The introduction of Patient Dosimetry in Belgium

BVS-ABR Training Day
ALARA in the medical world
20/06/2008
Patient dosimetry in Belgium

1. Why patient dosimetry?
2. Belgian regulatory framework
3. Practical implementation
4. Preliminary results
5. Conclusions
Patient dosimetry: why?

- Contribution of medical to population dose
- Increasing number of radiological examinations (new techniques vs. conventional)
- New HD Techniques: CT, interventional RL, interventional CT, virtual CT colonography, CT coronarography,…
- Belgium: top of the world…
- Still a lot of optimization possible
Number of radiology exams (per 1000 inhabitants)

**Unscear 1993 (1985-1990)**
health care level I countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Exams</th>
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<td>Belgium</td>
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**Mira 2007**

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<td>België</td>
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**Bron:** UNSCEAR, 2000 en RIZIV, 2000.
Contribution of medical to population dose

EU 1993

radon 51%

internal 12%

medical 12%

varia 1%

cosmisch 10%

terrestrial 14%

Belgium 2003
**Publication of the High Council for Health (BE) n° 8080 on CT**


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<td># RL examinations</td>
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<td>(per 1000 inhabitants)</td>
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<tr>
<td>Contribution CT (%)</td>
<td>11</td>
<td>8</td>
<td>7</td>
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<tr>
<td># NM examinations</td>
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<td>18</td>
<td>9</td>
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<td>(per 1000 inhabitants)</td>
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<tr>
<td>Mean medical dose/inhabitant (mSv/y)</td>
<td>2.0</td>
<td>0.54</td>
<td>0.38</td>
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First multi centre study to investigate high-dose X-ray procedures in Belgium (2003-2006)

Number of procedures AMI according to log DAP : Belgium

**Size corrected population:**
- Log DAP 0.01: 3.45 (29.10 cGy•cm²)
- Median = 3.67 (4509 cGy•cm²)
- Mean = 3.88 (7573 cGy•cm²)
- Mean ± 1 sd = (6476 ± 8459) cGy•cm²

**Complete population:**
- Log DAP 0.01: 3.51 (3263 cGy•cm²)
- Median = 3.76 (5863 cGy•cm²)
- Mean = 3.97 (9274 cGy•cm²)
- Mean ± 1 sd = (7356 ± 7218) cGy•cm²

Angiography of the lower limbs

(M.-T. Hoornaert, H. Bosmans et al.)
First multi centre study to investigate high-dose X-ray procedures in Belgium (2003-2006)

Skin Dose can be high

Correlation with
- complexity of procedure
- physician in training
But also
- fluoroscopy time
- distance skin-II

(E. Bogaert, K. Bacher, H. Thierens)
Patient dosimetry: from WHY to HOW
Patient dosimetry in Belgium

1. Why patient dosimetry?
2. Belgian regulatory framework
3. Practical implementation
4. Preliminary results
5. Conclusions
Belgian Regulatory Framework: Royal Decree of July 20, 2001

Responsibilities

- Justification
- Optimization
- Clinical evaluation of outcome
- Share information
- Inform about risks
- Collaborate in patient related dosimetry
- Participate in patient dose optimization

Roles

- QA programs
  - Examinations
  - Frequency
  - Procedures
- Protection of patients regulatory framework for
  - Measuring the dose
  - National DRLs
  - Procedures
Daily optimization and evaluation of individual doses

- **All radiodiagnostical equipments** for persons (except IO and DEXA) shall be equipped with an adequate « system » that allows to **evaluate the patient dose integrated during the radiological procedure**, provided such a system is available on the market (Art. 51.6.2)

- **All doses** due to medical radiological exposures shall be kept as low as reasonably achievable (ALARA) consistent with obtaining the required diagnostic information, taking into account economic and social factors (Art. 51.2.1).

- The **medical responsibility** of a practitioner includes justification and optimization (Art. 50.1). The optimization process includes among others the evaluation of the **doses administered to the patient** (Art. 51.2.5).
Periodic dose studies

- For radiodiagnostic examinations, the most appropriate available diagnostic reference levels (DRL) shall be used (Art. 51.2.2).

- DRL: dose levels for typical examinations for groups of standard-sized patients (or standard phantoms). These levels are not to be exceeded for standard procedures when good and normal practice is applied, regarding diagnostic and technical performance (GMP, « good medical practice ») (Art. 50.1). When exceeded, corrective actions have to be undertaken after investigation (Art. 51.2.2).

- In order to compare with DRLs, the operator makes sure that the mean patient dose is determined for the types of examinations, the time intervals and following the procedure defined by the FANC.
Patient dosimetry in Belgium

1. Why patient dosimetry?
2. Belgian regulatory framework
3. Practical implementation
4. Preliminary results
5. Conclusions
Realized in consultation with the **Consilium Radiologicum**, and, for the methodology, with the working group radiology of the BVZF/ SBPH

Published as annex of the brochure "**vade-mecum Use of X rays for medical purposes**", (available on www.fanc.fgov.be)

Published in the Official Gazette (12/10/06)

In order to define:

1. **for the dose studies:**
   - frequency
   - Types of examinations
   - Methodology
   - Roles

2. **for the individual dose evaluations**
   - Types of examinations
   - Methodology
   - Roles
Objectives of Patient Dosimetry

1. Retrospective evaluation of individual dose
2. Prevent deterministic effects
3. Optimize the dose

Patient oriented Repression tool
Objectives

1. Restrospective evaluation of individual dose

- Method: DAP or alternative method
- Registering requirements:
  - Children (<15 y): always register the relevant parameters for RX of head/trunk/pelvis
  - Adults: for all HD examinations: parameters in DICOM-header or logbook
  - Sensitive organs: uterus and/or gonads (RX lumbar spine, abdomen, pelvis)
Patient dosimetry in radiology

Objectives

2. Prevent deterministic effects

- on-line measurements for HD applications (interventional radiology)
- use of "trigger values" or "warning levels"
3 Optimization of the dose

- Is an element of **quality assurance**
- How? Compare mean dose for a given **type of examination** in a certain centre with the diagnostic reference level (DRL)
Objective:
• Determine the dose precisely: MPE
• Eliminate bad practices (> DRL)
• Optimize procedures (< DRL) and adapt written procedures

How?
• DAP or TLD (CT: integrated system, mammography: specific method)

Who?
• Method validated by MPE, rest of the process supervised by MPE
• Forms to be filled in by local staff: technologist, nurse

Number of examinations:
• Simple exam, CT: 50 successive patients or all patients during 3 months
• Dynamic, HD: 20 successive patients or all patients during 3 months

Which examinations?
• See list 1st year + list next years (>1 examination/month)
Patient dosimetry in radiology

Three-yearly dose studies

List of examinations

Periodic dose studies (3-yearly)

- Simple RX examinations children (< 15 y)
- Simple RX examinations adults
- HD and dynamic examinations (children + adults)
- CT (children + adults)

List for the 1st year:

Adults:
- RX lumbar spine
- RX pelvis
- CT skull, abdomen, thorax

Children:
- RX thorax and thorax-abdomen (incl. neonatologie <3 months)
- Cystography
- RX stomach (reflux examination)
- CT skull
Patient dosimetry in radiology
Three-yearly dose studies
Registration forms

now available in excel format on [www.fanc.fgov.be](http://www.fanc.fgov.be)

<table>
<thead>
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<th>N°</th>
<th>Date</th>
<th>m/f</th>
<th>Patient</th>
<th>Patient</th>
<th>Sub</th>
<th>Scope (cm)</th>
<th>KV*</th>
<th>mAs*</th>
<th>DAP</th>
<th>SSD***</th>
<th>Champ****</th>
<th>Nombre</th>
<th>Inhales</th>
<th>Remarques</th>
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</table>

*Valeur des KV et mAs de la graphie, pas de la scopie
**Unité à compter, ex: 0.5 cm
***Source skin distance (distance par de peau) : obligatoire
****Champ : surface tracée (x cm X y cm)
What to do with the registered data?

- **MPE**: determines mean dose + median
  - per apparatus
  - per type of examination

  **Feedback to the service/centre**
  - conclusions, interpretations, propositions

- **Feedback to the FANC**: further exploitation of the data
  - Collective dose
  - National DRLs
Objective:
- Prevent deterministic effects (HD applications)
- Determine or estimate the individual dose
- Optimize procedures and adapt written procedures

How?
- DAP
- Alternative methods for simple examinations (air kerma, CR specific exposure parameter, strict procedures, film-screen system)
- Alternative method for HD examinations: calculation of ESD

Who?
- Method validated by MPE

Which examinations?
- Simple RX examinations children head/trunc/pelvis (<15 y): individual retrospective evaluation
- Simple RX examinations adults: retrospective evaluation for specific situations (ex. RX abdomen pregnant woman)
- HD and dynamic examinations (children + adults): on-line measurement
- CT (children + adults): individual retrospective evaluation (integrated system or procedures)
Patient dosimetry in Belgium

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Patient dosimetry in radiology

Preliminary results

Results of the 1st year
• at this moment 15% of the centers have sent their data
• not enough data yet to draw statistically sound conclusions

Active cooperation from
• the Consilium radiologicum
• the MPEs
• the local staff
Patient dosimetry in radiology

Preliminary results

**Example 1: Thorax PA**
- Adult
- Simple examination

- **1168 patients, of which**
  - 852 for whom weight is registered (mean weight 71.47 kg)
  - 124 « standard patients » (70 ± 3 kg) (mean weight 71.16 kg)
- **19 rooms**
- **14 centers**

European DRL: 1 Gy.cm² for complete examination
French DRL: 25 cGy.cm²
French procedures: mAs 1.5 - 3
  kV 125 (115 - 140)
(NB the french DRL has been determined for this incidence, based on the DRL in terms of ESD)
## Example 1: Thorax PA

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<tr>
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<th>kV</th>
<th>mAS</th>
<th>DAP (cGy.cm²)</th>
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<td><strong>Min</strong></td>
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<td>1.3</td>
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<td>7.98</td>
<td>338.7</td>
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<td><strong>Mean</strong></td>
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<td>2.3</td>
<td>38.5</td>
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<tr>
<td><strong>75th perc</strong></td>
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<td>36.5</td>
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</table>
Example 2: Thorax P

- Adult
- Simple examination

- 776 patients, of which
  - 630 for whom weight is registered (mean weight 72.43 kg)
  - 124 « standard patients » (70 ± 3 kg) (mean weight 69.01 kg)
- 14 rooms
- 11 centers

European DRL: 1 Gy.cm² for complete examination
French DRL: 100 cGy.cm²
French procedures: mAs 1.5 - 3
                kV 125 (115 - 140)
## Example 2: Thorax P

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<th>mAS</th>
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<tr>
<td><strong>75th perc</strong></td>
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</table>

### All patients

- 70 kg - 3 kg
Example 3: Thorax F+P

Example 3: Thorax F+P
- Adult
- Simple examination

- 575 patients
- 5 rooms
- 5 centers

European DRL: 1 Gy.cm² for complete examination
No French DRL

<table>
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<tr>
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<td>75th perc</td>
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Patient dosimetry in radiology

Stakeholder involvement

Feedback to the stakeholders

- May 30, 2008: mutual feedback meeting FANC - MPEs

  Difficulties encountered  Feedback of first results

- Autumn 2008: Round Table Radiology
Feedback from the MPEs

• Some parameters difficult to incorporate in automated data collection (ex. weight)
  - Large data sets without weight could complement obligatory data sets with weight
  - Second iteration: forms could be simplified based on experiences

• Final aim of patient dosimetry
  - NOT a repression tool but an optimisation tool!

• Involvement of MPEs in process (DRLs, ...)

Patient dosimetry in radiology

Stakeholder involvement
Patient dosimetry in Belgium

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Introducing radioprotection in general and patient dosimetry in particular in the medical world is not «a piece of cake»

But progressively, this sector is becoming more conscious of the risks related to exposure to radiation, and the factor «dose due to medical exposure» is taken into account in their daily practice.

ALARA is not an issue of authorities or scientists, it is the issue of ALL people involved.

Today’s efforts imply a direct benefit to the thousands of patients that pass a radiological examination!
Introduction of patient dosimetry in Belgium

Thank you for your attention

But even more thanks for the efforts of
- Physicists
- Radiologists
- Nurses
- Technologists