CT Dose Excellence Project: A Pan European approach towards protocols unification and dose optimization

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Dose Excellence Project Leader
affi\_dea

affinity with doctors and patients

affi\_dea

trust and fidelity in everything we do

affi\_dea

constant progress through ideas and innovation
Leading independent provider of Advanced Diagnostic Imaging and Cancer Care services in Europe

170 medical centres
4.5m examinations
14 countries in Europe
3300 employees
680 medical doctors

Dutch holding company, owned by Waypoint Capital, the leading Swiss investor in Life Sciences

Europe’s biggest investor and consolidator on the Advanced Diagnostics and Cancer Care markets

The largest, most experienced healthcare provider under the Public Private Partnership (PPP) model and an integral part of national healthcare systems
Best-in-class medical technology

Affidea’s technology update investments, proprietary asset management system and large scale partnership with technology vendors result in the latest technology IB and youngest equipment fleet.

145 MRI units
100 CT scanners
910 diagnostic and cancer care modalities
22 linear accelerators
3 gamma knives
17 PET-CT scanners

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* COCIR Data

Restricted © Affidea

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Clinical Governance Infrastructure

- **Affidea Medical Council** comprising Country Medical Directors in all 14 countries.

- **Medical Advisory Board** Seven Leading European Radiology experts (four previous Presidents of ESR) providing international leadership.

- **Cancer Treatment Centre (CTC) Steering Committee** in collaboration with Houston Methodists Group and independent Senior Clinician from Oxford University.

- **Nuclear Medicine Working Group** specifically focusing on countries that provide nuclear medicine examinations such as PET CT.
Radiation from Medical Imaging
The per capita dose of radiation from medical imaging has increased by 600% since the early 1980s.

Continuing expansion of CT practice

Source: OECD Health Statistics 2015: CT exams, 2013 or nearest year
Facts for CT examinations

In 1996 the contribution to the annual cumulative effective dose by CT examinations was 5%.

In 2009 the contribution to the annual cumulative effective dose by CT examinations is 46%.
Diagnostic imaging radiation incidents

- 23 January 2008
A licensed technologist, in Arcata, California performed 151 CT scan slices on a single 3 mm level on the head of a 23-month child over a 65-min period. This led to a dose of 5.4Gy to the brain and 1.5Gy to the lenses of both eyes!

- February 2008 – August 2009
A software misconfiguration in a CT scanner used for brain perfusion scanning at Cedar Sinai Medical Center in Los Angeles, California, resulted in 206 patients receiving radiation doses approximately 8 times higher than intended.
COUNCIL DIRECTIVE 2013/59/EURATOM of 5 December 2013

Basic Safety Standards for Protection Against Dangers Arising from Exposure to Ionizing Radiation
Modern CT scanners are capable of providing precise detail of patient anatomy, but...this is not always required
appropriate image quality at optimized dose
...not too little
...not too much
perfect balance
Dose Excellence
BALANCED RADIOGRAPHY
The process

Standardized Input
- Standardized & Unified Protocols with DRLs
- Standard procedures

Monitoring System
- DoseWatch
- Track & Record dose data and more

Optimization
- Track & Justify high dose level alerts
- Analyze data
- Optimize protocols & DRL

Leadership Teams

Dose Excellence Balanced Radiography
Set clear goals

- Create a culture of dose awareness
- Provide comprehensive education on technology and effects of radiation
- Justify alerts and minimize through root-cause analysis
- Define and set up an adapted high dose level alert system

- Create a standard list of procedures based on clinical indication
- Prioritize optimization of acquisition parameters and practices
- Validate new protocols, update DRLs, implement best practice
- Analyse impact on dose levels and image quality
DEP Teams and Communication channels

**External Body**
- GE DoseWatch Steering Team

**HQ**
- Sponsor
- HQ Project Leader
- Chief Medical Officer
- Performance Optimization Manager
- Chief Information Officer
- Corporate Marketing Director
- STEERING COMMITTEE

**Country**
- CEO
- Project Leader
- Chief Radiologist
- Chief Radiographer
- Medical Physicist
- IT
- Marketing

**Centre**
- Centre Manager
- Chief Radiologist
- Chief Radiographer

**External Body**
- Application Specialists
- Service Providers
CT protocols and DRLs
Adult CT protocols categories

Routine
• By anatomic region and clinical indication. To further categorize by standard and big patients.

CTA
• By anatomic region

Oncology follow up
• By primary tumor type: lung, breast, upper abdomen, lower abdomen, lymphoma, sarcoma, melanoma, head & neck

Screening
• Chest

Cardiac
• By prospective, retrospective and BPM

Interventional
• Biopsy (liver, lung etc.), joint injection, drainage/therapy (abdominal cavity, liver, spine etc.)
Pediatric CT protocols categories

- **Routine**
  - By anatomic region, clinical indication, weight or age

- **Oncology follow up**
  - By primary tumor type: leukemia, brain/CNS, neuroblastoma, nephroblastoma, lymphoma, osteosarcoma
### Example of adult unified protocols setup

<table>
<thead>
<tr>
<th>Anatomic Area</th>
<th>Protocole Name= clinical indication</th>
<th>Main Clinical Indication</th>
<th>Main Diagnostic Task</th>
<th>Scanning Mode</th>
<th>Exam Description</th>
<th>NS</th>
<th>RPID</th>
<th>DRL P75 CTDivo (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEST</td>
<td>General Chest max 2 series</td>
<td>Metastasis detection, Staging, Tumor evaluation, Dyspnea, Unclear chest symptoms, First examination</td>
<td>Parenchyma, mediastinum, airways, mediastinal vessels</td>
<td>helical</td>
<td>with and/or without contrast</td>
<td>&lt;= 2</td>
<td>RPID17</td>
<td>10.0</td>
</tr>
<tr>
<td>CHEST</td>
<td>Pulmonary Embolism</td>
<td>Thrombus detection</td>
<td>Vessels, parenchyma</td>
<td>helical, recommended 1.5 mm thickness</td>
<td>with contrast</td>
<td>1</td>
<td>RPID336</td>
<td>10.0</td>
</tr>
<tr>
<td>CHEST</td>
<td>Chest follow-up</td>
<td>Follow-up for infection or nodules, tumor staging</td>
<td>Parenchyma, mediastinum</td>
<td>helical</td>
<td>1 phase without contrast for parenchyma evaluation OR 1 phase with contrast for mediastinum evaluation</td>
<td>1</td>
<td>RPID16</td>
<td>7.5</td>
</tr>
</tbody>
</table>
The number of unified protocols is important

29 Unified CT protocols
- Exams performed with unified protocols: 31%
- Other protocols: 69%

75 Unified CT protocols
- Exams performed with unified protocols: 13%
- Other protocols: 87%
Dose Monitoring software
GEHC DoseWatch

A multimodality, vendor independent tracking, recording and analyzing software of dosimetric data and much more…

Tools to facilitate Dose Excellence:

• RadLex playbook to map site CT protocols to Affidea’s Standardized CT protocols in order to track compliance
• Data to assess correct patient positioning in FOV, mA modulation function, CTDIvol, DLP, SSDE, patient cumulative dose, BMI and more
• Definition, monitoring and justification of high-level dose alerts
• Custom made report for analysis of data, sent automatically via email to all relevant recipients
High dose level alerts
Alert system definition

Alerts defined by protocol. An alert is triggered when DLP recorded for the specific patient examination is $2 \times$ median DLP from the collected data on the specific CT scanner and practice.
DEP outcomes
1. DASHBOARD

### JUSTIFICATION
- **2015-08-01 to 2016-07-31**
  - **2016-07-01 to 2016-07-31**
  - No alert
  - Justified alert
  - Not justified alert

### STANDARDIZATION
- **2015-08-01 to 2016-07-31**
  - % not analysed exams
  - % analysed exams (mapped with standard NS)

### OPTIMIZATION
- **2015-08-01 to 2016-07-31**
  - Number of protocols p75 (CTDI or DLP) ≤ DRL
  - Number of protocols p75 (CTDI or DLP) > DRL

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Justification, Standardization, Optimization - dashboard
### Dose levels analysis

**General protocols: Dose Reference Level (DRL) analysis - 2015-12-01 to 2015-12-31**

<table>
<thead>
<tr>
<th>Device</th>
<th>RPID</th>
<th>Max accepted NS</th>
<th>Protocol name</th>
<th># Exams</th>
<th>P25 of Max series CTDIvol (mGy)</th>
<th>P75 of Max series CTDIvol (mGy)</th>
<th>Max CTDI DRL (mGy)</th>
<th>CTDI diff</th>
<th>P75 of Total DLP (mGy.cm)</th>
<th>P25 of Total DLP (mGy.cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCT 64</td>
<td>RPID195</td>
<td>3</td>
<td>General abdomen/pelvis max 3 phases</td>
<td>46</td>
<td>5.56</td>
<td>9.35</td>
<td>3.97</td>
<td>17.00</td>
<td>-45.00 %</td>
<td>775.36</td>
</tr>
<tr>
<td>VCT 64</td>
<td>RPID248</td>
<td>4</td>
<td>5.8 TAP max 4 phases</td>
<td>34</td>
<td>7.04</td>
<td>13.69</td>
<td>5.13</td>
<td>15.00</td>
<td>-8.73 %</td>
<td>1066.92</td>
</tr>
<tr>
<td>VCT 64</td>
<td>RPID372</td>
<td>4</td>
<td>1.1 General Head incremental</td>
<td>20</td>
<td>50.79</td>
<td>51.83</td>
<td>5.13</td>
<td>55.00</td>
<td>-5.76 %</td>
<td>1566.40</td>
</tr>
<tr>
<td>VCT 64</td>
<td>RPID17</td>
<td>2</td>
<td>5.1 General Chest max 2 series</td>
<td>19</td>
<td>4.37</td>
<td>7.99</td>
<td>4.87</td>
<td>10.00</td>
<td>-20.05 %</td>
<td>441.12</td>
</tr>
</tbody>
</table>

This table shows DRL analysis for all scanned protocols with accepted NS. The P75 values Max series + CTDIvol that are above the DRL threshold are displayed in red writing.

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**DoseWatch is a registered trademark of General Electric Company**

Global solution for patient dose tracking and optimization in medical imaging.
Consolidated data analysis example
**General Head incremental protocol – RPID 372**

<table>
<thead>
<tr>
<th>Data period</th>
<th>01/02/16 – 31/03/16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of countries</td>
<td>7</td>
</tr>
<tr>
<td>Number of CT departments</td>
<td>21</td>
</tr>
<tr>
<td>Number of CT models</td>
<td>13</td>
</tr>
<tr>
<td>Total number of examinations</td>
<td>4,275</td>
</tr>
<tr>
<td>Max accepted number of series</td>
<td>4</td>
</tr>
<tr>
<td>Median of most used number of series</td>
<td>1</td>
</tr>
<tr>
<td>Excluded protocols</td>
<td>&lt; 20 examinations</td>
</tr>
<tr>
<td>Excluded series/examinations</td>
<td>Non diagnostic and tests</td>
</tr>
</tbody>
</table>
Alerts root – cause analysis

- Additional phases: 31%
- Patient movement: 16%
- Overweight: 15%
- Additional protocol: 17%
- Over length acquisition: 20%
- Wrong protocol: 1%
Standardization PRID 372

- GR
- HU
- IT
- PO
- PT
- RO
- TR

% Exams performed with not unified protocols per country
% Exams performed with unified protocols per country
CTDIvol per county
DLP per country

DLP (mGy.cm) for all countries

DRL = 825 mGy.cm

Country: Greece, Hungary, Italy, Poland, Portugal, Romania, Turkey

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CTDInvol per CT model
Challenges and tips
Challenges

- Resistance to change
- Fear of misdiagnosis
- Assessing image quality
- National Health System rules
- Unclear referral notes
Tips

- Choose your teams wisely and encourage collaboration
- Review your goals and reassess when required
- Do not make big changes, people need time to adjust
- Make sure your results are accurate before you implement changes
- Meet and communicate frequently
- Inspire, be enthusiastic and reward your teams for their work