

The impact of digital radiography on the quality of diagnosis in the hospital

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Abstract:

This study aimed to discuss the impact of digital radiography on the quality of diagnosis in the hospital. Digital radiography has come a long way since its inception. Traditional film-based radiography involves capturing X-ray images on photographic film, which then requires chemical processing. Digital radiography (DR) has greatly improved the quality of diagnosis in hospitals by enhancing diagnostic accuracy, efficiency, and patient safety. One of the most important advantages of digital radiography is its ability to produce high-resolution images with exceptional detail. Despite the numerous advantages of digital radiography (DR) in improving diagnostic quality in hospitals, several obstacles can impede its effectiveness. These challenges include high initial costs, technological limitations, training and adaptation issues, data security concerns, and technical malfunctions. The study underscores that while digital radiography significantly enhances diagnostic quality, efficiency, and patient safety, overcoming the associated obstacles requires strategic planning, investment in training and infrastructure, robust cybersecurity, and reliable technical support. Addressing these challenges is crucial for maximizing the potential of digital radiography in hospital settings.

Key words:

Introduction:

Digital radiography has come a long way since its inception. Traditional film-based radiography involves capturing X-ray images on photographic film, which then requires chemical processing. However, the shift to digital technology has greatly improved efficiency, image quality and accessibility.

Quality assessment should be based on a conceptual and operational definition of what “quality medical care” means [1]. Many problems are present at this fundamental level, for the quality of care is a remarkably difficult notion to define [2]. Few empirical studies delve into what dimensions and values are relevant at any given time and in each setting. Klein et al., found that among them, 24 “administrative officials” provided 80 criteria for evaluating “patient care.” They conclude that patient care, like morale, cannot be considered a unitary concept and “...it seems likely that there will be no single comprehensive standard by which the quality of patient care can be measured.” [3].

Radiography helps identify fractures or infections in bones and teeth. Diagnosis and evaluation of the structure of the oral cavity and jaw. Pick up signs of joint changes that indicate arthritis. Detection of tumors on bones. Radiographers are part of the medical staff and health care sector of the medical institution [4]. As part of their work, radiologists independently perform very complex diagnostic and therapeutic procedures that require a broad theoretical background, proven clinical training and high technical capabilities.

The role of digital radiography on the quality of diagnosis in hospitals

Digital radiography (DR) has greatly improved the quality of diagnosis in hospitals by enhancing diagnostic accuracy, efficiency, and patient safety. One of the most important advantages of digital radiography is its ability to produce high-resolution images with exceptional detail. These high-quality images allow radiologists to identify subtle abnormalities that may be missed in traditional film radiographs [5]. In addition, advanced software tools allow dynamic adjustment of image contrast and brightness, enhancing the visualization of different tissues and potential pathologies. This ability is crucial in detecting and diagnosing various medical conditions with greater accuracy.

The efficiency of diagnostic workflow in hospitals has also been greatly improved through digital radiography. Unlike traditional film radiography, which requires time-consuming processes to develop and dry the film, digital radiography provides almost instantaneous image acquisition. This rapid availability of images reduces the time from imaging to diagnosis, allowing faster clinical decisions to be made [6]. Furthermore, the streamlined workflow made possible by digital radiography improves patient throughput, reduces wait times, and increases the overall efficiency of hospital operations. The ability to review digital images instantly reduces the need for repeat checks due to poor image quality, saving time and resources.

Digital radiography improves access and communication inside and outside the hospital. Integration with picture archiving and communications systems (PACS) enables efficient storage and retrieval of digital images [7]. This system not only supports easy access to current and historical images, but also facilitates image sharing between healthcare providers. This seamless engagement is particularly useful in multidisciplinary teams and for obtaining second opinions, contributing to more accurate and comprehensive patient care. In addition, remote access to digital radiography supports telemedicine, enabling specialists to consult and provide expertise to remote or underserved locations [8].

Patient safety is another critical area where digital radiography has made great strides. Digital systems often require lower radiation doses than traditional film radiography, reducing the patient's exposure to potentially harmful radiation. This reduction in radiation dose is especially important for patients who require multiple imaging studies over time. Furthermore, the ability to immediately assess image quality reduces the necessity of re-imaging, reducing radiation exposure. The combined effect of lower radiation doses and fewer re-imaging procedures enhances overall patient safety in diagnostic imaging [6].

Economic and environmental benefits also stem from the adoption of digital radiography in hospitals. While the initial investment in digital radiography equipment can be significant, eliminating the costs associated with film, chemicals, and physical storage results in long-term savings. Digital storage solutions reduce the need for physical space, which can be repurposed for other important uses within the hospital [7]. Environmentally, digital radiography eliminates the use of hazardous chemicals needed to process films, contributing to a more sustainable and environmentally friendly medical practice.

Lastly, digital radiography has revolutionized diagnostic capabilities and patient outcomes in hospitals. The ability to produce high-quality images quickly and efficiently allows for earlier detection of diseases and more accurate monitoring. Easy access to and comparison of historical images allows for comprehensive patient assessments, aiding in continuous assessment of health status and treatment effectiveness [8]. These advances lead to faster diagnostic results, reducing patient anxiety and enabling timely medical interventions. Improved coordination of care facilitated by digital radiography ensures that patients receive the best possible treatment based on the most accurate and up-to-date information available.

Advantages of digital radiography (DR)

Digital imaging technologies of computed radiography (CR) and digital radiography (DR) have made a significant impact on imaging departments and have led to the possibility of reducing radiation doses for standard imaging examinations [9]. Digital radiography (DR) provides numerous advantages over traditional film-based radiography, significantly enhancing the quality and efficiency of medical diagnostics. One of the most notable benefits is the superior image quality. Digital radiographs offer higher resolution images, which reveal finer anatomical details and subtle pathologies that might not be visible on traditional film. Additionally, advanced software tools allow for dynamic adjustments of image contrast and brightness, aiding radiologists in visualizing different tissues and abnormalities more effectively.

The efficiency of workflow in medical imaging departments is greatly improved with digital radiography. Digital systems allow for almost instantaneous image acquisition, significantly reducing the time from imaging to diagnosis. This rapid availability speeds up clinical decision-making processes [10]. Moreover, digital radiography eliminates the need for developing and drying film, streamlining the workflow, reducing patient wait times, and increasing the throughput of imaging departments. Immediate quality control is another advantage, as radiologists can review

digital images on the spot to ensure they meet the necessary standards, thereby minimizing the need for repeat examinations due to poor image quality.

Digital radiography also enhances accessibility and storage of medical images. Images are stored in Picture Archiving and Communication Systems (PACS), ensuring easy retrieval, long-term storage, and efficient management of imaging data [11]. This integration supports remote access to images, facilitating telemedicine and enabling specialists to provide consultations and second opinions regardless of location. Such capabilities are particularly beneficial in providing specialized care to remote or underserved areas.

Patient safety is another critical area where digital radiography offers significant improvements. Digital systems typically require lower radiation doses compared to traditional film, reducing patient exposure to potentially harmful radiation [12]. The ability to immediately assess image quality reduces the frequency of retakes, further decreasing cumulative radiation exposure for patients. This enhancement in safety is particularly important for patients requiring multiple imaging studies over time.

From an economic and environmental perspective, digital radiography offers substantial benefits. Although the initial setup cost for digital radiography equipment can be high, it eliminates ongoing expenses associated with film, chemicals, and physical storage space, leading to long-term savings [9]. Additionally, the environmental impact is reduced as digital radiography eliminates the need for chemical processing of film, thus reducing hazardous waste and contributing to more environmentally friendly healthcare practices.

Digital radiography also provides advanced diagnostic capabilities. Integration with computer-aided detection (CAD) systems assists radiologists by automatically identifying potential areas of concern, reducing human error, and increasing diagnostic accuracy. High-quality digital images facilitate early detection of diseases and allow for accurate monitoring of disease progression and treatment response, improving patient outcomes. The ease of access to historical images enables comprehensive longitudinal studies, aiding in the continuous assessment and management of patient health [11].

Direct DR systems: These systems use a flat plate detector (FPD) to convert X-rays directly into electrical signals. The FPD consists of an array of photodiodes or amorphous selenium (a-Se) detectors [11]. One of the advantages of this type of imaging is high spatial resolution, as Direct DR provides exceptional image details, and the image is available immediately, as no processing time is required.

Finally, the overall patient experience is significantly enhanced with digital radiography. Faster imaging and processing times mean that patients receive diagnostic results more quickly, reducing anxiety and enabling timely medical intervention. The ability to easily share images and collaborate with other healthcare providers leads to more coordinated and effective patient care, ensuring that patients receive the best possible treatment based on the most accurate and up-to-date information available [12].

The impact of digital radiography on the quality of diagnosis in hospitals

Digital radiography (DR) has significantly impacted the quality of diagnosis in hospitals in several ways, improving diagnostic accuracy, efficiency, and patient care. diagnostic images can be obtained using a wider range of exposure factors as digital radiography is less mAs and kV dependent; this may reduce the need for repeat exposures however patients may be incurring higher radiation doses than are necessary [10]. The impacts of DR are:

1. Improved Image Quality

- **Higher Resolution:** Digital radiography produces images with higher resolution and greater detail than traditional film radiography, enabling more precise diagnosis.
- **Enhanced Contrast:** Advanced software allows for the adjustment of image contrast and brightness, making it easier to detect subtle abnormalities.

2. Rapid Image Acquisition and Processing

- **Immediate Image Availability:** Digital radiographs are available almost instantly after acquisition, reducing the time to diagnosis and allowing for quicker clinical decision-making.
- **Efficient Workflow:** The elimination of film processing steps (developing, drying) speeds up the entire imaging workflow, enhancing patient throughput.

3. Advanced Image Manipulation and Analysis

- **Post-Processing Capabilities:** Radiologists can manipulate digital images using various software tools to enhance visualization of specific areas, measure anatomical structures accurately, and apply filters to highlight different tissues.
- **Computer-Aided Detection (CAD):** Integration of CAD systems assists radiologists by highlighting potential areas of concern, reducing the likelihood of missed diagnoses.

4. Enhanced Storage and Accessibility

- PACS Integration: Digital images can be stored and managed using Picture Archiving and Communication Systems (PACS), which allows for easy retrieval, sharing, and comparison of images over time.
- Remote Access: Digital radiography facilitates telemedicine by allowing images to be accessed remotely by specialists for consultation and second opinions.

5. Reduction in Radiation Exposure

- Lower Doses: Digital radiography often requires lower radiation doses compared to traditional film radiography while still producing high-quality images, enhancing patient safety.
- Repeat Exams Reduction: The ability to immediately assess image quality reduces the need for repeat exams due to poor image quality, further minimizing patient exposure to radiation.

6. Cost-Effectiveness and Environmental Impact

- Reduced Costs: While the initial investment in digital radiography equipment is high, it eliminates ongoing costs associated with film, chemicals, and storage space.
- Environmental Benefits: The reduction in the use of chemicals for film processing and the elimination of film waste contribute to a more environmentally friendly radiography practice.

7. Improved Diagnostic Accuracy and Patient Outcomes

- Early Detection: The improved image quality and advanced diagnostic tools aid in the early detection of diseases, leading to better patient outcomes.
- Comprehensive Assessment: The ability to quickly compare current and previous images facilitates a more comprehensive assessment of disease progression or treatment response.

Obstacles of digital radiography (DR) in the quality of diagnosis in hospital

Despite the numerous advantages of digital radiography (DR) in improving diagnostic quality in hospitals, several obstacles can impede its effectiveness. These challenges include high initial costs, technological limitations, training and adaptation issues, data security concerns, and technical malfunctions [12]. The main obstacles are:

High Initial Costs: The transition to digital radiography involves significant upfront investment. Hospitals need to purchase advanced imaging equipment, upgrade existing infrastructure, and integrate new systems with existing hospital information systems. These costs can be prohibitive, particularly for smaller healthcare facilities with limited budgets. Additionally, there are ongoing maintenance and software update expenses that can strain financial resources.

Technological Limitations: While digital radiography offers superior image quality, it is not without its technological limitations. In some cases, digital images may suffer from artifacts or noise that can obscure diagnostic details. Additionally, the resolution of digital images, although generally high, may not always meet the requirements for diagnosing certain conditions. Technology also relies heavily on the quality of the digital sensors and processing algorithms, which can vary between manufacturers and models.

Training and Adaptation: The implementation of digital radiography requires substantial training for radiologists, technicians, and other healthcare professionals. Adapting to new technology can be challenging, particularly for staff accustomed to traditional film-based systems. There is often a learning curve associated with mastering new software and image interpretation techniques. Inadequate training can lead to errors in image acquisition, processing, and interpretation, potentially compromising diagnostic accuracy [6].

Data Security and Privacy Concerns: The digitization of radiographic images raises significant data security and privacy concerns. Digital radiography systems store sensitive patient information that must be protected from unauthorized access and cyber threats. Ensuring the security of these systems requires robust cybersecurity measures, regular updates, and compliance with healthcare regulations such as the Health Insurance Portability and Accountability Act (HIPAA). Breaches in data security can lead to the loss of patient confidentiality and trust, as well as legal repercussions for healthcare providers [5].

Technical Malfunctions and Downtime: Like any digital system, digital radiography equipment is susceptible to technical malfunctions and downtime. Hardware failures, software bugs, and network issues can disrupt imaging services, leading to delays in diagnosis and treatment. Dependence on digital systems also means that any technical issue can have a widespread impact, affecting multiple departments and processes within the hospital. Ensuring reliable technical support and maintaining backup systems are crucial to minimizing these disruptions [13].

Integration with Existing Systems: Integrating digital radiography with existing hospital information systems can be complex and challenging. Compatibility issues between different software platforms and legacy systems can hinder the seamless flow of information. Effective integration is necessary for the efficient sharing and storage of digital images and patient records. Without proper integration, the benefits of digital radiography can be undermined by inefficiencies and data management problems.

So, the researchers estimated that while digital radiography offers significant benefits in terms of image quality, efficiency, and patient care, several obstacles can impact its effectiveness in hospital settings. High initial costs, technological limitations, training and adaptation challenges, data security concerns, and potential technical malfunctions are among the key issues that need to be addressed [12]. Overcoming these obstacles requires careful planning, investment in training and infrastructure, robust cybersecurity measures, and effective technical support to fully realize the potential of digital radiography in enhancing the quality of diagnosis in hospitals.

Results

Digital radiography (DR) offers many benefits but faces several significant obstacles that can impact its effectiveness in hospitals. These results include high initial costs, technological limitations, training and adaptation challenges, data security and privacy concerns, technical malfunctions and downtime, and integration issues with existing systems. The main results of this study were:

1. **High Initial Costs:** The high upfront investment required for digital radiography equipment and infrastructure upgrades can be prohibitive, especially for smaller healthcare facilities with limited budgets. Ongoing maintenance and software update costs further strain financial resources, potentially slowing the adoption of DR technology across various healthcare settings.
2. **Technological Limitations:** Despite the superior image quality generally associated with digital radiography, technological limitations can hinder diagnostic accuracy. Issues such as image artifacts, noise, and variable sensor quality can obscure diagnostic details. These limitations necessitate continuous advancements in digital imaging technology to ensure consistent and reliable image quality for accurate diagnosis.
3. **Training and Adaptation:** The necessity for substantial training and adaptation to new digital radiography systems poses a significant challenge. Healthcare professionals accustomed to traditional film-based systems face a steep learning curve in mastering new software and image interpretation techniques. Inadequate training can lead to errors in image acquisition, processing, and interpretation, potentially compromising diagnostic accuracy and patient care.
4. **Data Security and Privacy Concerns:** The digitization of radiographic images introduces significant data security and privacy risks. Ensuring the protection of sensitive patient information from unauthorized access and cyber threats requires robust cybersecurity measures and compliance with regulations such as HIPAA. Breaches in data security can result in the loss of patient confidentiality, legal consequences, and erosion of trust in healthcare providers.
5. **Technical Malfunctions and Downtime:** Digital radiography systems are vulnerable to technical malfunctions, software bugs, and network issues, leading to potential disruptions in imaging services. These technical problems can cause delays in diagnosis and treatment, affecting multiple departments within the hospital. Reliable technical support and backup systems are essential to mitigate the impact of these disruptions and maintain continuous service delivery.
6. **Integration with Existing Systems:** Integrating digital radiography with existing hospital information systems can be complex and problematic. Compatibility issues between different software platforms and legacy systems can hinder the seamless flow of information, affecting the efficiency of data sharing and storage. Without effective integration, the advantages of digital radiography are compromised by inefficiencies and data management challenges, limiting its overall effectiveness.

Conclusion

Digital radiography (DR) represents a major development in medical imaging, providing many benefits such as higher image quality, improved efficiency, and increased patient safety. High-resolution digital images reveal fine anatomical details and subtle pathological elements that may be invisible on conventional films. The ability to adjust contrast and brightness helps visualize tissues and abnormalities more accurately, improving diagnostic accuracy and patient outcomes.

However, the transition to digital radiography faces challenges, the most important of which are the high initial cost of purchasing equipment, upgrading infrastructure and integrating new systems with existing systems in the hospital. Small hospitals may find these costs prohibitive. These systems also require constant maintenance and software updates, which increases costs.

Other technological challenges include distortions and noise in digital images that can obscure diagnostic details, necessitating continued technological development to ensure image quality. Adapting to new systems requires extensive training for health professionals accustomed to traditional systems, and lack of good training can lead to errors in image acquisition, processing and interpretation.

Data security and privacy issues arise with the digitization of radiographs, as sensitive information must be protected from unauthorized access and cyber threats through robust cybersecurity measures and compliance with health

regulations. Technical malfunctions and downtime represent an additional obstacle as they can disrupt diagnostic services and delay treatment.

Integration with existing systems can be complex, as compatibility issues between different software platforms may hinder the smooth flow of information. Efficient integration is essential to maximize the benefits of digital radiography and avoid data management issues.

While digital radiography offers significant benefits in terms of image quality, efficiency, and patient safety, associated challenges must be overcome to ensure its effective implementation in hospitals. Addressing high upfront costs, improving technology reliability, ensuring comprehensive training, implementing robust cybersecurity measures, and achieving seamless systems integration are critical steps to realizing the full potential of digital radiography.

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