IAEA and ICRP's Work on Radiation Protection in Interventional Procedures

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Who?

Those performing "interventions" e.g. opening a blocked artery, blocking blood supply to tumor, nerve root, biopsy…. under fluoroscopic guidance

Specialists performing interventions

Besides interventional radiologists (IR), either alone or with help of IR

- **Cardiologists**
- **Electro-physiologists (EPs)**
- **Vascular surgeons**
- **Orthopedic surgeons**
- **Urologists**
- **Gastroenterologists**
- **….many more……**

Interventional Procedures

Group I:

- **Interventional Cardiologists, Electro-physiologists, Interventional radiologists**

Group II:

- **Vascular surgeons**

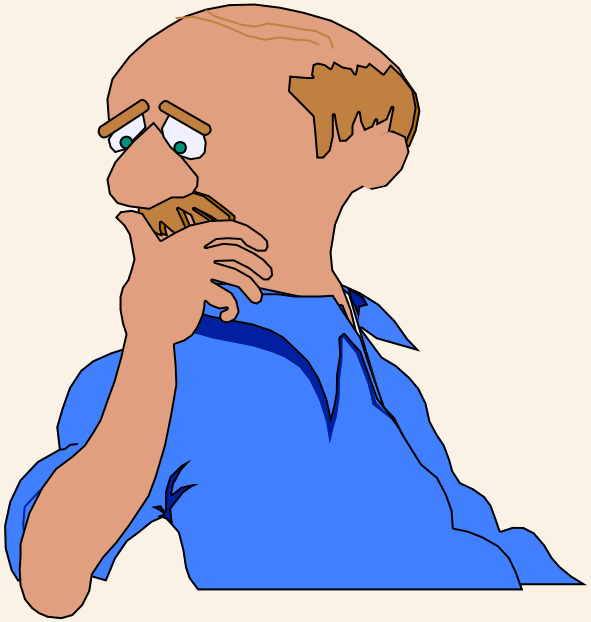
Group III:

- **Orthopedic surgeons, Urologists, Gastroenterologists, Anesthetists…..**

(Unofficial classification with overlap of functions)

Why focus on them?

- **Are there radiation risks?**



Cardiac Interventions

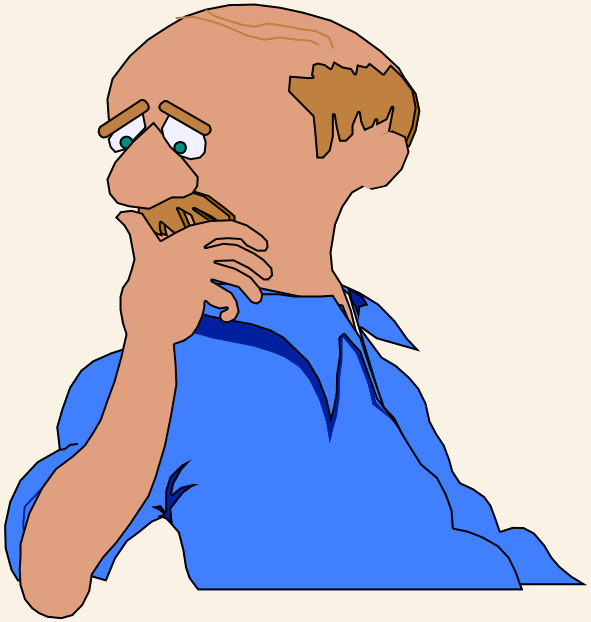
Where do the injuries occur in interventional procedures?

- Severe injuries have occurred from the neck to the buttocks
- Sometimes anteriorly &
- On the side of torso

non-cardiac procedures

Woh!!!

- **They must be rare but exaggerated by radiation protection people!!!**



Current situation

A case of radiation induced skin injury is filed in US courts every 4 to 6 weeks currently from interventional procedures

≈10 cases/year

Estimates of likely skin injuries

- **3.6 billion X ray examinations globally**
- **1 % interventional= 36 million**
- **1 in 10,000 skin injury= 3600/year**

(Conservative estimates)

Agony associated with such patients

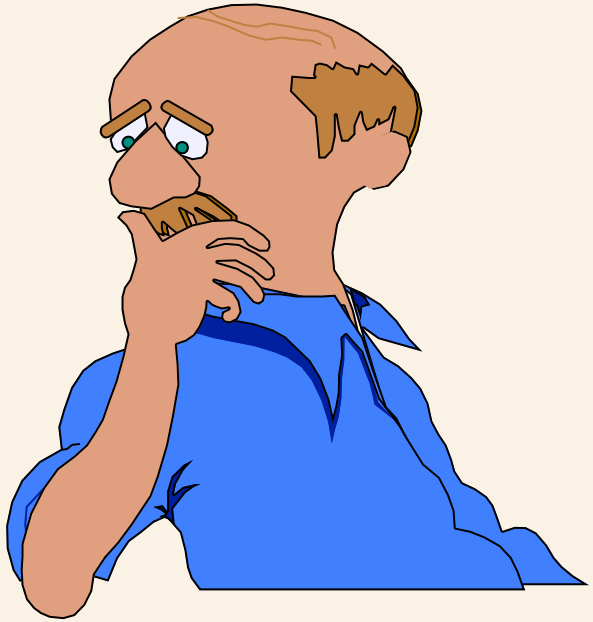
- Topical treatment ineffective
- Exhausted insurance limits
- Cannot lie down on back
- Cannot be at work for months
- Pain
- Skin grafting

Procedures with potential skin dose > 1 Gy

ICRP Publication 117 (non-cardiac)

- **Endovascular aneurysm repair (EVAR),**
- **Renal angioplasty, iliac angioplasty,**
- **Ureteric stent placement,**
- **Therapeutic ERCP**
- **Bile duct stenting and drainage**
- **Similarly a large number of cardiac procedures**

- **They must be primarily in developed countries and rare in developing countries!!**



American J Roentgenology Aug. 2009

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Radiation Exposure to Patients During Interventional Procedures in 20 Countries: Initial IAEA Project Results

OBJECTIVE. The purpose of our study was to investigate the level of radiation protection of patients and staff during interventional procedures in 20 countries of Africa, Asia, and Europe.

SUBJECTS AND METHODS. In a multinational prospective study, information on radiation protection tools, peak skin dose (PSD), and kerma–area product (KAP) was provided by 55 hospitals in 20 mainly developing countries (nine mostly in Eastern Europe, five in Africa, and six in Asia).

RESULTS. Nearly 40% of the interventional rooms had an annual workload of more than 2,000 patients. It is remarkable that the workload of pediatric interventional procedures can reach the levels of adult procedures even in developing countries. About 30% of participating countries have shown a 100% increase in workload in 3 years. Lead aprons are used in all participating rooms. Even though KAP was available in almost half of the facilities, none had experience in its use. One hundred of 505 patients monitored for PSD (20%) were above the 2-Gy threshold for deterministic effects.

CONCLUSION. Interventional procedures are increasing in developing countries, not only for adults but also for pediatric patients. The situation with respect to staff protection is considered generally acceptable, but this is not the case for patient protection. Many patients exceeded the dose threshold for erythema. A substantial number (62%) of percutaneous transluminal coronary angioplasty procedures performed in developing countries in this study are above the currently known dose reference level and thus could be optimized. Therefore, this study has significance in introducing the concept of patient dose estimation and dose management.

Keywords: developing countries, IAEA activities, interventional procedures, patient safety, percutaneous transluminal coronary angioplasty (PTCA), radiation exposure, radiation safety, staff safety

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SKIN INJURIES IN INTERVENTIONAL PROCEDURES

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Rehani & Srimahachota 2011

e 1. Skin injury in a patient with chronic total occlusion. a) 2 mths, b) 6 mths, c) 8 mths after last PCI, and d) after the flap surgery

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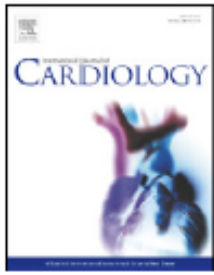

Letters to the Editor

Radiation skin injury caused by percutaneous coronary intervention, report of 3 cases

Suphot Srimahachota [a,*], Wasan Udayachalerm [b], Thupkaew Kupharang [a], Kanjana Sukwijit [a], Anchali Krisanachinda [c], Madan Rehani [d]

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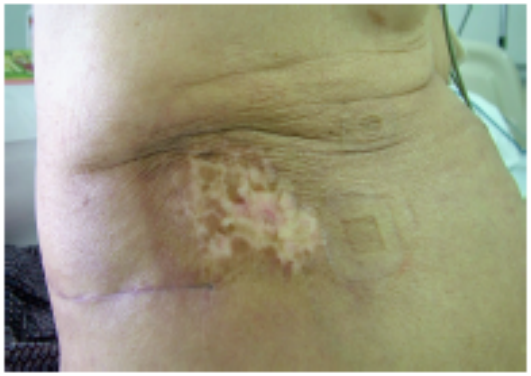
Malaysia



Chronic radiodermatitis in a 70 years old 77 kg male in Malaysia, from percutaneous aortic endovascular stent graft repeated again after 7 months. Photograph taken 11 months after first procedure (Case report under publication). [Photo courtesy HB Liew].

In most countries, procedures outside radiology

Common Factor

Lack of Training of Doctors operating Fluoroscopy machine

Interventional Cardiologists

Radiation Protection (RP) survey	Vienna 2004 (25 countries)
Is this 1st time you are attending a structured program on RP. Ans. Yes	88%
Any cardiologists conference you attended where there was lecture on RP. Ans. No	85%
Do you measure radiation dose to patient. Ans. No	96%

Interventional Cardiologists

Radiation Protection (RP) survey	Vienna 2004 (25 countries)	Singapore 2005 (8 countries)	Ethiopia 2006 (9 countries)	Iran 2006 (6)	Bangkok 2006 (8 countries)
Is this 1st time you are attending a structured program on RP. Ans. Yes	88%	84%	93%	100%	93%
Any cardiologists conference you attended where there was lecture on RP. Ans. No	85%	100%	100%	100%	100%
Do you measure radiation dose to patient. Ans. No	96%	100%	87%	89%	71%

San Jose 2007 (11 countries of Latin-America)

Yerevan 2008 (7 countries of Eastern Europe)

Manila 2009 (8 countries)

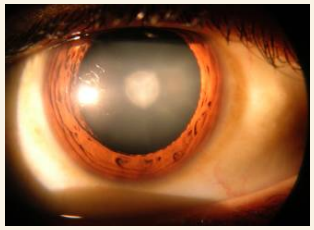
Urologists, Orthopedic surgeons, Gastroenterologists, Gynecologists..

Question regarding Radiation Protection (RP)	Auckland, New Zealand 2006	Dubai, UAE 2007	Sofia, Bulgaria 2008	Montevideo, Uruguay 2008
Is this 1st time you are attending a structured program on RP. Answer: Yes	100 %	100%	100%	95%
Any conference you attended where there was lecture on RP. Answer: No	100%	87%	100%	100%
Do you measure radiation dose to patient. Answer: No	100%	95%	89%	95%
Do you use badge to monitor your personal exposure. Answer: Yes	20%	9%	78%	47%
Was this course relevant to you (highly relevant)	100% (80%)	100 % (75%)	100 % (88%)	100 % (96%)

Year	Place	Participation of Doctor(s) from countries
2006	Auckland, New Zealand	Bangladesh, China, India, Malaysia, Pakistan, Thailand, Vietnam
2007	Dubai, UAE	Bangladesh, Iran, Jordan, Lebanon, Mongolia, Pakistan, Sri Lanka, Thailand, Yemen, UAE
2008	Sofia, Bulgaria	Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Kyrgyzstan, Lithuania, Poland, Bulgaria
	Montevideo, Uruguay	Bolivia, Brazil, Chile, Costa Rica, Ecuador, El Salvador, Panama, Paraguay, Peru, Uruguay, Venezuela.

Radiation Risks

- Skin injuries to patients
  - Demonstrated in IC/EP/ IR
- Not in other areas
- Skin injuries to staff- also in IC/EP/IR,
- Cataract also in above



Catheterization and Cardiovascular Interventions 76:826–834 (2010)

Risk for Radiation-Induced Cataract for Staff in Interventional Cardiology: Is There Reason for Concern?

Olivera Ciraj-Bjelac,[1] PhD, Madan M. Rehani,[2*] PhD, Kui Hian Sim,[3] MBBS, FRACP, Houng Bang Liew,[3] MBBS, FRCP, Eliseo Vano,[4] PhD, and Norman J. Kleiman,[5] PhD

Interventional cardiologists:

- Prevalence 52% (29/56. 95% CI: 35-73)
- Significance (Fisher exact test): $p<0.001$
- Relative risk: 5.7 (95% CI: 1.5-22)

Nurses:

- Prevalence 45% (5/11. 95% CI: 15-100)
- Significance (Fisher exact test): $p<0.05$
- Relative risk: 5.0 (95% CI: 1.2-21)

xyz ways to kill your training program

Some medical physicists are good at that

How are you going to reach them radiation protection without first teaching radiation units, interaction of radiation with matter, radiation detection?

No joke

Major Blunders in Training

- **Teaching clinicians the way you (MP) have been trained**
- **MP: Knowledge to understand all aspects so as to train others**
- **Clinician: Knowledge to practice radiation protection**

e.g. temperature, pressure, length

What you need is to create a FEEL

Participants

May come to class because of

- Regulatory requirements
- Formality
- Politeness, just to see what it is..
- Etiquette .....

These cannot assure mental presence

IAEA Training Material

Free Download of power point slides

Doctors using fluoroscopy outside radiology (Urologists, Gastroenterologists, Orthopaedic surgeons etc.)

Topics List

- Topics & Objectives (84 KB)

Lectures/Slides

All 9 modules (Zip of 9 files, 44.7 MB)

- 01. Overview of radiation protection (1,432 KB)
- 02. Understanding radiation units (3,307 KB)
- 03. What can radiation do? (3,353 KB)
- 04. Anatomy of fluoroscopy & CT Fluoroscopy Equipment (11,507 KB)
- 05. How do I reduce my radiation risk? (20,162 KB)
- 06A. Radiation protection for patients in orthopaedic surgery (3,959 KB)
- 06B. Radiation Exposure in Gastroenterology (4,322 KB)
- 06C. Other medical specialties that use fluoroscopy (2,247 KB)
- 07. International standards and recommendations (4,564 KB)

Making Cardiologists trainers in Radiation Protection

Singapore

Tunisia

Thailand

Uruguay

They are ALL interventional cardiologists

Radiation protection session at the AsiaPCR/SingLive 2011 (13-15 Jan)

A session on radiation protection was organized on 13th Jan. 2011 at Singapore and it had a catchy name: *Radiation protection issues that every cath lab staff needs to know, but may not have paid enough attention to.*

It was a 90 min session with following objectives:

Sessions in EP Conference

Network members in Jeju, S. Korea, 26-28 Oct.2010

Workshop on Radiation Protection for Interventional Cardiologists

Coimbatore, India

Report by Govinda Rajan and J.S.Bhuvaneswaran, India

News from Thailand: Training course & Eye Testing

Suphot Srimahachota,
Interventional Cardiologist, King Chulalongkorn Hospital, Bangkok

Heart Association of Thailand and the Cardiovascular Intervention Society of Thailand arranged the one-day course on radiation protection for cardiologists on 23rd December 2009. More than 120 participants including cardiac interventionists, cardiac surgeons, cardiac fellows,

Engaging people
Not just train

The IAEA establishes a network of gastroenterologists in radiation protection

Network of Gastroenterologists in Radiation Protection in Latin American Countries

-under IAEA project RLA 9067

Newsletter
Issue No. 3

Mission: To enhance cooperation among gastroenterologists on radiation safety in procedures that utilize ionizing radiations

From the Editor's Desk

Dr. Asadur Tchekmedyian
Montevideo - Uruguay
(asadur@adinet.com.uy)

Dear Colleagues and Friends,

A full year has gone and we now face our second year since the first issue of this network. In this period radiation protection became an important topic in our countries

Results from the survey of radiation protection in the endoscopy suite
(Latin-America - unpublished data)

	YES (%)
Lead Apron usage	97.3
Lead goggles usage	13.5
Thyroid collar usage	73.9
Personal dosimeter usage	42.3
Already attended some radiation protection course	21.6

Asian Network of Cardiologists in Radiation Protection - under RCA/IAEA project

Newsletter January 2008

Issue No. 2

Mission: To enhance cooperation among cardiologists on radiation safety in cardiac catheterization procedures and in procedures that utilise ionizing radiations

From the Editor's Desk

Kui Hian Sim
Sarawak General Hospital. Kuching, Malaysia
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Dear Colleagues,

Recent timely publications on radiation risks from cardiac imaging modalities have made this very important, but under-recognized, unglamorous topic in our cardiac profession very "hot" world–wide, particularly in Western countries.

Unfortunately, very little data on knowledge and practice of radiation protection among interventional cardiologist is available from Asia.

Through the desert, looking for garden

LIM Soo Teik
Head of Department of Cardiology,
Director of Interventional Cardiology,
National Heart Centre of Singapore
(lim.soo.teik@nhc.com.sg)

While it is pleasing to note the momentum Asian network is creating, the road ahead is long before one reaches garden.

Let me start as a critic. I had the chance of visiting many labs or interacting with cardiologists from China, Vietnam, Indonesia, Philippines, Thailand, India, Sri Lanka, Bangladesh, Myanmar, Malaysia, Japan and Singapore. I noticed scant attention to

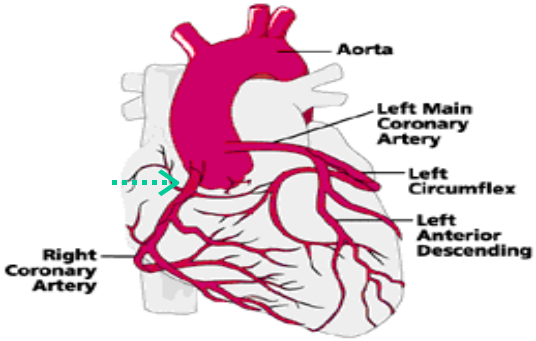
Approved Training Package

IAEA Training Material on Radiation Protection in Cardiology

Lessons from injured patients:

Cumulative buildup of dose for steeply angled high-dose beam through large patient not recognized.

Lesion required grafting

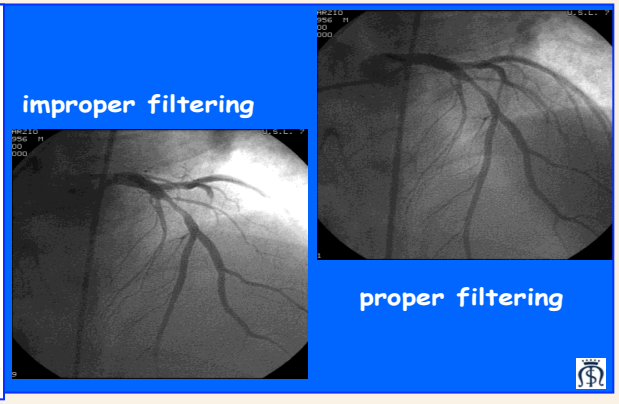


Threshold

Preventable

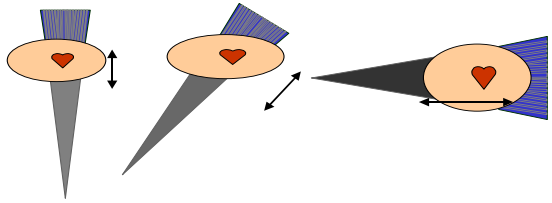
Factors affecting patient doses (I)

THE USE OF THE ANTISCATTER GRID → INCREASES PATIENT ENTRANCE DOSE BY A FACTOR OF 2 TO 6



Physical factors and challenges to radiation management

Thicker tissue masses absorb more radiation



In collaboration with

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IAEA | Radiation Protection of Patients (RPoP)

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Training material developed in collaboration with
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International Organization for Medical Physics (IOMP)
Society for Cardiovascular Angiography and Interventions (SCAI)

Lectures/Slides

All 14 Lectures/Slides ZIPPED (63.7 MB)

- 01. Why Talk about Radiation Protection in Cardiology? Download (471 KB)
- 02. Talking about Radiation Dose Download (2,237 KB)
- 03. What Radiation Effects are Possible? (besides skin injuries) Download (3,095 KB)
- 04. X ray production and Angiography Equipment Download (2,729 KB)
- 05. Patient Dose Management: Part 1 Download (4,057 KB)
- 05. Patient Dose Management: Part 2 Download (3,798 KB)
- 06. Standards and Guidance Download (1,925 KB)
- 07. Occupational exposure and protective devices Download (2,875 KB)
- 08. Image Quality in Cardiac Angiography Download (11,935 KB)
- 09. Optimization of Radiation Protection in Cardiology Download (1,860 KB)
- 10. Radiation Protection in Paedriatic Interventional Cardiology Download (1,853 KB)
- 11. Cardiac CT - radiation doses, dose management and practical issues Download (719 KB)
- 12. Examples of Good & Bad Practice (physical factors): Part 1 Download (6,767 KB)
- 12.Examples of Good & Bad Radiation Protection Practice: Part 2 Download (24,099 KB)

Information for
Health Professionals
→ Radiology
→ Radiotherapy
→ Nuclear Medicine
→ Interventional Radiology
→ Interventional Cardiology
→ Other Specialities & Imaging Modalities
Member States
Patients

Member Area
• Member States Area
• Drafts Management Area

Social Media

Interventional Cardiology

Erythema →
Different phases of erythema evolution →

Cardiologists are among the most intensive users of fluoroscopy in the medical profession, if not the most frequent. However, many of them are unaware that they may be exposing patients to relatively high levels of radiation during cardiac catheterization procedures - levels much higher than those handled by many radiologists. While staff protection is definitely important, there are bigger issues of patient protection in interventional procedures using X rays. For description of radiation units and dose quantities, please click here..

Patient protection

1. Are radiation induced skin injuries common among patients undergoing interventions?
2. What problems are associated with diagnosis of such injuries?
3. Can radiation injuries be prevented?
4. How high is the exposure in cardiac interventions in comparison to chest radiograph?
5. Which factors can affect patient dose in cardiac interventions?
6. How can I manage patient exposure?
7. What adverse effects could occur as a result of dose reduction actions?

Staff protection - Some of the measures to reduce patient dose will also result in a reduction of staff dose

8. Is the exposure to the cardiologist much higher than to non-interventionalists?
9. Is there a risk of cataract after several years of work in a catheterization laboratory?
10. Can I work my full professional life in a catheterization laboratory and have no radiation effects?
11. What are the typical radiation doses associated with diagnostic and therapeutic interventional procedures?

Related Links
• Cardiologists Training Events
• Asian Network of cardiologist in radiation protection

1. Are radiation induced skin injuries common among patients undergoing interventions?

No. Radiation induced skin injuries happen very rarely and the rough estimate is around one in 10,000 interventions. This figure can vary by a large margin as many injuries go unreported. The skin injuries can vary from mild erythema to deep skin ulceration. Many interventionalists still do not acknowledge that skin injuries have or could occur. Such denial has led, in many cases, to uncertain and ill-directed care for some patients. Injuries occur weeks or months after the interventional procedure was performed and could create problems in diagnosis. Most of these injuries can be avoided by using established radiation protection approaches.

Further details are available »

Page Top ↑

2. What problems are associated with diagnosis of such injuries?

Experience has shown that patients normally go to a physician or dermatologist when symptoms are detected. The delay between the interventional procedure and occurrence of symptoms coupled with the lack of instruction by the interventionalist to report back to him if there is any skin irritation on ports of entries of the X ray beam (typically patient's back), are responsible for misdiagnosis. There have been situations of misdiagnosis as insect bites, electrical burns, chemical burns or contact dermatitis. Typically in radiation induced injuries, normal methods of treatment with creams fail to give relief to the patient.

Further details are available »

Page Top ↑

3. Can radiation injuries be prevented?

In most, if not all cases, the answer is 'yes', at least as far as the severe injuries are concerned. The experience from a centre where cardiologists were trained in radiological protection and the equipment was monitored and covered by a quality control programme indicates an absence of skin injuries in patients who underwent 5-7 PTCAs and 5-14 additional angiographies [VA1].

Page Top ↑

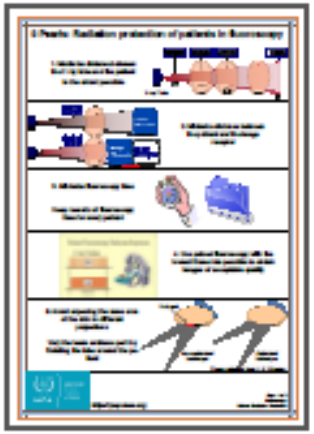
4. How high is the patient exposure in cardiac interventions in comparison to chest radiograph?

Entrance exposure to patients in diagnostic and therapeutic angiography might be a few hundreds to even a thousand times more than in a chest radiograph.

It must be emphasized that this way of comparing is an over-simplification as exposure situations are not similar.

- **Training- limited outreach**
- **Website- Better outreach**
- **Something more with still better outreach??????**

Radiation Protection in fluoroscopy

Language	Patient	Staff
		
English	10 pearls on radiation protection of patients in fluoroscopy Download PDF	10 pearls on radiation protection of staff in fluoroscopy Download PDF
Ελληνικά	10 χρυσοί κανόνες: Ακτινοπροστασία ασθενών κατά την ακτινοσκόπηση Λήψη αρχείου PDF	10 χρυσοί κανόνες: Ακτινοπροστασία προσωπικού κατά την ακτινοσκόπηση Λήψη αρχείου PDF
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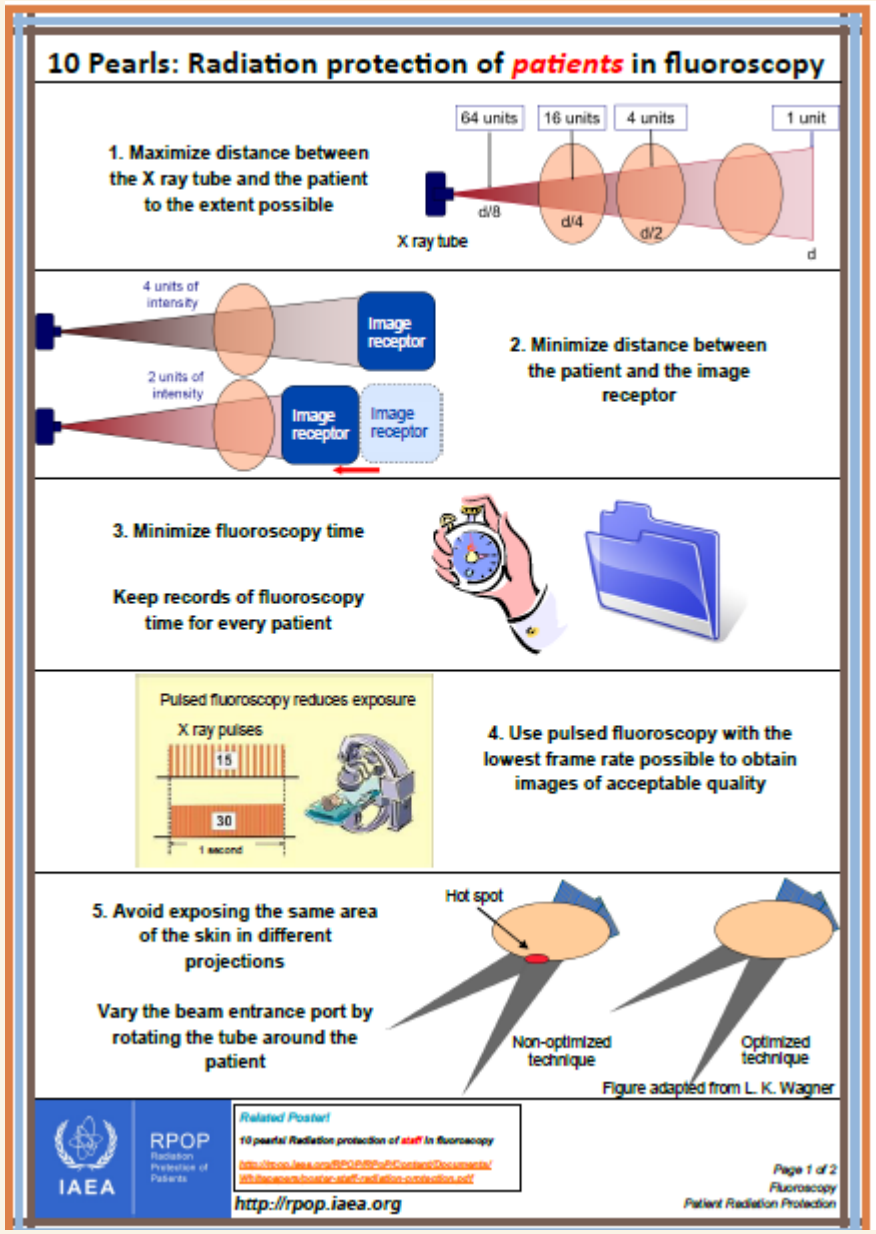
10 Pearls: Radiation protection of *patients* in fluoroscopy



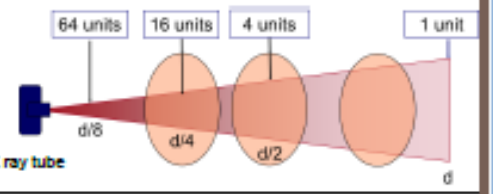
http://rpop.iaea.org

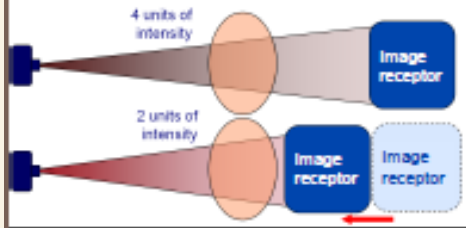
Translation into many languages

>5000 downloads in last 6 months

10 Pearls: Radiation protection of *patients* in fluoroscopy

1. Maximize distance between the X ray tube and the patient to the extent possible

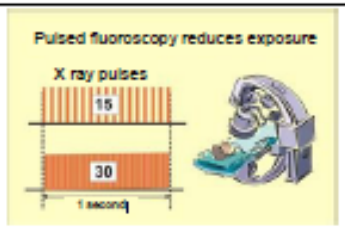




2. Minimize distance between the patient and the image receptor

3. Minimize fluoroscopy time

Keep records of fluoroscopy time for every patient



4. Use pulsed fluoroscopy with the lowest frame rate possible to obtain images of acceptable quality

5. Avoid exposing the same area of the skin in different projections

Vary the beam entrance port by rotating the tube around the patient

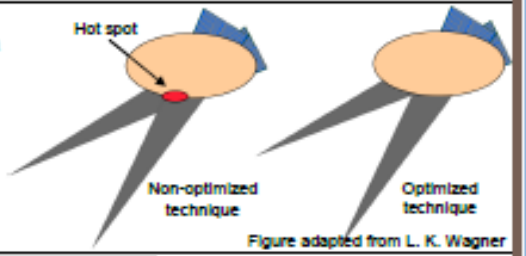


Figure adapted from L. K. Wagner

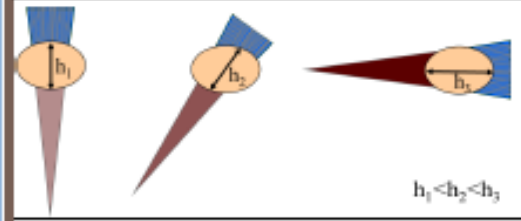
IAEA RPOP Radiation Protection of Patients

Related Poster!
10 pearls! Radiation protection of staff in fluoroscopy
http://www.iaea.org/RPOP/RPOPContent/Documents/InformationSheets/staff-radiation-protection.pdf

http://rpop.iaea.org

10 Pearls: Radiation protection of *patients* in fluoroscopy

6. Larger patients or thicker body parts trigger an increase in entrance surface dose (ESD)



7. Oblique projections also increase ESD

Be aware that increased ESD increases the probability of skin injury

INTENSIFIER Field-of-view (FOV)	RELATIVE PATIENT ENTRANCE DOSE RATE FOR SOME UNITS
12" (32 cm)	100
9" (22 cm)	200
6" (16 cm)	300
4.5" (11 cm)	400

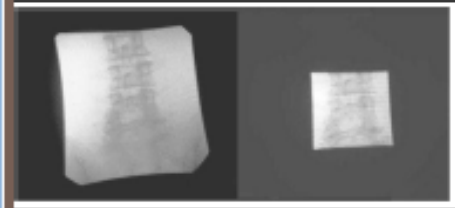
8. Avoid the use of magnification

Decreasing the field of view by a factor of two increases dose rate by a factor of four

9. Minimize number of frames and cine runs to clinically acceptable level

Avoid using the acquisition mode for fluoroscopy

Documentation should be performed with last image hold whenever possible and not with cine images



10. Use collimation

Collimate the X ray beam to the area of interest

IAEA RPOP Radiation Protection of Patients

Related Poster!
10 pearls! Radiation protection of staff in fluoroscopy
http://www.iaea.org/RPOP/RPOPContent/Documents/InformationSheets/staff-radiation-protection.pdf

http://rpop.iaea.org

10 Pearls: Radiation protection of *staff* in fluoroscopy

Reducing patient dose always results in staff dose reduction

1. Use protective devices!

Advisable skirt type lead apron to distribute weight

0.25 mm lead equivalence but with overlap on front to make it 0.5 mm on the front and 0.25 mm on the back (Provides >90% protection)

Lead glass eyewear with side protection

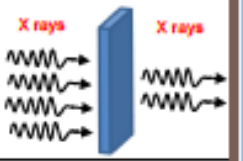
Thyroid protection

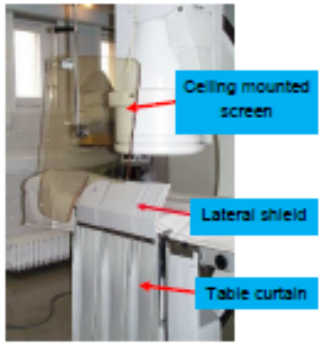
2. Make good use of time-distance-shielding (TDS) principle

Minimize time

Maximize distance as much as clinically possible

Use shielding

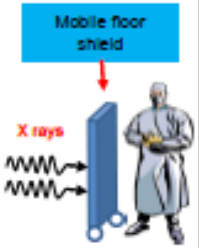




3. Use ceiling suspended screens, lateral shields and table curtains

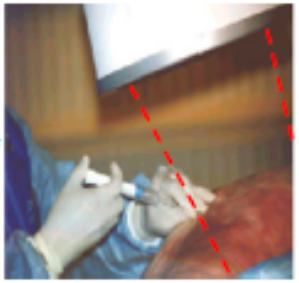
They provide more than 90% protection from scattered radiation in fluoroscopy

Mobile floor shielding is advisable when using cine acquisition



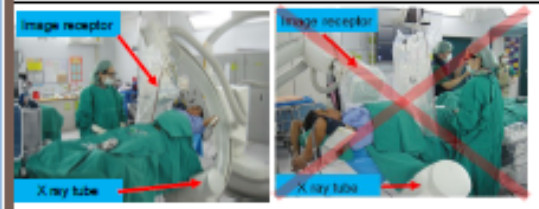
4. Keep hands outside the primary beam unless totally unavoidable

Hands inside the central area of the primary beam will increase exposure factors (kV, mA) and doses to patient and staff



10 Pearls: Radiation protection of *staff* in fluoroscopy

Reducing patient dose always results in staff dose reduction



Right! Wrong!

5. Only 1-5% of radiation falling on the patient's body exits the other side

Stand on the side of the *transmitted* beam (i.e. by the detector), which contains only 1-5% of the incident radiation and its respective scatter

6. Keep X ray tube under the patient table and not over it

Undercouch systems provide better protection from scattered dose

Right! Wrong!

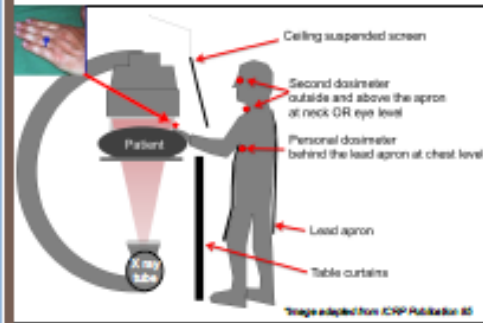


*Image adapted from ICRP Publication 85

7. Use personal dosimetry

Use at least two dosimeters

- One inside the apron at chest level
- One outside the apron at neck or eye level
- Additional finger ring dosimeter for procedures requiring hands close to primary beam

Real time dosimetry systems are useful

8. Update your knowledge about radiation protection

9. Address your concerns about radiation protection to radiation protection specialists (medical physicists)

10. REMEMBER!

- Quality control testing of fluoroscopy equipment enables safe and stable performance
- Know your equipment! Using the equipment's features appropriately will help reduce doses to patients and staff
- Use injector devices

IAEA RPOP Radiation Protection of Patients — http://rpop.iaea.org

ISEMIR — http://www-ns.iaea.org/tech-areas/communication-network/ahorp/search-web.htm

Related Poster!
10 pearls! Radiation protection of patients in fluoroscopy

Fluoroscopy outside radiology

Group I:

- **Interventional Cardiologists & Electro-physiologists** ✓

Group II:

- **Orthopedic surgeons, Urologists, Gastroenterologists, Anesthetists…..** ✓

Group III:

- **Vascular surgeons**

New Program

- New training program for Vascular surgeons, Dec 2012 in Bangkok for Asian countries- First ever for these specialists
- Second program being held again at Bangkok on 16-18 Dec 2013

ICRP

«Prev

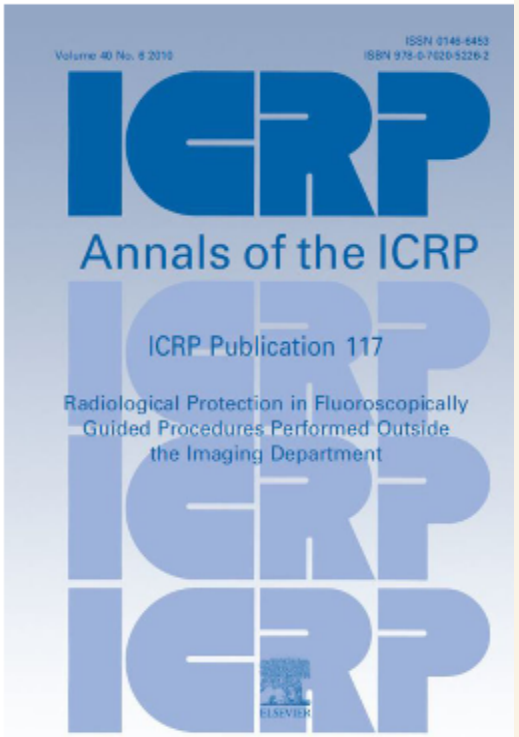
Radiological Protection in Fluoroscopically Guided Procedures outside the Imaging Department

ICRP Publication 117

Ann ICRP 40(6), 2010

M.M. Rehani, O. Ciraj-Bjelac, E. Vaño, D.L. Miller, S. Walsh, B.D. Giordano, J. Persliden

Abstract - An increasing number of medical specialists are using fluoroscopy outside imaging departments, but there has been general neglect of radiological protection coverage of fluoroscopy machines used outside imaging departments. Lack of radiological protection training of those working with fluoroscopy outside imaging departments can increase the radiation risk to workers and patients. Procedures such as endovascular aneurysm repair, renal angioplasty, iliac angioplasty, ureteric stent placement, therapeutic endoscopic retrograde cholangio-pancreatography, and bile duct stenting and drainage have the potential to impart skin doses exceeding 1 Gy. Although tissue reactions among patients and workers from fluoroscopy procedures have, to date, only been reported in interventional radiology and cardiology, the level of fluoroscopy use outside imaging departments creates potential for such injuries.



Chairman: Madan Rehani

O. Ciraj-Bjelac, E. Vañó, D.L. Miller, S. Walsh, B.D. Giordano, J. Persliden,

A new way to visually convey level of dose

Table 4.1. Typical patient dose levels (rounded) from vascular surgical procedures.

Procedure	Relative mean effective dose to patient 0 mSv 35	Relative mean radiation dose to patient*	Reported values			
			Fluoroscopy time (min)	Entrance skin dose (mGy)	Dose-area product ($Gy.cm^2$)	Effective dose (mSv)
EVAR		F,G	21	330-850	60-150	8.7-27
Venous access procedures		B	1.1-3.5	8-24	2.3-4.8	1.2
Renal/visceral angioplasty (stent/no stent)		G	20.4	1442	208	54
Iliac angioplasty (stent/no stent)		G	14.9	900	223	58

Table 4.2. Typical patient dose levels (rounded) from Urological procedures.

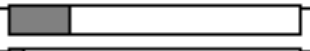
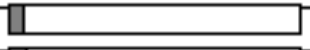
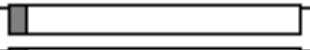
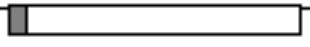
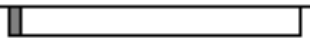
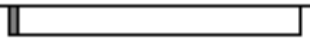
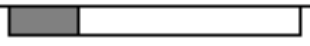
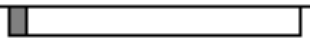
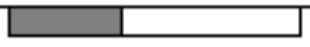
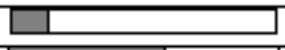
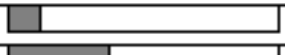
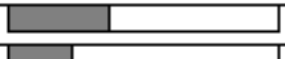
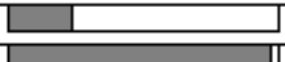
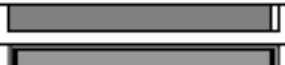
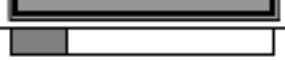
Procedure	Relative mean effective dose to patient 0 mSv 35	Relative mean radiation dose to patient*	Reporte Fluorosc (min)
IVU/IVP		C,D	na**
Cystometrography		B	n
Cystography		B	n
Excretion urography/MCU		C	n
Urethrography		B	n
PCNL		A	6-12
Nephrostomy		D	1.3-20
ESWL		B	2.6-3.4
Kidney stent insertion		E	/
Ureteric stent placement			

Table 4.6. Typical patient dose levels (rounded) from gastroenterology and hepato-biliary

Procedure	Relative mean effective dose to patient 0 mSv 35	Relative mean radiation dose to patient*	Reportedvalu Fluoroscopy (min)
ERCP (diagnostic)		C,D	2-3
ERCP (therapeutic)		E,F	5-10
Biopsy		C	na**
Bile duct stenting		E	na**
PTC#		D	6-14
Bile duct drainage		F,G	12-26
TIPS***		F,G	15-93
Transjugular hepatic biopsy		D	6.8

*A=<1 mSv; B=1 to<2 mSv ; C=2 to <5 mSv ;D=5 to <10 mSv ;E=10 to<20;F=20 to 35 mS

** not available

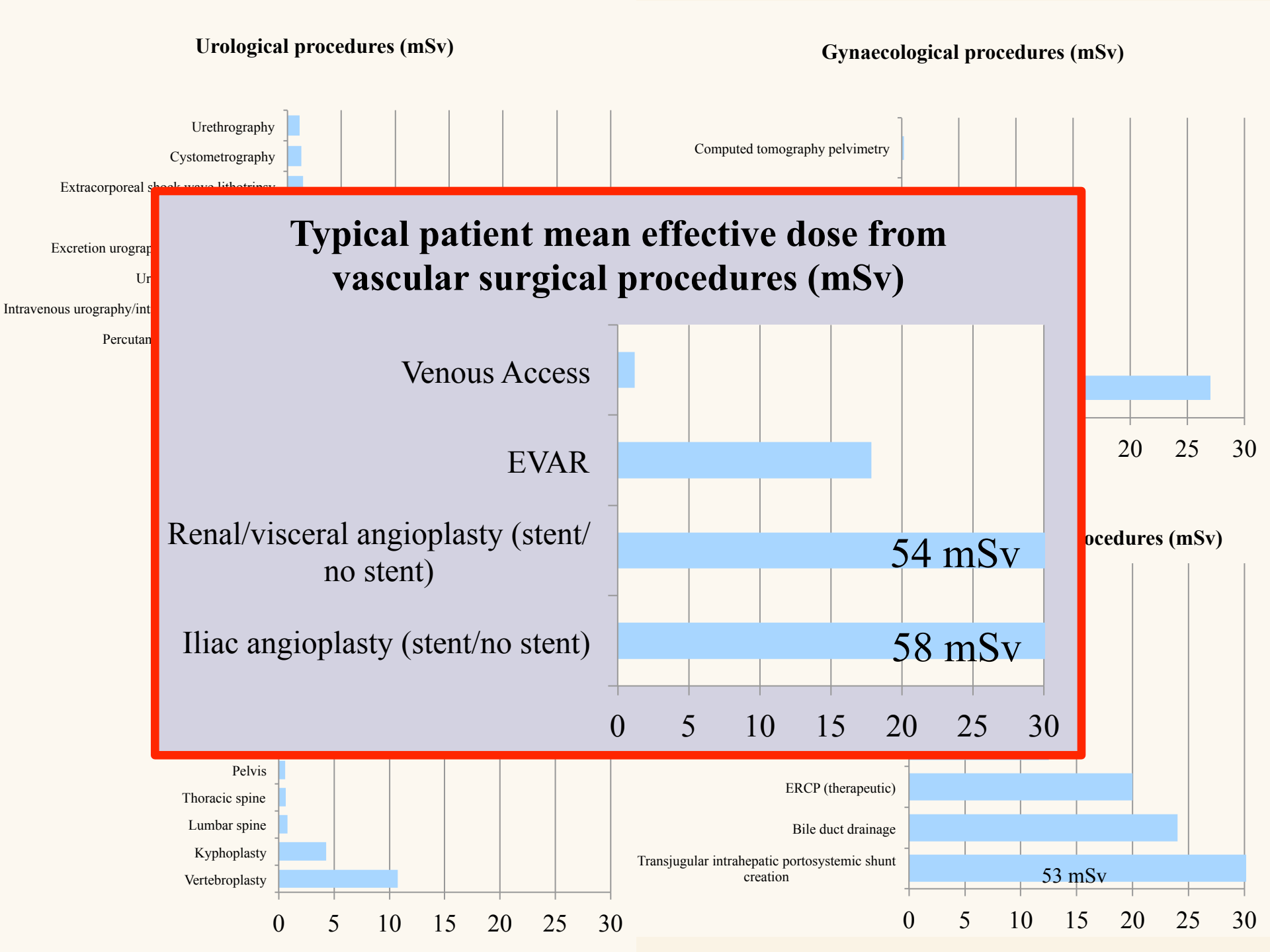
Table 4.5. Typical patient dose levels from gynaecological procedures (

Procedure	Relative mean radiation effective dose to patient 0 mSv 35	Relative m radiation dose
Pelvimetry, conventional		
Pelvimetry, digital fluorography		
CT Pelvimetry		
HSG		
UAE***		

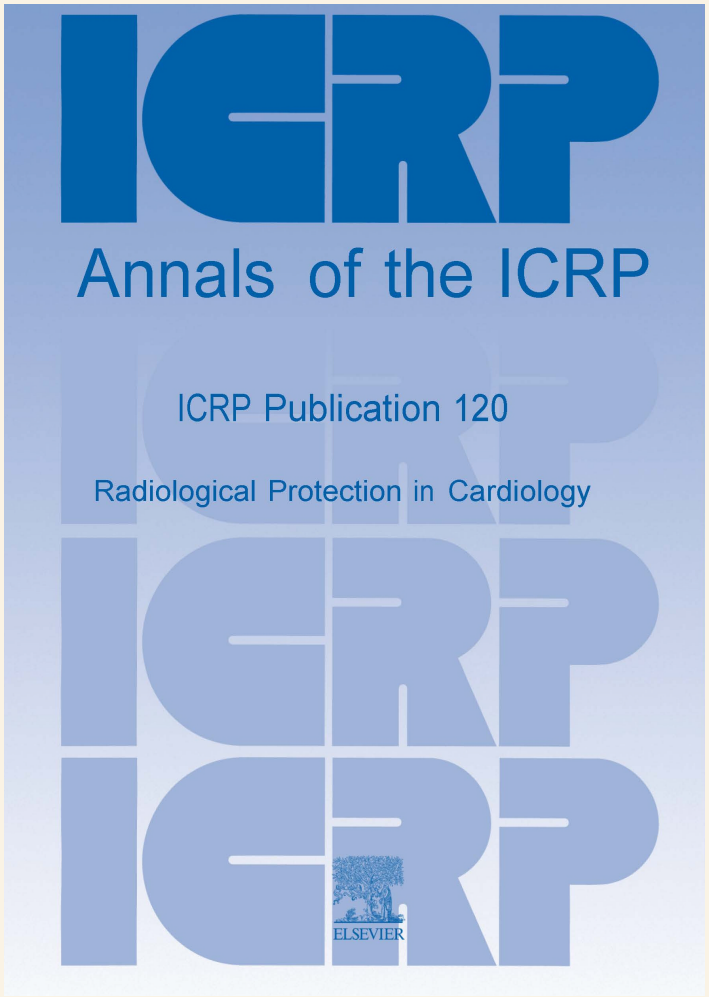
*A=<1 mSv; B=1 to<2 mSv; C=2 to <5 mSv; D

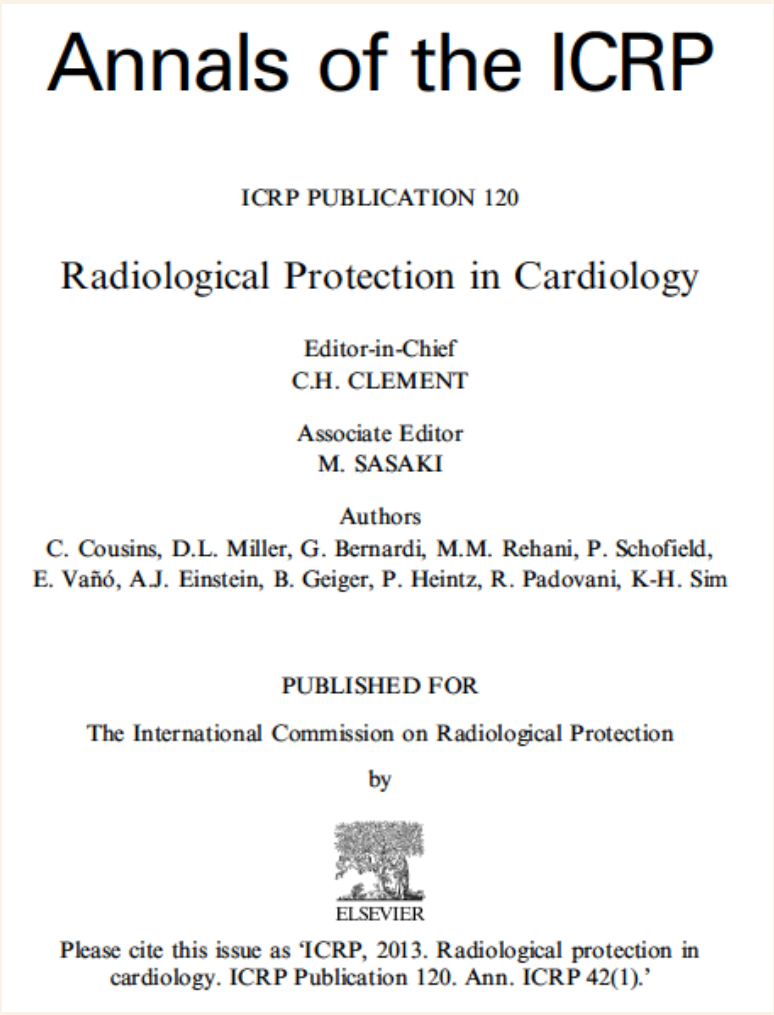
Table 4.4. Typical patient dose levels (rounded) from various **orthopaedic procedures**.

Procedure	Relative mean effective dose to patient 0 mSv 35	Relative mean radiation dose to patient*	Reported value Fluoroscopy (min)
Skull		A	na**
Cervical Spine		A	0.2-0.8
Thoracic Spine		B	0.85
Lumbar Spine		B	0.10-1.4
Pelvis		A	na**
Hip		A	0.020-1.15
Shoulder		A	na**
Knee		A	na**
Other extremities		A	na**
Hand/wrist		B,C	0.20-0.55
Distal radius plate osteosynthesis	na**	na**	1.8***
Osteosynthesis of malleolar fracture	na**	na**	1.5***
Plate osteosynthesis of tibial plateau fracture	na**	na**	1.2***
Arthroscopy for ACL reconstruction	na**	na**	0.9***
Tibial intramedullary nailing	na**	na**	5.7***
Intramedullary nailing of diaphyseal femoral fracture	na**	na**	6.3***


Urological procedures (mSv)
Urethrography
Cystometrography
Extracorporeal shock wave lithotripsy
Excretion urograp
Ur
Intravenous urography/int
Percutan
Pelvis
Thoracic spine
Lumbar spine
Kyphoplasty
Vertebroplasty
0 5 10 15 20 25 30
Gynaecological procedures (mSv)
Computed tomography pelvimetry
20 25 30
ocedures (mSv)
ERCP (therapeutic)
Bile duct drainage
Transjugular intrahepatic portosystemic shunt creation
53 mSv
0 5 10 15 20 25 30
Typical patient mean effective dose from vascular surgical procedures (mSv)
Venous Access
EVAR
Renal/visceral angioplasty (stent/ no stent)
54 mSv
Iliac angioplasty (stent/no stent)
58 mSv
0 5 10 15 20 25 30

Radiological Protection in Cardiology




Annals of the ICRP

ICRP PUBLICATION 120

Radiological Protection in Cardiology

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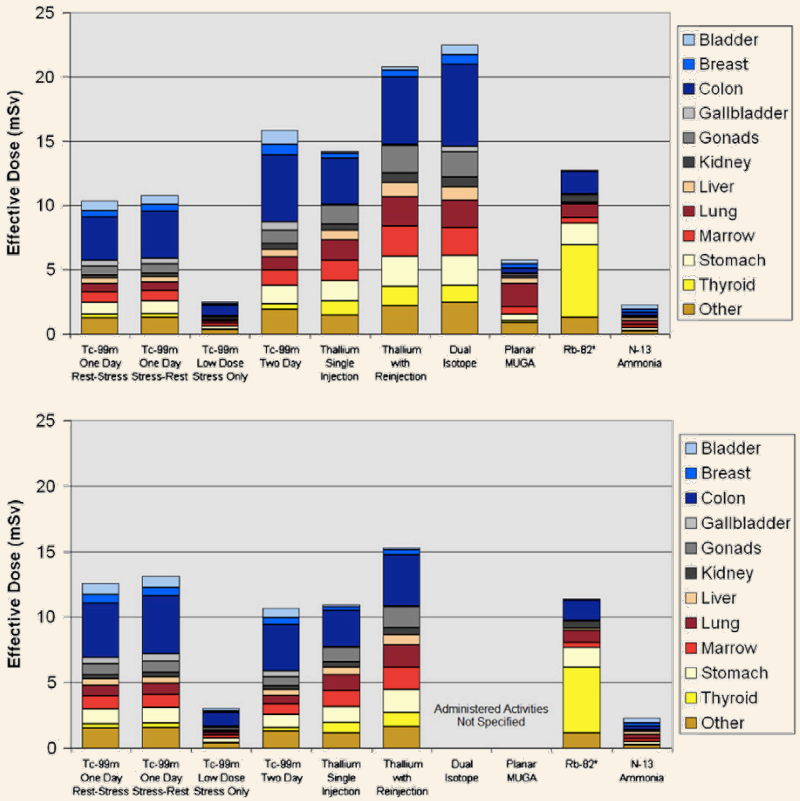
What does it cover?

1. Interventional cardiology and electrophysiology procedures
   - Cardiac procedures make up 28% of interventional procedures and 53% of exposure in USA
   - Increase in numbers and complexity of electrophysiology procedures – not just pacemaker insertions 554,000 in Europe in 2007
2. Cardiac computed tomography
   - 4.7% of CT examinations and 12.1% of CT exposure in USA
3. Nuclear cardiology examinations
   - In USA nuclear medicine accounts for 26% of patient

Risks of…

Tissue Reactions

Stochastic Effects



Protecting the eyes

- Ceiling suspended screens protect the whole head
  - Place as close to the image receptor and as low as possible
  - Tilt slightly away from operator to protect largest area
  - Protection depends on the diligence of operator

- Protective eyewear should be used
  - Where it is not practical to use ceiling suspended shields
  - With ceiling suspended screens where workloads are high

Protective eyewear

- Ill-fitting goggles are uncomfortable and provide less protection
- Interventional cardiologists turn their head to view images and so are exposed from side
- Shielding from side exposure provi
shields or wrap

- Offer reductions in dose by factors of 2 – 6

Personal protective equipment

- A 0.25 mm lead apron is sufficient for staff
- Two-piece skirt and vest distribute weight more evenly
- Thyroid collars can halve effective dose
- Leaded curtains are necessary for interventional work, as otherwise leg doses will be high
- Disposable radiological protection shields in the form of drapes or pads can also be useful

Personal dosimetry

- Two personal dosimeters are recommended for cardiac catheterisation laboratories:
  - one outside the lead apron at the collar or shoulder
  - one on the trunk under the apron
- At least one dosimeter, the collar dosimeter, should always be worn
- A dosimeter for the hands is useful
- There have been many reports of poor

Interventional Cardiology Summary

- Risk of high skin doses
- Patients should be aware of potential risks
- Set dose trigger levels in terms of RAK (or KAP)
- Monitor RAK throughout procedure
- Follow up patients exceeding trigger value
- Staff use protective devices to minimise eye doses
- Medical physicists involved in advice and training

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The EMAN project, financially supported by the European Commission, aims to create a sustainable European Medical ALARA Network (EMAN) where different stakeholders within the medical sector have the opportunity to discuss and to exchange information on various topics relating to the implementation of the ALARA principle in the medical field.

Thank You

madan.rehani@gmail.com