

# **CT Scans and Cancer Risk:- Past, Present & Future Studies**

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# How Can Pediatric CT Scan Studies Contribute?

- Low dose range (1-100mGy)
- Fractionated exposures
- Children - radiosensitive population
- Exposures primarily to radiosensitive organs – red bone marrow and brain

# Pediatric CT Studies Overview

<b>Population</b>	<b>N exposed</b>	<b>Publications</b>	<b>Current Status</b>
<b>UK</b>	<b>180,000</b>	<b>Pearce et al (Lancet, 2012)</b>	<b>Additional data collection</b>
<b>Australia</b>	<b>680,000</b>	<b>Mathews et al (BMJ, 2013)</b>	<b>Individual dosimetry construction</b>
<b>EPI-CT</b>	<b>1 million</b>	<b>2017</b>	<b>Data collection &amp; dosimetry</b>
<b>Canada</b>	<b>350,000</b>	<b>2016</b>	<b>Data collection complete</b>

# UK Pediatric CT Study: Design

**PIs: Mark Pearce (Newcastle), Amy Berrington (NCI)**

**Collaborators: Mark Little, Choonsik Lee (NCI)**

**Record linkage , Retrospective Cohort, Internal Comparison**



**100+  
Radiology  
departments**

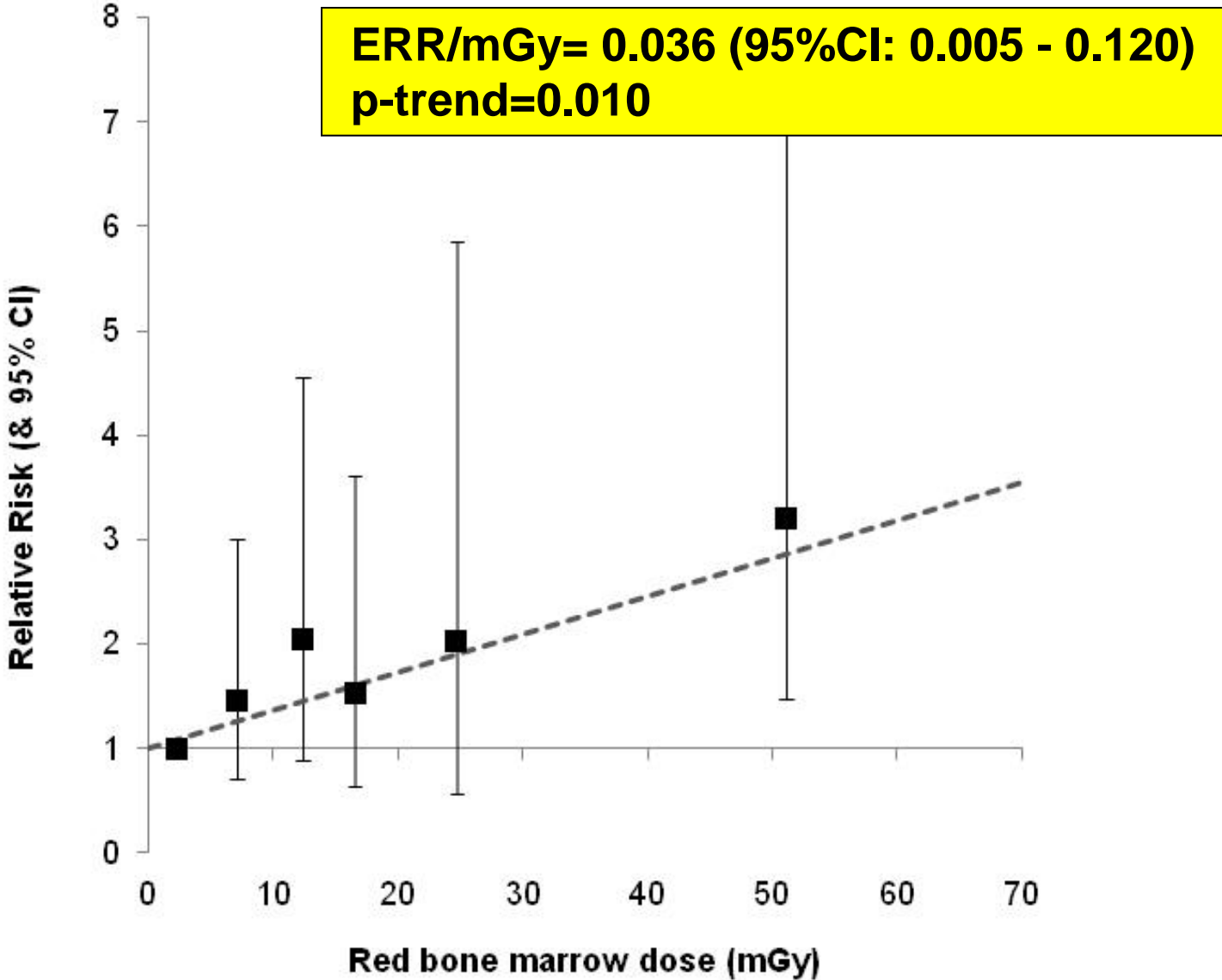


**CTs age 0-21 yrs  
1980-2003**

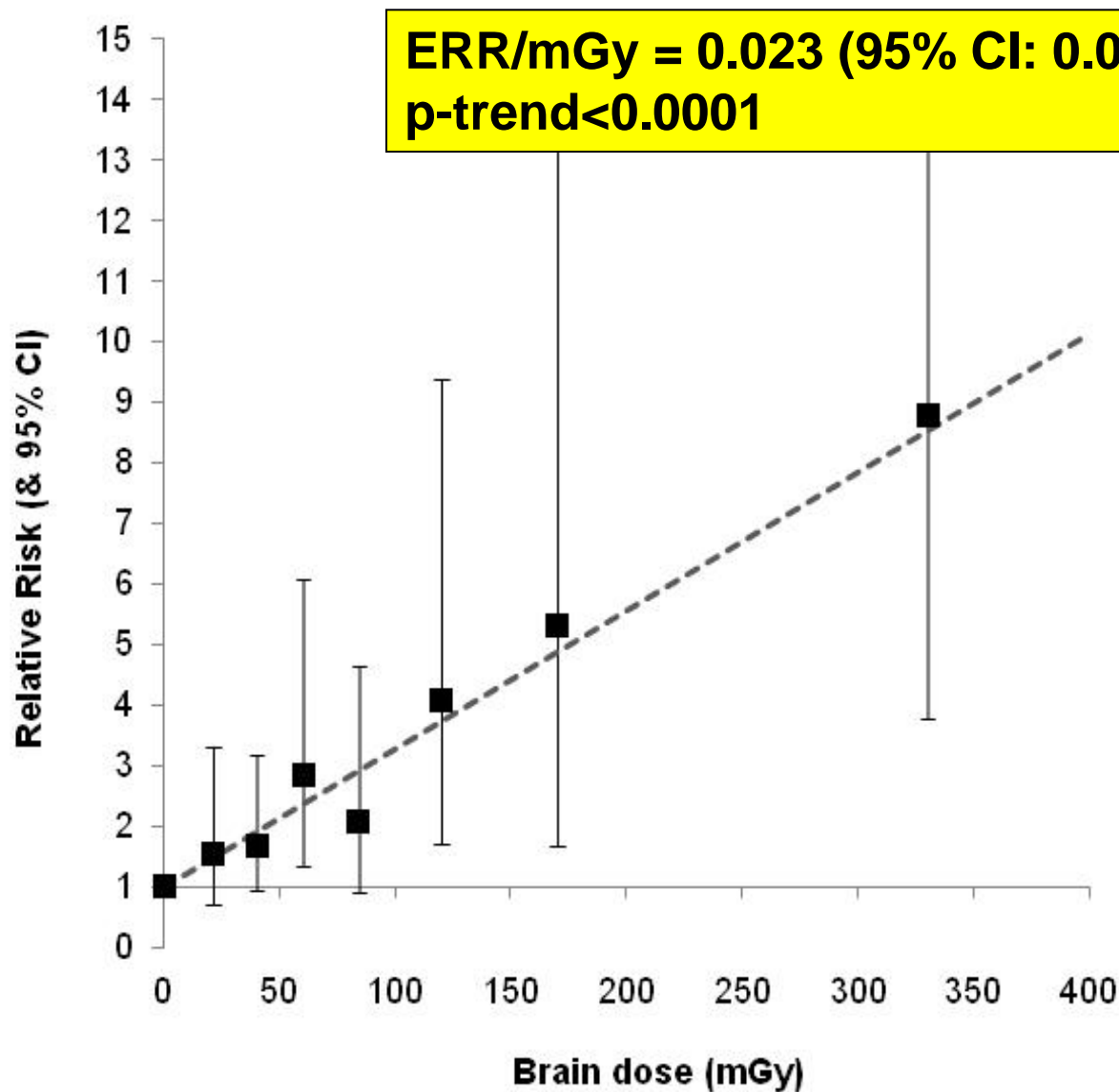


**Cancers &  
deaths <2009**

# Leukemia/MDS Risk & Red Bone Marrow Dose (n=74)



# Brain Tumors Risk & Brain Dose (n=135)

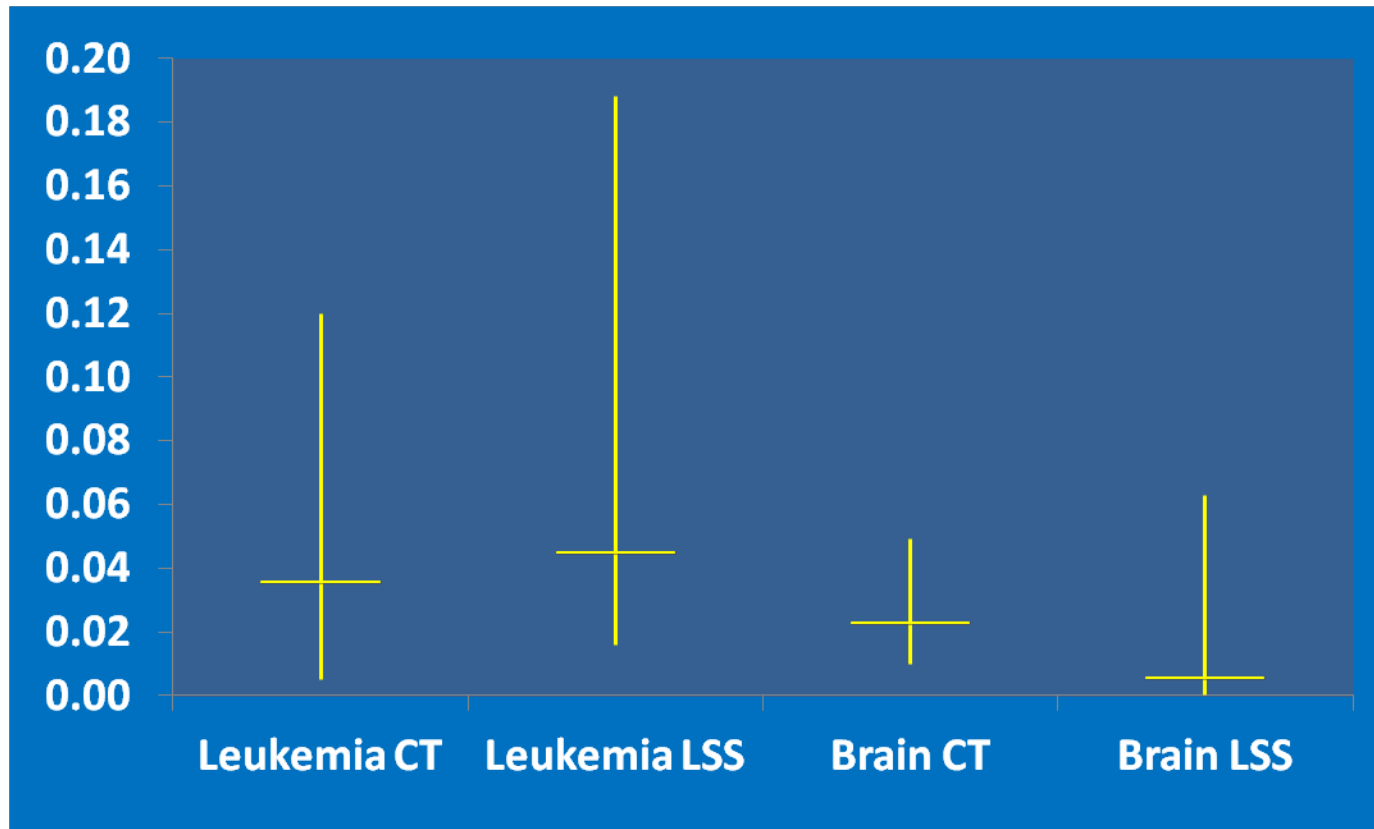


# Comparison with ERR/mGy from A-bomb Data

## Life Span Study

Single acute exposure ( $\gamma$  rays & small neutron dose)

Restricted to 0-21yrs at exposure & follow-up <15 yrs

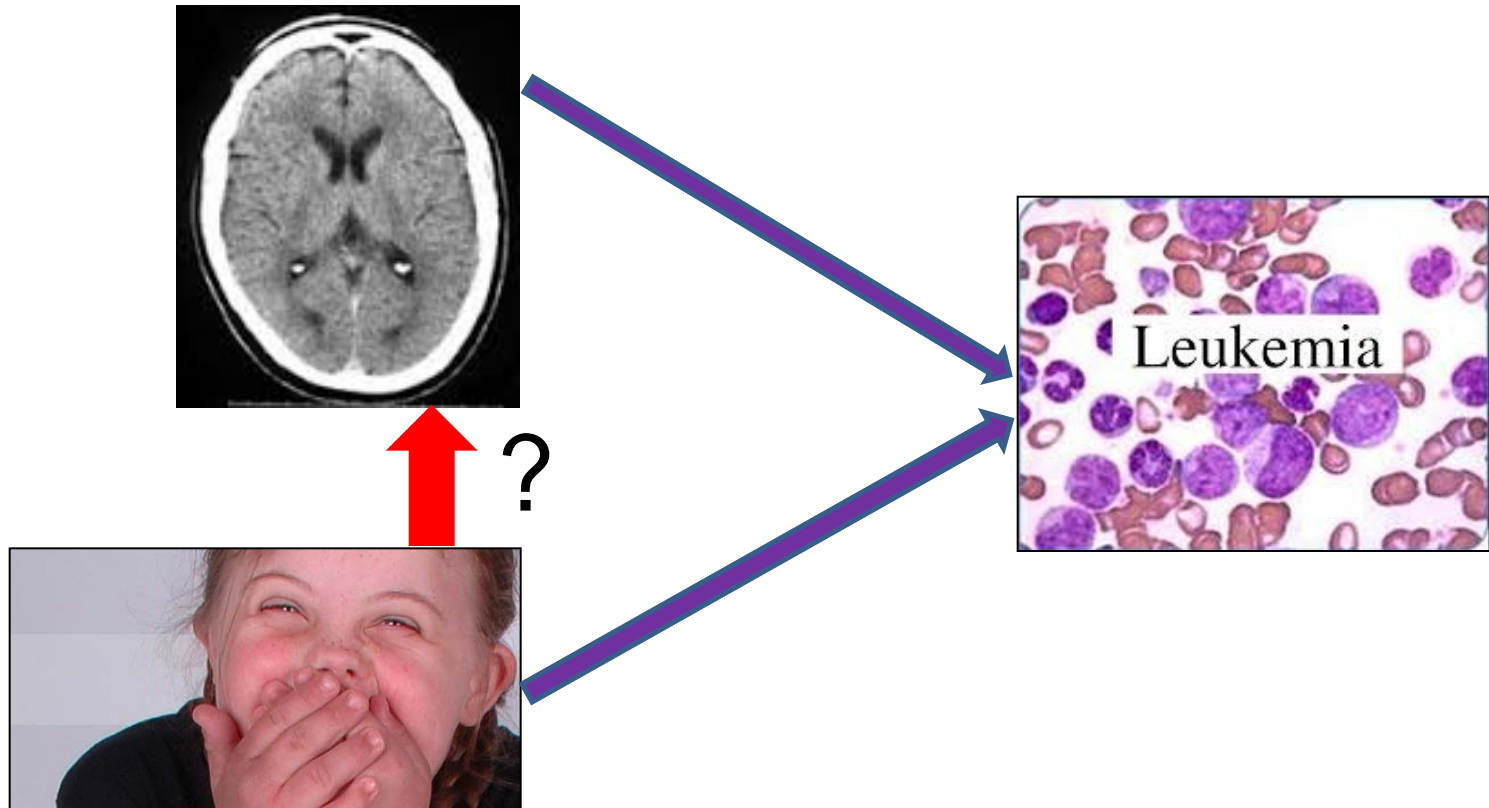


# **Potential Bias for Brain Tumors: Reverse Causation**



# Confounding by Indication

Underlying condition related to cancer & the condition related to CT scan frequency



# UK Assessment of Potential Biases: Results 2015

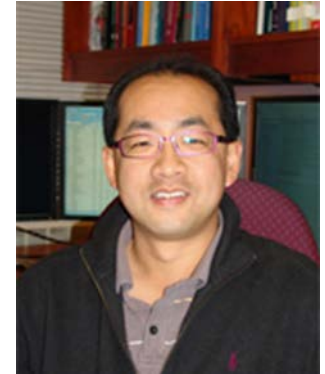


**Pathology  
reports**

**Radiologist's  
comments**

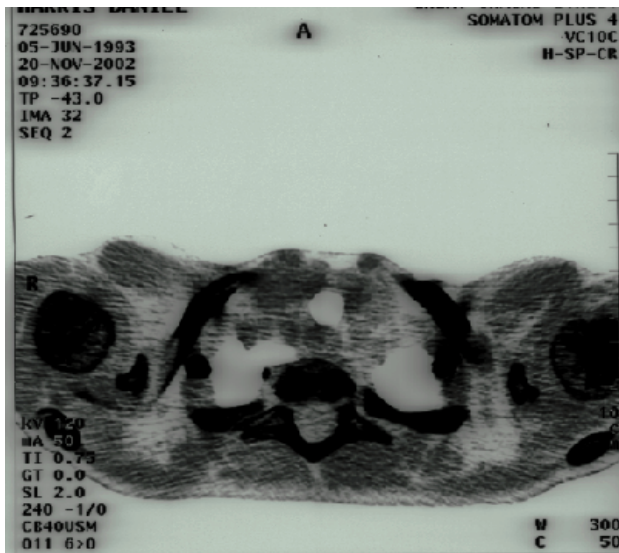
**Death  
certificates**

# UK: Dose Uncertainty Assessment 2015



## Patient-specific CT technique parameters

- Abstract 1000 films from hospitals
- Reconstruct doses using NCI-CT (Dr Lee, NCI)
- Incorporate into analyses with uncertainty



# Australian Pediatric CT Study

PI: Professor John Mathews (Melbourne)

Collaborators: Dr Zoe Brady, Sarah Darby (Oxford)

- 10.6 million unexposed and 680,000 exposed
- Number of CT scans, all cancers & site-specific
- RR=1.16 (1.13-1.19) per CT scan (1 year exclusion)
- **Dose reconstruction – expected publications 2015**
- Other exposures – publications 2015/16
- Potential biases – publications 2015

# European Study: EPI-CT

Ausra Kesimiene, Elisabeth Cardis, Mark Pearce,  
Michael Hauptmann, Isabelle Thierry-Chef

- 2011-16 EU grant
- 1 million children
- 9 countries
- **2000+ PACs data**
- Expanded UK cohort
- Results 2017



# **Canadian Pediatric CT Study**

**PI: Dr Vicki Kirsh (Cancer Care Ontario)**

**Collaborators: Amy Berrington, Choonsik Lee (NCI)**

- **350,000 Exposed Children**
- **Ontario state hospitals linked to cancer registration**
- **Follows UK CT model for dosimetry & analysis**
- **Some additional clinical data to incorporate**
- **Data collection completed – publication 2016**

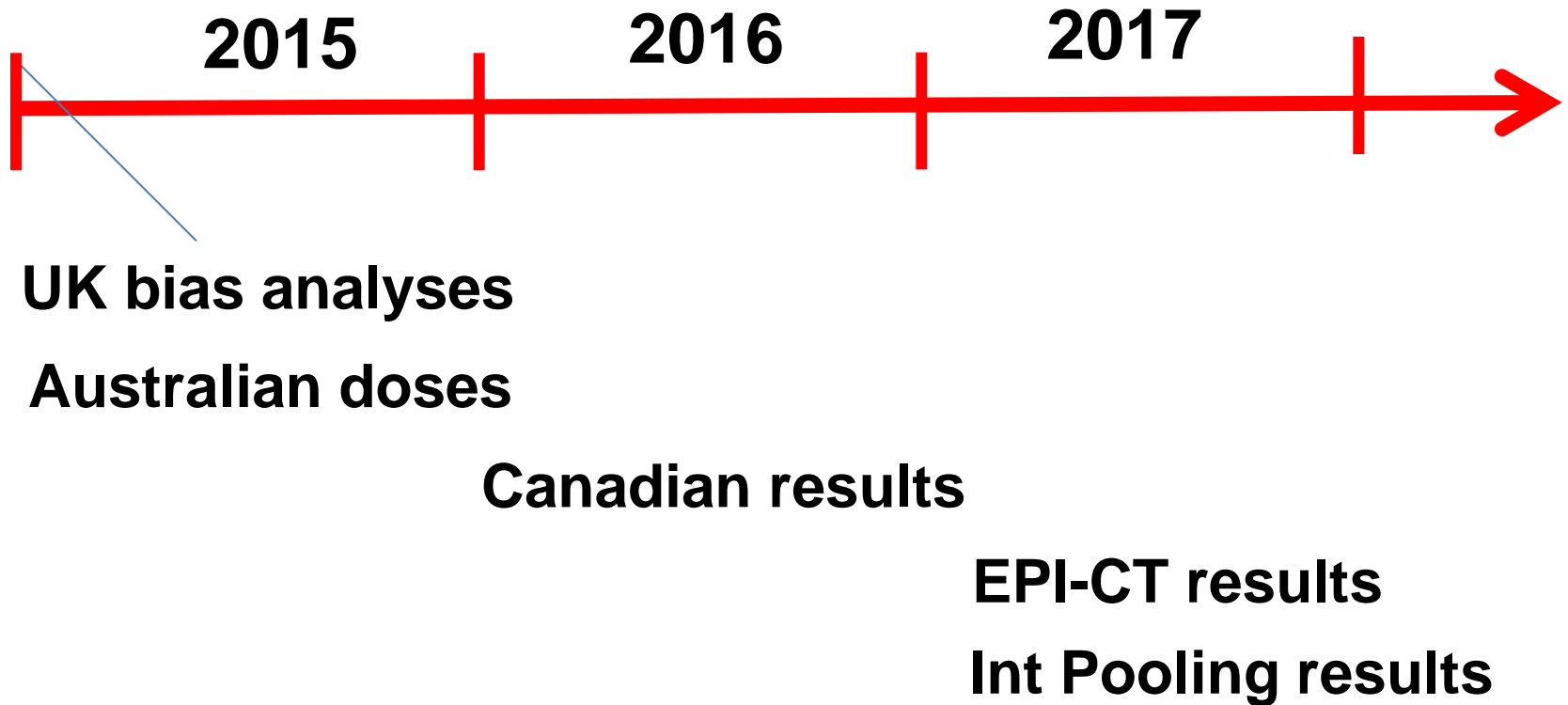
# International CT Pooling Project: 2017

- **Aims: Assess consistency, effect modification, tumor subtypes, breast & thyroid cancer**

<b>Study</b>	<b>Population</b>	<b>Leukemias</b>	<b>Brain tumors</b>	<b>Breast cancers</b>	<b>Thyroid cancers</b>
<b>Australia</b>	<b>544,000</b>	<b>200</b>	<b>226</b>	<b>116</b>	<b>207</b>
<b>Canada</b>	<b>350,000</b>	<b>249</b>	<b>454</b>	<b>111</b>	<b>94</b>
<b>UK</b>	<b>180,000</b>	<b>74</b>	<b>135</b>	<b>33</b>	<b>28</b>
<b>Israel</b>	<b>30,000</b>	<b>6</b>	<b>22</b>	<b>3</b>	<b>8</b>
<b>Total</b>	<b>1,104,000</b>	<b>529</b>	<b>837</b>	<b>263</b>	<b>337</b>

(Australia/Canada - estimated eligible case numbers)

# Timeline for Key Ongoing Studies





# Comments on Value of Pediatric CT

## Strengths

- Direct study of low-dose range (0-100mGy)
- Exposure based on medical records (no recall bias)
- Childhood exposure and risk of leukemia & brain tumors, possibly thyroid and breast cancer
- Dose-response relationships

## Limitations

- Potential biases need further evaluation – but shouldn't be generalized across cancer types
- Highly individualized dosimetry challenging (100k+ patients)
- Generalizability to adulthood exposure uncertain

# Other Diagnostic Exposure Cohorts

- **Ronckers et al (CEBP 2008) Scoliosis cohort**
  - Breast cancer dose-response ( $p=0.06$ ) with X-ray dose (mean 120mGy)
- **Rajaraman et al (BMJ 2011) UK Childhood Cancer Study**
  - Increased risk (non-significant) of all cancers and leukemia from *in utero* exposures
- **Australian CT study will examine other exposures**
  - Nuclear medicine publication 2015
- **Congenital heart disease & fluoroscopy**
  - France, UK, Canada & Denmark studies in progress