RESEARCH ARTICLE

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Improving the Timely Reporting of Critical Radiological Results in Oncology to Enhance Patient Safety (A Quality Improvement Initiative at SQCCCRC)

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Abstract

Background: Effective communication of critical radiological results is vital in oncology for timely interventions and preventing delays in patient care. Barriers such as radiologist workload, manual communication processes, and inconsistent protocols impede the timely reporting of critical findings. **Aim:** This study aims to the Timely Reporting of Critical Radiological Results in Oncology to improve patient safety. **Methods:** A pre-and-post design approach was used to assess key performance indicators before and after interventions. The study was conducted in in the radiology department of Sultan Qaboos Comprehensive Cancer Care and Research Center (SQCCCRC), University Medical city, Muscat, Oman. The FOCUS-PDCA framework guided the quality improvement process, addressing system inefficiencies, inconsistent communication, and non-standardized reporting. The intervention team included radiologists, oncologists, administrative staff, and IT personnel. Key issues identified were system downtimes, training gaps, inconsistent escalation practices, and lack of standardized protocols. Interventions targeted system modifications, staff education, and policy updates. Monthly compliance rates were tracked from June 2023 to May 2024, with audits assessing adherence to reporting protocols. Key performance indicators included reporting timeliness, documentation accuracy, and adherence to new protocols. **Results:** Post-intervention, compliance with critical radiology result reporting improved significantly, reaching 100%. Compliance initially fluctuated but rebounded after system modifications and staff training. Cochran's Q test showed a Q statistic of 7.6 with a p-value of 0.022, indicating a significant difference in compliance over the 12 months. Conclusion: Multidisciplinary collaboration, technology integration, and standardized protocols are crucial to improving critical result reporting and enhancing patient outcomes in Oncology settings.

Keywords: Critical radiology reporting- oncology- FOCUS-PDCA- quality improvement- Oman

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Introduction

Critical results in radiology refer to findings that indicate severe or potentially life-threatening conditions, such as new malignancies, metastases, or acute complications, requiring immediate communication between radiologists and clinicians to ensure timely interventions [1, 2] Effective communication of these findings is crucial for patient safety, particularly in oncology, where delays can lead to missed opportunities for prompt treatment adjustments. The Joint Commission International (JCI) mandates protocols ensuring critical results are reported promptly and communicated effectively to relevant healthcare providers, thereby preventing delays in care [2, 3, 4].

In oncology, timely reporting of critical radiological

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results is essential due to the rapid progression of many cancers and the need for precise treatment planning. Imaging plays a pivotal role in evaluating disease progression, monitoring treatment response, and identifying complications such as metastases or organ involvement [4, 5]. Given these high stakes, radiology departments must establish efficient reporting systems aligned with oncology care requirements. However, several barriers hinder timely and effective communication, including radiologist workload, interdepartmental communication breakdowns, and variability in reporting standards [5] Manual communication methods further complicate the process, leading to delays and potential miscommunication [5, 6]

Delayed communication of critical results severely impacts oncology patients, potentially leading to missed therapeutic windows and compromised care [6, 7]. For instance, detecting metastases or complications late may result in suboptimal treatment decisions. Improving the reporting process can mitigate these risks by ensuring prompt and accurate information delivery. Implementing automated systems, such as those employing artificial intelligence (AI) for radiology report generation, can streamline communication pathways and reduce delays [8, 9]. AI-based tools that generate alerts based on critical findings are becoming increasingly relevant, enhancing workflow efficiency [4, 7]

Quality improvement methodologies, such as the FOCUS-PDCA (Find, Organize, Clarify, Understand, Select – Plan, Do, Check, Act) framework, are particularly useful for addressing reporting inefficiencies. This structured approach allows healthcare teams to identify gaps in the current process, develop targeted interventions, and measure outcomes over time [10-16]. FOCUS-PDCA helps ensure that communication bottlenecks are resolved, enabling radiologists and oncologists to collaborate more effectively and respond to critical findings promptly [13].

Incorporating technology into the reporting process can further improve outcomes. Automated systems that integrate with Electronic Health Records (EHRs) facilitate the real-time delivery of reports to clinicians, minimizing delays [17, 18]

Despite technological advances and standardized protocols, significant gaps remain in the reporting of critical radiological results in oncology. Variability in adherence to protocols, differences in institutional practices, and staff shortages continue to pose challenges [15, 19-22]. These gaps highlight the need for further improvements and underscore the importance of consistent quality management practices.

The motivation for this study stems from observed delays in critical result reporting within our oncology department, leading to missed opportunities for timely intervention. Despite existing communication protocols, variability in the speed and accuracy of reporting has been noted, indicating the need for systematic improvements. These challenges prompted a comprehensive evaluation of the current process to identify areas for improvement.

Delayed reporting negatively impacts patient outcomes, particularly in oncology, where every moment counts [3,10]. Ensuring that critical findings are communicated without delay is essential for maintaining high standards of patient care. Addressing these challenges through targeted interventions can significantly enhance care delivery and improve clinical outcomes.

Quality improvement efforts, such as process standardization and the integration of automated alert systems, are essential to overcoming barriers in reporting. Studies show that leveraging AI tools can enhance the accuracy and speed of report generation, improving clinical workflow and reducing the risk of errors [3, 4]. These efforts align with the broader goals of enhancing radiology practices through technology and collaboration [6, 7].

The purpose of this study is to evaluate the existing critical result reporting system within the radiology department and identify areas for improvement, with a focus on oncology care. By applying the FOCUS-PDCA framework, the study aims to streamline communication, reduce delays, and ensure that critical findings are reported accurately and promptly. The goal is to develop a sustainable model for critical result reporting that improves patient outcomes and aligns with international standards for quality care.

Materials and Methods

Setting

This study was conducted at the Sultan Qaboos Comprehensive Cancer Care and Research Center (SQCCCRC), which is part of University Medical City, Oman. The setting is a comprehensive cancer care and research facility that offers specialized oncology services. The focus of this study was on improving the reporting process within this complex healthcare environment, addressing specific challenges related to communication, timeliness, and quality of reporting.

Design

The study utilized a pre-and-post design approach. This design allows for a comparison of outcomes before and after the implementation of interventions, providing insights into the effectiveness of the changes introduced. By evaluating key performance indicators both prior to and following the interventions, the study aimed to determine the impact on reporting quality, timeliness, and compliance.

Data Analysis

The data analysis for this study involved a thorough examination of compliance rates with critical radiology results reporting across a 12-month period, utilizing both descriptive statistics and inferential tests to assess changes over time. The analysis included Cochran's Q Test indicated a difference in compliance rates across the months.

Framework

The FOCUS PDCA framework was employed as the guiding methodology for this quality improvement initiative. The FOCUS PDCA framework is a structured approach used to identify and address performance issues

systematically:

• Find: Identify a process that requires improvement.

• Organize: Assemble a team with the necessary expertise to work on the improvement.

• Clarify: Clearly define the current process and determine any gaps or inefficiencies.

• Understand: Analyze data to understand why the current process is underperforming.

• Select: Choose an improvement strategy based on the findings.

• Plan: Develop a detailed plan for implementing the chosen improvements.

• Do: Implement the plan on a small scale, testing the proposed changes.

• Check: Assess the results of the implementation to see if it achieved the desired outcomes.

• Act: Standardize the successful changes, scaling them to a larger setting if the results are favorable.

This systematic framework ensured a thorough understanding of the existing issues and facilitated a step-by-step approach to implementing improvements and measuring their impact on reporting practices at the SQCCCRC. The FOCUS PDCA cycle also allowed for ongoing monitoring, enabling adjustments and refinements throughout the implementation process to achieve optimal results.

Identify the process

The flowchart in Figure 1 outlines the process for managing critical findings after a medical examination. It begins with the completion of an exam. If a critical finding is identified, the responsible party must contact the physician. If no critical finding is present, the process simply ends.

When a physician is contacted, the flow continues based on their availability. If the physician is available, the critical result is communicated directly. If the physician is not available, the contact is escalated to ensure that the information reaches the appropriate medical professional promptly.

Once the result is communicated, the process involves documenting the communication for proper record-keeping. This documentation step helps maintain compliance and ensures that the necessary actions are traceable. The process concludes after all communication and documentation are completed.

This flowchart emphasizes the importance of timely communication, proper escalation, and thorough documentation to ensure patient safety and effective management of critical findings.

Process Stakeholder

The process begins with the radiologist, who is responsible for identifying critical findings and initiating the communication chain. Once the critical findings are identified, the ordering physician receives the information, playing a pivotal role in taking the necessary actions based on the results. If the ordering physician is unavailable, a backup or on-call physician serves as an alternate point of contact to ensure there is no delay in response. To further facilitate communication, the radiology administrative staff or nurse coordinator helps manage and escalate the process as needed, ensuring effective follow-up.

The IT or communications team is also a key player, providing support for the documentation process and ensuring that the communication tools, such as PACS or RIS, are operational and able to log the information appropriately. RIS (Radiology Information System) is software designed to manage radiology workflows, including patient scheduling, tracking, reporting, and

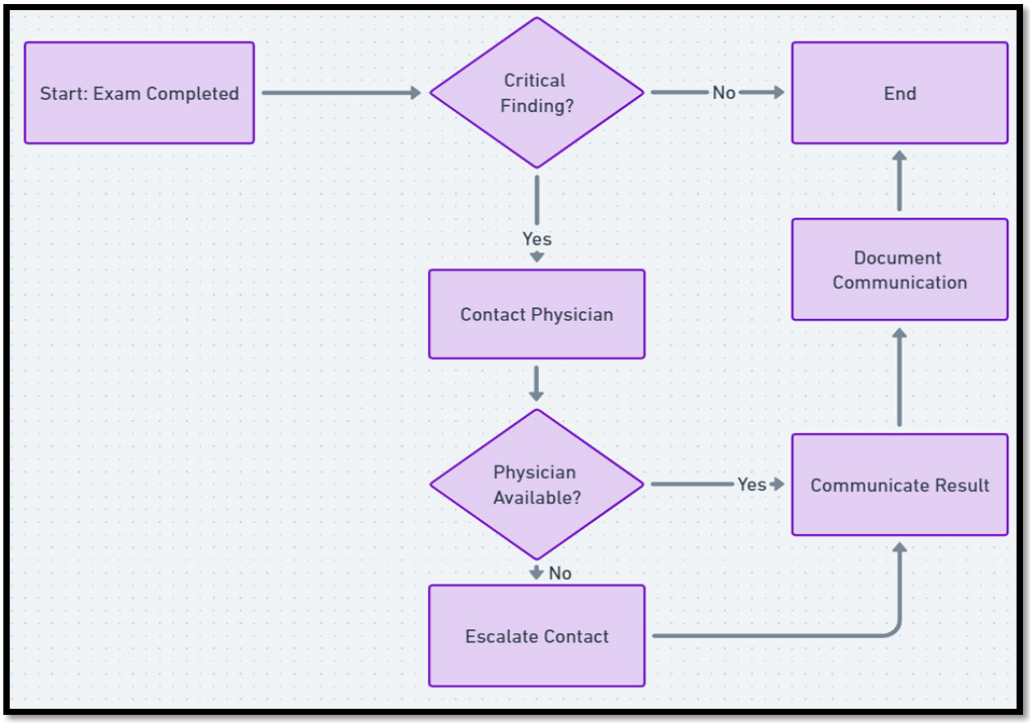

Figure 1. Process for Timely Reporting of Critical Radiology Findings

integration with Electronic Health Records (EHRs), streamlining administrative and clinical tasks [1, 3]. PACS (Picture Archiving and Communication System) is a technology for storing, retrieving, and sharing digital imaging data like X-rays and MRIs, providing radiologists with tools for viewing and interpretation. Together, RIS and PACS enhance radiology efficiency by managing both workflow and imaging data, ensuring seamless communication and collaboration in healthcare [1, 6].

Finally, the patient care team, although not directly involved in the initial communication, becomes a critical part of the process once the ordering physician takes action on the critical results to provide the necessary care for the patient.

Auditing, incident investigation, and brainstorming to identify Root Causes

The diagram in Figure 2 presents the root causes of improper reporting, identified through auditing, incident investigation, and brainstorming. These root causes are categorized into several areas: system modifications, staff education and training, policy updates, and additional causes.

System Modification issues include system downtimes or failures, which impact the timely completion of reports. Incorrect data entry and poor system integration between departments also contribute to improper reporting, leading to inconsistencies and delays.

Staff Education and Training is another significant factor. Misinterpretation of imaging results and errors in report documentation often stem from insufficient training or experience. High staff workloads, inadequate training on reporting procedures, and staff burnout also negatively affect the accuracy and timeliness of reports.

Policy Update challenges include inadequate reporting guidelines or protocols, missing follow-up processes for critical results, and weak or unclear escalation mechanisms. These gaps in policy can lead to inconsistent practices and delayed actions on critical findings.

Additional Causes that contribute to improper reporting include the lack of effective communication tools or channels, failure to prioritize critical results, delayed access to imaging systems, and the unavailability of backup staff during emergencies. Moreover, inconsistent monitoring and feedback on reporting, as well as differing escalation practices across shifts, add to the complexity of ensuring proper reporting.

Overall, these root causes collectively impact the accuracy, timeliness, and consistency of medical reporting, emphasizing the need for targeted interventions in systems, training, policies, and communication practices.

Prioritizing the Root Causes of Improper Reporting

The Pareto chart in Figure 3 presents the root causes of improper reporting and helps prioritize the issues that need the most immediate attention. By displaying the frequency of each cause and their cumulative impact, the chart allows us to identify which factors are contributing the most to improper reporting and thus should be addressed first.

According to the Pareto principle, 80% of the issues can be resolved by focusing on the top 7 causes. First,

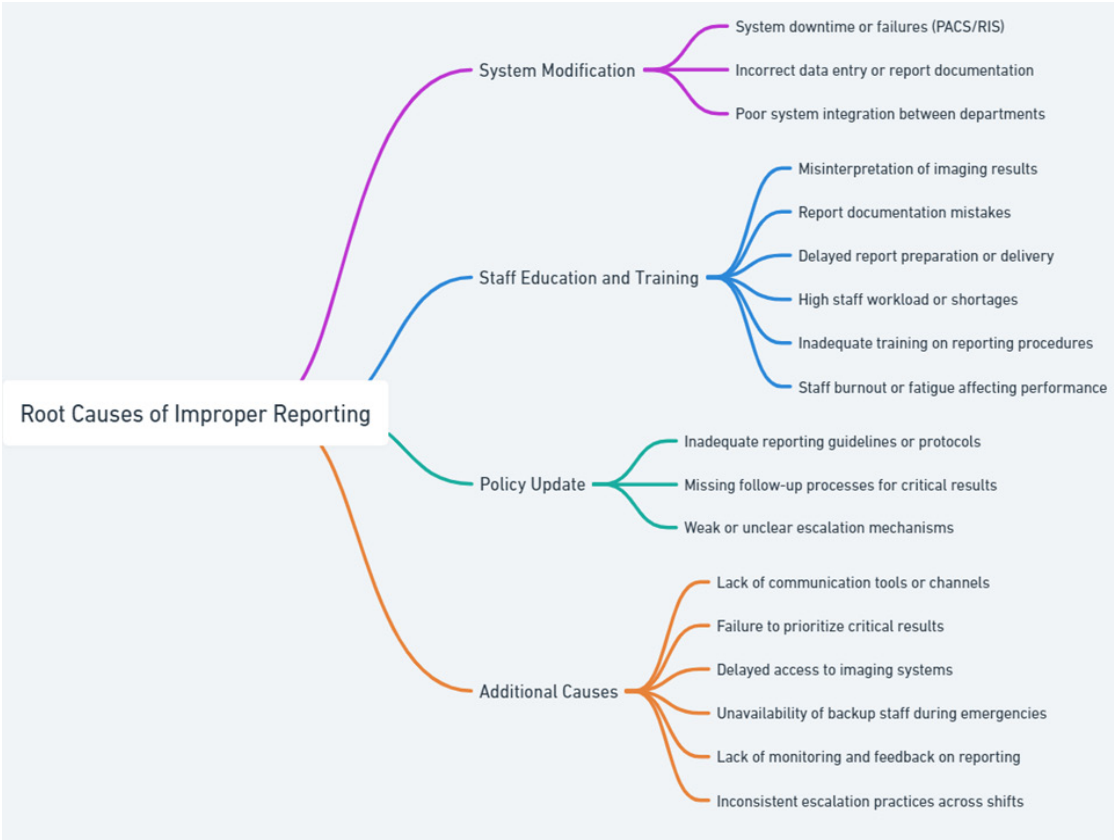

Figure 2. Root Causes of Improper Reporting in Radiology

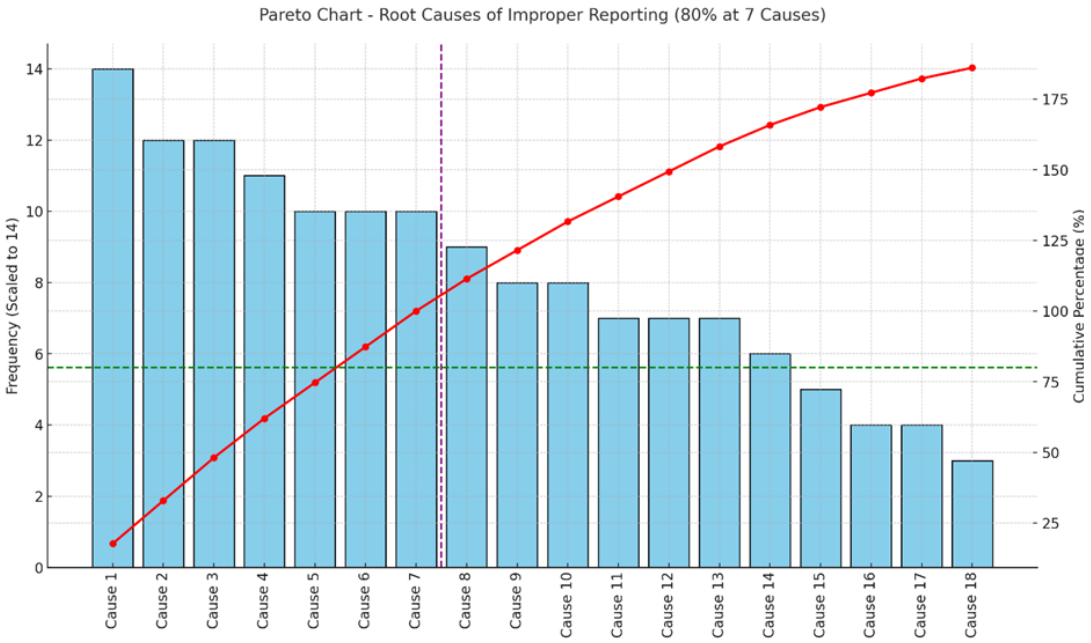

Figure 3. Pareto Chart - Root Causes of Improper Reporting (80% at Top 7 Causes)

poor system build-in, feature, and integration between departments is the most frequent issue, indicating significant challenges with the system's functionality and the way different departments interact through it. This affects the overall efficiency and accuracy of reporting.

Second, inadequate reporting guidelines or protocols contribute to inconsistency. Without clear guidelines, staff may have difficulty knowing the proper steps to take, leading to improper reporting practices. Third, inadequate training on reporting procedures is a significant issue. Insufficient training can lead to mistakes, delays, and miscommunication. Addressing training gaps is crucial to improving reporting accuracy and timeliness.

Fourth, poor system features and integration between departments highlights redundant system issues that need to be addressed. The redundancy between the first and fourth causes emphasizes the importance of improving the technical infrastructure that supports the reporting process. Fifth, missing follow-up processes for critical results is another key factor. When there is no structured follow-up, critical findings might not receive the necessary attention, affecting patient outcomes.

Sixth, inconsistent escalation practices across shifts contribute to delays in addressing critical information. When escalation procedures vary from shift to shift, it can lead to confusion and hinder effective communication of urgent findings. Seventh, lack of communication tools or channels impacts effective information sharing, particularly for time-sensitive situations. Addressing this issue is crucial to ensure timely communication of critical findings.

Addressing these top 7 causes have a significant positive impact on improving the reporting process, as they collectively contribute to the majority of improper reporting issues. The purple vertical line in the chart marks the 7th cause, illustrating the point at which focused interventions will yield the most considerable benefits.

The remaining causes, such as unavailability of backup staff, incorrect data entry, lack of monitoring and feedback, and others, while still contributing to improper reporting, have a lesser impact. Once the primary issues are resolved, the focus can then shift to addressing these secondary factors to further optimize the reporting process.

Area of Improvement and intervention

As Table 1 showed, the study implemented targeted interventions to address key areas of improvement in critical radiology result reporting. These interventions were developed based on our previous investigation and brain storming as well as reviewing many published studies [11-30], focusing on system modifications, staff training, and policy updates. Enhancements to the Radiology Information System (RIS) introduced reminder features to prompt timely reporting and ensure accurate documentation, with the IT Department overseeing these upgrades and tracking their effectiveness through system-generated reminders.

To address knowledge gaps, multiple training sessions were conducted by the Training and Development Team in collaboration with the Radiology Team, providing staff with a clear understanding of the new processes. The success of this intervention was measured using pre- and post-training assessments and monitoring compliance with reporting protocols.

Additionally, reporting policies were revised to clearly define critical findings and standardize procedures for communication and escalation. The Radiology and Quality Management Teams were responsible for these updates, with adherence monitored through audits and compliance reviews. Together, these interventions created a robust framework to streamline reporting, enhance staff performance, and promote standardized practices, ultimately improving patient safety.

Table 1. Areas of Improvement, Interventions, Operational Descriptions, Responsibilities, and Measures of Implementation

Area	Intervention	Operation Description	Responsibility	Measure of Implementation
System Modification	Enhancements in the Radiology Information System (RIS)	Introduced reminder features to prompt timely reporting and ensure accurate documentation	IT Department	Tracking system-generated reminders and their effectiveness in ensuring timeliness
Staff Education and Training	Multiple training sessions	Conducted sessions to provide staff with a thorough understanding of new reporting processes	Training and Development Team, Radiology team	Pre- and post-training assessments; monitoring compliance with reporting protocols
Policy Update	Revision of reporting policies	Revised policies to clearly define and identify critical radiology results	Radiology team, Quality Management and Leadership Teams	Audits of adherence to updated protocols and review of compliance documentation

Results

The compliance rate trends from June 2023 to May 2024 reveal a dynamic process of improvement, with notable fluctuations and successful interventions (Figure 4). Initially, compliance was inconsistent, starting at 67% in June 2023 and increasing to 86% in July. However, the rate declined over the following months, reaching a low of 60% in October, suggesting challenges in maintaining consistent adherence to protocols. This period of fluctuation indicates possible issues such as process adjustments, staff adaptation, or system inefficiencies.

A turning point occurred in November 2023, where compliance reached 100% and remained stable through February 2024. This improvement reflects the effective implementation of interventions such as system modifications, staff training, and policy updates. However, in March 2024, compliance dipped to 67%, which has been due to operational challenges, increased workloads, and staffing issues. Despite this setback, the compliance rate rebounded to 100% in April and May, demonstrating a successful recovery and commitment to sustaining high standards.

Overall, the trend shows an initial struggle with maintaining compliance, followed by significant improvements, occasional setbacks, and ultimately a return to full adherence, highlighting the impact of quality initiatives in improving reporting processes.

The compliance rate has improved by 49.25% from June 2023 to May 2024. Cochran's Q Test produced a Q statistic of 7.6 with a p-value of 0.022. This indicates that there is a significant difference in compliance rates across the 12-month period. Since the p-value is below the 0.05 threshold, it suggests that the compliance rates have significantly changed over time, demonstrating a notable trend throughout the observed periods.

Discussion

This study has several strengths that underscore its value in addressing critical radiology reporting in oncology. Firstly, it adopts a multidisciplinary approach, engaging radiologists, oncologists, IT staff, and administrative personnel to ensure comprehensive identification and resolution of barriers [23, 24]. Such collaboration strengthens the robustness of the interventions and promotes sustainable improvements in practice. Secondly, the study applies a well-established quality improvement framework, FOCUS-PDCA, which allows for a systematic and iterative process of problem-

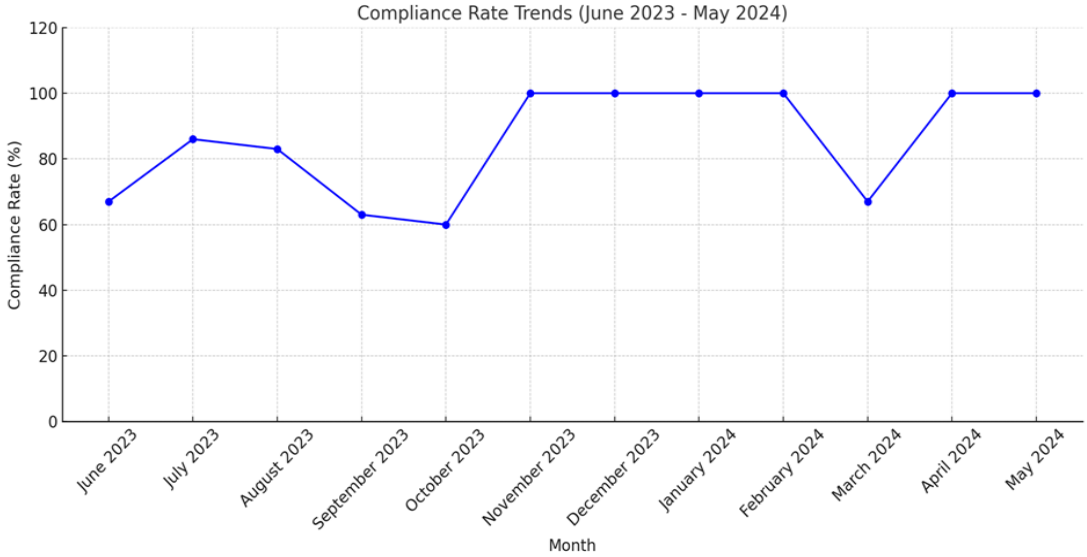

Figure 4. Compliance Rate with Critical Radiology Results Reporting Trends from June 2023 to May 2024

solving. This ensures that interventions are tailored to address specific gaps in the reporting process and are refined based on ongoing feedback [19, 26]. Thirdly, the use of a pre-and-post design provides strong evidence of the impact of the interventions by demonstrating measurable improvements in compliance and timeliness of reporting over time [13, 27]. The significant improvement in compliance rates, as evidenced by statistical analysis, further reinforces the effectiveness of the interventions.

Additionally, the integration of technology into the intervention process is another key strength [17, 18]. Automated tools and enhancements to the Radiology Information System (RIS) have been shown to streamline communication pathways and reduce dependency on manual processes, which are prone to errors and delays [10-14]. By addressing multiple facets of the reporting process system inefficiencies, lack of standardization, and staff training gaps. This study demonstrates a holistic approach to improving critical radiology reporting [18, 21, 28].

The rationale for the interventions implemented in this study stems from the identified barriers that impede timely and accurate reporting of critical radiology results in oncology. Each intervention was specifically designed to target a key challenge, ensuring that improvements were both practical and impactful.

Delays in reporting were partly attributed to inefficiencies in the existing radiology information system. Enhancements such as automated reminders, streamlined data entry processes, and real-time alerts for critical findings directly addressed these inefficiencies [21, 22]. The rationale behind these modifications was to eliminate the reliance on manual tracking and reduce errors associated with delayed or missed communications [19, 24]. These changes ensured that radiologists and clinicians received timely notifications of critical results, enabling prompt clinical decision-making [26, 27].

Inconsistent adherence to reporting protocols and errors in documentation were traced back to gaps in staff knowledge and training. Multiple training sessions were conducted to equip staff with a clear understanding of the revised processes and the importance of timely reporting in oncology care. The rationale for this intervention was that empowered and well-informed staff are better equipped to follow protocols and prioritize critical findings, thereby enhancing overall efficiency [20-22].

The absence of standardized reporting templates and protocols was a significant contributor to variability and delays in critical result reporting [19, 25]. Revising policies to clearly define what constitutes a critical finding and establishing standardized procedures for reporting and escalation ensured consistency across all cases. The rationale for this intervention was to reduce variability and create a clear, structured approach to handling critical results, which is essential in a high-stakes oncology setting [26-30].

The implemented interventions collectively addressed the key bottlenecks in the critical result reporting process, leading to substantial improvements in compliance and timeliness. The system modifications introduced automation and integration, minimizing delays associated with manual processes. For instance, automated alerts ensured that radiologists and oncologists were immediately notified of critical findings, allowing for faster response times [19. 23. 24]. Furthermore, the introduction of reminder features and streamlined data entry processes improved documentation accuracy and reduced errors, leading to better compliance with reporting protocols [17,18].

Staff education and training interventions ensured that all personnel were aligned with the revised policies and procedures. By emphasizing the importance of timely reporting and providing hands-on training, staff were better prepared to manage their workload efficiently and adhere to protocols. The resulting improvement in staff competence and confidence was reflected in the increased compliance rates observed during the post-intervention period [20-22].

Policy updates, including the introduction of standardized reporting templates, eliminated inconsistencies in how critical findings were communicated [13, 18]. These updates ensured that all relevant information was captured and shared in a uniform manner, reducing the risk of miscommunication or missed follow-up actions. The clear definition of escalation protocols further enhanced the process by [13, 18].

The use of the FOCUS-PDCA framework provided a structured methodology for ongoing evaluation and refinement of the interventions [10-16]. By regularly monitoring compliance rates and collecting feedback from staff, the study was able to identify and address additional challenges, such as operational disruptions and staff adaptation issues. For example, the dip in compliance observed during the middle of the study period highlighted areas for further improvement, such as enhancing staff support during high workload periods. These insights enabled the research team to implement targeted adjustments, ensuring sustained improvement in the reporting process [10, 18, 22].

The strength of this study lies in its ability to translate identified challenges into targeted, evidence-based interventions that address the specific needs of an oncology radiology department. The interventions were not only practical but also scalable, offering a sustainable model for improving critical result reporting in other healthcare settings. The rationale for these interventions was firmly rooted in the barriers identified during the initial assessment, ensuring that each solution directly tackled the underlying causes of delays and errors. This comprehensive approach has led to measurable improvements in timeliness, accuracy, and adherence to protocols, ultimately enhancing patient safety and outcomes in oncology care.

A key limitation of this study is its focus on a single oncology center, which may limit the generalizability of the findings to other healthcare settings. Additionally, the reliance on retrospective chart reviews introduces the possibility of missing or incomplete data, potentially affecting the accuracy of the results.

In conclusion, this study underscores the importance of

enhancing critical result reporting in radiology, particularly for oncology patients at the Sultan Qaboos Comprehensive Cancer Care and Research Center (SQCCCRC), which is part of University Medical City, Oman. Timely imaging updates are essential for optimal treatment. Healthcare institutions should focus on standardized communication processes, structured reporting templates, and continuous quality improvement efforts such as the FOCUS-PDCA framework. Strengthening collaboration among radiologists, oncologists, and other healthcare professionals ensures critical findings are promptly communicated, improving patient outcomes and aligning with international patient safety standards.

Author Contribution Statement

All authors contributed significantly to the study. Project Leader and Coordinator: Badriya Al Qassabi, Omar Ayaad. Data Collection and Analysis: Balaqis Al Faliti, Ahmed Sheikh Omar, Shima Alajmi. Study Supervisor: Rashid AlSukaiti, Khalid Al-Baimani. Project Implementation: Badriya Al Qassabi, Rashid AlSukaiti, Ahmed Sheikh Omar. Writing Manuscript: Omar Ayaad, Rawan Ibrahim, Balaqis Al Faliti. Manuscript Review: Aref Zribi, Juma Ali Hamed Al Kasbi, Salim Nasser AlDhahli, Mashan Mohammed AlGhaithi, Nabiha Said AlHasni, Sara Al Sheedi, Huda Shinoon Al-Awaisi, Abdallah Yahya AlFarai

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This manuscript is derived from the approved research plan conducted at SQCCCRC under the ethical guidelines and principles outlined by the institution's Code of Ethics. The study was implemented at SQCCCRC, University Medical City, Oman, with ethical approval obtained from the institutional ethics committee. The research plan commenced in June 2023 as part of ongoing quality improvement initiatives aimed at enhancing radiology reporting practices in oncology care.

Code of Ethics

The study adhered to the ethical principles outlined in the Declaration of Helsinki, ensuring respect, beneficence, and justice for all participants involved.

Scientific Approval

The study was conducted in accordance with institutional ethical guidelines and approved by the SQCCCRC research committee (code: CCCRC-115-2024). Patient confidentiality and data protection protocols were strictly maintained throughout the research.

Availability of Data

The data supporting this research are available upon reasonable request from the corresponding author.

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