RADIATION METRICS IN MEDICAL IMAGING

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President
(Huda’s Physics in Medicine)
“Input”

“Dose”

“Dose”/“Input” Factors
Imaging Modalities

Radiography

Fluoroscopy

Nuclear Medicine

Computed Tomography
Radiography and Fluoroscopy

$kV$ (HVL)

Air Kerma

X-ray Beam Area

Kerma Area Product (KAP)

<table>
<thead>
<tr>
<th>Air Kerma:</th>
<th>4 Gy</th>
<th>1 Gy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area:</td>
<td>4 cm²</td>
<td>16 cm²</td>
</tr>
<tr>
<td>KAP:</td>
<td>16 Gy cm²</td>
<td>16 Gy cm²</td>
</tr>
</tbody>
</table>
CTDI$_{vol}$ (mGy)

Dose-length product [DLP] (mGy-cm)
Nuclear Medicine

Administered Activity
Absorbed Dose to an Organ → Organ Risk
Organ Dose

Total $\text{CTD}I_{\text{vol}}$ (i.e., Incident Radiation) 
$x$ 
Patient Size Factor 
$x$ 
Scan Length Factor

Embryo Dose Estimates in Body CT
AJR 194 (2010) 874-880
Effective Dose

$\rightarrow$

Equivalent uniform whole body dose with same risk as the non-uniform dose

$E = \sum H_{\text{organ}} \times w_{\text{organ}}$

Cardiac CT Dose Pattern

Effective Dose (E)
“DOSE”/”INPUT” FACTORS
Radiography/Fluoroscopy (Adults)

F (Beam Quality)
CT E/DLP (k factors)

Averaged over all ages

Body Region

Head Neck Chest Abdomen Pelvis

Relative Sensitivity (at constant DLP)

Adult Head 2.4 $\mu$Sv/mGy-cm

Radiology 257 (2010) 158-166

“Independent” of Beam Quality
Nuclear Medicine

mSv/MBq
Computed Tomography

Averaged over all exams
(Head, Neck, Chest, Abdomen, Pelvis)

Relative Dose (at constant DLP)

Patient Age

- Adult
- 10 yr
- 5 yr
- 1 yr
- nb
Nuclear Medicine

18F FDG

Patient Age

Effective dose per unit activity (μSv/MBq)
PATIENT SIZE
Radiography/Fluoroscopy

Nominal E ~ E_{70} \times (70 / W)

PCXMC - A PC-based Monte Carlo program for calculating patient doses in medical x-ray examinations
Adult Body CT

Radiation Protection Dosimetry
doi:10.1093/rpd/ncr376
Nuclear Medicine

Age \Rightarrow "Nominal Weight"

18F (FDG)
CONCLUSION
INPUT

KAP + Beam Quality

DLP

MBq Administered

Input Radiation ➞ Optimization
EFFECTIVE DOSE (E)

Not “ideal”, but .....
"DOSE"/"INPUT" FACTORS

Data Exist ⇒ User Friendly

Exposed Region

Beam Quality (x-rays)

Age

Patient Size