Iatrogenic Radiation Exposure to Patients With Early Onset Spine and Chest Wall Deformities

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Investigation Performed at Seattle Children's Hospital

Disclosures

- Kit Song   - None
- Derek Khoursand   - None
- Adam Alesio   - None
- Jonathan Swanson   - None
- Greg Redding   - Synthes speaker
- John Waldhausen   - None

Early Onset Spine and Chest Wall Deformities

- Intense assessment of structure

- Surrogates for respiratory function

- Structural interventions assessed by imaging
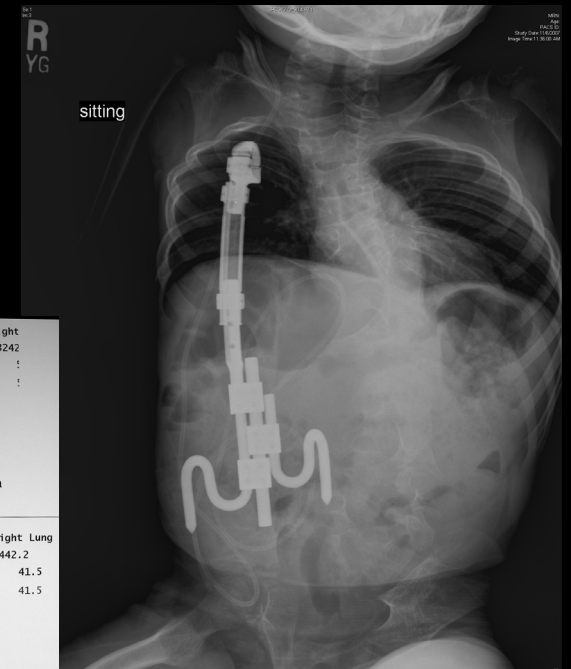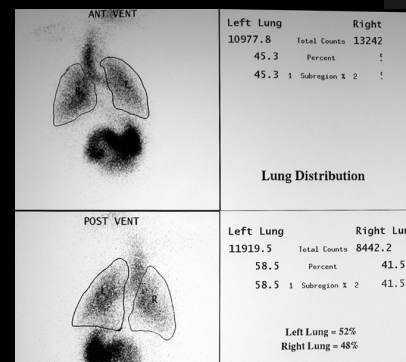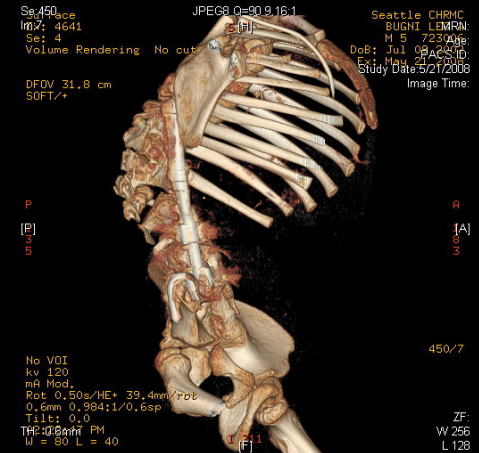
Aims

- What is effective dose radiation exposure to children undergoing evaluation and treatment?

- What contributes highest exposure?

- Understand where opportunities exist to decrease risk

Methods

- Retrospective cohort series
- All treated children
- Review of all xrays, CT scans, nuclear medicine, MRI, Fluoroscopy

Methods

Typical care - epochs of treatment

- **Initial evaluation** through primary surgery
  - » Serial xrays
  - » Chest CT
  - » V/Q scan
  - » MRI
- **At surgery** – spot fluoro
- **Follow up** – postop through next surgery
  - » Serial xrays (1 month postop, preop)
  - » Chest CT – V/Q Q 2 years if anbl.

Methods

- Radiation exposure – effective dose
- Xrays – reference values to each x-ray
  - » CXR: AP 0.08 mSv, LAT 0.6 mSv
  - » Spine XR: PA 0.1 mSv, LAT 0.15 mSv
  - » Pelvis XR:
- Fluoroscopy – direct calculation of dose area product (DAP) X 0.2mSv per Gy/cm^2 =

Methods

- **CT scans**
  - » Post 2007 – Direct exposure calculation (Allesio and Phillips):
    - – Dose length product (DLP)
    - – Kilovoltage peak (KVP)
    - – Phantom
    - – Age at time of study
  - » Pre 2007 scans – average of post 2007 scans
    - – Spine, chest, pelvis
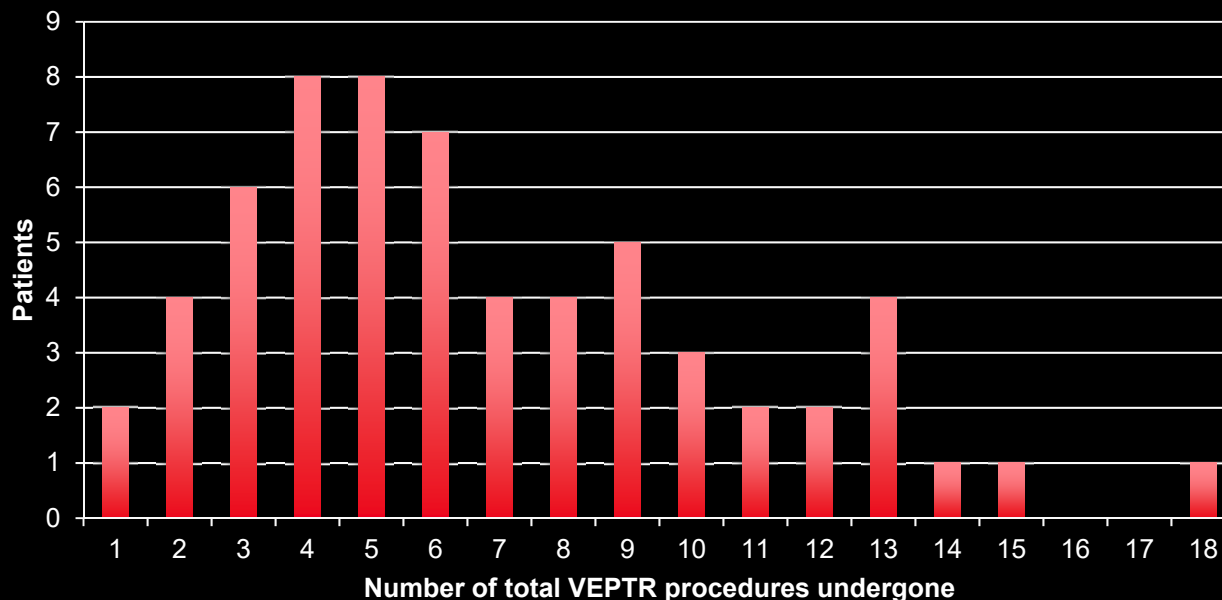- **Nuclear medicine scans** – direct calculation

Results

- 75 children 2001-2011
- Excluded:
    » Malignant tumor reconstruction (6)
    » Primary treatment at another center (6)
    » Primary surgeon other than senior author (1)

Results

- 62 children - 447 procedures
- Mean age at initial implant
  - » Male 5 years, Female 6.9 years
- 9 fusion after avg 10.2 procedures
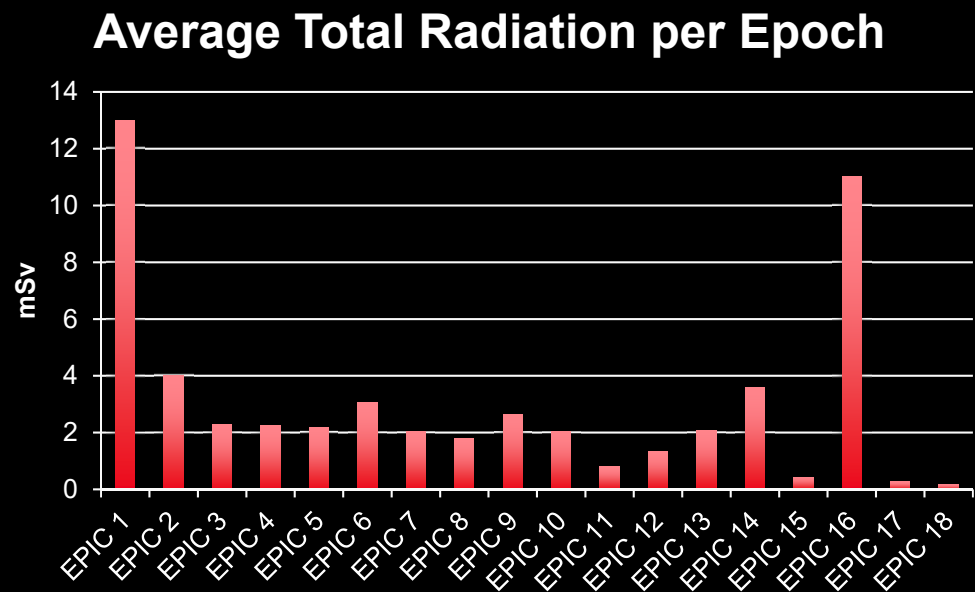
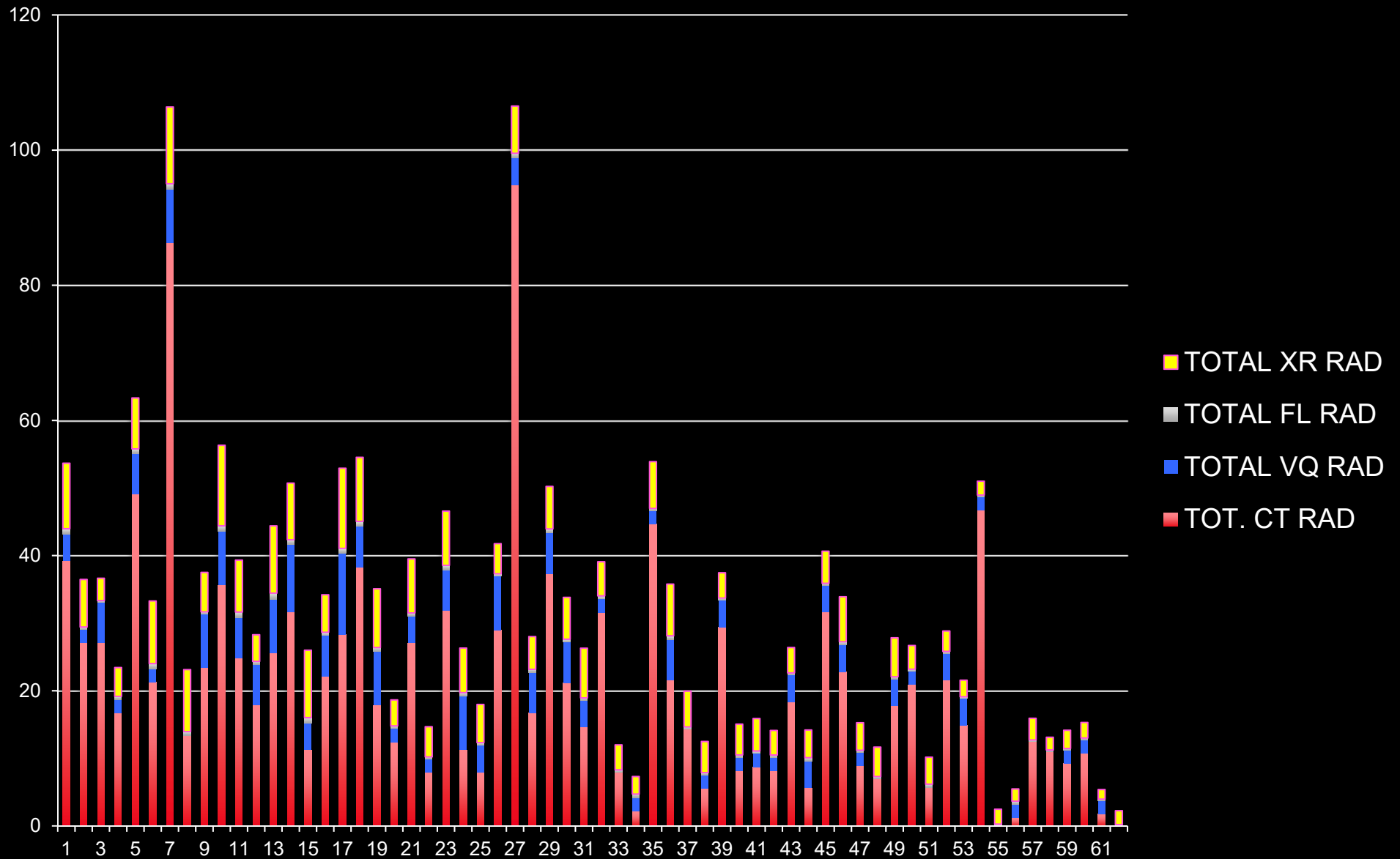**Patient surgery completion**

Results

- CT scans – 290
  - » 9 graduates – avg 6.8 CT/Pt (4-12)
- Xrays – 4293
- MRI scans – 147
- V/Q scans - 134

Results

- Avg total effective dose through initial implant
  - » 13 mSv (0.8 – 34.1)
- Avg effective dose/epoch for subsequent treatments
  - » 2.47 mSv (0.2- 11)

Average Total Radiation per Epoch

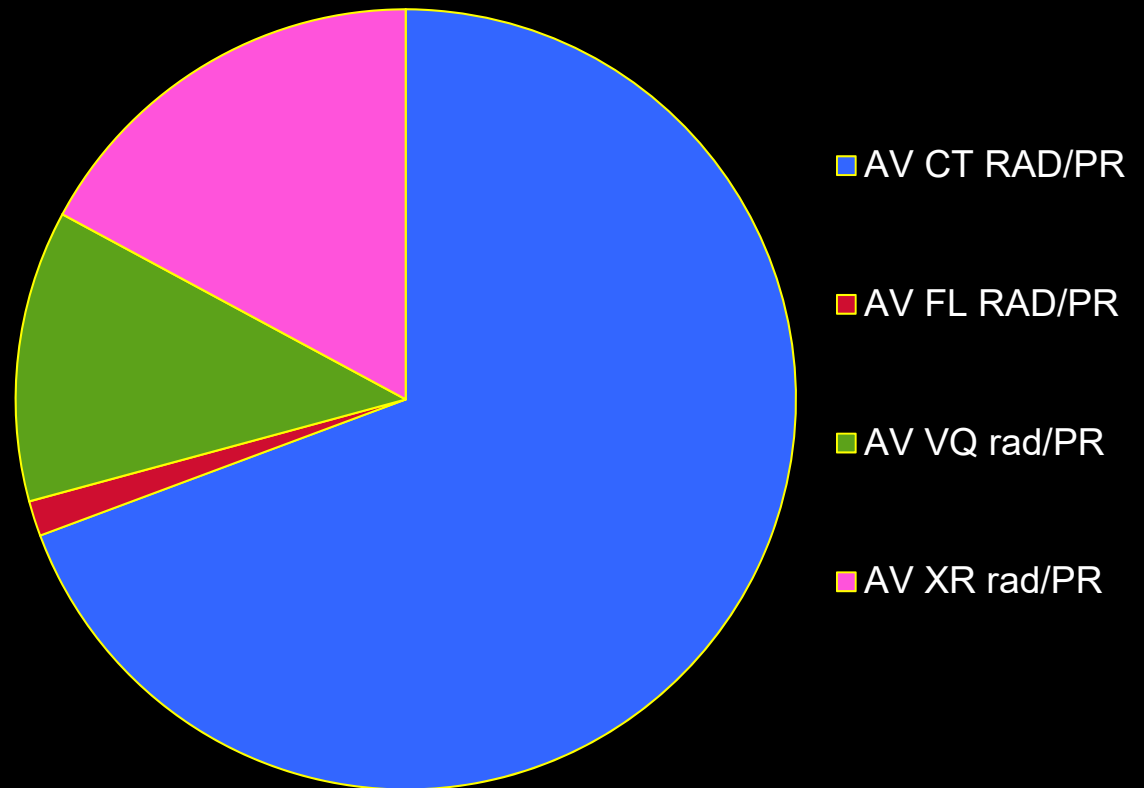# Results

Results

Relative contribution

- CT: 69%
  - » Spine 7.9 mSv
  - » Chest 3.34 mSv
  - » Pelvis 2.3 mSv
- X-ray: 17%
- Nuc Med: 12%
- Fluoro: 1%

- AV CT RAD/PR
- AV FL RAD/PR
- AV VQ rad/PR
- AV XR rad/PR

Radiation Exposure

- Inexact science

- Dose quantities and dose units
  - » Entrance surface dose   mGy
  - » Entrance dose   mGy
  - » Dose area product mGy/cm^2
  - » Effective dose   mSv

- **Effective dose** = weighted equivalent doses in all tissues and organs
  - » Best measure to infer radiation risk
  - » Calculated

BEIR VII 2006

HEALTH RISKS
FROM EXPOSURE TO
LOW LEVELS OF
IONIZING
RADIATION

BEIR VII PHASE 2

Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation

Board on Radiation Effects Research
Division on Earth and Life Studies

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- Background natural radiation 3-5 mSv / year
- Atlantic flight 0.1 mSv
- Atomic bomb surv 200 mSv
- Allowable limit to radiation workers 50 mSv/year

- Total body exposure
- Lifetime attributable risk cancer: 1.3%/100 mSv
- Lifetime attributable risk cancer mortality: 0.5%/100 mSv

Summary

- Great concern to families
- Radiation exposures of 30-40 mSv
    - » Prior to surgery – 13 mSV;
    - » Subsequent epochs - 2.5 mSv
- Highest effective doses in children < 15 years; increases as child size decreases
- CT 70% of exposure
    - » Spine > Chest > Pelvis

Summary

- Strategies to reduce dose
  - » Structure function correlates – what do we need to measure?
  - » Optimal methods for assessing respiratory function
    - – Avoid radiograph surrogates
    - – Direct measures of function
  - » CT strategies