Objectives

- Explain radiation dose terminology
- Recognize 2D and 3D dose values
- Explain exposure and whole body dose
  - MQSA regulations
  - Radiation safety
- State the clinical benefits of Combo mode acquisition

Explanation of Radiation Dose Terminology

- ACR Phantom Dose
  - Regulatory dose limits are based on phantom dose - Mammography Quality Standards Act (MQSA)
- Patient Breast Dose
  - Dose calculated for each clinical image
- Effective Dose
  - Organ dose normalized to whole body exposure
  - Allows one to compare risks due to radiation

Radiation Dose

Dose (50/50 4.5 cm breast)
- MQSA = 3 mGy
- 2D~ 1.2 mGy (Tungsten Tube)
- 3D~1.45 mGy
- Combo ~2.65 mGy
- Selenia FFDM ~1.6 mGy (Molybdenum Tube)
- Screen/Film (ACRIN ~2.0 mGy average)

American College of Radiology Phantom Dose: Single Exposure

Comparison of Cumulative Whole Body Doses
Radiation Dose Specification: Equivalent Dose (EqD)
• A radiation quantity used for radiation protection purposes when a person receives exposure from various types of ionizing radiation
• Attempts to numerically specify the differences in biologic harm that are produced by different types of radiation
• Enables the calculation of the effective dose (EfD)
• The SI unit of EqD is the sievert (Sv)
  • In the traditional system, the corresponding unit is the rem
  • 1 sievert equals 100 rem

Keeping Occupational Radiation Exposure Below a Tolerance Level
• Concept of Tolerance Dose (threshold dose)
  • Tolerance dose used for radiation protection purposes in 1930s
  • U.S. Advisory Committee on X-Ray and Radium Protection is formed to formulate recommendations for radiation control
  • 0.2 roentgen is recommended as a tolerance daily dose limit in 1934
  • 0.1 roentgen is recommended as a tolerance daily dose limit in 1936

The Modern Era of Radiation Protection
• Tolerance dose replaced by maximum permissible dose (MPD) in early 1950s
• Dose limits were calculated and established in the 1970s to ensure that the risk from radiation exposure acquired on the job did not exceed risks encountered in "safe" occupations
• ICRU adopted SI units for use with ionizing radiation in 1980
• NCRP adopted SI units for use
• ICRP adopted the term effective dose in 1991

Differences in Radiation Exposure from 1980 to 1982 and Data from 2006
• In NCRP Report No. 93, medical radiation was estimated to contribute 0.54 mSv to man-made background radiation.
• In 2006, that number had increased to 3.0 mSv, an increase of more than a factor of 5.
• Medical use now makes up 48% of total background radiation.
  • The main reason for the increase is increased usage of CT.
  • With the advent of multislice spiral CT, the utility of this imaging modality in areas such as emergency medicine has increased dramatically.
  • In 1980, use of CT resulted in a collective dose of 3700 person-sieverts.
  • In 2006, that number rose to 440,000 person-sieverts according to NCRP Report No. 160.
Radiation Dose: 2D plus 3D Tomosynthesis

- The additional effective dose of 3D tomosynthesis is equivalent to about 2 months of annual natural background radiation in the United States.
- This is less than natural variations in background radiation.
- Risk from these levels of radiation is low.
- For example, breast cancer incidence is lower in Colorado versus the average US, even though natural background radiation is higher.

Summary of Radiation Dose: 2D plus 3D Tomosynthesis

- Additional effective dose of 3D is equivalent to about 2 months of annual natural background radiation in the United States.
- ACR Phantom Dose for both 2D and 3D combined is less than the FDA MQSA regulatory limit for a single 2D exposure.

Background Radiation

- Radioactivity is present throughout the whole universe with radiation dose varying depending where you live.
- In the United States the dose of natural radiation can vary anywhere between 100 mrem to 1000 mrem per year depending on geographical regions.

Name some other man-made elements

- Potassium
- Smoke detectors
- Bricks and granite
- Fossil fuels (Coal, Oil, Natural Gas)
- Fertilizers
- Televisions

2D + 3D Tomosynthesis (Combo Mode) and Dose putting it in perspective

FDA panel of experts voting, unanimously agreed the benefits of combo mode imaging outweigh the risks.
Recent News........

- FDA panel gives nod to 2D synthetic mode for Hologic breast tomo
- By Kate Madden Yee, AuntMinnie.com staff writer.

October 25, 2012 — A U.S. Food and Drug Administration (FDA) panel voted 9 to 1 on October 24 to recommend approval for a new imaging mode on the Selenia Dimensions 3D digital breast tomosynthesis (DBT) system from Hologic that creates synthesized 2D images from 3D data.

- The recommendation specifically addresses the use of synthesized 2D images generated by Hologic’s C-View software module in place of traditional 2D images when used in conjunction with 3D mammography, Hologic said. C-View is designed to enable tomosynthesis to produce 2D mammography images without the higher radiation dose typically involved in combined 2D/3D studies.

- Since winning FDA approval in 2011, tomosynthesis has been promoted as a technology that could improve breast screening by collecting a range of data slices acquired as the mammography system’s tube head pans around the breast. These slices are typically reconstructed into dynamic 3D volumes that enable radiologists to see around superimposed tissue in the breast.

<table>
<thead>
<tr>
<th>Screening Breast Tomosynthesis (Bilateral)</th>
<th>Code</th>
<th>Global</th>
<th>Professional</th>
<th>Hospital</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>60911 - Iowaing Digital Tomosynthesis</td>
<td>7.77</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>71322 - Screening Breast Tomosynthesis</td>
<td>1.35</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnostics Breast Tomosynthesis Unilateral</th>
<th>Code</th>
<th>Global</th>
<th>Professional</th>
<th>Hospital</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>60921 - Digital Diagnostic Tomosynthesis</td>
<td>7.24</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>71323 - Diagnostic Breast Tomosynthesis</td>
<td>1.28</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnostics Breast Tomosynthesis Bilateral</th>
<th>Code</th>
<th>Global</th>
<th>Professional</th>
<th>Hospital</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>60921 - Digital Diagnostic Tomosynthesis</td>
<td>7.24</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td></td>
</tr>
<tr>
<td>71323 - Diagnostic Breast Tomosynthesis</td>
<td>1.28</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Preventive Breast Detection (CAB)</th>
<th>Code</th>
<th>Global</th>
<th>Professional</th>
<th>Hospital</th>
<th>Technical</th>
</tr>
</thead>
<tbody>
<tr>
<td>77992 - CAB Diagnostic mammography</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>77993 - CAB screening mammography</td>
<td>0.25</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>