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

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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

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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

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Estimated 2016 Effective Doses

- No effect due to change in w_T from ICRP 60 to ICRP 103: E_{103}/E_{60} = 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

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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_{US}) for 2016 is lower than the estimated 0.23 mSv for 2006 in NCRP Report No. 160.

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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

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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

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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

Miller DL. Med Phys 2020; 47(3):975-982. doi: 10.1002/mp.13990

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
(***Not*** *minimum – maximum doses!*)

- Abdominal diagnostic angiography 42.8 – 347 Gy·cm^2
- Biliary interventions 4.4 – 213 Gy·cm^2
- Nonvascular kidney interventions 4.8 – 121.5 Gy·cm^2

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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, arthrograms) 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

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Dose Estimation

- E determined either from Monte Carlo simulations or $E = DC_E P_{KA}$
- Published reports include data for E, more frequently for P_{KA}, and sometimes for DC_E
- Published DC_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 E due to changes in w_T from ICRP 60 to ICRP 103, E_{103}/E_{60} varies from 0.78 to 1.03, depending on the procedure

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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

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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

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