Ask EuroSafe Imaging
Tips & Tricks

IR Working Group

Medical Simulators for Training in Dose Management and Radiation Protection

G. Bartal MD, DFCIRSE, FSIR, Tel Aviv, Israel
R. Sánchez Hospital San Carlos & Universidad Complutense. Madrid, Spain
B. Hallinan, Beaumont Hospital, Dublin, Ireland
Why Simulation?

- Medical Simulation is

  - a cross-disciplinary,

  - realistic,

  - and economical training and feedback method
Why Simulation?

- Trainees can repeatedly practice & review tasks and processes.

- Using physical or virtual reality models (ranging from low to high fidelity), to identify and understand factors which control the system and/or predict its future behavior.

- Simulation is used to develop, maintain and improve skills of Image Guided Interventionalists in a protected environment until proficiency is achieved.

- Without harming patients.
Endovascular Simulators

- Shorten the training course
- Provide a safe, virtual, but realistic atmosphere for procedure performance
  - No radiation exposure
- Provide a complete log of the procedure, also considering:
  - Fluoroscopy time
  - Patient exposure
  - Estimate of operator exposure
Any Feature of Cath. Lab Equipment Can Be Simulated

- State of the Art Angiography systems have:
  - Virtually unlimited Fluoroscopy time,
  - DSA,
  - Road Maps,
  - Cone-beam CT and many other options that are based on Ionizing Radiation
Virtual Reality Simulators

- Significant differences have been noted between pre- and post-training performance of procedures when using medical virtual reality simulators
  - with shortening of procedure and fluoroscopy time [1]

- Virtual reality simulation provides a
  - risk-free (including radiation-free) setting
  - in which technical skills can be obtained through repetition [2]
Procedure Planning

- Procedure planning should integrate dose management measures
- The goal is an efficient and optimal use of radiation
  - not an irrational fear or negligence
- Simulation is based on accurate procedure planning
Radiation Protection Simulation - Goals

- Build up physician's awareness to dose levels during interventions
- To provide tools for dose reduction methods
- To practice dose management as an integral part of the hands-on simulation
  - shorten procedure and fluoroscopy time
- To provide scoring and subjective performance metrics
  - measure results
  - follow-up improvement
Real Time Dose Display

- Dose Rate/Cumulative Dose (mGy)
- Side Bar with Cumulative Dose/Dose Rate
- DAP mGycm²
Off-Fluoro Collimation
Messages and Alerts
These alerts are displayed intermittently according with time of procedure

Please remember to put on your protective wear:

- Lead Apron
- Thyroid Shield
- Protective Gloves
- Protective Eyewear
- Dosimeters

Fluoroscopy Time: 5 minutes
Cumulative Dose (Ka,r): 817 mGy
Press OK to continue.

It is recommended to move table away from the x-ray tube
Performance and Dose Report

- Displayed at the end of each session
- Stored in the system in order to follow-up the progress of trainee

### Procedure Dose Report

<table>
<thead>
<tr>
<th>#</th>
<th>Metric</th>
<th>Benchmark</th>
<th>Results</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fluoroscopy Time (Min)</td>
<td>&lt;07:00</td>
<td>02:20</td>
<td>1/13</td>
</tr>
<tr>
<td>2</td>
<td># of DSA Frames</td>
<td>&lt;150</td>
<td>29</td>
<td>1/13</td>
</tr>
<tr>
<td>3</td>
<td># of Roadmaps</td>
<td>&lt;4</td>
<td>2</td>
<td>1/13</td>
</tr>
<tr>
<td>4</td>
<td>Max Frame Rate (fps)</td>
<td>&lt;=3</td>
<td>3</td>
<td>1/13</td>
</tr>
<tr>
<td>5</td>
<td>Cumulative Dose (mGy)</td>
<td>&lt;1000</td>
<td>61</td>
<td>1/13</td>
</tr>
<tr>
<td>6</td>
<td>Total DAP (mGy/cm²)</td>
<td>&lt;44</td>
<td>7</td>
<td>1/13</td>
</tr>
<tr>
<td>7</td>
<td>Effective Dose (mSv)</td>
<td>&lt;98.0</td>
<td>0.856</td>
<td>1/13</td>
</tr>
<tr>
<td>8</td>
<td>Operator’s Effective Dose (mSv)</td>
<td>&lt;0.3</td>
<td>0.009</td>
<td>1/13</td>
</tr>
<tr>
<td>9</td>
<td>Collimation Used (% of time)</td>
<td>&gt;95%</td>
<td>85%</td>
<td>0/13</td>
</tr>
<tr>
<td>10</td>
<td>SSD &lt; 45cm (% of time)</td>
<td>&lt;5%</td>
<td>47%</td>
<td>0/13</td>
</tr>
<tr>
<td>11</td>
<td>SID &gt; 90cm (% of time)</td>
<td>&lt;5%</td>
<td>99%</td>
<td>0/13</td>
</tr>
<tr>
<td>12</td>
<td>Magnification used (% of time)</td>
<td>&lt;15%</td>
<td>0%</td>
<td>1/13</td>
</tr>
<tr>
<td>13</td>
<td>Oblique projections used (% of time)</td>
<td>&lt;30%</td>
<td>15%</td>
<td>1/13</td>
</tr>
</tbody>
</table>

**Total Score**: 77%

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Radiation Safety package

- Realistic and safe radiation safety training
- Hands-on training to newly-hired or current staff
- Hospital credentialing and privileging
- Skill center radiation training for nurses and techs
- Implementing an effective radiation safety program
Procedure Training Objectives

- Balancing between dose and image quality – ALARA
- Understanding deterministic and stochastic effects
- Understanding when and why high doses occur
- Adjusting table and detector height for optimal exposure
- Use of LIH, pulse rate and dose level to limit fluoroscopy dose
- Cine and DSA, frame rate and fluoro store
- Magnification, collimation, wedge filters, and virtual guidance
Procedure Training Objectives

- Reducing dose for steep angulation or large patients
- Varying beam angle and keeping extremities out of the beam
- Staff positions relative to direct beam and scatter
- Benefits of using protective wear and shielding
- Lowering dose throughout the case, not just after a notification
Summary

- Medical Simulation is an integral part of training personnel in the interventional suite
  - State of the art endovascular simulators allow training in complex interventions without staff radiation exposure
  - Effective and safe procedure performance saves exposure

- Virtual and augmented reality will become an indispensable tool in medical simulation and training [4]

- Simulation training is an **effective tool for creating safe environment and prevention of unnecessary patient and staff exposure**
REFERENCES


