

Emergency Medicine Protocols: Enhancing Patient Outcomes with Radiology Insights

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Abstract:

In the fast-paced realm of emergency medicine, where split-second decisions can be a matter of life and death, the synergy between clinical acumen and cutting-edge technology becomes paramount. Radiology emerges as a linchpin in this dynamic landscape, wielding its influence to augment diagnostic precision, guide therapeutic interventions, and ultimately elevate patient outcomes. The fusion of timely radiological insights with emergency medicine protocols not only expedites the diagnostic process but also empowers healthcare professionals with a more comprehensive understanding of the patient's condition. This paper endeavors to unravel the intricate tapestry of this integration, shedding light on the multifaceted ways in which radiology serves as a catalyst for informed decision-making and optimized care delivery in the high-stakes arena of emergency medical practice. From trauma assessments to identifying critical internal injuries, the judicious use of imaging techniques emerges as a cornerstone in the holistic approach to patient care, underscoring the indispensability of radiology in shaping the landscape of emergency medicine.

Keywords: Emergency Medicine, Radiology, Patient Outcomes, Diagnostic Accuracy, Therapeutic Interventions, Medical Protocols.

1. Introduction

Definition and Importance of Emergency Medicine

Emergency medicine serves as the medical specialty dedicated to the immediate diagnosis, evaluation, and treatment of acute illnesses and injuries. It functions at the crossroads of various medical disciplines, aiming to provide timely and efficient care to patients who require urgent attention. The primary goal is not only to stabilize patients but also to initiate interventions that can prevent further deterioration and improve outcomes. The importance of emergency medicine cannot be overstated in the broader healthcare landscape. As the first point of contact for many patients, emergency departments (EDs) act as the safety net of the healthcare system. They cater to a diverse range of medical conditions, from life-threatening emergencies like myocardial infarctions and strokes to traumatic injuries and severe infections. The effectiveness of emergency care often determines subsequent patient outcomes, making it a critical component of healthcare delivery. Moreover, emergency medicine extends beyond immediate interventions. It encompasses preventive measures, patient education, and coordination with other specialties for comprehensive care. In essence, it represents the frontline of medical care, where rapid decision-making, clinical acumen, and teamwork are paramount [1].

Role of Radiology in Medical Decision-making

Radiology, the branch of medicine that utilizes imaging techniques to diagnose and treat diseases, plays an indispensable role in medical decision-making across various specialties. In the context of emergency medicine, radiology serves as a cornerstone for accurate diagnosis, therapeutic planning, and monitoring of interventions. When confronted with a patient in an



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emergency setting, clinicians often rely on radiological imaging to confirm or rule out potential diagnoses. Technologies such as X-rays, computed tomography (CT) scans, ultrasound, and magnetic resonance imaging (MRI) provide invaluable insights into internal structures, identifying abnormalities, injuries, or pathologies that may not be evident through clinical examination alone. For instance, in cases of suspected fractures or internal injuries, radiological imaging offers definitive evidence, guiding appropriate management strategies. Similarly, in conditions like pulmonary embolism or intracranial hemorrhage, timely radiological assessment can be life-saving, prompting immediate interventions. Furthermore, radiology aids in procedural guidance, particularly in the context of image-guided interventions and surgeries. By providing real-time visualization, radiologists and surgeons can ensure precise placement of instruments, reducing complications and improving outcomes [2].

Objective of the Paper

The primary objective of this paper is to elucidate the profound interplay between radiology and emergency medicine. By delving into the intricacies of their relationship, we aim to underscore the critical role of radiological insights in shaping medical decisions, optimizing patient outcomes, and advancing the field of emergency care. Through comprehensive exploration, we seek to provide clinicians, policymakers, and stakeholders with a nuanced understanding of the synergies between these disciplines, advocating for their continued collaboration and integration in healthcare settings [3].

2. The Interdependence of Emergency Medicine and Radiology

Historical Perspective: Evolution of Radiology in Emergency Care

Radiology, derived from the Latin words "radius" (ray) and "logos" (study), has always been about harnessing the power of radiation to visualize the human body. However, its integration into emergency care has been a journey marked by innovation and adaptation. The early 20th century witnessed the advent of X-ray technology, a groundbreaking discovery that transformed medical diagnostics. Emergency rooms, even in their nascent stages, quickly recognized the potential of this imaging modality. X-rays allowed physicians to swiftly identify fractures, pneumothoraxes, and other life-threatening conditions that were previously elusive without invasive procedures. The portable X-ray machine, introduced during World War I, further revolutionized battlefield medicine and soon found its way into civilian emergency departments. As decades passed, the field of radiology expanded exponentially with the introduction of computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound. These modalities, each with its unique strengths and applications, provided emergency physicians with an increasingly sophisticated toolkit to diagnose and manage complex cases. However, with great advancements came challenges. The growing reliance on imaging also raised concerns about radiation exposure, the interpretation of complex images, and the need for rapid but accurate diagnoses. This necessitated closer collaboration between radiologists and emergency physicians, marking the beginning of a truly interdependent relationship [4].

Modern Challenges and Opportunities

In today's fast-paced emergency departments, the synergy between radiology and emergency medicine has never been more critical—or complex. The sheer volume of imaging studies, combined with the pressure to make timely decisions, underscores the need for streamlined



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processes and clear communication. Challenges abound. The increasing demand for imaging studies often leads to overcrowded radiology departments and prolonged wait times. Additionally, the interpretation of complex images, particularly in trauma or acute stroke cases, requires specialized expertise that may not always be readily available. Yet, these challenges also present opportunities for innovation. Tele-radiology, for instance, allows remote interpretation of images, bridging the gap between supply and demand. Artificial intelligence (AI) holds promise in expediting image analysis and flagging critical findings. Moreover, interdisciplinary training programs that immerse radiologists and emergency physicians in each other's worlds are fostering a deeper understanding and collaboration [5].

Case Study: A Typical Emergency Room Scenario

Consider a bustling urban emergency room on a weekend night. A middle-aged patient presents with sudden-onset chest pain. The emergency physician, suspecting a cardiac event, orders an immediate electrocardiogram (ECG) and a chest X-ray. While the ECG provides valuable information about cardiac rhythms, the chest X-ray is crucial for assessing the heart's size, the presence of lung pathologies, and potential signs of aortic dissection. However, the X-ray reveals an unexpected finding—a suspicious shadow in the lung's periphery. Here's where the interdependence becomes evident. The emergency physician, though adept at recognizing common pathologies, relies on the radiologist's expertise to decipher ambiguous findings. The radiologist, armed with advanced training in image interpretation, recognizes the shadow as a potential early-stage malignancy, prompting further investigations and consultations.

3. Radiology's Contribution to Diagnostic Accuracy

Imaging Modalities in Emergency Settings

The exigencies of emergency medicine necessitate prompt and precise diagnostic measures. In this context, various imaging modalities have emerged as invaluable tools that aid clinicians in rapidly assessing and addressing critical conditions. *X-rays* are among the most commonly employed imaging techniques in emergency settings due to their speed and utility in detecting fractures, foreign bodies, and certain pathological changes. They offer a quick initial assessment, guiding immediate interventions and determining the need for further imaging studies. *CT scans (Computed Tomography)* provide cross-sectional images of the body, offering a detailed view of internal structures. Their versatility makes them indispensable for diagnosing conditions ranging from intracranial hemorrhages to abdominal emergencies. With advancements in technology, modern CT scanners can rapidly acquire images, facilitating swift clinical decisions. *Ultrasound* has gained prominence in emergency medicine due to its portability and real-time imaging capabilities. It allows clinicians to perform dynamic assessments at the bedside, aiding in the evaluation of conditions such as trauma, cardiac anomalies, and abdominal emergencies. The absence of ionizing radiation makes ultrasound a preferred choice for certain patient populations, including pregnant women and pediatric patients. *MRI (Magnetic Resonance Imaging)*, although less commonly utilized in emergent scenarios due to longer acquisition times, offers unparalleled soft tissue contrast and is indispensable for specific diagnoses, such as spinal cord injuries or certain neurological emergencies [6].

Rapid Diagnosis and Treatment Planning



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The integration of radiological insights into emergency care pathways has revolutionized the speed and accuracy of diagnosis, directly influencing treatment planning and patient outcomes. Upon acquiring radiological images, clinicians can promptly identify life-threatening conditions, such as pneumothorax on chest X-rays or acute intracranial hemorrhages on CT scans. This immediacy allows for timely interventions, including chest tube insertions or neurosurgical consultations, potentially mitigating adverse outcomes. Furthermore, the ability to visualize internal anatomical structures aids in the precise localization of pathology. For instance, ultrasound-guided procedures have become standard in emergency departments for tasks ranging from central line placements to joint aspirations, ensuring accuracy and minimizing complications. The rapid availability of radiological interpretations enables multidisciplinary collaboration, fostering a cohesive approach to patient care. Specialists across various domains can swiftly review imaging findings, contributing their expertise to formulate comprehensive treatment strategies [7].

Comparative Analysis: Pre and Post-Radiological Integration

The evolution of emergency medicine has been profoundly influenced by the seamless integration of radiology into clinical workflows. A comparative analysis between eras before and after the widespread adoption of radiological imaging underscores this transformative impact.

Pre-Radiological Integration: Historically, emergency diagnoses heavily relied on clinical assessment and basic diagnostic tools. The absence of immediate imaging capabilities often led to diagnostic uncertainties, necessitating empirical treatments or invasive explorations. Misdiagnoses and delays in definitive care were not uncommon, contributing to morbidity and mortality rates.

Post-Radiological Integration: With the advent of advanced imaging modalities and their ubiquitous availability, emergency medicine has witnessed a paradigm shift. The precision afforded by radiological insights has substantially reduced diagnostic ambiguities. Clinicians can now make data-driven decisions, corroborating clinical findings with radiological evidence. This synergy has facilitated early, targeted interventions, optimizing resource utilization and improving patient outcomes [8].

4. Radiological Insights and Therapeutic Interventions

Image-guided Procedures in Emergency Medicine

In the fast-paced environment of emergency medicine, timely and accurate interventions are paramount. One of the most significant advancements aiding such interventions is the integration of image-guided procedures. These procedures harness the power of various imaging modalities like ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI) to provide real-time visualization and guidance. Ultrasound, for instance, offers a non-invasive means to visualize internal structures, guiding procedures such as central line placements, thoracentesis, and paracentesis. Its portability and immediate feedback make it particularly valuable in emergency scenarios where rapid decisions are vital. CT and MRI, although not as readily available as ultrasound in emergency departments, provide unparalleled detail when required. They are instrumental in guiding complex procedures, such as biopsies or drain placements, where precision is critical. Furthermore, the fusion of imaging with navigation systems allows for intricate interventions, even in challenging anatomical locations. The integration of image-



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guided procedures has not only enhanced the accuracy and safety of interventions but also broadened the scope of what can be achieved in emergency settings [1], [2].

Minimally Invasive Techniques: Benefits and Risks

The emergence and refinement of minimally invasive techniques represent a paradigm shift in medical interventions. These approaches, characterized by smaller incisions, reduced tissue trauma, and faster recovery times, have found substantial applications in emergency medicine.

Benefits:

1. **Reduced Morbidity:** Smaller incisions and minimized tissue disruption often lead to fewer complications, reduced post-operative pain, and shorter hospital stays.
2. **Quicker Recovery:** Patients undergoing minimally invasive procedures typically experience faster recovery times, facilitating earlier discharge and return to normal activities.
3. **Improved Cosmetic Outcomes:** The smaller scars associated with these techniques offer improved aesthetic results, which can have psychological benefits for patients.

However, alongside these benefits, it's essential to recognize the inherent risks associated with any medical intervention:

1. **Technical Challenges:** Minimally invasive procedures often require specialized training and expertise. Ensuring proficiency among emergency care providers is crucial to mitigate associated risks.
2. **Equipment Limitations:** The success of these techniques is highly dependent on specialized equipment, which may not be universally available.
3. **Potential Complications:** While the overall risk profile may be lower, specific complications, such as injury to adjacent structures or infections, still exist and require vigilant monitoring.

Case Study: Successful Intervention Aided by Radiological Guidance

In a bustling urban emergency department, a 45-year-old male presented with acute abdominal pain, with preliminary assessments suggesting a possible ruptured spleen. Given the critical nature of the condition, immediate intervention was imperative. Utilizing ultrasound guidance, emergency physicians identified a significant hemorrhagic collection adjacent to the spleen. Recognizing the potential for further deterioration and the need for drainage, a minimally invasive approach was chosen. Under real-time ultrasound guidance, a percutaneous catheter was successfully inserted into the collection, facilitating drainage and relieving pressure on the spleen. The integration of radiological guidance ensured precise needle placement, minimizing the risk of injury to adjacent structures and optimizing therapeutic outcomes. Follow-up imaging confirmed successful drainage, with the patient showing marked clinical improvement post-procedure [3], [6].

5. Enhancing Emergency Protocols with Radiological Data

Protocol Development: Best Practices Incorporating Radiology

In the realm of emergency medicine, protocols serve as the cornerstone for consistent, efficient, and effective patient care. Integrating radiological data into these protocols is paramount for several reasons. Firstly, it aids in expediting the diagnostic process. By having a streamlined pathway for ordering, interpreting, and acting upon radiological findings, healthcare providers can reduce the time between patient presentation and definitive treatment. Moreover,



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standardized protocols ensure that all medical professionals within an emergency setting are on the same page, minimizing discrepancies in care.

Best practices in incorporating radiology into emergency protocols involve:

- **Standardized Reporting Templates:** Radiologists can use structured templates that highlight crucial findings, ensuring that emergency physicians quickly identify and act upon significant abnormalities.
- **Interdisciplinary Collaboration:** Regular meetings between radiologists and emergency medicine physicians foster mutual understanding and promote the development of tailored protocols that meet the unique needs of their institution.
- **Continuous Updates:** Given the dynamic nature of medical knowledge and technology, protocols should be regularly reviewed and updated to reflect the latest evidence-based practices.

Training and Education: Ensuring Proficiency among Emergency Physicians

Radiology is an intricate field that requires specialized training to interpret and apply findings accurately. For emergency physicians, integrating radiological data effectively into patient care necessitates robust training and ongoing education [7], [8].

- **Structured Curriculum:** Medical schools and residency programs should emphasize radiology's role in emergency medicine, ensuring that future physicians have a solid foundation in interpreting basic radiological images.
- **Simulation Training:** Hands-on simulations allow emergency physicians to practice interpreting radiological findings in a controlled environment, refining their skills without compromising patient care.
- **Continuing Medical Education (CME):** Given the rapid advancements in imaging technology and interpretation techniques, regular CME courses can keep emergency physicians abreast of the latest developments in the field.

Feedback Mechanisms: Continuous Improvement and Adaptation

Feedback mechanisms are vital for refining protocols and ensuring that radiological data integration continually enhances patient care outcomes. Institutions can implement:

- **Morbidity and Mortality Conferences:** These conferences provide a platform for healthcare providers to discuss challenging cases, identify areas for improvement, and adapt protocols accordingly.
- **Radiologist-Emergency Physician Feedback Loops:** Establishing channels for direct communication between radiologists and emergency physicians can facilitate real-time discussions about imaging findings, fostering collaborative problem-solving.
- **Patient Outcomes Analysis:** Regularly analyzing patient outcomes in relation to radiological interventions can highlight areas of success and areas needing improvement, guiding future protocol adjustments.

6. Challenges and Considerations

Technological Limitations and Advances

While radiological advancements have revolutionized emergency care, they also present challenges. The adoption of new technologies often comes with a learning curve, requiring institutions to invest in training and infrastructure. Additionally, not all facilities have access to



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the latest imaging modalities, leading to disparities in care quality. However, technological advances like AI-driven diagnostics offer promising solutions, provided they are integrated thoughtfully to augment, not replace, human expertise [9].

Ethical and Consent-related Concerns in Emergency Radiology

Emergency settings often require rapid interventions where obtaining informed consent for every imaging procedure may not be feasible. This raises ethical concerns about patient autonomy and privacy. Institutions must strike a balance between respecting patient rights and ensuring timely, life-saving interventions. Clear guidelines, patient education materials, and documentation protocols can help navigate these complexities.

Balancing Speed with Accuracy: The Delicate Equilibrium

In emergency medicine, time is of the essence, yet accuracy cannot be compromised. The pressure to expedite care can sometimes lead to hasty interpretations or decisions based on incomplete radiological data. Conversely, overemphasis on exhaustive imaging can delay critical interventions. Achieving the delicate equilibrium between speed and accuracy requires well-trained personnel, robust protocols, and a culture that prioritizes patient safety above all else [1], [2].

7. Future Directions and Innovations

Advancements in Imaging Technology: The Next Frontier

The realm of imaging technology is ever-evolving, promising transformative changes in diagnostic capabilities within emergency medicine. As we venture further into the 21st century, innovations such as advanced CT and MRI techniques, spectral imaging, and real-time three-dimensional reconstructions are emerging. These advancements offer higher resolution, enhanced clarity, and faster processing times. For emergency scenarios, where time is often the most critical factor, these enhanced technologies can make a profound difference. Rapid and precise diagnoses can be facilitated, reducing the margin for error and expediting appropriate interventions. Furthermore, the integration of portable and handheld imaging devices provides an added layer of flexibility, allowing for immediate assessments in diverse settings, from accident sites to rural healthcare facilities [6], [7].

Artificial Intelligence and Radiology: Potential Impacts on Emergency Care

The integration of artificial intelligence (AI) into radiology heralds a new era of potentialities. Machine learning algorithms can rapidly analyze vast amounts of imaging data, identifying patterns and anomalies with remarkable accuracy. In the context of emergency care, AI-powered radiological tools can expedite the interpretation process, flagging critical findings and guiding clinicians towards timely interventions. Moreover, predictive analytics derived from AI can aid in forecasting patient trajectories, thereby enabling preemptive measures and personalized treatment strategies. However, as with any technological advancement, the responsible deployment of AI in radiology necessitates rigorous validation, ethical considerations, and continuous refinement. Ensuring that AI augments rather than replaces human expertise remains paramount, emphasizing collaborative synergies between technology and clinical acumen.

Global Perspectives: Radiology's Role in Varied Healthcare Systems

Radiology's significance transcends geographical boundaries, yet its integration and impact vary across diverse healthcare systems worldwide. In high-income countries, advanced imaging



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modalities and infrastructure are often readily accessible, facilitating comprehensive emergency care. Contrastingly, in resource-limited settings, challenges related to equipment availability, training, and infrastructure pose considerable constraints. Addressing these disparities requires multifaceted strategies, encompassing capacity building, technology transfer, and collaborative partnerships. Initiatives fostering knowledge exchange, skill development, and resource-sharing can foster equitable access to radiological services, irrespective of geographical location or economic status. By embracing a global perspective, radiology can serve as a catalyst for enhancing emergency care standards universally [10].

Conclusion

Throughout this exploration, the indispensable role of radiology in shaping the trajectory of emergency medicine becomes unequivocally evident. From pioneering diagnostic advancements to fostering therapeutic innovations, radiology remains at the epicenter of emergent care. Its transformative influence extends beyond mere imaging, encapsulating a broader ethos of precision, efficacy, and patient-centricity. As we navigate the complexities of modern healthcare landscapes, a resounding call to action emerges: the imperative for continued integration and collaboration. Radiology's potential is magnified exponentially when harmonized with interdisciplinary expertise, technological innovation, and patient advocacy. Embracing a collaborative ethos, fostering interdisciplinary dialogues, and prioritizing patient outcomes can propel emergency medicine into a future defined by excellence, resilience, and innovation. In the intricate dance of emergency medicine, radiology emerges as both a guiding force and an innovation hub, continually steering the course of patient care. Its influence extends far beyond the confines of traditional diagnostics, touching the very essence of emergent healthcare with a profound commitment to precision and efficacy. As we navigate the complexities of contemporary healthcare landscapes, the imperative for sustained integration and collaboration becomes increasingly evident. Radiology's potential for transformative impact is maximized when harmonized with the collective expertise of diverse disciplines, fueled by technological innovation, and grounded in a steadfast dedication to advocating for the well-being of patients.

The collaborative ethos that underpins this integration is not just a conceptual ideal but a practical necessity. Interdisciplinary dialogues between radiologists, emergency physicians, surgeons, and other healthcare professionals form the bedrock of a comprehensive approach to emergent care. These dialogues transcend departmental boundaries, paving the way for a holistic understanding of patient cases and fostering an environment where each expert's unique perspective contributes to a more nuanced and effective care plan. Moreover, the seamless integration of cutting-edge technologies amplifies radiology's impact, enabling quicker and more accurate diagnoses. From advanced imaging modalities to artificial intelligence applications, the collaborative synergy between technology and radiology propels emergency medicine into a future where the boundaries of what is possible are constantly pushed. At the heart of this transformative journey is a relentless focus on patient outcomes.

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