

From Complex to Clear: The Role of Readability in Radiology Reports and Crisis Management

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Abstract

Radiology reporting serves as a vital communication bridge between radiologists, clinicians, and patients, underpinning diagnostic and treatment decisions. With the growing emphasis on patient-centered care, there is an increasing need to make radiology reports more accessible and understandable for non-specialist audiences, including patients. Regulatory advancements, such as open access to medical records, have further underscored the importance of enhancing report readability. Simultaneously, the global healthcare landscape demands radiology practices that can adapt to crises, such as pandemics or mass casualty events, where clear, timely, and actionable reporting becomes critical for effective management. This literature review examines the intersection of these dual challenges—enhancing readability and improving crisis response—within the context of patient-centered care. It explores strategies for simplifying technical language without compromising clinical precision, the integration of multimedia elements, and the use of structured reporting formats. Additionally, key challenges, including the need for standardized practices, cultural competence, and the incorporation of artificial intelligence (AI) for personalized communication, are discussed. Finally, we highlight strategies for overcoming these barriers, such as adopting structured reporting systems, and leveraging AI tools.

Introduction

Radiology reports play a pivotal role in diagnosis, treatment planning, and patient outcomes. Traditionally, these reports were tailored exclusively for healthcare providers, often laden with medical jargon and inaccessible to patients. However, the paradigm shift toward patient-centered care has redefined the expectations for radiology reporting. Radiology reports must now cater to a broader audience, including referring physicians who require detailed clinical information for diagnosis and treatment planning, patients who need simplified, jargon-free explanations of their imaging results, non-specialist providers such as primary care physicians or nurse practitioners, who may require intermediate levels of detail (**Hartung et al., 2020**).

Radiology reports are written primarily for referring physicians and other healthcare providers, but patients and their family members are interested to read their radiology reports through electronic health record (EHR) “patient portals”, and do so with increasing frequency (**Petrovskaya et al., 2023**). Although radiology reports may help patients enhance the understanding of their care and achieve better health outcomes, patients cite lengthy reports and overly technical terms as barriers to comprehension (**Trofimova et al., 2018**). Readability indices provide objective metrics that can serve as a starting point for quality improvement efforts (**Martin-Carreras et al., 2019**). The movement toward enhancing readability in radiology reports arises from growing evidence that patients desire greater understanding of their

medical conditions and the implications of diagnostic findings. Studies have demonstrated that well-structured and patient-friendly reports can enhance patient comprehension, reduce anxiety, and foster shared decision-making (**Mityul et al., 2018**). This evolution aligns with the principles of health literacy, which prioritize clear and actionable communication in healthcare. Concurrently, the role of radiologists in crisis management—such as communicating unexpected findings, including critical diagnoses—has gained prominence. Effective reporting in these scenarios demands not only precision but also sensitivity, as poorly communicated results can lead to confusion, mistrust, or legal implications (Makary and Daniel, 2016). Recent initiatives have emphasized the importance of radiology as a discipline not just of imaging but also of communication, advocating for structured reporting systems, lay summaries, and advanced digital tools to bridge gaps in understanding (**Nobel et al., 2022**).

Looking to the future, the convergence of technological innovation, standardized practices, and a patient-centered ethos offers an opportunity to reimagine radiology reporting. The integration of artificial intelligence (AI) into radiology has already begun to revolutionize workflows, offering tools for enhanced image analysis, automated report generation, and personalized communication. AI-assisted reporting systems promise not only to improve diagnostic accuracy but also to tailor information to diverse audiences, including referring physicians and patients, fostering greater engagement and understanding (**Pesapane et al., 2018; Hosny et al., 2018**).

Standardization, another cornerstone of the future, is crucial for ensuring consistency and clarity in radiology reports. Organizations like the Radiological Society of North America (RSNA) have advocated for structured reporting templates, which provide uniformity in how findings are documented and communicated. These templates can be augmented with user-friendly features, such as hyperlinks to explanatory content, visual aids, and layperson summaries, ensuring accessibility for patients with varying levels of health literacy (**Langlotz, 2015**). Standardized practices, coupled with technological advances, can also support global outreach by enabling the seamless exchange of radiological expertise and reports across borders, addressing disparities in healthcare access and quality. A patient-centered ethos remains central to these innovations, demanding that radiology reports evolve to empower patients as active participants in their care. Initiatives to include lay summaries and visual tools like annotated images have shown promise in improving comprehension and reducing the anxiety associated with medical imaging results (**Epstein et al., 2017**). Additionally, training radiologists in effective communication and cultural competence is essential to bridging gaps in understanding and fostering trust, particularly in diverse and underserved populations.

Crisis management remains a critical component of radiology reporting, particularly in scenarios involving unexpected findings or life-threatening diagnoses. Proper crisis management requires a balance between technical accuracy and empathetic delivery, ensuring that both healthcare providers and patients receive clear and actionable information. Structured reporting systems play a pivotal role in these situations by streamlining the communication of critical results, reducing variability in reporting practices, and minimizing the risk of miscommunication (**Kahn et al., 2013**). Furthermore, incorporating standardized terminology and prioritization protocols, such as the ACR's RADPEER program, can help radiologists convey the urgency of findings effectively while maintaining consistency across institutions (**Jackson et al., 2009**). Advances in digital platforms and real-time alerts have further enhanced crisis communication, enabling rapid dissemination of critical findings to multidisciplinary teams.

This literature review explores the intersection of radiology reporting with patient-centered care, focusing on enhancing readability and addressing challenges in crisis communication. By

synthesizing recent evidence and recommendations, this review aims to highlight strategies for improving report clarity, promoting patient engagement, and ensuring effective management of critical findings in an evolving healthcare landscape.

1. The Evolution of Radiology Reporting

Radiology reporting has undergone significant transformations since the early 20th century. Initially, reports were simple narratives intended to communicate findings to referring physicians. These early reports were unstructured and heavily reliant on the expertise of the radiologist, who would craft descriptive accounts based on their interpretation of radiographic images. While this approach allowed flexibility, it often resulted in variability, ambiguity, and missing critical details, leading to misinterpretations by referring physicians **(Reiner et al., 2007)**. The lack of standardization became increasingly problematic as radiology expanded to encompass a wide range of imaging modalities such as X-rays, CT scans, MRIs, and ultrasounds. Organizations like the ACR (American College of Radiology), ESUR (European Society of Urogenital Radiology), RSNA (Radiological Society of North America), and ESR (European Society of Radiology) have made significant strides in enhancing radiological practice by introducing standardized reporting systems, templates, and collaborative platforms **(Pesapane et al., 2023)**. These initiatives aim to ensure consistency in radiology reports, improve communication among healthcare professionals, and facilitate better clinical decision-making. However, challenges persist in seamlessly integrating these systems into existing workflows. Variability in language, reporting formats, and regional practices often complicates adoption, while the need for extensive validation to ensure accuracy and reliability remains a critical barrier. Addressing these issues is essential to realizing the full potential of standardized reporting in radiology **(Marcovici & Taylor, 2014)**.

2. Impact of Technological Advancements

Technological innovation has played a pivotal role in the evolution of radiology reporting. Picture Archiving and Communication Systems (PACS), introduced in the 1980s, revolutionized the storage, retrieval, and sharing of radiological images and reports **(Andriole, 2023)**. Radiologists could now seamlessly integrate imaging data with electronic health records (EHRs), enabling real-time access to patient information. PACS reduced reliance on physical film, which was cumbersome to store and share, and allowed for more efficient reporting workflows **(Hood & Scott, 2006)**.

Voice recognition software, such as Dragon Medical, streamlined the reporting process by allowing radiologists to dictate findings directly into the system, saving time compared to manual typing. Coupled with NLP, this technology has facilitated automated generation of structured reports and highlighted inconsistencies or omissions in narratives **(Rana et al., 2005)**. Voice recognition software, like Dragon Medical, has revolutionized radiological reporting by enabling radiologists to dictate their findings directly into reporting systems, bypassing the slower process of manual typing. This not only speeds up the documentation process but also allows radiologists to focus more on interpreting imaging studies rather than administrative tasks. When integrated with Natural Language Processing (NLP), this technology takes efficiency a step further. NLP algorithms analyze the dictated narrative in real-time, identifying key clinical terms, standardizing terminology, and generating structured, template-based reports automatically. For example, if a radiologist describes a lesion's size, location, and characteristics, NLP can organize this information into a structured format suitable for standardized reporting systems **(Pereira et al., 2024)**. Moreover, NLP can detect inconsistencies or omissions within the dictated findings, prompting the radiologist to provide clarifications or add missing

information before finalizing the report. For instance, if a narrative mentions a suspicious lesion but omits the recommendation for follow-up imaging, the system might flag this omission. Such features not only enhance the completeness and clarity of reports but also improve the quality of communication with referring physicians. As these tools evolve, they increasingly contribute to better workflow efficiency, reduced errors, and greater uniformity in radiological reporting practices **(Banerjee et al., 2023)**.

Artificial Intelligence (AI) has emerged as a transformative tool in radiology, significantly enhancing both the efficiency and accuracy of reporting processes. AI algorithms are trained to analyze medical images such as X-rays, CT scans, and MRIs, automatically detecting abnormalities like nodules, fractures, or vascular anomalies **(Hosny et al., 2018)**. By employing deep learning techniques, these algorithms can identify patterns and subtle findings that might be challenging for the human eye, particularly in high-volume or time-sensitive settings. For example, AI systems can flag suspicious lung nodules on a chest CT or detect microfractures in a wrist X-ray, drawing the radiologist's attention to areas that need closer review **(Chiu et al., 2022)**. Some advanced AI systems go further by generating preliminary reports based on their analysis. These reports include key findings, measurements, and even suggested diagnoses, providing radiologists with a starting point for their final interpretation. This capability is especially beneficial for high-priority or emergency cases, such as suspected strokes or acute trauma, where rapid diagnosis and reporting can significantly impact patient outcomes **(Najjar, 2023)**. For instance, in stroke imaging, AI can identify ischemic changes or large vessel occlusions within minutes, expediting the treatment decision-making process **(Zebrowitz et al., 2024; Kagiya et al., 2019)**.

Modern reporting incorporates multimedia, such as annotated images and 3D reconstructions. These additions provide visual aids that improve comprehension for clinicians and patients alike, especially for complex diagnoses. 3D and 4D reconstructions derived from imaging modalities like CT or MRI take this further by providing a more comprehensive view of anatomical structures. These models can rotate and zoom, enabling clinicians to visualize complex spatial relationships, such as the proximity of a tumor to surrounding vessels or organs **(Blum et al., 2020)**. For example, in pre-surgical planning, a 3D model of a kidney tumor can help surgeons assess the best approach to excision while preserving vital structures **(Wake et al., 2017)**. Similarly, for orthopedic cases, 3D reconstructions of fractures offer a more intuitive understanding of the alignment and severity of the injury than traditional 2D images **(Liu et al., 2024)**. Incorporating multimedia also enhances communication with patients, particularly for explaining complex diagnoses. Visual aids can bridge the gap between medical jargon and patient comprehension, empowering individuals to better understand their conditions and treatment options **(Hafner et al., 2022)**. For example, showing a patient a 3D rendering of their spine can clarify why surgery is necessary or what changes have occurred due to a degenerative disease **(Zhuang et al., 2019)**.

3. Patient-Centered Care

The evolution of healthcare delivery models has placed patients at the center of care. This paradigm shift emphasizes the importance of engaging patients as informed participants in their healthcare journey. Patient-centered reporting represents a shift from traditional, clinician-focused radiology reports toward formats that prioritize accessibility and understanding for patients. The goal is to bridge the communication gap, empowering patients to take an active role in their healthcare decisions. Radiology reporting, traditionally viewed as a tool for

communication between specialists, is now being adapted to serve patients directly (**Rockall et al., 2022**). This approach involves three critical elements;

Simplified Language: Patient-centered reports use non-technical language to ensure comprehension without compromising clinical accuracy. Instead of specialized medical terminology, the reports explain findings in layman's terms (**Hans Vitzthum von Eckstaedt et al., 2020**). For example, to develop a prototype patient-centered radiology report (PACERR), input was gathered from both patients undergoing prostate MRI and medical experts to determine key elements for inclusion. The prototype was designed through a collaborative effort involving experts in human factors engineering, medical imaging, biomedical informatics, and cancer patient education, ensuring a well-rounded approach that prioritized usability and patient understanding (**Perlis et al., 2020**).

Inclusion of Visual Aids: Visual aids such as annotated images, diagrams, or infographics play a vital role in enhancing understanding. For instance, if a CT scan shows a kidney stone, the report might include an image of the scan with the stone highlighted and labeled, accompanied by a simple diagram showing its position in the urinary tract (**Hafner et al., 2022**). Explanatory visuals make abstract or complex medical concepts more tangible.

4. Enhancing Readability in Radiology Reports

Readability in radiology reporting refers to the ability of a report to be understood easily by its intended audience. Readability is typically assessed using metrics like the Flesch Reading Ease Score and the Flesch-Kincaid Grade Level, which quantify text complexity (Martin-Carreras et al., 2019). Studies show that most radiology reports are written at a level well above the average patient's comprehension, with a significant proportion requiring advanced medical knowledge to interpret. This can lead to confusion, anxiety, and even poor adherence to recommended care plans (Hansberry et al., 2015).

Structured radiology reports use predefined templates and standardized headings to organize findings, impressions, and recommendations effectively. This format is particularly advantageous as it promotes consistency, completeness, and clarity—qualities crucial for effective communication with referring physicians (**Larson et al., 2013**). Standardized headings ensure all critical elements are addressed, reducing the likelihood of omission. Templates help radiologists maintain a clear narrative structure, which is especially important for actionable findings that physicians rely on for patient management. By adhering to this approach, reports become easier to interpret, particularly for non-radiologist end readers, including patients who are increasingly accessing their medical records (**Gunn et al., 2017**). Additionally, structured reports align with the broader goal of improving the quality and reliability of radiological communication. Structured reports use predefined templates and headings to organize findings, impressions, and recommendations. This approach ensures consistency, completeness, and clarity, particularly for referring physicians (**Nobel et al., 2022**). Structured radiology reports offer notable advantages, including the ability to standardize reporting practices, thereby supporting the creation of robust databases for research and quality assurance purposes. Additionally, their integration with AI technologies enhances diagnostic accuracy by ensuring that no critical details are overlooked, fostering more reliable and comprehensive patient care.

Standardization: Standardizing radiological reports is a transformative initiative aimed at enhancing the clarity, consistency, and clinical value of radiology communication. Standardized reports use structured templates with predefined sections, consistent terminology, and organized layouts, ensuring that findings are easily interpretable by referring physicians and other stakeholders. This approach reduces ambiguity, improves decision-making, and facilitates

multidisciplinary collaboration, particularly in complex cases like oncology, where comprehensive and coherent documentation is crucial (Pesapane et al., 2023). Efforts such as the creation of common lexicons like RadLex (Langlotz, 2006) and systems like BI-RADS for breast imaging have established templates that support consistency across institutions (Sickles, 2013). These templates allow for data integration into broader healthcare systems, enabling research, auditing, and AI applications. Technological advancements, including AI integration, have enhanced the standardization process by automating certain elements, such as inserting lesion measurements or generating preliminary findings (Goldberg-Stein & Chernyak, 2019). By adopting best practices and leveraging these innovations, standardized radiology reports improve not only the readability and precision of medical documentation but also its impact on patient outcomes and the efficiency of healthcare delivery.

5. Crisis Management in Radiology Reporting

Crisis settings exacerbate burnout among radiologists, fueled by high workloads, isolation, and the pressure to deliver high-stakes diagnoses. Promoting a culture of collaboration, where radiologists actively engage with the care team and patients, may help alleviate some of these stressors. Involving radiologists more visibly in patient care enhances their sense of professional fulfillment and reduces the depersonalization often associated with burnout (Chetlen et al., 2019). The integration of crisis management in radiology reporting within the framework of patient-centered care is an evolving yet critical domain. The emphasis lies on accurate and timely communication of radiological findings, which is essential for diagnosis and subsequent management to prevent harm due to missed or delayed responses (Murphy et al., 2014). Radiology departments frequently serve as pivotal hubs in diagnosing conditions that require urgent attention, such as acute injuries, cancer, or life-threatening anomalies. Effective crisis management in radiology involves identifying, communicating, and ensuring follow-up on critical imaging results (Singh et al., 2008). Key practices include the use of synchronous communication, the implementation of structured communication Protocols, and the adoption of critical test result management systems (CTRMs).

Synchronous Communication: For findings requiring immediate attention (e.g., pneumothorax or intracranial hemorrhage), direct verbal communication between radiologists and clinicians is paramount (Kushner & Lucey, 2005).

Structured Communication Protocols: The SBAR (Situation, Background, Assessment, Recommendation) method ensures clear, structured communication during crises to minimize errors (Martínez-Fernández et al., 2022).

Critical Test Result Management Systems (CTRMs): These systems enable efficient and documented communication of urgent results, ensuring the provider receives and acts on critical findings promptly (Haig et al., 2006).

During crises, healthcare systems often face heightened demand, resource limitations, and emotional stress on patients and healthcare workers alike. In radiology, this translates into increased workloads, rapid decision-making, and the need to prioritize urgent cases. The traditional radiology reporting model, which often emphasizes technical accuracy over direct patient interaction, may fall short in addressing patients' holistic needs in such scenarios (Herraiz-Recuenco et al., 2022). Radiology reporting is crucial in patient-centered care, particularly during crises like the COVID-19 pandemic. It involves clear, compassionate communication of findings directly to patients and referring physicians, balancing technical accuracy with accessibility (Al-Dahery et al., 2023). Crises highlight the need for timely, patient-friendly reports that empower patients while addressing emotional and informational

needs. Challenges include managing complex cases, breaking bad news empathetically, and supporting healthcare system resilience under stress. Solutions include adopting structured, readable reports, integrating technology, and fostering radiologist-patient interaction to humanize care.

5.1. Patient-Centered Reporting Approaches

To address these challenges, radiologists must embrace patient-centered reporting methods that emphasize communication, compassion, and collaboration (Gutzeit et al., 2019). Structuring reports with non-specialists in mind is a key step. This involves avoiding overly technical language and incorporating summaries that clarify findings and their implications for care (Itri, 2015). Direct radiologist-patient interactions, though less common, are increasingly recognized as beneficial. Studies suggest that engaging with patients through in-person consultations or even virtual platforms enhances understanding, trust, and overall satisfaction with care. This approach humanizes the radiologist's role, transforming them from a "behind-the-scenes" specialist to an active participant in the care team (Cox et al., 2020).

Standardized communication protocols play a pivotal role in ensuring the timely and accurate transmission of critical findings in radiology. Organizations like the American College of Radiology (ACR) have established comprehensive guidelines to support this process. These protocols specify which findings are considered critical, the appropriate timeline for communication, and the method of reporting. For instance, urgent findings like life-threatening hemorrhages or acute conditions require immediate notification to the referring physician to expedite intervention and improve patient outcomes (Radiology, 2014). The ACR's Practice Parameter for Communication of Diagnostic Imaging Findings emphasizes structured reporting and direct communication for time-sensitive diagnoses. These standards also address the importance of clear documentation to create an audit trail that verifies proper notification. Additionally, the guidelines advocate for using secure and reliable communication channels to maintain patient confidentiality (Butler et al., 2010).

The integration of artificial intelligence (AI) and advanced imaging technologies also holds promise for improving radiology reporting during crises. AI can assist in identifying critical findings rapidly, aiding radiologists in prioritizing urgent cases. Automated tools for generating patient-friendly report summaries can streamline communication and ensure consistency in messaging (Hartung, 2024).

Conclusion

Radiology reporting stands at the nexus of diagnostic accuracy and effective communication, playing a pivotal role in both routine and crisis scenarios within patient care. As the healthcare landscape shifts toward a patient-centered model, radiology departments face the challenge and opportunity of reimagining traditional reporting practices. Enhancing readability, integrating patient-friendly language, and employing structured reporting templates are essential steps in making radiology findings accessible and actionable for diverse audiences, including patients. The future of radiology reporting will depend on a synergy between innovation, education, and standardization, ensuring that reports are both precise and inclusive. By embracing these advancements, radiology can transcend its role as a diagnostic service to become a central pillar in patient-centered care, fostering trust, improving health literacy, and ultimately enhancing healthcare outcomes.

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