Guideline for Radiation Safety
Evidence Table

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
1	Chaffins JA. Radiation protection and procedures in the OR. *Radiol Technol* . 2008;79(5): 415-428.	Describes radiation protection measures and procedures for radiation protection in the OR.	Expert oninion	VB	N/A	N/A	N/A	N/A	N/A
2	Bindal RK, Glaze S, Ognoskie M, Tunner V, Malone R, Ghosh S. Surgeon and patient radiation exposure in minimally invasive transforaminal lumbar interbody fusion. *J Neurosurg Spine.* 2008;9(6):570–573.	The amount of radiation received by patients and physicians is low during minimally invasive transforaminal lumbar interbody fusion.	Descriptive	IIIC	1 surgeon, 24 patients	N/A	N/A	1 surgeon, 24 patients	Radiaiton dose
3	Cattani F, Vavassori A, Polo Aet al. Radiation exposure after permanent prostate brachytherapy. *Radiother Oncol.* 2006;79(1):65–69.	A visitor should stay 1 meter away from the patient who has radioactive seeds implanted for a period of time equal to the half life of the radionuclide to achieve a radiation does as low as reasonably/readily achievable.	Descriptive, retrospective	IIIC	Patients	N/A	N/A	216 patients	Radiation dose
4	Brown KR, Rzucidlo E. Acute and chronic radiation injury. *J Vasc Surg.* 2011;53(1 Suppl):15S–21S.	Suggestions for patient education and tips to avoid injury, description of injuries from radiation, patient risk factors for injury.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
5	Miller DL. Efforts to optimize radiation protection in interventional fluoroscopy. *Health Phys.* 2013;105(5): 435-444.	Historical review of all aspects of radiation safety.	Literature review	VA	N/A	N/A	N/A	N/A	N/A
6	Wagner LK. Radiation injury is potentially a severe consequence of fluoroscopically guided complex interventions. *Health Phys.* 2008;95(5):645–649.	Report on various injuries and recommendations for actions to take to prevent the injuries.	Case report	VB	N/A	N/A	N/A	N/A	N/A
7	Huda W, Schoepf UJ, Abro JA, Mah E, Costello P. Radiation-related cancer risks in a clinical patient population undergoing cardiac CT. *Am J Roentgenol.* 2011;196(2) W159–W165.	The average cancer induction risk for patients having cardiac CT angiography is 0.13%, with a female to male cancer induction risk ratio of 2.6.	Descriptive	IIIB	Adult patients	N/A	N/A	100 patients	Radiation dose

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8	Yuan MK, Chien CW, Lee SKet al. Health effects of medical radiation on cardiologists who perform cardiac catheterization. *J Chin Med Assoc.* 2010;73(4):199–204.	Physicians who perform cardiac catheterization have more cataracts than physicians of the same age who do not perform cardiac catheterizations.	Qualitative	IIIB	Adult physicians	N/A	Those who performed cardiac catheterization to those who didn't	2,292	Amount of cancer and cataracts present in the physicians
9	O'Connor U, Gallagher A, Malone L, O'Reilly G. Occupational radiation dose to eyes from endoscopic retrograde cholangiopancreatography procedures in light of the revised eye lens dose limit from the International Commission on Radiological Protection. *Br J Radiol.* 2013;86(1022):20120289	Occupational eye dose of staff members performing ERCP may exceed the ICRP annual limits.	Descriptive	IIIC	Physicians and staff in ERCP suite	N/A	N/A	62 procedures with 22 nurses, 4 physicians, 2 hospitals	Eye radiation dose
10	Vano E, Kleiman NJ, Duran A, Rehani MM, Echeverri D, Cabrera M. Radiation cataract risk in interventional cardiology personnel. *Radiat Res.* 2010;174(4): 490-495.	Interventional radiologists and staff in IR suites have a higher percentage of cataracts than the control group.	Comparative	IIIB	Physicians and staff in IR suite	N/A	Physicians and staff in IR suite to a control group	116 staff and 93 control	Eye radiation dose
11	Ciraj-Bjelac O, Rehani M, Minamoto A, Sim KH, Liew HB, Vano E. Radiation-induced eye lens changes and risk for cataract in interventional cardiology. *Cardiology.* 2012;123(3):168–171.	A higher percentage of the interventional radiology staff have cataracts than the control group.	Comparative	IIIB	Adult staff members	N/A	Cataract number in control -vs- staff	52 staff/34 control	# of staff with cataracts
12	Ciraj-Bjelac O, Rehani MM, Sim KH, Liew HB, Vano E, Kleiman NJ. Risk for radiation-induced cataract for staff in interventional cardiology: is there reason for concern? *Catheter Cardiovasc Interv.* 2010;76(6):826–834.	A higher percentage of the interventional radiology staff have a cataracts than the control group.	Comparative	IIIB	Adult staff members	N/A	Cataract number in control -vs- staff	67 staff 44 control	# of staff with cataracts
13	Williams PM, Fletcher S. Health effects of prenatal radiation exposure. *Am Fam Physician.* 2010;82(5):488–493.	Expert opinion on effects of radiation on pregnant women.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
14	Killewich LA, Falls G, Mastracci TM, Brown KR. Factors affecting radiation injury. *J Vasc Surg.* 2011;53(1 Suppl):9S–14S.	Summarizes the radiology risk factors for the patient.	Literature review	VB	N/A	N/A	N/A	N/A	N/A

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15	Health effects of ionising radiation. *Ann ICRP.* 2010;40(6): 21-26.	Describes the health effects of ionizing radiation.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
16	Cousins C, Miller DL, Bernardi Get al. ICRP Publication 120: Radiological protection in cardiology. *Ann ICRP.* 2013;42(1):1–125.	Scientifically supported guidelines for cardiology.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
17	Saberi A, Salari E, Latifi SM. Cytogenetic analysis in lymphocytes from radiation workers exposed to low level of ionizing radiation in radiotherapy, CT-scan and angiocardiography units. *Mutat Res.* 2013;750(1–2):92–95.	Those in the radiotherapy, CT-Scan, and angiography groups had greater numbers of aberrant chromosomes than the control group.	Comparative	IIIB	Adults (control and occupationally exposed to health care	N/A	Aberrant chromosome numbers in each group	11 in each group (control, radiotherapy, CT-Scan, angiography	# of aberrant chromosomes
18	Mohapatra A, Greenberg RK, Mastracci TM, Eagleton MJ, Thornsberry B. Radiation exposure to operating room personnel and patients during endovascular procedures. *J Vasc Surg.* 2013;58(3):702–709.	Shielding should be worn by everyone in the room because wearing it leads to a lower dose.	Descriptive study	IIIC	Adult surgeon, assisting surgeons' scrub nurse, radiation	N/A	N/A	Staff involved in 39 FEVAR procedures (218 personnel)	Radiation dose
19	Adriaens I, Smitz J, Jacquet P. The current knowledge on radiosensitivity of ovarian follicle development stages. *Hum Reprod Update.* 2009;15(3): 359-377.	The risk of genetic effects is very low compared with the spontaneous risk of genetic effects.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
20	Koukorava C, Carinou E, Ferrari P, Krim S, Struelens L. Study of the parameters affecting operator doses in interventional radiology using Monte Carlo simulations. *Radiat Measur.* 2011;46(11):1216–1222.	Use of protective shielding is the best way to reduce radiation exposure.	Descriptive/ Comparative	IIIC	Phantom	Use of the shield	Ceiling shielding placement	N/A	Radiation dose
21	TuTuohy CJ, Weikert DR, Watson JT, Lee DH. Hand and body radiation exposure with the use of mini C-arm fluoroscopy. *J Hand Surg Am.* 2011;36(4):632–638.	The radiation dose received with the use of mini-c-arm is well below the NCRPM dose limits.	Descriptive	IIIB	Surgeons	N/A	N/A	4 physicians totaling 200 cases	Radiation dose
22	Cuaron JJ, Hirsch AE, Medich DC, Hirsch JA, Rosenstein BS. Introduction to radiation safety and monitoring. *J Am Coll Radiol.* 2011;8(4):259–264.	Description of strategeis to limit exposure to radiation.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A

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23	Duran A, Hian SK, Miller DL, Le Heron J, Padovani R, Vano E. Recommendations for occupational radiation protection in interventional cardiology. *Catheter Cardiovasc Interv. 2* 013;82(1):29–42.	Multi-society endorsed, evidence based practice guideline for occupational radiation protection in interventional cardiology.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
24	Guideline for specimen management. In: *Guidelines for Perioperative Practice.* Denver, CO: AORN, Inc; 2015:389–418.	Guidlines on handling of radioactive specimens.	Professional Guideline	IVA	N/A	N/A	N/A	N/A	N/A
25	Linet MS, Kim KP, Miller DL, Kleinerman RA, Simon SL, Berrington de Gonzalez A. Historical review of occupational exposures and cancer risks in medical radiation workers. *Radiat Res.* 2010;174(6): 793-808.	The amount of exposure to staff members is decreasing.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
26	Chambers CE, Fetterly KA, Holzer Ret al. Radiation safety program for the cardiac catheterization laboratory. *Catheter Cardiovasc Interv.* 2011;77(4):546–556.	Contains information on radiation programs including monitoring, location of dosimeters.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
27	10 CFR 20. Standards for protection against radiation. 2013. *US Government Publishing Office.* http://www.gpo.gov/fdsys/pkg/CFR-2013-title10-vol1/pdf/CFR-2013-title10-vol1-part20.pdf. Accessed April 14, 2015.	Regulations for radiation safety.	Regulatory	R	N/A	N/A	N/A	N/A	N/A
28	10 CFR 35. Medical use of byproduct material. 2011. *US Government Publishing Office* . http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol1/pdf/CFR-2011-title10-vol1-part35.pdf. Accessed April 14, 2015.	Regulations covering use of radioactive seeds and other byproducts.	Regulatory	R	N/A	N/A	N/A	N/A	N/A
29	42 CFR 416.49. Condition for coverage—Laboratory and radiologic services. 2014. *US Government Publishing Office* . http://www.gpo.gov/fdsys/pkg/CFR-2014-title42-vol3/pdf/CFR-2014-title42-vol3-sec416-49.pdf. Accessed April 14, 2015.		Regulatory	R	N/A	N/A	N/A	N/A	N/A

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30	42 CFR 482.26. Condition of participation: Radiologic services. 2011. *US Government Publishing Office* . http://www.gpo.gov/fdsys/pkg/CFR-2011-title42-vol5/pdf/CFR-2011-title42-vol5-sec482-26.pdf.		Regulatory	R	N/A	N/A	N/A	N/A	N/A
31	*ACR–AAPM Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures.* 2013. American College of Radiology.	Recommendations for documentation, and protection, including pregnancy.	Professional Guideline	IVC	N/A	N/A	N/A	N/A	N/A
32	Guideline for product selection. In: *Guidelines for Perioperative Practice* . Denver, CO: AORN, Inc; 2015:179–186.	Guidlines on the process for purchasing equipment.	Professional Guideline	IVB	N/A	N/A	N/A	N/A	N/A
33	Stecker MS, Balter S, Towbin RBet al. Guidelines for patient radiation dose management. J *Vasc Interv Radiol.* 2009;20(7 Suppl):S263–S273.	Guidelines for patient radiation dose management published by the Society of Interventional Radiologists.	Professional Guideline	IVA	N/A	N/A	N/A	N/A	N/A
34	Lakkireddy D, Nadzam G, Verma Aet al. Impact of a comprehensive safety program on radiation exposure during catheter ablation of atrial fibrillation: a prospective study. *J Interv Card Electrophysiol* . 2009;24(2):105–112.	A radiation safety program, including wearing of shields is effective at reducing radiation dosage.	RCT	IB	Adult patients	Radiation safety program	Pre and post initiation of radiation safety program.	41 procedures	Radiation dose
35	Weiss EM, Thabit O. Clinical considerations for allied professionals: radiation safety and protection in the electrophysiology lab. *Heart Rhythm.* 2007;4(12):1583–1587.	Summary of safety issues and protection methods in an electrophysiology lab.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
36	Strauss KJ. Interventional suite and equipment management: cradle to grave. *Pediatr Radiol.* 2006;36(Suppl 2):221–236.	Report on requirements for building and purchasing of new radiology equipment.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A

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37	Dumonceau JM, Garcia-Fernandez FJ, Verdun FRet al. Radiation protection in digestive endoscopy: European Society of Digestive Endoscopy (ESGE) guideline. *Endoscopy.* 2012;44(4):408–421.	Professional guideline from ESGE (European) describing radiation protection for personnel in GI labs.	Professional guideline	IVA	N/A	N/A	N/A	N/A	N/A
38	Jaco JW, Miller DL. Measuring and monitoring radiation dose during fluoroscopically guided procedures. *Tech Vasc Interv Radiol.* 2010;13(3):188–193.	Recommendations on what should be documented and the time frames for notification of the operator.	Expert Opinion	VB	N/A	N/A	N/A	N/A	N/A
39	Vance AZ, Weinberg BD, Arbique GM, Guild JB, Anderson JA, Chason DP. Fluoroscopic sentinel events in neuroendovascular procedures: how to screen, prevent, and address occurrence. *Am J Neuroradiol.* 2013;34(8):1513–1515.	Suggests steps to take for recording patient radiation dose and methods to prevent patient over dose.	Expert opinion	VC	N/A	N/A	N/A	N/A	N/A
40	10 CFR 71.5. Transportation of licensed material. 2013. http://www.gpo.gov/fdsys/pkg/CFR-2014-title10-vol2/pdf/CFR-2014-title10-vol2-sec71-5.pdf. Accessed April 14, 2015.		Regulatory	R	N/A	N/A	N/A	N/A	N/A
41	Park PE, Park JM, Kang JEet al. Radiation safety and education in the applicants of the final test for the expert of pain medicine. *Korean J Pain.* 2012;25(1):16–21.	Radiation safety education should be provided and leads to better compliance with protective measures.	Descriptive	IIIC	Korean pain physicians	N/A	N/A	27 physicians	Safety measures taken with and without education
42	Ricketts ML, Baerlocher MO, Asch MR, Myers A. Perception of radiation exposure and risk among patients, medical students, and referring physicians at a tertiary care community hospital. *Can Assoc Radiol J.* 2013;64(3):208–212.	There is a need for education on radiation safety among Canadian physicians and medical students; and the location for this education should be medical schools and conferences.	Descriptive	IIIB	patients, referring physicians, medical students	N/A	N/A	127 patients, 32 referring physicians, 30 medical students	Knowledge of radiation exposure and associated risk

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43	Friedman AA, Ghani KR, Peabody JO, Jackson A, Trinh QD, Elder JS. Radiation safety knowledge and practices among urology residents and fellows: results of a nationwide survey. *J Surg Educ.* 2013;70(2):224–231.	Urology resident education in radiation safety was lacking and use of protective equipment and radiation monitoring was insufficient.	Survey	IIIB	N/A	N/A	N/A	165 trainees	Sources of education, knowledge of occupational dose limits, exposure frequency, protective item utilization
44	Kirkwood ML, Arbique GM, Guild JBet al. Surgeon education decreases radiation dose in complex endovascular procedures and improves patient safety. *J Vasc Surg.* 2013;58(3):715–721	Surgeon education improved operator practice and decreased the patient and therefore the personnel radiation dose. Education on radiation should occur for all vascular surgeons.	Descriptive	IIIA	Patients	N/A	N/A	300 procedures	Radiation dose
45	Vano E, Fernandez JM, Sanchez RMet al. Patient radiation dose management in the follow-up of potential skin injuries in neuroradiology. *Am J Neuroradiol* . 2013;34(2):277–282	The amount of radiation received was decreased after education on radiation protection.	Descriptive	IIIB	Patients	N/A	N/A	708 procedures	Presence of skin injuries
46	Sheyn DD, Racadio JM, Ying J, Patel MN, Racadio JM, Johnson ND. Efficacy of a radiation safety education initiative in reducing radiation exposure in the pediatric IR suite. *Pediatr Radiol.* 2008;38(6):669–674.	Staff radiation safety education leads to a decrease in radiation dose & increase in safety practices.	Quasi-experimental	IIA	Staff in IR suite	Education program	Use of safety measurers pre and post education	11 operators. (5 physicians, 6 techs) 432 procedures before and 616 procedures after	Use of safety measures
47	Miller DL, Vano E, Bartal Get al. Occupational radiation protection in interventional radiology: a joint guideline of the Cardiovascular and Interventional Radiology Society of Europe and the Society of Interventional Radiology. *J Vasc Interv Radiol.* 2010;21(5):607–615.	Guidelines for occupational radiation protection.	Professional guideline	IVA	N/A	N/A	N/A	N/A	N/A

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48	Kelsey L, Herron-Rice L, Anderson P, et al. SGNA guideline. Radiation safety in the endoscopy setting. *Gastroenterol Nurs.* 2008;31(4): 308-311.	Guidelines for radiation safety in the GI Lab.	Professional Guidelines	IVB	N/A	N/A	N/A	N/A	N/A
49	Vano E, Rosenstein M, Liniecki J, Rehani MM, Martin CJ, Vetter RJ. ICRP Publication 113. Education and training in radiological protection for diagnostic and interventional procedures. *Ann ICRP.* 2009;39(5):7–68.	Guidelines describing the education required for personnel in interventional radiology.	Professional Guideline	IVC	N/A	N/A	N/A	N/A	N/A
50	Abatzoglou I, Koukourakis M, Konstantinides S. Reduction of the radiation dose received by interventional cardiologists following training in radiation protection. *Radiat Prot Dosimet.* 2013;155(1):119–121.	After education on radiation safety the dose of radiation received was decreased.	Descriptive	IIIC	Adult cardiologists	Education	Level of radiation before and after education	3 cardiologists	Radiation dose
51	Pitcher CD, Melanson MA. The impact of peer-based training on reducing radiation doses from x-ray operations in an interventional pain management clinic. *US Army Med Dep J.* *2* 010:43–47.	Describes the reduction in the amount of radiation exposure of patient and staff before and after an education session. The conclusion is that the education was successful.	Quality Report	VB	staff, patients, general public	Education on proper used of flouro	Dose before and after an educational session	Number not provided just staff within one large facility	Radiation dose
52	Widmark A, Friberg EG. How “do’s” and “dont’s” can be of significant importance in radiation protection: a case report. *Radiat Prot Dosimet* . 2011;147(1–2):99–101.	Education is needed to reduce the amount of radiation received by the patient.	Quality report	VC	Adult patients	N/A	Before and after education session	8 before, 6 after	Radiation dose
53	Guideline for perioperative health care information management. In: *Guidelines for Perioperative Practice.* Denver, CO: AORN; 2015:491–512.	Guidelines for documentation.	Professional guideline	IVB	N/A	N/A	N/A	N/A	N/A
54	Miller DL, Balter S, Dixon RGet al. Quality improvement guidelines for recording patient radiation dose in the medical record for fluoroscopically guided procedures. *J Vasc Interv Radiol.* 2012;23(1):11–18.	Guidelines for determining when to record the patient radiation dose.	Professional Guideline	IVA	N/A	N/A	N/A	N/A	N/A

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55	Voros S, Rivera JJ, Berman DSet al. Guideline for minimizing radiation exposure during acquisition of coronary artery calcium scans with the use of multidetector computed tomography: a report by the Society for Atherosclerosis Imaging and Prevention Tomographic Imaging and Prevention Councils in collaboration with the Society of Cardiovascular Computed Tomography. *J Cardiovasc Comput Tomogr.* 2011;5(2):75–83.	Radiation doses should be documented.	Professional Guideline	IVB	N/A	N/A	N/A	N/A	N/A
56	Marx MV. Interventional radiology: management of the pregnant patient. *Tech Vasc Interv Radiol.* 2010;13(3):154–157.	Provides guidance for managing the dose of radiation received by the pregnant patient.	Expert opinion	VC	N/A	N/A	N/A	N/A	N/A
57	Miller DL, Balter S, Schueler BA, Wagner LK, Strauss KJ, Vañó E. Clinical radiation management for fluoroscopically guided interventional procedures. *Radiology.* 2010;257(2):321–332.	Recommendations for reducing radiation exposeure during fluoro guided procedures.	Expert opinion	VA	N/A	N/A	N/A	N/A	N/A
58	ICRP; Khong PL, Ringertz H, Donoghue Vet al. ICRP publication 121: radiological protection in paediatric diagnostic and interventional radiology. *Ann ICRP* . 2013;42(2):1–63.	Guidelines for pediatric patients and staff in pediatric settings.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
59	Steele JR, Jones AK, Ninan EP. Quality initiatives: establishing an interventional radiology patient radiation safety program. *Radiographics.* 2012;32(1):277–287	The radiation dose should be monitored and documented.	Quality report	VB	N/A	N/A	N/A	N/A	N/A
60	Erickson BA, Demanes DJ, Ibbott GSet al. American Society for Radiation Oncology (ASTRO) and America College of Radiology (ACR) practice guideline for the performance of high-dose-rate brachytherapy. *Int J Radiat Oncol Biol Phy* s. 2011;79(3):641–649	Guidelines for brachytherapy as described by the ACR and ASTRO.	Professional Guideline	IVC	N/A	N/A	N/A	N/A	N/A

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61	Chen J, Einstein AJ, Fazel Ret al. Cumulative exposure to ionizing radiation from diagnostic and therapeutic cardiac imaging procedures: a population-based analysis. *J Am Coll Cardiol.* 2010;56(9):702–711.	Cardiac imaging procedures expose the patient to substantial amounts of radiation.	Descriptive	IIIB	Nonelderly adults (Mean age 35.6 yrs.)	N/A	N/A	952,420	Radiation dose
62	Hui CM, MacGregor JH, Tien HC, Kortbeek JB. Radiation dose from initial trauma assessment and resuscitation: review of the literature. *Can J Surg.* 2009;52(2):147–152.	Trauma patients are exposed to large amounts of radiation from CT scans.	Literature review	VB	N/A	N/A	N/A	N/A	Radiation dose
63	Martinez LC, Vano E, Gutierrez F, Rodriguez C, Gilarranz R, Manzanas MJ. Patient doses from fluoroscopically guided cardiac procedures in pediatrics. *Phys Med Biol.* 2007;52(16):4749–4759.	Report on the radiation dose of pediatric patients undergoing pediatric cardiac procedures in Spain. Estimated maximum skin doses are far below the threshold for deterministic effects.	Descriptive	IIIB	Patients between the age of 10 days and 16 years	N/A	N/A	137 patients	Radiation dose
64	Weiss DJ, Pipinos II, Longo GM, Lynch TG, Rutar FJ, Johanning JM. Direct and indirect measurement of patient radiation exposure during endovascular aortic aneurysm repair. *Ann Vasc Surg.* 2008;22(6):723–729.	The amount of radiation received by standard endovascular AAA repair at this facility was well below the 2Gy threshold for skin injury.	Quality report	VB	Adult patients having standard endovascula	N/A	N/A	12 patients	Radiation dose
65	Wang W, Zhang M, Zhang Y. Overall measurements of dose to patients in common interventional cardiology procedures. *Radiat Prot Dosimet.* 2013;157(3):348–354.	The patient receives large amounts of radiation during the studied cardiac procedures and legislation should be changed to list dose constraints for these procedures. The amount of education and experience of the physician is related to the dose received.	Descriptive	IIIB	Adult patients	N/A	N/A	238 patients	Radiation dose
66	Majewska N, Stanisic MG, Klos MAet al. Patients' radiation doses during thoracic stent-graft implantation: the problem of long-lasting procedures. *Ann Thorac Surg.* 2012;93(2):465–472.	Patients with a high BMI, large number of stent graft parts and when the aneurysm neck angulation exceeded 60 degrees received a higher radiation dose.	Retrospective study	IIIB	Adult patients having thoracic stent-graft	N/A	N/A	100 patients	Radiation dose

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67	Mancini JG, Raymundo EM, Lipkin Met al. Factors affecting patient radiation exposure during percutaneous nephrolithotomy. *J Urol* . 2010;184(6):2373–2377.	Pts with high BMI received a higher radiation dose during percutaneous nephrolithotomy.	Retrospective study	IIIB	Adult patients	N/A	N/A	96 patients	Radiation dose
68	Sandilos P, Tsalafoutas I, Koutsokalis Get al. Radiation doses to patients from extracorporeal shock wave lithotripsy. *Health Phys* . 2006;90(6):583–587.	Patients having ESWL receive well below the dose of radiation required to cause deterministic effects is zero but the dose may contribute to stochastic effects.	Descriptive	IIIB	Patients having ESWL procedures	N/A	N/A	50	Radiation dose
69	Stratis AI, Anthopoulos PL, Gavaliatsis IPet al. Patient dose in cardiac radiology. *Hellenic J Cardiol.* 2009;50(1):17–25.	There is a correlation between dose area product, fluoro time, and the number of reframes presequence and cine recording time.	Descriptive	IIIB	Adult patients	N/A	N/A	209 patients	Radiation dose
70	Staton RJ, Williams JL, Arreola MM, Hintenlang DE, Bolch WE. Organ and effective doses in infants undergoing upper gastrointestinal (UGI) fluoroscopic examination. *Med Phys.* 2007;34(2):703–710	The radiation dose to infants for UGIs was not statistically different than VCUG.	Descriptive	IIIB	Females under 6 months of age	N/A	N/A	5 patients	Radiation dose
71	Tsalafoutas IA, Goni H, Maniatis PN, Pappas P, Bouzas N, Tzortzis G. Patient doses from noncardiac diagnostic and therapeutic interventional procedures. *J Vasc Interv Radiol.* 2006;17(9):1489–1498.	The techniques used by the interventionalist, skill of the radiations techs and the performance of the x-ray unit in this facility did not present deficiencies in patient radiation protection.	Descriptive	IIIB	Adult patients	N/A	N/A	N/A	Radiation dose
72	Sandborg M, Rossitti S, Pettersson H. Local skin and eye lens equivalent doses in interventional neuroradiology. *Eur Radiol* . 2010;20(3):725–733.	The radiation dose received at the interventional reference point was not a good indicator for the amount received at the eyes.	Descriptive	IIIA	Adults	N/A	N/A	1023 patients	Radiation dose
73	Beathard GA, Urbanes A, Litchfield T. Radiation dose associated with dialysis vascular access interventional procedures in the interventional nephrology facility. *Semin Dialysis.* 2013;26(4):503–51	The radiation dose received was variabile between pts, procedures and operators.	Descriptive	IIIC	Interventional nephrologists	N/A	N/A	69 nephrologists in 24 centers	Radiation dose

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74	Sulieman A, Paroutoglou G, Kapsoritakis Aet al. Reduction of radiation doses to patients and staff during endoscopic retrograde cholangiopancreatography. *Saudi J Gastroenterol. 2* 011;17(1):23–29.	The dose to the patient and the staff is reduced with use of a c-arm fluoro versus conventional technique.	Descriptive	IIIB	Adult males and females, consisting of patients, physicians and	N/A	N/A	54 patients over 5 months,	Radiation dose
75	Thierry-Chef I, Simon SL, Miller DL. Radiation dose and cancer risk among pediatric patients undergoing interventional neuroradiology procedures. *Pediatr Radiol.* 2006;36(Suppl 2):159–162	Columniation and dose optimization should be used to decrease the dose received to pediatric patients.	Descriptive	IIIA	Children from 0-15 yrs.	N/A	N/A	50 patients	Radiation dose
76	Ho P, Cheng SW, Wu PMet al. Ionizing radiation absorption of vascular surgeons during endovascular procedures. *J Vasc Surg.* 2007;46(3):455–459.	The amount of radiation received by this team of physicians, while using proper radiation protection does not exceed the annual dose set by the ICRP.	Descriptive	IIIB	Vascular surgeons	N/A	N/A	149 procedures conducted by 4 surgeons and one trainee.	Radiation dose
77	Peach G, Sinha S, Black SAet al. Operator-controlled imaging significantly reduces radiation exposure during EVAR. *Eur J Vasc Endovasc Surg* . 2012;44(4):395–398.	Operator controlled imaging can reduce patient radiation dose.	Comparative	IIIB	Patients having EVAR	Instituting operator controlled imaging (OCI)	Pre and post OCI radiation dose	122 patients	Radiation dose
78	Joemai RM, Zweers D, Obermann WR, Geleijns J. Assessment of patient and occupational dose in established and new applications of MDCT fluoroscopy. *Am J Roentgenol.* 2009;192(4):881–886	The patient can receive high doses of radiation during CT scans but the levels received by patients and staff were below the threshold levels.	Descriptive	IIIB	Adult patients and staff	N/A	N/A	210 patient procedures, one IR physician, one assisting radiologist, one radiologic technologist per procedure	Radiation dose
79	Church CA, Kuhn FA, Mikhail J, Vaughan WC, Weiss RL. Patient and surgeon radiation exposure in balloon catheter sinus ostial dilation. *Otolaryngol Head Neck Surg.* 2008;138(2):187–191.	Use of fluoroscopy during balloon catheter dilations of the sinus exposes the physician and patient to very low dose of radiation.	Descriptive	IIIB	Patients and surgeons	N/A	N/A	34 patients	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
80	Karthikesalingam A, Markar SR, Weerakkody R, Walsh SR, Carroll N, Praseedom RK. Radiation exposure during laparoscopic cholecystectomy with routine intraoperative cholangiography. *Surg Endosc.* 2009;23(8):1845–1848.	The radiation dose received by patients during intraoperative cholangiography is not enough to contraindicate the procedure.	Descriptive	IIIB	Adult patients	N/A	N/A	108 patients	Radiation Dose
81	Storm ES, Miller DL, Hoover LJ, Georgia JD, Bivens T. Radiation doses from venous access procedures. *Radiology* . 2006;238(3):1044–1050.	The patient radiation dose received during venous access procedures is low and should not cause skin effects.	Descriptive	IIIB	Adults	N/A	N/A	N/A	Radiation dose
82	Tsapaki V, Christou A, Nikolaou Net al. Radiation doses in a newly founded interventional cardiology department. *Radiat Prot Dosimet* . 2011;147(1–2):72–74.	The radiation doses in this center for patients undergoing coronary angiography and percutaneous transluminal coronary angioplasty were below the European and international reference levels.	Descriptive	IIIB	Adult patients	N/A	N/A	336 patients	Radiation dose
83	Hidajat N, Wust P, Felix R, Schroder RJ. Radiation exposure to patient and staff in hepatic chemoembolization: risk estimation of cancer and deterministic effects. *Cardiovasc Interv Radiol.* 2006;29(5):791–796.	A patient and the staff receive high does of radiation during transarterial chemoembolization of hepatocellular carcinoma.	Descriptive	IIIB	Adults	N/A	N/A	65 patients	Radiation dose
84	Kirousis G, Delis H, Megas P, Lambiris E, Panayiotakis G. Dosimetry during intramedullary nailing of the tibia. *Acta Orthopaedica.* 2009;80(5):568–572.	During tibial nailing procedures the patient gonad radiation dose is negligible, the nurse in the OR receives the smallest dose followed by the assistant, surgeon, and the equipment operator receives the highest dose. The greater the distance from the source the lower the radiation dose.	Descriptive	IIIC	OR staff	N/A	N/A	25 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
85	Kocinaj D, Cioppa A, Ambrosini Get al. Radiation dose exposure during cardiac and peripheral arteries catheterisation. *Int J Cardiol.* 2006;113(2):283–284.	Radiation dose varies based on the procedure.	Descriptive	IIIC	Adults	N/A	N/A	500 patients	Radiation dose
86	Komiya K, Igarashi T, Suzuki H, Hirabayashi Y, Waechter J, Seo N. In vitro study of patient's and physician's radiation exposure in the performance of epiduroscopy. *Reg Anesth Pain Med* . 2008;33(2):98–101.	The radiation dose received during 1 epiduroscopy procedure was found to be less than the threshold dose that could lead to injuries.	Descriptive	IIIB	Adults	N/A	N/A	14 patients	Radiation dose
87	Safak M, Olgar T, Bor D, Berkmen G, Gogus C. Radiation doses of patients and urologists during percutaneous nephrolithotomy. *J Radiol Prot.* 2009;29(3):409–415.	The radiation dose received by the patient and the physician performing percutaneous nephrolithotomy is within safe limits.	Descriptive	IIIC	Adults physicians and patients	N/A	N/A	20 procedures	Radiation dose
88	Nishizawa K, Masuda Y, Morinaga Ket al. Surface dose measurement in patients and physicians and effective dose estimation in patients during uterine artery embolisation. *Radiat Prot Dosimet.* 2008;128(3):343–350.	The radiation dose to the patient varied with the clinical conditions of the patient and the dose to the physician was high in the upper arm, hand and fingers.	Descriptive	IIIB	Phantom	N/A	N/A	29 procedures	Radiation dose
89	Olgar T, Bor D, Berkmen G, Yazar T. Patient and staff doses for some complex x-ray examinations. *J Radiol Prot.* 2009;29(3):393–407.	The radiation dose to the patient and the staff vary widely due to many reasons including procedures and technique.	Descriptive	IIIB	Physicians and patients	N/A	N/A	107 procedures	Radiation dose
90	Tsapaki V, Patsilinakos S, Voudris Vet al. Level of patient and operator dose in the largest cardiac centre in Greece. *Radiat Prot Dosimet* . 2008;129(1–3):71–73.	The patient and staff radiation dose varies with procedure.	Descriptive	IIIB	Adult patients and physicians	N/A	N/A	549 procedures	Radiation dose
91	Topaltzikis T, Rountas C, Moisidou R, Fezoulidis I, Kappas C, Theodorou K. Radiation dose to patients and staff during angiography of the lower limbs. Derivation of local dose reference levels. *Physica Medica* . 2009;25(1):25–30	The dose of radiation received by radiologist is negligible, the radiation dose varies based on the physical characteristics of the patient, the radiologist's procedure preferences and procedural difficulties.	Descriptive	IIIB	Adult patients and physicians	N/A	N/A	30 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
92	Steinfort DP, Einsiedel P, Irving LB. Radiation dose to patients and clinicians during fluoroscopically-guided biopsy of peripheral pulmonary lesions. *Respir Care.* 2010;55(11):1469–1474	Radiation dose for patients is within safe limits for a fluoroscopy guided bronchoscopy. Staff dose is negligible if protection is worn.	Descriptive	IIIB	Adult patients and staff	N/A	N/A	42 procedures	Radiation dose
93	Daneault B, Balter S, Kodali SKet al. Patient radiation exposure during transcatheter aortic valve replacement procedures. *Eurointervention.* 2012;8(6):679–684	Describes the amount of radiation received by patients during transcatheter aortic valve replacement procedures.	Descriptive	IIIB	Adult patients	N/A	Transfemoral vs transapical access	105 procedures	Radiation dose
94	Arbique GM, Gilleran JP, Guild JB, Harris JE, Poon CI, Zimmern PE. Radiation exposure during standing voiding cystourethrography in women. *Urology.* 2006;67(2):269–274.	The patient receives an acceptable amount of radiation during voiding cystourethrography.	Descriptive	IIIC	Adult patients	N/A	N/A	118 women	Radiation dose
95	Gelfand AA, Josephson SA. Substantial radiation exposure for patients with subarachnoid hemorrhage. *J Stroke Cerebrovasc Di* s. 2011;20(2):131–133.	Patients with a subarrachnoid hemmorage receive a significant amount of radiation.	Quasi-experimental	IIC	Patients	N/A	N/A	70 men	Radiation dose
96	Butter C, Schau T, Meyhoefer J, Neumann K, Minden HH, Engelhardt J. Radiation exposure of patient and physician during implantation and upgrade of cardiac resynchronization devices. *Pacing Clin Electrophysiol.* 2010;33(8):1003–1012.	A follow-up program for patients receiving a radiation dose exceeding 400 Gy/cm^2 and for operators during fluoroscopically guided cardiac resynchronization device implantation should be considered.	Descriptive	IIIB	Physicians and patients	N/A	N/A	104 patients, 3 experienced operators	Radiation dose
97	Budd H, Patchava A, Khanduja V. Establishing the radiation risk from fluoroscopic-assisted arthroscopic surgery of the hip. *Int Orthop.* 2012;36(9):1803–1806.	Fluoroscopic-assisted arthroscopic surgery of the hip is safe with a low maximum radiation dose.	Descriptive	IIIC	Adult patients and surgeons	N/A	N/A	50 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
98	Noor M, Shekhdar J, Banner NR. Radiation exposure after heart transplantation: trends and significance. *J Heart Lung Transplant.* 2011;30(3):309–314.	Heart transplant patients recipients received an increased exposure to radiation impart related to the diagnostic and surveillance procedures but their cancer risk related to the increased dose was not significantly increased.	Retrospective	IIIA	Heart transplant patients at a single facility	N/A	N/A	202	Radiation dose
99	Molyvda-Athanasopoulou E, Karlatira M, Gotzamani-Psarrakou A, Koulouris Ch, Siountas A. Radiation exposure to patients and radiologists during interventional procedures. *Radiat Prot Dosimet.* 2011;147(1–2):86–89.	The operator eye radiation exposure is high and wearing of leaded glasses is recommended.	Quasi-experimental	IIB	Adult surgeon and patients	N/A	N/A	Patients and doctors involved in 32 cardiac angiographies and angioplasties.	Radiation dose
100	Jamal JE, Armenakas NA, Sosa RE, Fracchia JA. Perioperative patient radiation exposure in the endoscopic removal of upper urinary tract calculi. *J Endourol.* 2011;25(11):1747–1751.	Patients with a dx. of urinary calculi receive large doses of radiation during the periprocedure period.	Descriptive	IIIB	Adult patients	N/A	N/A	233 procedures	Radiation dose
101	Jeskowiak A, Hubmer M, Prenner G, Maechler H. Radiation induced cutaneous ulcer on the back in a patient with congenital anomaly of the upper cava system. *Interact Cardiovasc Thorac Surg.* 2011;12(2):290–292	Summarizes a case of patient radiology burns.	Case report	VB	N/A	N/A	N/A	N/A	N/A
102	Otterburn D, Losken A. Iatrogenic fluoroscopy injury to the skin. *Ann Plast Surg* . 2010;65(5):462–465.	Report of three cases of radiation burns which were diagnosed long after the exposure.	Case report	VC	N/A	N/A	N/A	N/A	N/A
103	Spiker A, Zinn Z, Carter WH, Powers R, Kovach R. Fluoroscopy-induced chronic radiation dermatitis. *Am J Cardiol.* 2012;110(12):1861–1863.	Report of a person experiencing itchy nontender skin lesion (aka Radiation dermatitis) after 2 cardiac catheterizations with stent placement.	Case report	VB	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
104	Takikawa M, Nambu M, Yamamoto N, Azuma R, Kiyosawa T. Radiation-induced skin injury on the upper arm following cardiac interventional radiology: a review and case report. *Wounds.* 2012;24(4):91–98.	Radiation induced skin injuries occur after large doses of radiation.	Case report and review of literature	VB	N/A	N/A	N/A	N/A	N/A
105	Suzuki S, Furui S, Matsumaru Yet al. Patient skin dose during neuroembolization by multiple-point measurement using a radiosensitive indicator. *Am J Neuroradiol.* 2008;29(6):1076–1081.	The radiation dose in some neuro embolizations exceed the thresholds for skin injuries.	Descriptive	IIIB	Adult patients	N/A	N/A	75 women; 28 men	Radiation dose
106	ACR–SPR Practice Parameter for Imaging Pregnant of Potentially Pregnant Adolescents and Women with Ionizing Radiation. 2013. American College of Radiology.	Guideline for imaging pregnant or potentially pregnant women.	Professional Guideline	IVC	N/A	N/A	N/A	N/A	N/A
107	Kennedy EV, Iball GR, Brettle DS. Investigation into the effects of lead shielding for fetal dose reduction in CT pulmonary angiography. *Br J Radiol.* 2007;80(956):631–638.	Lead shielding helps decrease the amount of radiation received by a fetus during a CT scan to rule out pulmonary embolism.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
108	Patient and occupational protection. *Ann ICRP.* 2010;40(6):27–39.	Provides guidance for most of the aspects of radiation exposure especially related to fluoroscopy.	Professional guideline	IVB	N/A	N/A	N/A	N/A	N/A
109	Justino H. The ALARA concept in pediatric cardiac catheterization: techniques and tactics for managing radiation dose. *Pediatr Radiol* . 2006;36(Suppl 2):146–153	Unnecessary body parts should be removed from the field including the operators hands.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
110	Foley SJ, McEntee MF, Achenbach S, Brennan PC, Rainford LS, Dodd JD. Breast surface radiation dose during coronary CT angiography: reduction by breast displacement and lead shielding. *Am J Roentgenol.* 2011;197(2):367–373.	Breast displacement during coronary CT angiography significantly reduces the radiation dose to the breast surface and this reduction is enhanced when shielding is also included.	RCT	IB	Adult females	Breast displacement and breast displacement plus lead shielding	control vs breast displacement vs breast displacement plus lead shielding	54 patients	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
111	Clancy CL, O'Reilly G, Brennan PC, McEntee MF. The effect of patient shield position on gonad dose during lumbar spine radiography. *Radiography.* 2010;16(2):131–135.	When protecting the patients gonads a tube side apron should be used.	Descriptive/ qualitative	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
112	Shortt CP, Fanning NF, Malone L, Thornton J, Brennan P, Lee MJ. Thyroid dose during neurointerventional procedures: does lead shielding reduce the dose? C*ardiovasc Interv Radiol.* 2007;30(5):922–927.	Thyroid shields should be used on patients when having neurointerventional procedures of the head and neck.	RCT	IB	Patients with AVM or cerebral aneurysm	Placement of thyroid shield	No shield	56 procedures	Radiation dose
113	Shortt CP, Malone L, Thornton J, Brennan P, Lee MJ. Radiation protection to the eye and thyroid during diagnostic cerebral angiography: a phantom study. *J Med Imaging Radiat Oncol.* 2008;52(4):365–369.	Thyroid shields should be used on patients when having cerebral angiograms.	Comparative	IIIC	Phantom	Placement of thyroid shield	Those with and without a shield	4 studies with and 4 studies without shield	Radiation dose
114	Sancaktutar AA, Bozkurt Y, Onder Het al. A new practical model of testes shield: the effectiveness during abdominopelvic computed tomography. *J Androl.* 2012;33(5):984–989.	The use of a radiation glove over the testes is an effective radiation shield.	Descriptive	IIIB	Adult males	N/A	N/A	200 males	Radiation dose
115	Entrikin DW, Leipsic JA, Carr JJ. Optimization of radiation dose reduction in cardiac computed tomographic angiography. *Cardiol Rev.* 2011;19(4):163–176.	Recommends breast sheilds only if they do not interfer with the field of view.	Literature review	VA	N/A	N/A	N/A	N/A	N/A
116	Jackson G, Brennan PC. Radio-protective aprons during radiological examinations of the thorax: an optimum strategy. *Radiat Prot Dosimet* . 2006;121(4):391–394	The best location of an apron to protect the gonads during a chest x-ray will depend on the sex of the patient, the direction of the beam and the type of the apron.	Comparative	IIIC	Phantom representing the gonad region of the male and	Change in apron type and location	No apron to half apron facing the image receptor or X-ray tube or wrap around	N/A	Radiation dose
117	Connolly B, Racadio J, Towbin R. Practice of ALARA in the pediatric interventional suite. *Pediatr Radiol* . 2006;36(Suppl 2):163–167.	Summary of measures to take to use ALARA in Peds patients.	Expert opinion	VC	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
118	Giordano BD, Baumhauer JF, Morgan TL, Rechtine GR. Cervical spine imaging using standard C-arm fluoroscopy: patient and surgeon exposure to ionizing radiation. *Spine.* 2008;33(18):1970–1976.	The patient radiation dose is decreased as the patient moves closer to the image intensifier. Physicians performing c-arm fluoroscopy are exposed to radiation.	Descriptive	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
119	Sawdy JM, Kempton TM, Olshove Vet al. Use of a dose-dependent follow-up protocol and mechanisms to reduce patients and staff radiation exposure in congenital and structural interventions. *Catheter Cardiovasc Interv.* 2011;78(1):136–142.	A dose based follow-up protocol is better than a fluoroscopy time based follow-up protocol.	Comparative	IIIA	Children up to 18 yrs. of age	Changed followup protocol	Number of radiation burns before and after changing followup protocol	413 pts in phase 1 and 459 in phase 2	# of radiation burns
120	Rahimi SA, Coyle BW, Vogel TR, Haser PB, Graham AM. Acute radiation syndrome after endovascular AAA repair. *Vasc Endovasc Surg.* 2011;45(2):178–180	Report of a person experiencing GI problems as a portion of acute radiation syndrome after an endovascular AAA repair.	Case Report	VC	N/A	N/A	N/A	N/A	N/A
121	Marti N, Lopez V, Pereda C, Martin JM, Montesinos E, Jorda E. Radiation-induced temporary alopecia after embolization of cerebral aneurysms. *Dermatol Online J.* 2008;14(7):19	Patient lost her hair after each of two carotid-ophthalmic artery embolization. The hair loss was attributed to the amount of radiation received during the embolizations.	Case report	VC	Adult female	N/A	N/A	N/A	N/A
122	Balter S, Hopewell JW, Miller DL, Wagner LK, Zelefsky MJ. Fluoroscopically guided interventional procedures: a review of radiation effects on patients' skin and hair. *Radiology.* 2010;254(2):326–341.	The minimum radiation dose required to cause a specific reaction in the skin or hair is within a range, and the period of time before onset of the reaction is a range.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
123	Bor D, Olgar T, Onal E, Caglan A, Toklu T. Assessment of radiation doses to cardiologists during interventional examinations. *Med Phys.* 2009;36(8):3730–3736.	Cardiologists should wear dosimeters above and below their apron.	Descriptive	IIIA	Cardiologists and phantom	N/A	N/A	9 Cardiologists performing 166 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
124	Classic KL, Furutani KM, Stafford SL, Pulido JS. Radiation dose to the surgeon during plaque brachytherapy. *Retina.* 2012;32(9):1900–1905.	A surgeon can safely perform >1,000 cases without reaching the annual regulatory radiation dose for extremities.	Descriptive	IIIC	Surgeon	N/A	N/A	16 procedures plus laboratory measurement	Radiation dose
125	Cohen SA, Rangarajan SS, Chen T, Palazzi KL, Langford JS, Sur RL. Occupational hazard: radiation exposure for the urologist—developing a reference standard. *Int Braz J Urol.* 2013;39(2):209–213.	Total radiation exposure for the studied endourology practice is within the ICRP limits.	Descriptive	IIIC	1 urologist	N/A	N/A	134 endourology procedures	Radiation dose
126	Sanchez R, Vano E, Fernandez JMet al. A national programme for patient and staff dose monitoring in interventional cardiology. *Radiat Prot Dosimet.* 2011;147(1–2):57–61.	The amount of radiation received varied between the systems used, the locations and between staff members.	Descriptive/ questionnaire	IIIB	Adult staff in intervention al cardiology	N/A	N/A	42 professionals 1467 procedures	Radiation dose
127	Taher F, Hughes AP, Sama AAet al. 2013 Young Investigator Award winner: how safe is lateral lumbar interbody fusion for the surgeon? A prospective in vivo radiation exposure study. *Spine.* 2013;38(16):1386–1392.	A surgeon can do 2703 LLIF procedures in a year without exceeding the 2-rem whole body average dose per year.	Descriptive	IIIB	Surgeons	N/A	N/A	Surgeons who performed 18 procedures	Radiation dose
128	Ingwersen M, Drabik A, Kulka Uet al. Physicians' radiation exposure in the catheterization lab: does the type of procedure matter? *JACC: Cardiovasc Interv.* 2013;6(10):1096–1102.	Peripheral endovascular procedures resulted in greater radiation dose than coronary procedures.	Comparative	IIIB	Physicians	N/A	Endovascular procedures of the pelvic, upper limb, and below-the-knee and coronary procedures	3 operators in 284 procedures	Radiation dose
129	Kim KP, Miller DL, Berrington de Gonzalez Aet al. Occupational radiation doses to operators performing fluoroscopically-guided procedures. *Health Phys.* 2012;103(1):80–99.	Radiation is received by non-cardiologists and the amount received varies with the procedure.	Systematic literature Review	IIIA	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
130	Sciahbasi A, Romagnoli E, Trani Cet al. Operator radiation exposure during percutaneous coronary procedures through the left or right radial approach: the TALENT dosimetric substudy. *Circ Cardiovasc Interv.* 2011;4(3):226–231.	The cumulative radiation dose received during right or left radial artery approach for transradial percutaneous coronary procedures was similar and the cumulative dose was well under the annual limit.	Quasi-experimental	IIA	Physicians	Approach used for transradial percutaneous coronary procedures.	Compared radiation dose received during RRA vs LRA approaches	3 physicians conducting 390 procedures	Radiation dose
131	Domienik J, Brodecki M, Carinou Eet al. Extremity and eye lens doses in interventional radiology and cardiology procedures: first results of the ORAMED project. *Radiat Prot Dosimet* . 2011;144(1–4):442–447	The experience of the physician, the procedure and it's complexity, protective equipment used and technique all impact the dose of radiation received by the physician.	Descriptive	IIIA	Physicians	N/A	N/A	34 European hospitals/ 682 interventional radiology procedures	Radiation dose
132	Singh PJ, Perera NS, Dega R. Measurement of the dose of radiation to the surgeon during surgery to the foot and ankle. *J Bone Joint Surg Br.* 2007;89(8):1060–1063.	Orthopedic surgeons receive a low dose of radiation during fluoroscopy cases and that the dose to both hands is the same.	Prospective study	IIIC	Surgeons	N/A	N/A	One surgeon	Radiation dose
133	Vano E, Gonzalez L, Fernandez JM, Haskal ZJ. Eye lens exposure to radiation in interventional suites: caution is warranted. *Radiology.* 2008;248(3):945–953.	Eye doses may exceed limits if no protection is used.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
134	Lie OO, Paulsen GU, Wohni T. Assessment of effective dose and dose to the lens of the eye for the interventional cardiologist. *Radiat Prot Dosimet.* 2008;132(3):313–318.	The occupational exposure eye limits could be exceeded and therefore the eye would be the limiting organ.	Descriptive	IIIB	Cardiologists	N/A	N/A	N/A	Radiation dose
135	Mariscalco MW, Yamashita T, Steinmetz MP, Krishnaney AA, Lieberman IH, Mroz TE. Radiation exposure to the surgeon during open lumbar microdiscectomy and minimally invasive microdiscectomy: a prospective, controlled trial. *Spine.* 2011;36(3):255–260.	A surgeon is exposed to more radiation during a MIS lumbar microdiscectomy when compared to a open microdiscectomy and the staff should stand on the side opposite of the radiation source.	Quasi-experimental	IIB	Surgeons	MIS lumbar microdiscectomy	Open microdiscectomy	10 procedures split between 5 surgeons	Radiation dose
136	Kesavachandran CN, Haamann F, Nienhaus A. Radiation exposure of eyes, thyroid gland and hands in orthopaedic staff: a systematic review. *Eur J Med Res.* 2012;17:28.	Current radiation precautions appear to be accurate.	Systematic literature Review	IIIB	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
137	Radhi AM, Masbah O, Shukur MH, Shahril Y, Taiman K. Radiation exposure to operating theatre personnel during fluoroscopic-assisted orthopaedic surgery. *Med J Malaysia* . 2006;61(Suppl A):50–52.	Personnel in the OR received varying doses of radiation during orthopedic procedures, with the surgeon receiving the greatest dose, but all are below the maximum dose limits.	Descriptive	IIIC	OR personnel	N/A	N/A	25 procedures	Radiation dose
138	Ubeda C, Vano E, Gonzalez Let al. Scatter and staff dose levels in paediatric interventional cardiology: a multicentre study. *Radiat Prot Dosimet.* 2010;140(1):67–74.	The knowledge of differing scatter doses present with different operating modes, patient thicknesses and use of biplane systems may help pediatric cardiologists decrease their occupational radiation dose.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
139	Stavas JM, Smith TP, DeLong DM, Miller MJ, Suhocki PV, Newman GE. Radiation hand exposure during restoration of flow to the thrombosed dialysis access graft. *J Vasc Interv Radiol.* 2006;17(10):1611–1617.	Radiation dose to the hand is high in procedures to restore flow in thrombosed dialysis access grafts.	Descriptive	IIIB	Radiologists	N/A	N/A	54 patients	Radiation dose
140	Mroz TE, Abdullah KG, Steinmetz MP, Klineberg EO, Lieberman IH. Radiation exposure to the surgeon during percutaneous pedicle screw placement. *J Spinal Disord Tech* . 2011;24(4):264–267.	When radiation protective devices are used the radiation dose is well below the occupational exposure level and the surgeon can perform many pedicle screw insertions.	Descriptive	IIIC	Cadaver	N/A	N/A	N/A	Radiation dose
141	Hammer GP, Scheidemann-Wesp U, Samkange-Zeeb F, Wicke H, Neriishi K, Blettner M. Occupational exposure to low doses of ionizing radiation and cataract development: a systematic literature review and perspectives on future studies. *Radiat Environ Biophys* . 2013;52(3):303–319	The physician receives a dose of radiation to the eye and it may cause lens opacity.	Literature review	VA	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
142	Amoretti N, Lesbats V, Marcy PYet al. Dual guidance (CT and fluoroscopy) vertebroplasty: radiation dose to radiologists. How much and where? *Skeletal Radiol.* 2010;39(12):1229–1235.	The left orbit and the right hand of the operator are the most irradiated anatomical sites during Dual guidance (CT and fluoroscopy) vertebroplasty and the dosage may limit the number of procedures that can be safely performed.	Descriptive	IIIC	Physicians	N/A	N/A	24 procedures on 18 patients	Radiation dose
143	Fransen P. Fluoroscopic exposure in modern spinal surgery. *Acta Orthop Belg.* 2011;77(3):386–389.	Radiation dose may be decreased by simple awareness and training.	Descriptive	IIIB	Surgeons	N/A	N/A	95 procedures	Radiation dose
144	Schiefer H, von Toggenburg F, Seelentag Wet al. Exposure of treating physician to radiation during prostate brachytherapy using iodine-125 seeds: dose measurements on both hands with thermoluminescence dosimeters. *Strahlenther Onkol.* 2009;185(10):689–695.	If no other radiation exposure is considered, an experienced physician can perform about 400 prostatic brachytherapy seed applications per year without exceeding the limit of 500 mSv/year; but only 200 for novices.	Descriptive	IIIB	Physicians	N/A	N/A	4 physicians performing a total of 24 procedures	Radiation dose
145	T. The risk of radiation exposure to assisting staff in urological procedures: a literature review. *Urol Nurs.* 2013;33(3):136–139.	The dose of radiation received by assisting personnel using radiation protective devices is well below the ICRP recommendations.	Literature review	VB	N/A	N/A	N/A	9 articles	N/A
146	Dagal A. Radiation safety for anesthesiologists. *Curr Opin Anaesthesiol.* 2011;24(4):445–450.	The anesthesia care professional must understand the physical principles, the sources of radiation exposure, the potential risks, and safe practices helps to minimize the exposure risk and its potential deleterious effects.	Literature review	VB	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
147	Vanhavere F, Carinou E, Donadille Let al. An overview on extremity dosimetry in medical applications. *Radiat Prot Dosimet.* 2008;129(1–3):350–355.	The occupational limits of radiation should not be reached if good practices are used and protective measurers are present.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
148	Nottmeier EW, Pirris SM, Edwards S, Kimes S, Bowman C, Nelson KL. Operating room radiation exposure in cone beam computed tomography-based, image-guided spinal surgery: clinical article. *J Neurosurg Spine.* 2013;19(2):226–231.	The radiation dose received by dosimeters placed at various distances from the O-arm gantry decreased as the distance from the gantry increased.	Comparative	IIIB	N/A	N/A	Amount of radiation received at 6 locations each being farther away from the gantry	25 spinal surgery procedures	Radiation dose
149	Kumari G, Kumar P, Wadhwa P, Aron M, Gupta NP, Dogra PN. Radiation exposure to the patient and operating room personnel during percutaneous nephrolithotomy. *Int Urol Nephrol.* 2006;38(2):207–210.	The radiation dose to the personnel in the OR is inversely related to the distance they are away from the radiation source.	Descriptive	IIIB	OR staff involved in the 50 procedures	N/A	N/A	50 patients	Radiation Dose
150	Majidpour HS. Risk of radiation exposure during PCNL. *Urol J.* 2010;7(2):87–89.	The radiation dose to the personnel in the OR is less than that received by the urologist.	Descriptive	IIIB	Adults	N/A	N/A	100	Radiation dose
151	Haqqani OP, Agarwal PK, Halin NM, Iafrati MD. Defining the radiation “scatter cloud” in the interventional suite. *J Vasc Surg* . 2013;58(5):1339–1345	The radiation scatter cloud varies with the imaging technique and does not follow concentric circles described in the inverse square law. Need to keep as far away from the emitter as possible.	Descriptive	IIIB	Cadaver	N/A	N/A	N/A	Radiation dose
152	Abdullah KG, Bishop FS, Lubelski D, Steinmetz MP, Benzel EC, Mroz TE. Radiation exposure to the spine surgeon in lumbar and thoracolumbar fusions with the use of an intraoperative computed tomographic 3-dimensional imaging system. *Spine* . 2012;37(17):E1074–E1078.	Radiation exposure to the surgical staff when using an O-ARM is less than the occupational exposure level if appropriate distances are maintained from the scanner.	Prospective/ Descriptive	IIIC	1 surgeon	N/A	N/A	10 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
153	Efstathopoulos EP, Pantos I, Andreou Met al. Occupational radiation doses to the extremities and the eyes in interventional radiology and cardiology procedures. *Br J Radiol.* 2011;84(997):70–77.	The physicians standing near the source of the radiation receive a higher dose than the nurses who are farther away.	Descriptive	IIIB	Adults	N/A	N/A	5-cardiologists, 5- radiologists, 3-nurses	Radiation dose
154	Lee K, Lee KM, Park MS, Lee B, Kwon DG, Chung CY. Measurements of surgeons' exposure to ionizing radiation dose during intraoperative use of C-arm fluoroscopy. *Spine.* 2012;37(14):1240–1244.	Scatter radiation dose is decreased with increasing distance from the patient and thyroid shield use decreases the scatter radiation dose by 11.1% in the inverted configuration.	Descriptive	IIIC	Phantom patient and physician	N/A	N/A	N/A	Radiation Dose
155	Sulieman A, Elzaki M, Khalil M. Occupational exposure to staff during endoscopic retrograde cholangiopancreatography in Sudan. *Radiat Prot Dosimet.* 2011;144(1–4):530–533.	The radiation dose received by the nurse is much lower than the endoscopist because the nurse is further away from the source than the physician.	Retrospective descriptive	IIIB	Adults	N/A	N/A	Team of physician, nurse, second operator, at 3 hospitals, 55 procedures total	Radiation dose
156	Mesbahi A, Rouhani A. A study on the radiation dose of the orthopaedic surgeon and staff from a mini C-arm fluoroscopy unit. *Radiat Prot Dosimet.* 2008;132(1):98–101.	The staff radiation dose at a distance of >20 cm from the beam of a mini-c-arm was minimal when compared to the physician who is near the source.	Descriptive	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
157	Schueler BA, Vrieze TJ, Bjarnason H, Stanson AW. An investigation of operator exposure in interventional radiology. *Radiographics.* 2006;26(5):1533–1541.	Radiation exposure to the operator can be reduced by using dose reduction techniques such as increasing the distance from the source.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
158	Kim TW, Jung JH, Jeon HJ, Yoon KB, Yoon DM. Radiation exposure to physicians during interventional pain procedures. *Korean J Pain.* 2010;23(1):24–27.	Use of fluoroscopy during pain procedures is safe when using proper precautions.	Descriptive	IIIA	Physicians	N/A	N/A	505 procedures	Radiation Dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
159	Patel AP, Gallacher D, Dourado Ret al. Occupational radiation exposure during endovascular aortic procedures. *Eur J Vasc Endovasc Surg.* 2013;46(4):424–430.	The assistant received a lower dose than the operator because of being a greater distance away from the source.	Descriptive	IIIB	Adult physicians or residents	N/A	Dosimeter readings inside the apron and outside the apron	10 operators performing 36 cases	Radiation dose
160	Mitchell EL, Furey P. Prevention of radiation injury from medical imaging. *J Vasc Surg.* 2011;53(1 Suppl):22S–27S.	Radiation injury to both patient and staff injury is decreased if the operator minimizes total fluoroscopy time, keeps the image intensifier close to the patient, collimates to the region of interest, and uses appropriate radiation shielding and monitoring.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
161	von Wrangel A, Cederblad A, Rodriguez-Catarino M. Fluoroscopically guided percutaneous vertebroplasty: assessment of radiation doses and implementation of procedural routines to reduce operator exposure. *Acta Radiol* . 2009;50(5):490–496	There is less radiation exposure when the operator stands on the side opposite the X-ray tube.	Comparative	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
162	Blake ME, Oates ME, Applegate K, Kuligowska E; American Association for Women Radiologists; Association of Program Directors in Radiology. Proposed program guidelines for pregnant radiology residents: a project supported by the American Association for Women Radiologists and the Association of Program Directors in Radiology. *Acad Radiol* . 2006;13(3):391–401.	Guidelines for the pregnant resident in relation to radiation exposure.	Professional guideline	IVB	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
163	Best PJ, Skelding KA, Mehran Ret al.; Women in Innovations (WIN) group of the Society of Cardiac Angiography and Intervention. SCAI consensus document on occupational radiation exposure to the pregnant cardiologist and technical personnel. *Heart Lung Circ.* 2011;20(2):83–90.	Guideline for pregnant cardiologists.	Professional guideline	IVB	N/A	N/A	N/A	N/A	N/A
164	Chandra V, Dorsey C, Reed AB, Shaw P, Banghart D, Zhou W. Monitoring of fetal radiation exposure during pregnancy. *J Vasc Surg.* 2013;58(3):710–714.	If standard safety measurers are followed the fetus of a pregnant employee receives a negligible radiation dose.	Retrospective/ descriptive	IIIC	Pregnant physicians	N/A	N/A	81 women	Radiation dose
165	Kesavachandran CN, Haamann F, Nienhaus A. Radiation exposure and adverse health effects of interventional cardiology staff. *Rev Environ Contam Toxicol.* 2013;222:73–91.	Radiation doses for the anatomical locations of eye, thyroid gland and hands were lower than the dose levels recommended.	Systematic literature Review	IIIB	N/A	N/A	N/A	N/A	N/A
166	Basic B, Beganovic A, Skopljak-Beganovic A, Samek D. Occupational exposure doses in interventional procedures in Bosnia and Herzegovina. *Radiat Prot Dosimet.* 2011;144(1–4):501–504.	Two dosimeters should be used	Descriptive	IIIB	Staff in IR suite	N/A	N/A	90 staff members in 5 facilities	Radiation dose
167	Chida K, Takahashi T, Ito D, Shimura H, Takeda K, Zuguchi M. Clarifying and visualizing sources of staff-received scattered radiation in interventional procedures. *Am J Roentgenol.* 2011;197(5):W900–W903.	Radiation protection is needed by physicians who stand close to the source of the radiation. The sources of scatter radiation are the patient and the x-ray source.	Descriptive	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
168	ASGE Technology Committee; Pedrosa MC, Farraye FA, Shergill AKet al. Minimizing occupational hazards in endoscopy: personal protective equipment, radiation safety, and ergonomics. *Gastrointest Endosc.* 2010;72(2):227–235.	Guidelines for radiation protection for the Endoscopy Suite.	Professional Guidelines	IVB	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
169	Chida K, Kato M, Kagaya Yet al. Radiation dose and radiation protection for patients and physicians during interventional procedure. *J Radiat Res.* 2010;51(2):97–105.	Describes safety measurers that should be used to decrease the radiation dose.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
170	Schueler BA. Reducing occupational exposure from fluoroscopy. *J Am Coll Radiol.* 2007;4(5):335–337.	Shielding devices should be worn.	Expert opinion	VC	N/A	N/A	N/A	N/A	N/A
171	Smilowitz NR, Balter S, Weisz G. Occupational hazards of interventional cardiology. *Cardiovasc Revasc Med.* 2013;14(4):223–228.	Education, new technologies, and protection can all decrease the cardiologists exposure to scatter radiation.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
172	Koshy S, Thompson RC. Review of radiation reduction strategies in clinical cardiovascular imaging. *Cardiol Rev.* 2012;20(3):139–144.	Provides a good listing of safety measures to take.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
173	Lymperopoulou G, Papagiannis P, Sakelliou L, Georgiou E, Hourdakis CJ, Baltas D. Comparison of radiation shielding requirements for HDR brachytherapy using 169Yb and 192Ir sources. *Med Phys* . 2006;33(7):2541–2547.	The radiation shielding requirements for 169Yb are less than the requirements for 192Ir.	Comparative	IIIB	Phantom	N/A	Thickness of protection required for 169Yb vs 192Ir.	N/A	Radiation dose
174	Facility Guidelines Institute. *Guidelines for Design and Construction of Hospitals and Outpatient Facilities.* Chicago, IL: American Society for Healthcare Engineering; 2014.	Guidelines for building facilities.	Professional Guidelines	IVC	N/A	N/A	N/A	N/A	N/A
175	Sabnis RB, Mishra S, Sharma R, Desai MR. Pre-operative planning and designing of a fluorocompatible endourology operating room. *J Endourol.* 2009;23(10):1579–1585.	The design of an endourology suite requires a variety of equipment and shielding.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
176	Brusin JH. Radiation protection. *Radiol Technol.* 2007;78(5):378–395.	Expert opinion on the different measures to take for protection.	Expert opinion	VB	Adult physicians	Non-lead aprons	Lead aprons	X-ray attenuation	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
177	Uthoff H, Pena C, West J, Contreras F, Benenati JF, Katzen BT. Evaluation of novel disposable, light-weight radiation protection devices in an interventional radiology setting: a randomized controlled trial. *Am J Roentgenol.* 2013;200(4):915–920.	An RCT which concludes that hat the amount of radiation protection provided by the bilayer barium sulfate–bismuth oxide composite thyroid shield is not significantly different than the amount of protection provided by the standard 0.5-mm lead-equivalent thyroid collar.	RCT	IA	Interventional opeartors	application of protective garments	Dosage outside versus inside protective garments	2 operators performing 60 procedures	Radiation attentuation
178	Mori H, Koshida K, Ishigamori O, Matsubara K. Evaluation of the effectiveness of X-ray protective aprons in experimental and practical fields. *Radiol Phys Technol.* 2014;7(1):158–166.	0.25-mm lead-equivalent thick aprons are effective for interventional radiology operators and 0.35-mm lead aprons are effective for computed tomography nurses.	Descriptive	IIIC	Adults	N/A	N/A	4 types of aprons	Radiation dose
179	Chatterson LC, Leswick DA, Fladeland DA, Hunt MM, Webster ST. Lead versus bismuth-antimony shield for fetal dose reduction at different gestational ages at CT pulmonary angiography. *Radiology* . 2011;260(2):560–567.	A shield of bismuth-antimony was as effective as a lead shield when conservative scanning parameters are used.	Descriptive	IIIC	Phantom	N/A	With or without shielding, lead or bismuth-antimony	N/A	Radiation dose
180	Lee SY, Min E, Bae Jet al. Types and arrangement of thyroid shields to reduce exposure of surgeons to ionizing radiation during intraoperative use of C-arm fluoroscopy. *Spine.* 2013;38(24):2108–2112.	Thyroid shields should be worn tightly or loosely in combination with a bismuth masking reagent. Some form of a thyroid shield should be worn.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
181	Zuguchi M, Chida K, Taura M, Inaba Y, Ebata A, Yamada S. Usefulness of non-lead aprons in radiation protection for physicians performing interventional procedures. *Radiat Prot Dosimet.* 2008;131(4):531–534.	Non-lead aprons provide sufficient protection for personnel in the room.	Comparative	IIIC	Phantom	N/A	Non-lead vs lead aprons	N/A	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
182	Ploux S, Ritter P, Haissaguerre M, Clementy J, Bordachar P. Performance of a radiation protection cabin during implantation of pacemakers or cardioverter defibrillators. *J Cardiovasc Electrophysiol* . 2010;21(4):428–430.	The use of a radiation cabin is as effective as the use of the apron, thyroid shield and leaded glasses but provides additional radiation to the head without having to wear the other shielding devices.	RCT	IB	1 surgeon	Use of cabin	Use of lead apron thyroid collar and leaded glasses without cabin	30 with and 30 without	Radiation dose
183	Behan M, Haworth P, Colley Pet al. Decreasing operators' radiation exposure during coronary procedures: the transradial radiation protection board. *Catheter Cardiovasc Interv.* 2010;76(1):79–84.	A transradial radiation protection board is effective at reducing the amount of radiation received by the operator.	RCT	IB	5 physicians	Protection board used	No protection board	106 procedures	Radiation dose
184	Nikodemová D, Brodecki M, Carinou Eet al. Staff extremity doses in interventional radiology. Results of the ORAMED measurement campaign. *Radiat Measur.* 2011;46(11):1210–1215.	A ceiling suspended shield and a below the table shield should be used to reduce the operator radiation dose.	Comparative	IIIA	Physicians	N/A	The use or non-use of a ceiling suspended shield and a below the table shield	645 procedures	Radiation dose
185	Vanhavere F, Carinou E, Domienik Jet al. Measurements of eye lens doses in interventional radiology and cardiology: final results of the ORAMED project. *Radiat Measur.* 2011;46(11):1243–1247.	A well placed suspended ceiling shield and lead glasses provide the best protection to the eyes.	Descriptive	IIIA	Physicians	N/A	N/A	34 hospitals, 1300 procedures	Eye radiation dose
186	Koukorava C, Carinou E, Simantirakis Get al. Doses to operators during interventional radiology procedures: focus on eye lens and extremity dosimetry. *Radiat Prot Dosimet.* 2011;144(1–4):482–486.	The radiation dose to the eyes was reduced up to 98% with the use of the ceiling suspended shield.	Descriptive	IIIB	Phantom	N/A	N/A	N/A	Radiation dose
187	Carinou E, Brodecki M, Domienik Jet al. Recommendations to reduce extremity and eye lens doses in interventional radiology and cardiology. *Radiat Measur.* 2011;46(11):1324–1329.	Sheilding devices of all types should be used.	Descriptive	IIIA	Flouroscopy Operators	N/A	N/A	850 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
188	Tsapaki V, Paraskeva KD, Mathou Net al. Patient and endoscopist radiation doses during ERCP procedures. *Radiat Prot Dosimet.* 2011;147(1–2):111–113.	The use of fixed shields keeps the radiation dose to the endoscopist low.	Descriptive	IIIB	Endoscopist	N/A	N/A	1 endoscopist performing 157 procedures	Radiation dose
189	Shortt CP, Al-Hashimi H, Malone L, Lee MJ. Staff radiation doses to the lower extremities in interventional radiology. *Cardiovasc Interv Radiol.* 2007;30(6):1206–1209.	A lead curtain under the table reduced the radiation dose received by the operator's legs by 64%.	Comparative	IIIB	Physicians	Application of below bed curtain	Before and after application of curtain	9 procedures	Radiation dose
190	Jordan RM, Mohammad F, Taylor WB, Cura M, Savage C. Comparison of fluoroscopic operator eye exposures when working from femoral region, side, or head of patient. *Baylor Univ Med Cent Proc.* 2013;26(3):243–246.	Use of a suspended personal radiation protection system greatly reduced the radiation dose to the eyes of the operator.	Comparative	IIIB	Adults	Use of suspended personal radiation protection system	Use of routine shielding vs use of the suspended personal radiation protection system.	3 operators performing a total of 130 procedures	Radiation dose
191	Marichal DA, Anwar T, Kirsch Det al. Comparison of a suspended radiation protection system versus standard lead apron for radiation exposure of a simulated interventionalist. *J Vasc Interven Radiol.* 2011;22(4):437–442.	Use of a suspended personal radiation protection system greatly reduced the radiation dose to the left axilla, eyes, and gonads of the operator.	Comparative	IIIC	Phantom	Use of a suspended personal radiation protection system	Suspended personal radiation protection system -vs- standard lead apron.	N/A	Radiation dose
192	Maeder M, Brunner-La Rocca HP,Wolber Tet al. Impact of a lead glass screen on scatter radiation to eyes and hands in interventional cardiologists. *Catheter Cardiovasc Interv.* 2006;67(1):18–23.	The use of the transparent lead glass screen decreased the radiation dose to the eyes of the operators.	Comparative	IIIB	3 operators	Use of transparent lead glass screen	Procedures with and without the transparent lead glass screen	753 procedures without screen 250 procedures with screen	Radiation dose
193	Mesbahi A, Mehnati P, Keshtkar A, Aslanabadi N. Comparison of radiation dose to patient and staff for two interventional cardiology units: a phantom study. *Radiat Prot Dosimet.* 2008;131(3):399–403.	The use of shielding attached to the unit decreases the amount of scatter radiation received by the operator.	Comparative	IIIB	Phantom	Placement of shield	No shielding present	N/A	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
194	Schulz B, Heidenreich R, Heidenreich Met al. Radiation exposure to operating staff during rotational flat-panel angiography and C-arm cone beam computed tomography (CT) applications. *Eur J Radiol.* 2012;81(12):4138–4142.	Radiation dose to the eye and thyroid is reduced when a leaded glass shield is used.	Descriptive	IIIC	Phantom	N/A	N/A	N/A	Radiation dose
195	Thornton RH, Dauer LT, Altamirano JP, Alvarado KJ, St Germain J, Solomon SB. Comparing strategies for operator eye protection in the interventional radiology suite. *J Vasc Interv Radiol.* 2010;21(11):1703–1707.	Maximum protection to the eye is provided by the use of scatter-shielding drapes plus leaded glasses or use of suspended or rolling leaded shields.	Descriptive	IIIC	Phantom	N/A	With and without a leaded table skirt, nonleaded and leaded eyeglasses, disposable tungsten-antimony drapes, and suspended and rolling transparent leaded shields.	N/A	Eye radiation dose
196	Sauren LD, van Garsse L, van Ommen V, Kemerink GJ. Occupational radiation dose during transcatheter aortic valve implantation. *Catheter Cardiovasc Interv.* 2011;78(5):770–776.	Use of a lead drape decreases radiation dose to the legs and feet.	Descriptive	IIIC	Cardiologist, CT surgeon, 2 assistants per case	N/A	N/A	Staff involved in 22 TAVI	Radiation dose
197	Fetterly KA, Magnuson DJ, Tannahill GM, Hindal MD, Mathew V. Effective use of radiation shields to minimize operator dose during invasive cardiology procedures. *Cardiovasc Interv.* 2011;4(10):1133–1139.	The use of shields decreases the amount of scatter radiation received by the staff members.	Descriptive	IIIC	Phantom	N/A	N/A	Phantom	Radiation dose
198	Mahnken AH, Sedlmair M, Ritter C, Banckwitz R, Flohr T. Efficacy of lower-body shielding in computed tomography fluoroscopy-guided interventions. *Cardiovasc Interv Radiol.* 2012;35(6):1475–1479.	Lower body shielding was effective at reducing scatter radiation at 50 and 100 cm above the floor.	Descriptive	IIIC	Phantom	N/A	N/A	3 scans at 20, 40, 60, and 80 mAs with a fixed fluoroscopy time of 20 sec.	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
199	Karadag B, Ikitimur B, Durmaz Eet al. Effectiveness of a lead cap in radiation protection of the head in the cardiac catheterisation laboratory. *EuroIntervention.* 2013;9(6):754–756.	Use of a radiation protective cap reduces the radiation dose to the head.	Comparative	IIIB	1 surgeon	Application of cap	Dose with and without cap	1232 procedures	Radiation dose
200	Ahn Y, Kim CH, Lee JH, Lee SH, Kim JS. Radiation exposure to the surgeon during percutaneous endoscopic lumbar discectomy: a prospective study. *Spine.* 2013;38(7):617–625.	The allowable number of percutaneous endoscopic lumbar discectomy cases per year is 291 without protective equipment and increases with protective equipment.	Prospective/ Descriptive	IIIB	3 surgeons	N/A	N/A	30 procedures over 3 months	Radiation dose
201	Parashar B, Wernicke AG, Pavese Aet al. Cesium-131 permanent seed brachytherapy: dosimetric evaluation and radiation exposure to surgeons, radiation oncologists, and staff. *Brachytherapy.* 2011;10(6):508–513.	Surgical staff should wear shielding devices during brachytherapy insertion procedures because they lower the amount of exposure to the staff, and the implantation should be done at the end of the procedure.	Descriptive	IIIC	Surgeon and staff	N/A	Radiation dose from 131Cs compared with 125I.	28 patients	Radiation dose
202	Ismail S, Khan F, Sultan N, Naqvi M. Radiation exposure to anaesthetists during interventional radiology. *Anaesthesia.* 2010;65(1):54–60.	Lead protection devices should be used by anesthesia staff and use will assist in keeping the doses ALARA.	Descriptive	IIIB	Anesthesia professionals	N/A		124 procedures. Number of anesthesia professionals not cited	Radiation dose
203	van der Merwe B. Radiation dose to surgeons in theatre. *S Afr J Surg.* 2012;50(2):26–29.	Wearing an apron reduces the amount of radiation received during fluoroscopic procedures.	Descriptive	IIIA	Surgeons	N/A	N/A	94 procedures	Radiation dose
204	Alzimami K, Sulieman A, Paroutoglou G, Potamianos S, Vlychou M, Theodorou K. Optimisation of radiation exposure to gastroenterologists and patients during therapeutic ERCP. *Gastroenterol Res Pract.* 2013;2013:587574.	The person who faces the radiation source receives the greatest dose of radiation when compared to those who who do not face the source. Wrap around aprons should be worn by those who face away from the source.	Comparative	IIIB	Physicians and trainees.	N/A	Level of radiation dose received by the 1st, 2nd, 3rd examiner	153 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
205	Mechlenburg I, Daugaard H, Soballe K. Radiation exposure to the orthopaedic surgeon during periacetabular osteotomy. *Int Orthop* . 2009;33(6):1747–1751.	Use of a thyroid collar reduces the radiation dose received to the thyroid area.	Descriptive	IIIC	1 surgeon	N/A	N/A	23 procedures	Radiation dose
206	Vano E, Kleiman NJ, Duran A, Romano-Miller M, Rehani MM. Radiation-associated lens opacities in catheterization personnel: results of a survey and direct assessments. *J Vasc Interv Radiol.* 2013;24(2):197–204.	Eye protection should be worn during radiation exposure.	Quasi-experimental	IIA	Adult staff in interventional radiology	N/A	Eye lens opacity in worker group to control group	58 physicians/69 nurses and technicians	Radiation dose
207	Antic V, Ciraj-Bjelac O, Rehani M, Aleksandric S, Arandjic D, Ostojic M. Eye lens dosimetry in interventional cardiology: results of staff dose measurements and link to patient dose levels. *Radiat Prot Dosimet.* 2013;154(3):276–284.	Workers radiation exposure to the eye correlates with the dose received by the patient therefore eye protection should be used.	Descriptive	IIIB	Staff in IR suite	N/A	N/A	106 procedures	Eye radiation dose
208	Burns S, Thornton R, Dauer LT, Quinn B, Miodownik D, Hak DJ. Leaded eyeglasses substantially reduce radiation exposure of the surgeon's eyes during acquisition of typical fluoroscopic views of the hip and pelvis. *J Bone Joint Surg Am* . 2013;95(14):1307–1311.	Leaded eyeglasses should be worn by orthopedists during intraoperative fluoroscopic procedures.	Descriptive	IIIB	Phantom	N/A	N/A	16 different radiographic views	Radiation dose
209	Mroz TE, Yamashita T, Davros WJ, Lieberman IH. Radiation exposure to the surgeon and the patient during kyphoplasty. *J Spinal Disord Tech.* 2008;21(2):96–100.	Surgeons should wear radiation protective devices including lead glasses when performing kyphoplasty.	Comparative/ prospective	IIIC	Surgeons	Dosimeter outside shield	Dosimeter inside shield	27 procedures	Radiation dose
210	Sturchio GM, Newcomb RD, Molella R, Varkey P, Hagen PT, Schueler BA. Protective eyewear selection for interventional fluoroscopy. *Health Phys.* 2013;104(2 Suppl 1):S11–S16.	Protective eyewear should be worn and needs to be selected based on the task being performed.	Comparative	IIIB	Phantom	N/A	Three types of eye shields	N/A	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
211	*NCRP Report No. 168, Radiation Dose Management for Fluoroscopically-Guided Interventional Medical Procedures.* Bethesda, MD: National Council on Radiation Protection & Measurements; 2010.	Report on the recommendations of the NCRP.	Expert opinion	VA	N/A	N/A	N/A	N/A	N/A
212	Rehani MM, Vano E, Ciraj-Bjelac O, Kleiman NJ. Radiation and cataract. *Radiat Prot Dosimet.* 2011;147(1–2):300–304.	Leaded eyeglasses or other eye protection should be used.	Literature review	VB	N/A	N/A	N/A	N/A	N/A
213	Taylor ER, Kramer B, Frye TP, Wang S, Schwartz BF, Kohler TS. Ocular radiation exposure in modern urological practice. *J Urol.* 2013;190(1):139–143.	The typical urologist may not need to use lead lined glasses to prevent cataracts related to the small amount of radiation received.	Descriptive	IIIB	Urologists	N/A	N/A	6 urologists performed 28 urological procedures	Radiation dose
214	Penfold SN, Marcu L, Lawson JM, Asp J. Evaluation of physician eye lens doses during permanent seed implant brachytherapy for prostate cancer. *J Radiol Prot.* 2012;32(3):339–347.	The typical urologist may not need to use lead lined glasses to prevent cataracts when performing brachytherapy using I-125 seeds related to the small amount of radiation received, but the surgeon needs to consider the annual total radiation exposure.	Descriptive	IIIC	Surgeons	N/A	N/A	3 surgeons performing 1 procedure each	Radiation dose
215	Politi L, Biondi-Zoccai G, Nocetti Let al. Reduction of scatter radiation during transradial percutaneous coronary angiography: a randomized trial using a lead-free radiation shield. *Catheter Cardiovasc Interv.* 2012;79(1):97–102.	Use of a sterile, disposable bismuth-barium radiation shield drape reduces the amount of scatter radiation dose received by the operator significantly.	RCT	IB	1 surgeon	Application of shield drape	No shield drape used	60 procedures	Radiation dose
216	Murphy JC, Darragh K, Walsh SJ, Hanratty CG. Efficacy of the RADPAD protective drape during real world complex percutaneous coronary intervention procedures. *Am J Cardiol.* 2011;108(10):1408–1410.	The amount of scatter radiation received by the operators hand was decreased with the use of a sterile, disposable bismuth and antimony-containing drape.	RCT	IB	Cardiologists	Placement of RADPAD drape	No drape	60 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
217	Lange HW, von Boetticher H. Reduction of operator radiation dose by a pelvic lead shield during cardiac catheterization by radial access: comparison with femoral access. *Cardiovasc Interv.* 2012;5(4):445–449.	The operator radiation exposure is lessened with the placement of a pelvic lead shield on the patient during cardiac catheterizations.	RCT	IB	Operators	radial vs femoral access, and placement of pelvic lead shielding on the patient	radial vs femoral access with and without pelvic lead shielding of the patient	210 patients	Operator radiation dose
218	Brambilla M, Occhetta E, Ronconi M, Plebani L, Carriero A, Marino P. Reducing operator radiation exposure during cardiac resynchronization therapy. *Europace* . 2010;12(12):1769–1773.	The amount of scatter radiation received by the operators hand was decreased by 54% with the use of a sterile, disposable bismuth and antimony-containing drape.	Quasi-experimental	IIC	1 cardiologist	Radpad applied	Without Radpad	22 procedures	Scatter radiation dose
219	Iqtidar AF, Jeon C, Rothman R, Snead R, Pyne CT. Reduction in operator radiation exposure during transradial catheterization and intervention using a simple lead drape. *Am Heart J.* 2013;165(3):293–298.	A sterile lead drape decreases operator exposure, to all dosimeter sties except those at the collar level.	Comparative	IIIB	Physicians	N/A	Enhanced-vs-standard shielding	137 procedures	Radiation Dose
220	Synowitz M, Kiwit J. Surgeon's radiation exposure during percutaneous vertebroplasty. *J Neurosurg Spine.* 2006;4(2):106–109.	Use of leaded gloves reduces the surgeon's radiation exposure to the hands.	Quasi-experimental	IIB	Surgeons	Application of glove	No glove	40 procedures/2 surgeons	Radiation dose
221	Schueler BA. Operator shielding: how and why. *Tech Vasc Interv Radiol.* 2010;13(3):167–171.	New and innovative products for radiation should be created.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
222	Challa K, Warren SG, Danak S, Bates MC. Redundant protective barriers: minimizing operator occupational risk. *J Interv Cardiol.* 2009;22(3):299–307.	The use of a combinations of personal and movable lead barriers resulted in a significant reduction in total-body operator radiation exposure.	Descriptive	IIIB	Physician	N/A	Dosages inside and outside personal and movable protective barriers used concurrently	50 procedures by one operator	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
223	von Boetticher H, Lachmund J, Hoffmann W. Cardiac catheterization: impact of face and neck shielding on new estimates of effective dose. *Health Phys.* 2009;97(6):622–627.	The greatest amount of protection was received when the apron was worn with the thyroid shield and the table mounted upper and lower body protection were used.	Quasi-experimental	IIB	Phantom patient and operator	N/A	N/A	N/A	Radiation dose
224	Oyar O, Kislalioglu A. How protective are the lead aprons we use against ionizing radiation? *Diagn Interv Radiol.* 2012;18(2):147–152.	All aprons were needing replacement even those less than 2 yrs. old. They used a control group of never used aprons.	Descriptive	IIIB	N/A	X-rayed the aprons to check for breaks.	N/A	85 aprons	Presence or absence of breaks
225	White T. Management of leaded PPE in the healthcare environment. *Health Phys.* 2013;105(5 Suppl 3):S231–S236.	A quality report covering a program in one facility which is used for tracking and identifying the shielding devices and the testing of the shields.	Quality report	VB	N/A	N/A	N/A	N/A	N/A
226	Guideline for environmental cleaning. In: *Guidelines for Perioperative Practice* . Denver, CO: AORN, Inc; 2014:9–30.	Guidlines on cleaning the OR.	Professional Guideline	IVA	N/A	N/A	N/A	N/A	N/A
227	Boyle H, Strudwick RM. Do lead rubber aprons pose an infection risk? *Radiography.* 2010;16(4):297–303.	Aprons contain microorganisms after use and need to be routinely cleaned.	Quantitative	IIIC	Aprons	N/A	N/A	15 aprons	Presence of microorganisms
228	Grogan BF, Cranston WC, Lopez DM, Furbee C, Murray CK, Hsu JR. Do protective lead garments harbor harmful bacteria? *Orthopedics.* 2011;34(11):861–861.	Weekly cleaning of lead protective garments was adequate.	Descriptive	IIIB	N/A	N/A	N/A	182 aprons	Presence of bacteria
229	10 CFR 30.41—Transfer of byproduct material. US NRC. http://www.nrc.gov/reading-rm/doc-collections/cfr/part030/part030-0041.html. Accessed April 14, 2015.	Regulations for handling radioactive byproduct.	Regulatory	R	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
230	29 CFR 1910.1096. Toxic and hazardous substances: Ionizing radiation. Occupational Safety and Health Administration. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10098. Accessed April 13, 2015.	Regulations covering disposal of radioactive materials.	Regulatory	R	N/A	N/A	N/A	N/A	N/A
231	Chida K, Kaga Y, Haga Yet al. Occupational dose in interventional radiology procedures. *Am J Roentgenol.* 2013;200(1):138–141.	The two-badge method for estimating the occupational dose in interventional radiology should be used.	Comparative	IIIB	Staff in an IR suite	wearing one or two dosimeters	One to two dosimeters	18 physicians, 7 IR nurses, 8 IR techs	Radiation dose
232	Ginjaume M, Perez S, Ortega X. Improvements in extremity dose assessment for ionising radiation medical applications. *Radiat Prot Dosimet.* 2007;125(1–4):28–32.	Finger dosimeters should be worn by personnel who are within one meter (39.37 inches) of the primary x-ray beam.	Descriptive	IIIC	Radiologist and radiation technologists	N/A	N/A	4 people each having about 13 hours of flourotime and receiving 4850 GY/square cm.	Difference between ring dosimeter, wrist and whole body dosimeter.
233	Hausler U, Czarwinski R, Brix G. Radiation exposure of medical staff from interventional x-ray procedures: a multicentre study. *Eur Radiol.* 2009;19(8):2000–2008.	Shielding is effective and finger dosimeters should be worn by physicians; dose received by assistants were less then the physicians.	Descriptive/ Comparative	IIIB	Adults	N/A	N/A	39 physicians and 9 assistants in 73 procedures	Radiation dose
234	Fujii K, Ko S, Nako Yet al. Dose measurement for medical staff with glass dosemeters and thermoluminescence dosemeters during 125I brachytherapy for prostate cancer. *Radiat Prot Dosimet* . 2011;144(1–4):459–463.	The staff in the OR who were greater distance away from the source and behind a lead glass partition during brachytherapy received a lesser dose than the surgeon who was handling the seeds.	Descriptive	IIIB	Staff in OR during brachytherapy seed implantation	N/A	N/A	20 procedures	Radiation dose
235	*NRC: Iodine-125 and Palladium-103 Low Dose Rate Brachytherapy Seeds Used for Localization of Non-Palpable Lesions.* US NRC. http://www.nrc.gov/materials/miau/med-use-toolkit/seed-localization.html. Accessed April 14, 2015.	Regulations covering use of radioactive seeds.	Regulatory	R	N/A	N/A	N/A	N/A	N/A

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
236	Coventry BJ, Collins PJ, Kollias J,et al. Ensuring radiation safety to staff in lymphatic tracing and sentinel lymph node biopsy surgery—some recommendations. *J Nucl Med Radiat Ther.* 2012;S2:008.	Proective clothing and dosimeters do not need to be worn during sentinal node biopsies.	Descriptive	IIIC	Perioperative team	N/A	N/A	36 procedures	Radiation dose
237	Guideline for prevention of retained surgical items. In: *Guidelines for Perioperative Practice.* Denver, CO: AORN, Inc; 2015:347–363.	Guidlines for counting items on the surgical field.	Professional Guideline	IVB	N/A	N/A	N/A	N/A	N/A
238	Lamm IL, Horton P, Lehmann W, Lillicrap S. Practical application of suspension criteria scenarios: radiotherapy. *Radiat Prot Dosimet.* 2013;153(2):179–184.	Case report covering incidents involving brachytherapy including a lost seed.	Case report	VB	N/A	N/A	N/A	N/A	N/A
239	Guideline for sterilization. In: *Guidelines for Perioperative Practice.* Denver, CO: AORN, Inc; 2015:665–692.	Guidlines on sterilizing instruments.	Professional Guideline	IVA	N/A	N/A	N/A	N/A	N/A
240	Pavlicek W, Walton HA, Karstaedt PJ, Gray RJ. Radiation safety with use of I-125 seeds for localization of nonpalpable breast lesions. *Acad Radiol. 2006;13(7):909–915.*	Report of a procedure within one faculty.	Quality Report	VB	N/A	N/A	N/A	N/A	N/A
241	Miner TJ, Shriver CD, Flicek PRet al. Guidelines for the safe use of radioactive materials during localization and resection of the sentinel lymph node. *Ann Surg Oncol* . 1999;6(1):75–82	Guidelines for the safe use of radioactive materials during localization and resection of the sentinel lymph node.	Descriptive	IIIB	Tissue of patients	N/A	N/A	342 specimens	Radiation present
242	Michel R, Hofer C. Radiation safety precautions for sentinel lymph node procedures. *Health Phys.* 2004;86(2 Suppl):S35–S37.	Provides recommendations for safety precautions during sentinel lymph node procedures.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
243	Klausen TL, Chakera AH, Friis E, Rank F, Hesse B, Holm S. Radiation doses to staff involved in sentinel node operations for breast cancer. *Clin Physiol Funct Imaging.* 2005;25(4):196–202.	The radiation dose received by the surgeon who is the closest to the source of the radiation is within the safe limits when radiating sentinel nodes during surgery.	Descriptive	IIIB	Surgeons	N/A	N/A	79 procedures	Radiation dose

Reference #	Citation	Conclusion(s)	Evidence Type	Concensus score	Population	Intervention	Comparision	Sample size	Outcome measure
244	Law M, Chow LW, Kwong A, Lam CK. Sentinel lymph node technique for breast cancer: radiation safety issues. *Semin Oncol.* 2004;31(3):298–303.	Dosimeter readings should be used as a guide when implementing guidelines for safe handling of radioactive specimens.	Quality report	VB	N/A	N/A	N/A	N/A	N/A
245	Khan S, Syed A, Ahmad R, Rather TA, Ajaz M, Jan F. Radioactive waste management in a hospital. *Int J Health Sci.* 2010;4(1):39–46.	Describes the different disposal methods for radioactive waste.	Expert opinion	VB	N/A	N/A	N/A	N/A	N/A
246	10 CFR 20.1905. Exemptions to labeling requirements. 2013. *US Government Publishing Office.* http://www.gpo.gov/fdsys/pkg/CFR-2013-title10-vol1/pdf/CFR-2013-title10-vol1-part20.pdf. Accessed April 14, 2015.	Regulations for labeling radioactive materials.	Regulatory	R	N/A	N/A	N/A	N/A	N/A
247	Kaulich TW, Bamberg M. Radiation protection of persons living close to patients with radioactive implants. *Strahlenther Onkol.* 2010;186(2):107–112.	Wearing radiation protective clothing decreased the amount radiation received by family & etc when the patient had brachytherapy implants.	Descriptive	IIIC	N/A	N/A	N/A	Mathematical calculations bsed on a formula.	Radiation dose
248	Keller BM, Pignol JP, Rakovitch E, Sankreacha R, O'Brien P. A radiation badge survey for family members living with patients treated with a (103)Pd permanent breast seed implant. *Int J Radiat Oncol Biol Phys.* 2008;70(1):267–271.	Breast patches should be worn when the patient having a radioactive breast implant is in the presence of toddlers or pregnant women.	Descriptive	IIIB	Men with prostatic brachytherapy implants.	Wearing radioprotective shorts.	Wearing day of implant to not wearing to appying 3 days later.	200 patients	Radiation dose received by family and friends.