

# Safety barriers

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**IAEA**

International Atomic Energy Agency

# Radiation incidents and accidents

## Trinidad Express Newspaper National News of Trinidad and Tobago

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### Khan makes statement on radiation overexposure

Originally printed at

[http://www.trinidadexpress.com/news/Khan\\_makes\\_statement\\_on\\_radiation\\_overexposure-150524645.html](http://www.trinidadexpress.com/news/Khan_makes_statement_on_radiation_overexposure-150524645.html)

May 7, 2012



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### Radiation Treatment Lawsuit in Hawaii Settled for \$15M



# Radiation incidents and accidents

## Accidents in external radiotherapy in Japan

Akifumi Fukumura and Hideyuki Mizuno  
National Institute of Radiological Sciences, Japan

The following table summarizes the 8 accidents in external radiotherapy, which have been made public in Japan. This poster describes the four typical cases of No. 3, 4, 6 and 7, which were reported by the expert team from Japanese Society for Therapeutic Radiology and Oncology (JASTRO) and Japan Society of Medical Physics (JSMP).

No.	Location (City, Prefecture)	Disclosure	Patients	Main Cause
1	Minato, Tokyo	April 2001	23	Input error of TPS data
2	Kanazawa, Ishikawa	July 2002	12	Input error of TPS data
3	Hirosaki, Aomori	October 2003	276	Misunderstanding between RO and RT
4	Yamagata, Yamagata	February 2004	32	Input error of TPS data
5	Yamagata, Yamagata	March 2004	25	Input error of TPS data
6	Aizuwakamatsu, Fukushima	April 2004	256	Incorrect dosimetry
7	Wakayama, Wakayama	May 2004	1	Data transfer error to LINAC
8	Morioka, Iwate	May 2004	111	Input error of TPS data

# Radiation incidents and accidents

Similar events in France 2004 and U.S.A some years later

**Proper Functioning ...**

Radiation is beamed through an opening controlled by two pairs of movable **metal jaws**.

The opening is supposed to constrain the X-ray beam to an area smaller than the cone's diameter.

**X-RAY SOURCE**  
**LARGE X-RAY BEAM**

**STAINLESS STEEL MOUNT PLATE**

**The cone assembly blocks all but a small beam of X-rays.**

**PINPOINT BEAM**

**Tumor**

**... And Missteps That Have Caused Injuries**

**1 JAW SETTINGS WRONG**  
If the opening made by the jaws is too large, the X-ray beam is sent spilling beyond the edges of the cone, overradiating the patient.

In some cases, jaw-related mistakes were caused by human error or software problems.

**2 NO VISUAL CHECK**  
The hospital personnel's view of the jaw's opening is obstructed by the mount plate. The plate also blocks a light source inside the gantry that could flag such problems.

**BEAM TOO LARGE**

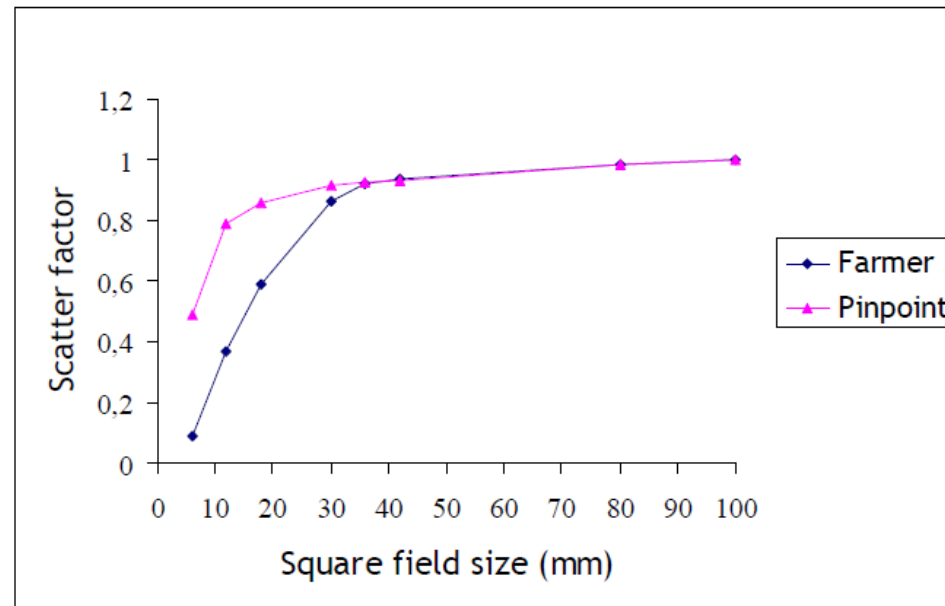
**3 CONES** have been used improperly, or have been **left off entirely** during treatments. Some machines were not designed to alert operators to these errors.

**The plate doesn't block the excess radiation from the patient.**

The diagram illustrates the correct setup for an X-ray beam. An X-ray source emits a large cone of radiation. Two pairs of metal jaws are positioned to narrow this cone into a pinpoint beam that targets a tumor. A stainless steel mount plate is used to hold the jaws, and a cone assembly blocks the radiation, leaving only the pinpoint beam. Three scenarios of error are shown: 1. Jaws are set too wide, allowing a large beam to spill over the tumor. 2. The mount plate is positioned such that it obstructs the view of the jaws and blocks a light source that would normally alert the operator. 3. The cone assembly is missing or misaligned, allowing a large beam to reach the patient's head.

# Radiation incidents and accidents

Similar events in France 2007 and U.S.A some years later



« Farmer » chamber :  $0,65 \text{ cm}^3$   
« Pinpoint » chamber :  $0,03 \text{ cm}^3$

# Radiation incidents and accidents

## Error killed mother

A MOTHER died after she was administered a double dose of radiation due to an error at a [REDACTED] hospital, an inquest was told yesterday.

[REDACTED] (54) was diagnosed with cancer and underwent major surgery at [REDACTED]. She then began radiation as an out-patient. It was discovered that an error had been made which resulted in her receiving a double dosage.

A post-mortem examination found radiation-induced injuries led to her death.

● Report: Page Eight

# Radiation incidents and accidents

- Still difficulties in ensuring systematic learning from radiotherapy safety-related events that have happened

# Radiation incidents and accidents

- Radiation accidents involving medical uses:
  - Over the last three decades, **at least 3000 patients** have been affected by radiotherapy incidents and accidents
  - Radiation accidents involving medical uses have accounted for more **acute radiation deaths** than any other source, including Chernobyl
  - These accidents do not only affect patients directly (e.g. harm and death), but might also **undermine the public's confidence** in the treatment
  - Preventable medical errors overall also **cost** countries billions of dollars each year

**Table 10. Numbers of deaths and early acute health effects due to radiation accidents**

Based on published information; excludes malicious acts and nuclear testing

<i>Type of accident</i>	<i>1945–1965</i>		<i>1966–1986</i>		<i>1987–2007</i>		<i>Total</i>
Accidents at nuclear facilities	13 deaths	42 early effects	34 deaths	123 early effects	3 deaths	2 early effects	50 deaths 167 early effects
Industrial accidents	0 deaths	8 early effects	3 deaths	61 early effects	6 deaths	51 early effects	9 deaths 119 early effects
Orphan source accidents	7 deaths	5 early effects	19 deaths	98 early effects	16 deaths	205 early effects	42 deaths 308 early effects
Accidents in academic/ research work	0 deaths	2 early effects	0 deaths	22 early effects	0 deaths	5 early effects	0 deaths 29 early effects
Accidents in medical use	Unknown	Unknown	4 deaths	470 early effects	42 deaths	153 early effects	46 deaths <b>623 early effects</b>





# Radiation incidents and accidents

- Radiotherapy-related error rate compares favourably with the rate of other medical errors\*

(\*World Health Organization: Radiotherapy Risk Profile 2008)

# In a radiotherapy facility

**Initiating events**



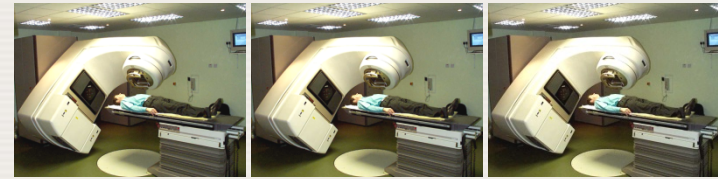
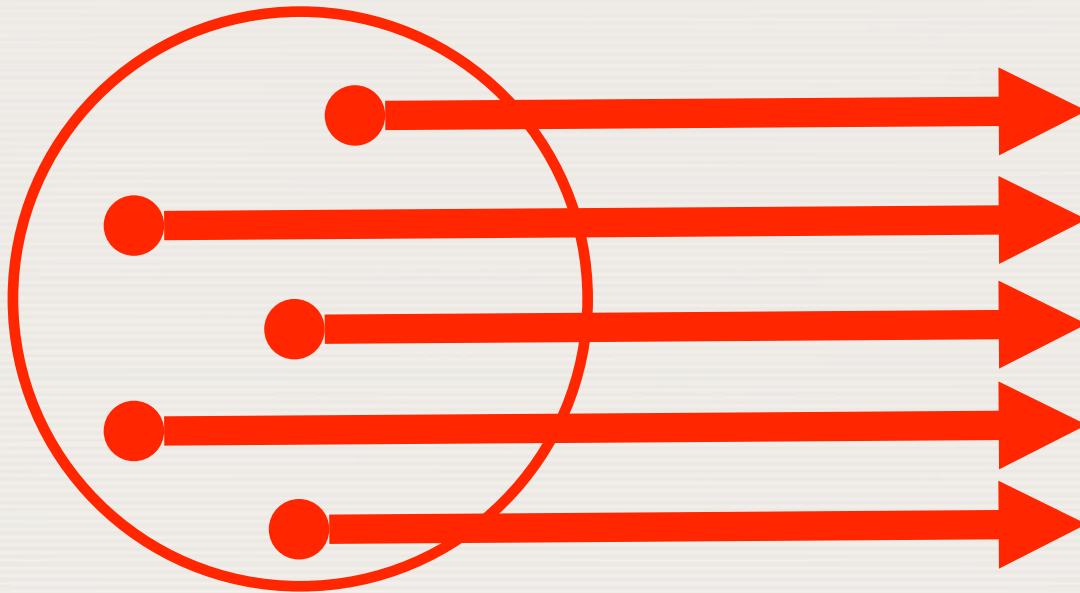
**Patients**



# In a radiotherapy facility

**Initiating events**

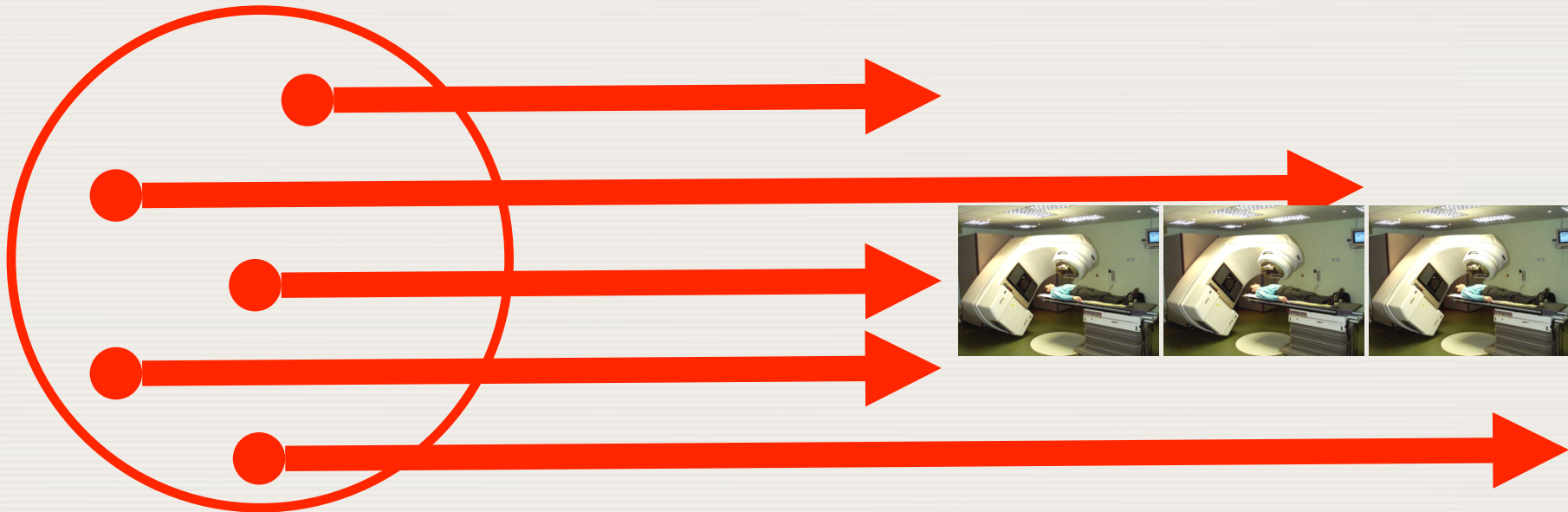
**Patients**



# In a radiotherapy facility

**Initiating events**

**Patients**



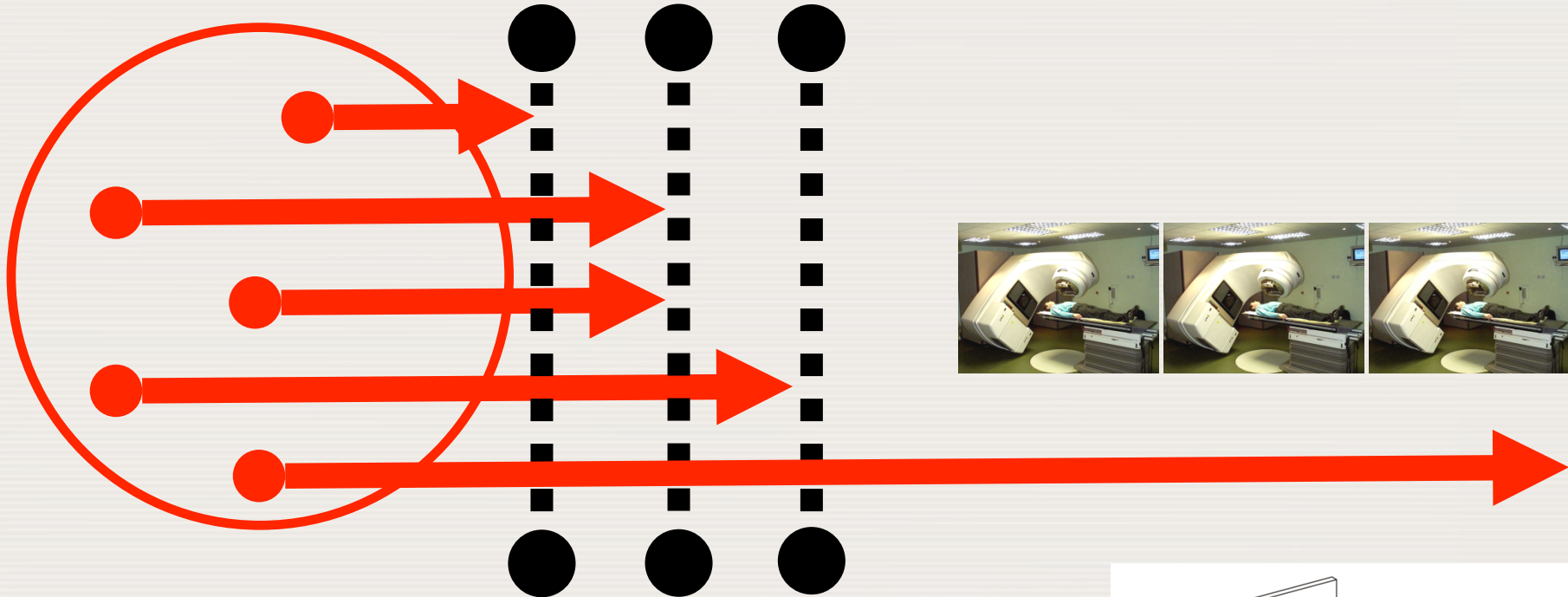
**More severe consequences**

# In a radiotherapy facility

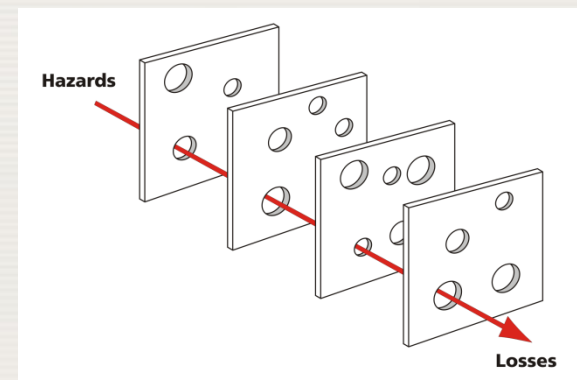
Initiating events

Safety barriers

Patients



Swiss cheese model

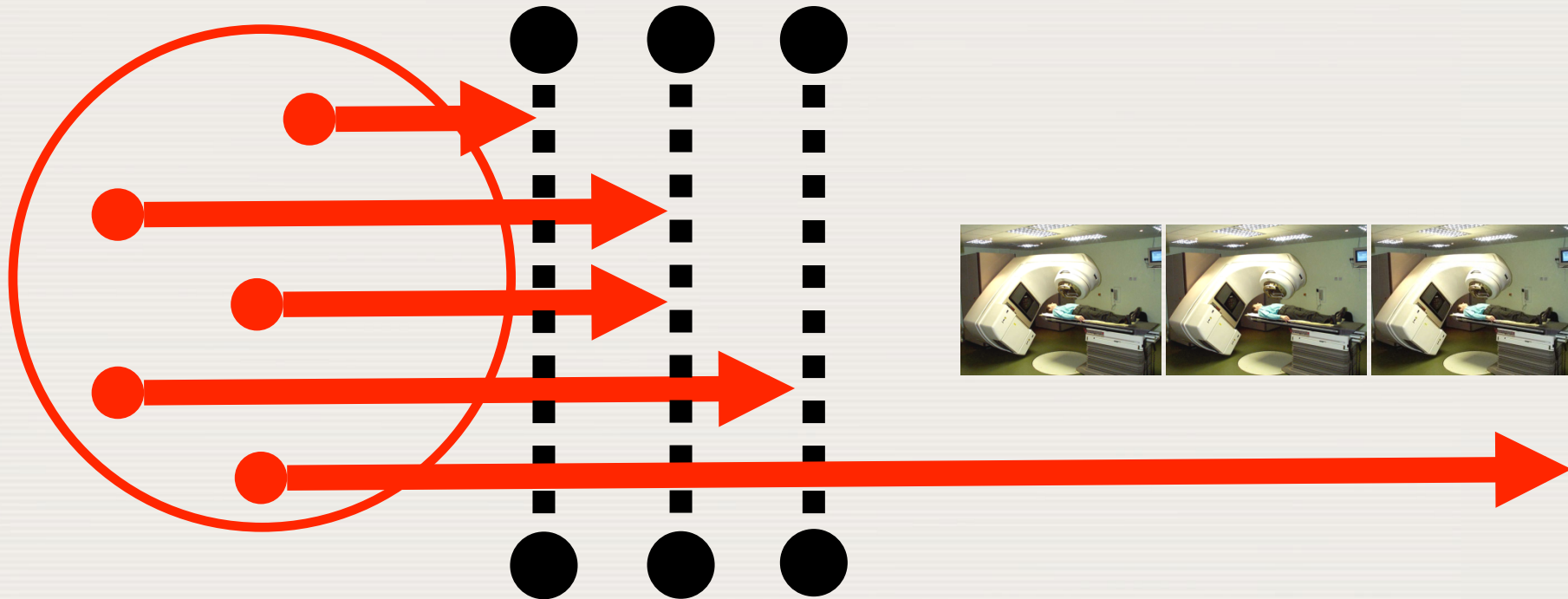


# In a radiotherapy facility

Initiating events

Safety barriers

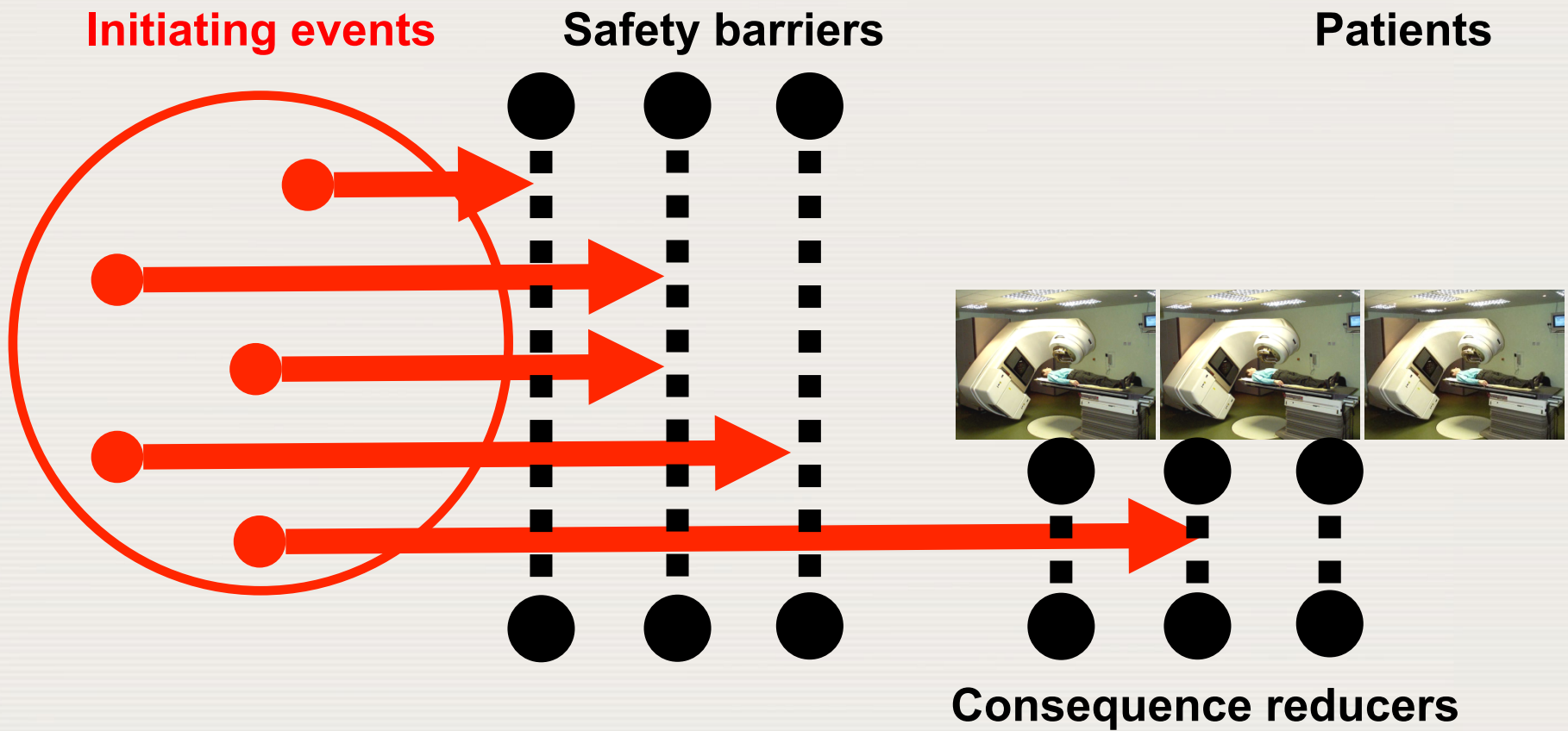
Patients



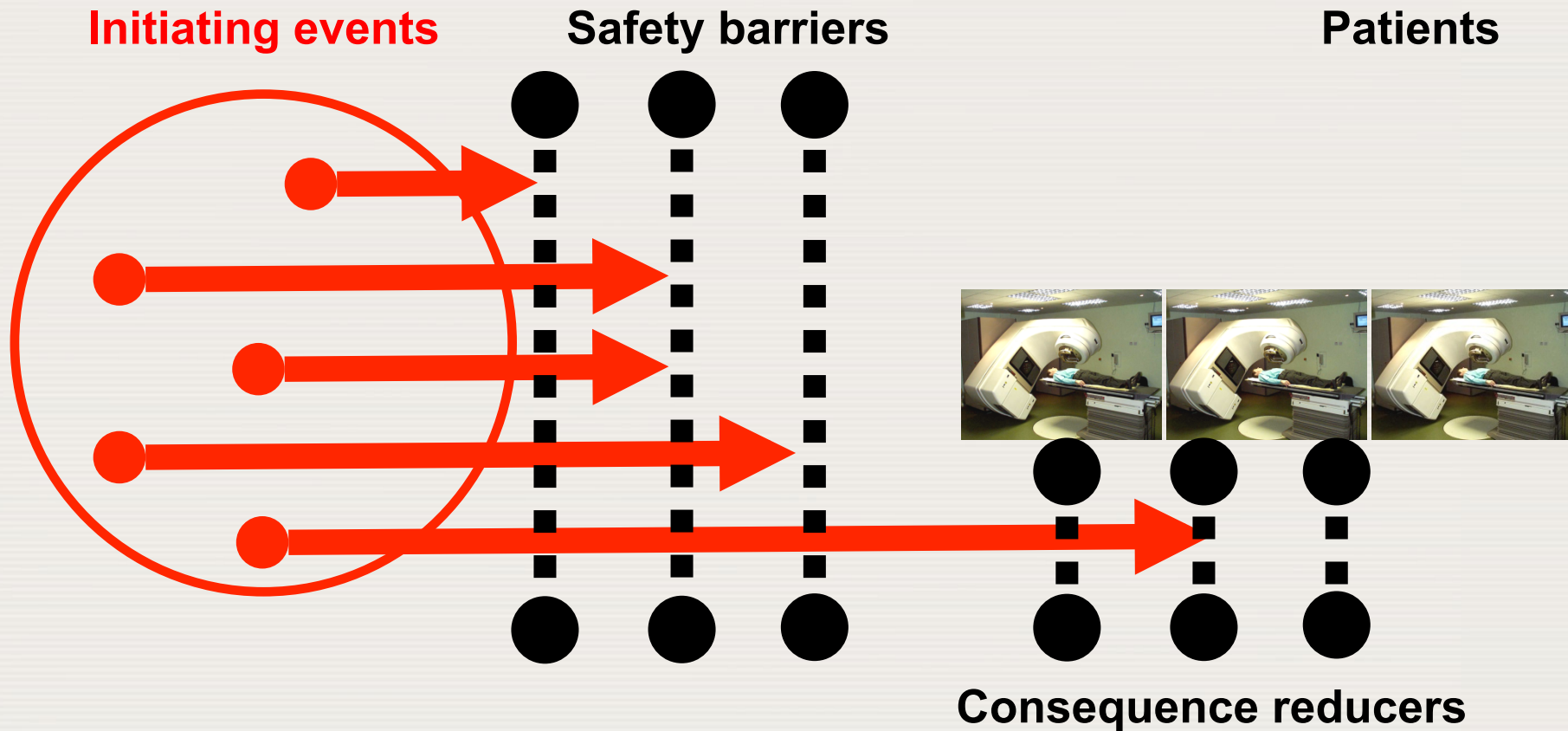
**Safety barriers (procedures or equipment), e.g.:**

Patient identification card; Independent check of monitor units;  
Verification of data transferred to the LINAC; Personalized  
positioning and immobilization devices; Initial portal imaging;  
Initial in-vivo dose verification

# In a radiotherapy facility



# In a radiotherapy facility



**Consequence reducers (procedures or equipment),**  
e.g.: Weekly quality control; Weekly chart check; Weekly medical review



**IAEA**

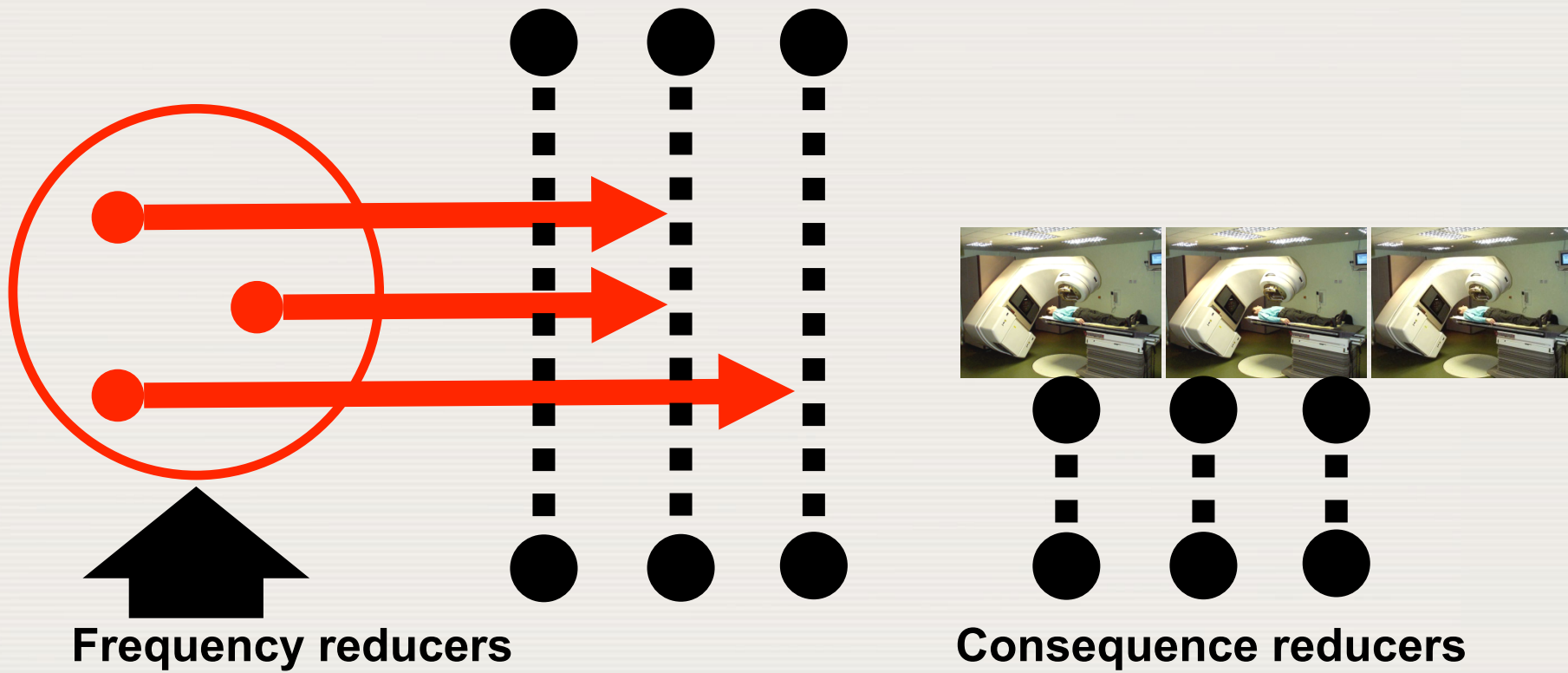


# In a radiotherapy facility

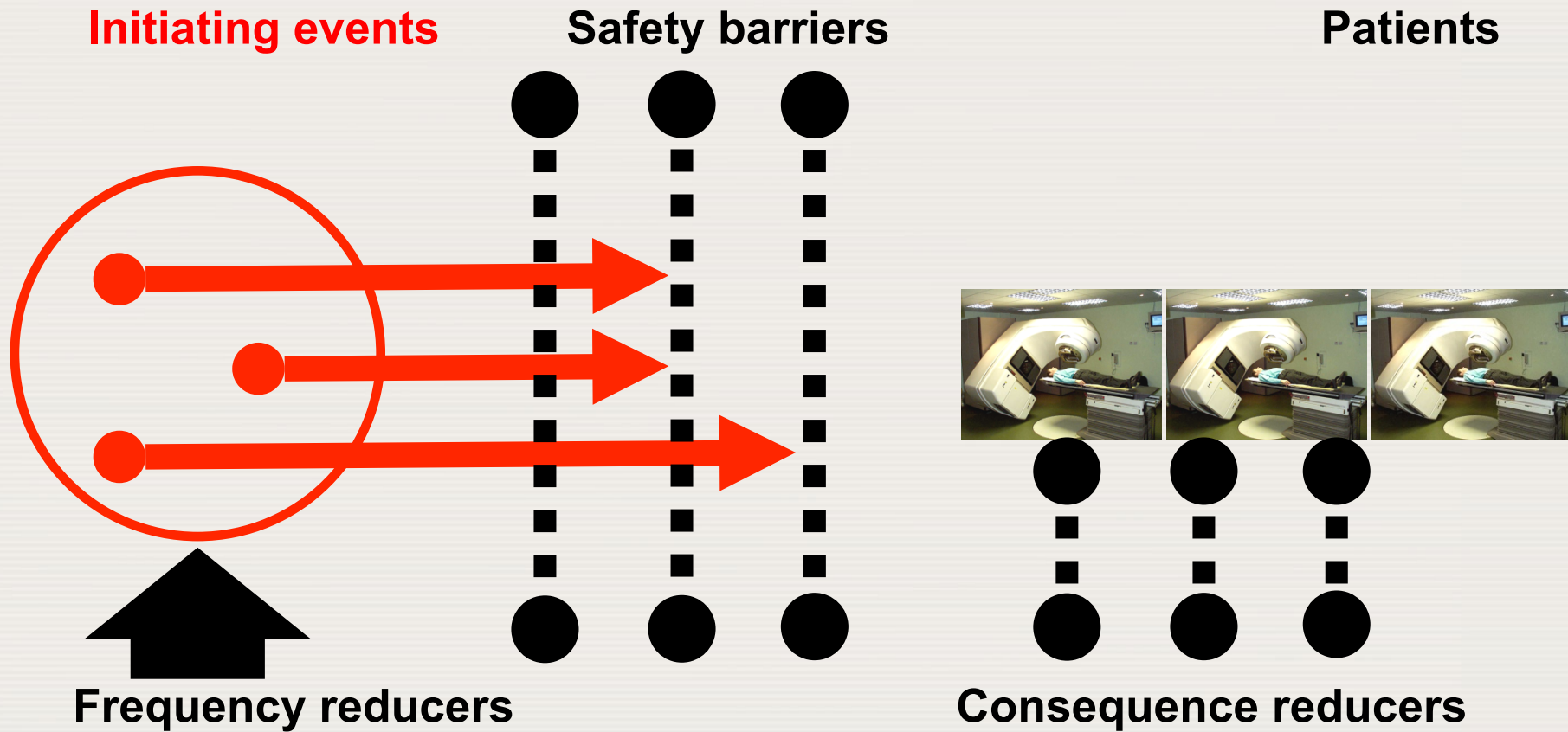
Initiating events

Safety barriers

Patients



# In a radiotherapy facility



**Frequency reducers, e.g.:** Workload according to staffing level; Staff training in radiation safety; Preventive maintenance

# In a radiotherapy facility

## PROSPECTIVE RISK ANALYSIS:

SEVRRRA (risk evaluation software tool) developed under the Ibero-American Regulators Forum (FORO)

The screenshot displays the SEVRRRA web application interface. The browser address bar shows the URL: localhost:8080/riesgo/usuarios/riesgo.php?idregistro=5&idpractica=1. The page header includes the IAEA logo and the FORO logo (Foro Iberoamericano de Organismos Reguladores Radiológicos y Nucleares). The main content area is titled "Summary Treatment Modality by Phase in the process (Initiator Event Count)".

Num.	Phase in the process	Risk Very High (RVH)	Risk High (RH)	Risk Medium (RM)	Risk Low (RL)	Not
1	Initial setup of the equipment	0	0	2	0	
2	Acceptance and Commissioning	0	0	5	0	
3	Equipment maintenance.	0	0	1	0	
4	Treatment Clinic Prescription	0	1	1	0	
5	Patient anatomical data acquisition	0	0	1	1	
6	Volume delineation	0	0	0	0	
7	Treatment Planning	0	0	0	0	
8	Preparation of molds	0	0	0	0	
9	Beginning of treatment	0	0	0	0	
10	Positioning for daily treatment	0	0	0	0	
11	Implementation of treatment	0	0	0	0	
Total		0	1	10	1	

Below the table is a "Graphic" section showing a semi-circular gauge chart. The chart is divided into segments representing risk levels: Risk Very High (RVH) in red, Risk High (RH) in orange, Risk Medium (RM) in yellow, and Risk Low (RL) in green. The chart shows 10% in the RH segment and 80% in the RM segment. The word "Treatment" is written across the chart.

The footer of the application displays "Sistema de Evaluación del Riesgo en Radioterapia (SEVRRRA)".

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*Aplicación del método  
de la matriz de riesgo  
a la radioterapia*

*Texto Principal*

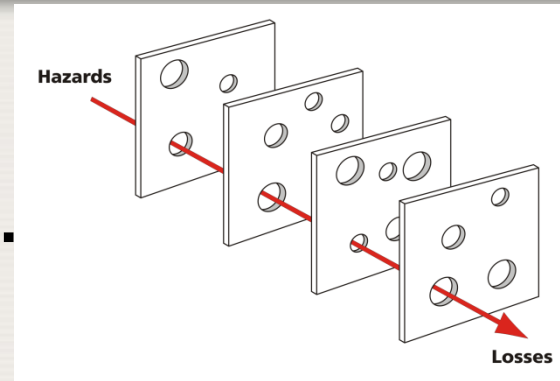


# Bonn Call-for-Action

- **Action 7: Improve prevention of medical radiation incidents and accidents**
  - a) **Implement and support voluntary educational safety reporting systems** for the purpose of learning from the return of experience of safety related events in medical uses of radiation;
  - c) Work towards **inclusion of all modalities of medical usage of ionizing radiation in voluntary safety reporting**, with an emphasis on **brachytherapy**, interventional radiology, and therapeutic nuclear medicine in addition to external beam radiotherapy;
  - d) **Implement prospective risk analysis** methods to enhance safety in clinical practice;

# Finally

Taking the  
Swiss Cheese Model ...



... from Emmentaler ...



... towards Gruyère

