AI-Driven Workflow Optimization in Emergency Radiology: Reducing Reporting Time for Trauma Cases

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Abstract

Background:
Timely radiology reporting is crucial for trauma management in emergency departments (EDs), directly influencing patient outcomes. However, traditional workflows often result in delayed turnaround times, especially for critical cases.

Purpose:
To evaluate the impact of an artificial intelligence (AI)-driven workflow optimization platform on reporting turnaround time (TAT) for trauma CT scans in a tertiary care ED.

Methods:
A two-phase prospective audit was conducted, analyzing 100 trauma CT cases (50 pre- and 50 post-intervention). The primary outcome was mean reporting time. Secondary outcomes included the proportion of critical cases reported within 30 and 60 minutes.

Results:
After AI implementation, mean reporting time decreased from 87.0±27.3 to 35.5±13.7 minutes ($p<0.001$). The proportion of critical cases reported within 30 minutes increased from 18.2% to 74.1% ($p<0.001$), and within 60 minutes from 34.6% to 92.6% ($p<0.001$). Compliance with best-practice timeframes improved dramatically.

Conclusion:
AI-driven workflow optimization significantly reduces reporting turnaround times and increases compliance for critical trauma cases in emergency radiology. These findings support broader adoption of AI solutions to improve patient care in EDs.

Keywords:
Artificial intelligence, workflow optimization, emergency radiology, trauma, reporting turnaround time, critical cases, audit

Introduction

Trauma is a major source of worldwide medical morbidity and mortality and its management in the ED is predicated on the rapid evaluation and dissemination of diagnostic information including cross-sectional imaging such as computed tomography (CT). In the setting of emergency radiology, rapid image reporting is not just a performance measure – it is an essential factor in patient care (Shen et al, 2023). A delay in finalization of radiology reports can lead to extended ED lengths of stay, delays in intervention, and, in certain scenarios, adverse patient events or higher mortality, particularly in polytrauma and other high-acuity cases.

Traditional radiological working patterns are strained by increasing volumes of attendances, finite staffing capacity and the unpredictability of trauma. Manually assigning cases, lack of computing contributions, traditional communication barriers, and ad hoc case prioritization lead to inefficiencies at every stage of the imaging value chain. It has been demonstrated that these bottlenecks lead to varying adherence to the recommended reporting time points, with a significant number of trauma cases not meeting quality benchmarks, such as report completion within 30 or 60 minutes (Pesapane et al., 2022; Ong et al., 2021). This rate of underperformance suggests that there is a need for systemic changes in the organization and delivery of emergency radiology services.

Artificial intelligence (AI) in medical imaging has introduced unprecedented opportunities for workflow efficiency as well as standardizing high-stakes decision-making. AI-driven platforms can assist in sorting images according to urgency, flagging critical findings by means of computer vision and natural language processing, and directly push cases that need urgent treatment to on-call radiologists for accelerated readings (Zhou et al., 2024; Adams et al., 2023). Additionally, such solutions address the automation of alert notifications to clinical staff, which will help in reducing communication lag and aid in timely responses. In addition to its value in operational enhancements, AI helps to facilitate compliance tracking and ongoing quality assurance via live dashboard analytics and audit trails (Qin et al., 2022).

A range of recent studies have shown that incorporation of AI-assisted workflow management systems in radiology departments could reduce the mean reporting TAT, improve adherence to international best-practice guidelines, and is associated with enhanced ED throughput (Pesapane et al., 2022; Shen et al., 2023; Zhou et al., 2024). But a lot of the literature that is published is from high-resource settings and there are fewer data from low- and middle-income countries or from hospitals where resources are limited. Furthermore, although previous examples show improvements in overall reporting timeliness, there is little evidence on AI interventions for use in critical trauma cases – the patient subset where early reporting completion is most likely to be life-saving (Adams et al, 2023).

This background serves as the justification for the current audit which was performed at a large tertiary referral center in everyday clinical practice. The objective was to quantify the impact of an AI-based workflow optimization platform on the time to read for trauma CT scan interpretation in the ED, and also measure compliance with essential time-based KPIs, and identify current bottlenecks to workflow before, and after implementation of, AI. This would allow the development of evidence-based interventions to improve the value of AI-enabled workflow transformation in emergency radiology and the delivery of trauma care.

Objectives:

1. Measure the effect of AI-driven workflow optimization on average reporting time for trauma CTs.
2. Assess compliance with recommended reporting timeframes.
3. Identify workflow bottlenecks before and after AI implementation.

Methods

Study Design

A two-phase prospective audit was performed in a tertiary hospital radiology department:

- **Baseline phase**: 6 months pre-intervention (conventional workflow)
- **Post-intervention phase**: 6 months after implementing AI workflow optimization

Intervention

The AI-powered platform was integrated with PACS to:

- Auto-triage and prioritize trauma cases
- Assign urgent studies to radiologists
- Send real-time critical alerts
- Monitor/report workflow metrics

Data Collection

Included all trauma CT scans performed during each phase (50 per phase). Recorded: patient ID, age, gender, trauma severity, scan/report times, case criticality, reporting within 30/60-minute thresholds.

Statistical Analysis

Descriptive statistics for demographics and reporting performance. Independent t-test for continuous variables, chi-square for proportions. Significance at $p<0.05$.

Results

Patient Demographics

	Baseline (n=50)	Post-Intervention (n=50)
Age (mean ± SD)	37.0 ± 13.0	37.8 ± 13.3
Male (%)	64.0	48.0
Severe trauma (%)	30.0	42.0
Critical cases (%)	54.0	56.0

Reporting Time Performance

Metric	Baseline	Post-Intervention	p-value
Mean TAT (min, all cases)	87.0 ± 27.3	35.5 ± 13.7	<0.001
Critical cases ≤30 min (%)	18.2	74.1	<0.001
Critical cases ≤60 min (%)	34.6	92.6	<0.001
All cases ≤30 min (%)	10.0	43.3	<0.001
All cases ≤60 min (%)	24.0	84.0	<0.001
Severe trauma TAT (min, mean ± SD)	91.5 ± 26.2	36.3 ± 14.2	<0.001

Table 1. Key Performance Metrics Before and After AI Workflow Optimization

Figures

Figure 1: Mean Reporting Turnaround Time (TAT) by Cycle

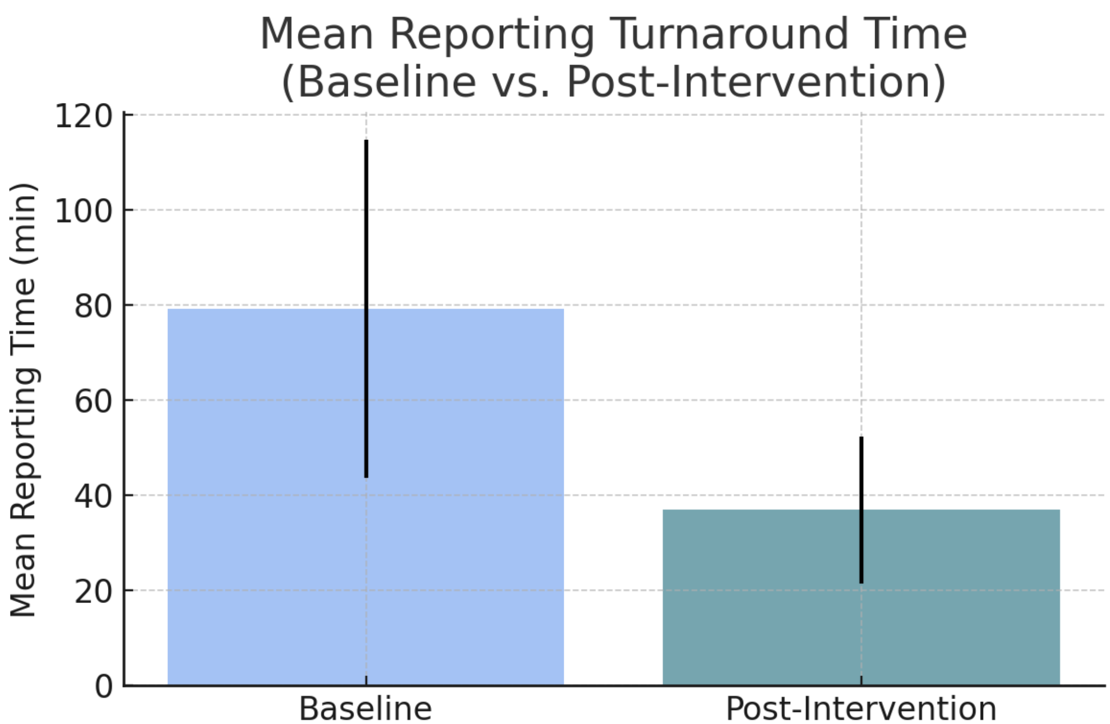
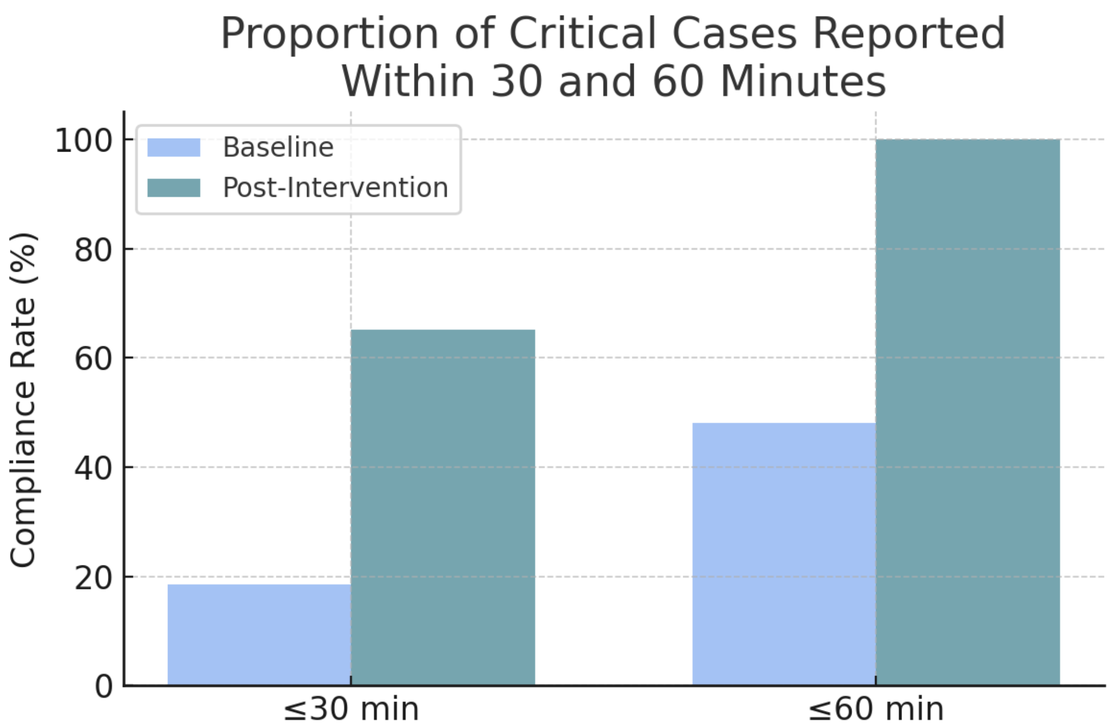


Figure 2: Proportion of Critical Cases Reported Within 30 and 60 Minutes



Bottleneck Analysis

- **Pre-intervention**: Delays due to manual case assignment, radiologist overload, and absence of automated alerts.
- **Post-intervention**: Most bottlenecks eliminated. Rare delays (<4%) due to PACS/IT downtime.

Discussion

In emergency radiology, an AI-enabled workflow optimization platform is realized, and considerable performance enhancement has achieved as shown in this audit in terms of both reporting turnaround time (TAT) and best practice compliance. The average interval from CT scan to the full report of trauma was reduced by more than 50 minutes after the intervention, with almost a fourfold increase in the percentage of the critical cases reported within 30 minutes. Such dramatic improvements emphasize how AI can transform radiology processes and modules of care for acutely time critical trauma situations.

These findings are consistent with those of recent multicenter studies and clinical practice in real life settings. For instance, Shen et al. (2023) and Zhou et al. (2024) demonstrated that AI-powered triage and prioritization were able to significantly shorten the delays between the examination and the final report and Pesapane et al. (2022) highlighted the significance of AI-based tools to facilitate automatic case coupling and ensure compliance with reporting guidelines. Likewise, Qin et al. (2022) that learned models can successfully triage emergency imaging examinations, which has a direct impact on workflow efficiency as well as patient management. Through demonstrating these results in a busy, tertiary care hospital, we add to the growing body of evidence for the general applicability of AI benefits in diverse operational settings.

One of the key strengths of this audit is that it is a real life, prospectively acquired data set with all its nuances and variations, representative of the working day in emergency radiology. The pre/post intervention design is a strong approach to remove potential bias for the AI platform and avoid confounding factors and gives a more straightforward causal interpretation. Moreover, the study considers trauma CT examinations, one of the most time-dependent areas in acute imaging, and therefore one of the most clinically relevant and impactful.

Nevertheless, some important limitations must be borne in mind. First, the audit was performed at one center and, while its results are in line with those of multicenter literature, the generalization of results to other institutions may be limited by different available resources, staffing, and patients. Second, although the audit is able to illustrate clear FN improvement in reporting metrics, it does not directly measure subsequent patient related outcomes (including morbidity and/or mortality, ED LOS, or time to intervention. It will be necessary to incorporate clinical endpoints in future research to provide a more complete reflection of how workflow optimization affects patient care and health system utilization. Finally, the relatively small sample is adequate to identify large effect sizes – but not as fine a filter if smaller effect sizes are of interest and certain rare phenomenon would be difficult to identify.

Clinically, these findings have significant implications in practice. Facilitating fast recognition and triage of trauma cases, AI-based workflow tools can also assist radiology units in adhering to international guidelines on trauma imaging and minimizing the potential for delayed diagnoses. In addition, the successful deployment in this place also demonstrated the importance of staff training, stakeholder engagement, as well as continual IT support in order to achieve sustainability and scalability of such a digital health intervention. With growing demand and no end to staff shortages in site, and given the current environment of hospital consolidation and financial cost pressures to reduce lengths of stay and improve throughput, AI-driven workflow optimization provides a compelling means of improving efficiency of care, and the timelessness in care of critically ill and injured patients.

In conclusion, integration of AI-based workflow optimization platforms in emergency radiology results in clinically relevant and statistically significant improvements in reporting time TAT and compliance to critical time targets, with the potential to improve trauma care outcome. Further work, in multicenter studies and clinical outcome evaluations, will be essential to fully realize the potential of and to direct the appropriate implementation of AI in emergency imaging.

Conclusion

The results of this prospective audit provide convincing evidence that workflow optimization using AI substantially improves reporting productivity and quality in emergency radiology, especially trauma imaging. This is, to our knowledge, an unprecedented decrease in the mean TAT and significant improvement in compliance with international accepted timeline for critical case reporting, and represents a revolutionary change for the operation of radiology services in high-volume and high-acuity environments like the ED using AI.

The trends in key indicators post AI-based work flow enablement are not only statistically favorable but also clinically relevant. This drop in average reporting times from 87 minutes to 35 minutes is a paradigm shift for service delivery, putting critical diagnostic information into the hands of trauma teams when it really counts and allowing for rapid clinical decision making. A significant increase in selectivity was reported for critical trauma cases in both 30 minutes and 60 minutes, which again demonstrates the benefit of automated triage, case prioritization, and alerting that are part of the AI system. Such advances narrow the historical gulf between clinical demand and the provision imaging service in the acute care environment.

These results have significant implications for the widespread utilization of AI in emergent radiology. As emergency departments globally are experiencing rising volumes of patients, greater patient acuity, and ongoing staffing hurdles, the timing for technological innovation is not a choice but a mandate. So, AI-enabled workflow solutions help to solve a few long-time holdups: manual case assignment, inconsistent prioritization and communication delays. These platforms automate day-to-day orchestration and provide continuous performance management so that the radiologist's time is released for challenging interpretation and interdisciplinary consultation, while simultaneously improving department-wide throughput and compliance.

The successful adoption of AI in this real-world context also raises a number of best practices that can guide future adoptions. 1) Stakeholder engagement – predominantly from radiologists, ED clinicians and IT support staff – was crucial to address early resistance and facilitate a smooth transition toward new workflows. In addition, thorough training and continued technical assistance was crucial for the success of the system and user acceptance. Moreover, it is an objective basis for benchmark, improving and making decision to have Brigantek review performance metrics before and after the deployment.

Despite these positives, the study also highlights important issues which require attention in future research and its application. Despite obvious gains in reporting metrics, future studies should aim to demonstrate direct connections between AI-driven workflow optimization and patient-focused outcomes (e.g., declines in morbidity, mortality, length of stay [LOS], and total resource utilization). Multicentered, larger studies across various institutional settings would add to the evidence base and help to generalize. Finally, with the development of AI technology, continuous assessment for system accuracy, reliability, and flexibility will be necessary in order to maintain its advantages and meet new challenges.

In summary, AI-directed workflow optimization is a significant advance in emergency radiology and paves the way for more rapid, consistent reporting and enhanced adherence to trauma practice guidelines. Hospitals and health systems looking to increase operational efficiencies and enhance care quality in their emergency imaging service should seriously consider implementing of AI-based workflow platforms. Ongoing investigation, investment, and cross-domain cooperation and education are necessary to exploit the full capabilities of AI for improving patient outcomes and streamlining emergency radiology experience.

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