Major accidents in radiotherapy

... related to treatment units (a)
Incorrect decay data (USA)
Background

• A cobalt unit was used for teletherapy at Riverside Hospital in Columbus, Ohio, USA

• This unit was initially calibrated correctly
Background

- During the period 1974-1976 the physicist failed to perform regular measurements (calibrations and QA).
- The physicist relied on estimations of the decay of the source to predict dose rate and calculate treatment time.
- Rather than calculated decay, the physicist plotted dose rate on graph paper and extrapolated.
What happened?

Decay was determined from straight-line plot on semi-log graph paper with calendar ordinate.
What happened?

When edge of graph paper was reached, physicist continued plot on linear paper.
What happened?

- The physicist used a continuation page that had linear scales on both axes.
- This created two problems:
  - Linear Y-axis did not correspond to log Y-axis, so straight line extrapolation resulted in ever more incorrect output values.
  - Linear X-axis did not correspond to calendar axis, so extrapolation led to incorrect date values.
These errors in predicting the dose-rate were made by the physicist in the time period 1974-1976.

The errors resulted in:
- Dose-rate being under-estimated by 10% to 45%.
- Patients received corresponding overdoses of 10% to 55%.

Magnitude of error increased almost linearly with time.
Magnitude of accident

Patient Overdoses

Year/Month

Percent Overdose [%]

Aug-74  Nov-74  Mar-75  Jun-75  Sep-75  Jan-76  Apr-76

IAEA
Prevention of accidental exposure in radiotherapy
Discovery / investigation of accident

• The incident came to light because patients started exhibiting symptoms of overexposure.

• The accident was investigated by the US Nuclear Regulatory Commission.
Investigation: further complications

• When requested, the physicist produced ten calibration documents showing the correct machine output
• These were **discovered to have been fabricated**
• The output of the cobalt unit had not been checked for 22 months
Impact of accident

- 426 patients received significant overdoses
- 11 were untraced - 415 followed up
- 795 sites at risk identified
- 57% (243) died within the first year
- In 87 patients there was local control with no documented recurrence
- Survivors beyond the second year had an increased frequency of complications
Impact of accident

- 426 patients received significant overdoses
Lessons: Radiotherapy Department

- **Include in the Quality Assurance Programme:**
  - Independent check of physicist’s work
  - Formal procedures for calibrating treatment unit on a regular schedule
  - Department should provide sufficient staff to handle workload
  - Records must accurately document performance of accepted QA procedures
  - Establish an accurate database for follow-up
Lessons: Radiotherapy Department

• In case of unusual reactions in one patient - notified by a technologist or directly by the patient - the radiation oncologist should immediately request the medical physicist to perform a verification to detect a possible error in any of the treatment steps.

• Unusual reactions in more than one patient should lead to a request to the medical physicist to immediately verify the dosimetry of the treatment unit.
References
