

# Improving Patient Safety in Radiation Oncology: Clinical Tools and National Initiatives

Eric Ford, PhD

Johns Hopkins University

Department of Radiation Oncology and Molecular Radiation Sciences



JOHNS HOPKINS  
M E D I C I N E

---

DEPARTMENT OF RADIATION ONCOLOGY  
& MOLECULAR RADIATION SCIENCES

*AAPM Southeast Chapter Meeting, April 7, 2011, Myrtle Beach, SC*

## **Overview**

### **Finding the next error**

- incident learning systems

### **Preventing the next error**

- QA double checks
- principles of error-proofing



**EDITORIAL**

---

**HOW SAFE IS SAFE? RISK IN RADIOTHERAPY**

ERIC C. FORD, PH.D., AND STEPHANIE TEREZAKIS, M.D.

Departments of Radiation Oncology and Molecular Radiation Sciences, Johns Hopkins University, Baltimore, MD

*Estimates for US patients*

- 1200 mistreatments per year
- 1 in 600 patients affected

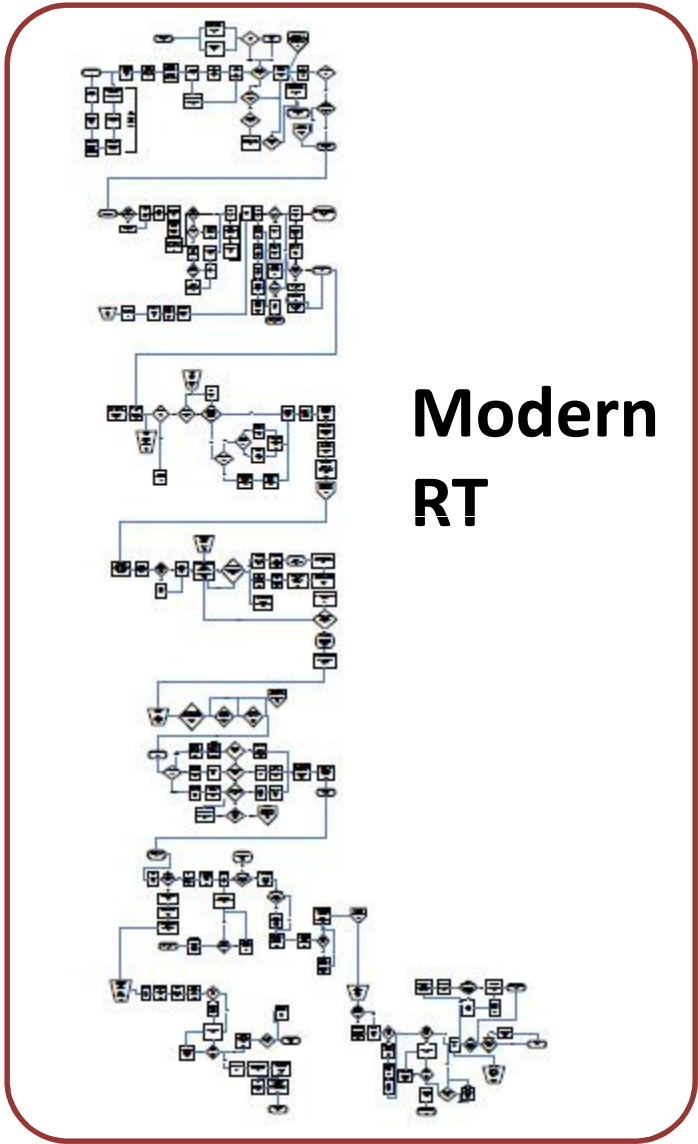
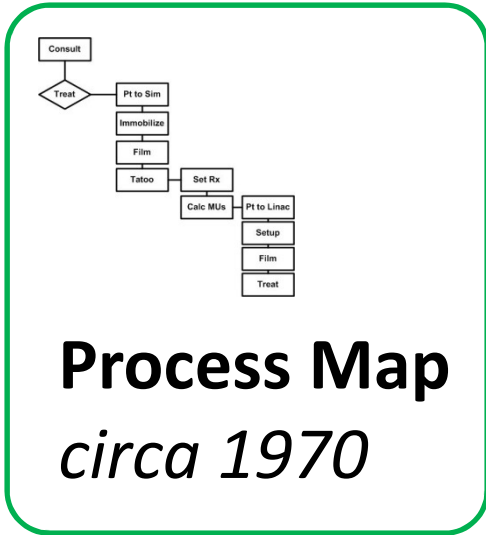
# Increasing Complexity of Radiation Treatments

**Control Console**  
*circa 1970*



**Console 2010**

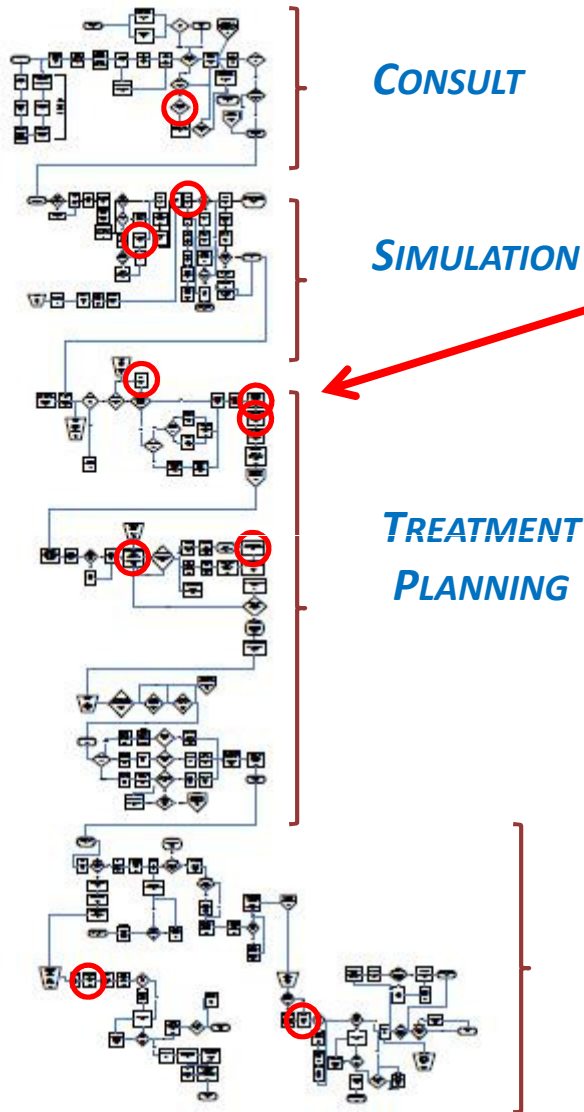
# Increasing Complexity



<u>Step</u>	<u>Rate</u>
1	99.9%
2	99.9%
.	.
.	.
.	.
.	.
.	.
n	99.9%

**n=76:**  
 **$(99.9\%)^{76} = 93\%$**

# Where do errors originate?



## High-risk areas

- Scattered throughout process
- Traditional QA does not address these
- How to find them?

*Ford et al. Int J Radiat Oncol Biol Phys, 74(3), 852-858, 2009*

# Quality Assurance in Radiotherapy

## Traditional approach

vs.

## Systems approach

Machine QA

IMRT QA

Port films

etc ....

Considers specific points

In the chain

Define hazards

Analyze and prioritize

Mitigate

Considers the whole chain

and prioritize

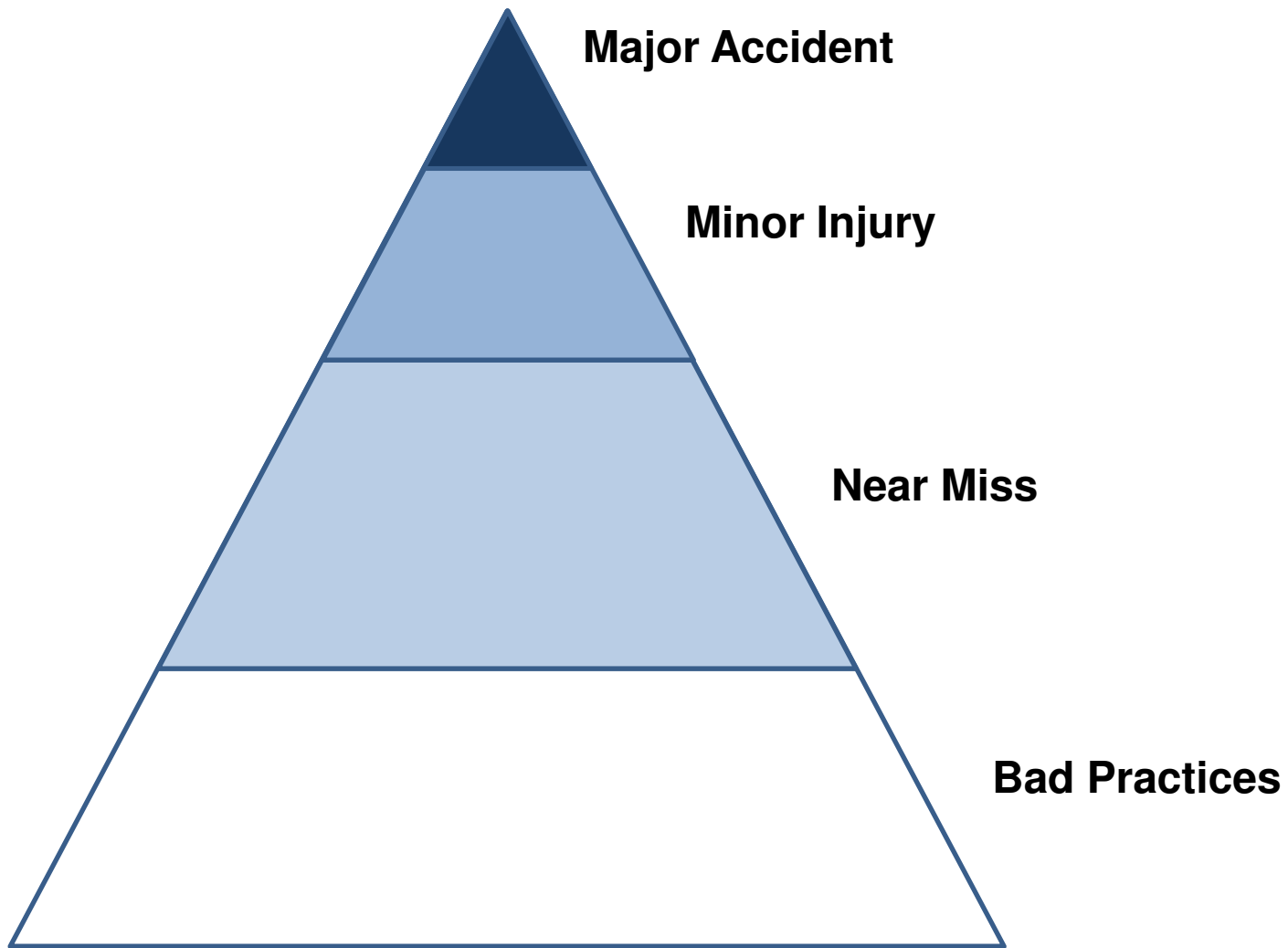
## Overview

### Finding the next error

- incident learning systems

### Preventing the next error

- QA double checks
- principles of error-proofing



**Heinrich's  
Triangle**

*Heinrich, HW. Industrial accident prevention:  
a scientific approach, 1<sup>st</sup> Ed., 1931*

# Hopkins Variance Learning System

Radiation Oncology -  
Variance Learning System

Patient MRN:

Patient's Name:

Reporter's login:  (e.g. jsmith1)

Where was incident discovered:

Variance description:

*2007-present*

## **An example “hard to anticipate” incident**

### *Collimator/gantry angle not correct in R&V system*

- Clinical electron setup on weekend. Correct information noted but not entered into R&V system.
- Not caught at physics check.
- Caught by RTT checking chart.
- Potential result: large underdose to part of tumor.

Underscores the value of a reporting system.

# Incident Reporting System Statistics

<u>Severity</u>	<u>n</u>	<u>%</u>
0	100	40%
1	65	26
2	28	11
3	23	9
4	34	14
5	1	0.4
Total	250	

*2007-2010*

## Actual reports \*, Dec-Jan 2011

Role	% of all reports
Attending physician	0
Resident	0
Dosimetrist	1%
Physicist	5%
Nurse	20%
Radiation therapist	73%

\*Combined data from all four department sites

*Harris, Terezakis, et al.*

# Learning from our mistakes: Radiation oncology safety survey

- Multi-institutional,\* IRB-approved
  - Surveymonkey<sup>®</sup>, anonymous, Dec-Jan 2011
    - Reporting patterns
    - Barriers to reporting
    - Perceptions about reporting
    - Reporting culture
- Overall response rate: 76%

\*Johns Hopkins, Washington University, University of Miami, North Shore-Long Island Jewish Hospital

*Harris, Terezakis, et al.*

# Error reporting:

- It's my responsibility ..... 96%
- I know how to do it ..... 81%
- I know what to report ..... 83%
  
- I'm too busy to report ..... 27%
- Should be anonymous ..... 37%

*Harris, Terezakis, et al.*

# Future directions

- Understand the barriers to reporting
- Develop good reporting systems
- Interconnect systems

# AAPM Working Group on Prevention of Errors

## Taxonomy Project

**Goal:** Develop a structure to facilitate radiation oncology-specific reporting systems

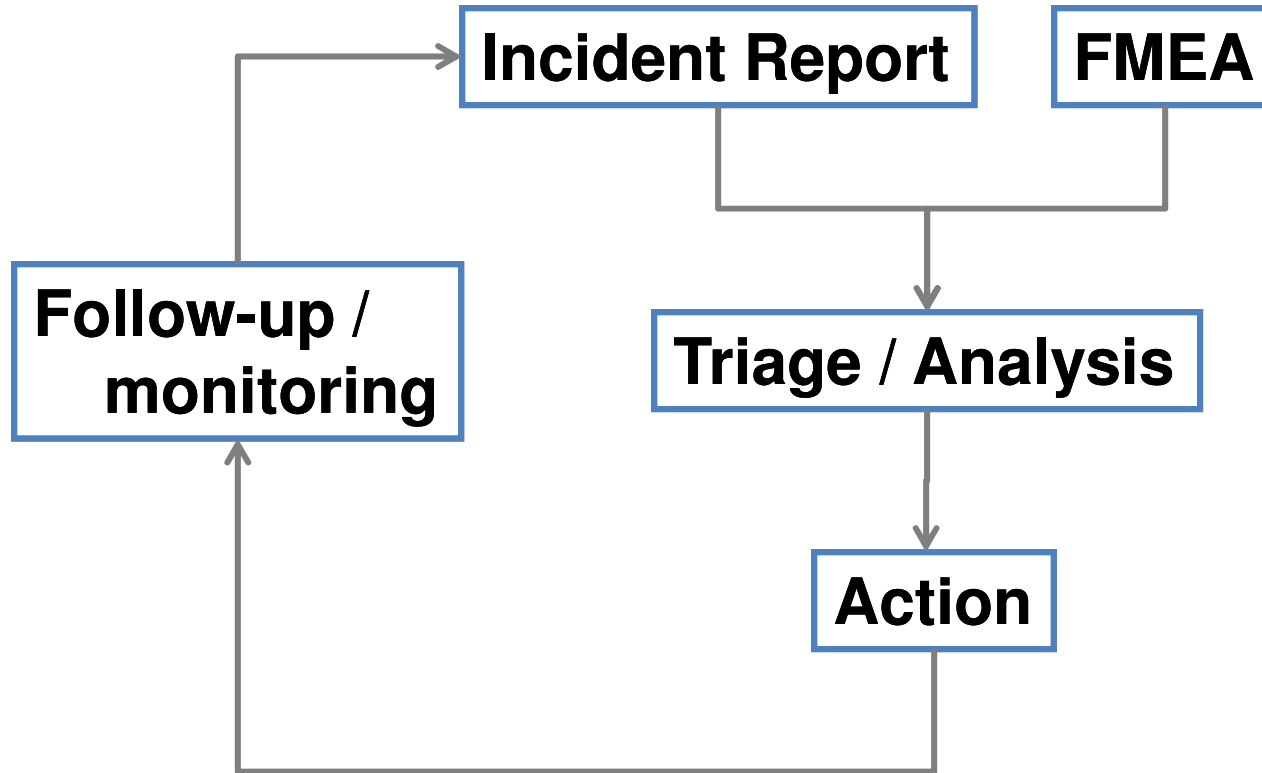
Team: physicists and physicians + ad-hoc

Five key areas:

- Definitions
- Common process map
- Severity ranking scale
- Root causes taxonomy
- Recommended data structures

Workshop to finalize: April 14-15

# Conclusions: A Quality Management System



## NTSB: Air traffic controller fell asleep, leaving planes on their own

March 24, 2011 | By the CNN Wire Staff

The air traffic controller suspended for failing to respond to two planes heading into Ronald Reagan Washington National Airport has told investigators that he had fallen asleep, according to the National Transportation Safety Board.

The controller, a 20-year veteran, "indicated that he had fallen asleep for a period of time while on duty," according to a statement released Thursday by the safety board. "He had been working his fourth consecutive overnight shift (10:00 p.m. to 6:00 a.m.)."

"Human fatigue issues are one of the areas being investigated," the statement read.



This is a 2009 file photo of a jetliner at Reagan National Airport in Washington.

## ... vs. Radiation Oncology

- “... I am personally outraged ...” – Randy Babbitt, the FAA administrator. **A Spokesman**
- Babbitt, who suspended the unidentified 20-year veteran, is reviewing the incident. **Sanction** **Anonymized**
- The controller told the NTSB it was his fourth straight overnight shift. **Investigative body** **Root-Cause**
- The FAA is looking at overnight staffing issues nationwide. About 30 towers operate with just one controller after midnight.
- Suspected controller errors in 2010 hit 1,887 up from 1,233 the previous year. **Statistics**

- Source: Reuters, March 25, 2011



## **Overview**

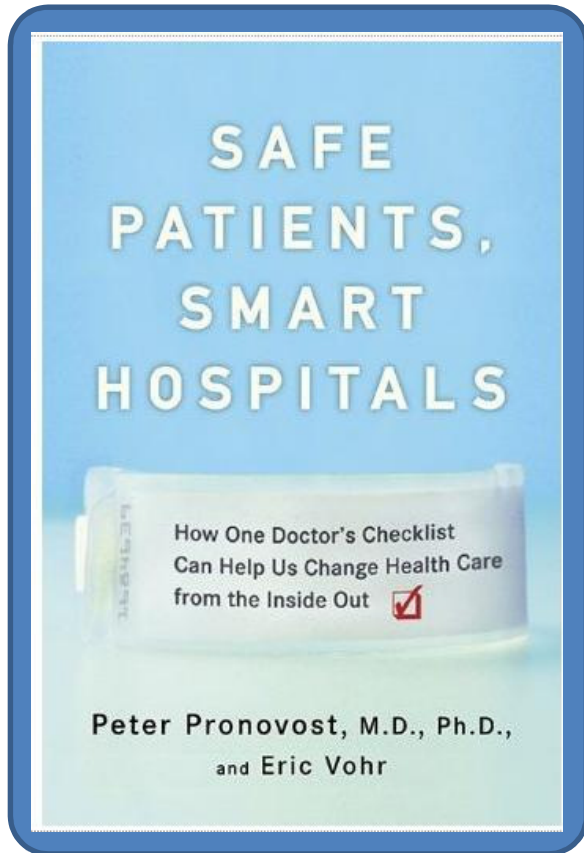
### **Finding the next error**

- incident learning systems

### **Preventing the next error**

- Checklists
- QA double checks
- principles of error-proofing

# Checklists



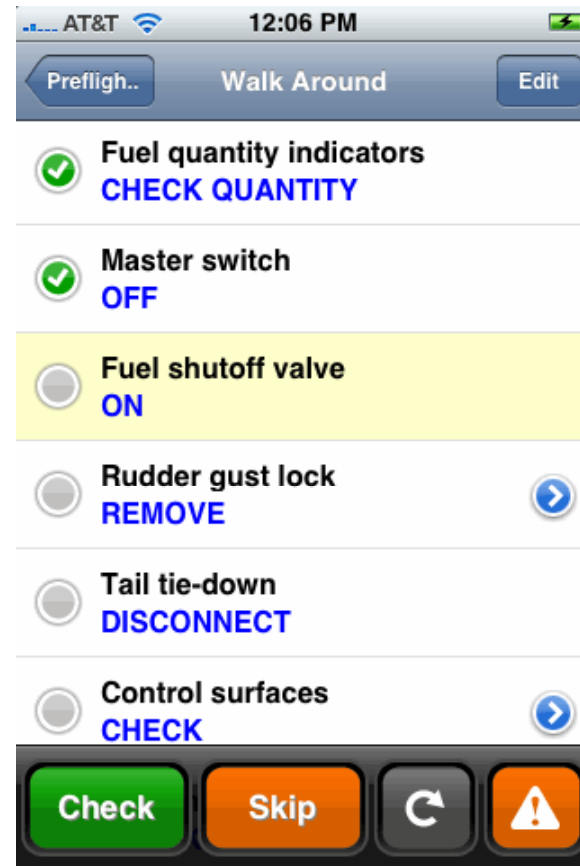
- Standardization of important tasks
- Making sure they get done

# Checklists

Cessna 60146  
 Preflight  
 A R O W

- |                     |                     |
|---------------------|---------------------|
| Remove Control Lock | ✓ Leading Edge      |
| ✓ Ignition Off      | ✓ Cables & Bolts    |
| Master ON           | ✓ Elevator & Rudder |
| Lower Flaps         | Remove Tiedown      |
| ✓ Fuel Guages       | ✓ Leading Edge      |
| Fuel On ___         | ✓ Flaps             |
| Master Off          | ✓ Weights & Hinges  |
| ✓ Tire and Brake    | Remove Tiedown      |
| ✓ Tank for Water    | ✓ Leading Edge      |
| ✓ Fuel & Cap        | ✓ Tire & Brake      |
| ✓ Pitot Opening     | ✓ T & B for Water   |
| ✓ Overflow Opening  | ✓ Fuel & Cap        |
| ✓ Stall Opening     | ✓ Oil & Drain Str   |
| Remove Tie Down     | ✓ Strut & Tire      |
| ✓ Leading Edge      | ✓ Prop Nicks/Sec    |
| ✓ Weights & Hinges  | ✓ Carb Filter       |
| ✓ Flaps             | ✓ Static Port       |

Cessna150.net



ForeFlight Inc. ©

# A Rad Onc Checklist

Date	
Time	
+	New Patient Referral
-	Resident/Nursing
	Consent For IV Contrast
	Consent For Tx
	Diagnostic Tests (MRI,CT,PET)
	Pregnancy Test
	Recent BUN/Creatine
	Pacemaker Evaluation
	Anesthesia
	Prior Treatment
	Prior Treatment Records
	Pathology Report
	Special Procedure
	Approved sim note
	Resident/Nurse Comment
	1: Completed - Completed
	0: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	3: Assessment Pending - Assessment Pending
	1: Required - Required
	1: Prior RT at JHU - Prior RT at JHU
	1: Received - Received
	1: No Pathology - Consented - No Pathology - Pt. Consented
	1: ABC-4D Required for sim - ABC-4D Required for sim
	1: Completed - Completed
	1
+	Nursing
+	Billing/Compliance
-	Simulation Therapists
	Mosaiq demographics PT/MD
	Bolus placed in sim
	Immob eqpmnt labeled and dated
	CT transferred to Pinnacle
	Couch, pre-mark set - Pinnacle
	RTT Contours completed
	Dosimetry scheduled
	ReTx: CT to old Pt in Pinnacle
	Sim therapist comment
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	2: Pending - Pending
-	Resident/Attending
	Fusion requested
	Fusion with correct sim CT
	Beam, block & contour approval
	Dosimetry goals
	Prescription completed
	Site verification sheet
	Exceeding dose tolerance
	Neurosurgeon identified
	Fetal dose evaluation
	Resident/Attending Comment
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Per standard protocol - Per standard protocol
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	0: Not Applicable - Not Applicable
	0: Not Applicable - Not Applicable
-	Dosimetry
	Verify couch, premarks set
	Verify bolus in prescription
	Plan review
	Film & treat scheduled
	MDSAIQ record completed
	Plan & prescription approved
	Physics QA submitted
	1: Completed - Completed
	1: Completed - Completed
	1: Approved - Approved
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed
	1: Completed - Completed

## Common QA checks

- Double check of every plan by 3 people
- Measurement of dose (in some cases)
- Peer review (Chart rounds)
- Films and CT (daily to weekly)
- Checklists

# Common QA checks

- MD chart review
- Physics chart review
- RTT chart review
- IMRT QA
- Chart rounds
- Timeout RTT
- SSD check
- Port film – RTT check
- Port film – MD check
- CBCT – RTT check
- CBCT – MD check
- Diodes
- Physics weekly

Wrong isocenter: 

*BB premark not set right in treatment planning system*

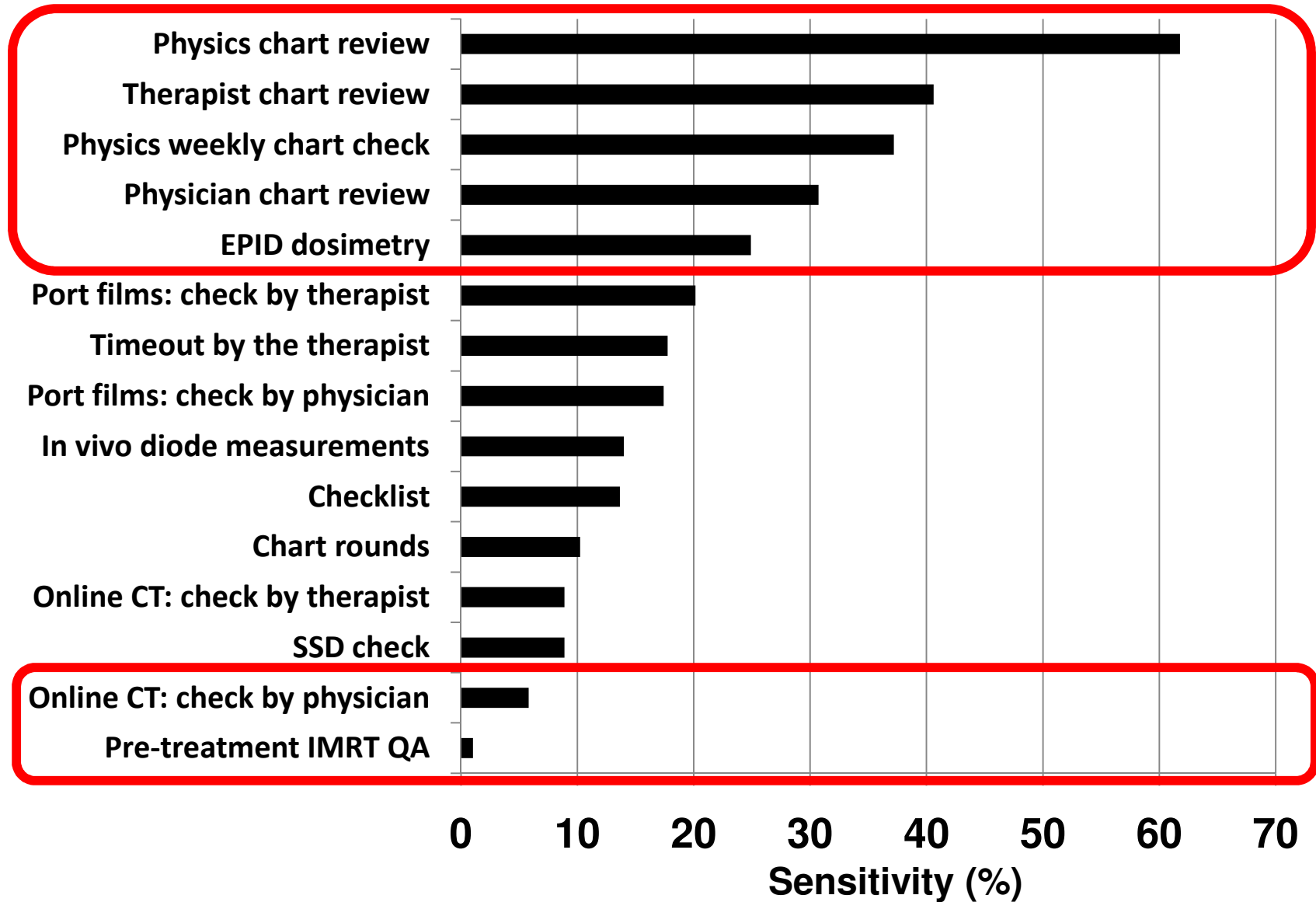
# Common QA checks

## An analysis of the effectiveness of common QA checks

- JHU & Wash U
- Data:
  - incident reports: 2007-2011
  - 4,407 reports
  - 292 (7%) “high potential severity”

*Ford, Mutic, et al.*

# Common QA checks



# Common QA checks

## Limitations

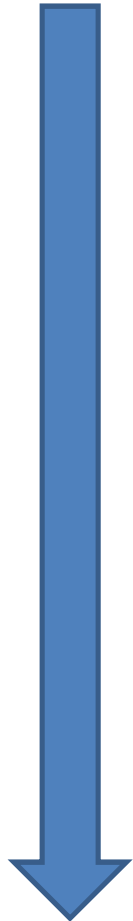
- Based on *reported* events (biased)
- Asked: **Could** the check prevent this error?

Not: **Will** the check prevent this error?

*Ford, Mutic, et al.*

# Principles of Error Proofing

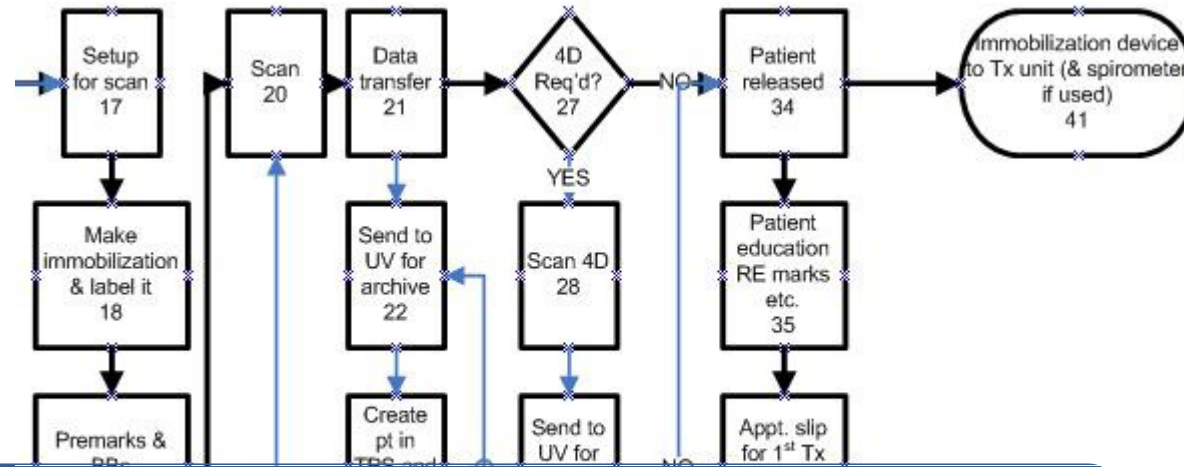
**BETTER**



- **Mitigate** – control damages
- **Detect** – make problems more obvious
- **Facilitate** – make work easier
- **Replace** – more reliable process
- **Eliminate** – make mistake impossible

QA

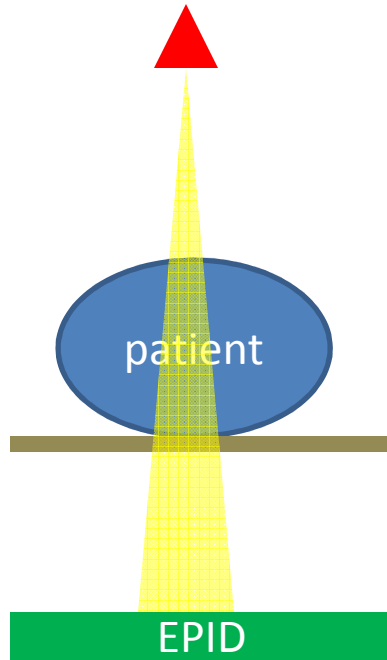
## Example QA check



Goal: Make errors **impossible**

- How to prevent this error?
  - QA check
  - **Software double check on demographics**

# Portal Dosimetry



Plan vs. EPID-  
measurement

**During  
Treatment**

# Portal Dosimetry

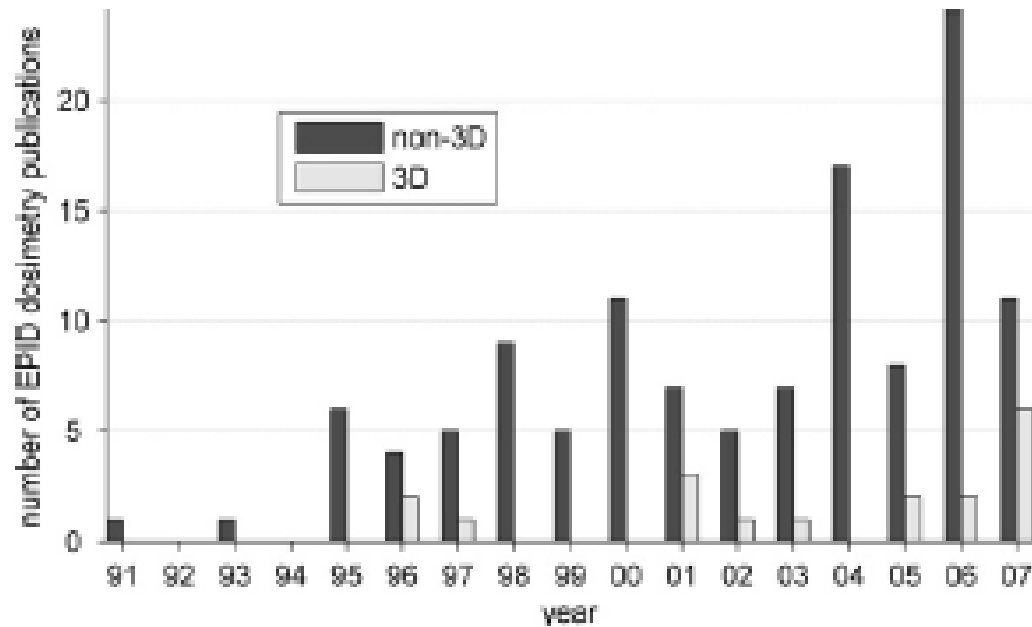


Fig. 1. Number of publications on EPID dosimetry (as found on Pubmed [www.pubmed.com](http://www.pubmed.com)).

*From van Elmpt et al. R&O review, 2008*

## Catching errors with *in vivo* EPID dosimetry

A. Mans,<sup>a)</sup> M. Wendling,<sup>b)</sup> L. N. McDermott,<sup>c)</sup> J.-J. Sonke, R. Tielenburg, R. Vijlbrief,  
B. Mijnheer, M. van Herk, and J. C. Stroom  
*Department of Radiation Oncology, The Netherlands Cancer Institute—Antoni van Leeuwenhoek Hospital,  
Plesmanlaan 121, 1066 CX Amsterdam, The Netherlands*

Medical Physics, Vol. 37, No. 6, June 2010

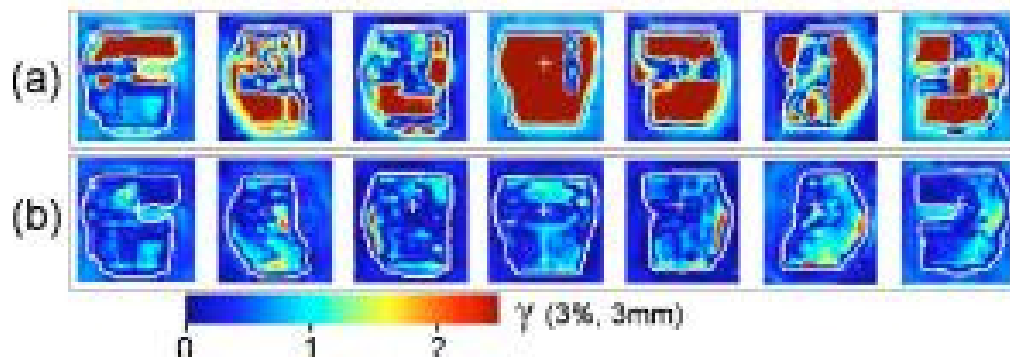


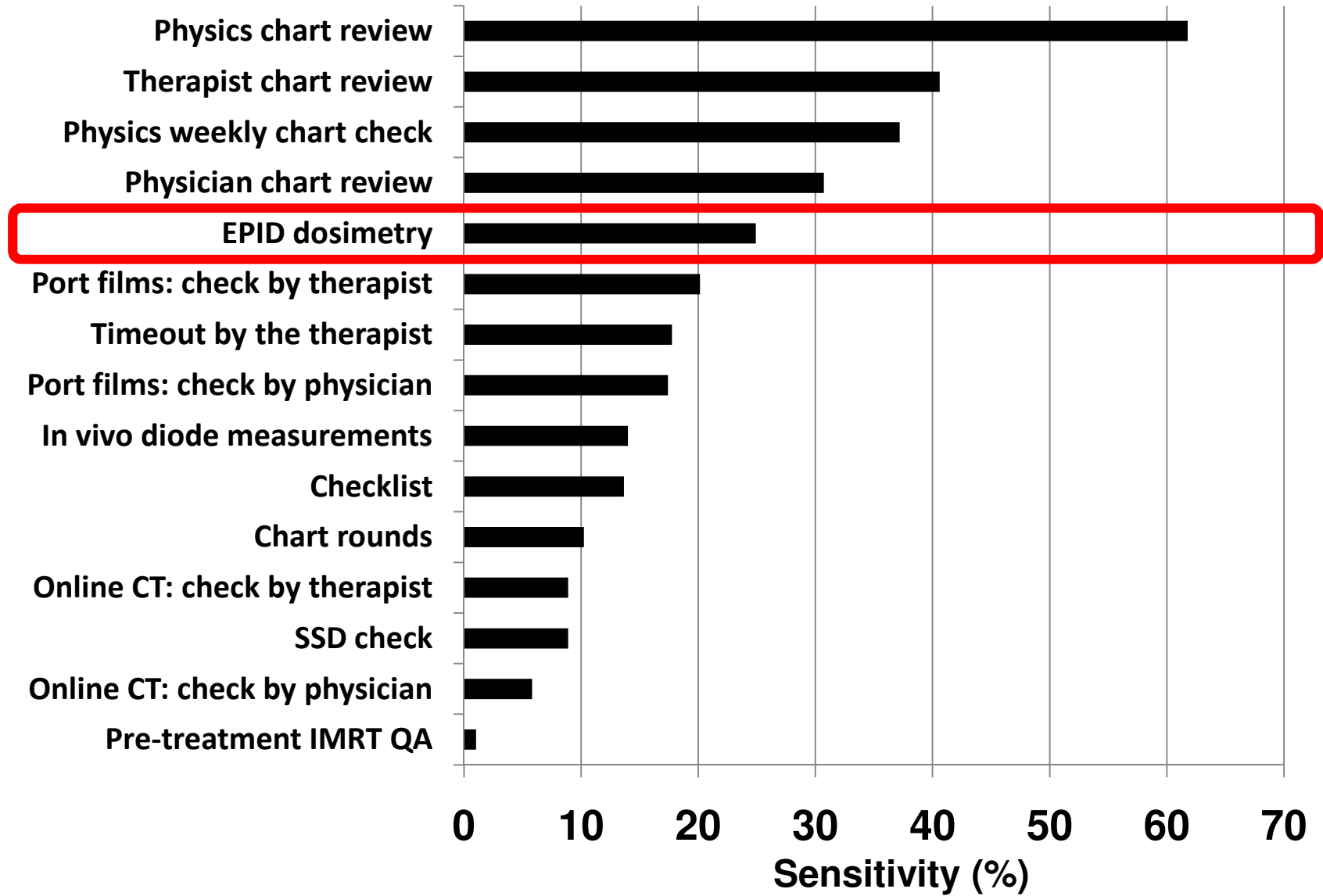
FIG. 2.  $\gamma$ -evaluations of (a) the first (malformed plan) and (b) the second (corrected plan) fractions in a plane parallel to the EPID, intersecting the isocenter. The white “+” indicates the isocenter.

Jan 2005 – Jul 2009:  $n=1400$

17 ‘errors’

40% patient anatomy changes, 60% planning/transfer/delivery

# Common QA checks



## Making Rad Onc Safer

- What can I do?
- What can AAPM, ASTRO and the government do?
- What can industry do?

# Making Rad Onc Safer

- What can I do?
  - error proofing – *make errors impossible*
  - incident reporting
  - checklists
- What can AAPM, ASTRO and the government do?
- What can industry do?

## Making Rad Onc Safer

- What can AAPM, ASTRO and the government do?

### AAPM:

- Task group reports
- Working group on prevention of errors

### ASTRO:

- White papers: IMRT, SRS, IGRT, etc.
- ACR/ASTRO accreditation and practice standards

### Government:

- Reporting, investigation and follow-up

# Making Rad Onc Safer

- What can I do?
- What can AAPM, ASTRO and the government do?
- What can industry do?

➤ Listen



Acknowledgements

***eric.ford@jhmi.edu***

**Stephanie Terezakis, MD**  
Lee Myers, PhD  
Ruth Bell, RTT

Quality Safety Research Group  
Johns Hopkins

**Ted DeWeese, MD**

**Peter Pronovost, MD, PhD**  
**Jill Marsteller, PhD**  
**Ayse Gurses, PhD**  
Lilly Engineer, MD  
Bruce Vanderver, MD

Annette Souranis, RTT  
Danny Song, MD  
Richard Zellars, MD  
John Wong, PhD

