Medical Exposure Studies

Amy Berrington de Gonzalez, Dphil (Oxon), Chief and Senior Investigator
Division of Cancer Epidemiology & Genetics,
Radiation and Epidemiology Branch
Multiple Fluoroscopies in TB Patients

4,940 TB patients (US cohort)

- 234 breast cancer cases

Repeated chest fluoroscopies

- Mean = 88 examinations
- Mean total dose = 0.8Gy

Boice et al (Radiat Res 1991); Howe and McLaughlin (Radiat Res 1996); Howe (Radiat Res 1995);
Multiple Spine X-rays in Scoliosis Patients

3,002 Scoliosis patients
- 78 breast cancer cases

Repeated spine X-rays
- Mean X-rays = 27
- Max X-rays = 332
- Mean dose = 120 mGy
- Max dose = 1110 mGy

Ronckers et al (CEBP 2008)
UK Pediatric CT scans cohort

178,000 exposed children
- 74 leukemias/MDS
- 135 brain tumors

300,000 pediatric CT scans
- 64% head CTs

Pearce, ..., Berrington de Gonzalez (Lancet 2012)
9 cohorts of childhood exposure

- 394 thyroid cancers
- 221 leukemias

Diagnostic/Therapeutic radiation

- Restricted to <200 or <100mGy

Lubin,…, Veiga (JCEM 2017); Little,…, Berrington (Lancet Haematology, 2018)
<table>
<thead>
<tr>
<th>Summary of Key Results from Past Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeated low-dose medical exposures related to increased cancer risk</td>
</tr>
<tr>
<td>Evidence of excess risks from cumulative doses &lt;100mGy for childhood leukemia &amp; thyroid cancer</td>
</tr>
<tr>
<td>Risk estimates for non-uniform exposures and children and women (not covered by occupational studies)</td>
</tr>
<tr>
<td>Risk estimates compatible with Life Span Study of A-bomb survivors</td>
</tr>
<tr>
<td>DDREF = 1 ?</td>
</tr>
</tbody>
</table>
Present
EPI-CT: 1 Million Children from 9 Countries

Expanded UK cohort + 8 countries
• UK 320k
• Netherlands 150k
• Sweden 120k
• 150+ leukemias
• 200+ brain tumors

CT scans from RIS/PACs
• 1.4m CTs (72% head CT)

Bernier et al (IJE 2019)
USA Kaiser Pediatric Imaging Case-Control Study

4 Kaiser HMOs
- 750 leukemias (estimated)
- Controls matched on age & time in health plan (exposure window)

Imaging data from PACs
- In utero & childhood exposures
Progress in Uses of Medical Radiation and Radiation Protection
Recent trends in CT scan use in the USA
International Trends in Diagnostic Imaging

Mettler et al (Radiology 2009)

Per 1000 popn/yr

- United States
- Well developed countries

CT scans
- 1991-96
- 1997-2007

Nuclear medicine
- 1991-96
- 1997-2007
## Reduction in Doses for Pediatric CT scans

<table>
<thead>
<tr>
<th>Organ</th>
<th>Head CT</th>
<th>Chest CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain</td>
<td>60mGy</td>
<td>30mGy</td>
</tr>
<tr>
<td>Lung/Breast</td>
<td>30mGy</td>
<td>5mGy</td>
</tr>
</tbody>
</table>

Lee...Berrington, Br J Radiology (2016)
Diagnostic medical radiation exposure continues to expand and evolve

Increasing low-dose exposure from modern radiotherapy (scatter dose)

Expansion of electronic medical records facilitates studies

Opportunities to study non-cancer outcomes from low-doses eg CVD & cataracts
### Summary of Epidemiological Considerations

| Study highly radiosensitive populations/outcomes to maximize power eg children/leukemia |
| Retrospective record linkage design for efficiency & to avoid recall bias |
| Long follow-up periods necessary given minimum latency of 5+ years (solid cancers) |
| Confounding by indication & reverse causation need careful evaluation |