

Restructuring of a Hospital Radiology Department: Subspecialization Between Man, Machine, and Multidisciplinary Board

Restrukturierung einer Krankenhausradiologie: Subspezialisierung zwischen Mensch, Maschine und Tumorboard

Authors

Jeanette Henkelmann , Constantin Ehrengut, Timm Denecke

Affiliation

Klinik für Diagnostische und Interventionelle Radiologie, Universitätsklinikum Leipzig, Germany

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Georg Thieme Verlag KG, Rüdigerstraße 14, 70469 Stuttgart, Germany

Correspondence

Dr. Jeanette Henkelmann

Klinik für Diagnostische und Interventionelle Radiologie, Universitätsklinikum Leipzig, Liebigstraße 20, 04103 Leipzig, Germany

Tel.: +49/3 41/9 72 06 16

jeanette.henkelmann@medizin.uni-leipzig.de

ABSTRACT

Background Radiology, like almost no other discipline, is faced with a rapid increase in information and technology. This and the growing demands regarding referring medicine, quality requirements, and personnel efficiency increasingly require subspecialization in terms of content. There is already an established move towards radiological subspecialization in the Anglo-American region. In this review article, the content and possibilities of restructuring a hospital radiology department are presented in order to support acceptance in German-speaking countries.

Method Based on the current literature, the aspects of subspecialized radiology as well as its necessity, advantages, and disadvantages are discussed and the challenges to hospital management with respect to strategic implementation in the individual phases are presented based on the example of a university radiology department. The viewpoints also take

into account the education regulations and integrate a modern learning concept.

Results and Conclusion Modern restructuring of hospital radiology departments is faced with increasing demands on a traditionally technically organized radiology department with regard to the complexity of referring medicine, subspecialization pressure (including in certified boards), and staff efficiency. The restructuring of a radiology department must be aligned with the clinical requirements and discussed in the overall concept of radiology including its environment.

Key points:

- The tremendous expansion of knowledge requires a content-based subspecialization of modern radiology as a cross-sectional discipline.
- Proactive radiology meets the increasing demands of its clinical partners and offers great potential for improving quality and efficiency.
- The restructuring of a hospital radiology department requires well-planned strategic management taking into account all involved processes, resources, and personnel qualifications.

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ZUSAMMENFASSUNG

Hintergrund Die Radiologie muss sich fast wie kein anderes Fach einem so rasanten Wissenszuwachs an Informationen und Technik stellen. Dies und wachsende Ansprüche der zuweisenden Medizin, Qualitätsforderungen und Personaleffizienz erfordern zunehmend eine inhaltliche Subspezialisierung. Bereits im angloamerikanischen Raum lässt sich ein etablierter Umschwung zur radiologischen Subspezialisierung beobachten. Im Rahmen dieses Übersichtsartikels werden die Inhalte und Möglichkeiten einer Restrukturierung einer radiologischen Klinik dargestellt, um die Akzeptanz im deutschsprachigen Raum zu unterstützen.

Methoden Anhand der aktuellen Literatur werden die Aspekte zur subspezialisierten Radiologie sowie deren Notwendigkeit, Vor- und Nachteile erörtert und die Heraus-

forderungen an das Klinikmanagement zur strategischen Umsetzung in ihren einzelnen Phasen am Beispiel einer Universitätsradiologie dargelegt. Die Standpunkte berücksichtigen zudem die Weiterbildungsordnung und integrieren ein modernes Lernkonzept.

Ergebnisse und Schlussfolgerung Die moderne Restrukturierung der Krankenhausradiologie stellt sich den wachsenden

Anforderungen an eine traditionell technisch organisierte Radiologie hinsichtlich der Komplexität der zuweisenden Medizin, dem Subspezialisierungsdruck (u. a. in zertifizierten Boards) und der Personaleffizienz. Die Restrukturierung einer Einrichtung ist an den klinischen Anforderungen auszurichten und im Gesamtkonzept der Radiologie mit dessen Umgebung zu diskutieren.

Introduction

Due to high pressure to innovate, all areas of medicine are faced with the challenges of rapid increases in knowledge [1, 2]. Radiology is also developing quickly and functions as the information interface to other medical disciplines due to its interdisciplinarity and versatility. Radiology is based on the entire medical spectrum and also continuous education in individual areas of specialization. Therefore, radiology is simultaneously a cross-sectional discipline and a specialized medical discipline. It provides access to technical and information processing innovations, thereby making an important contribution to the optimization of patient care.

How can the enormous increase in information be handled for an adequate increase in knowledge to improve inpatient care? In recent years, medical specialization has also driven discussions regarding radiological subspecialization and increasingly influenced practical exercising of the profession [3]. To date, pediatric radiology and neuroradiology are the only subspecializations currently certified by state medical chambers in Germany. In addition, there is a trend toward the creation of sections in large radiology departments with organ-specific and clinical subspecialization [3, 4].

In modern terms, radiology should be considered a clinical partner that addresses increasing requirements and implements these under consideration of patient safety, quality, and economic efficiency. The interests of referring medical specialties differ significantly from one another and subspecialization in the different subareas of radiology seems to be an essential requirement of demand-based restructuring [4].

Traditionally, radiology departments are structured on a modality basis. This conflicts with the subject-based organizational structure of referring departments inside and outside the hospital thereby complicating workflows. If reporting can be thematically linked to thematically related referring groups in a targeted cross-modality manner, restructuring has the potential to make internal workflows more efficient and to make radiology more compatible with the surrounding structure. The content and possibilities of such subspecialized restructuring of a radiology department are presented and explained in this review article.

Subspecialization – necessity and quality initiative

Demand-based diagnosis and active patient care

Without a doubt, content-based subspecialization is necessary after specialist training in order to manage the constant increase in knowledge and innovations. The plurality of radiology societies makes it possible to meet the need for subspecialization. Therefore, some work groups include structured training as part of subspecialization, which can sometimes already be started during specialist training, and offer corresponding certification programs. The subspecialized structure of a hospital radiology department provides not only the potential for increasing the quality of radiology reporting, education, and patient care but also advantageously adjusts to certification programs and can accordingly focus and accelerate the attainment of quality certificates for employees.

In most hospital radiology departments, personnel are assigned on a modality basis. Personnel planning and continuing medical education are often implemented based on fixed rotations in conventional radiography, computed tomography, magnetic resonance imaging, ultrasound, etc. However, patient care is different. As of late, radiology is no longer a passive service provider. Interdisciplinary conferences, tumor boards, and treatment planning require specialized knowledge regarding the patient and the clinical picture across the individual modalities. In preparation, the findings of different examinations are recorded and evaluated in relation to time and treatment. The creation of radiology reports, which are often written by residents under the supervision of a specialist, is usually performed parallel to the clinical conference and in the case of modality-based supervision typically does not coincide with the conference preparation. This ultimately results in multiple reviews and sometimes subsequent corrections since the interdisciplinary board and overall context can result in new information that was unknown at the time the initial report was written and supervised.

Radiologists are valuable here as active clinical partners in health care. Direct communication between referring physicians and radiologists results in a consensus diagnosis and treatment strategy for improved patient quality and safety [5–8]. The undisputed relevance of radiology case presentations is substantiated by numerous studies examining the effect of second opinions and reinterpretation in clinical conferences and interdisciplinary boards. In addition to the subspecializations of neuroradiology and pediatric radiology, almost all areas, and in some cases breast

imaging and emergency radiology, showed a subjectively expected increase in report quality [9–12]. As a further example, the systematic analysis by Dendl et al. shows the necessity of radiology conferences, with a significant number (approx. 38%) of the discussed cases resulting in a change in diagnosis or treatment management [13].

On the whole, there has been an increase in case presentations in interdisciplinary conferences resulting in significant extra work particularly as a result of second opinions regarding externally acquired images. The unfortunately inadequate compensation situation in the current billing system shows the urgent need for a long-term solution on an internal hospital and a health care policy level [14]. However, this highlights the importance of a subject-based subspecialized structure in radiology with a largely consistent radiology team being responsible for the cross-modality radiological care of a patient. Therefore, the additional effort due to conference activities can be limited.

Efficient interaction between man and machine

The pressure to subspecialize in different areas is also the result of the demand to meet increasing quality criteria. The number of “certified centers” is becoming unmanageable resulting in more and more corresponding qualification certificates also in radiology. However, it is difficult for patients as well as medical colleagues to keep track of the overwhelming number of certifications that are supposed to promise quality and instill trust so that a “clearing of the certification jungle” was recommended in 2009 [15]. Consequently, medical certification standards were defined by the German Medical Association [16]. This was undoubtedly necessary to differentiate expensive and questionable certificates from those of professional societies providing high-quality certification.

Ultimately, the competitiveness of a radiology department is maintained and expanded by supply and demand-based innovation and quality management. Referring physicians demand quick turnaround times for radiology reports that are considered a quality criterion and can thus affect the selection of a radiology department. Moreover, reducing report turnaround times and increasing productivity can help to shorten the stay of hospitalized patients, thereby affecting the overall profitability of a hospital [17, 18]. Faster clinical decisions and the implementation of necessary treatments increase the quality of care [3, 18].

Profitability and the health care industry are becoming increasingly intertwined. Radiology has enormous potential to contribute to process optimization and quality improvement in patient care. Radiologists are also increasingly expected to efficiently manage the limited resources in the health care system and also to proactively reduce costs and unnecessary imaging examinations in conferences [5, 6]. The current literature includes a growing number of studies evaluating an increase in efficiency based on report turnaround times or number of reports as a basis for measurement.

With respect to increased efficiency, Stern et al. examined the influence of workflow restructuring on subspecialized reporting (certified radiologists with subspecialization training) [19]. This study was able to confirm the hypothesis that a change from

general reporting to subspecialized reporting would accelerate the turnaround time of radiology reports resulting in an increase in radiology report availability within 24 hours. Following subspecialized restructuring, report turnaround times decreased significantly, and the productivity of individual radiologists increased 4.7 times.

In the study by Meyl et al., as expected, radiologists were able to focus on their areas of specialization. However, in contrast, this study showed longer report turnaround times in some areas [20]. This effect was due to a more complex workflow for residents and a greater number of highly complex reports. In addition, the advantage of subspecialization for patient care and the organization of research units have been discussed in some comparative studies as an argument for potentially higher acceptance in the compensation system [21].

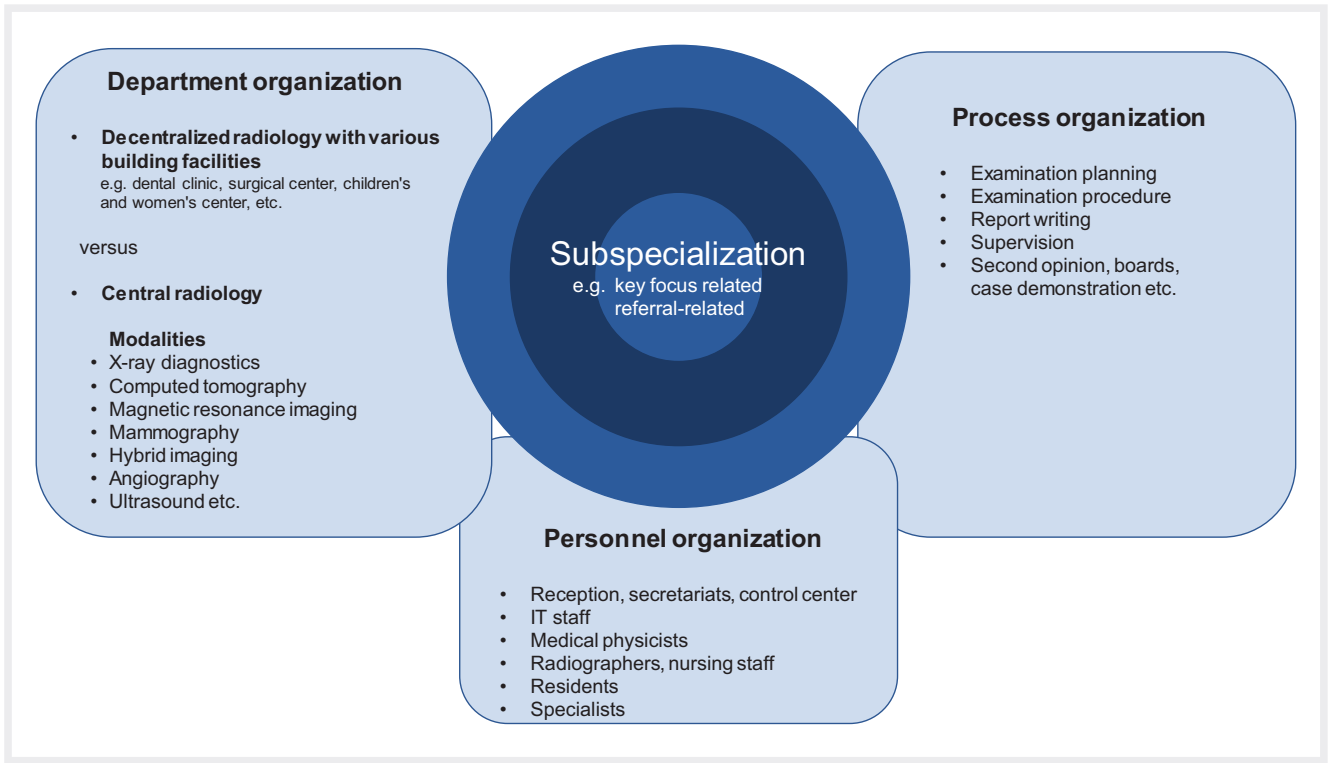
The switch to radiological subspecialization already seen in America and Britain has been observed not only in academic hospitals but also in communal hospitals and private practices. In a survey regarding subspecialization in radiology conducted by the American College of Radiology, Smith et al. stated that almost 63% of practicing radiologists report recent expansions in subspecialization within their practices [3]. Furthermore, a speech recognition system and a customized Picture Archiving and Communication System (PACS) were described as essential components of the effectiveness of a radiology department [22–24]. Moreover, increased efficiency can be expected when supervision and conference preparation are coordinated in the daily routine.

Restructuring – challenge for hospital management

The structure of operations is a main responsibility of hospital management and a fundamental requirement for success. In the 1960s, Alfred Chandler formulated the “structure follows strategy” thesis. Subspecialization can be introduced on various operational, procedural, and personnel levels (► Fig. 1), with complex and interconnected processes and resources needing to be taken into consideration in planning.

Subspecialization-based team structuring and formation of sections

In Germany, there are already individual radiology departments practicing subject-based structuring. The planning and implementation of subspecialization-based restructuring are presented in the following based on the example of the University Hospital Leipzig with approximately 1500 beds and over 34 clinics and departments. The goal was to modernize the radiology department with its strictly modality-based structure as a new referring medicine-based and specialized care facility. The planned restructuring was based on the thematic and referring clusters of the university hospital (e. g., oncology and infectious disease, liver and pancreatic surgery, diseases of the musculoskeletal system (trauma surgery/orthopedics, rheumatology), obstetrics, etc.). ► Fig. 2 shows an example of the restructuring of general radiology for the formation of subspecialized sections. Restructur-



► **Fig. 1** For subspecialized restructuring of important structural elements of a radiology department.

ing also focused on clinical conferences and tumor boards in order to increase efficiency regarding specialist supervision and conference preparation.

A department should be structured in alignment with the relevant clinical requirements. The allocation of radiology sections is determined by each department and should be discussed in the overall concept of radiology including its environment. There are individual advantages and disadvantages here. Separate reports in the case of combination examinations (e. g., head/neck/chest/abdomen) and reporting for individual organs do not seem to be efficient in any respect. Assignment of a patient to a particular cluster must be practicable and also understandable for non-physician radiology personnel. The new “radiology teams” were linked to individual referring departments independently of the requested examination modality and body region. In the majority of cases, the requested examination corresponds to the content focus of the referring clinic. In addition, the portfolio of the team includes general radiology questions (e. g., CT of the cervical spine after a fall out of bed or to rule out pulmonary embolism) and prevents overly rigid subspecialization (“no tunnel vision”). This continues to be a requirement of a general radiology specialist standard. The “exclusive” linking of a referring department to a fixed radiology team allows specialization in specific medical issues and provides a contact person with an overview of the relevant group of patients. The protocol is determined, and “triage” is performed to determine indication prior to examination. Specialized medical issues outside the area of expertise of the section and complicated examination methods can and should be processed in consensus in a cross-team manner. In the

present example, ultrasound and interventional radiology remained virtually unchanged due to spatial and qualification-specific or personnel-dependent aspects.

Change management in radiology restructuring

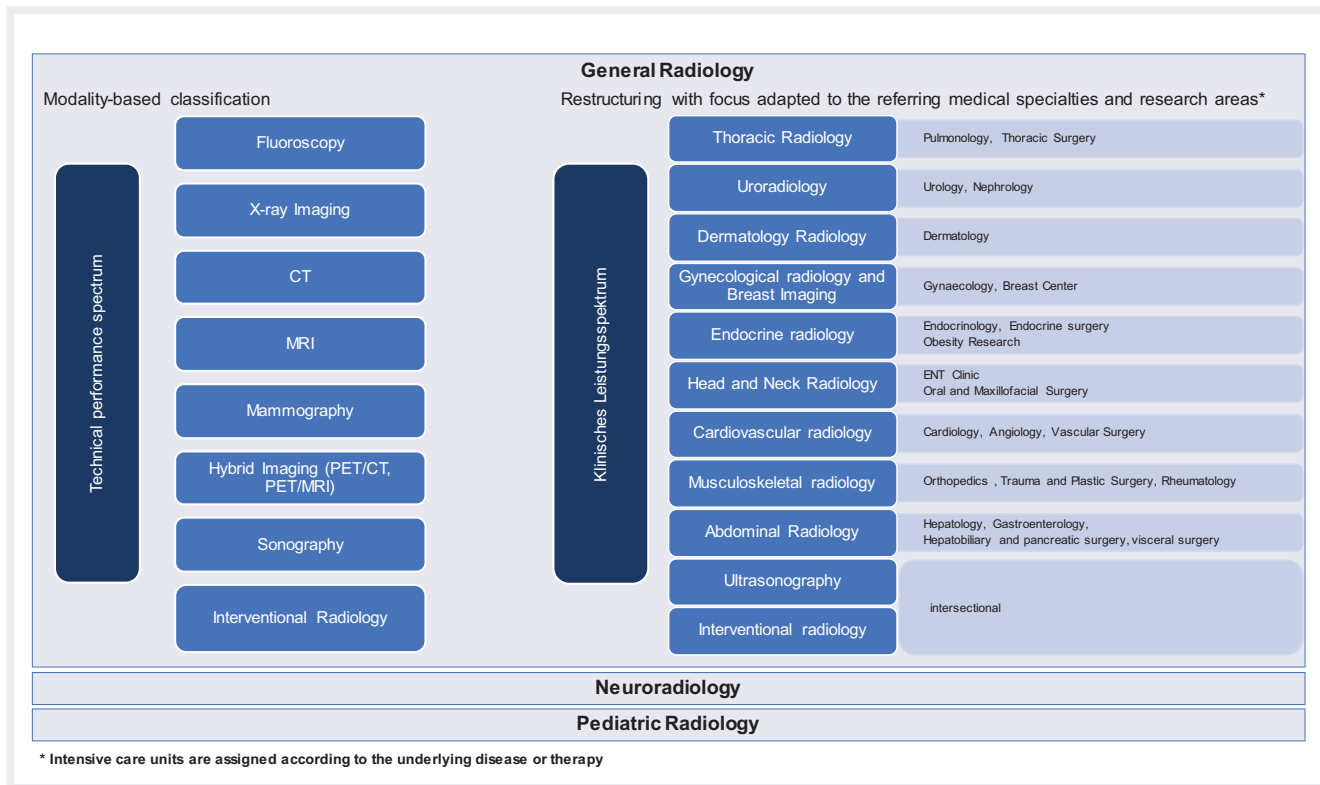
Change management that implements cross-section measures for realizing new systems, processes, and behaviors in an existing organization provides a scientific approach to restructuring. Different consecutive process phases (based on Lewin and Kotter) are run through in this restructuring process [25, 26].

Preparation, planning, and implementation phase

It is necessary to determine all requirements regarding the new organizational structures and the personnel requirements of the sections. A case number analysis according to referring physician, modality, and requested service serves as the basis for calculation for performance units [22, 27, 28] and requires corresponding capacity of a designated radiology information system (RIS). The total pool is divided according to the selected sections. The incorporation of individual competences and personal preferences as well as close communication within the team are requirements for successful implementation and lasting motivation during the complex implementation process.

Implementation and movement phase

When creating subspecialized teams, corresponding team or section leaders and their responsibilities must be defined. Tasks are assigned to the individual sections by corresponding RIS



► Fig. 2 Example of the restructuring of general radiology at a university hospital with focus adapted to the referring medical specialties.

confirmation. In this example the restructuring of report supervision was initially implemented on the specialist level and after three months also on the resident level. Incremental testing of the new processes allowed a rapid response in the case of problems. In addition to the creation of a new workplace plan, a spatial solution for the determination of the team structures and effective communication was developed.

Finally, all procedural process steps for the restructuring need to be analyzed since every change to an established structure can result in problems [27]. In the past, comprehensive quality management systems have been used to ensure efficient process organization [28–30]. An important component of an efficient workflow is the ability to organize and implement examinations directly at medical imaging systems. In the present example, it was necessary to assign CT and MRI floaters in a fixed daily plan on a modality basis. These floaters are responsible for informed consent discussions, checking for fitness for examination, etc. They also function as a fixed contact person for technologists during examinations. Particularly in the case of MRI scanners, good communication is required for sequence planning. In addition, a responsible team member should be available during the examination in the case of complex issues. Clear responsibilities in the individual modalities regarding general organizational and technical obligations (modality management) must also be defined.

Stabilization and reevaluation

In this phase, the new processes are cemented and implemented in the clinical routine. The members of the team can be reevaluated

transparently and changed as needed in close discourse and with another performance analysis. Every change process must ultimately be considered a continuously adapting type of organization.

After a six-month reevaluation, positive effects could already be seen in patient care in the presented example. The introduction of section telephones facilitated communication with referring physicians and need-based examination planning and prioritization. Subspecialization-based reporting and supervision resulted in more in-depth report content and ensured understanding of additional recommendations also by residents. In addition, simultaneous supervision and conference preparation increased efficiency.

Implementation of restructuring in continuing education

The concept of associative learning has been used by integrative model courses of study for several years. The radiology curriculum in medical school also includes methodical and cross-specialization organ and subject-centered modules [31]. This learning can be continued in continuing medical education in the form of a subspecialized rotation program that ensures full qualification in specialist training. A challenge here is the timely attainment of specialist knowledge and professional readiness on the part of residents.

Like in the model course of study, workflows can be linked in a more concentrated manner with the advantage of deeper integration of subject-centered knowledge regardless, for example, of a late MRI rotation, which is viewed by residents as one of the most

► **Table 1** Advantages and disadvantages of a traditional modality-based and a subspecialized department structure

	advantages	disadvantages
modality-based radiology		
radiography CT MRI mammography angiography, etc.	<ul style="list-style-type: none"> ▪ simple, manageable structure ▪ fast understanding of routine device management (simple daily planning) ▪ self-contained and easily controllable functional areas ▪ broad disease spectrum in short time in continuing education ▪ possibly faster technical understanding in continuing education 	<ul style="list-style-type: none"> ▪ loss of synergy and efficiency in clinical conference preparation and board preparation (redundant supervision) ▪ risk of “departmental self-interest” ▪ more difficult to get an overview of patient care as a whole ▪ limitation of personnel development ▪ exchange of knowledge between different departments sometimes difficult ▪ vulnerable in the case of personnel shortages
subspecialized radiology		
<ul style="list-style-type: none"> ▪ only supervisor level/specialists 	<ul style="list-style-type: none"> ▪ more targeted patient care ▪ higher report quality ▪ increase in specialized know-how ▪ efficient board preparation ▪ greater personnel development ▪ flexible, cross-section coverage in the case of personnel shortages ▪ better incorporation of part-time staff 	<ul style="list-style-type: none"> ▪ greater coordination effort <ul style="list-style-type: none"> – personnel scheduling – equipment staffing through additional planning of an “equipment floater/libero” ▪ risk of tunnel vision (loss of overview) ▪ risk of loss of know-how in the case of personnel fluctuations (when residents are not involved)
<ul style="list-style-type: none"> ▪ incorporation of residents 	<ul style="list-style-type: none"> ▪ inclusion of board preparation ▪ networked learning ▪ early contact with “advanced” imaging (e. g., MRI) ▪ simple specialized exchange ▪ reduced loss of know-how in the case of personnel fluctuations among specialists 	<ul style="list-style-type: none"> ▪ challenge regarding rotation curriculum for timely achievement of professional readiness ▪ reduced equipment and technician contact (possible solution: regular assignment as equipment floater/libero)

relevant advantages. Restructuring does not represent fundamental demands for further subspecialization designations analogous to pediatric radiology and neuroradiology but rather highlights the necessity for a subspecialization-based education structure during the process of becoming a specialist.

In-depth knowledge of highly complex technical devices and physical principles is an essential component of specialist training. To ensure this knowledge, the Regulation on Continuing Education requires proof of a minimum number of examinations in the particular modality per body region, e. g., via DICOM or RIS search for examinations in the relevant team rotation. An important aspect of this is regular assignment to the equipment as an equipment floater. The revision of a structured Regulation on Continuing Education and preparation to become a specialist must be performed on a method and content basis. Restructuring and innovative specialist training ultimately also contribute to the sustainability of knowledge production in that the teams function as “clusters of knowledge” and counteract loss of knowledge due to personnel fluctuations. Their function as incubators for internal radiology and interdisciplinary questions and science projects complement the concept of integrative education.

Challenges and limitations

The occasionally political discussions regarding subspecialization are not new and include diverse advantages and disadvantages. ► **Table 1** shows possible aspects and limitations in the practical daily routine. In contrast to smaller hospitals, large university clinics have easier access to multiple specialists. In addition, not every subspecialization can be covered by a subspecialized radiologist for the entire daily routine or at night or on the weekend. There needs to be coverage also in the case of illness, vacation, and continuing education and substitutions must be taken into consideration in education as well as in the assignment of personnel. On the whole, this can result in greater personnel requirements in the case of subspecialized structuring. However, part-time employees can be more easily incorporated into a subspecialized work structure than into a full-time scanner-based system. However, personal interests and excessive specialization may conflict with a change in work site. Greater coordination effort runs the risk of slowing the workflow. In contrast to the increase in efficiency discussed above, the study by Meyl et al. reported a higher report turnaround time [21]. Specialization is associated with a decrease in the broad radiology spectrum, which is supported by modality-based structuring. This should be taken into consideration particularly in education and in rotation programs.

Summary

Modern restructuring of hospital radiology departments is facing the growing demands on traditional technically organized radiology departments regarding the complexity of referring medicine, subspecialization pressure (including in certified boards), and personnel efficiency. To succeed in competitive areas of specialization, radiology must work more closely with referring physicians and be an integral consultant and clinical partner far beyond purely radiological knowledge.

Implementation is successful when the service focus and requirements in radiology are congruent with those of clinical partners. Strategic planning requires precise analysis of the associated process steps, resources, and personal qualifications. Ensuring completeness and adjusting personnel planning, substitutions, and education are the greatest challenges here. A paradigm shift to proactive radiology offers great potential for increasing quality and efficiency in hospitals.

Conflict of Interest

The authors declare that they have no conflict of interest.

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