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# The Role of Radiological Technologists in Advancing Precision Medicine within Diagnostic Imaging

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**ABSTRACT**

**Introduction:** Precision medicine is a new treatment model for medical conditions that takes into account the individual genetic and environmental characteristics. As for imaging, it is an integral part of screening, early detection, defining a therapeutic strategy, and evaluation of the tumour relapse.

**Aim of work:** To explore the role of radiological technologists in advancing precision medicine within diagnostic imaging.

**Methods:** We conducted a comprehensive search in the MEDLINE database's electronic literature using the following search terms: Role, Radiological, Technologist, Advancing, Precision, Medicine, and Diagnostic Imaging.The search was restricted to publications from 2016to 2024 in order to locate relevant content. We performed a search on Google Scholar to locate and examine academic papers that pertain to my subject matter. The selection of articles was impacted by certain criteria for inclusion.

**Results:** The publications analyzed in this study encompassed from 2016 to 2024. The study was structured into various sections with specific headings in the discussion section.

**Conclusion:**In conclusion, radiological technologists play a crucial role in the advancement of precision medicine within diagnostic imaging, yet they face numerous challenges as they adapt to this new paradigm. Addressing these challenges requires ongoing education, advanced training, enhanced communication skills, and an understanding of ethical principles, along with institutional support to ensure adequate resources and manageable workloads. By tackling these challenges, radiological technologists can continue to contribute significantly to the precision medicine model, helping to improve patient care through personalized and accurate diagnostics.

**Keywords:** Role, Radiological, Technologist, Advancing, Precision, Medicine, Diagnostic Imaging

## INTRODUCTION

Precision medicine has quickly evolved over the last couple of years as one of the significant approaches in rendering health solutions. This model is founded on genomics, environment, and lifestyle biomarkers to prescript treatment to patients notably in oncohematology, neurology, and cardiothoracic surgery (Iriart, 2019). Imaging plays a central role in precision medicine it is used exclusively to decipher complex anatomical and functional information essential in developing individualized therapy. In this regard, radiological technologists go beyond taking perfect images but also incorporate new imaging techniques and methods that improve diagnostic accuracy and treatment (Lastrucci et al., 2020).

Some twenty years ago, radiological technologists ran machines that performed imaging and then acquired high-quality images in this process; today, they lead research in the underlying technological solutions that enable precision medicine. These professionals are colleagues of radiologists, using imaging methods, such as MRI, CT, and PET, that help to contribute to a highly specialized diagnosis and interventions (Thorogood, 2021). In this era of patient-centered medical practice, radiological technologists are increasingly assuming tasks in data handling, teamwork, and being accountable to professional and organizational ethical principles. The present work aims to analyze how radiological technologists contribute to the development of precision medicine, including technological, educational, and ethical considerations in diagnostic imaging.

### Aim Of Work

To explore the role of radiological technologists in advancing precision medicine within diagnostic imaging

## METHODS

A comprehensive search was conducted on recognized scientific platforms, including Google Scholar and Pubmed, using specific keywords such as Role, Radiological, Technologist, Advancing, Precision, Medicine, and Diagnostic Imaging. The aim was to gather all relevant research papers. The articles were chosen according to certain criteria. Upon conducting a comprehensive analysis of the abstracts and notable titles of each publication, we eliminated case reports, duplicate articles, and publications without full information. The reviews included in this research were published from 2016 to 2024.

## RESULTS

The current investigation concentrated on the role of radiological technologists in advancing precision medicine within diagnostic imagingbetween 2016 and 2024. As a result, the review was published under many headlines in the discussion area, including:Understanding Precision Medicine in Diagnostic Imaging, Roles and Responsibilities of Radiological Technologists in Precision Medicine and Challenges Faced by Radiological Technologists in Precision Medicine.

## DISCUSSION

- **Understanding Precision Medicine in Diagnostic Imaging**

Precision medicine is a proactive, patient-specific model of medicine that seeks to customize medical treatments according to genetic makeup, performance data, and other patient characteristics (Pandey & Gupta, 2024). Whereas conventional medicine operates by treating all patients similarly, precision medicine attempts to focus on the individual particulars of the patient to maximize the success rate of the given course of treatment and to eliminate or reduce the side effects. This approach has quickly gained popularity across numerous medical specializations, of which the personalization of treatments is vital, especially in oncology, cardiology, and neurology. An essential element of precision medicine is diagnostics with the help of imaging, which helps the clinician obtain valuable information about a patient's structure and functions of the body and, thus, more accurately examine the patient and design an appropriate therapy (Kosorok&Laber, 2019).

Radiology, which can be sub-divided into MRI, CT scan, PET scan, and ultrasound, all play critical roles in precision medicine (Shaikh, 2022). These imaging techniques are safe and help the providers visualize a disease's internal structures and functions at the individual level without invasive procedures. For instance in oncological patient, imaging is employed to detect or identify the tumor, and to define some characteristic features e.g., vascularity or metabolic rate of the cancer that can influence the management of the condition. Two other modern techniques known as functional magnetic resonance imaging (fMRI) and molecular imaging are other additions to the concept of precision medicine since, as they work, provide images that capture physiological and cellular aspects that need exhaustive mapping for comprehensive treatment (Ghasemi et al., 2016).

Diagnostic imaging is also used in the creation of tiers within precision medicine according to the distribution of diseases which characterize different communities of patients. This stratification process is more important in cancer care delivery as the treatment outcomes may vary dependant on the molecular characteristics of the tumour (Giardino et al., 2017). Apart from molecular and genetic information, functional imaging aids the clinician to describe the disease state and prognosis to intervention. For instance in breast cancer, MRI and PET scans when used along with genomic profiling to identify the individuals that will benefit from certain chemotherapy or immunotherapy regimen or may not need any treatment at all improves the efficiency of treatment plan for the patient while reducing the unnecessary exposure (Pinker et al., 2018).

Applying precision medicine in diagnostic imaging has benefitted from innovation in artificial intelligence and machine learning in interpreting images. GIS in AI is also efficient as it can answer complex questions based on large sets of imaging data; it can also discover patterns and irregularities that the naked eye cannot observe, which adds extra layers of decision-making to the doctor (Ahmed et al., 2020). They also enable radiologists and radiological technologists to analyze the imaging data, bringing out fewer diagnosis errors and timely decision-making errors.

Nevertheless, the delivery of precision medicine along with diagnostic imaging is subject to challenges. Radiological technologists need the proper knowledge to utilize the latest imaging equipment and software to obtain and analyze precise imaging results. Furthermore, as imaging is integrated with the patient's data factors, data protection, security, and ethical concerns receive more attention. Nevertheless, introducing precision medicine to diagnostic imaging can enhance efficacy in patient care (Jules et al., 2024).

In conclusion, precision medicine together with help of diagnostic imaging is bringing transformations in healthcare systems. Diagnostic imaging improves not only diagnostic and discriminative capabilities for various diseases but also forms the cornerstone of the differentiation and management of individual treatments. Given that, as technologies advance, there is improvement in imaging technologies, diagnostic imaging continues to expand its contribution to precision medicine that the future of medical treatment will be far more individualized and efficient.

- **Roles and Responsibilities of Radiological Technologists in Precision Medicine**

It is crucial to understand how radiological technologists consist of the cornerstone in applying precision medicine in diagnosing imaging. They have increased with evolution in imaging technique and callback to patient center metrics. Today, these professionals not only operate imaging equipment but also contribute directly to the precision and quality of imaging, collaborate with multidisciplinary healthcare teams, and apply ethical considerations crucial for handling sensitive patient data(Lastrucci et al., 2024).

**1. Ensuring High-Quality Data Acquisition**

In precision medicine, it is critical to acquire diagnosis information with high accuracy and reliability because the treatment plans are uniquely tailored to the data about the patients. Radiological technologists capture the best quality images by applying professional technical experience in handling sophisticated imaging devices, including MRI, CT, and PET (Alsubaiei et al., 2023). They effectively position patients, set up contrast and other imaging parameters, and apply case-specific protocols that directly feed into generating the precise images on which precision medicine must rely (Lambin et al., 2017).

Other vital aspects that technologists pay attention to include the contrast volume, exposure to radiation, and the resolution of images required to produce illustrations that would be conclusive without exposing the patients to likely health dangers. This duty is particularly crucial in pediatric and oncology imaging, where the exact imaging data is needed to detect disease processes or responses to therapy, and the doses of radiation should be kept as low as possible (Lambin et al., 2017).

**2. Image-Guided Interventions and Supporting Targeted Treatments**

As interventional radiology techniques with enhanced, minimal invasiveness, image-guided procedures, radiological technologists play an active role in procedures like biopsies, ablations, and deliveries of targeted drugs into body-specific areas. These procedures frequently involve image capture in real-time, and the technologists need to exercise precision when using the imaging equipment to direct physicians. For instance, radiological technologists assist in targeting and tracking tumors necessary for oncology interventional therapies by offering the possibility to hit malignant tissue while sparing the healthy one accurately (Baumann et al., 2016).

Technologists also need to know various conditions for imaging modalities and distinguish such fine details of anatomy so they can assist physicians during procedures. As application of real-time imaging equipment to deliver these specific therapies significantly affects their outcomes, the skills of these specialists are crucial to precision medicine (Khan, 2023).

**3. Collaboration with Multidisciplinary Teams**

Both diagnostics and therapies in PM tend to involve cross-sectional teams of highly specialized experts such as radiologists, oncologists, surgeons, and geneticists. Radiological technologists collaborate with these professionals to ensure the coordination of imaging data with other parameters, including genetic and molecular data. They assist in developing effective imaging reports and sufficiently comprehending the peer's clinical requirements and thus contribute to developing diagnostic reports that construct the diagnostic strategies or plans of treatment (Krzyszczyk et al., 2018).

They help in precise imaging requirement intendment to overall patient data, making them part of precision medicine. In this collaborative role, the radiological technologists also contribute to multidisciplinary meetings to share the findings and imaging and conquer the divide between the imaging department and the clinical team (Martín-Noguerol et al., 2021).

**4. Adapting to and Leveraging Advanced Imaging Technologies**

Professionals in diagnostic imaging, for instance, apply AI technology in the field, and the radiological technologist has to use the technology. Applications of AI in imaging help to identify patterns, improve image quality, and even make prognoses concerning further developments of diseases. Radiological technologists are expected to operate and understand this technology in the patient's best interest (Towbin et al., 2017).

He added that most of these tools support semi-automated analysis of extensive imaging data to minimize workload and increase diagnostic productivity. This has made radiological technologists required to undertake continued education to master these complex technologies and help in the evaluation process of diagnosis results produced by artificial intelligence. According to Marques, their skills guarantee the accuracy and practical relevance of the imaging-supported AI components, which will remain crucial in precision medicine (Marques, 2024).

**5. Upholding Ethical Standards and Ensuring Patient Safety**

Radiological technologist are major players in diagnostic imagining that have gained more importance in precision medicine, the role of the technologist is therefore going to be more important regarding

professionalism especially on issues of patient's information privacy, radiations, and other information security concerns.Diagnostic imaging in precision medicine entails integration of imaging data with genetic and other personal health information, putting radiological technologists under pressure to follow confidentiality and data security measures (Jhonson& Smith, 2023).

They are also useful in reducing patient's exposure to radiation in all the situations which may require serial imaging. Technologists have the responsibility of changing the techniques in order to minimize irradiation while offering the appropriate picture results for diagnoses. Additionally, they involve the patient in informed conversation and offer the patient adequate information on imaging in general, risks involved and the specifics of accurate imaging that is required in the determination of their treatment plans and strategies(Shui et al., 2021).

In conclusion, radiological technologists are the professionals who have a promising and evolving task for promoting the concept of PPM through imaging. Far from a mere technical management of instruments of the physical environment, they are also qualified to manage quality data, provide procedural support in immediate care, foster inter-professional relationships, adapt to changes in technology and practice professional ethical responsibility with patients. Based on the current development of precision medicine, radiological technologist is poised to perform other capacities to enhance their significance for delivering precise and specific patient care.

- **Challenges Faced by Radiological Technologists in Precision Medicine**

The role of radiological technologists in precision medicine presents several unique challenges. As precision medicine advances, these professionals adapt to new technologies, maintain high image quality standards, ensure patient safety, and navigate complex ethical and data privacy concerns. The following outlines vital challenges radiological technologists face within the evolving landscape of precision medicine (Ibrahim et al., 2021).

**1. Need for Advanced Education and Specialized Training**

Precision medicine specification and implementation requires the application of essential technologies that include; functional MRI, PET-CT, and molecular imaging. These require core skills and maximum understanding of best practice imaging techniques. Under current developments, radiological technologists must ensure adequate knowledge of the latest equipment, imaging methods, and analytical tools. This need for technical knowledge raises the demand for continual training and higher certifications (Baumann et al., 2016). Nevertheless, to achieve that, it is often difficult to find time for enhanced training during work, especially considering how quickly technology advances, necessitating constant updates to the acquired skills. Moreover, the professionals may occasionally need more funds or time to attend classes that would enable them to update themselves (Gallegos, 2019).

**2. Balancing Image Quality with Radiation Dose Optimization**

Another goal of the concept of precision medicine is to reduce health risks that are as beneficial for diagnostics. For radiological technologists, this tends to imply a need to ensure good image quality while minimizing radiation dose, especially in cases of young patients and cancer patients where imaging is more likely to be repeated. While having to adapt specific procedures to achieve diagnostic efficiency without exposing patients to unneeded radiation, there can be technical considerations and some fundamental understanding of how dose minimization and control work is needed (Jebur et al., 2024). Occasionally, increasing the image resolution and reducing the irradiation dose is difficult because of technical constraints or patients' conditions. This balance cannot be achieved without sound judgment, pin-point accuracy, and knowledge of the radiation parameters for each imaging mode (Agadakos, 2024).

**3. Ethical and Data Privacy Concerns**

Precision medicine is accompanied by imaging data on highly personal data such as gene and molecular information to establish an individualized treatment plan. This information is frequently stored in linked databases and available in different departments and organizations. Thus, one of the significant challenges is patient identity protection. Since imaging records form part of large data sets that are increasingly frequently stored on distant servers or clouds, radiological technologists are responsible for data protection and compliance with confidentiality requirements(Pesapane& Summers, 2024).

Nevertheless, radiological technologists experience ethical dilemmas concerning informed consent, especially if imaging applies new techniques or if images are used in research. They have to make sure that a patient is aware of what imaging involves the potential consequences of the process, and all possible implications, especially if the patient data may end up being used for other purposes such as research. This calls for good communication and knowledge of the ethical standards to uphold the patient-technologist relationship (Younger et al., 2020).

**4. Adapting to Rapid Technological Advancements**

The application of artificial intelligence and machine learning in diagnostic imaging is reinventing precision medicine. In SM, these technologies help in image processing to recognize the patterns that cannot be easily GA, as well as in predictive analysis. Nonetheless, the shift toward web-based AI tools poses multiple complex tasks for radiological technologists now deciphering AI-enhanced data and incorporating it into treatment. Often, the output generated by AI systems is entirely opaque, with no means for technologists to quickly assess or even trust the result they are being given (Sahu et al., 2022).

Furthermore, data management and image analysis skills need to be taught in or beyond the remit of traditional radiology. A shift in basic practices of managing medical imaging technologies is essential. However, radiological technologists need time to train themselves on these matters and apply changes in practice that put patient care at the forefront (Najjar, 2023).

**5. Workload and Time Constraints**

The precision medicine approach often calls for intricate, patient-specific imaging regimens that take more time and effort than conventional treatments. Radiological technicians may experience increased workload and time pressure due to this change, particularly in imaging facilities with high throughput. Technologists may need to devote more time to precision medicine-related duties, including processing large amounts of imaging data, creating unique procedures, and carrying out exacting quality checks. When combined with a lack of radiology workers, these expectations may cause stress, burnout, and even mistakes, especially in hectic clinical settings (Shubayr et al., 2017).

**6. Inter-Professional Collaboration and Communication**

Collaboration between diverse healthcare professionals, such as radiologists, oncologists, geneticists, and primary care physicians, is essential to precision medicine. Radiological technicians must interact with these professions to correctly translate complicated imaging data into clinically valuable insights. Technologists working in this collaborative setting must possess excellent interpersonal and communication skills and the capacity to comprehend different viewpoints within the healthcare team (Qian et al., 2023). It may be challenging to manage these relationships, especially when treatment choices need immediate imaging findings under pressure.

## CONCLUSION

Precision medicine is a medical model used to treat patients and targets specific and personalized data of patients, including genomic makeup, lifestyle, and the environment. It has been adopted in different specialties, emphasizing oncology, cardiology, and neurology. MRI, CT, PET, and Ultrasound are invasive imaging techniques that provide efficient diagnostic analysis and tailored treatment strategies in the drug development processes. New artificial intelligence and machine learning technologies improve image analysis so radiologists and technologists can analyze and interpret data better.

Radiological technologists participate in precision medicine and diagnostic imaging technology precision, including AI and machine learning. These tools assist in perceiving repeat patterns and image improvement, as well as sifting and gauging upcoming stages of diseases. Knowing this, they have to relate to these technologies to optimize the benefits of the related applications for patient care. Radiological technologists need further professional development to remain knowledgeable of such technologies and to assess artificial intelligence results. They also receive more pressure as the guardians of ethical principles among healthcare facilities, especially concerning patients' rights to privacy and confidentiality of their data, protection from access to patient's personal information, and radiation dangers. Radiographers must, therefore, strike a delicate balance between obtaining good picture quality and minimizing the radiation dose that patients are exposed to, which is effective for diagnosis. Ethical and data privacy questions are questioned because imaging data contains patient-specific data. In particular, fast-growing technological developments in the healthcare system challenge the profession because radiological technologists need never lose sight of the patient. They also have to deal with carga and time since most of the processes in precision medicine are less streamlined and more time-consuming than routine ones. Another requirement of precision medicine is the capacity to interact with other professionals involved in the process since they have to exchange information with other healthcare workers.

## REFERNCES

1. Agadakos, M. E. T. (2024). Optimizing CT Protocols: Advanced Dose Reduction and Contrast Media Strategies for Personalized Patient Care–Today's Innovations and Tomorrow's Horizons. Journal of Medical Imaging and Radiation Sciences, 55(3), 101456.
2. Ahmed, Z., Mohamed, K., Zeeshan, S., & Dong, X. (2020). Artificial intelligence with multi-functional machine learning platform development for better healthcare and precision medicine. Database, 2020, baaa010.

3. Alsubaiei, N. K. M., Almalki, F. R. M., Almutairi, T. R., Al Sharyah, S. H. A., Al Sharyah, H. S. F., Al Juraib, M. H. M., ... &Jali, H. M. A. (2023). Advancements In Imaging Technology: Revolutionizing Radiology Practice. Journal of Namibian Studies: History Politics Culture, 36, 1953-1965.
4. Baumann, M., Krause, M., Overgaard, J., Debus, J., Bentzen, S. M., Daartz, J., ... &Bortfeld, T. (2016). Radiation oncology in the era of precision medicine. Nature Reviews Cancer, 16(4), 234-249.
5. Gallegos, M. S. (2019). Certified Radiology Technologists: Perceptions regarding Learning Modalities for Continuing Education Courses (Doctoral dissertation, Alliant International University).
6. Ghasemi, M., Nabipour, I., Omrani, A., Alipour, Z., &Assadi, M. (2016). Precision medicine and molecular imaging: new targeted approaches toward cancer therapeutic and diagnosis. American journal of nuclear medicine and molecular imaging, 6(6), 310.
7. Giardino, A., Gupta, S., Olson, E., Sepulveda, K., Lenchik, L., Ivanidze, J., ... &Ganeshan, D. (2017). Role of imaging in the era of precision medicine. Academic radiology, 24(5), 639-649.
8. Ibrahim, A., Primakov, S., Beuque, M., Woodruff, H. C., Halilaj, I., Wu, G., ... &Lambin, P. (2021). Radiomics for precision medicine: Current challenges, future prospects, and the proposal of a new framework. Methods, 188, 20-29.
9. Iriart, J. A. B. (2019). Precision medicine/personalized medicine: a critical analysis of movements in the transformation of biomedicine in the early 21st century. Cadernos de saúdepublica, 35, e00153118.
10. Jebur, S. A., kadhim Mohammed, S., &Shalal, L. A. (2024). OPTIMIZATION OF RADIATION DOSE IN MEDICAL IMAGING: BALANCING IMAGE QUALITY AND PATIENT SAFETY. EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE, 4(10), 5-24.
11. Jhonson, D., & Smith, J. (2023). Upholding Ethics in Medical Science: a Critical Examination of Progress and Patient Safety (No. 11541). EasyChair.
12. JULES, M., LUHARIA, A., &DAHAkE, S. (2024). Role of Radiotherapy Technologists in Clinical Radiation Therapy Practices: A Comprehensive Review. Journal of Clinical & Diagnostic Research, 18(8).
13. Khan, I. (2023). Radiology in Emergency Situations: Diagnosing and Managing Critical Cases.
14. Kosorok, M. R., &Laber, E. B. (2019). Precision medicine. Annual review of statistics and its application, 6(1), 263-286.
15. Krzyszczyk, P., Acevedo, A., Davidoff, E. J., Timmins, L. M., Marrero-Berrios, I., Patel, M., ... &Yarmush, M. L. (2018). The growing role of precision and personalized medicine for cancer treatment. Technology, 6(03n04), 79-100.
16. Lambin, P., Leijenaar, R. T., Deist, T. M., Peerlings, J., De Jong, E. E., Van Timmeren, J., ... & Walsh, S. (2017). Radiomics: the bridge between medical imaging and personalized medicine. Nature reviews Clinical oncology, 14(12), 749-762.
17. Lastrucci, A., Wandael, Y., Barra, A., Miele, V., Ricci, R., Livi, L., ... &Giansanti, D. (2024). Precision Metrics: A Narrative Review on Unlocking the Power of KPIs in Radiology for Enhanced Precision Medicine. Journal of Personalized Medicine, 14(9), 963.
18. Marques, O. (2024). AI for Radiology. CRC Press.
19. Martín-Noguerol, T., Paulano-Godino, F., López-Ortega, R., Górriz, J. M., Riascos, R. F., & Luna, A. (2021). Artificial intelligence in radiology: relevance of collaborative work between radiologists and engineers for building a multidisciplinary team. Clinical radiology, 76(5), 317-324.
20. Najjar, R. (2023). Redefining radiology: a review of artificial intelligence integration in medical imaging. Diagnostics, 13(17), 2760.
21. Pandey, A., & Gupta, S. P. (2024). Personalized Medicine:(A Comprehensive Review). Oriental Journal of Chemistry, 40(4).
22. Pesapane, F., & Summers, P. (2024). Ethics and regulations for AI in radiology. In Artificial Intelligence for Medicine (pp. 179-192). Academic Press.
23. Pinker, K., Chin, J., Melsaether, A. N., Morris, E. A., & Moy, L. (2018). Precision medicine and radiogenomics in breast cancer: new approaches toward diagnosis and treatment. Radiology, 287(3), 732-747.
24. Qian, M., Zhan, Y., Ji, L., & Cheng, Y. (2023). Strategy on precision medicine multidisciplinary team in clinical practice. Clinical and Translational Discovery, 3(4), e217.
25. Sahu, M., Gupta, R., Ambasta, R. K., & Kumar, P. (2022). Artificial intelligence and machine learning in precision medicine: A paradigm shift in big data analysis. Progress in molecular biology and translational science, 190(1), 57-100.
26. Shaikh, S. (2022). Advances in Imaging: Step Towards Precision Medicine. Springer Nature.
27. Shubayr, N., Faraj, H., Hurbush, M., Khormi, M., Alyami, A., Majrashi, N., &Alomairy, N. (2022). Assessment of job satisfaction, lifestyle behaviors, and occupational burnout symptoms during the COVID-19 pandemic among radiologic technologists in Saudi Arabia. Radiography, 28(4), 1087-1092.

28. Shui, L., Ren, H., Yang, X., Li, J., Chen, Z., Yi, C., ... &Shui, P. (2021). The era of radiogenomics in precision medicine: an emerging approach to support diagnosis, treatment decisions, and prognostication in oncology. Frontiers in Oncology, 10, 570465.
29. Thorogood, J. (2021). Out of the Darkroom and Into the Dark: The Experiences of Medical Imaging Technologists Regarding the Introduction and Ongoing Use of New Technology (Doctoral dissertation, Auckland University of Technology).
30. Towbin, A. J., Perry, L. A., & Larson, D. B. (2017). Improving efficiency in the radiology department. Pediatric Radiology, 47, 783-792.
31. Younger, C. W. E., Douglas, C., & Warren-Forward, H. (2020). Informed consent guidelines for ionising radiation examinations: A Delphi study. Radiography, 26(1), 63-70.