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Professional Challenges in Medical Imaging for Providing Safe Medical Service

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Abstract

This study explores the organization of medical physicists', radiologists', and radiographers' professional work and the challenges they encounter ensuring quality and safe medical service within medical imaging. A practice theory perspective was used for data collection, which consisted of 14 open interviews, and data analysis. The concept of tension was used for the interpretation of findings. Three tensions are presented in the findings: 1) between diverse general and practical understandings about the activities in practice; 2) between material-economic conditions and activity in practice; and 3) between discursive-culture conditions and activity in practice. This study found that new technology, economical rationality, and the organisation of work processes lead to fewer face-to-face meetings between different professions. Therefore, medical imaging as dispersed practices misses opportunities for learning across practices, which can lead to patient safety

risks. To ensure patient safety, new forms for learning across practices are needed.

Keywords

Medical imaging, professional work, collaborative work, qualitative method, practice theory, tensions

Introduction

This paper investigates how organisation of work affects professional work and inter-professional collaboration within health care. According to Mintzberg (1989; 2017), the overall organization of work and the coordination between different professionals affect the quality of the performed work. Coordination among professionals during work can be either direct supervision or mutual adjustment as well as the coordination of standardization of the skills, the outputs, and the norms at work. Standardization and commodification of professional work affect collaboration for quality and safety of the performed work (Mintzberg, 1989; 2017).

In this paper, organization and coordination between professional tasks and responsibilities are studied from the perspective of three professions in medical imaging, a specialist domain within healthcare. Medical imaging is continuously developing due to the introduction of new techniques and methods for image production, which makes the diagnosing of diseases more accurate (Bentourkia, 2012; Comaniciu, Engel, Georgesau & Mansi, 2016). This technical development comprises both the improvement of established techniques, such as computed tomography (CT) and magnetic resonance imaging (MRI) and the introduction of new types of modalities. These novel types of modalities are often combinations of different imaging techniques, such as positron emission tomography (PET)/ CT and PET/MRI (Comaniciu et al., 2016). These improvements in diagnosing diseases certainly benefit patients. At the same time, however, there are also concerns about the justification of examinations against the backdrop of the increasing number of examinations performed, both in relation to the radiation risks to which patients are exposed and to the rising costs of healthcare (Litkowski, Smetana, Zeidel & Blanchard, 2016; Smith-Bindman, Miglioretti & Larsson, 2008; Swedish Radiation Authority, 2009). This indicates that more knowledge is needed about involved professions' work and collaboration for securing patient safety and medical service within this field. Three professions' perspectives—medical physicists, radiologists, and radiographers—are investigated in this paper. Descriptions of their work and responsibilities in a European context indicate that all three professions are responsible for patient safety in terms of the risks related to image production, but with slightly different focuses in their professional responsibilities (European Federation of Organizations for Medical Physics [EFOMP], 1984; European

Federation of Radiographer Societies [EFRS], 2018; European Society of Radiology [ESR], 2020b).

According to existing competence descriptions, medical physicists' responsibilities are stated to cover work with the physical medical equipment to ensure correct and safe standards for image production. Medical physicists, in collaboration with physicians and other involved personnel, are held accountable for the use of optimal methods for image production. Medical physicists should also provide continuous professional development courses in applied physics for professional groups involved in the use of medical equipment (EFOMP, 1984). Radiologists, on the other hand, are described as responsible for the justification of requested examinations in relation to each patient's medical problems and the safety risks connected with the examination. Radiologists are also responsible for the choice of an adequate method for image production. Furthermore, radiologists should perform diagnoses from the images produced and should report the results to the referring physician in a clear and patient-safe manner. This can appear both as written reports and as special cases in clinical round-table meetings with referring physicians (ESR, 2020b). Radiographers are described as being responsible for conducting the image production in accordance with ALARA (As Low As Reasonably Achievable) principles for radiation protection through the use of standards and methods for image production. Other responsibilities of radiographers are patient care and the safe administration of medical drugs related to image production. Radiographers should also critically judge the methodology in use and the quality of the produced images to ensure their appropriateness for diagnosis (EFRS, 2018).

The above description of the various responsibilities and tasks expected of the involved professional groups illustrates the complexity and logistics of medical imaging practice. We can also note from the competence descriptions that the facets of responsibility for patient safety in image production are distributed across and linked between the three professional groups.

Previous research

Former studies about how technical development in medical imaging has affected professional work and collaboration has focused on the effects of the introduction of digitalised image production (Larsson et al., 2007; Fridell, Aspelin, Edgren, Lindsköld & Lundberg, 2009; Tillack & Breiman, 2012). Studies focusing on collaboration between radiologists and radiographers in a Swedish context claimed that the professions work more separately in a digitalised workflow compared to when working with analogue imaging techniques. To optimise the workflow of patients through the departments, radiographers took responsibility for judging image quality, a responsibility that formerly belonged to radiologists. This resulted in more isolated work, but at the same time radiographers gained

more independence in relation to radiologists (Fridell et al., 2009; Larsson et al., 2007). The introduction of digitalised image production and usage of the picture archiving and communication system (PACS) is a disruption of professional work in medical imaging because it altered professional responsibilities and tasks (Fridell et al., 2009; Larsson et al., 2007).

In an American context, Tillack and Breiman (2012) studied how the introduction of the PACS has changed the communication and trust between neuro-radiologists and neurologists and meant that neurologists obtained access to the images in their departments. They then learned more about interpreting the images themselves, perhaps not even reading the reports from the radiological department (Tillack & Breiman, 2012). A similar result regarding orthopaedic surgeons learning how to interpret images through access to the PACS was reported from a Swedish context (Fridell, Aspelin, Felländer-Tsai & Lundberg, 2011). Tillack and Breiman (2012) claimed that, in practice, this meant that learning and discussion between different medical specialists about the images and clinical cases occurred less frequently than when working in an analogue workflow. The more frequent physical meetings between clinicians and radiologists in the analogue workflow built mutual trust in their different areas of expert knowledge. Working more separately in a digitalised workflow could lead to the misinterpretation of images and poorer content in the referrals, probably related to less interdisciplinary communication. All this put together might negatively affect patient safety (Tillack & Breiman, 2012).

There are studies on collaborative work in medical imaging from the perspective of the interprofessional collaboration between radiologists and clinicians (Aripoli, Fishback, Morgan, Hill & Robinson, 2016; Dickerson, Alam, Brown, Stojanovska & Davenport, 2016; Tillack & Borgstede, 2013). Aripoli et al. (2016) and Dickerson et al. (2016) reported that the material arrangements and physical localisation of the work was important for improvement of collaborative work, and clinical round-table meetings resulted in better communication about the complex information contained in the findings from the images. This facilitated the clinicians' decisions about treatments for patients (Dickerson et al., 2016). Tillack & Borgstede (2013) compared how the communication between radiologists and clinicians differed in relation to where the radiologists' reading rooms were placed in the hospital. Having reading rooms located in areas where clinicians worked led to more verbal interactions, such as telephone calls or physical meetings. Other locations for the reading rooms resulted in more interaction through IT systems (Tillack & Borgstede, 2013). These studies, conducted in an American context, indicate that physical meetings improve collaborative work regarding the complex information provided by medical images (Aripoli et al., 2016; Dickerson et al., 2016; Tillack & Borgstede, 2013) and are in line with recommendations from the World Health Organisation (WHO, 2010) about how changes in the environment can improve collaborative work (WHO, 2010).

Meghzifene et al. (2010) found that physicists were involved in teamwork and competence descriptions of The European Federation of Organizations for Medical Physics (EFOMP, 1984), describing collaborative work around the use of optimal methods for image production. How this was arranged in practice was not explained (EFOMP, 1984; Meghzifene et al. 2010;).

The introduction of digital image production has led to more dispersed locations of the involved professions and to changes in professional responsibilities (Fridell et al., 2009; Larsson et al., 2007; Tillack & Breiman, 2012). According to competence descriptions for medical physicists, radiologists, and radiographers, all three professions are responsible for patient safety and the quality of the examinations (ESR, 2020b; EFOMP, 1984; EFRS, 2018). Against the background of the concerns about the increasing number of performed examinations (Litkowski et al., 2016; Smith-Bindman et al., 2008; Swedish Radiation Authority, 2009), more knowledge is needed about how the studied professions' every day practices are organized.

This study explores the organization of medical physicists', radiologists', and radiographers' professional work and the challenges they encounter ensuring quality and safe medical service within medical imaging.

Theoretical framework

To identify the professionals' everyday activities a practice-theory perspective was chosen as the theoretical framework for of the study.

Practice theory is an umbrella concept for theories about practices (Feldman & Orlikowsky, 2011). Common standpoints in practice theories are that both people and materiality perform activities in practice, doings, and sayings (Schatzki, 2012). There are also relations between people and material things that have an impact on the activities that take place in practice. The view of practices as relational means that they are shaped relationally through how people act and interact, both socially and through the way in which these actions and interactions are bundled with the physical environment. Material arrangements and set-ups are not seen as just passive structural features or as passive containers for actions. On the contrary, materials and objects are seen as dynamic and integrated with human activities in ways that also act in practice. The relations are not always equal and can lead to conflicting interests or power (Feldman & Orlikowsky, 2011).

Kemmis (2014; 2019) refer to the external structures of practices as practice architectures. These are shaped by material-economical, discursive-cultural, and socio-political conditions. The practice architectures are built up and held together in specific ways that impact the activities in practice. The material-economical arrangement of practice architectures form and can enable or constrain the practical doings in practice. The language in practice, both

the spoken and written, is shaped by discourses and culture about how to reason about that specific practice. Socio-political conditions such as power, solidarity, and rules impact on how people relate to each other and to non-human objects in practice (Kemmis 2014; 2019).

In practice, Schatzki (2002) claims that both humans and non-human objects perform activities that can be combined into different tasks and projects. These can be regular, irregular, occasional, or rare. The activities are bodily doings and sayings that are organised and held together through the practitioners' shared practical and general understanding, rules, and teleo-affective structures. *Practical understanding* means to know and be able to perform the required bodily actions within the specific practice. *Rules* are the principles and instructions that should be followed when carrying out the activities. *Teleo-affective* structures are prescribed and acceptable ends, i.e., the goals that are achievable using the tasks and projects that are shared in practice. Lastly, *general understanding* means an overall understanding and sense about what is going on in practice and the aesthetic values of the activities in practice (Schatzki, 2002).

Different practices connect and build up networks of practices. The connections are through activities and common projects, ends, and/or rules. Furthermore, physical things that are used in multiple practices can connect different practices (Schatzki, 2002). There is also a relationship through intentional relations, i.e., what people feel, think or believe about another practice. Intentional relations can form a special type of causal relations leading to a certain chain of actions in or between practices (Schatzki, 2002).

To investigate the challenges these three professional groups encounter in practice, the concept tension was used (Engeström & Sannino, 2011; Helle, 2000). Historically, tensions in practice have been caused by the organisations where the tensions turn up. Disorganization, dynamic forces, and opportunities for change are revealed when tensions are observed. Recognized tensions can be used for changes and learning within that specific organisation (Engeström & Sannino, 2011; Helle, 2000).

Methodology

In research on practices, it is common to apply ethnographic fieldwork as the way to study how practices are enacted. In this study, the practices are dispersed and located separately from each other, which makes it difficult to trace how the interconnections between the different practices are constituted. Hence, to explore how the different professional practices, interconnect to ensure patient safety and quality, interviews were chosen as the means of data collection. Through these interviews, the professionals' intentions relating to their own professional actions were investigated, together with descriptions of their connections with other professional practices during their work.

Data collection

This study was conducted in Sweden. All three studied professions work in medical imaging with diverse tasks and responsibilities (EFOMP, 1984; EFRS, 2018; ESR, 2020b). An exploratory design was used because there are few previous studies about the connections between different professional practices in medical imaging.

The interview guide consisted of four open-ended questions. The first question was influenced by Nicolini's (2009) interview method for studying practices. In this method, called "interview to the double", the interviewee is asked to describe how their work should be performed to a fictive person who will have to do their job the next day. This method illuminates practical work, rules, and logical structures in practice (Nicolini, 2009). The second and third questions were influenced by Schatzki's (2002) description of activities in practices. The fourth question was about collaborative work with other professions.

The questions were (with suggested probing questions in italics): 1) If you had to tell somebody, who had never been to your workplace, what you do during your work, what would you tell them? 2) Which goals are most important to achieve with your work? *Is there anything that facilitates achieving these goals? Is there anything that complicates things for you to reach these goals?* 3) What are you responsible for during your professional work? *Are there areas of responsibility that collide?* 4) Tell me about how you collaborate with other professional groups during your work? *Tell me about an event that you have experienced when you collaborated with other professional groups.*

A purposeful sampling technique was used to gather a variety of interviewee experiences of the object under study (Patton, 2015). Five different people were asked to nominate physicists, radiologists, and radiographers suitable for interviewing in a study about collaborative work in this area. The persons who nominated interviewees were three radiographers, one radiologist, and one medical physicist. Between them, they suggested 21 possible interviewees. All were contacted by email by the first author, who sent them written information about the study after they answered the first email. Fourteen agreed to participate, and 14 interviews were performed by the first author between August 2015 and October 2016. The first three interviews were discussed at a research seminar in September 2015, and the suggested probing questions were added to the interview guide after the seminar. The interviewees' workplaces were a university hospital (N = 5), a district hospital (N = 7), and a local hospital (N = 2).

All 14 interviewees chose the place and time for their interview. Nine interviews were conducted in undisturbed conditions at the interviewees' workplace; one was conducted at the interviewee's home, and one in a room at a university. Three interviews were conducted by Skype, two because of the long distance to the interviewees' workplace and one for personal reasons. The interviewees were four medical physicists, five radiologists, and five radiographers. Five were male and nine were female. The length of work experience ranged

from 1 to 35 years, with a median length of 8.5 years. The length of the interviews ranged from 17 to 57 minutes. All interviews were recorded using a digital voice recorder and were transcribed verbatim by the first author. The interviews were in Swedish, and the extracts have been translated into English.

Data analysis

All 14 interviews were used in the analysis. First, the separate professional practices of the interviewees were traced through a search for expressions of *practical understanding*, i.e., descriptions of practical work and performances, *rules*, i.e. references to explicit directives or regulations in use, *teleo-affective structures*, i.e. references to what it made sense to do given the unique situation they were describing, and their *general understanding* of their practice.

Second, expressions concerning connections between the different professional practices were identified (i.e., common activities and projects, ends and/or rules, physical things used in different practices, and intentional connections) (Schatzki, 2002). A particular focus was on how these connections influenced the activities and how the arrangements enabled or constrained professional work for ensuring patient safety. Third, the identified connections between the different professional practices were interpreted from the concept tension, leading to three themes that became the final result.

Ethical considerations

The study was conducted in accordance with the Helsinki Declaration and was approved by the regional ethics committee in Linköping (Dnr 2010/74-31).

Tension between diverse general and practical understandings about the activities in practice

In the workflow with image production, the planned tasks/projects were mainly visible through written statements in IT systems. The referent physician requested a radiological examination by sending a written electronic referral to the radiological department. The radiologist was responsible for justification and prioritisation of the examination. When using multidimensional imaging techniques, such as CT and MRI examinations, written prescriptions were made in the referral notes about how the examination should be conducted. Then the radiographer prepared the examinations based on these prescriptions. During work with conventional imaging techniques, the method for image production was chosen by the radiographer from the expressed question at issue in the referral. The examinations were then performed by the radiographers based on the written method descriptions. The radiologist made a diagnosis from the images and wrote a radiological report to the referring physician. Some cases were even reported to referent clinicians during clinical rounds.

In the following we will show how the planned tasks and projects occasionally might be changed in practice for ensuring high quality and safe medical services.

Radiologists were responsible for the justification and prioritisation of the examinations both from the viewpoints of radiation protection and proper usage of resources in health care. The content in the referral should give a description of the patient's medical problem and state the relevant clinical question for the requested radiological examination. The content and quality of the referral was important for the radiologist to be able to justify the examination in relation to the patient's medical problem and to prioritise when the examination should be done. When the quality of the referral was poor or information was lacking, there was a need for discussions between the radiologist and the referring physician for clarification of the content in the referral.

> I am rather active when it comes to discussions with referring physicians. I usually say that the referral is another work tool. If you can be precise and I know what I must respond to, then you can get a very good answer. (Interview 13, radiologist)

During the image production, the radiographers' and radiologists' activities were organised as parallel projects. The radiographer, who met the patient in the radiological department, read the referral and prescription and checked whether there were any patient safety risks with the planned examination. In the interviews it was expressed that occasionally the radiographers discovered things that indicated that the planned activities should not be performed. It could be that the description in the referral about the patient's symptoms differed from the patient's actual medical status in such a way that the method of image production needed to be modified. It was also shown that sometimes the radiographer identified patient safety risks with the planned method. This could be related to the usage of ionising radiation or to medical risks related to undergoing the examination. There could also be issues about whether the image quality was sufficient to assist in resolving the issue that gave rise to the examination. These decisions were identified in the interviews as radiologists' professional responsibilities. To achieve optimal image quality and patient safety to undergo the examination there was a need to discuss the case. This might interrupt radiologists while they were involved in other activities, tasks or projects, as the following quotes show.

> I still think it makes it really difficult to get any continuity in my own work. I have very little time to sit and do what might actually be the largest part of the radiologist's work—to sit and review images—because there are an unbelievably large number of interruptions. (Interview 5, radiologist)

> It happens sometimes that you read the referral, and if the prescription does not match what you have read you must have an explanation for that, and then you must co-operate with the radiologist". (Interview 6, radiographer)

The informants said that there were different ways in which the practice was arranged for this occasional collaborative work during image production. If there was no radiologist available for this collaborative work, it could affect image quality, leading to difficulties in making a diagnosis or affecting patient safety.

The result (diagnosis) of the examination was mainly communicated to the referring clinician as a written statement in a radiological report. The written response could be formulated differently depending on the radiologist's habits and way of organising written notes. The following quote illuminates how this can affect patient safety.

> It's difficult with written communication. There is usually so much information in the radiological statements that it can be missed. Also, it can be read carelessly and only the summary might be read, and we might have missed writing some things in the summary.
>
> We also express ourselves in different ways, and a radiological statement can be presented in many ways. It can go from head to foot, or it can concern different organs, or the pathology first and then the normal findings, or the normal findings first and then the important pathology. There are many ways to write it. (Interview 2, radiologist).

Some cases were also communicated to referring physicians during ordinary radiological rounds with different medical disciplines. These rounds meetings also involved planning for the treatment and care of the patients. The informants said that nowadays this collaboration between different medical disciplines is a common task for radiologists. It includes learning activities about the images of patients and interactions with clinicians, who together decide about the treatment for each patient.

> Sometimes we don't reach the goal and sometimes we do reach the goal. I think that [the collaboration at multidisciplinary round-table meetings] is very fruitful because I can see what comes out of my work, what my work leads to. What I find on the images leads to the patient coming to this department to get that treatment. (Interview 13, radiologist)

Tensions between material-economic conditions and activity in practice

Technical developments in medical imaging have led to better possibilities for the visualisation of pathologies. In practice this means more modalities and methods to choose from. The choice of the proper examination for each individual patient has become a common task for radiologists. The improved possibilities to identify pathologies with imaging also mean more frequently usage of examinations performed by medical imaging techniques for judging patients' medical status. Economic incentives for a fast flow of patients through the health care system, mainly because of a shortage of hospital beds, has

led to a need for tools for making decisions about patients' medical status, especially in emergency care. Radiation protection issues such as the importance of justification of examinations performed with ionising radiation are not clearly expressed in the organisation of health care.

> I think that we are heading towards a kind of paradigm shift where you see radiology examinations as more like a lab test than a consultation. (Interview 13, radiologist).

> There is no overall hospital mission about what radiation physics is. People don't know about it. If you take infection protection, for example, or if you ask any person at the hospital about, if they get stuck by a needle, what they do then, which incident report they write and how they indicate a needle injury. They then know which person to tell about it. (Interview 11, medical physicist).

Planning work regarding the justification of the examinations and the choice of accurate methods for image production was time consuming. In the interviews, it was expressed that this could sometimes lead to conflicting interests about how the practice should be carried out from economic incentives in the health care system. The informants said that if a mutual discussion with the referent physician did not take place, this might lead to a longer time before the radiological examination was performed. However, these could also be learning opportunities because of their diverse practical understandings about the case. Radiologists' collaborative work with general medicine about the planning of the examinations was not visible in evaluations of the work performed in radiological departments.

> We have [quality assurance], which is relatively important and good for us, especially as a basis for discussion. But every time I return a referral or call a referring physician or educate any referring physician, it costs working hours and it costs money and I get zero so-called credits because only conducted radiological examinations get credits. So it looks worse the better you work because it looks like you are being ineffective. (Interview 10, radiologist).

There was also planned collaborative work involving medical physicists, radiologists, and radiographers about optimisation of the protocols for image production using the different modalities. In the interviews, this was explained as important for radiation safety issues and for attaining sufficient image quality. The informants also reported that optimisation of radiation doses and adjustment of the protocols for image production in the modalities had become more important due to technical developments. The techniques for image production have become more complex with more parameters to control for when determining the radiation dose for each examination. This collaborative work involved all three professions. Their diverse practical understandings were needed for reaching a common goal within the practice, namely lowest radiation doses possible while gaining sufficient image quality for diagnostic certainty. The medical physicist had practical

understanding about how the different parameters in the protocols affected radiation doses. The radiographers knew how to make changes in the protocols and how to conduct the examinations. Sufficient diagnostic quality of the images was the radiologists' practical understanding. However, this collaborative work, in the above-described sense, was also seen as vulnerability due to the pressure and increased productivity requests for medical imaging examinations. The following quotes show that it was sometimes difficult to find time for optimisation work because of the workload.

> About optimisation work, above all it's a dialogue with both radiologists and radiographers because usually we need help with the practical adjustment of the modalities, and then we must have that dialogue with the radiographers. We simply trim a few settings in the protocols so that we get the change that we want. (Interview 8, medical physicist).

> Operations managers are focused on production and, unfortunately, I haven't often experienced that production comes first and development comes later and there are total misunderstandings sometimes, where you think that you can produce radiological examinations and that the development will take place in parallel, and in some parts it does but you have to take time in some way away from production for development. In my case, I've required CT meetings with the staff, especially when the new machines with high pre-standards came. Then, [collaborative work] was urgent because you didn't know there was such a big difference in pre-standards, so we had to build a team. (Interview 7, radiologist).

Tensions between discursive-culture conditions and activity in practice

In the interviews it was expressed that producing the images was mainly the radiographers' professional area and that radiologists were responsible for interpretation of the images. Radiographers conducted examinations based on written method descriptions. Radiologists performed some examinations, which had to be performed in a non-standardised manner where the findings on the images steered how to perform and complete the examination. In the interviews, it was revealed that radiographers had the ability to identify findings on the images. This was mainly used for steering patient flow through the health care system.

> When you get the images on the screen, for example, when you are doing an emergency CT examination of the brain and you are looking for bleeding, then it is up to the radiographer to find bleedings quickly and fetch the radiologist and say to them that there is bleeding. Yes, formally this is not our task to interpret the images, but we must still do it. (Interview 4, radiographer).

This ability was also used for identifying findings on the images of importance for how the examination should be completed and for addressing issues about whether the method should be changed or modified. Such decisions are the radiologists' tasks and

responsibilities, and this leads to a need for consultation with a radiologist for attaining high quality and diagnostic certainty with the examinations. This might interrupt radiologists' work in other tasks and projects such as the interpretation of images containing a lot of information that must be dealt with before formulating a written report. This collaborative work can also be an area for professional extension for radiographers' responsibility as the following quote shows.

> They can also be disturbed in their reviewing when we come and ask questions. It's clear that if we could act more independently, we might decide that we want to take an extra image. It looks like our professional role could be extended so that we interpret the images a little more than we do now. The answers could be improved, too, because the radiologist should not be disturbed either. Yes, I think there are many answers that have been too short or too imprecise because of interference. (Interview 5, radiographer).

Discussion

This study explored the organization of medical physicists', radiologists', and radiographers' professional work and the challenges they encounter ensuring quality and safe medical service within medical imaging.

Main findings are that different professionals work in the workflow of image production is mainly organized as standardized workflows with connections through IT-systems. Economic incentives in health care and improved technology lead to increasing demand of service from medical imaging. Radiation safety issues are not clearly expressed in the organization of health care which led to tensions regarding how the practice should be carried out. Radiologists' and radiographers' professional tasks with image production and image quality are interwoven and shared to provide safe medical service.

Identified tensions between physicians in general medicine and radiologist, about the quality of the referral, reveal that technical development in medical imaging with more methods available for image production might causes this scenario. In the interviews it was displayed that usually this was solved through mutual adjustment in between radiologists and physicians in general medicine. There are systems under development for clinical decision support, named iGuides, for facilitate for clinicians to select appropriate method for image production (ESR, 2020a) which means an opportunity for change. This might ease radiologists' work in the future but learning events from discussion with clinicians about different cases might become rare.

Our findings show that radiologists' and radiographers' professional tasks during image production are organized as standardized parallel workflows of their diverse professional tasks. Coordination in between their different workflows is organized as direct supervision

through written prescriptions in referral notes or by usage of written method descriptions. The EFRS (2018) states that radiographers should critically judge the methodology in use and the quality of the images produced to ensure the appropriateness of the diagnosis. The findings of this study show that, in practice, radiographers critically judge the intended actions from the referral in relation to the individual patient and the findings from the images to achieve diagnostic certainty, the lowest radiation doses possible, and no medical harm. This means that occasionally when the radiographer meets the patient, they discover issues that affect quality and safe medical service. Because of diverse professional responsibilities, these issues must be solved through mutual adjustment, which is not always organized for in practice. This identified tension indicates disorganization in this connection. Previous studies might shed light on this identified tension. Fridell et al. (2009) and Larsson et al. (2007) showed that the introduction of digitalised image production has led to changed responsibilities from radiologists to radiographers regarding the image quality of the produced images. Thus, the introduction of new techniques and improved visualisation of pathology might be a reason for that there are still a need for occasional consultation with a radiologist for securing the diagnostic certainty and quality of the produced images that was reported in our findings. However, these occasions were not stated as learning events because they disturbed or interrupted other types of organised activity. Our finding can either be interpreted as a need for more face-to-face meetings between radiologists and radiographers about complex cases for improving quality and safe medical service or as an area for role extension for further educating radiographers in this national context.

Our findings show that clinical round meetings and collaborative work on the development of methods are occasions when the involved professionals' diverse practical understanding can be expressed. This leads to interprofessional collaboration for achieving common goals in practice. This has similarities with finding in studies about how radiologists learn to view and diagnose new types of images together in mixed groups (Asplund et al., 2011; Ivarsson et al., 2016; Rystedt et al., 2011). Viewing and discussing the content on the images by both experienced and inexperienced viewers makes expert knowledge visible, and communication of their decisions articulates things that might be taken for granted in a homogeneous group of experts (Asplund et al., 2011; Ivarsson et al., 2016; Rystedt et al., 2011). This is also in line with the findings of Dickerson et al. (2016) that in-person meetings between different professions improve decision making.

Gherardi (2015) argues that professional work is more than just performing tasks efficiently. It is also about fulfilling aesthetic and ethical values through practice. Our findings show that economic incentives in health care affect professional work and can sometimes lead to conflicting interests between different professional groups about how the practice should be carried out from an ethical perspective. One reason can be that the technical development within medical imaging and its accessibility seems to have caused a change in

opinions about the risks to patients. The findings in this study might shed light on the reported increasing number of examinations performed in medical imaging (Litkowski et al., 2016; Smith-Bindman, Miglioretti & Larsson, 2008; Swedish Radiation Authority, 2009). There is a need to investigate this topic from the viewpoint of general medicine.

This study's exploratory design was used to identify the organization of work and challenges professionals encounter in medical imaging. Practices can be studied by observation or by interviewing people. Observation provides data about the actual actions and interactions in the studied practice, while interviews are used to obtain insights into people's narrative stories about the studied subject (Patton, 2015). Data collection with observations is seen as beneficial when studying practices (Schatzki, 2012). However, interviewing was chosen for data collection for this study because the different professional practices in focus in this study are dispersed and located in different physical spaces. This can be seen as a weakness and also that the interviewees worked in diverse contexts in health care. Therefore, this study should be seen as an explorative study, and the findings can be used for designing future studies about the changing conditions of professional work due to organisational or environmental factors.

The practice-theory perspective was useful for tracing the professional activities in practice, the goals with their work, and connections with other practices. For interpretation of the findings, the concept tension was deemed suitable.

Conclusions

The new technologies, economical rationalities, and organisation of work processes in medical imaging have led to fewer face-to-face meetings between different professions. Medical imaging as dispersed practices misses out on opportunities for learning across practices, which can negatively affect quality and lead to patient safety risks. This means that new forms for learning across practices are needed.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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