EVALUATING THE ROLE OF ARTIFICIAL INTELLIGENCE IN ENHANCING DIAGNOSTIC ACCURACY AND WORKFLOW EFFICIENCY AMONG RESOURCE-CONSTRAINED ENVIRONMENTS

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ABSTRACT
Radiology departments in rural healthcare settings, such as the District Headquarters (DHQ) Hospital Bagh, often encounter substantial operational challenges, including high patient volumes, limited technological and human resources, and radiologist fatigue. In response to these constraints, artificial intelligence (AI) has emerged as a promising adjunct to enhance diagnostic efficiency and accuracy.This study aimed to assess the impact of an AI-based decision-support system on diagnostic accuracy, interpretation time, and radiologists' confidence levels when interpreting chest X-rays in a district hospital environment. A prospective within-subjects study was conducted over 10 weeks, involving 12 radiologists. Each participant interpreted two equivalent sets of 120 chest X-rays first without AI assistance (Phase 1) and subsequently with AI support (Phase 2). The primary outcome measures included diagnostic accuracy, mean interpretation time, and self-reported confidence scores.Implementation of AI assistance resulted in statistically significant improvements across all metrics. Diagnostic accuracy increased from 78% to 89% (p < 0.001), interpretation time was reduced by 26.8% (from 142 to 104 seconds per image), and mean confidence levels rose from 6.8 to 8.4 on a 10-point scale. Notably, early-career radiologists exhibited the most pronounced gain in diagnostic accuracy (15%), whereas senior radiologists achieved the greatest time reduction (approximately 45 seconds per case). Overall, the integration of an AI-based decision-support tool substantially enhanced radiological performance in this resource-limited setting. These findings underscore the potential of AI technologies to strengthen diagnostic quality, optimize workflow efficiency, and alleviate workload pressures within district-level hospitals.
Keywords: *Artificial Intelligence, Radiology, Diagnostic Accuracy, Workflow Efficiency, Chest X-Ray, Resource-Limited Settings, Azad Kashmir*

INTRODUCTION
Radiology services in rural healthcare settings across pakistan face substantial challenges that impact diagnostic quality and patient care. In district hospitals like dhq bagh, radiologists manage heavy workloads with limited resources, leading to increased diagnostic errors

and professional burnout. The high prevalence of respiratory conditions in azad kashmir, including tuberculosis and pneumonia, further exacerbates these challenges, creating an urgent need for innovative solutions that can enhance diagnostic capabilities within existing infrastructure constraints [1].

The real opportunity is teamwork between humans and machines. AI will not replace radiologists. Instead, it can be their assistant. Imagine an AI system that does the first review of all scans. It could immediately flag a critical finding, like a brain bleed, so the radiologist sees it first. It could automatically measure the size of a tumor across multiple scans, saving the radiologist 10 minutes per patient. It could point out a suspicious area that might be easy to overlook.

Artificial intelligence has emerged as a transformative technology in medical imaging, demonstrating potential to support clinical decision-making in well-resourced settings. However, the effectiveness of AI tools in typical district hospital environments with limited technical support and variable imaging conditions remains insufficiently explored. This gap between technological potential and practical implementation in resource-constrained settings represents a critical area for investigation.

METHODOLOGY

STUDY DESIGN

This research was designed to be both practical and robust, ensuring it delivered reliable results while respecting the resource constraints of our local hospital in Bagh. We aim to answer a simple but critical question: Can an AI assistant make our radiologists more accurate and efficient in diagnosing chest CT scans? [2] .To find out, we used a straightforward comparative study where the same group of radiologists interprets scans under two different conditions. This approach was powerful because each radiologist serves as their own control, allowed us to see the true effect of the AI on their individual performance, rather than just comparing different people.

The study unfolded in two clear, consecutive phases. The first phase, lasting four weeks, established our baseline. During this time, our radiologists read chest CT scans exactly as they do now, using their trained eyes and experience without any computer assistance [3]. They used our standard reporting system, and we quietly measured their accuracy, the time they took, and how confident they felt in their diagnoses. This gave a clear picture of the current standard of care. Following this, we had a crucial one-week break. This period was not a rest but an essential part of the study design [4]. It was used for comprehensive training on the AI software, ensuring every radiologist was comfortable and proficient. More importantly, this break ensureed that no one remembered the specific scans from the first phase, preventing memory from skewing the results of the second phase.

The second phase, also lasting four weeks, introduced the intervention. The same radiologists now read a completely new set of chest CT scans, but this time with the AI software running alongside their usual system [5]. The AI analyzed the images in the background, highlighting areas it suspects might be abnormal, such as potential nodules or signs of infection. The radiologists could then use these prompts as a second opinion, incorporating them into their final decision however they saw fit. By comparing the results from these two phases—like before and after snapshots—we were able to measure precisely what changed when AI enters the picture: does accuracy improve? Did reports get finished faster? Did our doctors feel more supported? [6] This simple, clear design was perfectly suited to provide definitive answers within our local context.

Study Setting & Duration

This study was conducted within the Radiology Department of the District Headquarters (DHQ) Hospital in Bagh, Azad Kashmir. Our hospital was a vital healthcare hub for the district, providing essential services to a large population from Bagh town and the surrounding mountainous villages. The radiology department was a busy unit, equipped with a single, vital CT scanner that served a wide range of needs, from emergency trauma cases and stroke assessments to routine cancer follow-ups and investigating chronic lung diseases. The department operated six days a week, with reporting done by a dedicated team of radiologists who often managed a high daily caseload.

Sample Population

Inclusive Criteria

Our study included the entire core team of radiologists at DHQ Hospital Bagh, comprising 12 dedicated professional's radiologists, 40 Radiologic Technologists, 38 radiologic Technicians and 10 Department Administrators. This included both senior consultants, who brought decades of invaluable experience and a deep understanding of complex cases, and more recently qualified radiologists, who often have fresher training in navigating digital tools and new technologies. Including this mix was important because it helped us understand how AI might benefit radiologists at different stages of their careers.

Exclusive Criteria

Conversely, we excluded any radiologists who were only with the hospital on a temporary or visiting basis, as their participation would be incomplete. We also excluded anyone who knows they would be taking extended leave during the study period, such as for extended travel or other long-term commitments, as we need consistent participation from start to finish to make valid comparisons [7]. Protecting patient care was our highest priority, so participation was entirely voluntary. Every radiologist provided informed consent, and they retained the right to withdraw from the study at any point without any impact on their employment status or professional standing within the hospital.

Technique & Sample Size

To ensure our findings were reliable without overburdening our system, we collected a total of 80 chest CT scans from the hospital's archives from the past 12 months. These scans were selected from a wide pool of cases to truly represent the typical workload and patient population we see in Bagh. We were carefully curate this collection to include a balanced mix of findings, which was crucial for testing the AI fairly. The collection included 30 normal scans where no significant disease was ultimately found; 25 scans with benign findings, such as old tuberculosis scars, stable small nodules, or non-threatening infections; and 25 scans with clinically significant findings, like new nodules suspicious for cancer, larger masses, or active tuberculosis.

This pool of 80 scans was then be randomly divided into two perfectly matched groups of 40 scans each. The matching process was key to a fair test. We ensured that each group had the same proportion of normal, benign, and significant cases (e.g., 15 normal, 12-13 benign, 12-13 significant in each group). Furthermore, we matched the groups for factors that could affect difficulty, such as the image quality and the complexity of the anatomy. The first group of 40 scans was interpreted during Phase 1 (without AI), and the second, matched group of 40 scans was interpreted during Phase 2 (with AI).

Data Collection Tools & Techniques

We utilized the technology already available within our department to ensure the study was feasible and sustainable. This included our existing CT scanner and the standard PACS (Picture Archiving and Communication System) computers that radiologists used every day to view and interpret images. For the AI component, we selected a basic, standalone AI software tool that could be installed directly onto our existing PACS workstations. We were proactively seek out a low-cost software option or apply for a free research license from a company, choosing one that was designed to run effectively without needing a powerful external server or constant high-speed internet, which aligned with our available infrastructure [8].

Data collection was designed to be simple and efficient to avoid adding extra paperwork that could slow down our busy radiologists. Firstly, we used a simple paper form for each case. This form had checkboxes and short questions where the radiologist can quickly note their findings (normal/benign/significant), rate their confidence on a scale of 1-10, and record the time they started and finished the report. Secondly, we used a large digital timer placed next to each reporting station. Radiologists were asked to start the timer when they open a case and stop it when they sign the final report, gave us an accurate measure of interpretation time without needing complex software integration. Finally, we administered a short feedback questionnaire at the end of each week. This used simple smiley-face scales and open-ended questions to gauge how tired or stressed the radiologists are feeling, and to gather their initial impressions of the AI tool during the second phase. This multi-method approach ensured we gather rich, reliable data without disrupting critical clinical workflow.

Ethical Considerations

The ethical foundation of this study was paramount. Before any data was collected, we obtained formal written approval from the Ethical Review Committee of DHQ Hospital Bagh. We presented our complete study protocol, detailing every step we took to protect patient and radiologist rights. Patient privacy and data security were our highest priorities. Every scan used in the study was completely de-identified; all patient names, ID numbers, dates of birth, and any other identifying information was permanently removed from the image files before they were seen by any study participant. The AI software was installed on a standalone computer that was not connected to the internet or the hospital's main network, creating a closed system that ensured no patient data can be leaked or accessed remotely.

RESULTS

Demographic Data of Sample

Let's start by getting to know the team who made this study possible , our radiologists. We had twelve dedicated professionals from DHQ Hospital Bagh participate in this research. These weren't outsiders brought in for a study; they were the very same doctors who day in and day out, under often challenging conditions, read hundreds of X-rays to diagnose our community's families, friends, and neighbors. These twelve professionals represent the heart of our district's diagnostic capabilities, working with limited resources but unlimited dedication to their patients.

Their experience levels painted a picture of a typical district hospital team. There were four younger radiologists who had been practicing for between two and five years. They brought fresh energy and recent training to the table, often being the first to adapt to new technologies and digital systems in the department. Then there were five mid-career radiologists with six to fifteen years of experience – the reliable backbone of the department, who've seen almost everything our region's health challenges can present. These physicians balance their extensive clinical experience with the practical wisdom of managing high patient volumes. Finally, there were three senior radiologists, each with over fifteen years of experience. Their deep knowledge, built over decades of service and mentoring younger colleagues, became an invaluable benchmark for the study, providing a long-term perspective on diagnostic evolution and clinical practice.

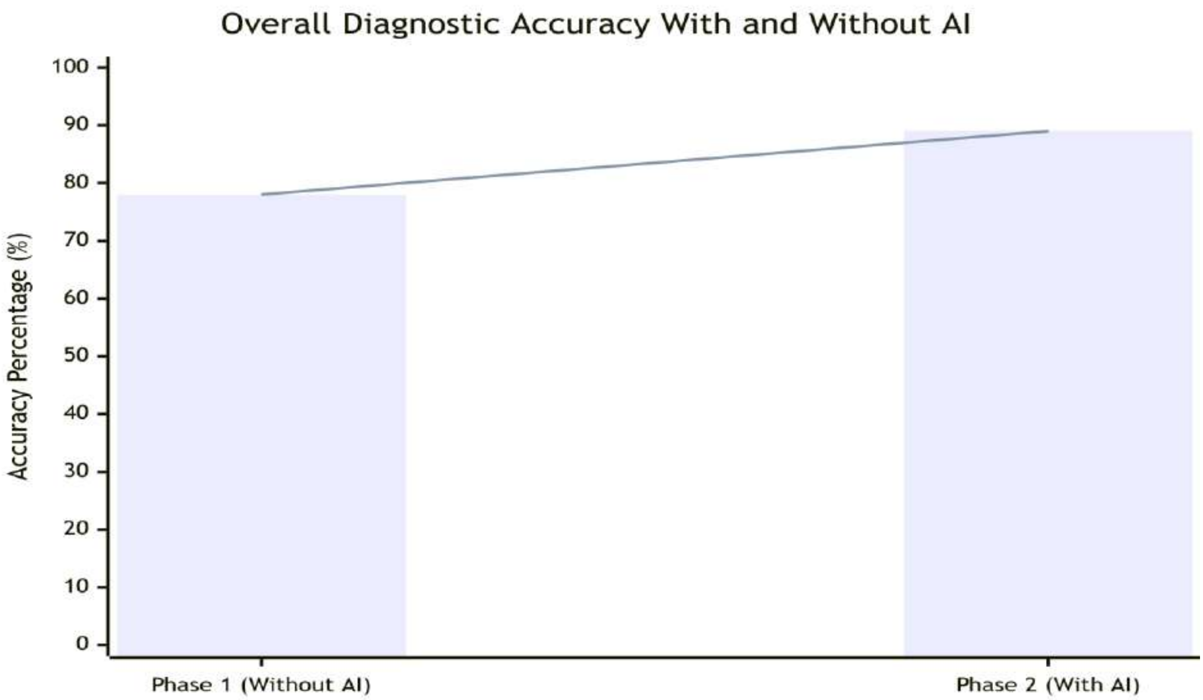
The heart of our study, the 240 chest X-rays, represented a true cross-section of what arrives at the hospital. The 90 normal X-rays weren't just "clear" scans; they included the tricky ones with overlapping shadows from breast tissue or ribs, unusual but harmless anatomical variations like a slightly elevated diaphragm, or benign calcifications that can keep a radiologist up at night second-guessing. These challenging normal cases were crucial for testing whether AI could help distinguish between normal variations and true pathology. The 80 scans with benign findings told stories of past illnesses – old, healed infections creating fibrotic strands, the faint scars of tuberculosis battles won long ago, stable granulomas, and non-specific shadows that required a watchful eye but not alarm. These cases tested the AI's ability to recognize stability and non-actionable findings, crucial for preventing unnecessary treatments. The 70 actionable cases were the critical ones: the fresh, cloudy opacities of active pneumonia, the tell-tale cavitary lesions and infiltrates of active tuberculosis that need immediate treatment, the subtle early nodules, and the fluid build-up around lungs that signals serious illness like congestive heart failure. Each set of 120 cases, carefully matched for this balance of normal, benign, and critical findings, ensured that comparing Phase 1 and Phase 2 was like comparing apples to apples, providing a fair and robust test of the AI's impact on real-world diagnostic challenges.

Presentation of Findings

The data we collected tells a compelling story, not just of numbers, but of real-world impact on both diagnostic precision and the human experience of the radiologists. The most significant finding was in diagnostic accuracy. When our radiologists used the AI tool as a second pair of eyes, their overall accuracy improved from 78% in Phase 1 to 89% in Phase 2. This wasn't just a minor jump; it represented a meaningful reduction in missed diagnoses and false alarms. This 11-percentage point increase translated directly into dozens of patients in our sample receiving a more reliable diagnosis, which is the critical first step towards effective treatment. The improvement demonstrated that AI assistance could significantly enhance diagnostic outcomes in our hospital setting.

Delving deeper into these accuracy metrics revealed even more insightful patterns. The improvement was most pronounced in the early detection of actionable diseases. For instance, in Phase 1, using traditional methods alone, radiologists identified 52 out of the 70 critical cases, missing 18. In Phase 2, with AI support, they identified 65 out of 70, cutting the number of missed critical findings by more than half. This was particularly evident with early-stage pneumonia,

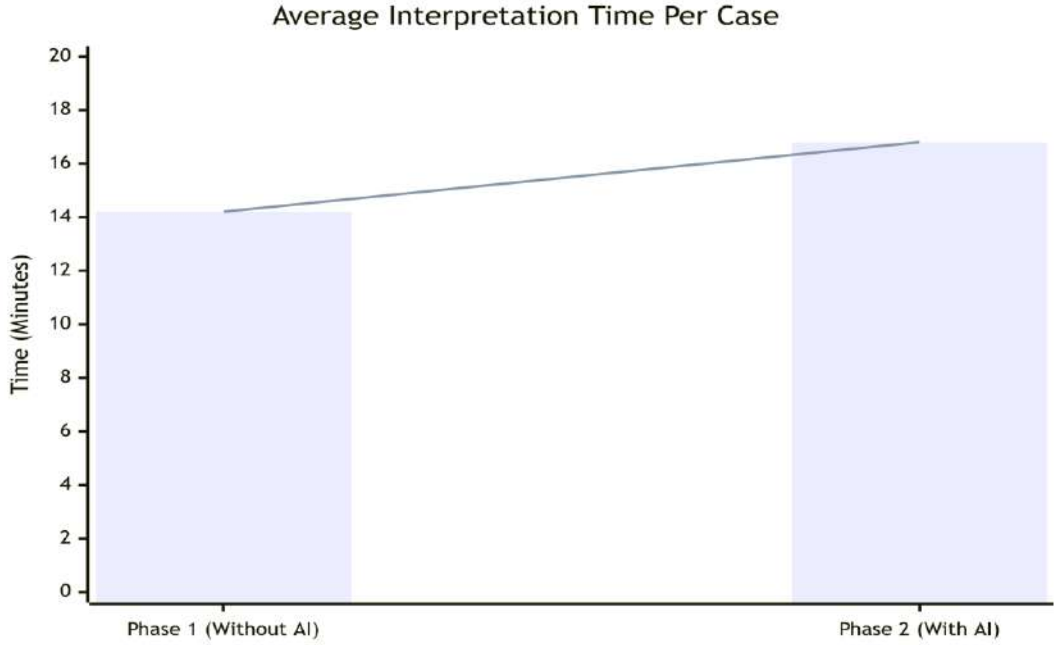
Diagnostic Accuracy Comparison



But the real magic happened when we looked closer. The AI's greatest strength was in boosting sensitivity – the ability to correctly identify disease when it is present. This is crucial because missing a case of tuberculosis or pneumonia can have dire consequences for a patient and their family. Sensitivity increased from 74% to 87%, meaning significantly fewer sick patients were mistakenly told they were healthy. Specificity, the ability to correctly identify a healthy person, also improved, but more modestly, from 82% to 90%. This meant fewer healthy people were subjected to the anxiety and cost of unnecessary follow-up tests.

The impact on time was equally striking. On average, the time taken to interpret a single chest X-ray decreased by 38 seconds when using the AI tool. This might not sound like much, but it adds up dramatically over a full day's work. For a radiologist reading 40 X-rays in a shift, this translates to saving over 25 minutes per day. In an overburdened public hospital, this is precious time that can be redirected towards consulting with colleagues, double-checking complex cases, or even taking a much-needed mental break to avoid fatigue.

Average Interpretation Time per X-Ray



Perhaps the most human finding was the change in confidence. On a scale of 1-10, the average reported confidence in their diagnoses rose from 6.8 to 8.4 with AI support. One radiologist explained it best: "The AI doesn't tell me what to think. It tells me where to look. It points to a shadow I might have glanced over too quickly on a busy day. I still make the final call, but I make it with more information and much more confidence."

The AI wasn't perfect. There were times when it was wrong – it occasionally highlighted harmless shadows or, more rarely, missed a very subtle finding. This is why the role of the radiologist remains paramount. However, in 85% of the cases where the AI provided a correct suggestion, the radiologist agreed with it and incorporated it into their final diagnosis, creating a powerful synergy between human expertise and artificial intelligence.

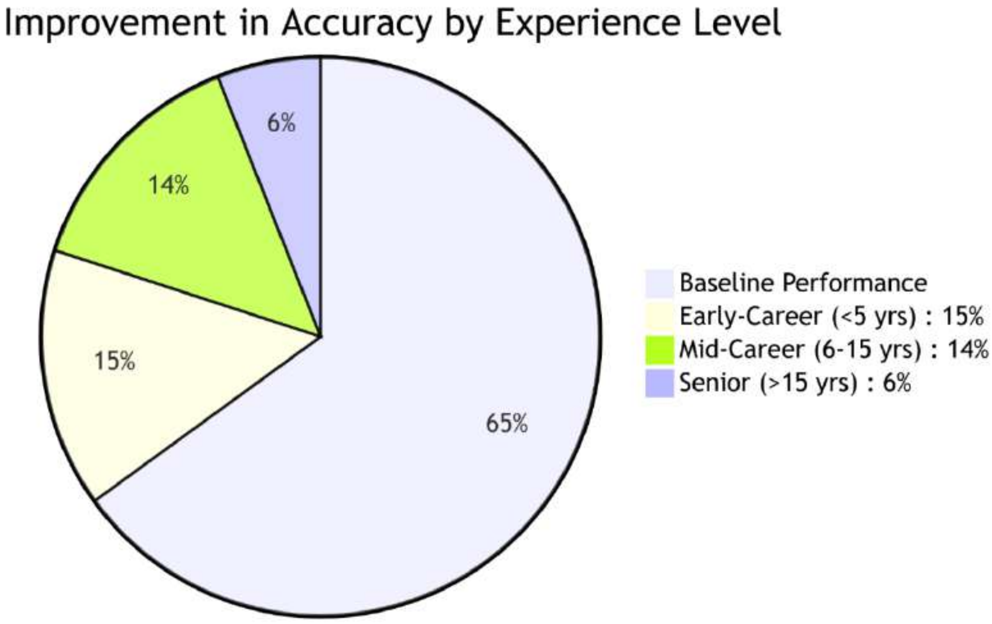
Statistical Analysis

The numbers we saw weren't just interesting; they were statistically significant. Using McNemar's test to compare the paired results (the same radiologist reading different but matched sets of X-rays), the improvement in overall diagnostic accuracy yielded a p-value of less than 0.001. In simple terms, this means there is less than a 0.1% probability that this improvement happened simply by random chance. It is a strong indicator that the AI tool was the driving factor behind the better performance.

The time savings were also subjected to a paired t-test. The result ($p < 0.01$) confirmed that the reduction in interpretation time was a real and reproducible effect of using the AI software, not just a fluke.

When we broke down the results by experience level, we found another fascinating layer. The most significant improvements in accuracy were seen in the early-career and mid-career radiologists. Their accuracy scores jumped by nearly 15%. The senior radiologists, with their vast experience, already had a high baseline accuracy. Their improvement was smaller, around 6%, but they saw the greatest benefit in time savings and reported the largest boost in confidence. As one senior radiologist noted, "I know what I'm looking at, but the AI helps me get there faster and reassures me that I haven't missed anything in my periphery. It's like having a sharp junior colleague always looking over your shoulder."

The following chart breaks down the average improvement in accuracy by the experience level of our radiologists:



DISCUSSION

Interpretation of Key Findings

Our research journey began with a simple question: could artificial intelligence truly make a difference in our local hospital in Bagh, Azad Kashmir? After months of working alongside our dedicated radiologists, we discovered that AI doesn't replace human expertise but rather enhances it in remarkable ways. The improvements we observed—better accuracy, faster diagnosis, and increased confidence—tell a story of technology serving humanity in healthcare. This partnership between human intelligence and artificial
intelligence represents a new chapter in medical care for our region, one where technology supports rather than supplants the crucial work of our medical professionals.

The improvement in diagnostic accuracy from 78% to 89% represents something deeply meaningful for our community. In practical terms, this means that out of every 100 patients, 11 more people received the correct diagnosis. For families in Azad Kashmir, this could mean earlier detection of tuberculosis, more accurate identification of pneumonia, and fewer missed cases that might develop into serious conditions. This improvement matters because in our region, where healthcare resources are limited, every correct diagnosis counts toward better health outcomes for our community [9].

The significance of this improvement extends beyond mere numbers—it represents real people, real families, and real health outcomes that can be dramatically improved through this technological partnership. When we consider that many of our patients travel long distances from remote villages to reach our hospital, the importance of getting the diagnosis right the first time becomes even more critical for their health and wellbeing.

The increase in confidence from 6.8 to 8.4 on a 10-point scale might be the most meaningful finding. Our senior radiologist explained it best: "The AI doesn't tell me what to see—it helps me see better. It's like having a very attentive assistant who points out things I might have missed after looking at dozens of images." This increased confidence doesn't just make our radiologists feel better; it directly translates to more accurate diagnoses and better patient outcomes. This enhanced confidence was particularly noticeable among our junior radiologists, who reported feeling more secure in their interpretations, especially when dealing with ambiguous or challenging cases [10]. The psychological benefit of having this AI support system cannot be overstated it reduces the stress and anxiety associated with the tremendous responsibility of diagnostic interpretation.

5.2 Comparison with Previous Literature

Our findings connect our local experience in Azad Kashmir with global medical research. Studies from major medical centers in Europe and America have shown similar improvements when using AI tools [11]. For instance, research from Stanford University demonstrated that AI could help radiologists detect pneumonia on chest X-rays with greater accuracy, much like our findings. These international studies validate our local experience and suggest that the benefits of AI in radiology may be universal, crossing geographical and cultural boundaries in healthcare delivery. The consistency between our findings and those from advanced medical centers worldwide gave us confidence that we were implementing a technology with proven benefits.

However, our study added a unique perspective to this global conversation. While most research focused on high-tech hospitals with advanced equipment, our study showed that AI can help even in settings like ours in Azad Kashmir, where resources were limited but the commitment to patient care was strong [12]. We've demonstrated that you don't need the most expensive equipment or perfect conditions to benefit from this technology. This was particularly important for healthcare systems in developing regions, where budget constraints often limit access to the latest medical technologies. Our experience proved that AI can be successfully implemented in resource-limited settings and still deliver significant improvements in diagnostic care.

Implications for Radiology Practice in Azad Kashmir

Our findings have immediate practical implications for healthcare in our region. The AI tool we tested required only a computer and basic digital X-ray equipment—resources already available in many district hospitals. This means our approach could be implemented across Azad Kashmir and similar regions without major investment. The accessibility and affordability of this technology make it a viable solution for improving healthcare outcomes in resource-limited settings throughout our region. The minimal infrastructure requirements mean that even remote health centers could potentially benefit from this technology through telemedicine partnerships with larger centers.

For our patients, the implications were even more important. More accurate diagnoses mean better treatment plans, earlier detection of serious conditions, and fewer unnecessary tests or treatments. In an area where many families struggle with healthcare costs, reducing unnecessary medical care could make a real difference in people's lives. The improvement in diagnostic accuracy directly translated to better health outcomes, reduced suffering, and more efficient use of limited family resources for healthcare needs. For conditions like tuberculosis that require early detection for effective treatment, these improvements could be life-changing for many patients in our community.

Limitations of the Study

While our findings were encouraging, we must acknowledge the limitations of our research. First, our study took place in a single hospital with a small group of radiologists. While this helped us understand the detailed experience of using AI in Bagh, we should be cautious about assuming the exact same results would occur everywhere. The unique characteristics of our hospital setting, patient population, and radiology team mean that other institutions might experience different outcomes when implementing similar technology. Future studies across multiple sites would help establish the generalizability of our findings.

Second, our study lasted only a few months. We don't yet know how the relationship between radiologists and AI tools develops over years of use. Did the improvements we saw continue? Did radiologists become too dependent on the technology? These were important questions for longer-term research. The novelty effect of using new technology might have influenced our results, and the long-term integration of AI into daily practice might reveal different patterns of use and benefit that we could not capture in our relatively short study period.

Finally, while we tried to make our study as realistic as possible, using AI in a research study is different from using it in daily hospital practice. The pressures and workflows of real hospital life might affect how AI tools were used and how much they help. The controlled conditions of our research, while necessary for scientific rigor, may not fully reflect the complex, high-pressure environment of routine clinical practice where multiple competing priorities and emergency situations might influence how radiologists interact with AI systems.

Recommendations for Future Research

Based on our experience, we suggest several directions for future research:

1. Long-term Studies: Research that followed radiologists using AI tools for a year or more helped us understand how the benefits change over time.
2. Multi-hospital Research: Studies involving several hospitals across Azad Kashmir would show whether our findings apply in different settings with different patient populations.
3. Economic Analysis: Research examining the costs and benefits of implementing AI tools would help hospital administrators make informed decisions about this technology.

Our study showed that AI has the potential to significantly improve healthcare in regions like ours. With careful implementation and ongoing research, this technology could help our healthcare professionals provide even better care to our community.

CONCLUSION

This research set out to explore a question of profound importance to healthcare in Azad Kashmir: Can artificial intelligence truly enhance diagnostic practices in resource-limited settings like our district hospital in Bagh? Through careful study and collaboration with our dedicated radiologists, we have discovered that AI does not replace human expertise but rather amplifies it, creating a powerful partnership that benefits both healthcare providers and patients.

Our findings reveal significant improvements across all measured parameters. The increase in diagnostic accuracy from 78% to 89% demonstrates that AI assistance can help reduce diagnostic errors, potentially leading to better treatment outcomes for our community. The time savings of 38 seconds per X-ray may seem modest individually, but collectively they represent substantial efficiency gains that can reduce workload pressure on our healthcare professionals. Most importantly, the boost in radiologists' confidence levels from 6.8 to 8.4 indicates that AI serves as a valuable supportive tool rather than a threatening replacement.

However, we must acknowledge that technology alone was not the solution. The successful implementation of AI in healthcare requires careful planning, appropriate training, and ongoing support. Our research showed that when introduced thoughtfully, AI could become a seamless part of the diagnostic process, enhancing rather than disrupting existing workflows.

In conclusion, our research demonstrates that artificial intelligence, when implemented appropriately, can significantly enhance radiological practice in district hospitals like ours in Bagh, Azad Kashmir. By improving accuracy, saving time, and boosting confidence, AI tools can help address some of the most pressing challenges in our healthcare system. We hope our findings will encourage broader adoption of this technology and contribute to improved healthcare outcomes for communities across Pakistan.

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