Major events from conventional radiotherapy, with severe consequences, have been reported for the last two decades.
Lessons from accidental exposures with conventional techniques are available
In 2000 lessons were compiled by the ICRP in publication 86.
Preventing accidental exposures from new external beam radiation therapy technologies

ICRP Publication 112

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The information provided consists of

- A description of the events
- The initiators, that triggered the accidental exposure (initiating event)
- The lessons to avoid repeating it
Initial step in safety assessment is an exercise on applying the lessons

- Asking yourself
  - “What if this initiating event would occur in my department?”
  - “Would it be detected and stopped with no consequences?”
  - “What exactly would stop it in my department?”
In the preparation of the ICRP 112 report on the new technologies the following questions were asked

1. Are lessons from conventional techniques applicable to newer technologies?
2. Are there new lessons from new technologies?
3. Apart from these lessons from experience, is there anything else that can go wrong?”
1st question

Are lessons from conventional techniques applicable to *new technologies*?
Overall lesson from conventional techniques

- “...purchasing new equipment without a concomitant effort on education and training and on a programme of quality assurance is dangerous”.

Is it valid for new technologies?
What about my department?
Was this criterion applied when the last equipment was purchased?
Lessons from conventional techniques valid for new technologies?

- Beam calibration: independent verification

Accidental Overexposure of Radiotherapy Patients in San José, Costa Rica

115 patients severely affected
Lessons from conventional techniques valid for new technologies?

- Complete commissioning of the TPS
- Validation of any change of procedures
Lessons from conventional techniques valid for new technologies?

- Notification of maintenance and repairs to the person responsible for radiotherapy physics, before resuming patient treatments

27 patients severely affected in Spain
In conclusion: most lessons from conventional techniques are applicable to new technologies.
2nd question

Are there lessons from new technologies available?

Yes, the following
New lessons:
More and more accelerator functions are controlled by software

Computer program “crash” or “frozen”

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Loss of data integrity

- When saving data on treatment plan, the computer got “frozen”. After restarting, data on collimator setting was “lost” from the data file.
- As a result, open fields instead of small fields were applied, and one patient received 39 Gy in the first three sessions.
- **Checking procedures are required for computer “crashes”. Irradiation parameters may be wrong upon**
Loss of data integrity

- When saving data on treatment plan, the computer got “frozen”. After restarting, data on collimator setting was “lost” from the data file.
- As a result, open fields instead of small fields were applied, and one patient received 39 Gy in the first three sessions.
- **Lesson:** Checking procedures are required for computer “crashes”. Irradiation parameters may be wrong upon.
- **Am I sure that my staff will check for data integrity after a “software program frozen” situation? How can I ensure it?**
Errors from imaging:
Wrong site treatment (right-left)
Image distortion
Multiple imaging modalities: problem with consistency in identification and labelling

- Left-right error
- Distortion of images when transferring them from the TPS to the “record and verify”
- Potential problems of image artefacts and wrong tissue density
- With increased use of different imaging modalities, consistency in imaging identification and image labelling becomes more critical
Several events due to

- poor understanding of new techniques and

- poor communication and recording
Marks for virtual simulation

- The tatoo for the initial plane of virtual simulation (A) was taken as the isocenter plane (B).
- Lesson: understanding and becoming fully familiar
Calibration of very small beams (micro multileaf collimators)

- Partial volume irradiation of the chamber. Wrong absorbed dose determination
- **Knowledge needs to be sharper, as well as the level of awareness of the task at hand**
- **Education and specific training essential for new technologies**
Dynamic wedges

- Erroneous selection of the type of wedges with the result of excessive monitor units
- 23 patients overdosed, four of them died in the first year
Small fields in stereotactic treatment with applicator
Confusion 40 mm - 40 cm
Patient died from the accidental exposure
Lesson from poor understanding

No “quick” training...

... but solid training
All these new lessons are useful in preventing reported types of events,

- They should be included in the training and in continued education programmes and
- Should be incorporated into the procedures

- but
The unknown or unreported

- What about other possible types of events, which went unreported or which have not happened yet?
- **Do we need to wait until they occur, to learn the lessons?**
3rd question

Can we anticipate “what else can go wrong?”
Three proactive methods have been adapted to radiation therapy

- Failure mode and effect analysis (FMEA)
- Risk matrix approach
- Probabilistic safety assessment (PSA)

Example: work done by the Ibero American FORO of Nuclear and Radiation Safety Regulatory Agencies and by the American Association of Physicists in Medicine, briefly described in ICRP 112
All three have in common

• The identification of a list of potential events in every step of the radiation therapy process
• It produces a long list of potential events to deal with
Risk matrix

- A simple method easily applicable by individual radiotherapy departments
- It consists of a two-step screening to deal with comprehensive list of potential events
- With the first screening, the lower risk events are filtered out.
- A second screening is then applied to the shorter list of higher risk events
In addition: the risk matrix

- Analizes in detail each the provisions to detect errors
- It allows for sensitivity analysis, by identifying what would happen if a given check or safety provision (barrier) would not be present in the radiotherapy department or would be removed
Aplicación del método de la matriz de riesgo a la radioterapia
Texto principal
The risk is quantitatively evaluated and common-cause failures are identified.

It is complex, requires much resources in terms of time, effort and expertise.

It is not amenable for individual radiotherapy departments, but could be used by professional bodies, for example for a new technology.
Análisis probabilista de seguridad de tratamientos de radioterapia con acelerador lineal

Texto principal
Take-home messages from ICRP publication 112
Introducing new technologies

- Decision to implement a new technology should be based on an evaluation of the expected benefit, rather than being driven by technology itself.
- A step-by-step approach should be followed to ensure safe implementation.
Replacement of proper training with a short briefing or demonstration should be avoided, because important safety implications of new techniques cannot be fully appreciated from a short briefing.
New protocols for

- Dosimetry protocols are needed for small and non-standard radiation fields.
Computers and data integrity

- Procedures should be in place to deal with situations created by computer “crashes” or program “frozen”
Overcoming the lack of experience when introducing new technologies

- Prospective safety assessments
Thank you

• More details in
  • Free educational material on the website
  • ICRP publication 112