

A Comprehensive Yearly Review of U.S. NRC Event Notification Reports

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ABSTRACT

Purpose:

To evaluate 2024 NRC medical-related Event Notification Reports and identify recurring incident patterns as well as isotope-specific trends from January through December. By characterizing common failure modes and operational vulnerabilities, this analysis aims to support quality-management improvements and guide targeted strategies to reduce future occurrences.

Methods:

All NRC Event Notification Reports from January–December 2024 were compiled into a structured database (N=1,240). Reports were classified as medical or non-medical, with only medical events included in the final evaluation dataset. Two supplemental datasets were generated: an incident-category dataset (N=89) and an isotope-incident dataset (N=84) derived from monthly tabulations. Events were categorized by facility type, radionuclide, incident mechanism, and regulatory significance. Quantitative analyses were performed using Python and Excel to generate frequency distributions, temporal trends, and graphical summaries. Root-cause patterns were classified and evaluated across human-factor, procedural, and equipment-related contributors.

Results:

A total of 89 medical-related incidents were identified across 10 incident categories. Underexposure was the most frequent type of event, followed by contamination, lost source, and retraction events when ranking the incidents based on their occurrence throughout the year. Monthly totals remained stable, indicating a consistent baseline for reportable occurrences. The isotope-specific dataset contained 84 events total, with 5 events of unidentified isotope. Y-90 accounted for 42 incidents, representing the largest proportion of radionuclide-related reports.

Conclusion:

The 2024 data reveal persistent patterns in underexposure, contamination, and lost-source incidents, along with a disproportionate number of Y-90–related events. The concentration of Y-90 events suggests workflow-specific vulnerabilities in radiopharmaceutical handling and verification. These findings highlight opportunities to strengthen verification protocols, source-tracking practices, and radiopharmaceutical procedures. The development of targeted quality-control interventions may reduce recurrence and enhance institutional safety performance. Organizations that address lessons learned from these events have an opportunity to strengthen their quality management programs.

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INTRODUCTION

The U.S. Nuclear Regulatory Commission (NRC) requires licensed facilities to report medical events involving the use of radioactive materials, providing a comprehensive record of reportable incidents each year. Analysis of the 2024 NRC medical event reports identifies recurring trends and contributing factors, providing valuable insights that can inform targeted recommendations to improve safety practices and reduce the occurrence of future incidents.

METHODS AND MATERIALS

Using the 2024 NRC Event Notification Reports, 89 medically related cases were identified and extracted to construct structured datasets of incident types and associated isotopes. These datasets were used to support quantitative analysis and visualization aimed at identifying potential root causes. Data extraction and organization were initially performed in Excel before being transferred to Python for statistical analysis and chart generation. This workflow enabled systematic evaluation of incident patterns, with root-cause factors categorized across human, procedural, and equipment-related contributors.

RESULTS

Monthly incident totals remained relatively stable, indicating a consistent baseline of reportable events throughout the year

- **84 incidents had an identified radionuclide** (5 incidents involved an unidentified isotope)
- **Yttrium-90 (Y-90)** was associated with 42 incidents, making it the most frequently reported radionuclide

We were able to identify 10 incident categories

- Most common incident type: **Underexposure**

Other frequently reported incidents included:

- Contamination, Lost source, and Retraction events

Isotope Incident Counts for 2024

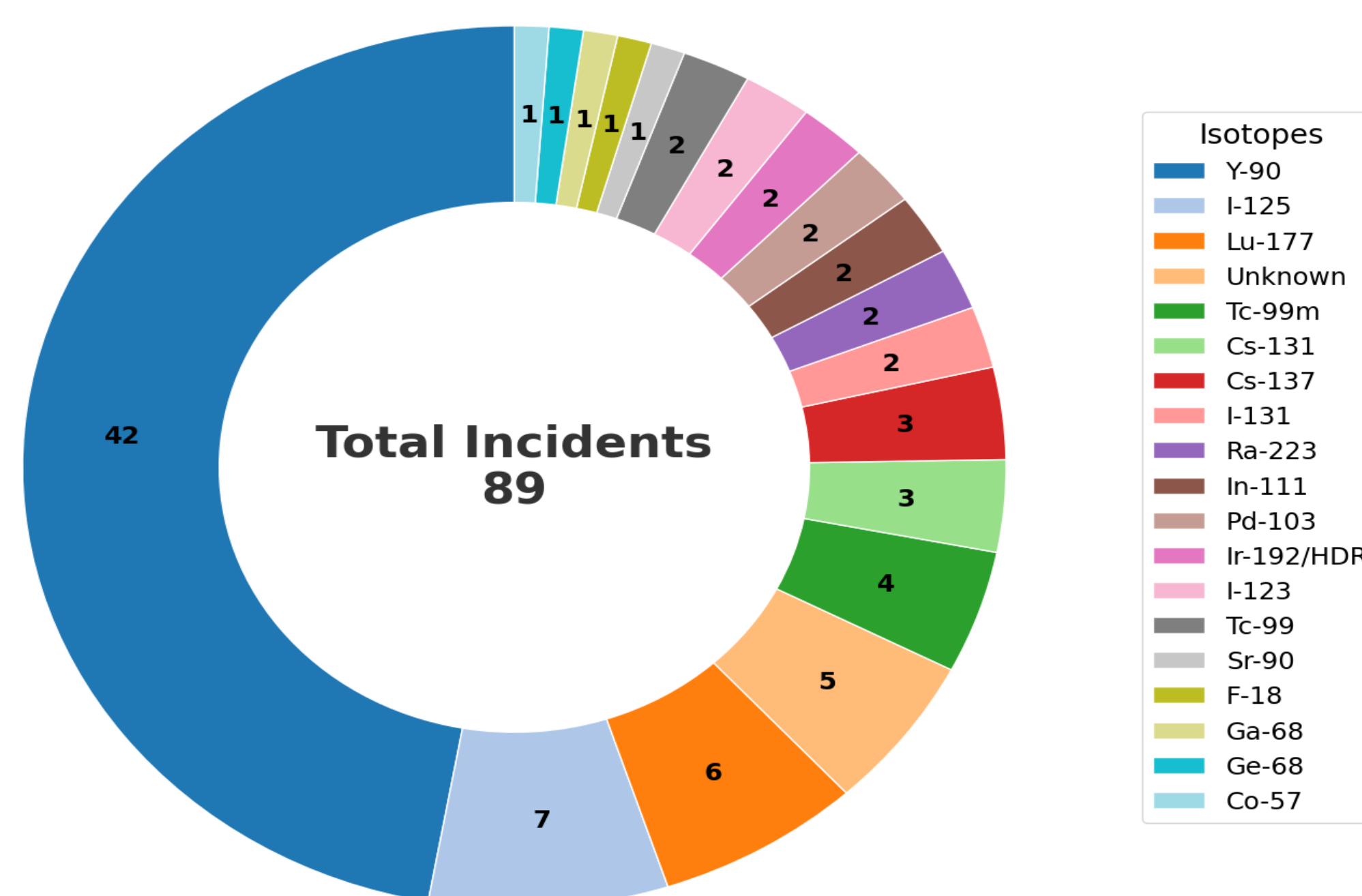


Figure 1. Y-90 was the predominant isotope involved in reported radiation incidents during 2024, accounting for 42 of the 89 total incidents (47.2%).

Radiation Incident Types for 2024

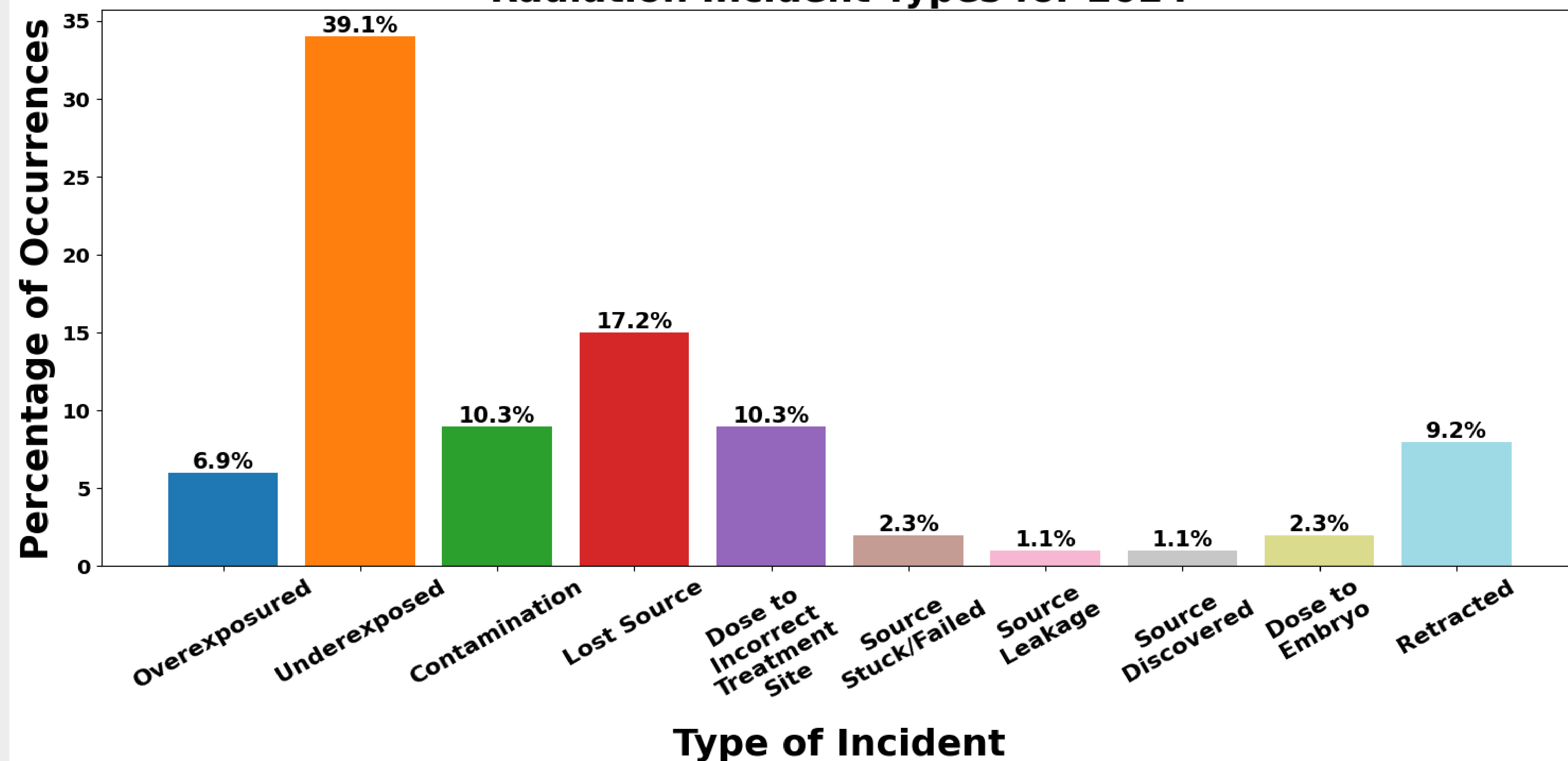


Figure 2. Underexposure was the most common radiation incident reported in 2024, comprising 39.1% of all incidents. This proportion was more than double that of the second most frequent incident type, lost source (17.2%), indicating that under delivery of the prescribed radiation dose remained the most prevalent event across reports.

DISCUSSION

- **Underexposure events** corrective actions included stopping treatment or notifying the patient after treatment completion
- **Administration errors** (contamination, lost source, incorrect treatment site, etc.) occurred at multiple stages of the treatment process, indicating workflow vulnerabilities
- **Lost source incidents** were attributed to either implanted sources that could not be fully located in patients or radioactive materials misplaced during shipping, delivery, or facility inventory
- **Overexposure events** had the potential for serious biological impact, requiring further investigation and subsequent tracking
- **Yttrium-90 (Y-90)** was most associated with underexposure events, particularly during liver-directed therapies
- **Retraction events** were either issued without explanation or followed NRC review determining that the event no longer met reporting criteria
- **Five incidents** involved unidentified radionuclides due to incomplete or unavailable isotope information in the licensee reports
- **Root causes** were primarily linked to human error, procedural deficiencies, and equipment-related issues across the reported incidents

CONCLUSIONS

- **Most reportable medical events** were associated with preventable human and procedural errors, particularly underexposure, lost source, contamination, and incorrect treatment site incidents.
- **Yttrium-90 (Y-90)** was the radionuclide most frequently involved, emphasizing the need for enhanced quality assurance during Y-90 treatment planning and delivery.
- Strengthening **workflow standardization, staff training, inventory control, and independent dose verification** can reduce the occurrence of future reportable events.
- Requiring **complete and standardized NRC event reports** will improve root-cause analysis, facilitate knowledge sharing among licensees, and support the development of more effective safety practices.
- Implementing **independent treatment verification** (e.g., second-check procedures by a qualified medical physicist) and improving procedural compliance can help minimize underexposure events and enhance patient safety.

REFERENCES

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