Clinical Results of a Medical Error Reduction/Compliance Software Program in Radiation Oncology

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Purpose/Objective

To describe the results of two medical error reduction models, one paper-based and one software-based, and compare their findings with error rates found at other institutions.

Materials/Methods

Both models are designed to monitor key processes and self-identify patient safety errors, accreditation failures, and regulatory violations in radiation oncology. Identification and tracking of errors is accomplished using preset standardized error codes and classification of pre- and post-treatment errors. The paper-based model was deployed at 17 geographically dispersed radiation oncology centers located in 9 states. Self-reported errors were collected over 1.75 years. The software-based model (MERP) was deployed at one free-standing center and errors were collected over 2 years.

Results: Paper-Based

Excluding the initial "learning curve", the overall error rate for both minor and significant errors was 0.052% (5.2 in 10,000 patient fractions) for the paper-based model Illustration A..

Ill. A — Summary of Total Unintended Deviations
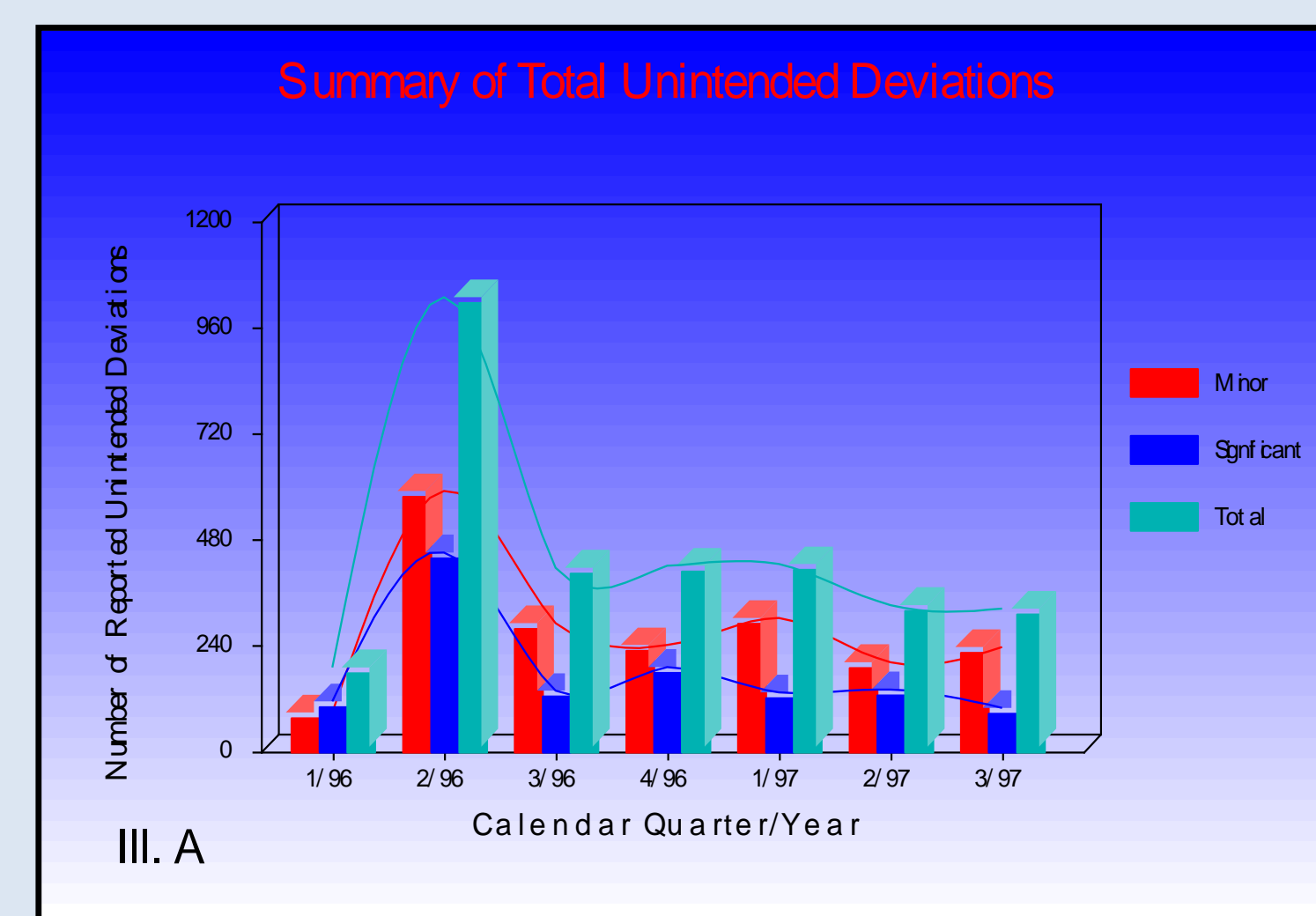
Results: Software-Based

MERP showed most pre-Tx errors occurred due to untimely entry/approval of the Rx in the IMPAC (IMPAC Medical Systems, Inc.) and ARIA (Varian, Inc.) R&V systems. Data entry errors in the Eclipse (Varian, Inc.) treatment planning computer followed second (Fig 1).


Fig 1 — Patient Pre-Tx Errors Freq. vs Category
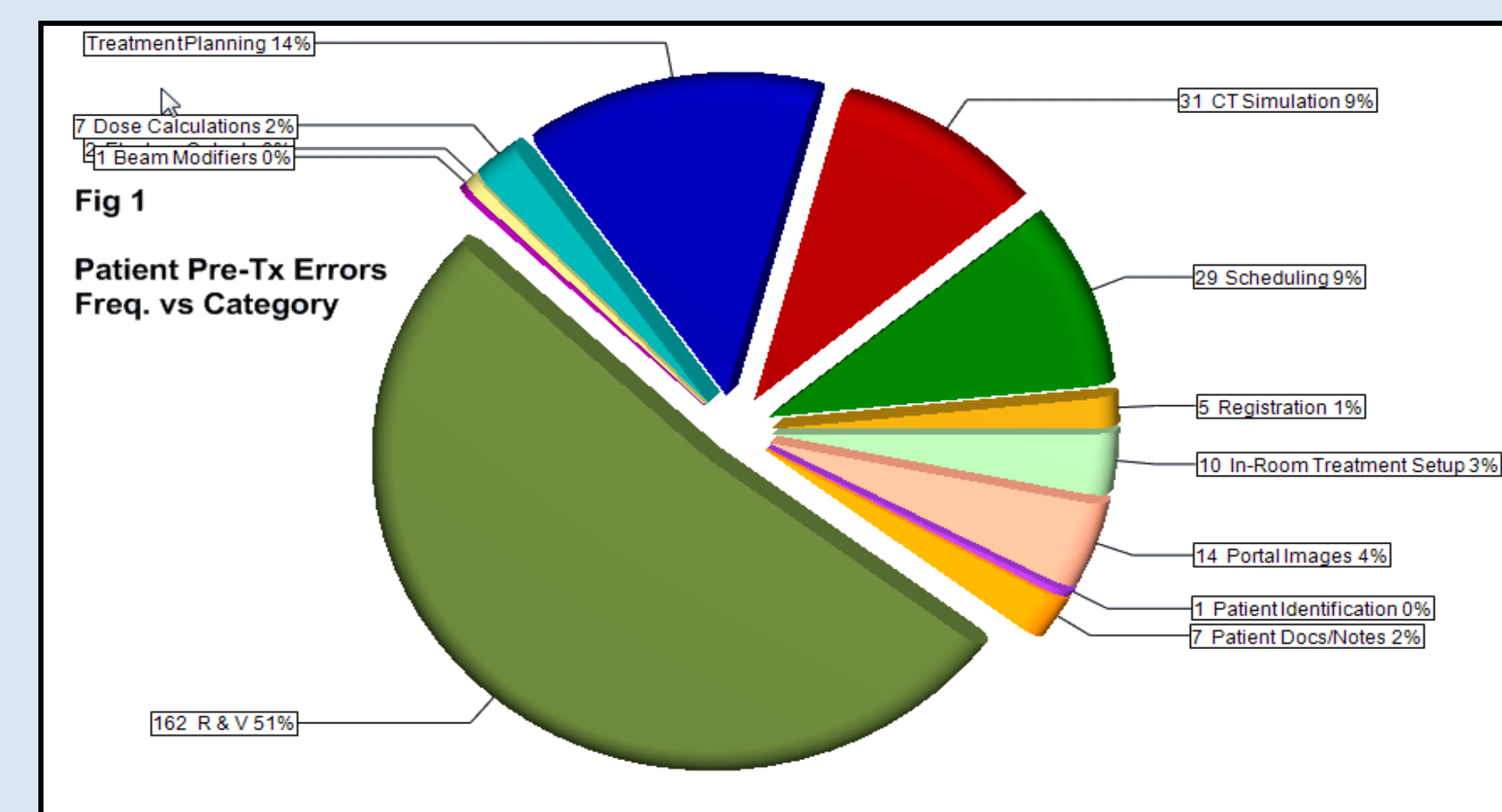
Post-Tx errors occurred mostly in billing (cpt coding) and patient documentation (simulation notes) (Fig 2).

Fig 2 — Patient Post-Tx Errors Frequency vs Category
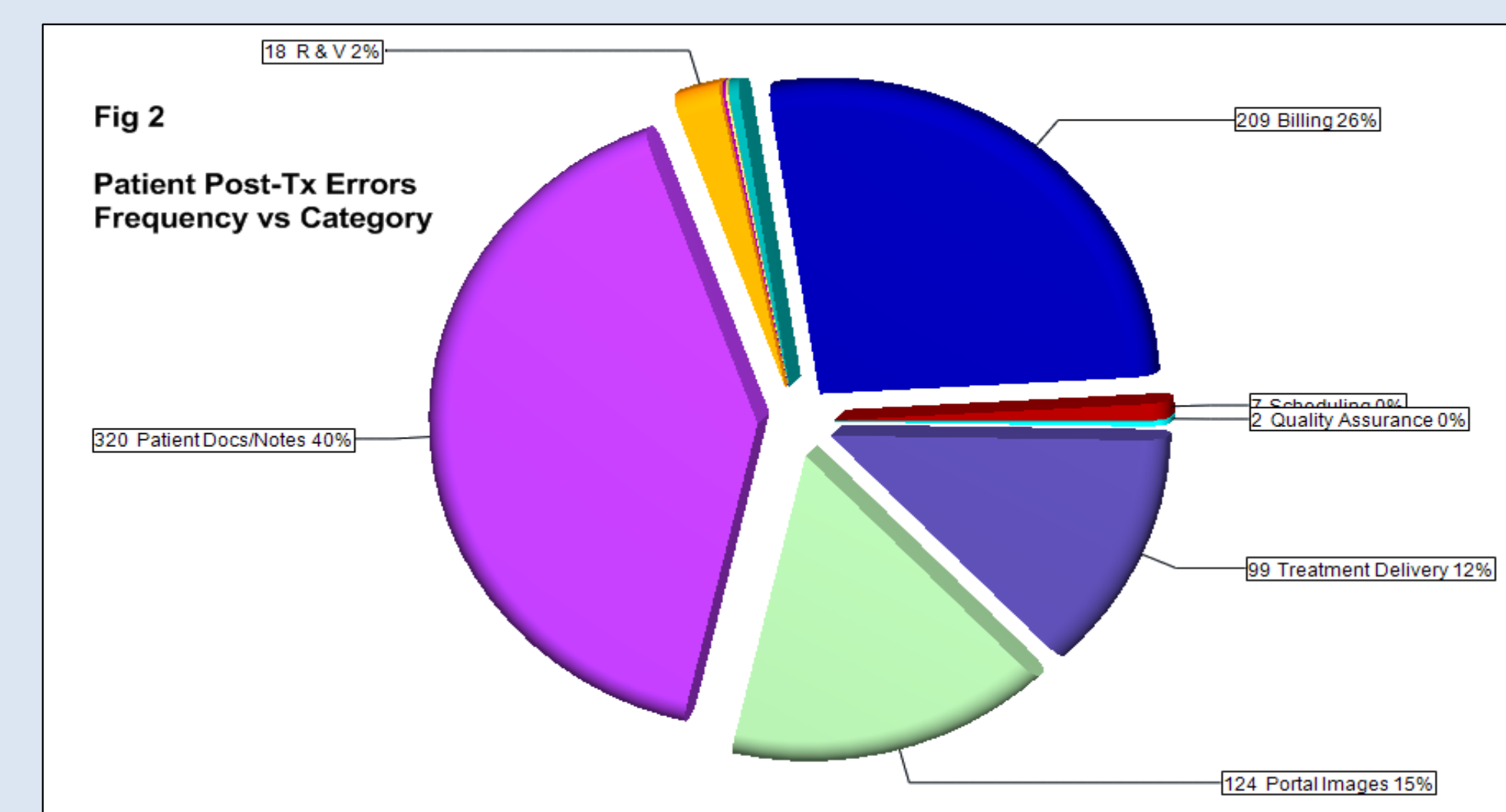
Most errors that affected the patient's Tx occurred during Tx delivery (patient setup, input of machine parameters) (Fig 3).

Fig 3 — Patient Post-Tx Errors Affected Tx
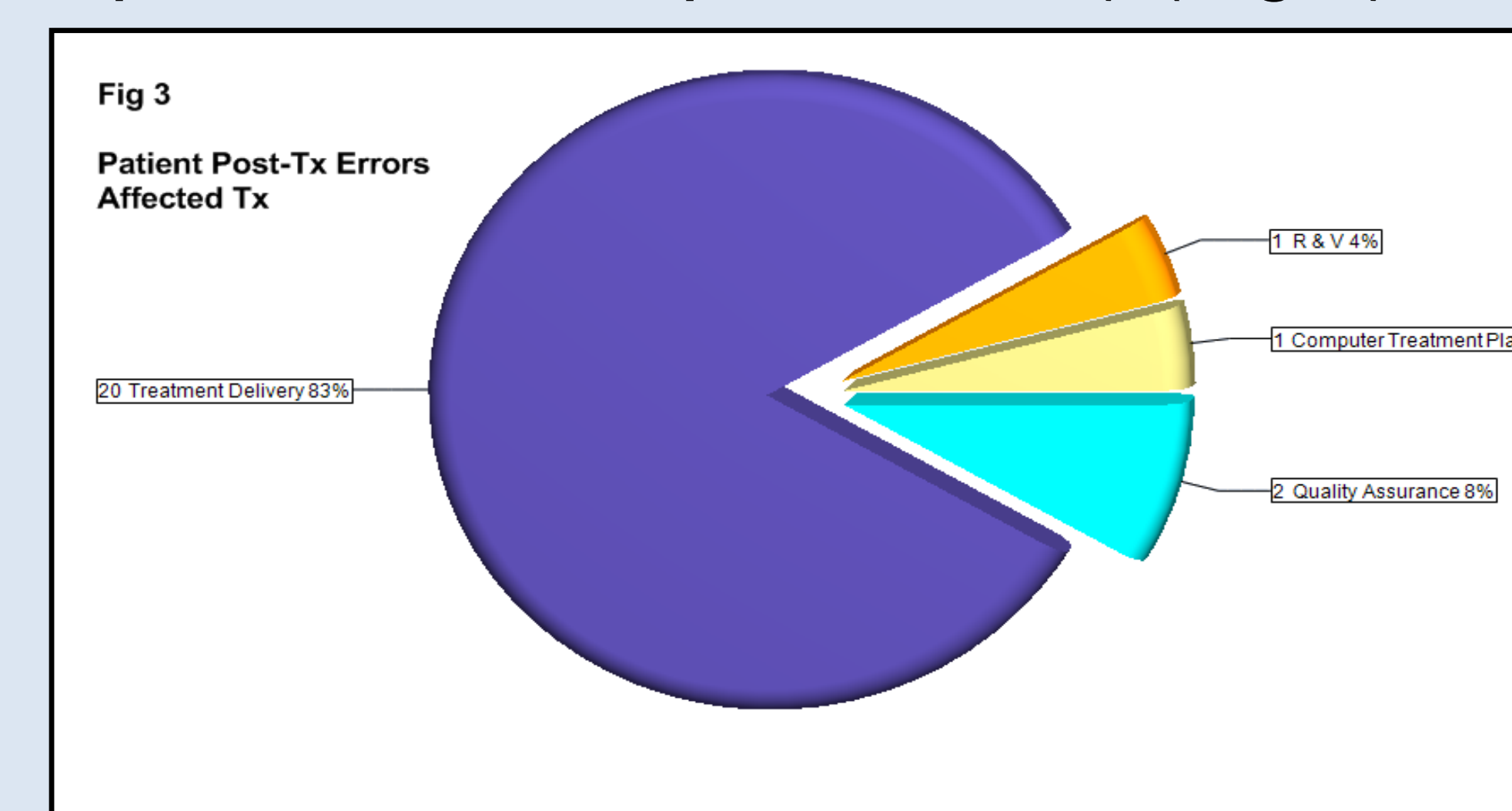
In areas of QA, missing or untimely machine tests and measurements occurred most frequently (Fig 4).

Fig. 4 — Non-Tx Errors Frequency vs Category
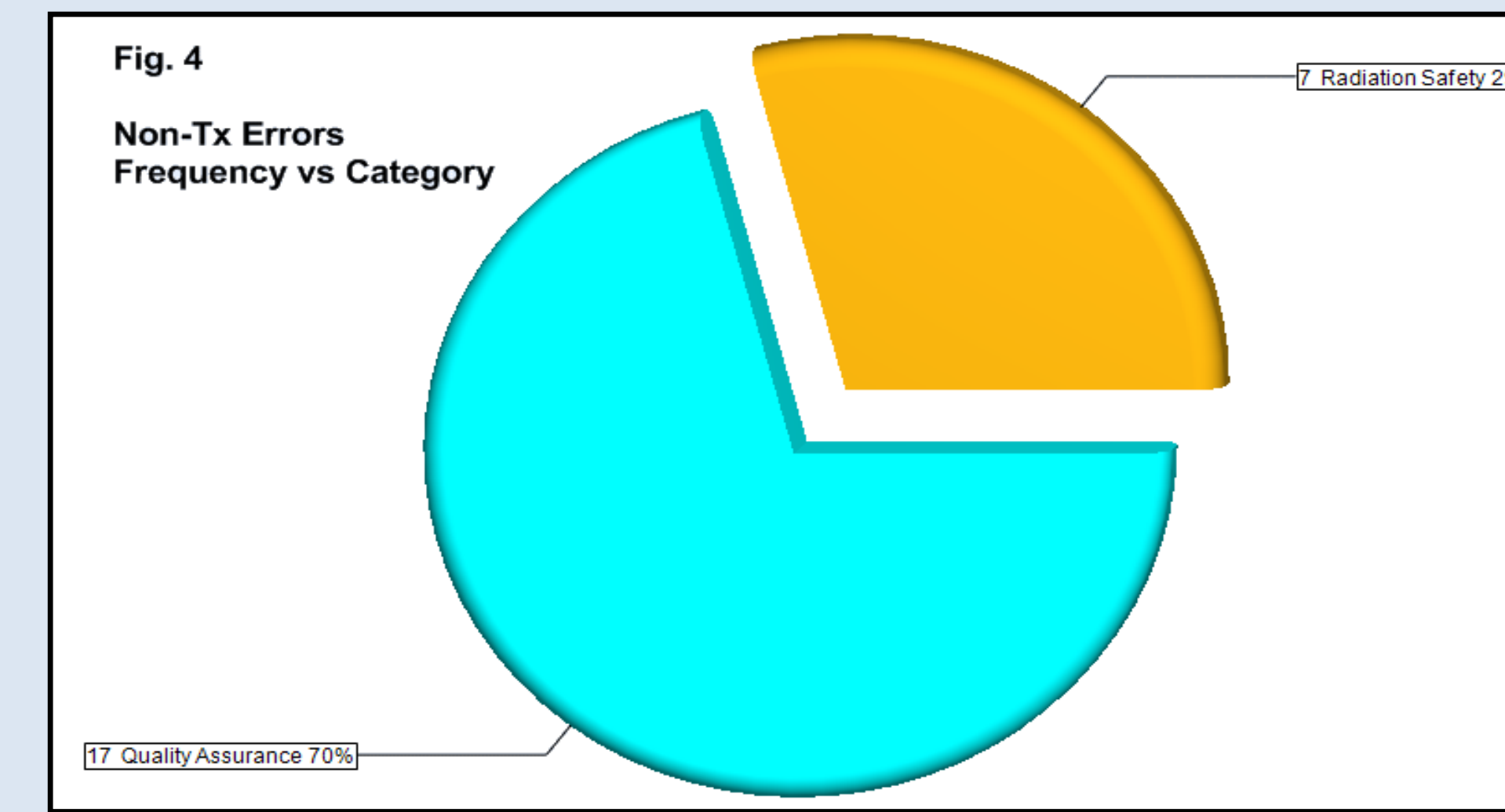
Categories, subcategories, and attributes divide types and frequency of errors (Table 1). Based on significance (Levels 1 – 5), each error suggests a level of corrective action. A root cause analysis is used for significant errors and regulatory violations.

Table 1. Errors of Greatest Frequency

Pre/Post	Category	Subcategory	Attribute	Occurrences
Pre-Tx	Billing	Codes	CPT code incorr./miss.	141
Post-Tx	Portal Images	Electronic Imager	Weekly images not approved	112
Pre-Tx	R & V	Prescription	Electronic approval before 1st tx miss.	90
Post-Tx	Patient Docs/Notes	Simulation Notes	Tx planning sim note not completed	84
Post-Tx	Patient Docs/Notes	Simulation Notes	Field verification sim note not completed	74
Post-Tx	Patient Docs/Notes	Simulation Notes	Isocenter verification sim note not completed	60
Post-Tx	Patient Docs/Notes	Simulation Notes	CT sim note not completed	59
Post-Tx	Treatment Delivery	Patient Setup	RTT note incorr./miss.	50

A comparison of MERP error rates with other institutions shows an increase in errors per patient but decrease in errors per fraction and Tx field (Table 2). This may be influenced by the recentness of studies and IMRT versus 3D-CRT workloads.

Table 2. Error Rates in Treatment Delivery

Error Category	This Work Paper	This Work MERP	Frass et. al.	French	Grace et. al.
Per Patient, %		3.2			1.97
Per Fraction, %		0.11	0.44	0.32	0.29
Per Field, %		0.0012	0.13	0.037	
Overall, %	0.052 [1]	0.0092 [2]		0.13 [3]	

[1] Errors per fraction   [2] Errors per Tx field   [3] Errors per total Tx units

Error rates increase due to the larger number of clinical interactions in the process (Table 3).

Table 3. Error Rates in Treatment Process Using MERP

Error Category	Pre-Tx	Post-Tx	Pre-Tx + Post-Tx
Per Patient, %	10.1	25.4	27.33
Per Fraction, %	0.34	0.85	0.92
Per Field, %	0.004	0.0092	0.01

Misadministration rates (CRCPD criteria) were comparable to calculated rates (Table 4).

Table 4. Misadministration Rates

Error Category	This Work Paper	This Work MERP	US NRC
Per Patient, %		0.065	
Per Fraction, %	0.017	0.0022	0.0042
Per Field, %		0.000023	

Conclusion

The paper-based model identified 1,052 errors over 1.75 years and reduced the overall error rate by 326%. The MERP model identified 1,122 errors over 2 years. MERP provides an improved means to demonstrate compliance and identify, analyze, and correct medical errors.