NCRP Report No. 184: Radiation Exposure from Interventional Fluoroscopy Procedures

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Nothing to disclose

Case Mix

• Cardiac interventional fluoroscopy
  – Diagnostic and therapeutic
• Noncardiac interventional fluoroscopy (everything else)
  – Diagnostic and therapeutic
    • No pain management
    • No ERCP
    • No procedures with low radiation dose, e.g., central lines, arthrograms
    • No general diagnostic procedures, e.g., barium studies, voiding cystourethrograms
• No pediatric cases

Cardiac Interventional Fluoroscopy

• Diagnostic studies and interventional procedures
• Interventional cardiology
  – Coronary artery disease
  – Structural heart disease (e.g., valve implantation, defect closure)
• Electrophysiology (EP)
  – Device implantation (e.g., pacemakers, defibrillators)
  – Ablation for dysrhythmias
• Reasonably good data for procedure numbers and patient dose

Data Sources

• Procedure numbers
  – IMV Cardiac Catheterization Report (2014)
  – Medicare (2016)
  – ACC National Cardiovascular Data Registry
• Patient dose
  – Published literature
  – NEXT cardiac cath survey 2012 (data from 2008-2009)
• Uncertainties low to medium

Estimated 2016 Procedure Numbers

• Category of ‘combined’ diagnostic and therapeutic procedures no longer used
• Estimated numbers of procedures:
  – ~2,500,000 diagnostic coronary angiography
  – ~850,000 percutaneous coronary interventions
  – ~70,000 structural heart procedures
  – ~360,000 EP device insertions
  – ~350,000 EP ablations and other procedures
• Increased number of EP procedures compared to 2006
• Total number of procedures slightly less than in 2006 due to removal of ‘combined’ category
Estimated 2016 Effective Doses

- No effect due to change in $w_e$ from ICRP 60 to ICRP 103: $E_{1.18}/E_{0.6} = 1.0$ for cardiac procedures
- Substantial variation in complexity for most cardiac interventional procedures
- No change in $E$ values from NCRP Report No. 160
  - Diagnostic cardiac angiography 7 mSv
  - Percutaneous coronary intervention 23 mSv
  - Structural heart procedures 50 mSv
  - EP device insertion 1 mSv
  - Other EP procedures 3.2 mSv

Summary - Cardiac Interventional Fluoroscopy

- Total number of procedures essentially the same as in 2006 (~4.1 million)
  - ‘Combined’ category eliminated
  - Increase in EP procedures
  - New category for treatment of structural heart disease
- 2016 collective effective dose is lower (~42,000 person-Sv) than estimated for 2006 diagnostic and therapeutic category (68,000 person-Sv)
- ~0.13 mSv estimated effective dose per individual ($E_{1.18}$) for 2016 is lower than the estimated 0.23 mSv for 2006 in NCRP Report No. 160.

Noncardiac Interventional Fluoroscopy

- Many different procedure types
- Substantial reclassification of procedure groups compared to NCRP Report No. 160
- Substantial uncertainty in procedure numbers and patient doses
  - Poor data on procedure numbers
  - Wide variation in reported patient doses

Changes from NCRP Report No. 160

- New procedure categories: nonvascular kidney interventions, percutaneous intestinal access, abscess drainage
- Reclassification or redefinition of some procedures
  - For vascular procedures, interventions categorized by body region (neurologic, abdomen, pelvis, peripheral vascular), not type of intervention (embolization, thrombolysis, angioplasty)
  - Easier to estimate $E$
  - Better correlation with procedure classifications in the literature

Data Sources

- Procedure numbers
  - IMV reports
  - Medicare
  - Nationwide Inpatient Sample
  - Healthcare Cost and Utilization Project
- Very general and limited picture of the number of procedures
  - Difficulties with ICD-9, ICD-10 codes, CPT codes
- Patient dose
  - Published literature
  - Most papers cover a limited number of procedure types
- Wide range of doses and reported average dose

Examples of Data Limitations

- Procedure Numbers
  - IMV Interventional Angiography Benchmark Report 2013-2014
    - 3.8 million cases performed in ‘angiography labs’, 2.1 million (55%) were classified as "other" procedures
    - "Other" included more than 35 specific procedures; no data on numbers for any of these
- Range of reported average patient doses
  - Abdominal diagnostic angiography 42.8 – 347 Gy-cm²
  - Biliary interventions 4.4 – 213 Gy-cm²
  - Nonvascular kidney interventions 4.8 – 121.5 Gy-cm²

Estimated 2016 Procedure Numbers

- Medicare data used to identify temporal trends in interventional procedures
- IMV data suggest a decrease in the volume of noncardiac interventional procedures since 2006
  - Many procedures previously done with fluoroscopy now done with other imaging modalities (e.g., PICC placement, arthograms) or replaced by other imaging studies (e.g., diagnostic angiography)
  - Cases performed in operating rooms and nonhospital facilities are not included in the IMV surveys

Dose Estimation

- Dose estimation either from Monte Carlo simulations or $D_e = D c_e P_{KA}$
- Published reports include data for $D_e$, more frequently for $P_{KA}$, and sometimes for $D c_e$
- Published $D c_e$ values vary due to differences among facilities in:
  - Protocols (number and projection angle of the fluoroscopic and radiographic views)
  - Technical and geometric factors (e.g., tube voltage, total filtration, focus-to-skin distance, beam angulation, field size)
- Minimal effect on $D_e$ due to changes in $w_f$ from ICRP 60 to ICRP 103, $E_{103}/E_{60}$ varies from 0.78 to 1.03, depending on the procedure

Estimation of Collective Effective Dose and $E_{US}$

- Based on:
  - Estimates in Report No. 160
  - Subsequent trends in total procedures
  - Likely interval changes in procedure numbers
  - Changes in estimates of effective dose
- A collective effective dose of 40,000 person-Sv is assumed for this Report, unchanged from 2006; medium to high uncertainty
- $E_{US}$ estimated as 0.12 mSv

Summary

- Difficult to compare 2006 and 2016 due to changes in procedure categories
- Greater confidence in estimates of numbers and doses for cardiac interventional fluoroscopy
- For interventional cardiology, collective effective dose decreased from 68,000 person-Sv to ~42,000 person-Sv in 2016; $E_{US}$ decreased from 0.23 mSv to 0.13 mSv
- For noncardiac interventional fluoroscopy, estimated collective effective dose unchanged at 40,000 person-Sv; $E_{US}$ is 0.12 mSv