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Radiation Oncology Incident Analysis: Timing and QA Effectiveness

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Abstract

Purpose: This study aimed to evaluate the timing of incident occurrence and detection across the radiation oncology workflow to identify error-prone workflow processes and to assess the effectiveness of quality assurance (QA) processes. The findings provide insights to improve QA processes and clinical workflows to enhance patient care.

Methods: Incident reports submitted between August 2021 and July 2025 were retrospectively reviewed. Each incident was categorized by the workflow step when it occurred, workflow step when it was detected, the clinical role that caused the incident, and the QA process or workflow step that identified the incident. Analysis was conducted to determine which processes were most susceptible to cause incidents and which QA processes were most effective in incident detection.

Results: Most incidents were detected within zero or one workflow step, highlighting the effectiveness of self-checks and subsequent QA processes. Noticeable delayed detection was observed with 11% of treatment planning incidents detected during treatment delivery (four steps later) and 18% of simulation incidents detected during treatment delivery (five steps later). The physics initial chart check identified 49% of planning incidents that progressed beyond planning, while the physics weekly chart check detected 40% of treatment-related incidents, with an additional 40% identified before the chart check occurred. Trends in incident reporting suggest an ongoing commitment to safety improvement in the radiation oncology department.

Conclusion: By characterizing when and how incidents occur and are detected, this study provides insight to enhance the effectiveness of QA processes within radiation oncology workflows. Trends in reported events over the study period reflect a commitment to reporting and improving safety within the radiation oncology department.

Introduction

This study identifies error-prone workflow processes and evaluates the effectiveness of quality assurance (QA) in radiation oncology by characterizing the occurrence and detection of clinical incidents. By linking incident timing to specific workflow steps and clinical roles, this analysis identifies where existing QA practices succeed and where gaps exist. The findings provide insights to improve QA processes and clinical workflows to enhance patient care.

Methods

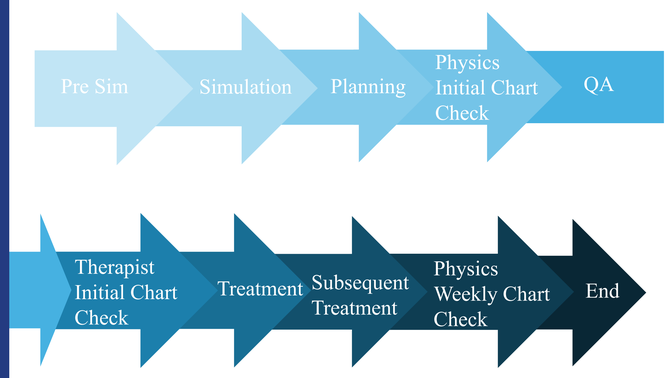
Retrospectively analyzed 769 incidents reported from September 2021 to March 2025 at Duke University. This comprised approximately 0.5% of patient encounters within this time.

4 centers within the Duke Network were analyzed.

Cancer Center (Duke Main)	8 linacs, 3 CTs, 1 MRI
Duke Wake County	4 linacs, 3 CTs, 1 MRI
Duke Regional Hospital	1 linac, 1 CT, 1 MRI
Mariah Parham	1 linac, 1 CT, 1 MRI

Incident was categorized by
(1) Origin - When it occurred and the associated role
(2) Detection - When it was found and who found it

The "when" was one of the following clinical workflow steps, in the order in which they appear below:



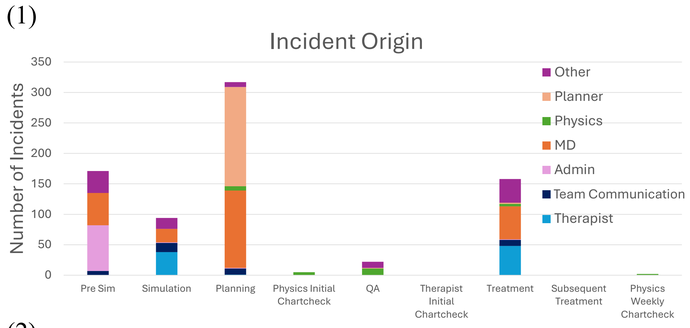
The role associated with causing or finding the incident are: Planner, Physicist, MD, Admin, Team Communication, and Therapist. Where, a physicist or dosimetrist can act as a planner and residents are categorized with their associated MD or physics role.

Analysis was then conducted to identify strengths and gaps in QA processes.

Results

Identifying Error Prone Workflow Processes

(1)



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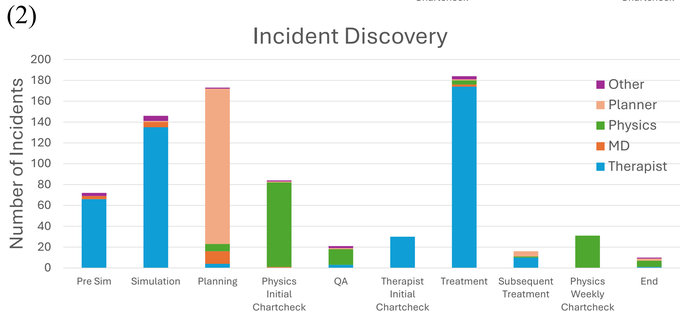


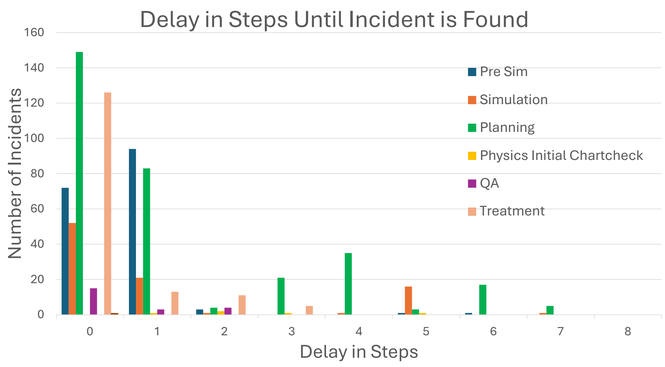
When do the most incidents occur?

41% - Planning (317)
22% - Pre Sim (171)
21% - Treatment (158)
12% - Simulation (92)

Assessing the Effectiveness of QA Processes

The delay in incident detection is defined as the number of workflow steps between error occurrence and discovery, with a delay of zero indicating identification within the same step.

Many incidents were detected with delays of zero or one step, reflecting the effectiveness of built-in self-checks and QA processes.

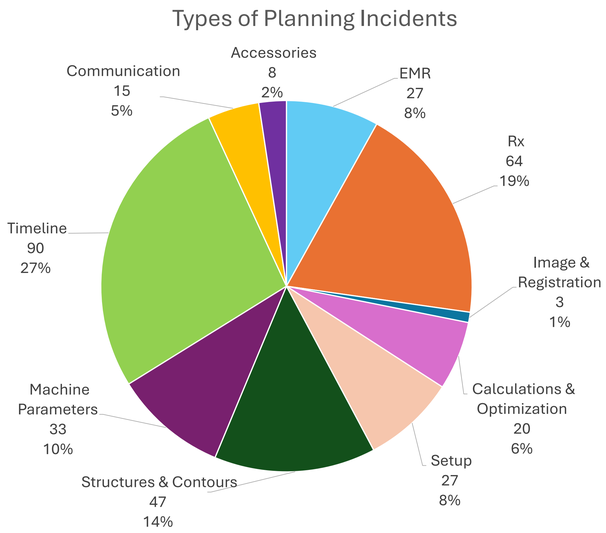


Delay in Identifying Incidents

- 18% of simulation incidents were not found until treatment, 5 steps later
  - Most are incorrect setup notes
- 11% of planning incidents were not found until treatment, 4 steps later
- 5% of planning incidents were found 6 steps later during weekly chart check

Planning Incidents

Many simulation cases that reach treatment are related to incorrect setup notes discovered at treatment. In contrast, planning cases show greater variation, reflecting the diverse processes involved in this workflow step.
The variation in planning incidents is seen below:



Discussion

In general, the role actively involved in a workflow step was most frequently responsible for both introducing and detecting incidents, while review processes, such as chart checks, identified errors without contributing to their creation.

The majority of reported incidents were within the planning stage, which was expected due to the number of tasks associated with this step. Timeline violations and prescription typos caused almost 50% of all planning incidents, associated with human error.

About 2/3 of reported events are good catches, with the remaining 1/3rd reaching patients resulting in no harm.

Conclusion

- Most incidents originate in planning
- Detection of simulation and planning incidents can be delayed due to workflow processes
- Chart check plays a crucial role in incident detection, not creation
- Trends observed show a commitment to safety and continuous improvement

This study provided greater insight into the effectiveness of QA processes within the radiation oncology workflow. Highlighting success of chart checks while also bringing attention to where improvements can occur.