Safety reporting and learning

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Outline

1. Background
2. Learning from incidents as well as accidents
    i. Why is it important?
    ii. What can we learn?
3. Radiation safety reporting systems in medicine
    i. Mandatory and voluntary reporting
    ii. Internal and external reporting
4. Some terminology

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Background

Accident:

Any unintended event, including operating errors, equipment failures and other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

Incident:

Any unintended event, including operating errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorized act, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.

(Source: IAEA Safety Glossary, 2007)

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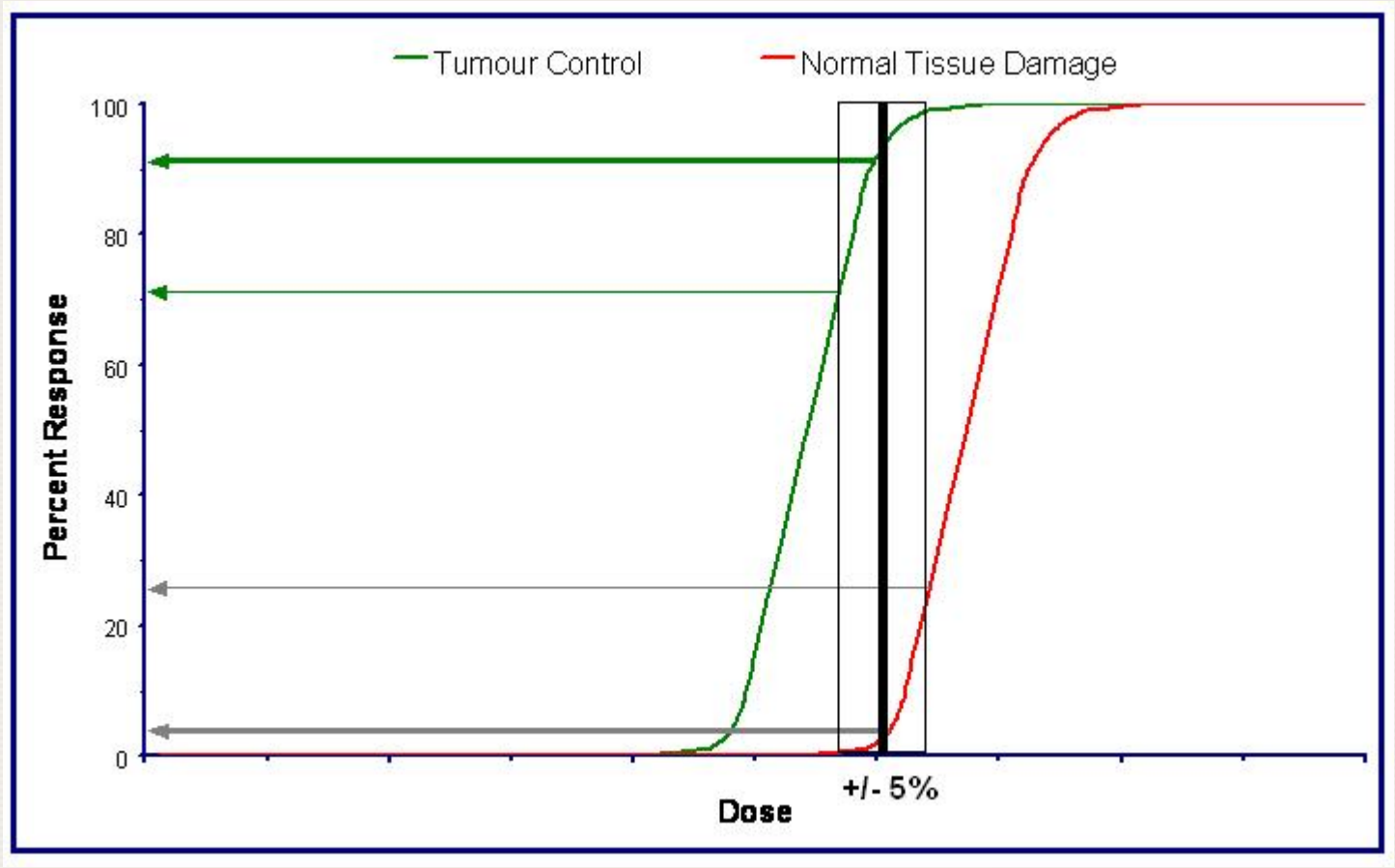
Learning from incidents



ICRU 62 - "... a dose difference as small as 5% may lead to real impairment or enhancement of tumour response, as well as to an alteration of the risk of morbidity."

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Learning from incidents

Variable magnitude:

Many incidents (*e.g.* mistake in calculation of monitor units for a single patient) can have a variable magnitude (*e.g.* for Patient 1, the mistake causes a dose deviation of 5%, while for Patient 2, the same type of mistake causes a dose deviation of 50%).

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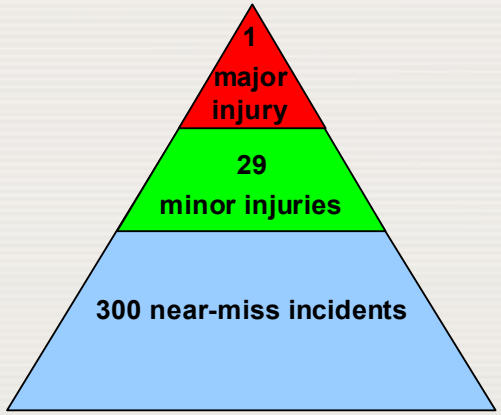
Learning from incidents

More events:

Incidents are more numerous than accidents, so there are more opportunities to learn and improve the safety, than by only looking at major accidents



H.W. Heinrich (1931)

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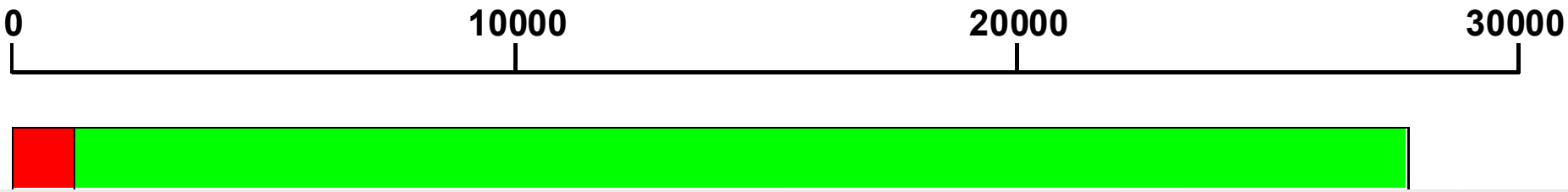
Learning from incidents

- Independent calculation checks monitored between 1998 and 2003 (27830 charts / treatment plans were checked)



- In total, 4.3% of charts / treatment plans had mistakes found at some point: either prior to treatment or when treatment had started

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Learning from incidents

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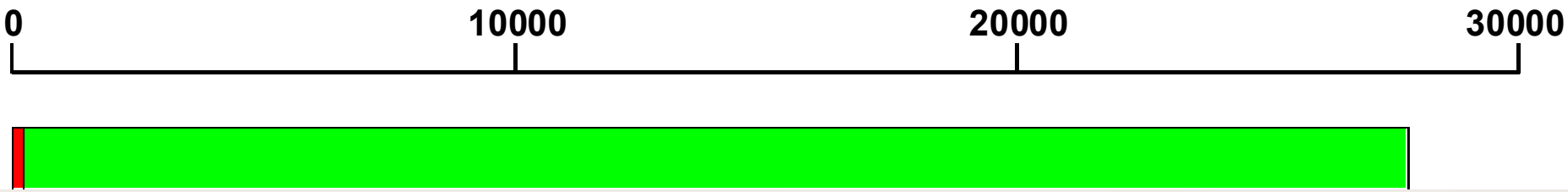
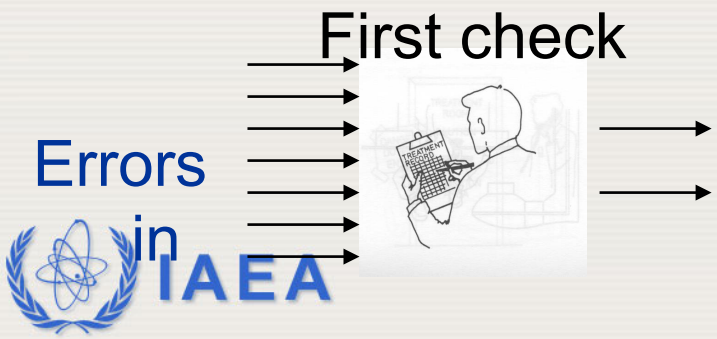


- The first check found mistakes in 3.5% of all charts / treatment plans – 0.8% remained



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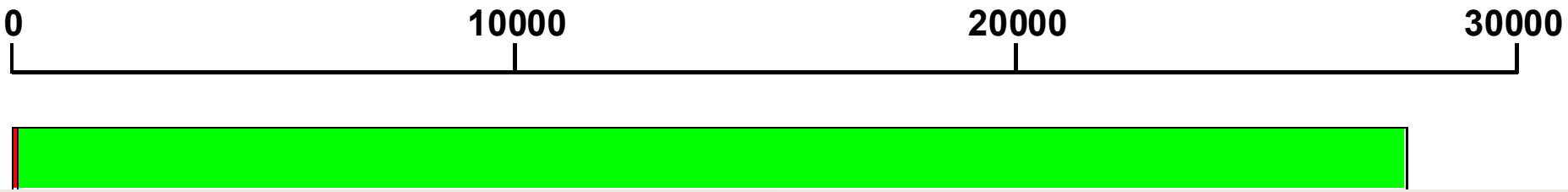
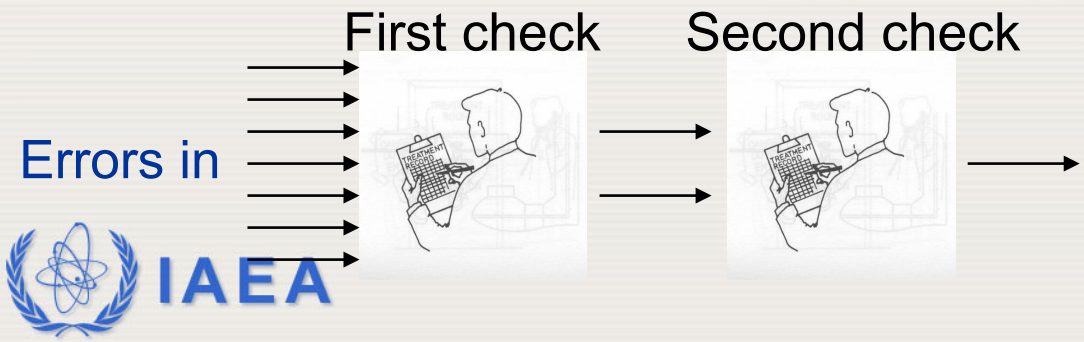


- The second check found mistakes in 0.5% of all charts / treatment plans – 0.3% remained



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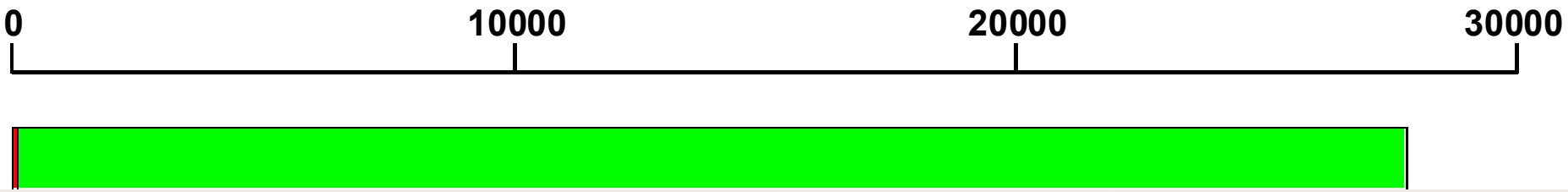

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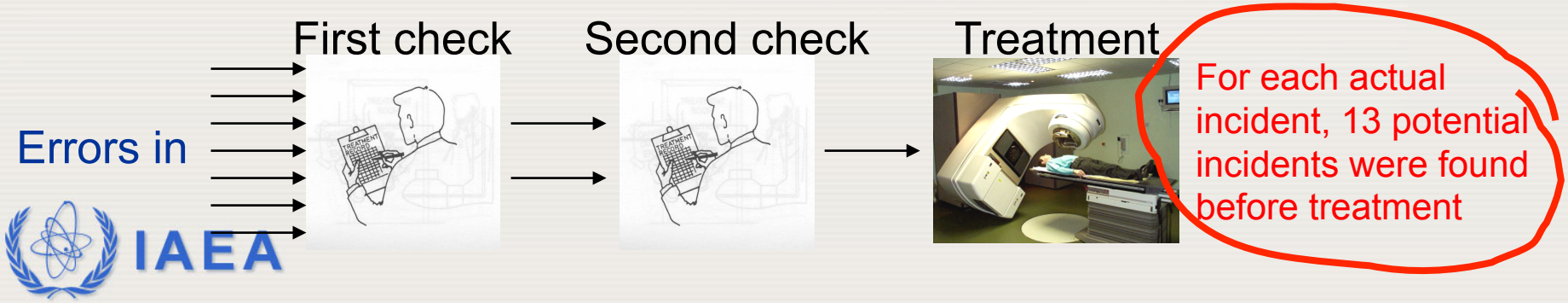

Learning from incidents

Examples:

(B) Mistake during the act of manually creating new information for input into TPS

1. Field name	14	
2. Volume matrix	8	
3. Patient orientation	4	
4. Wedge direction	1	
5. Isocentre position	1	
6. Dose plan addition	1	
TOTAL	**Σ 29**	**0.3 %**

(C) Mistake during the act of doing manual calculations for TPS plan

1. Arithmetic	110	
2. Tray factor	94	
3. Dose per fraction	30	
4. Isodose level	27	
5. Addition of open+wedged MU's	8	
6. Equivalent square	2	
TOTAL	**Σ 271**	**2.6 %**

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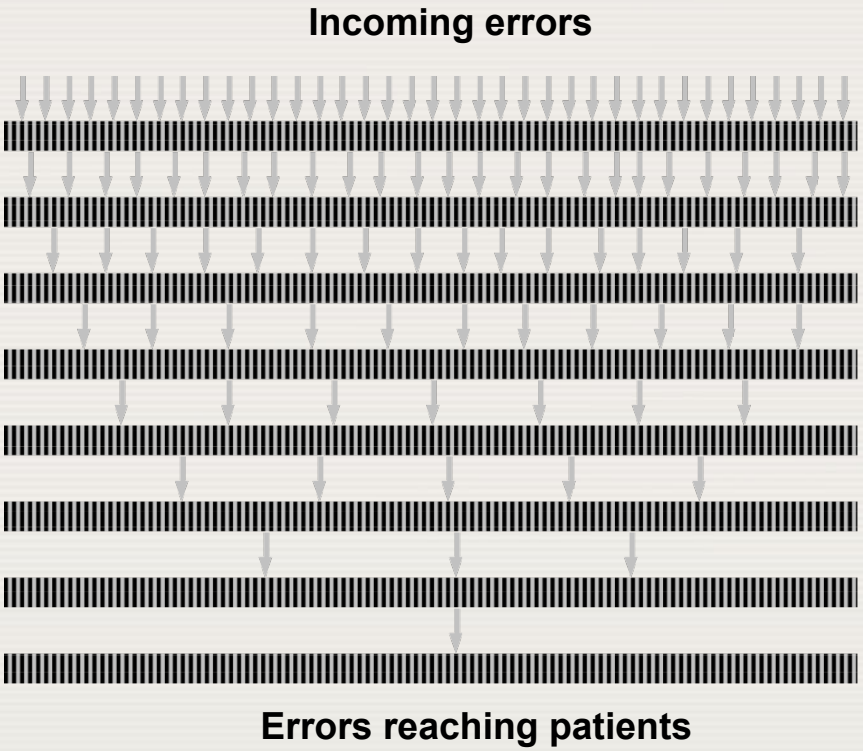
Radiation safety reporting systems

When addressing medical errors…

…we aim to minimise the risk through multilayered prevention



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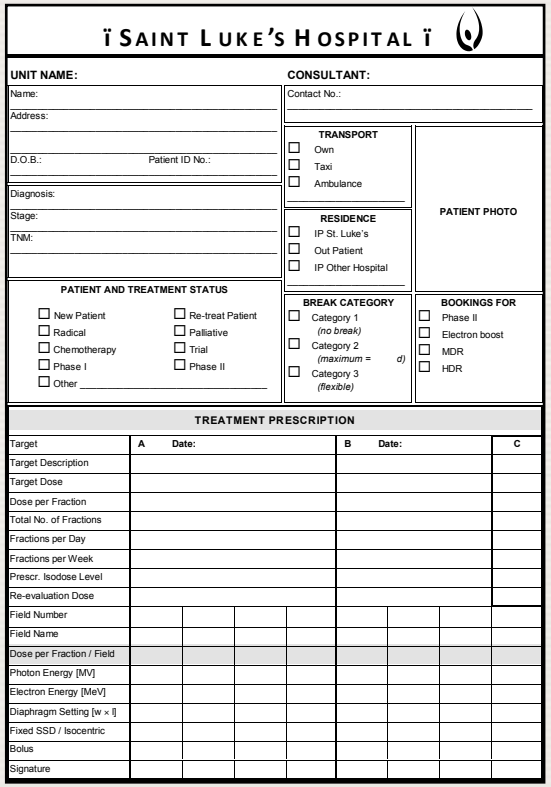
Radiation safety reporting systems

These layers should encompass:

Actions where potential deviations from intended dose and geometry can be found before the first irradiation fraction of the patient (*e.g.* chart-checking)



ï SAINT LUKE'S HOSPITAL ï

UNIT NAME: **CONSULTANT:**

Name:
Address:
D.O.B.: Patient ID No.:
Diagnosis:
Stage:
TNM:
Contact No.:

TRANSPORT
☐ Own
☐ Taxi
☐ Ambulance

RESIDENCE
☐ IP St. Luke's
☐ Out Patient
☐ IP Other Hospital

PATIENT PHOTO

PATIENT AND TREATMENT STATUS
☐ New Patient ☐ Re-treat Patient
☐ Radical ☐ Palliative
☐ Chemotherapy ☐ Trial
☐ Phase I ☐ Phase II
☐ Other _____

BREAK CATEGORY
☐ Category 1 *(no break)*
☐ Category 2 *(maximum = d)*
☐ Category 3 *(flexible)*

BOOKINGS FOR
☐ Phase II
☐ Electron boost
☐ MDR
☐ HDR

TREATMENT PRESCRIPTION

Target	A Date:	B Date:	C
Target Description			
Target Dose			
Dose per Fraction			
Total No. of Fractions			
Fractions per Day			
Fractions per Week			
Prescr. Isodose Level			
Re-evaluation Dose			
Field Number			
Field Name			
Dose per Fraction / Field			
Photon Energy [MV]			
Electron Energy [MeV]			
Diaphragm Setting [w × l]			
Fixed SSD / Isocentric			
Bolus			
Signature			

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Radiation safety reporting systems

These layers should encompass:

Actions where deviations can be found during or after the treatment course (*e.g.* in-vivo dosimetry)

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Radiation safety reporting systems

These layers should encompass:

Application of safety technology (*e.g.* integrated radiotherapy networking)

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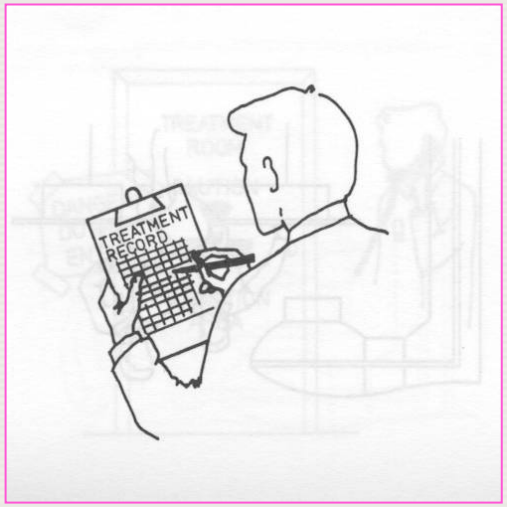
Radiation safety reporting systems

These layers should encompass:

Actions where contributing factors such as staffing-levels and structure, training and communication are addressed (*e.g.* monitoring of workload)



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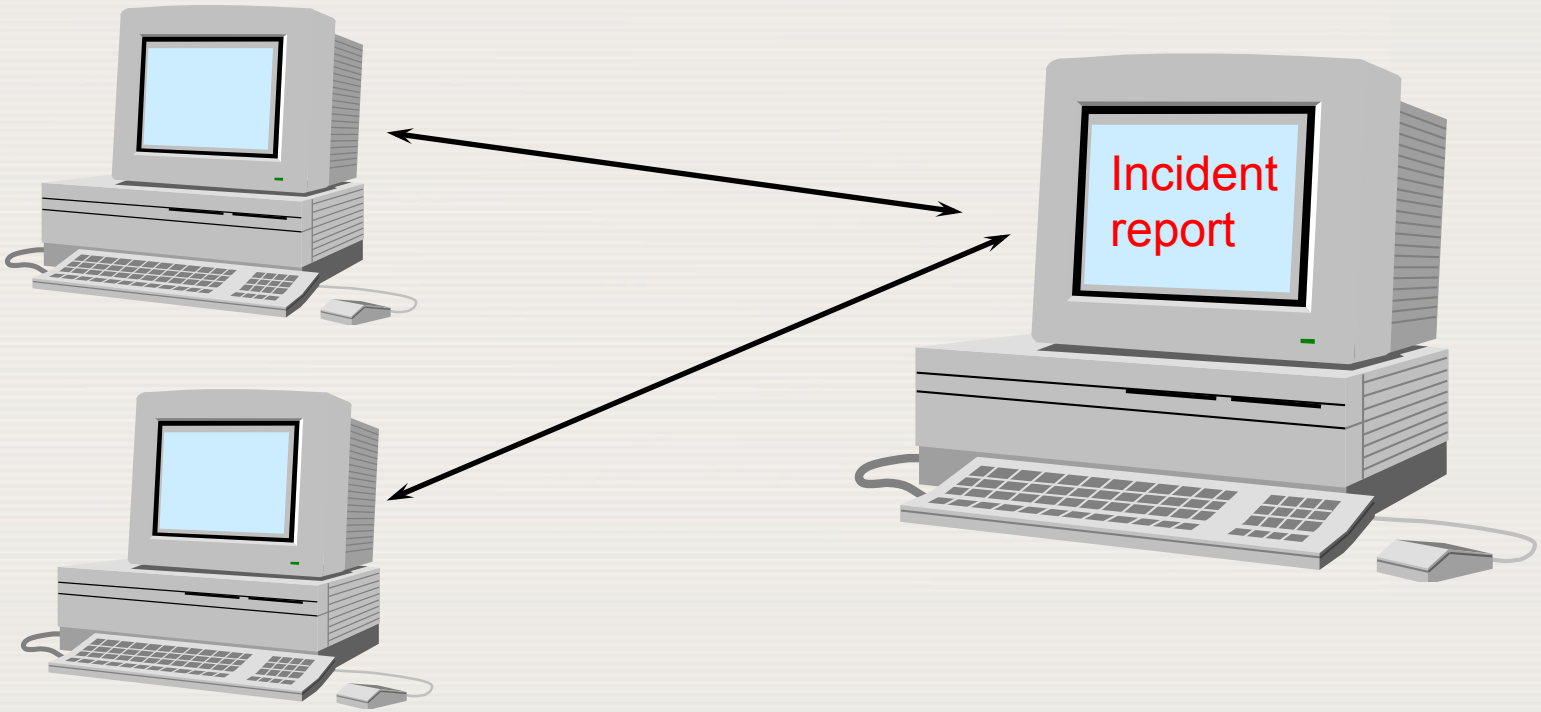
Radiation safety reporting systems

These layers should encompass:

Application of safety procedures (*e.g.* incident reporting systems)



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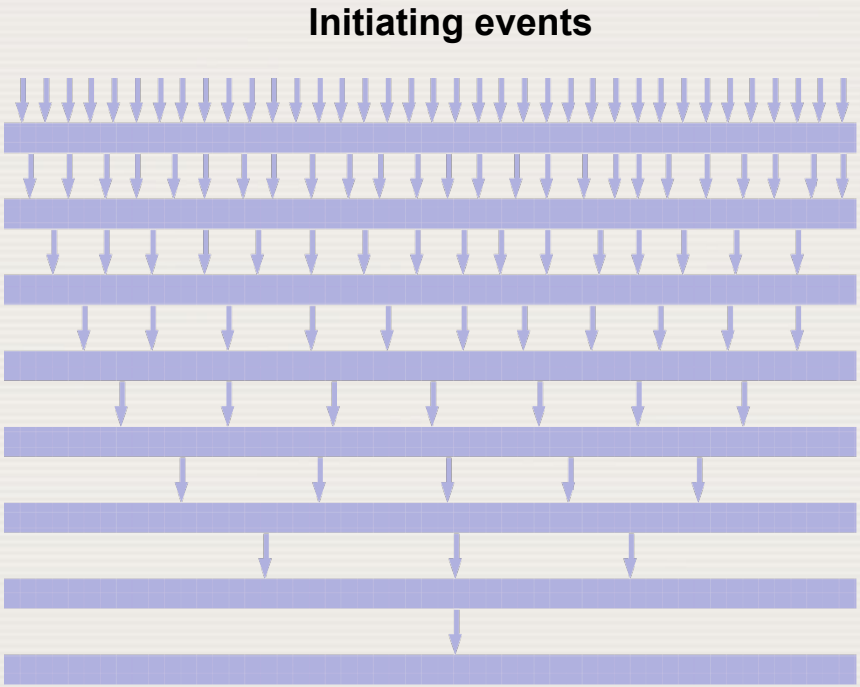
Radiation safety reporting systems

Safety in radiotherapy requires many safety-layers

- Implementing lessons learned from reported events is only one of these layers



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Why Safety Reporting and Learning?

Reported by a hospital in Toulouse, France.

In April 2006, a hospital physicist commissioned the new stereotactic unit.

This unit can operate with microMLC's (3 mm leaf-width) or conical standard collimators.

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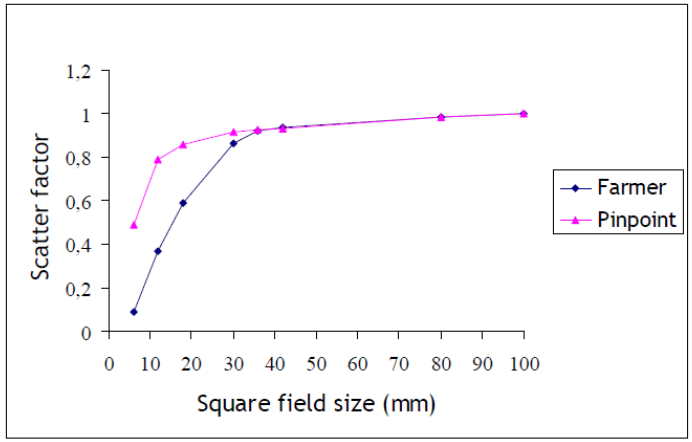
Why Safety Reporting and Learning?

High dose to a 6 x 6 mm field is within capability. Measuring device not suitable for the smallest micro-beams was used (Farmer 0.6 cm^3 ion chamber)

Incorrect data was entered into TPS. All patients treated with micro MLC were planned based on this incorrect data.

All patients treated with microMLC for a year were affected (145 of 172 stereotactic patients). Maximum overdose of about 200%



« Farmer » chamber : 0,65 cm^3
« Pinpoint » chamber : 0,03 cm^3

From: S. Derreumaux, IRSN, France

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Why Safety Reporting and Learning?

2009: Report from Missouri, U.S.A., on overdose of 76 patients during 5-year period

- Commissioning of stereotactic equipment
- Detector used for calibration of the smallest fields was too large
- Overdose to patients as a result

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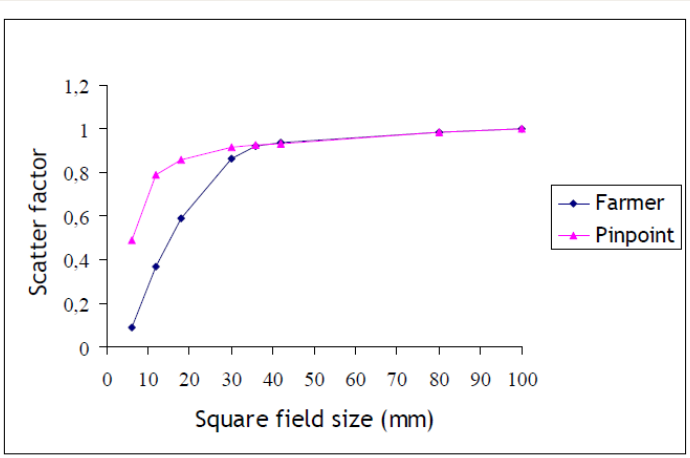
Why Safety Reporting and Learning?

France 2007 (1-year period)



« Farmer » chamber : 0,65 cm^3
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From: S. Derreumaux, IRSN, France

USA 2009 (5-year period)

Radiation Errors Reported in Missouri

By WALT BOGDANICH and REBECCA R. RUIZ
Published: February 24, 2010

A hospital in Missouri said Wednesday that it had overradiated 76 patients, the vast majority with brain cancer, during a five-year period because powerful new radiation equipment had been set up incorrectly even with a representative of the manufacturer watching as it was done.

From: W. Bogdanich, N.Y.Times, USA

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Why Safety Reporting and Learning?

France 2007 (1-year period)

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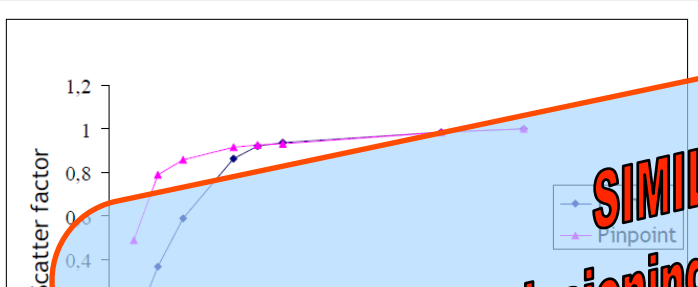

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... Bogdanich, N.Y.Times, USA

SIMILAR ACCIDENTS:

- Commissioning of stereotactic equipment
- Detector used for measuring in the smallest fields was too large
- Overdose to patients as a result (>200 in total)

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Why Safety Reporting and Learning?

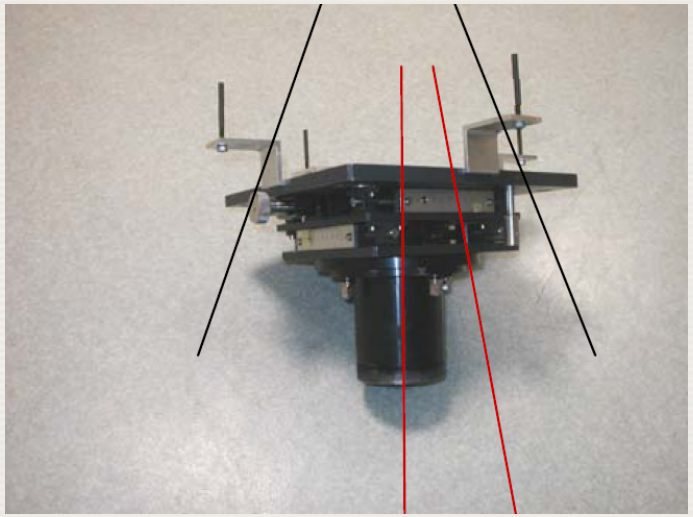
A clinic was using a linac for stereotactic treatment using additional cylindrical collimators (Ø 10-30 mm) mounted on opaque brass tray.

For correct use, it is necessary to set jaws to 4 cm x 4 cm

When treating one patient, operator was verbally instructed to narrow aperture to "40 40".

Instead of setting 40 mm x 40 mm as intended, the operator set 40 cm x 40 cm

Large volumes outside target were given nearly full absorbed dose



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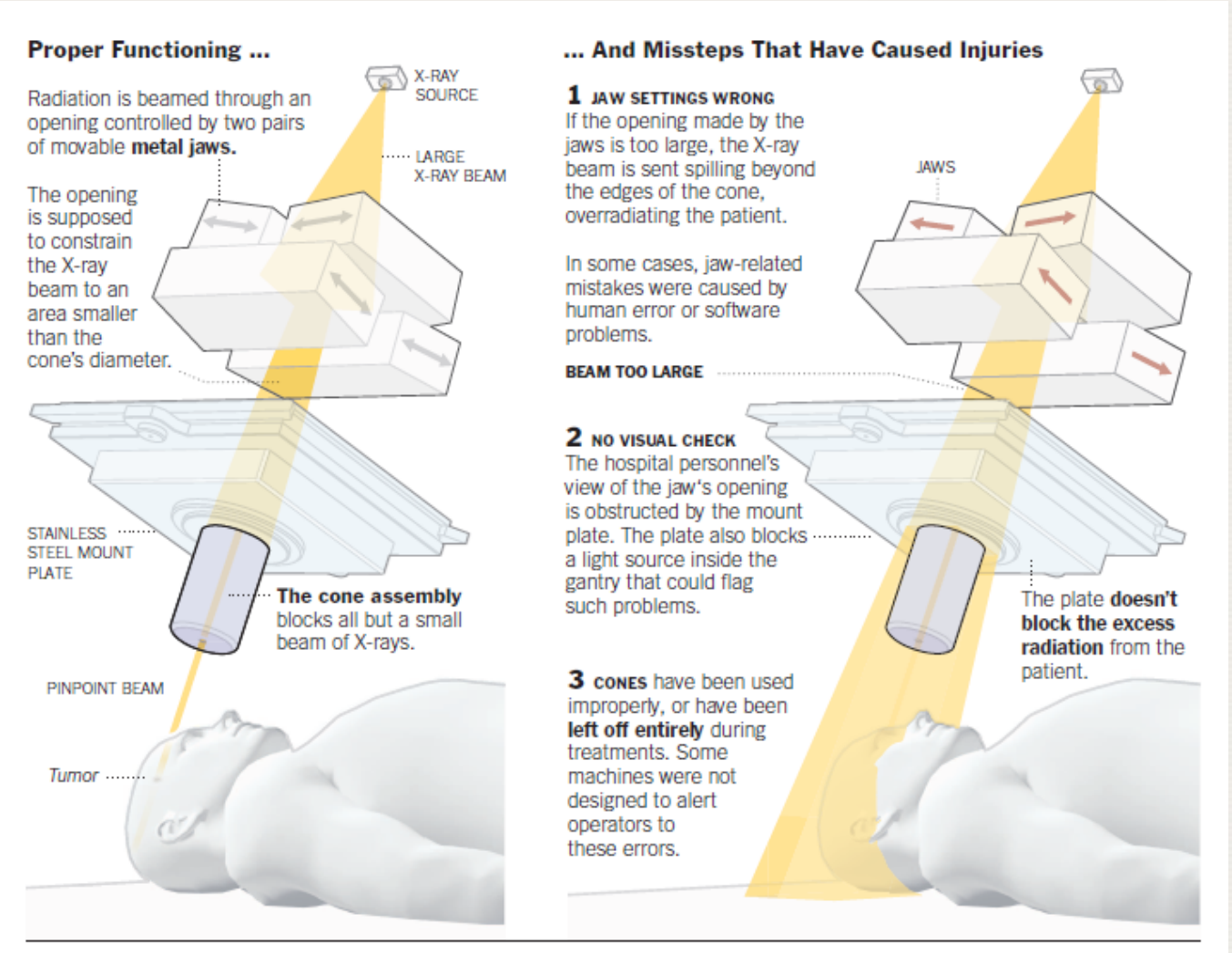

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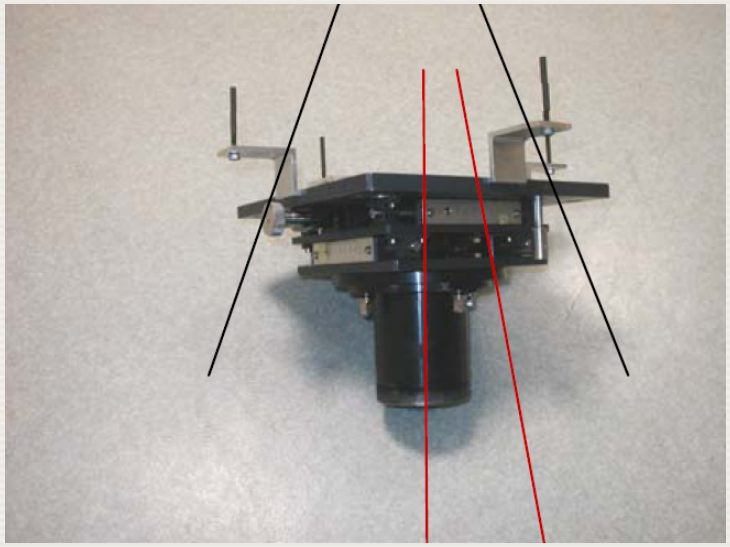
Why Safety Reporting and Learning?

France 2004

USA 2009?



From: S. Derreumaux, IRSN, France

The New York Times

© 2010 The New York Times NEW YORK, WEDNESDAY, DECEMBER 29, 2010

A Pinpoint Beam Strays Invisibly, Harming Instead of Healing

By WALT BOGDANICH and KRISTINA REBELO

The initial accident report offered few details, except to say that an unidentified hospital had administered radiation overdoses to three patients during identical medical procedures.

It was not until many months later that the full import of what had happened in the hospital last year began to surface in urgent nationwide warnings, which advised doctors to be extra vigilant when using a particular device that delivers high-intensity, pinpoint radiation to vulnerable parts of the body.

Marci Faber was one of the three patients. She had gone to Evanston Hospital in Illinois seeking treatment for pain emanating from a nerve deep inside her head. Today, she is in a nursing home, nearly comatose, unable to speak, eat or walk, leaving her husband to care for their three young daughters.

Two other patients were overdosed before the hospital realized that the device, a linear accelerator, had inexplicably allowed radiation to spill outside a heavy metal cone attachment that was supposed to channel the beam to a specific spot in the brain. One month later, the same accident happened at another hospital.

The treatment Ms. Faber received, stereotactic radiosurgery, or SRS, is one of the fastest-growing radiation therapies, a technological innovation designed to target tiny tumors and other anomalies affecting the brain or spinal cord, while minimizing damage to surrounding tissue.

Because the radiation is so concentrated and intense, accuracy is especially important. Yet, according to records and interviews, the SRS unit at Evanston lacked certain safety features, including those that might have prevented radiation from leaking outside the cone.

The mistakes in Evanston involve linear accelerators — commonly used for standard radiation therapy — that were redesigned by the manufacturer, Varian Medical Systems, so they could also perform SRS. As the devices became more versatile and complex, problems arose when vital electronic components could not communicate with one another.

In the last five years, SRS sys-

Continued on Page A12

An Incorrect Setting Leads to Injury

Problems involving machines that deliver therapeutic radiation have led to patient injuries.

CONE ASSEMBLY

CORRECT SETUP

A beam passes through an adjustable opening and then through a heavy metal cone that focuses the beam on the treatment area.

INCORRECT SETUP

The beam passes through a mistakenly large opening, exceeding the cone's diameter, and irradiates healthy tissue, causing injury.

MIKA GRÖNDAHL AND BILL MARSH/THE NEW YORK TIMES

Marci Faber is nearly comatose after a treatment mistake.

THE RADIATION BOOM

Missing the Target

From: W. Bogdanich, N.Y.Times, USA

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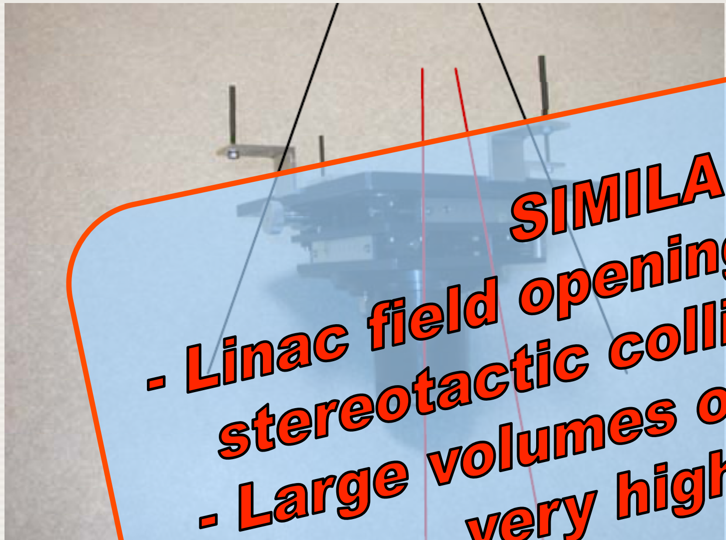
Why Safety Reporting and Learning?

France 2004

USA 2009?



From: S. Derreumaux, IRSN, France

The New York Times

TUESDAY, DECEMBER 29, 2010

of Healing

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MIKA GRÖNDAHL AND BILL MARSH/THE NEW YORK TIMES

tose after a treatment mistake.

Missing the Target

From: W. Bogdanich, N.Y.Times, USA

SIMILAR ACCIDENTS:

- Linac field opening set too large when using stereotactic collimator mounted on linac

- Large volumes outside target were given very high absorbed dose

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Radiation safety reporting systems

What is the role of a safety reporting system?

A safety reporting system can play an important role in …

- identifying system design flaws and safety critical steps in the radiotherapy pathway
- highlighting critical problems and patterns of causes of these problems
- spreading knowledge on new risks or involving new technology
- promoting safety culture and safety awareness through involvement of and feedback to staff and managers

To fulfil this role, the event reporting needs to be a link in a longer chain:

- Incident Identification => Reporting => Investigation => Analysis => Management => Learning

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Radiation safety reporting systems

What makes safety reports meaningful?

"the narrative"

Charles Billings (the designer of the Aviation Safety Reporting System in the USA)

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Radiation safety reporting systems

Mandatory safety reporting systems:

• Reporting of certain events is required *(e.g. reporting to regulatory authorities on events above certain magnitude)*

Voluntary safety reporting systems:

• Reporting is encouraged *(e.g. reporting to professional organization or international organization, voluntarily)*

and

Internal safety reporting systems:

• Reporting inside organisation *(e.g. local incident reports)*

External safety reporting systems:

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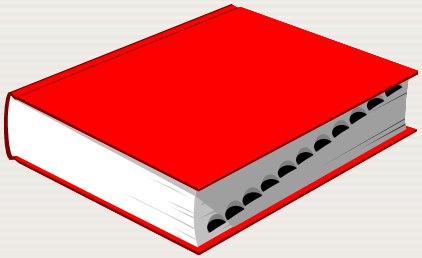
• Reporting outside organisation *(e.g. sharing with peers)*

Radiation safety reporting systems

Mandatory safety reporting systems

Mandatory reporting (to authorities) should …

- … focus on serious errors resulting in injury or death
- … ensure providers of medical care are held accountable to the public
- … require reporting of information in a standardised format to a national database



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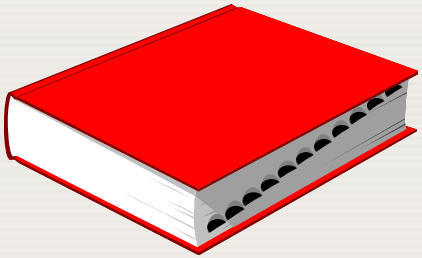
Radiation safety reporting systems

Mandatory safety reporting systems

Two purposes:

- … to provide public with certain level of protection by assuring that most-serious errors are reported and investigated, and action is taken

- … to provide an incentive to hospitals to improve and invest in patient safety, helping to assure that hospitals offer comparable care



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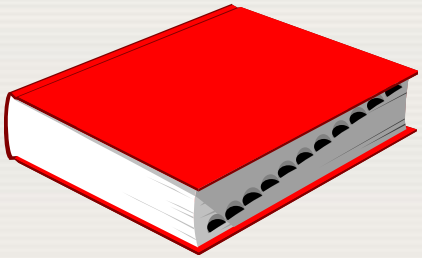
Radiation safety reporting systems

Mandatory safety reporting systems

Filing of a report should not trigger a release of information:

- … reporting should trigger an investigation
- … release of information should occur only after incident has been investigated thoroughly, and information released should be accurate and verified
- … employees should feel confident that response to reporting of significant error will be reasonable and justified



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Radiation safety reporting systems

Mandatory safety reporting systems –

Radiotherapy: A mix of radiation and medicine

- Legislation and regulations concerning reporting of incidents in radiotherapy can be covered in relation to radiation protection and / or health
- In some European countries, radiation protection legislation makes it mandatory to report radiotherapy incidents to a higher authority
- In some European countries, health legislation makes it mandatory to report radiotherapy incidents to a higher authority
- Some countries stipulate that local recording of incidents is mandatory. Potential incidents are covered in some countries

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Radiation safety reporting systems

Voluntary safety reporting systems

Voluntary reporting should …

- … focus on errors that result in little or no harm to patients
- … encourage hospitals to focus on improvement of safety environment
- … have mechanisms to ensure that information and lessons learned can be shared effectively

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Radiation safety reporting systems

Voluntary safety reporting systems

Voluntary reporting should …

- … have mechanisms that allow for anonymous reporting of errors or circumstances that could lead to errors, and allow handling in confidence

Staff reporting should not fear punishment

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Radiation safety reporting systems

Internal safety reporting systems

Reporting of incidents within organisation

- Specific in relation to intra-organisation …
  - … procedures
  - … equipment
  - … characteristics
- "Lessons to learn" become more direct and explicit
- Follows up management of actual patients affected by the incidents

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Radiation safety reporting systems

Internal safety reporting systems

Local report forms (European sample) – Some results:

General sections:

- Administrative information
- Patient information
- Incident information
- Action information

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Radiation safety reporting systems

Internal safety reporting systems

Local report forms (European sample) – Some results:

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Radiation safety reporting systems

Internal safety reporting systems

Section: Incident information (a sample of results)

- Description of event (25 / 27)
- Possible cause of error (9 / 27)
- Number of fractions affected (10 / 27)
- Occurrence: date (18 / 27), time (12 / 27) and day (1 / 27)
- Detection: how (4 / 27), who (2 / 27), work area (1 / 27), date (3 / 27)

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Radiation safety reporting systems

Internal safety reporting systems

Section: Incident information (a sample of results)

- Estimation of deviation: dose (2 / 27), dose after correction (2 / 27), field location (1 / 27), correctable or not (3 / 27)
- Clinical significance or risk to patient (12 / 27)
- Contributing factors: general comment (4 / 27), complex or simple treatment plan (1 / 27), staffing levels (4 / 27), experienced staffing levels (2 / 27), staff on leave (1 / 27), distractions (1 / 27)

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Radiation safety reporting systems

Internal safety reporting systems

Local report forms (European sample) – Some results:

General sections:

- Administrative information
- Patient information
- Incident information
- Action information

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Radiation safety reporting systems

Internal safety reporting systems

Section: Action information (a sample of results)

- Corrective action: action to be performed and / or already taken (22 / 27), responsible for this (3 / 27), date for completion (5 / 27)
- Preventive action: recommended action to prevent recurrence (10 / 27), procedural changes (2 / 27), confirmation of preventive action (3 / 27)
- Communication: patient informed (4 / 27), responsible physician informed (13 / 27), authority informed (9 / 27), general (6 / 27)

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Radiation safety reporting systems

External safety reporting systems

Reporting of incidents outside organisation

- "Lessons to learn" will come from a bigger pool of events
- An incident in another hospital can lead to identification of the hazard before a similar incident is realised in your own hospital
- More extensive pool of events → better identification of safety-critical steps in the radiotherapy process where errors are likely to occur or be detected
- A general culture of safety awareness can be created by making information available on details of incidents, near-incidents and corrective actions

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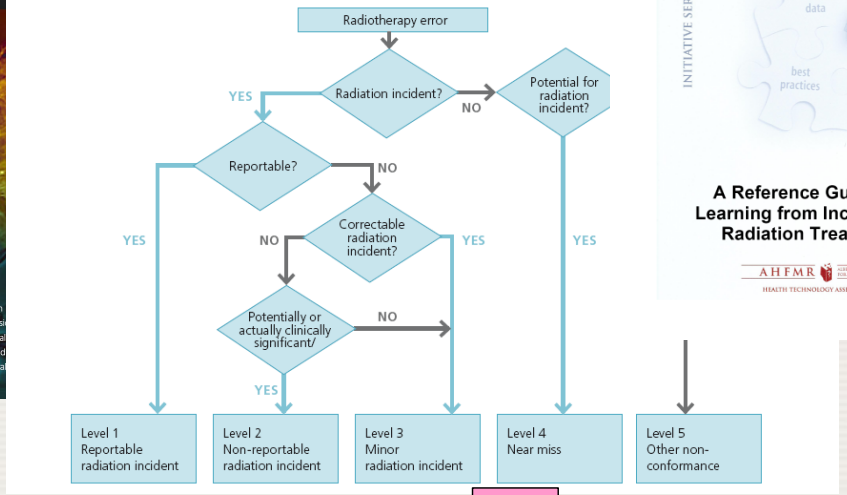
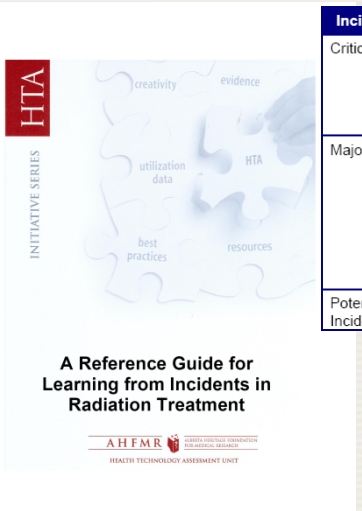
Radiation safety reporting systems

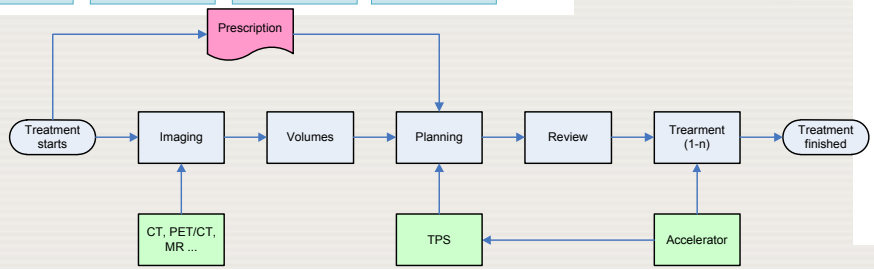
Taxonomy for safety reporting systems

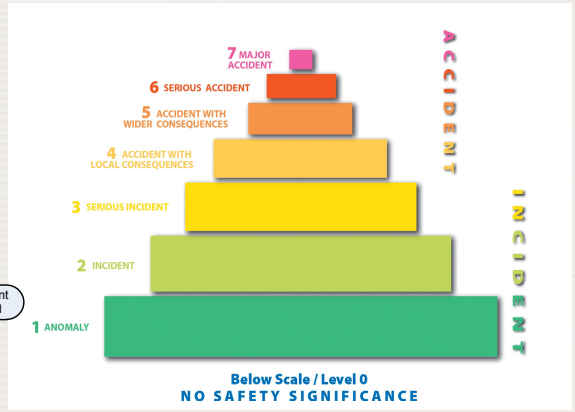
Severity classification; Causes / contributing factors classification; Standardized process map; Other terminology





Incident Severity	Examples: Clinical Incident	Individuals to be notified
Critical Incident	Radiation dose or medication error causing death or disability. Dose variation from prescribed total dose of >20%. Completely incorrect volume.	*Immediately notify*: Senior Management, Manager, Supervisor, Physician
Major Incident	Dose variation from prescribed total dose of 10 – 20%. Radiation dose or medication error causing side effects requiring major treatment and intervention or hospitalization. Set up variation that will/could impact on normal tissue effects (e.g. Heart, lung, eyes, kidney etc.).	*Immediately notify*: Senior Management, Manager, Supervisor, Physician
Potential Major Incident	A near miss that could have been a major incident.	Manager, Supervisor





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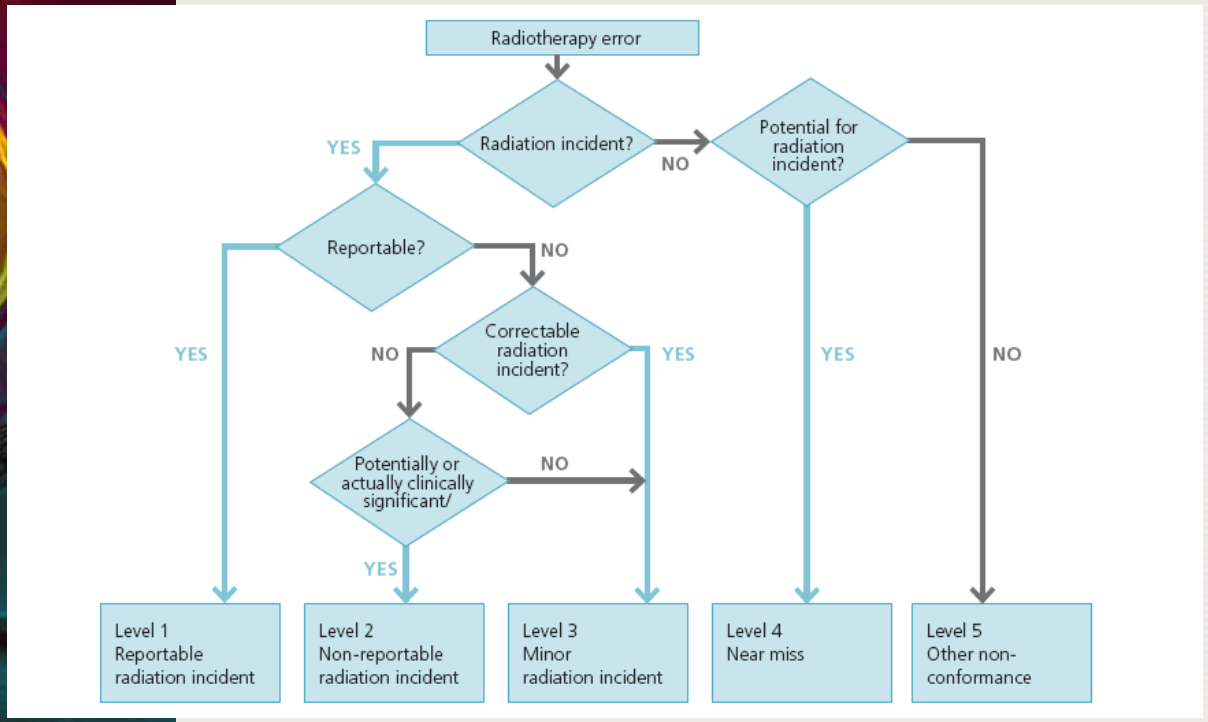
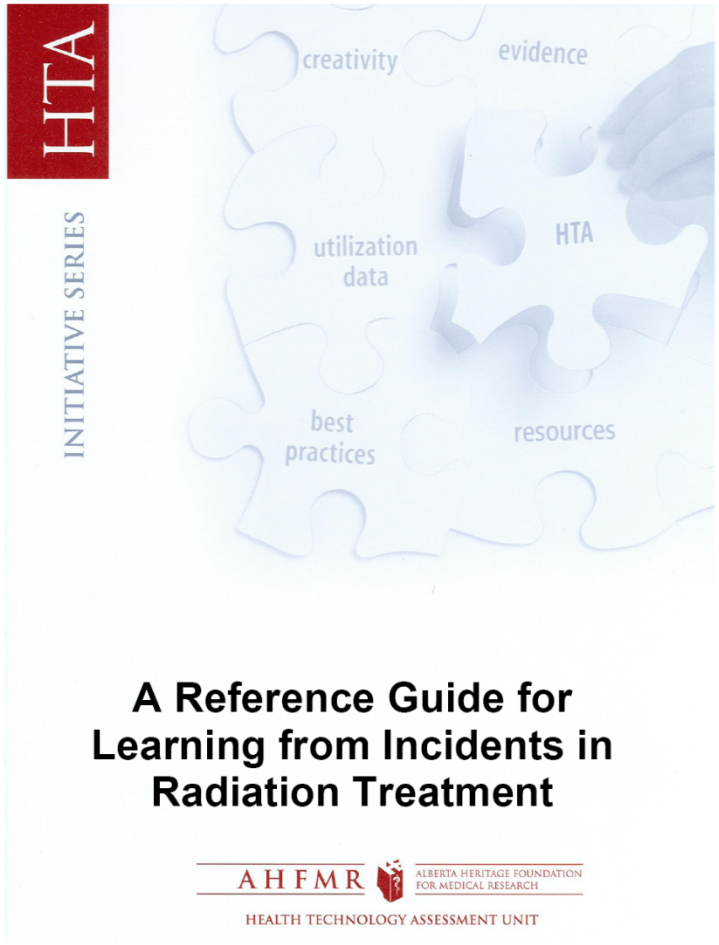
Severity Classification – HPA (GBR)

Guidance to the legislation issued by the Department of Health in 2000 indicated that the term 'much greater than intended' should be interpreted as 10% or more than that intended for a whole course of treatment, or 20% or more than that intended for any given fraction. This threshold was based on a judgement of the level of overexposure that would place the patient at risk of adverse outcome from their treatment. However, it should be noted that only incidents where the dose is *greater* than that intended are reportable, even though underdose can also result in adverse outcome for the patient. This guidance is currently under revision.[33]



Severity Classification – TBCC (CAN)



Clinical incident severity

Incident Severity	Examples: Clinical Incident	Individuals to be notified
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Potential Major Incident	A near miss that could have been a major incident.	Manager, Supervisor
Serious Incident	Dose variation from prescribed total dose of 5 - <10%. Radiation dose or medication error causing side effects requiring minor treatment or ongoing monitoring and assessment. Set up variation > 1cm – no critical structures included.	Within 24hrs notify: Manager, Supervisor, Physician
Potential Serious Incident	A near miss that could have been a serious incident.	Supervisor
Minor Incident	Dose variation from prescribed total dose of <5%. Near miss or unsafe condition which could potentially cause a treatment error.*	Supervisor, Physician*

Table 4: Occupational incident severity

Incident Severity	Examples: Occupational Incident	Individuals to be notified
Critical Incident	Death, life-threatening injury or illness, or	*Immediately notify*: Senior

Table 5: Operational incident severity

Incident Severity	Examples: Operational Incident	Individuals to be notified
Critical Incident	Equipment failure and/or damage not considered normal wear and tear costing more than $50,000.	*Immediately notify*: Senior Management, Manager,

Table 6: Environmental incident severity (cont'd)

Incident Severity	Examples: Environmental Incident	Individuals to be notified
Serious Incident	**Radiation** - • Source found to be leaking.	*Within 24hrs notify*: Manager, Supervisor, Radiation Safety Officer

Table 7: Security/other incident severity

Incident Severity	Examples: Security Incident	Individuals to be notified
Critical Incident	Events that result in a formal investigation by a regulatory body or public agency.	*Immediately notify*: Senior Management, Manager,

Severity Classification – TBCC (CAN)

Incident Type	Process or System that Failed
Clinical	Patient safety or treatment-related processes
Occupational	Staff, student and visiting worker safety
Operational	Operational and technical systems related to machines, equipment, facilities, procedures, patient flow and staff scheduling
Environmental	Processes preventing environmental exposure to radiation, drugs or chemicals
Security/Other	Personal and public security, information security, system integrity and public image

From: Brenda Clark (Ottawa) - The Incident Learning System as an Error Management Tool

Severity Classification – TBCC (CAN)

Actual Incidents	Potential Incidents
1 Critical	
2 Major	5 Major
3 Serious	6 Serious
4 Minor	7 Minor

The guide clearly indicates the appropriate notification process at each level

Severity Classification – TBCC (CAN)

Desription	Actual	Potential
ΔD > 25% Incorrect vol, wrong pt	Critical	
10% < ΔD < 25% Wrong beam parameters or shielding for > 10%	Major	Major
5% < ΔD < 10% Set up variation >1cm	Serious	Serious
ΔD < 5%	Minor	Minor

The guide clearly indicates the appropriate notification process at each level

Severity Classification – SAFRON

Incident Severity Help

- **Minor Incident**
  - Dose variation from prescribed total dose of <5%
  - Near miss or unsafe condition which could potentially cause a treatment error
  - Patient complaint
- **Potential Serious Incident**
  - A near miss that could have been a serious incident
- **Serious Incident**
  - Dose variation from prescribed total dose of 5 - 10%
  - Radiation dose or medication error causing side effects requiring minor treatment or ongoing monitoring and assessment
  - Set up variation > 1cm - no critical structures included
- **Potential Major Incident**
  - A near miss that could have been a major incident
- **Major Incident**
  - Dose variation from prescribed total dose of 10 - 20%
  - Radiation dose or medication error causing side effects requiring major treatment and intervention or hospitalization
  - Set up variation that will/could impact on normal tissue (e.g. heart, lung, eyes, kidney etc.)
- **Critical Incident**
  - Radiation dose or medication error causing death or disability
  - Dose variation from prescribed total dose of >20%
  - Completely incorrect volume

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Severity Classification – ROSIS (Int.)

ROSIS
Radiation Oncology Safety Information Sys

Severity:

Was any part of the treatment delivered incorrectly?

Yes

How many fractions were delivered incorrectly?: 0

How many fractions were prescribed in total?: 0

Outcome for the patient(s)/person(s) affected

- None: Event without consequences
- Light (grade 1): Event with dosimetric consequences but no expected clinical consequence - No expected symptom
- Moderate (grade 2): Event leading to or liable to lead to a moderate impairment of an organ or function - Dose higher than recommended doses liable to lead to unexpected but moderate complications
- High (grade 3): Event leading to a severe impairment of one or more organs or functions - Dose or irradiated volume higher than tolerable doses or volume
- Severe (grade 4): Serious life-threatening event, disabling complication or sequelae - Dose or irradiated volume far higher than tolerable doses or volumes
- Death (grade 5): - Dose or irradiated volume far higher than normal leading to fatal complications or sequelae

Comments regarding actual outcome

Enter here...

Potential outcome for the patient(s)/person(s) if the incident was not detected/corrected

- None: Event without consequences
- Light (grade 1): Event with dosimetric consequences but no expected clinical consequence - No expected symptom
- Moderate (grade 2): Event leading to or liable to lead to a moderate impairment of an organ or function - Dose higher than recommended doses liable to lead to unexpected but moderate complications
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Comments regarding potential outcome

Enter here...

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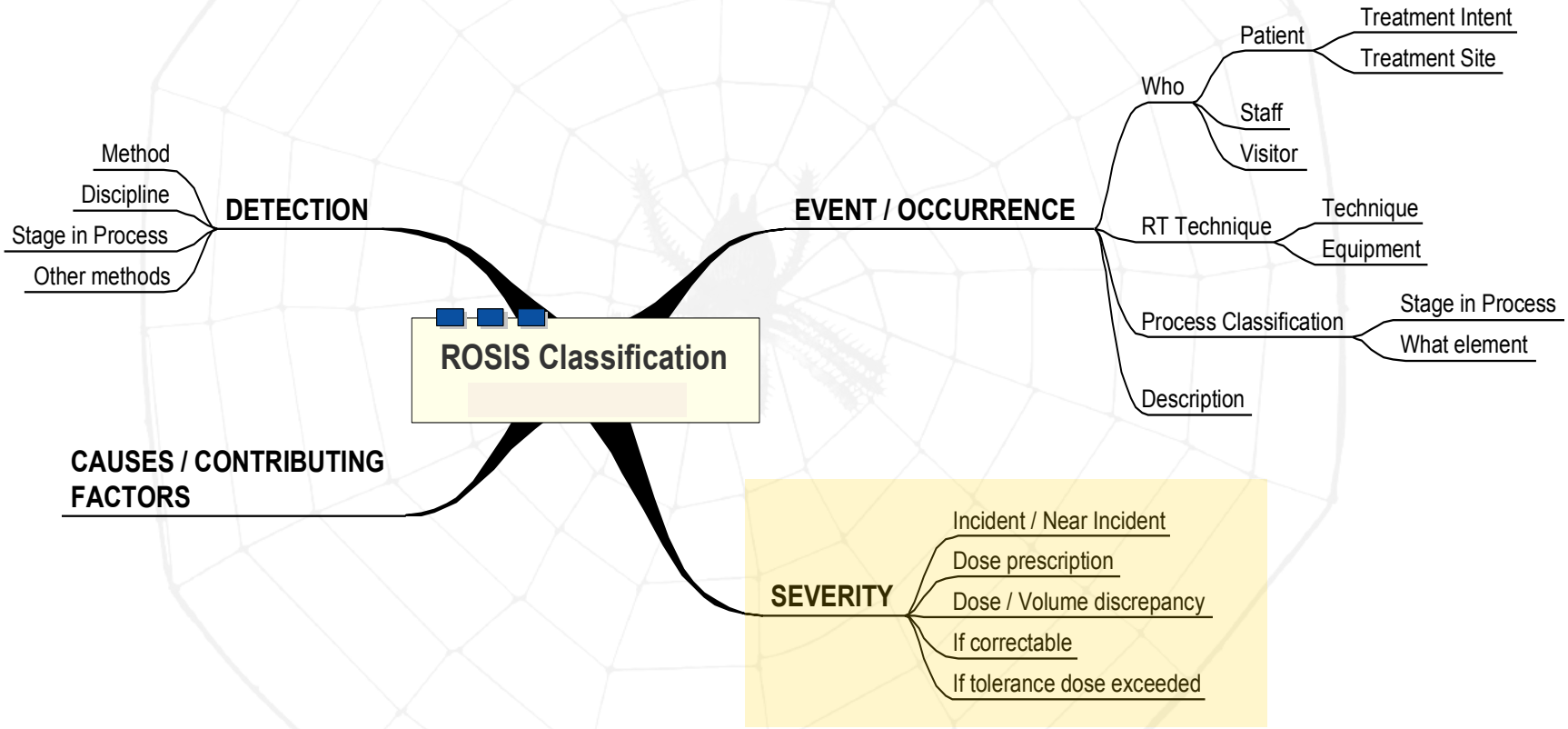
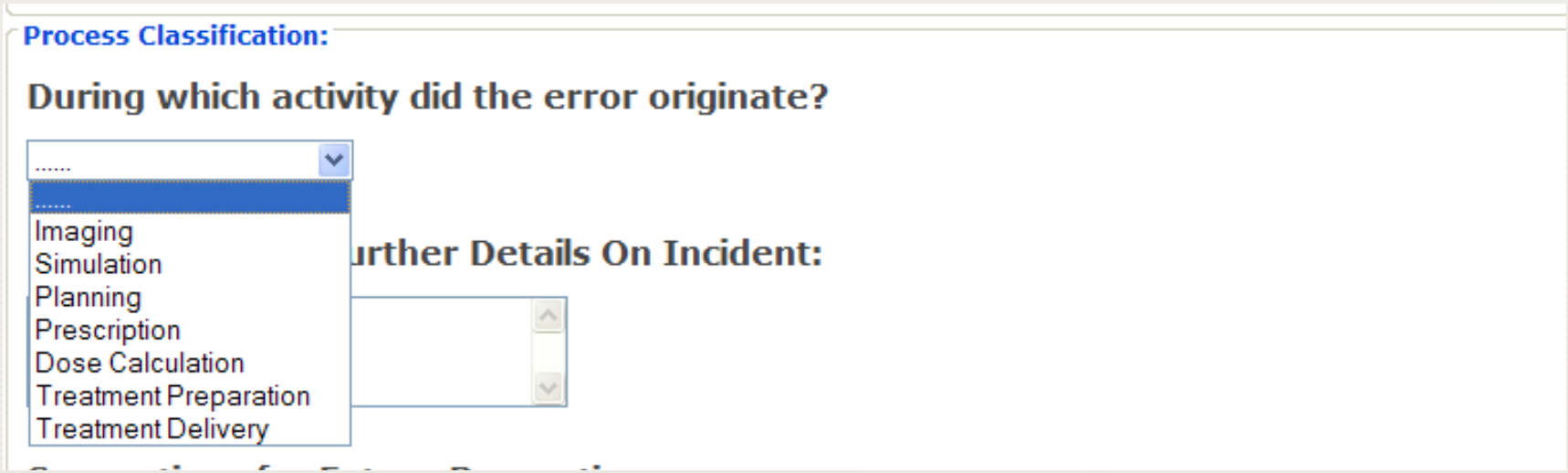
Severity Classification – ROSIS (Int.)



From: Joanne Cunningham (Dublin) – ROSIS: An Overview

Process steps – ROSIS



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Process steps – ROSIS

Process Classification:

During which activity did the error originate?

Treatment Delivery

What activity of treatment delivery was affected?

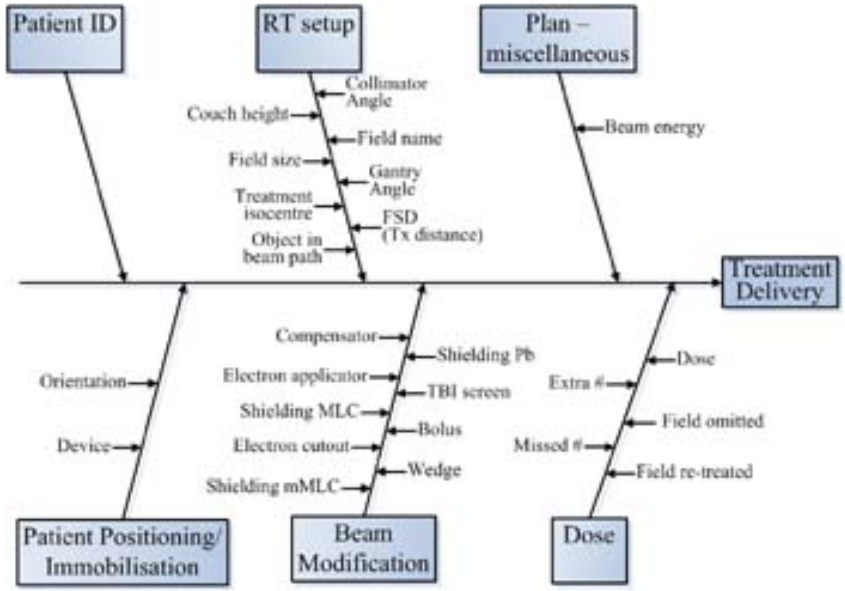
RT Set-Up

Which parameter was affected?

Field Size

Please Give Any Further Details On Incident:

Enter here...



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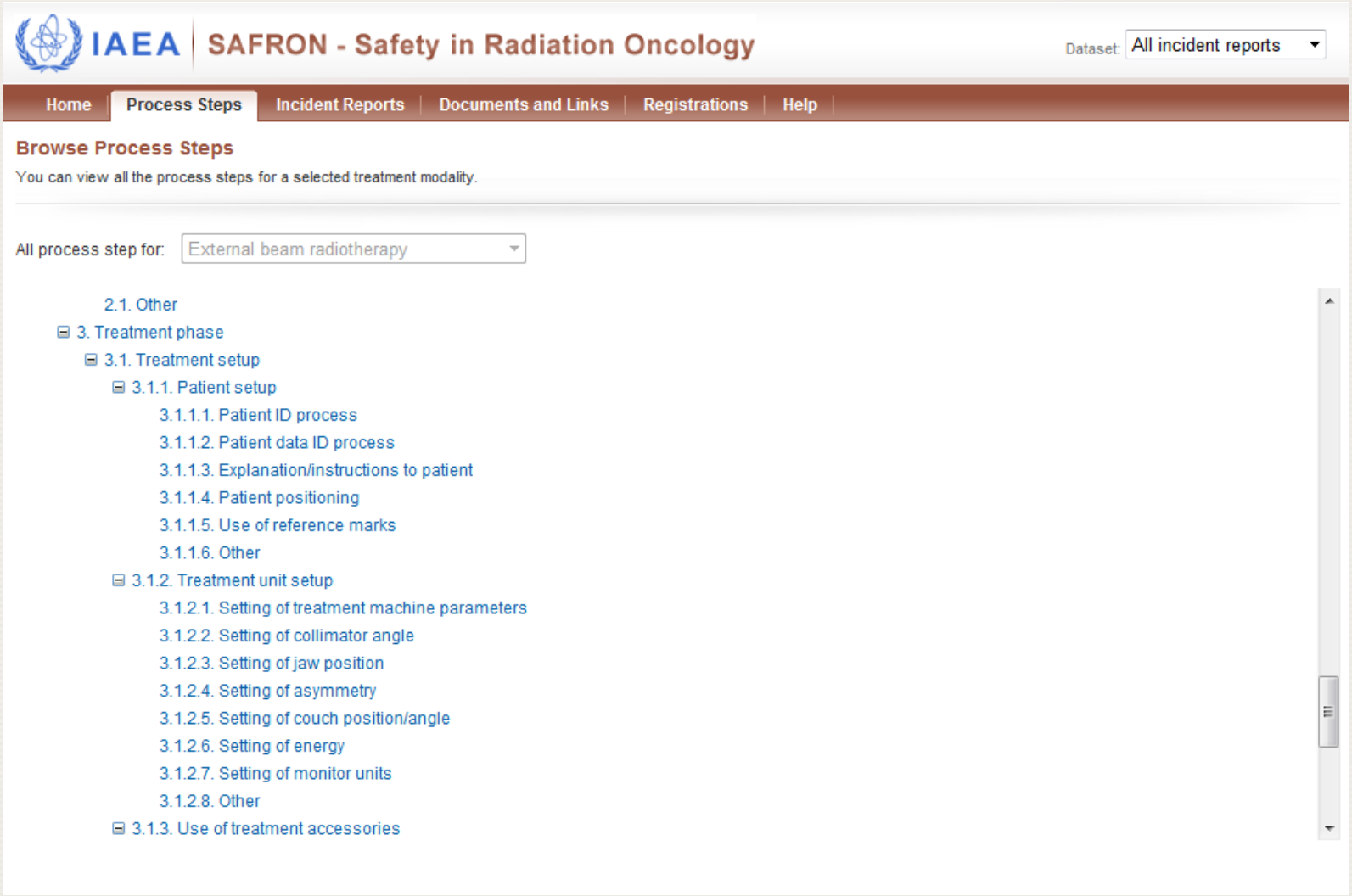
Process steps – SAFRON



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Safety barriers – SAFRON

New feature introduced in SAFRON: Safety Barriers

- Which safety barriers did NOT find the incident?
- Which safety barrier found the incident?
- If this safety barrier had not found the incident, which of your subsequent barriers might have found it?

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Safety barriers – SAFRON

New feature introduced in SAFRON: Safety Barriers

- Overall available safety barriers queried in Registration form (check-boxes)
- Relevant safety barriers in context of incident queried in Incident Report form
- Might influence reporter to think about defence-in-depth, effectiveness of safety barriers, and what safety barriers are in place for safety critical steps

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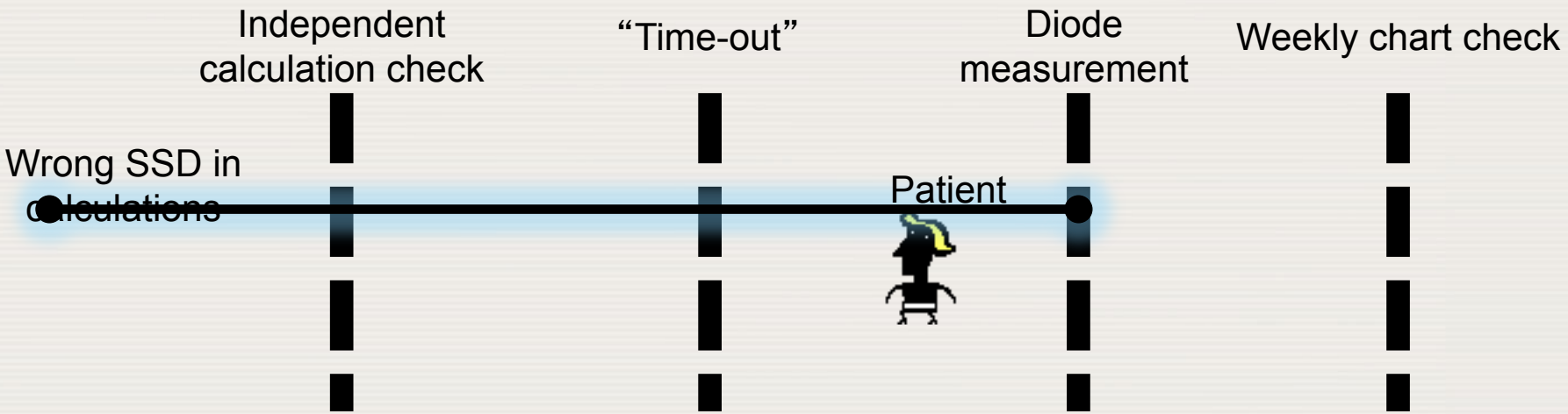
Safety barriers – SAFRON

New feature introduced in SAFRON: Safety Barriers

- Example: Wrong SSD used for manual inverse square calculation of MU for manually calculated patient plan



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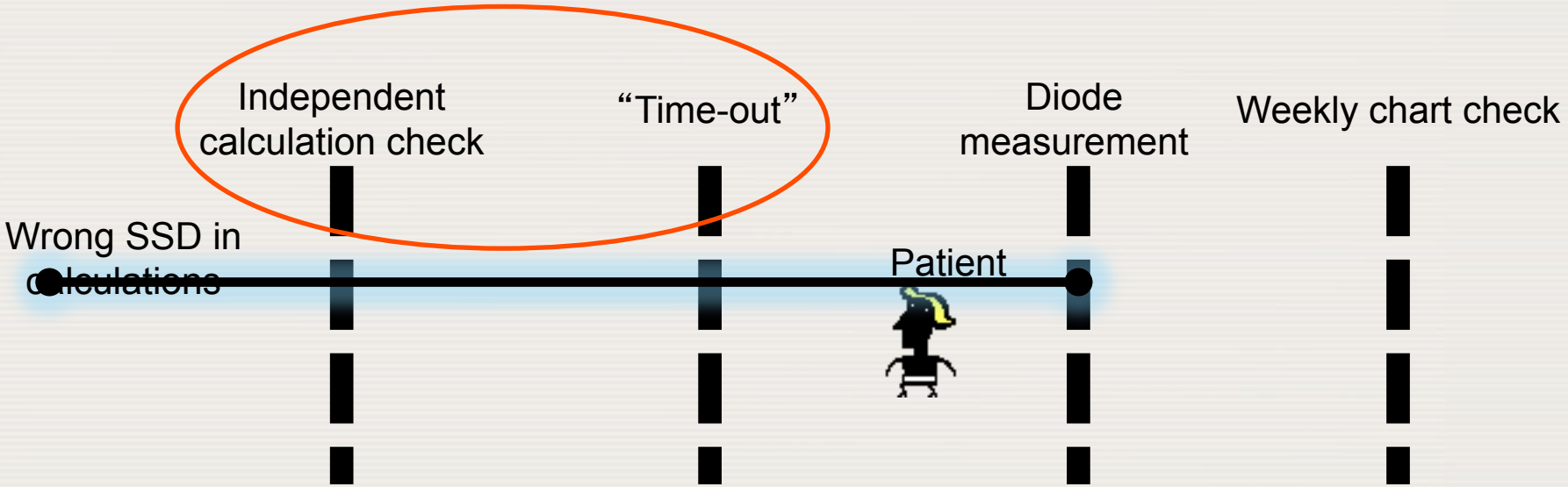

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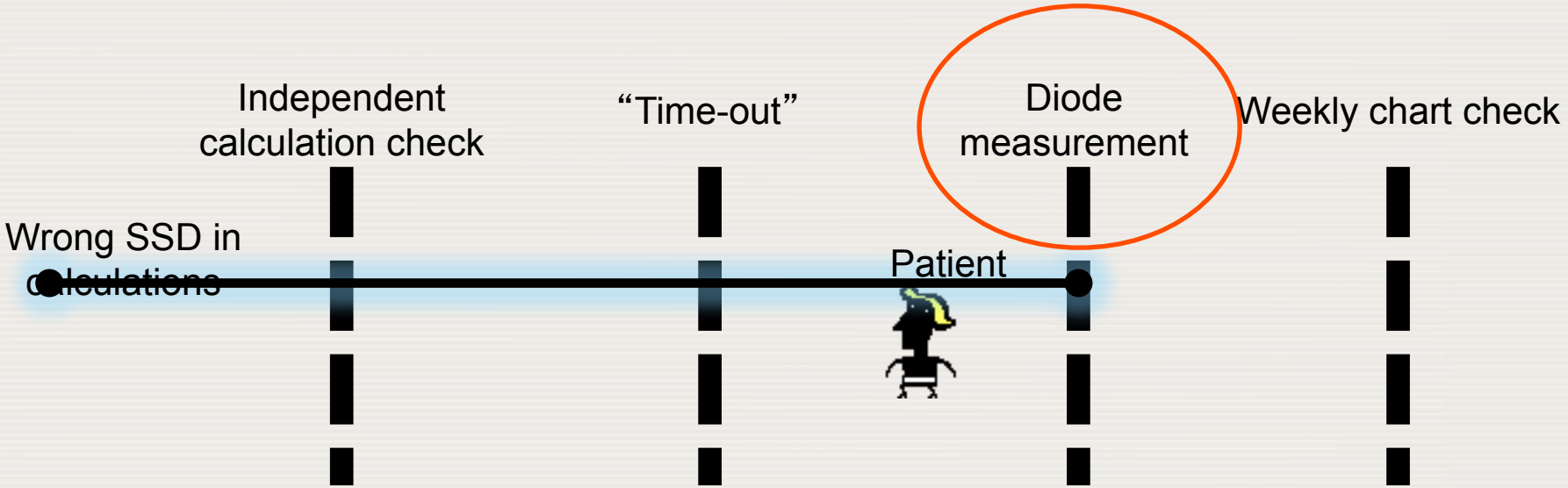

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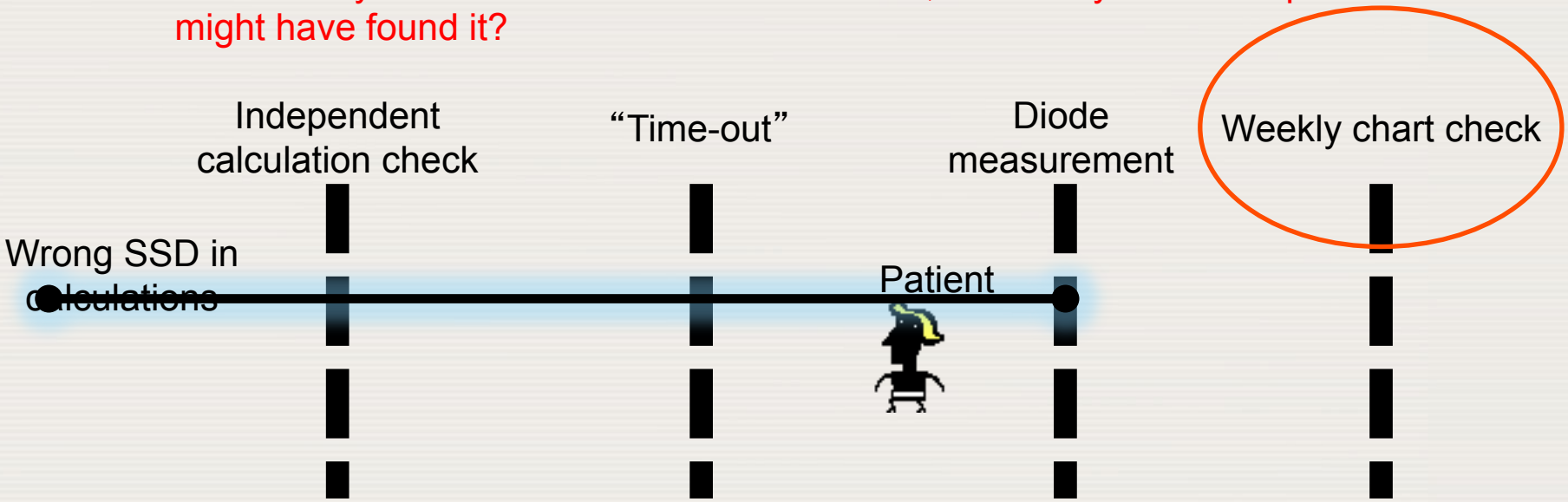

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Safety barriers – SAFRON

What safety barrier	failed to identified the incident?	identified the incident?	might have identified it?
Verification of patient ID	☐	☐	☐
Verification that pretreatment condition have been taken into account	☐	☐	☐
Verification of imaging data for planning (CT scan, fusion, imaging modality, correct data set)	☐	☐	☐
Verification reference points	☐	☐	☐
Physician peer review	☐	☐	☐
Review of treatment plan	☐	☐	☐
Independent confirmation of dose	☐	☐	☐
Time out	☐	☐	☐
Use of record and verifying system	☐	☐	☐
Verification of treatment accessories	☐	☐	☐
Image based position verification	☐	☐	☐
In vivo dosimetry	☐	☐	☐
Intra-treatment monitoring	☐	☐	☐
Regular independent chart checks	☐	☐	☐
Regular clinic patient assessment	☐	☐	☐
Post treatment evaluations (evaluation of clinical and process)	☐	☐	☐
Independent review of commissioning	☐	☐	☐
Regular internal audit	☐	☐	☐
Regular external audit	☐	☐	☐
Regular equipment performance verification	☐	☐	☐
Other, please specify	☐	☐	☐

Standardized causes – SAFRON

Job Factors

- Standards/Procedures/Practices
  - [ ] 1.1 Not developed
  - [ ] 1.2 Inadequate standard/procedure/practice
  - [ ] 1.3 Standard/Procedure/Practice not followed
  - [ ] 1.4 Inadequate communication of procedure
  - [ ] 1.5 Inadequate assessment of risk
  - [ ] 1.6 Not implemented
- Materials/Tools/Equipment
  - [ ] 2.1 Availability
  - [ ] 2.2 Defective
  - [ ] 2.3 Inadequate maintenance
  - [ ] 2.4 Inspection
  - [x] 2.5 Used incorrectly
  - [ ] 2.6 Inadequate assessment of materials/tools/equipment for task
- 3. Design
  - [ ] 3.1 Inadequate hazard assessment
  - [ ] 3.2 Inadequate design specification
  - [ ] 3.3 Design process not followed
  - [ ] 3.4 Inadequate assessment of ergonomic impact
  - [ ] 3.5 Inadequate assessment of operational capabilities
  - [ ] 3.6 Inadequate programming

Systemic/Management Factors

- 4. Planning
  - [ ] 4.1 Inadequate work planning
  - [ ] 4.2 Inadequate management of change
  - [ ] 4.3 Conflicting prorities/planning/programming
  - [ ] 4.4 Inadequate assessment of needs & risks
  - [ ] 4.5 Inadequate documentation
  - [ ] 4.6 Personnel availability
- 5. Communication
  - [ ] 5.1 Unclear roles, responsibilities, and accountabilities
  - [ ] 5.2 Lack of communications
  - [x] 5.3 Inadequate direction/information
  - [ ] 5.4 Misunderstood communications
- 6. Knowledge/Skills
  - [x] 6.1 Inadequate training/orientation
  - [ ] 6.2 Training needs not identified
  - [ ] 6.3 Lack of coaching
  - [ ] 6.4 Failure to recognize hazard
  - [ ] 6.5 Inadequate assessment of needs and risks

Personal Factors

- 7. Capabilities
  - [ ] 7.1 Physical capabilities (height, strength, weight, etc.)
  - [ ] 7.2 Sensory deficiencies (sight, sound, sense of smell, balance, etc.)
  - [ ] 7.3 Substance sensitivities/allergies
- 8. Judgment
  - [ ] 8.1 Failure to address recognized hazard
  - [ ] 8.2 Conflicting demands/priorities
  - [ ] 8.3 Emotional stress
  - [ ] 8.4 Fatigue
  - [ ] 8.5 Criminal intent
  - [ ] 8.6 Extreme judgment demands
  - [ ] 8.7 Substance abuse

Natural Factors

- 9 Natural Factors
  - [ ] 9.1 Fires
  - [ ] 9.2 Flood
  - [ ] 9.3 Earthquake
  - [ ] 9.4 Extreme weather
  - [ ] 9.5 Other

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