Radiation Exposure, Reduction Techniques, & Standardization of Swallow Study Evaluations

Mason A. Brown, MD, Shelly Reimer, MD, Leah Presper, Theresa Ackerman, and William MacDonald, MD
Aurora St. Luke's Medical Center, Department of Radiology, Department of Speech Pathology, Milwaukee, WI

INTRODUCTION

- **Swallow Study Evaluation – Fluoroscopic Procedure**
  - Most frequent fluoroscopic procedure performed in radiology department
  - Patient drinks contrast while being assessed under real-time X-ray
  - Required a Team: (1) Radiology resident who controls the radiation; (2) Fluoroscopy technician who controls the positioning of the X-ray machine; and (3) a speech pathologist who administers the contrast

- **Long-term exposure** to ionizing radiation from fluoroscopic procedures can lead to side effects
  - Standardization of lead aprons and thyroid shields
  - However the eyes are currently the most at-risk organ

- **No literature** on residents’ cumulative radiation exposure over the course of training
  - Badge-dosimeter is inconsistent and thus unreliable

- **Personal protective equipment** recommended by Occupational Safety and Health Administration (OSHA)
  - Lead aprons/vests, thyroid shields, lead gloves, and safety goggles

PURPOSE

To retrospectively establish a fluoroscopic radiation exposure baseline and monitor prospective reduction techniques.

METHODS

- **Interventions**
  - Replaced/Provided personal protective equipment per OSHA guidelines to all medical personnel involved in swallow study evaluations (eg, new leaded glove for speech pathology; radiation safety goggles for the fluoroscopy technicians)
  - Developed a standardized swallow study evaluation flowchart in conjunction with the speech pathology department
    - Barium contrast is the agent of choice as its effects (if aspirated) are lesser than other contrast agents, (eg, gastrografin)
    - Patients trial different consistencies of thin liquids, honey-thick liquids, puree, barium pill, and crackers in order to evaluate risk of laryngeal penetration or aspiration
    - Aspiration increases the risk of developing pneumonia

- **Data Analysis**
  - Baseline: Swallow studies performed by 1 resident during Oct 2018 & Feb 2019
  - Midpoint: Completion of Clinical Learning Environment Quick Survey (CLEQS) to evaluate teamwork and at midpoint
  - Post Intervention: Swallow study evaluations performed by same resident in Sept 2020 + CLEQS

RETROSPECTIVE AND PROSPECTIVE RESULTS

- **Swallow Study Flowchart**

<table>
<thead>
<tr>
<th>Patient Radiation Exposure</th>
<th>Prior to Implementations</th>
<th>After Implementations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (minutes)</td>
<td>Radiation (mGy)</td>
</tr>
<tr>
<td>Average</td>
<td>1.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Median</td>
<td>1.8</td>
<td>7.2</td>
</tr>
<tr>
<td>Range</td>
<td>0.3 – 4.3</td>
<td>1.5 – 24.3</td>
</tr>
</tbody>
</table>

- **Resident Radiation Exposure**

<table>
<thead>
<tr>
<th>Extrapolated Exposure per 4-week Rotation</th>
<th>Time (minutes)</th>
<th>Radiation (mGy)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>183.7</td>
<td>21.2</td>
</tr>
<tr>
<td>Median</td>
<td>174 ↓</td>
<td>22.3 ↑</td>
</tr>
</tbody>
</table>

- **MEASURES/METRICS**
  - **Absorbed Dose**: Ionizing radiation absorbed per unit mass, measured in Grays (Gy)
    - X-ray machine records patient radiation exposure into patient’s chart
    - Due to a variety of complications, badge-type dosimeter readings were unable to be utilized for comparison in this study
  - Extrapolated radiation exposure was calculated using the inverse square law (Intensity = 1/distance²)
    - Patients seated approx 0.5 meters from the C-arm emitter
    - Residents were stationed approx 3 meters from the C-arm emitter

- **Clinical Learning Environment Quality Survey (CLEQS)**

<table>
<thead>
<tr>
<th>Radiology</th>
<th>Supported by Team/unit %SDA - 5 SA</th>
<th>Treated on each %SDA, including %SA - 5 SA</th>
<th>IP Teams Work Collaboratively, Collaborative DB</th>
<th>CLEQS Enabling Resources, Assigned &amp; Available %SDA - 5 SA</th>
<th>Access to Info, Ressources Equip %SDA - 5 SA</th>
<th>Team &amp; my Roles &amp; Expectations - Clear %SDA - 5 SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Midpoint</td>
<td>18</td>
<td>4.0</td>
<td>4.1</td>
<td>3.7</td>
<td>4.3</td>
<td>4.0</td>
</tr>
<tr>
<td>Post</td>
<td>17</td>
<td>4.2</td>
<td>4.3</td>
<td>3.8</td>
<td>4.4</td>
<td>4.2</td>
</tr>
<tr>
<td>Δ</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

- **REFERENCES**
  1. Mooney et al. Absorbed dose and deterministic effects to patients from interventional neuroradiology. British Journal of Radiology. 10.1259/bjr.73.871.11089467JO.

Key Findings

- Implementing a standardized swallow study flowchart did not have a significant effect on decreasing fluoroscopy time or care team member radiation exposure
- Providing fluoroscopic technologists with radiation safety goggles in addition to individually and directly promoting radiation safety awareness did not increase goggle usage, and thus, radiation exposure to their eyes did not significantly change
- Radiation dosimetry badges were unreliable (eg, responsible department not collecting/recording data, technologists wearing resident leads without changing the badges, incorrect monthly badge updates/turn-ins)

Limitations

- Speech pathology perceived Swallow Study Flowchart as an over-simplified restraint instead of as an efficiency tool
- Limited use of radiation safety goggles due to COVID PPE (face shields)
- Radiation exposure side effects occur long-term; safety ignored

DISCUSSION

- **Next Steps and Sustainability**
  - Improve badge-dosimetry reporting and documentation
  - Continue to encourage proper use of radiation safety equipment

REFERENCES