CDC’s need for reference materials to validate analytical methods for Public Health exposure assessments after a radiological or nuclear incident

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After a Radiological Incident, Public Health Officials Will Need to Answer the following:

- **What** are people exposed to or contaminated with
- **Who** was exposed
- **How much** exposure or contamination did each person have

The decision to medically treat people will depend on our ability to rapidly and accurately identify and quantify internal contamination
• **Biodosimetry**: Use of clinical and laboratory observations to estimate radiation dose received after radiation exposure. (HHS/BARDA method R&D) *Most effective for estimating injury due to irradiation [shine] (IND, RED or NPP).*

• **Bioassay**: Any procedure used to determine the nature, location or retention of radionuclides in the body (contamination) by direct (*in vivo*) measurement or by indirect (*in vitro*) analysis of material excreted or otherwise removed from the body (CDC methods). Generally used for the purpose of estimating intake and committed dose. *Most effective for estimating injury due to inhalation or ingestion after a RDD, IND or NPP fallout.*
The Boston Marathon

What if,

It had been an RDD

(“Dirty Bomb”)?
Deposition Patterns

Without buildings

With buildings

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Deposition Patterns

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Deposition Patterns in 3D

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Assessment: Epidemiology

- Epidemiologic activities
  - Epidemiologic investigation (e.g., Litvinenko)
    - Identify scope of event
    - Identify persons affected
  - Assess radiation hazard to affected persons
Assessment: External Monitoring

- **External screening**
  - Uses portable survey meters, portal screening
  - Guides decontamination
  - Responsible entity: State/local agencies

- **CDC capabilities**
  - Guidance developed for state, local programs
  - Very limited CDC capacity to assist/support
Rapid Response: Epidemiologic, Laboratory and Health Physics or Toxicology Coordination

300,000 People

EPI Prioritization

100,000 Samples

Lab Screening

1,000 Samples

Return Results for Medical Management

Flag/Evaluate High/Elevated Results

Dose Calculation Program

ID & Quantitative analysis
# Bioassay: Key Issue

## Detection of Internal Contamination

<table>
<thead>
<tr>
<th>Radionuclides</th>
<th>Urine bioassay detection</th>
<th>Primary radiation detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium ($^{235}$U, $^{238}$U), Thorium</td>
<td>yes</td>
<td>alpha and beta</td>
</tr>
<tr>
<td>Strontium, Plutonium ($^{238}$Pu, $^{239}$Pu)</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Americium, Californium, Neptunium,</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Phosphorus, Curium, Polonium</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Cesium, Cobalt ($^{57}$Co, $^{60}$Co), Radium</td>
<td>yes</td>
<td>Gamma rays</td>
</tr>
<tr>
<td>Iodine ($^{125}$I, $^{131}$I), Technetium-99m</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Selenium, Molybdenum, Iridium</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>

Internal radiation screening via hand held detectors or portals is only applicable for gamma emitting radionuclides.

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Radionuclides of concern can be found at:  
www-pub.iaea.org/MTCD/publications/PDF/Pub1309_web.pdf  
www.energy.gov/media/RDDRPTF14MAYa.pdfc  
The “Grand Rounds” presentation and slides can be found at:  
www.cdc.gov/about/grand-rounds/archives/2010/03-March.htm
CDC's Urine Radionuclide Screen

Urine "Spot" Sample

- Gamma Radionuclide Screen
- Alpha/Beta Radionuclide Screen/Quantification
- Alpha (Long Lived) ICP-MS Screen

- Gamma Spectrometry Quantification
- Alpha Spectrometry Quantification
- Mass Spectroscopy Quantification
- High Resolution Mass Spectroscopy Quantification
SRM/CRM Uses at CDC

Some uses of SRMs and CRMs:

- Method Validation
- Daily QC Preparation or Validation
- CLIA Proficiency Testing (PT) Material Production or Validation (2 challenges per year at 5 levels)
- Calibration Verification (CLIA) Material Production or Validation (2 verifications per year with 5 levels across the calibration range)

QC, PT and Calibration Verification materials should be from different sources or production lots.

Non-SRMs or Non-CRMs should be traceable to a SRM or CRM.
SRM/CRM Levels for Bioassay: Selected examples

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>CDG Level (Adult) Bq/L</th>
<th>NIST SRM</th>
<th>NIST Level Bq/g</th>
<th>Total Bq/vial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sr-90</td>
<td>345,000</td>
<td>4239</td>
<td>32,000</td>
<td>160,000</td>
</tr>
<tr>
<td>Cs-137</td>
<td>Out of Stock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>885,000</td>
<td>4233E</td>
<td>300,000</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Ra-226</td>
<td>120</td>
<td>4967A</td>
<td>2,500</td>
<td>12,500</td>
</tr>
<tr>
<td>U- Total</td>
<td>18.0</td>
<td>3164</td>
<td>250</td>
<td>1,250</td>
</tr>
<tr>
<td>Pu-239</td>
<td>110</td>
<td>4330C</td>
<td>40</td>
<td>120</td>
</tr>
<tr>
<td>Am-241</td>
<td>115</td>
<td>4322C</td>
<td>100</td>
<td>500</td>
</tr>
</tbody>
</table>

CDG = NCRP Clinical Decision Guide
SRM/CRM Needs at CDC

- P-32
- Se-75 (Out of stock)
- Mo-99 (Out of stock)
- I-125 (Out of stock)
- I-131 (Out of stock)
- Cs-137 (Out of stock)
- Ir-192
- Po-210
- Cf-252
Radiological Event Impact

• Loss of life, mainly from blast
• Potential future cancer risk
• Psychosocial issues
• Economic impact, including area denial (due to contamination)
• Increased anxiety among citizens
Summary

• Radiation Laboratory Methods (bioassay): Require SRMs or CRMs for validated methods

• Radiation Laboratory Methods (bioassay): rapidly identify and quantify specific radionuclides in people potentially contaminated in a radiological or nuclear event.

• Provides critical information for effective medical management of individuals by assessing risk for medical management and follow-up

• Provides information for population monitoring (populations and population sub-groups)

• Provides “negative” results for people who think that they may be contaminated, but, are not truly contaminated.
Questions and Discussions
Thank you!

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
Visit: www.cdc.gov | Contact CDC at: 1-800-CDC-INFO or www.cdc.gov/info

The findings and conclusions in this study are those of the authors and do not necessarily represent the views of the U.S. Department of Health and Human Services, or the U.S. Centers for Disease Control and Prevention. Use of trade names and commercial sources is for identification only and does not constitute endorsement by the U.S. Department of Health and Human Services, or the U.S. Centers for Disease Control and Prevention.
Backup

Slides
Examples of Mass Screening/Analysis

- 1987 Goiania – $^{137}$Cs - 112,000 tests
- 1995-1996 U.S. Methyl parathion – 16,000 tests
- 2001-2002 U.S. Anthrax (clinical) - 250,000 tests
- 2001-2002 U.S. Anthrax (environmental) – 1,000,000
- 2005 NV Mercury exposure – 280 tested
- 2006 London - $^{210}$Po - 800 tested
Concerned Citizen Multiplier

- 1987 Goiania – $^{137}\text{Cs}$ – 50 treated / 112,000 screened = 2240 “concerned citizen multiplier” (CCM)
- 1995-1996 U.S. Methyl parathion – 16,000 CCM
- 2001-2002 U.S. Anthrax (clinical) – 30 casualties or infected / 250,000 tests = 8,500 CCM
- 2005 NV Mercury exposure – 1 contaminated / 280 tested = 280 CCM
- 2006 London - $^{210}\text{Po}$ – 1 casualty / 800 tested = 800 CCM