residents, as in our department, which is one of the largest teaching institutions for radiology residents in Switzerland, results in a more complex and time-consuming reporting workflow. For all imaging studies performed in our department, reporting begins with a resident generating a preliminary report. This is followed by repeated interpretation of the imaging dataset in conjunction with the supervising radiologist and a revision of the report. The revised report is then read by the responsible radiologist and finalized following any needed editing. Resident involvement in the routine reporting workflow thus is an important factor contributing to longer RTATs. In contrast, the results of Stern et al. [13] show that, median RTATs can be dramatically shortened, from approximately 17 h to approximately 3 h and 30 min, when fully trained radiologists directly report imaging studies under a subspecialized system.

Another, specific factor contributing to longer RTATs for radiologist A in our analysis may be that, as head of the abdominal imaging team, he/she was also responsible for all complex reports and imaging examinations revealing rare findings. The policy at our department is that the members of a subspecialized team can send reports to each other for a second opinion. An effect of this policy is that radiologist A tends to get a large share of difficult abdominal imaging cases for a second opinion.

Conversely, for radiologist B (head of emergency imaging), focusing on a specialized range of examinations to be reported (28% decrease, from 87 to 63 types of examinations, in 2016, see Table 2) resulted in consistently shorter or nearly unchanged RTATs compared to 2014 (see Table 3 Radiologist B). For this radiologist, introduction of

subspecialized reporting led to a focus on emergency imaging. Moreover, the spatial arrangement, with the supervising radiologist being based directly next to the emergency CT scanner during standard weekday working hours, facilitates workflow and finalization of preliminary reports generated by the residents of the team.

Overall, our results show that subspecialized reporting has not only benefits but also disadvantages and risks. Staff satisfaction is an issue to be considered. Working in a clearly defined area and gaining great expertise can improve a radiologist's confidence and skills, resulting in greater job satisfaction. Increasing subspecialization is observed in all areas of medicine [14, 15]. As a result, referring colleagues have increasingly specific expectations when requesting an imaging study [16]. Greater in-depth skills in a well-defined area of their field allow radiologists to solve more complex problems, which is likely to have a positive mental effect. In addition, the growing complexity of a specialty like radiology makes it more and more difficult for an individual radiologist to master all its many facets with the required depth of expertise [17, 18].

Subspecialization can also have a positive impact on residents who rotate through different fields of radiology during their training. Clearly defined rotations allow radiologists to focus on a specialized area for a predefined time [19] rather than having to constantly switch between many different types of examinations. Budgets for advanced and further training can thus also be used more efficiently for dedicated seminars and workshops tailored to accompany well-defined subspecialized rotations. Various studies have so far shown that subspecialization in radiology can lead to a higher quality and precision in radiologic reports in the individual sub-disciplines [20, 21]. We could also recognize this effect in our clinic after the implementation of a subspecialized reporting system. Although it was not the aim to quantify changes in the quality of reports after introducing a subspecialized system, we nevertheless achieved an apparently significantly higher perceived quality among our referrals with multiple positive feedbacks.

On the other hand, subspecialization can have negative effects [22], because repetition can be boring and less motivating. Monotony can lead to greater fluctuation, making staff to leave and seek employment where they work on a broader, more generalized range of imaging studies if they prefer such an approach to focus on a narrow subspecialized area. The proportion of reports that took more than 72 h to be finalized significantly increased from 2.2 to 4.8% with the implementation of a subspecialized reporting. From our perspective, there are different possible reasons for this: (1) the number of reports that are being sent between different senior radiologists to get a "second opinion" had significantly increased after the implementation of the subspecialized system. In a radiology information system (RIS) database research, we found that there were only about 2% of the reports signed by two senior radiologists in 2014, while this percentage increased to over 10% in the year 2016. A possible reason for this especially in the group of abdominal imaging was that reporting on liver imaging was dedicated to three specific radiologists with the best experience in this field. Obviously, this not only leads to a higher quality of the reports, but also causes longer reporting time; (2) difficult findings and reports are intentionally withheld by individual specialized radiologists in order to first discuss these with the referring colleagues in a weekly tumor board. The reports then become more focused and there are fewer misunderstandings in difficult situations, but the reporting time increases; (3) non-urgent reports were not finally completed before weekends or public holidays.

According to the directive of the European Union as of February 2018, it is mandatory for the member states to make sure that for radiologic examinations which are based on ionizing radiation, the dose is being documented afterward in the radiologic report (article 58, b) [23]. It can be assumed that the mandatory documentation would take a small amount of extra time in radiologic reports. To our knowledge, there are no data on this so far, especially as the directive came into force only recently. Our study has limitations. Only six radiologists were selected for analysis. This is due to the fact that we wished to include radiologists from each of the four subspecialized areas introduced with the new system. Moreover, all radiologists selected had to be present throughout the two study periods, i.e., throughout 2014 and 2016, without longer leaves of absence. The size of the university department of radiology investigated makes it likely that the reporting volume included a higher share of more complex cases. The involvement of residents in reporting workflow in all areas including complex and highly specialized imaging studies further contributed to a much greater complexity and hence longer RTATs in our study. This is in contrast to other studies that found shorter RTATs. Therefore, our findings may probably not be representative for departments and offices that do not train residents. Teams without residents may achieve shorter RTATs under a subspecialized reporting system. Moreover, we did not include ultrasound examinations in our analysis. From our perspective, ultrasound is different from all the other diagnostic methods like CT, MRI or conventional radiography as the reporting time as a part of the overall procedure time is less important than for all the other procedures. As the process workflow for the ultrasound section in our department did not change with the implementation of a subspecialization in our clinic, we did not consider ultrasound examinations in our study.

Conclusion

In conclusion, our findings suggest that subspecialized reporting in a university department of radiology has the desired effect of leading to individual radiologists focusing on a clearly defined area based on body region or organ system. On the other hand, the much greater complexity of subspecialized reporting workflow that results from the inclusion of residents makes reporting more time-consuming and can result in longer report turnaround times compared with general reporting.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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