Maine Medical Center
Department of Emergency Medicine

Journal Club / Research Article Summary - (Adapted from Schultz Table)

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ARTICLE:
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PURPOSE:
• Research Aims:
  • Estimate how much radiation exposure is associated with the types of CT examinations performed most commonly in the United States
  • To estimate variation across study types, patients, and institutions
  • Estimate the lifetime attributable risk (LAR) of cancer associated with CT

DESIGN:
• Study Design:
  • Prospective cohort study
    • 4 Institutions in San Francisco Bay Area, all using CT scanners from same manufacturer
    • Most common 11 types of CT examinations selected based on all CT scans performed in March 2008 at UCSF (each comprising >1% of total scans performed, total comprising ~80% of all scans performed)
  • Dependent / outcome Variable(s):
    • Radiation exposure with most common types of CT examinations in US
    • Lifetime attributable risk (LAR) of cancer associated with CT scans
  • Independent / research Variable:
    • Type of scan (body region)
    • “Effective dose” of radiation
    • Where scan was performed

SETTING / SUBJECTS:
• Research Setting:
  • 4 San Francisco Bay Area hospitals
    • UCSF: 600-bed academic hospital
    • Alta Bates Summit Medical Center: 555-bed private, community
    • Marin General Hospital: 235-bed acute care hospital
    • California Pacific Medical Center: 1300 bed private, community
• Subjects:
  • Study population: 1119 patients receiving CT scans at one of the 4 participating
San Francisco Bay Area hospitals aged 18 and older

- **Inclusion / Exclusion criteria:**
  - Excluded CT examinations performed in conjunction with therapeutic procedure
  - Included 20 to 30 consecutive patients 18 yo and older from each of the 4 institutions for each study type between Jan 1, 2008 and May 31, 2008

- **Demographics:** Older than 18 years old

**METHODS:**

- **Interventions:** CT scan

- **Study Groups:**
  - Head and Neck: routine head, routine neck, suspected stroke
  - Chest: routine chest (non-con), routine chest (with contrast), Suspected PE, Coronary angiogram
  - Abdomen/Pelvis: Routine abd-pelvis (non-con), Routine abd-pelvis (with contrast), Multiphase abd-pelvis, Suspected aneurysm or dissection

- **Instruments:** CT scanners at the selected 4 San Francisco Bay Area hospitals, all by the same manufacturer

- **Data Collection:** The DLP (an approximation of the total energy a patient absorbs) was measured with each scan; this was used in combination with the area imaged and conversion factors to calculate the “effective dose” (the amount of radiation to the exposed organs and each organ’s sensitivity to developing cancer from radiation exposure)

**DATA ANALYSIS:**

- **Level of Data:** ('').
  - Categorical (two or more categories without order, (ie: male / female)  '
  - Ordinal (hierarchical categories without set spacing, (ie: education level, death / discharge)
  - Interval (continuous data with set spacing, (ie: age, weight, hemoglobin)

- **Statistics Used:**
  - Descriptive statistics of the effective doses were calculated for each CT type
  - Differences within and across institutions were assessed using ANOVA
    - Because the data were right skewed, the log transformation of the dose was modeled
  - Variation in dose was calculated as the difference between the highest and lowest radiation dose observed for each CT type
  - Effective dose for each CT study was compared with the radiation from a 2-view chest and a standard screening mammogram
  - Estimation of LAR
    - Based on BEIR VII study of atomic bomb survivors, people living near leaking nuclear facilities, workers with occupational radiation exposures, and people receiving diagnostic and therapeutic medical studies
• Takes into account magnitude of single radiation exposure and age at the time of that exposure
• LAR defined as additional cancer risk above and beyond baseline cancer risk
• Used this to define number of CTs to cause one radiation-induced cancer

RESULTS:
• Brief answers to research questions:
  • Variation in dose between study types
    • Huge variation depending on type of study
    • Higher doses for angiograms
    • Higher doses for multi-phase studies
  • Variation in dose within study types
    • Mean 13-fold variation between the highest and lowest doses for each CT study type included
    • Effective doses higher and more variable in the abdomen and pelvis
  • Adjusted LARs of Cancer
    • Routine head CT: median adjusted LAR of cancer was 0.23/1000
    • Multiphase abd-pelvis: median adjusted LAR of cancer 4/1000
  • Estimated # of CTs that would lead to cancer by study type
    • Varies widely by age at exposure, sex, and amount of exposure
      • Females > risk than males
      • Younger > risk than older
      • More radiation exposure > less exposure
    • Coronary angiography had lowest # CT scans resulting in a single cancer
    • 40 yo females, 270 studies would result in 1 cancer
    • Routine head scans had highest # required to result in single cancer
    • 40 yo females, 8108 studies resulting in 1 cancer for routine head

• Additional findings:
  • Higher and more variable doses than typically quoted for most types of diagnostic CTs
    • Variation in dose across the 4 clinical sites reflects site-specific methods of choosing technical parameters
    • Estimated doses in patients rather than plastic phantom models
    • Most prior studies look at only one institution or CT study type
    • Most prior work groups all studies within one anatomic area together
    • Corresponding LARs of cancer higher than typically reported and markedly variable by study type, patient and hospital

• Limitations:
  • Did not look at radiation exposure in children <18 yo
  • Study cohort was insufficiently large to understand reasons for variation of dose associated with each study
  • Did not assess relationship between image quality and radiation dose
• LAR of cancer needs to be contextualized to patient’s remaining life expectancy

**IMPLICATIONS FOR PRACTICE:**

- **Applicable and relevant to our clinical practice:**
  - Highly applicable to our practice and setting
  - Need to consider risks and benefits of every study with each individual and
    work with radiology to protocol studies in a way in which you get maximal
    information with minimal radiation exposure
  - Previous reports show that 30% or more of CT exams performed may
    be unnecessary

**LEVEL OF EVIDENCE / DECISION FOR USE:**

- **Level of Evidence:**
  - Ia Evidence obtained from meta-analysis of randomized controlled trials
  - Ib Evidence obtained from at least one RCT
    - IIa Evidence obtained from at least one well-designed controlled study
      without randomization
    - IIb Evidence obtained from at least one other type of well-designed
      quasi-experimental study
    - III Well-designed non-experimental studies
    - IV Expert committee reports, opinions of experts