Electronic recording of radiography, fluoroscopy and computed tomography dose metrics: When should they be included in the patient chart?

JA Seibert, PhD
Department of Radiology
University of California Davis Health
Sacramento, California, USA
Disclosures

- Member, Medical Advisory Board – Bayer Radimetrics
Presentation sequence

- **What** – what are dose metrics?
- **Why** – why record dose metrics?
- **How** – how are dose metrics recorded?
- **When** – when (if) dose metrics should be included in patient chart?
What – what are dose metrics?

Why – why record dose metrics?

How – how are dose metrics recorded?

When – when (if) dose metrics should be included in patient chart?
What are dose metrics?

- A parameter associated with the radiation dose for an exam
- May or may not represent “patient dose”
- Defined in DICOM Radiation Dose Structured Report TIDs
  - CT Radiation Dose
  - Projection X-ray Radiation Dose
  - Radiopharmaceutical Radiation Dose
Dose metrics

- Often not a dose measure
  - Exposure Index to detector
  - Deviation Index - feedback to radiographer
  - X-ray technique factors for estimating dose
  - Number of images in a sequence
- Often used in determining DRLs
Dose metrics
Radiography, Mammography, Fluoroscopy

- Entrance surface air kerma ($K_{a,e}$)
- Incident air kerma ($K_{a,i}$)
- Incident air kerma at reference point ($K_{a,r}$)
- Mean glandular dose ($D_G$)
- Kerma Area Product ($P_{KA}$)
Dose metrics
Computed Tomography

- Volume CT Dose Index ($\text{CTDI}_{\text{vol}}$)
- Size Specific Dose Estimate (SSDE)
- Dose Length Product (DLP)
Dose metrics
Injected Radiopharmaceuticals

- Injected radiopharmaceutical activity
- DICOM Radiopharmaceutical RDSR (R-RDSR)
- Provides estimate of effective dose
- Systems Interoperability? IHE REM-NM
Patient Dose

- Energy imparted and absorbed in tissues and organs
- For medical imaging exams, dose to a region is typical
- For tissue reactions, peak skin dose is overriding
Effective Dose

- Not really a “dose” but an estimate of risk
- Not specifically intended for medical procedures
- Serves as a whole body risk estimate for a partial exposure
- Convenient one-number value
- Widely mis-used
- **What** – what are dose metrics?
- **Why** – why record dose metrics?
- **How** – how are dose metrics recorded?
- **When** – when (if) dose metrics should be included in patient chart?
Radiation Dose Monitoring

Radiation Overdoses Point Up Dangers of CT Scans

Written by Humboldt Online Editor on 16 October 2009

New York Times
Raven
Knickerbocker, then an x-ray technologist at Mad River Community Hospital in Arcata, Calif., activated a CT

Legislation with California State Law SB-1237
Radiation Dose Monitoring
Requirements in the United States

- FDA initiative (2010)
- California SB-1237 (2012)
- CMS (2016)
- The Joint Commission Sentinel Event Alert (2011)
- The Joint Commission (2015)
Components of the FDA Initiative

- Appropriate use
- Equipment safety features
- Education and communication
- Tracking radiation safety metrics
- Facility guidelines and personnel qualifications
- Research and development
MITA Smart Dose CT

- NEMA XR 29 – 2013
  Standard attributes on CT equipment related to dose optimization & management

- PAMA – 2014
  15% CMS reduction in reimbursement for non-compliant exams after January 1, 2017


Adapted from Tessa Cook, MD
Joint Commission Reporting Requirements
Major accreditation body for hospitals in the USA

- Recording sentinel events
- CT, PET, MRI requirements
- Interventional imaging requirements

https://www.jointcommission.org/diagnostic_imaging_standards/
California “CT Dose” Reporting Requirements

Medical Radiation Safety Act of 2010
Preventing Excessive Exposure To Radiation

- Implemented 2010, law in effect on January 1, 2012
- Requires CTDI_{vol} and DLP to be entered into the Interpretive Report
- Requires CT systems to be accredited
- Requires dose reporting to State DPH if doses exceed stated values
USA: Merit-based Incentive Payment System - MIPS

- Driven by Centers for Medicare and Medicaid Services
- Designed to incentivize patient safety issues and lower costs
- ACR is the primary measure steward
- Relevant to this discussion:
  - Quality ID #145: Radiology: Exposure Dose or Time Reported for Procedures Using Fluoroscopy – National Quality Strategy
    Domain: Patient Safety
MIPS - 2018 Measure 145 - reporting requirements

Definition: Radiation exposure indices - For this measure, radiation exposure indices should, if possible, include at least one of the following:

1. Skin dose mapping
2. Peak skin dose (PSD)
3. Reference air kerma \((K_{a,r})\)
4. Kerma-area product \((P_{KA})\) or Dose area product \((DAP)\)

Report must state what radiation quantity is being submitted - reporting dose in mGy is insufficient. Example: PSD in mGy is very different from \(K_{a,r}\) in mGy.

If fluoroscopic equipment does not provide any above indices, exposure time and number of fluorographic images taken during the procedure may be used.
What – what are dose metrics?
Why – why record dose metrics?
How – how are dose metrics recorded?
When – when (if) dose metrics should be included in patient chart?
How are dose metric values recorded?

- Manual recording and reporting
- Radiation Dose Management System (RDMS)
- Collection of dose metric values from imaging systems (DICOM, RDSR)
- Synthesis of radiation dose events, for example:
  - Cumulative radiation dose
  - Peak Skin Dose
- *Patient-specific?* -- Use of DICOM P-RDSR
Implementing Electronic Radiation Dose Monitoring

- Software
- Equipment
- Protocols
- DICOM
- IHE REM
- ACR DIR
- Societies
- Budget
- People

Adapted from Tessa Cook, MD
Automated Reporting of CT dose metrics

- Use of RDMS and system interfaces to scanner, PACS, RIS, Voice, EHR

CT dose metrics in report: single series

EXAM: CT ABDOMEN + CT PELVIS, WITH CONTRAST
DATE OF STUDY: 10/9/2012 11:29 AM

CLINICAL INFORMATION: Pain(acute), location: Pelvis: Left Other, specify: left Ileum Bowel Comments.

TECHNIQUE: Helically acquired contrast enhanced multidetector CT of the abdomen and pelvis acquired in the portal venous phase, extending from the lung bases through the groins. Uneventful administration of 125 ml of Omnipaque 350 injected at a rate of 2.5 ml/sec. Images are reconstructed in the axial plane with subsequent reformatting in coronal and sagittal planes.

No P.O. contrast was administered.

DOSE REPORT: This study involved (1) CT acquisition(s). The CTD\textsubscript{vol} and DLP values are included below as required by state law:

1; Series: 3; Abdomen; 32 cm; CTD\textsubscript{vol}=17.7 mGy; DLP=86.7 mGy-cm

For further information on CT radiation dose, see http://www.ucdmc.ucdavis.edu/radiology/RadiationDose.html

COMPARISON: None.

FINDINGS:

LOWER CHEST:

There is a calcified granuloma noted in the posterior left lung base. The lung bases are otherwise clear.
Automated Reporting of CT dose metrics

- Use of RDMS and system interfaces to scanner, PACS, RIS, Voice, EHR

CT dose metrics in report: multiple series

DATE: 10/9/2012 11:42 AM

EXAM TYPE: CT ANGIO CHEST WITH / WITHOUT CONTRAST

COMPARISON: 8/12/2011

INDICATION: History of 4-cm ectatic aorta. Follow-up CT.

TECHNIQUE: Helical scanning from the thoracic inlet through the aortas was performed following the uneventful administration of 100 mL of Omnipaque 350 at a rate of 4.0 mL/s through a 20-gauge left antecubital vein. Reconstruction of 5-mm and 1.0-mm contiguous axial images was performed. 5-mm contiguous coronal and sagittal images and 10-mm contiguous MIP axial images were reformatted.

RADIATION DOSE:
This study involved (3) CT acquisition(s). The CTDIvol and DLP values are included below as required by state law:
1. Series: 2; Chest: 32 cm; CTDIvol=2.9 mGy; DLP=3 mGy-cm
2. Series: 3; Chest: 32 cm; CTDIvol=26.4 mGy; DLP=26 mGy-cm
3. Series: 5; Chest: 32 cm; CTDIvol=13.5 mGy; DLP=692 mGy-cm

For further information on CT radiation dose, see http://www.ucdmc.ucdavis.edu/radiology/RadiationDose.html

FINDINGS:
Neck: The visualized portion of the lower neck shows normal caliber of vessels. Normal trachea. No masses.
Modalities (beyond CT)
# Interventional RDSR

<table>
<thead>
<tr>
<th>Type</th>
<th>Protocol</th>
<th>DAP [mmHg x 2]</th>
<th>Reference Point</th>
<th>BEAM On Time [h]</th>
<th>NW [A]</th>
<th>NW [B]</th>
<th>Start Time</th>
<th>Primary Angle [°]</th>
<th>Secondary Angle [°]</th>
<th>Fluor Mode</th>
<th>Pulses per Sec</th>
<th>Number of Pulses</th>
<th>Pulsed Width [ms]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stationary Acquirs</td>
<td>UCA</td>
<td>20789</td>
<td>15cm from isoc</td>
<td>100-99</td>
<td>3557.7</td>
<td>80</td>
<td>220</td>
<td>768 117</td>
<td>5</td>
<td>19.9</td>
<td>56</td>
<td>90</td>
<td>0.3</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>616</td>
<td>15cm from isoc</td>
<td>5 11</td>
<td>3691.7</td>
<td>75</td>
<td>94</td>
<td>368.01</td>
<td>5</td>
<td>19.9</td>
<td>Pulsed</td>
<td>7.5</td>
<td>157</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>72</td>
<td>15cm from isoc</td>
<td>0.35</td>
<td>527.1</td>
<td>70</td>
<td>47</td>
<td>35.359</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>21</td>
<td>25.1</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>97</td>
<td>15cm from isoc</td>
<td>0.8</td>
<td>927.5</td>
<td>75</td>
<td>94</td>
<td>41.118</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>25</td>
<td>25.5</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>200</td>
<td>15cm from isoc</td>
<td>1.33</td>
<td>2182.5</td>
<td>70</td>
<td>40</td>
<td>30.327</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>13</td>
<td>20.7</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>10</td>
<td>15cm from isoc</td>
<td>0.5</td>
<td>301.2</td>
<td>71</td>
<td>65</td>
<td>18.729</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>12</td>
<td>25.1</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>613</td>
<td>15cm from isoc</td>
<td>3.9</td>
<td>1441.7</td>
<td>75</td>
<td>94</td>
<td>93.672</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>57</td>
<td>25.4</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>425</td>
<td>15cm from isoc</td>
<td>8.9</td>
<td>2368.6</td>
<td>90</td>
<td>94</td>
<td>162.684</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>69</td>
<td>25.6</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>240</td>
<td>15cm from isoc</td>
<td>7.92</td>
<td>1660.6</td>
<td>104</td>
<td>94</td>
<td>101.903</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>59</td>
<td>26.6</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>128</td>
<td>15cm from isoc</td>
<td>6.44</td>
<td>4861.8</td>
<td>104</td>
<td>94</td>
<td>163.499</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>183</td>
<td>25.8</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>204</td>
<td>15cm from isoc</td>
<td>4.24</td>
<td>1200</td>
<td>104</td>
<td>94</td>
<td>91.756</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>64</td>
<td>26.9</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>335</td>
<td>15cm from isoc</td>
<td>22.31</td>
<td>3026.8</td>
<td>115</td>
<td>94</td>
<td>183.874</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>135</td>
<td>25.1</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>438</td>
<td>15cm from isoc</td>
<td>29.9</td>
<td>3960</td>
<td>115</td>
<td>94</td>
<td>307.359</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>120</td>
<td>26.6</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>712</td>
<td>15cm from isoc</td>
<td>47.42</td>
<td>6356.4</td>
<td>115</td>
<td>94</td>
<td>412.409</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>240</td>
<td>26.6</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>1227</td>
<td>15cm from isoc</td>
<td>81.69</td>
<td>1123</td>
<td>94</td>
<td>94</td>
<td>733.021</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>426</td>
<td>26.9</td>
</tr>
<tr>
<td>Fluoroscopy</td>
<td>FL-Neuro</td>
<td>467</td>
<td>15cm from isoc</td>
<td>8.51</td>
<td>2364.9</td>
<td>94</td>
<td>94</td>
<td>161.215</td>
<td>5</td>
<td>Pulsed</td>
<td>7.5</td>
<td>86</td>
<td>26.6</td>
</tr>
</tbody>
</table>

**Note:** The table represents various interventions with different parameters and modes of operation for RDSR procedures.
• Reference point: 11007 mGy
• Largest dose by position: 2200 mGy
• Soon: peak skin-dose mapping
Patient-Specific Dose Reporting

- Patient Radiation Dose Reporting (P-RDSR) -- DICOM WG-28-Physics
- Current SR contains only information about x-ray system
  - Radiation output, geometry, x-ray source, detector system
- Estimation of patient / organ dose requires knowledge of:
  - Radiation beam characteristics
  - Models of the patient and organs
  - Models of radiation interaction within the patient
Patient Radiation Dose SR (P-RDSR)

Registration between Patient Model and RDSR

**Case #1**

- Table, position
- Gantry Angle
- Beam Geometry, collimation

Registration matrix between:
- each RDSR FOR and
- the Patient Model FOR

\[
\begin{bmatrix}
A_x \\
A_y \\
A_z \\
1
\end{bmatrix} =
\begin{bmatrix}
M_{11} & M_{12} & M_{13} & T_x \\
M_{21} & M_{22} & M_{23} & T_y \\
M_{31} & M_{32} & M_{33} & T_z \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
B_x \\
B_y \\
B_z \\
1
\end{bmatrix}
\]
Patient Radiation Dose SR (P-RDSR)

Registration between Patient Model and RDSR

Case #2

- Table position vs. Isocenter
- Gantry Angle vs. Isocenter
- Beam Geometry, collimation

\[
\begin{bmatrix}
\alpha_x \\
\alpha_y \\
\alpha_z \\
\end{bmatrix} =
\begin{bmatrix}
M_{11} & M_{12} & M_{13} & T_x \\
M_{21} & M_{22} & M_{23} & T_y \\
M_{31} & M_{32} & M_{33} & T_z \\
0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
\beta_x \\
\beta_y \\
\beta_z \\
1
\end{bmatrix}
\]

Registration matrix between:
- each RDSR Fiducial FOR and
- the Patient Model FOR
Patient Radiation Dose SR (P-RDSR)

Registration between Patient Model and RDSR

Case #3

Note: the patient fiducials can be defined through a manual measurement on the actual patient landmarks, or through image-based measurements of landmarks visible on the X-Ray images.

Registration matrix between:
- each RDSR Fiducial FOR and
- the Patient Fiducial FOR
Patient Radiation Dose SR (P-RDSR)
Registration between Patient Model and RDSR
Case #4

X-Ray Equipment
No Patient Model

Radiation Dose SR (RDSR)
- Table position vs. Isocenter
- Gantry Angle vs. Isocenter
- Beam Geometry, collimation

Registration

No X-Ray Images
No Equipment Fiducials

Free Text Comment:
E.g. "Distance from Patient Head to Table Top Head is 15 cm"
Peak Skin Dose Mapping
Courtesy of Mark Supanich PhD, Rush Memorial Hospital

Initial Peak Skin Dose Map

Parameter adjustment inputs
### Placement of first fluoro position

![Image of a person with a highlighted position](image)

<table>
<thead>
<tr>
<th>Reference Point Dose [mGy]</th>
<th>DAP [mGy·cm²]</th>
<th>kVp</th>
<th>Distance Source</th>
<th>Distance Source</th>
<th>kVp</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000000</td>
<td>11.5</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td></td>
</tr>
<tr>
<td>0.000000</td>
<td>21.8</td>
<td>75</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.88</td>
<td>262.9</td>
<td>75</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>2.22</td>
<td>663.4</td>
<td>75</td>
<td>1198</td>
<td>785</td>
<td>79</td>
</tr>
<tr>
<td>1.23</td>
<td>389.1</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.13</td>
<td>42.4</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>2.63</td>
<td>788.4</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.13</td>
<td>43.2</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.16</td>
<td>46.5</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>1.68</td>
<td>502.8</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.55</td>
<td>165.4</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.27</td>
<td>83.8</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.65</td>
<td>194.6</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.11</td>
<td>32.6</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.23</td>
<td>69</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>0.76</td>
<td>226.1</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>2.23</td>
<td>667.5</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>1.87</td>
<td>557.1</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>1.45</td>
<td>607.6</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>2.04</td>
<td>599.6</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
<tr>
<td>16.46</td>
<td>4368.2</td>
<td>81</td>
<td>1198</td>
<td>785</td>
<td>81</td>
</tr>
</tbody>
</table>
Re-adjustment to new position
PSD Final Map after adjustment

Frame of Reference adjusted

Original Peak Skin Dose Map
Presentation sequence

- **What** – what are dose metrics?
- **Why** – why record dose metrics?
- **How** – how are dose metrics recorded?
- **When** – when should be included in patient chart?
When should dose metrics be placed in the patient chart?

- When required by law
- When required by an accreditation agency
- When required by local policies & procedures
- When other related procedures might have an impact on patient health, for example, a punch biopsy in a high skin dose area of an IR patient
# Exceeding Investigational Levels

## HEART AND VASCULAR CENTER: CARDIOVASCULAR SERVICES

### POLICY AND PROCEDURES

<table>
<thead>
<tr>
<th>Radiation Safety</th>
<th>Approved By: Reginald Low, MD</th>
<th>Section:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invasive Cardiovascular Services</td>
<td>Issued By: Kori Harder RN, MS</td>
<td>Page(s): 2 of 4</td>
</tr>
<tr>
<td></td>
<td>Supersedes: NEW</td>
<td>Date: 02-2017</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient Room(s)</th>
<th>Procedural Pause</th>
<th>Dose Received within 7 days</th>
<th>6 Month Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult: 1745A, 1745B, All Pavilion</td>
<td>6,000 mGy</td>
<td>8,000 mGy</td>
<td>12,000 mGy</td>
</tr>
<tr>
<td>Peds: 1745A, 1745B, All Pavilion</td>
<td>1,500 mGy</td>
<td>2,000 mGy</td>
<td>3,000 mGy</td>
</tr>
</tbody>
</table>
Patient Exposure Form

PATIENT IDENTIFICATION STICKER OR (NAME AND MR#)

Date:                                  Room:
Fluoroscopist:
Exam:                                  (circle unit)
DAP/KAP:                               (mGy or cGy-cm²)
Fluo Time:                             (minutes) # Digital Images:

Dates of previous similar fluoro procedures involving the same areas of the body within the past year:

Procedure Summary                      (circle response)
Do you anticipate a repeat of the procedure within a year?  Yes  No
If yes, was the patient counseled to look for skin changes?  Yes  No

Indicate irradiated areas on the diagram above.

Comments

<table>
<thead>
<tr>
<th>Investigational Levels (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient: Room(s)</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Adult: 1623, 1625, 1627</td>
</tr>
<tr>
<td>Peds/Neuro: 1623, 1625, 1627</td>
</tr>
<tr>
<td>Adult: 2326 Vascular</td>
</tr>
<tr>
<td>Peds: 2326 Vascular</td>
</tr>
<tr>
<td>Adult: 1745A, 1745B, All Pavilion</td>
</tr>
<tr>
<td>Peds: 1745A, 1745B, All Pavilion</td>
</tr>
</tbody>
</table>

Units for numbers beneath this row ▶|

Investigational Levels (cGy-cm²) ▼

| Adult: 1629 Puncture       | 67,500           | 90,000                 | 135,000            |
| Peds: 1629 Puncture       | 33,750           | 45,000                 | 87,500             |
# Patient Exposure Assessment

<table>
<thead>
<tr>
<th>SECTION I</th>
<th>PATIENT DATA</th>
<th>SECTION II</th>
<th>PATIENT DOSE DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Name</td>
<td>Estimated Patient Skin Dose</td>
<td>(mGy)</td>
<td></td>
</tr>
<tr>
<td>MR Number</td>
<td>Date(s) Received</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Patient Contact: Call #1 at 2 weeks, and Call #2 at 4 weeks from the latest date in section II. If any effect is identified, the patient will be followed quarterly for 2 years.

## SECTION III FOLLOW UP CALLS

<table>
<thead>
<tr>
<th>CALL NUMBER</th>
<th>DATE</th>
<th>TIME</th>
<th>PATIENT CONTACTED Y/N?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indicate if any of the effects in the table below have been reported by the patient and/or the patient’s physician. Specifically inquire about hair loss, skin redness, or rash.

<table>
<thead>
<tr>
<th>Effect</th>
<th>Date Reported</th>
<th>Effect</th>
<th>Date Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early transient erythema</td>
<td></td>
<td>Dermal atrophy</td>
<td></td>
</tr>
<tr>
<td>Temporary epilation</td>
<td></td>
<td>Telangectasis</td>
<td></td>
</tr>
<tr>
<td>Main erythema</td>
<td></td>
<td>Moist desquamation</td>
<td></td>
</tr>
<tr>
<td>Permanent epilation</td>
<td></td>
<td>Late erythema</td>
<td></td>
</tr>
<tr>
<td>Dry desquamation</td>
<td></td>
<td>Dermal necrosis</td>
<td></td>
</tr>
<tr>
<td>Invasive Fibrosis</td>
<td></td>
<td>Secondary ulceration</td>
<td></td>
</tr>
</tbody>
</table>
Directives and Opportunities

- Interface all imaging ionizing radiation devices to RDMS
- Identify pertinent parameters to track
- Require RDSR when purchasing new equipment
- Track patient radiation dose metrics history in RDMS
- Define a path to electronic health record
- Develop pathways to dose index registries
- Achieve and maintain high patient safety goals
Conclusions

- Understanding dose metrics requires understanding nuances.
- Ideally, all ionizing radiation encounters should be recorded.
- Access to patient longitudinal history should be available.
- When to include dose metrics in the patient chart requires careful consideration.