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Review Article

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AI for Optimizing Imaging Department

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Abstract

Objectives: Demand for medical imaging continues to rise while radiology departments face personnel shortages, administrative bottlenecks, and increasing diagnostic complexity. Artificial intelligence (AI) offers tools that can automate repetitive tasks, streamline workflows, and enhance operational efficiency. This review examines contemporary literature on AI applications in imaging department management, with a special focus on the real-world implementation of an AI-assisted referral processing and scheduling system in a hospital CT unit.

Methods: A narrative review of peer-reviewed literature on AI in radiology workflow optimization was conducted, focusing on optical character recognition (OCR), natural language processing (NLP), triage systems, protocol selection, automated scheduling, and human-in-the-loop oversight models. Findings are integrated with a real-world case study from Tzafon Medical Center, where an AI workflow incorporating OCR, NLP, and a deterministic rule engine was deployed to support CT operations.

Results: Published studies demonstrate that AI can reduce administrative burden, improve protocol accuracy, assist triage, shorten turnaround times, and increase imaging throughput. The case example demonstrates comparable gains: automated referral processing improved CT volume by 20%, reduced administrative workload by 10 hours weekly, shortened waiting times by 30%, improved patient satisfaction by ~12%, and reduced annual complaint rates by 95%.

Conclusions: AI-enhanced workflow systems can substantially improve the efficiency, accuracy, and safety of imaging services—particularly when paired with robust human oversight. While clinical decision-making remains primarily the responsibility of trained radiologists and clinicians, administrative AI provides a scalable and reproducible method for optimizing imaging department operations. Future development will likely focus on more adaptive decision support, patient-specific protocol customization, and integration with hospital-wide resource management platforms.

Keywords: Artificial intelligence; Natural language processing; Optical character recognition; Radiology workflow; Patient safety; Clinical operations; Computed tomography

Introduction

Radiology departments worldwide face increasing pressure from growing imaging volumes, rising patient complexity, and persistent shortages of trained personnel. Computed tomography (CT) is a high-demand modality

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that serves a broad spectrum of inpatient and outpatient needs. The administrative processes supporting CT—referral handling, patient identification, triage, protocol selection, and scheduling—are labor-intensive and prone to errors or delays [1]. Artificial intelligence (AI), specifically optical character recognition (OCR), natural language processing (NLP), and machine-assisted decision support, has emerged as a promising approach to streamline administrative workflows. Recent advances in transfer learning, automated clinical concept extraction, and domain-adapted NLP pipelines enable extraction of meaningful structured data from unstructured referrals, scanned documents, and electronic health records (EHRs) [2-4]. This review summarizes the current state of AI in imaging department workflow optimization. We highlight the roles of OCR, NLP, rule-based decision engines, and human-supervised AI systems; discuss ethical and regulatory considerations; and contextualize the literature by presenting real-world evidence from the implementation of an AI workflow in a CT unit at Tzafon Medical Center (a regional hospital in the north of Israel). The results illustrate both the feasibility and the utility of AI-enhanced administrative systems in modern radiology practice.

AI in Radiology Workflow Optimization: Current Evidence

Automating Referral Processing and Patient Identification

Radiology referrals often arrive through heterogeneous formats, including handwritten notes, scanned PDFs, emails, and faxes. Manual transcription contributes significantly to administrative workload and introduces risk of human error. OCR systems have evolved to support multilingual and domain-specific text extraction, enabling automated capture of key identifiers and clinical information [4]. However, general OCR remains limited by document quality, no uniform formatting, and lack of clinical awareness. Studies evaluating medical OCR highlight the value of hybrid models that combine commercial OCR systems with contextual pattern matching and error-correction engines [1,4].

Natural Language Processing for Clinical Information Extraction

NLP has been increasingly used for extracting diagnoses, symptoms, comorbidities, and negated findings from medical text. Tools such as Deep Phe-CR have demonstrated high utility in cancer registry automation, producing structured clinical abstractions from pathology and diagnostic reports [1]. Similarly, rule-based and machine-learning NLP systems have been used to support triage, detect critical findings, and categorize studies [2,3]. NLP pipelines adapted to electronic health records (EHRs) can achieve precision levels of 90–99% in structured concept extraction, often outperforming manual abstraction [2,3]

Scheduling Optimization and Protocol Recommendation

AI-based scheduling tools can analyze modality availability, preparation requirements, contrast contraindications, and urgency levels to recommend appropriate scanning times. Systems integrating protocol rules with structured patient histories can reduce variability in protocol selection and minimize last-minute cancellations caused by improper preparation. Rule-based approaches remain dominant in clinical protocol management because of their transparency, auditability, and alignment with regulatory expectations. However, AI-assisted triage models incorporating machine learning are emerging.

AI for Radiology Operations: Impact on Efficiency and Safety

Studies in radiology workflow optimization have shown:

- 20–60% reductions in administrative workload through automation
- Improved standardization of exam preparation
- Faster triage and interpretation, especially in emergency care
- Higher protocol accuracy, reducing repeat imaging
- Patient-centered improvements, including better communication and shorter waiting times

These benefits are most pronounced when AI is paired with human supervision rather than used autonomously [5-8].

Real-World Case Study: AI-Assisted CT Workflow at Tzafon Medical Center

The CT unit at a Medical Center experience rising demand and administrative burden. To address this, the team developed a hybrid AI system combining:

1. OCR for digitizing heterogeneous referrals
2. Pattern matching for patient and provider identification
3. NLP (DigitalOwl) for extracting diagnoses, comorbidities, and negated findings
4. Deterministic rule-based engine for protocol recommendation and scheduling
5. Human-in-the-loop clinical oversight
6. Automated patient communication via SMS

Performance outcomes

These findings align with published evidence showing that administrative AI improves efficiency and reduces variability while maintaining clinical safety [1-7].

Human-in-the-Loop Safety Frameworks

A recurring theme across literature is the essential role of human oversight, particularly in:

Outcome	Result
CT volume	+20% (10,000 → 12,000 annual exams)
Administrative workload	10 hours/week saved
Waiting times	30% reduction
Patient satisfaction	↑ from 82–85% to 90–91%
Complaints	↓ from 170 (2019) to 7 (2024)
OCR patient ID accuracy	91.20%
NLP accuracy	F1 score 92.6% (8-quarter audit)

- Protocol selection
- Urgent or complex clinical pathways
- Verification of patient identifiers
- Handling ambiguous or low-quality input data
- Managing exceptions outside rule-based boundaries

Studies evaluating large language models (LLMs), including ChatGPT, emphasize significant limitations—hallucinations, inconsistencies, and gaps in domain-specific reasoning, underscoring the need for trained professionals to supervise AI-generated outputs [5]. Hybrid systems, such as the CT workflow described here, balance efficiency with patient safety by ensuring that staff review all AI-generated decisions.

Ethical and Regulatory Considerations

AI in radiology must adhere to ethical requirements involved:

Patient Privacy and Data Security

AI systems must comply with regulatory standards, ensure minimal exposure of identifiable information, and follow controlled data-sharing practices.

Transparency and Auditability

Regulators increasingly require that AI recommendations be explainable and traceable. Rule-based engines offer advantages because their logic is explicit.

Responsibility and Clinical Accountability

AI cannot replace clinical judgment; responsibility remains with clinicians and radiologists. 5–9

Equity and Bias Mitigation

Algorithms trained on unrepresentative data risk producing biased recommendations. Continuous audit—like the quarterly NLP accuracy assessments performed in the CT unit—helps reduce disparity.

Future Directions

- Based on current literature and real-world implementation experience, future opportunities include:
- Patient-specific protocol adaptation, integrating renal function, prior contrast exposure, radiation history, and comorbidities
- Dynamic triage algorithms using machine learning to stratify urgency
- Predictive scheduling that models' no-show patterns and modality turnover
- Cross-departmental hospital AI systems for resource allocation
- Greater NLP integration with imaging reports and clinical notes
- Continuous autonomous learning under supervised frameworks

Such advancements could reshape operational workflows across radiology and hospital systems more broadly.

Conclusion

AI-driven administrative systems offer a powerful approach to improving radiology workflow efficiency, safety, and patient satisfaction. OCR and NLP enable accurate data extraction from unstructured referrals; rule-based engines support consistent protocol selection and scheduling; and human oversight ensures clinical reliability. The real-world example from a Medical Center demonstrates substantial gains in throughput, accuracy, and patient experience—mirroring trends in published literature. AI will continue to transform operational aspects of radiology, provided its implementation remains responsible, transparent, and clinician supervised.

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