Ionising radiation and skin lesions

WORKSHOP RADIOBIOLOGY
17/06/2004
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Ionising radiation injuries
A real concern?

Turai I*, BMJ 328, March 2004:

‘Events that expose people to radiation are rare, but the threat of radiation injury is increasing. Doctors should know how to recognize and manage suspected exposure or contamination’

* Medical officer, Department of Protection of the Human Environment, WHO
Health effects induced by ionising radiation

Stochastic effects

Deterministic effects

Skin injuries: deterministic!
- threshold
- severity of effect increases with dose
Health effects induced by ionising radiation

Deterministic effects (actually mostly due to accidents – industrial or medical):

- **radiation sickness**
  whole body (or a large part) exposure to high doses of ionising radiation

- **radiation (skin) injury**
  exposure of a small part of the body (skin) to high doses of ionising radiation

→ presentation of an accidental case
Case: dose estimation?

Result film badge dosimeter: doubtful!!!

- Biological dose estimation
  1. Blood cell count (lymphocytes)
  2. Cytogenetic examination (H. Thierens, UG)
    2.a. metafase analysis (dicentric chromosomes)
    2.b. micronucleustest
  3. Clinical signs: skin lesions

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Biological dosimetry
Clinical: skin lesions

Reconstruction:
> 1-3 week(s): localised erythema
  (back, abdomen)
>> later: blisters, wet desquamation
>>> later: ulceration (+ infection) back

Therapy:
- surgery?
- conservative (wound care)
Radiation accidents: statistics

- Publications IAEA ([www.iaea.org](http://www.iaea.org))
- Turai e.a., BMJ, 2004:
  - Between 1944 and 2002:
    - 420 incidents worldwide
    - 134 deaths (28 deaths Chernobyl 1986)
  - 50% radiations incidents in industry (NDC)
  - 10% medical incidents (diagnose/therapy)
  - 50% of fatal exposures due to calibration errors in medical equipment or because of insecure storage of spent sources for radiotherapy
Radiation induced skin lesions

Radiodermatitis
Radiation dermatitis
Cutaneous radiation syndrome

- Acute
- Chronic
- Late stage/long term risks
The normal skin

More sensitive to radiation: keratocytes, hair follicles, sebaceous glands
More resistant: sweat glands, connective tissue
# Acute radiation dermatitis

*(single exposure RX, $\gamma$; $\beta$ contamination)*

<table>
<thead>
<tr>
<th>Dose Range</th>
<th>Description</th>
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<tbody>
<tr>
<td>&gt; 2 à 3 Gy</td>
<td>Epilation (temp.; def &gt; 7 à 10 Gy)</td>
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<tr>
<td>&gt; 3 Gy</td>
<td>Erythema ($\geq$ 1 week)</td>
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<td>Heals with (dry) desquamation and hyperpigmentation</td>
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<tr>
<td>&gt; 10 à 20 Gy</td>
<td>Erythema, oedema, large painful blisters, wet desquamation, ulceration (weeks–months), radionecrosis.</td>
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<td>Heals slowly with atrophy, telangiectasia, irregular pigmentation</td>
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<td>Some lesions may never completely heal $\rightarrow$ chronic stage</td>
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Acute radiation dermatitis
6.5 h. local exposure to Iridium-192 source

day 2: early blister, erythema  
day 9: extended erosion, inflammation

Turai e.a., BMJ 2004, 328: 568-572

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Acute radiation dermatitis
Accidental overexposure X-ray diffractiometer

Evolução do paciente

Chronic radiation dermatitis

Occurrence:
- In the past: radiologists and radiation technicians whose hands were constantly exposed.
- Today: rarely? Can reappear!
  - patients with multiple cardiac catheterisations
  - professional overexposure of the hands of interventional radiologists
Chronic radiation dermatitis
After multiple coronary angiography and angioplasty procedures

> 6-8 weeks
redness, peeling

16-18 weeks
Small ulcerated area

18-21 month
Tissue necrosis

Shope T. Radiation-induced skin injuries from fluoroscopy. FDA/CDRH, 1995

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Chronic radiation dermatitis

Professional overexposure: interventional RX

Artignan e.a., Arch. mal. prof. 2003, case study: chronic radiodermatitis on the hands of an interventional radiologist

Estimated cumulative skin dose > 10 Gy (20 y) = > 500 mSv/y

Observations:
- nail abnormalities (grooves in nails of thumb & index)
- hyperkeratotic lesions around the nails
- cyclic keratosis – ulcerations – keratosis - desquamation
- capillary microscopy: specific abnormalities of the cutaneous capillary network of the nailfold region
Chronic radiation dermatitis
Features

- Months to years after initial dose of radiation
- Skin atrophy, telangiectasia, hypo- and hyperpigmentation (poikilodermia)
- Hyperkeratosis, desquamation
- Chronic post-radiation ulcers
Chronic radiation dermatitis

Features

Shane Chapman M. Medscape Dermatology 2(2), 2001

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Chronic radiation dermatitis

Post-radiation ulcer


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Radiation dermatitis
long term risks

Chernobyl experience: Steinert M, 2003:
Reassessment of 99 long term survivors from 237 most exposed individuals

- 22/99 patients: radiation induced cutaneous lesions
  - 22/22: epidermal atrophy, telangiectases, pigment alterations
  - 14/22: keratotic lesions
  - 8/22: cutaneous fibrosis
  - 5/22: radiation ulcer
  - 1/22: 2 basal cell carcinoma

Radiation dermatitis

Long term risks

Long term risk: skin cancer!

IARC Monographs, vol 75, 2000

‘X-radiation and $\gamma$-radiation:
carcinogenic to humans (Group 1)’

- Squamous cell carcinoma
- Basal cell carcinoma

- Long-term follow-up of skin lesions is necessary!

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Radiation dermatitis
Long term risks

- Basal cell carcinoma


17/06/2004 I. Boesman IKMO
Radiation dermatitis
Long term risks

- Squamous cell carcinoma

Rinker M. e.a Cancer Control 2001; 8(4): 354-363
Radiation dermatitis
Long term risks

- Squamous cell carcinoma

Ratner D. SKINmed 2003; 2(4):251-252

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Turai e.a. BMJ 328, march 2004: Medical response to radiation incidents and radionuclear threats.

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→ Prevention is better dan healing!
Especially for ‘preventable’ professional applications!
References

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