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INTERNATIONAL SYMPOSIUM ON THE RADIOLOGICAL PROTECTION OF PATIENTS

School of Medicine - University of Malaga- SPAIN

2nd to 4th of October 2006

How can medical physicists help to improve Radiological Protection in Interventional Radiology?

E. Vano. San Carlos University Hospital. Complutense University. Madrid/ES

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Before trying to help, we must ..

- Learn how our colleagues (medical doctors) are working.
- Understand that the first priority is the clinical outcome.
- Realise that RP is not a priority for interventionists.

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After that, we can try to help in the management of radiation dose

1. How modern X-ray systems can be used properly.
2. How interventional procedures could be optimised.
3. Understand dose information and dose reports.
4. Realize that still some problems exist (but ICRP will help us to solve them!).

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1. How modern X-ray systems can be used properly

- How is the "cost" in dose you are "paying" for the image quality you are requiring?.
- Have you evaluated if lower image quality could be acceptable?.
- Do you know dose rate values and dose/mage for the different operation modes?.
- Do you know the increase in dose for the different field of view formats (magnification)?.

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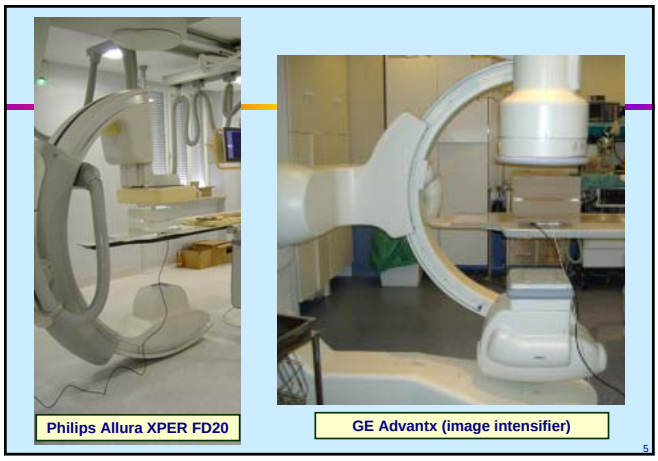
Philips Allura XPER FD20
GE Advantx (image intensifier)
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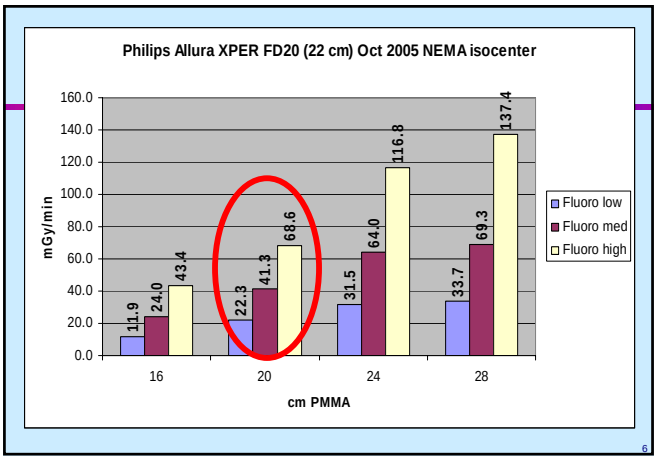
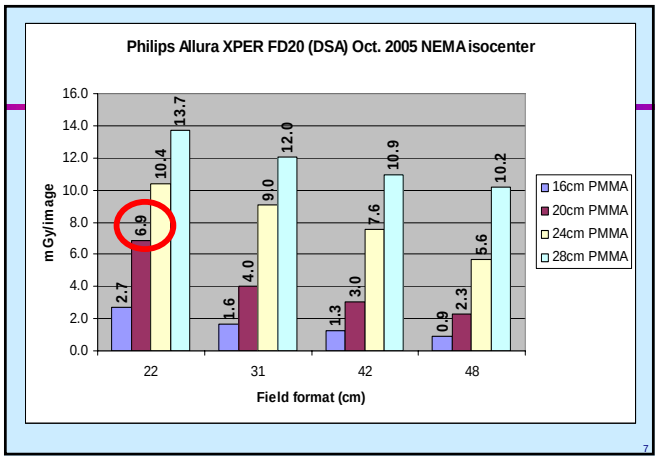
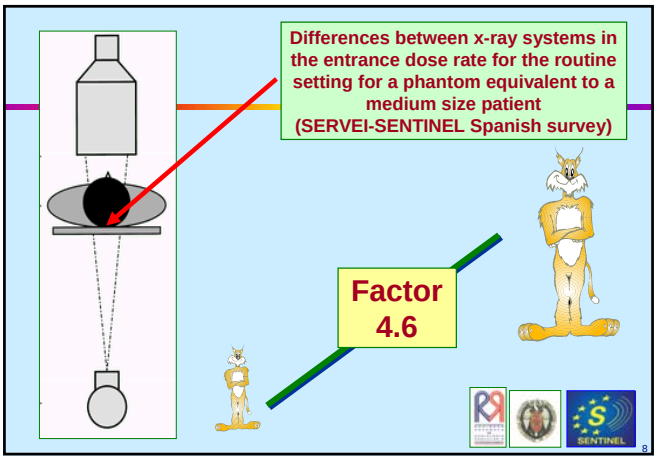

Philips Allura XPER FD20 (22 cm) Oct 2005 NEMA isocenter
mGy/min
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
11.9
24.0
43.4
22.3
41.3
68.6
31.5
64.0
116.8
33.7
69.3
137.4
16
20
24
28
cm PMMA
Fluoro low
Fluoro med
Fluoro high
6


Philips Allura XPER FD20 (DSA) Oct. 2005 NEMA isocenter
mGy/image
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
2.7
6.9
10.4
13.7
1.6
4.0
9.0
12.0
1.3
3.0
7.6
10.9
0.9
2.3
5.6
10.2
22
31
42
48
Field format (cm)
16cm PMMA
20cm PMMA
24cm PMMA
28cm PMMA
7


Differences between x-ray systems in the entrance dose rate for the routine setting for a phantom equivalent to a medium size patient (SERVEI-SENTINEL Spanish survey)
Factor 4.6
SENTINEL
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2a. How interventional procedures could be optimised

- C-arm angulations. How patient and staff doses are modified?.
- Increasing table high you can save skin dose to the patient but you will work out from the isocenter … have you balanced this option for some of the procedures?.
- Have your series too many images?. Do you know the typical dose/image for these series?.
- Proper sincronisation between contrast injection and image acquisition and number of images/s.

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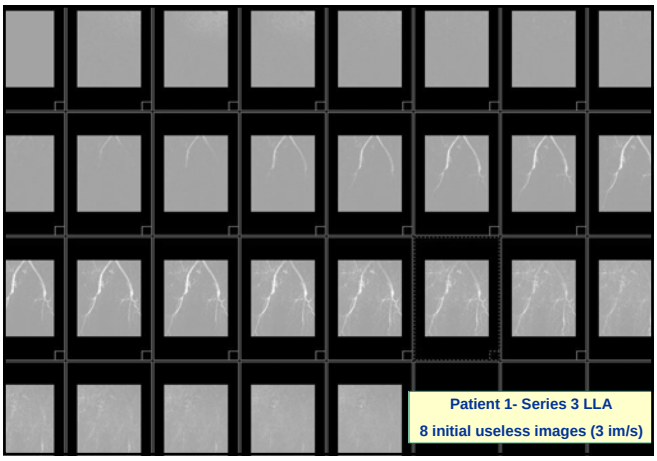

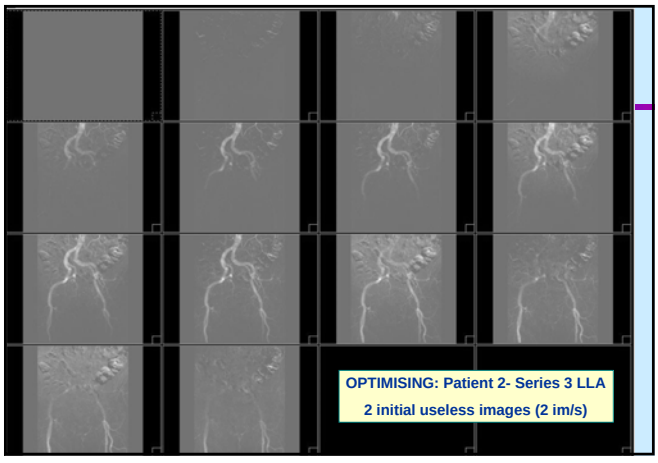

Series	kV	mA	ms	mm Cu	frames	mGy/frame	Gy.cm2/fr
1	84	796	36.7	0	14	3.63	1.33
2	76	799	46.5			4.35	1.66
3	88	763	36.2	0	11	4.35	1.66
4	64	409	54.5	0.3	16	0.25	0.10
5	61	426	44.4	0.6	26	0.06	0.03
6	61	317	33.3	0.6	28	0.03	0.01
7	61	341	43.1	0.6	28	0.06	0.01
8	61	335	44.2	0.6	25	0.06	0.01
9	60	471	44.3	0.9	34	0.03	0.01

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2b. How interventional procedures could be optimised

- Fluoroscopy runs can be archived as series of images … are you using this option?.
- Collimation and semitransparent filter positioning can be done with the virtual option (without radiation) in digital systems … are you using this option?.
- You can select the automatic exposure control area in some systems … are you using this option?.
- Using rotational angiography, some series could be avoided …

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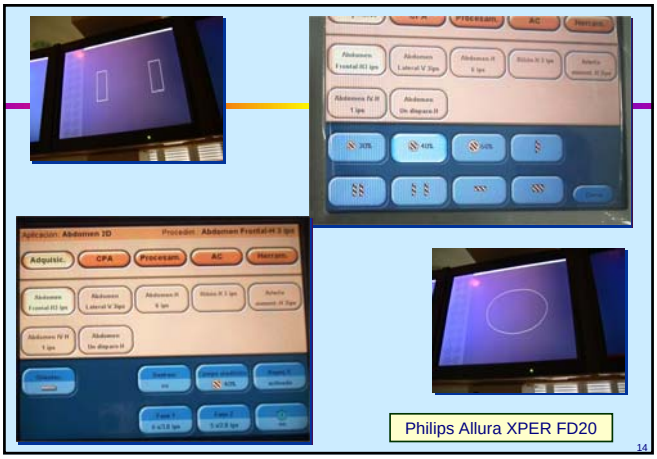

Philips Allura XPER FD20

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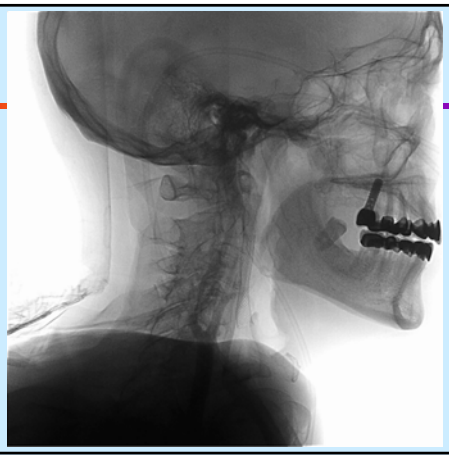

Philips Allura XPER FD20

Hospital Clínico San Carlos

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Hosp. Clinico San Carlos; Patient name: XXXXXXXXXXXXX
Date and time: 07 March 2006 11:14; Identificación solicitud: TSA

Fluoroscopy time: 00:04:03 hh:mm:ss
DAP (fluoroscopy): 5626 mGycm^2; DAP (exposures): 101096 mGycm^2
DAP total: 106722 mGycm^2; Cumulative air kerma: 602.95 mGy
Total number of series: 10; Total number of images: 351

Nº sec.	Procedim.	Tiempo hh:mm	Velocidad-sgs	kV	mA mAs	ms	Rot	Ang	DFI [cm]	Nº imágenes
1	Cerebral-H 3 ips	11:47	3	80	17		OAI 38	CAUD 2	95	16
2	Cerebral-H 6 ips	11:50	6	75	11		OAI 44	CAUD 2	95	37
3	Cerebral-H 3 ips	11:56	3	80	19		OAD 49	0	101	16
4	Cerebral-H 3 ips	11:57	3	80	61		OAD 2	CRAN 6	101	18
5	Carótida Propulsión-V	12:03	30	77	213	8	OAD 106	0	120	121
6	Cerebral-H 3 ips	12:05	3	80	41		OAI 25	0	106	18
7	Cerebral-H 3 ips	12:07	3	80	70		OAI 5	CRAN 17	106	24
8	Cerebral-H 3									
9	Cerebral-H 6									
10	Cerebral-H 6 ips	12:15	6	75	17		OAI 3	CAUD 13	107	39

mAs	ms	mAs/fr	mA
213	8	1.76	220

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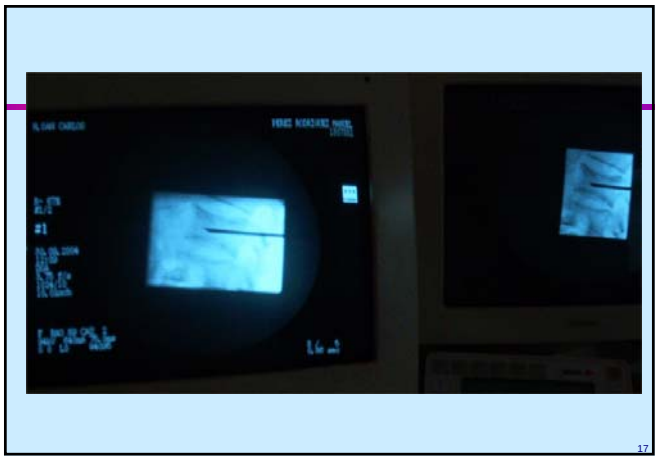

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Hosp. Clinico San Carlos
Nombre del paciente: XXXXXXXXXXXXXX
Reference number: YYYYYYYYYYYYY
Procedure: VERTEBROPLASTY

Total fluoroscopy time: 00:07:01 hh:mm:ss
DAP (Fluoroscopy): 26898 mGycm^2
DAP (Acquisition): 0 mGycm^2

DAP total: 26898 mGycm^2
Cumulative air kerma: 677.22 mGy
Total number of series: 5
Total number of images: 531

N° sec	[illegible]	Tiempo hh:mm	Velocidad-ips	kV	mA mAs	ms	Rot	Ang	DFI [cm]	N° imag
1	Fluoroscopia	10:47	15	104	17		OAD 90	CAUD 4	120	150
2	Fluoroscopia	10:48	15	87	17		OAD 35	CAUD 4	120	102
3	Fluoroscopia	10:57	15	120	17		OAD 90	CAUD 4	120	76
4	Fluoroscopia	11:00	15	118	17		OAD 88	CAUD 4	120	150
5	Fluoroscopia	11:00	15	91	16		OAD 11	CAUD 3	120	53

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3a. Understand dose information and dose reports

- **Do you understand the dose information you have in the room?.**
- **Do you follow (and archive) patient dose reports?.**
- **Do you understand the dose values in your occupational dose report?.**
- **Can you distinguish if these dose values are “normal” or “too high”?.**

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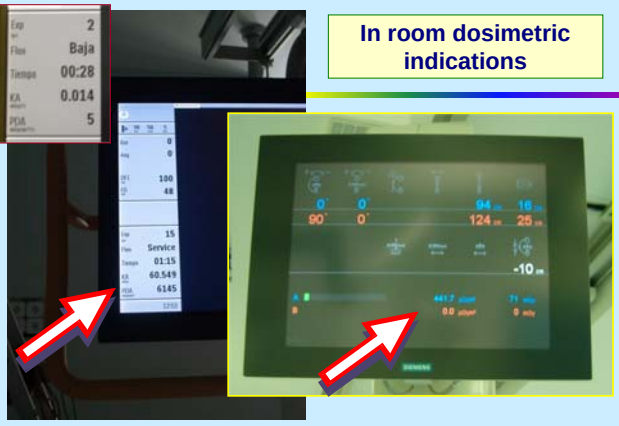
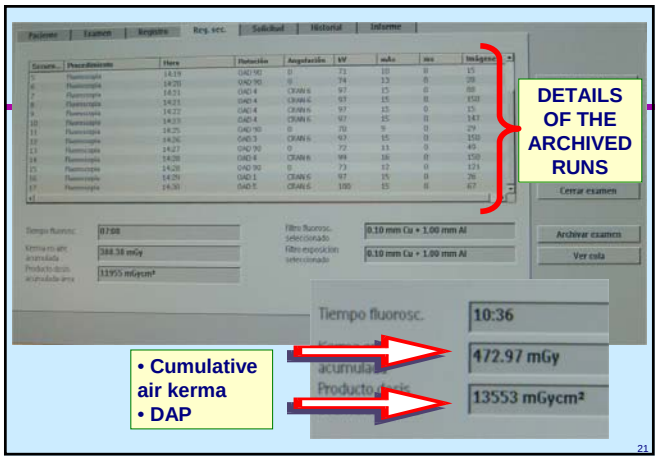
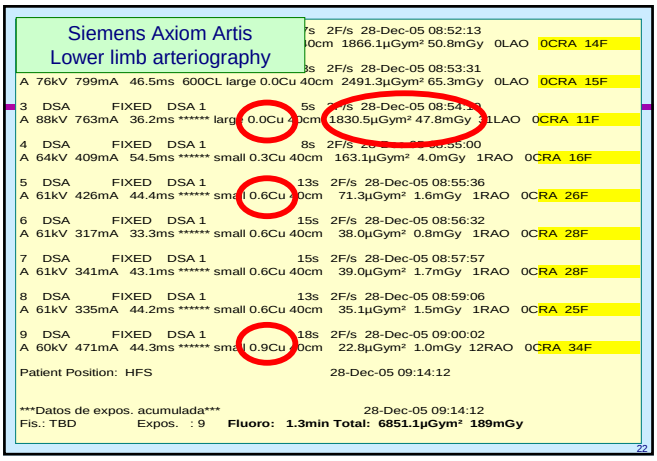
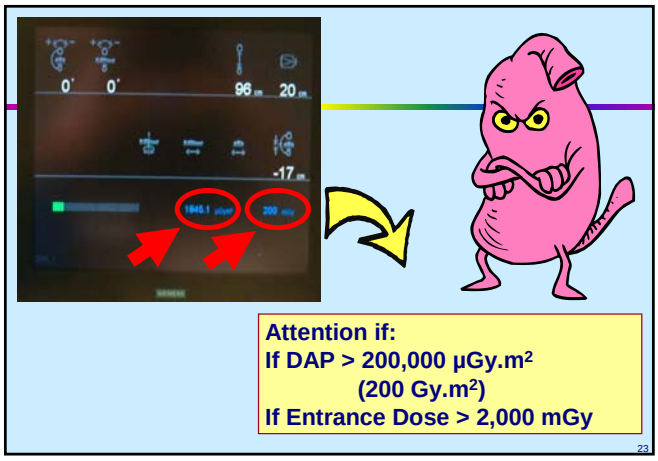
In room dosimetric indications



20







3b. Understand dose information and dose reports

- IEC and DICOM are producing a new standard for the “dose structured report”.
- Reference values indicating the “state of the practice” would help in the optimisation.

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IEC and DICOM working together

- IEC is working on a standard (drafted with the name "DICOM-DOSE").
- The irradiation objects, along with other information, shall be stored in a "Radiation Dose Structured Report" (RDSR).
- The RDSR could be archived in the RIS, or PACS, or to be transferred to a "Radiation Safety Reporting System" (RSRS).

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Radiation Doses in Interventional Radiology Procedures: The RAD-IR Study

Part I: Overall Measures of Dose

Donald L. Miller, MD, Stephen Balter, PhD, Patricia E. Cole, PhD, MD, Hollington T. Lu, MS, MA, Beth A. Schueler, PhD, Michael Geisinger, MD, Alejandro Berenstein, MD, Robin Albert, MD, Jeffrey D. Georgia, MD, Patrick T. Noonan, MD, John F. Cardella, MD, James St. George, MD,[1] Eric J. Russell, MD, Tim W. Malisch, MD,[2] Robert L. Vogelzang, MD, George L. Miller III, MD,[3] and Jon Anderson, PhD

J Vasc Interv Radiol 2003; 14:711–727

Procedure	Cases	Mean fluoroscopy time (min)	Mean number of images	Mean DAP Gy.cm2	Mean cumulative dose Gy
TIPS	135	38,7	231	335.4	2.00
Biliary drainage	123	23.6	15	70.6	0.91
Renal stent	103	21.6	159	190.0	1.61
Iliac stent	93	18.4	241	212.8	1.34
Hepatic chemoembol.	126	16.8	216	282.3	1.41
Pelvic fibroid embol.	90	29.5	305	298.2	2.46
Vertebroplasty	98	16.2	77	78.1	1.25

Seven academic medical centers; 2142 procedures

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	SPANISH SURVEY					USA (Miller DL, Balter S et al. 2003)			
	Sample	Median image number	Median fluoroscopy time min	Median DAP Gy.cm²	Mean DAP Gy.cm²	Sample	Mean number of images	Mean DAP Gy.cm²	Mean fluoroscopy time (min)
Biliary drainage	98	6	11.5	23.7	60.3	123	15	70	23.3
Hepatic chemoembolization	62	100	17.7	175.0	209.1	126	216	282	16.8
Iliac Stent	25	54	5.5	59.3	87.7	93	159	213	21.6
	185								

Spanish mean values are 16-60% lower than the USA values.
But mean value is not the good descriptor for these patient dose distributions.

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4a. Realize that still some important problems exist

- Staff dosimetry for interventional radiology is still quite poor (specially for lens and hands) and several lens injuries in interventionistas have been reported recently.
- Reference levels for interventional radiology will be a challenge in the next years. Complexity of the procedures need to be included.

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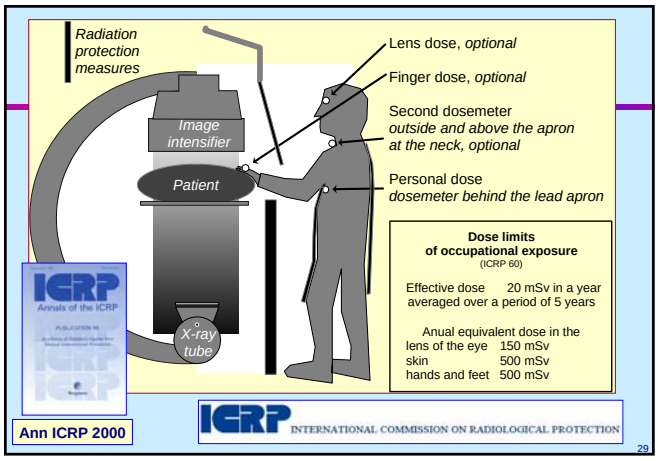
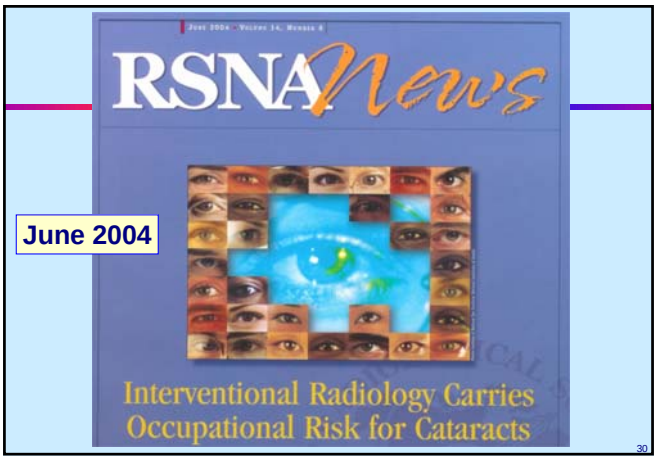


Ann ICRP 2000



June 2004

Haskal study

- The investigators screened 59 practicing interventional radiologists during a medical conference in New York City in November 2003 to evaluate posterior subcapsular cataract (PSC) formation caused by ionizing radiation.
- Nearly half of the interventional radiologists screened had signs of radiation-related lens changes.
- PSC cataracts were found in five (8 percent) of the 59 radiologists screened, and an additional 22 subjects (37 percent) showed small paracentral dot-like opacities

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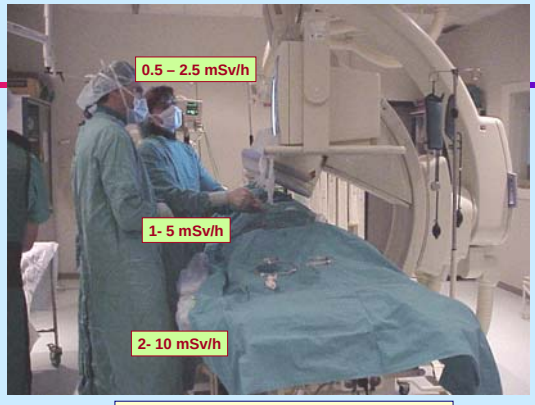

Typical scatter dose rates during fluoroscopy

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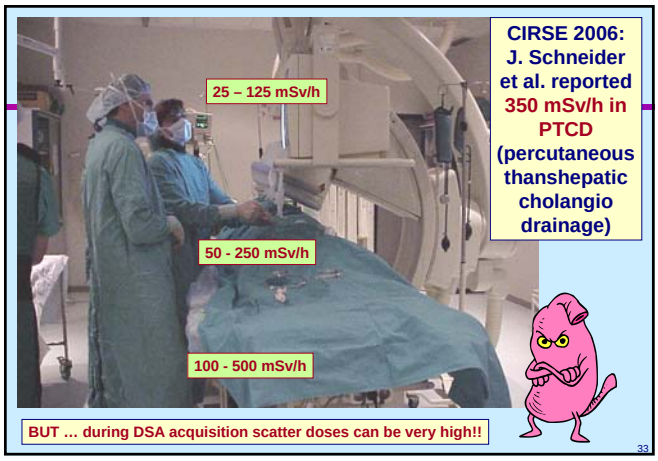
25 – 125 mSv/h
50 - 250 mSv/h
100 - 500 mSv/h
CIRSE 2006: J. Schneider et al. reported 350 mSv/h in PTCD (percutaneous thanshepatic cholangio drainage)
BUT … during DSA acquisition scatter doses can be very high!!
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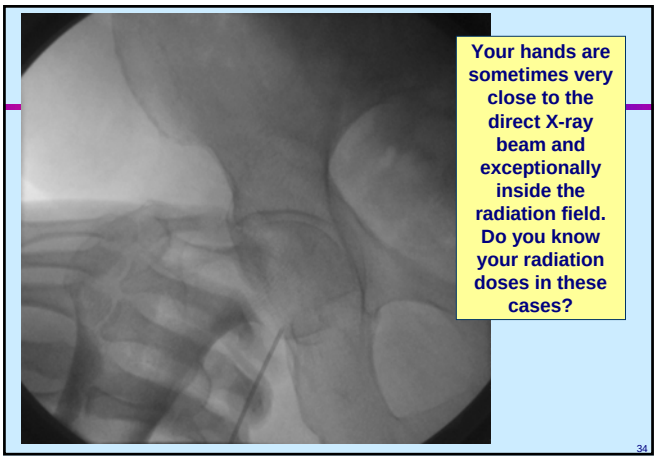
Your hands are sometimes very close to the direct X-ray beam and exceptionally inside the radiation field. Do you know your radiation doses in these cases?
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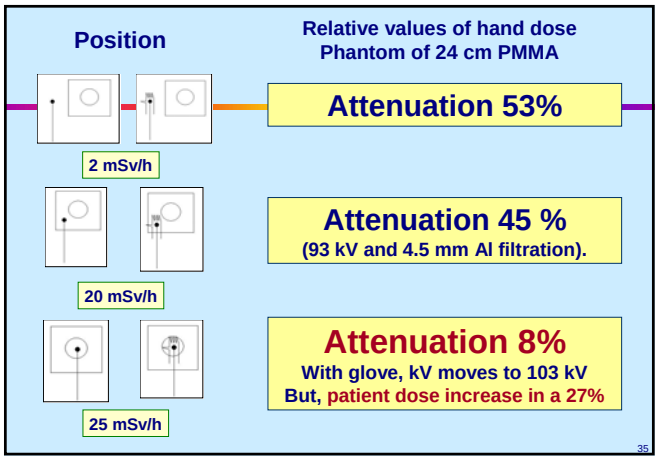
Position
Relative values of hand dose
Phantom of 24 cm PMMA
2 mSv/h
Attenuation 53%
20 mSv/h
Attenuation 45 %
(93 kV and 4.5 mm Al filtration).
25 mSv/h
Attenuation 8%
With glove, kV moves to 103 kV
But, patient dose increase in a 27%
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A general recommendation
Be aware of the radiological protection of your patient and you will also be improving your own occupational protection
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4b.Realize that still some important problems exist

- ICRP will help us to solve of the problems!.
- During the last meeting of Committee 3 of ICRP (Protection in Medicine) (San Francisco, September 2006) it has been agreed two new topics for future documents:
  - Occupational RP and staff dosimetry in interventional radiology and correlation with patient protection (C Cousins).
  - Widening the use of reference levels for digital and interventional radiology (E Vano).

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Conclusions

- We, interventionists and medical physicists, still have a lot of job to do together.
- Training in radiation dose management should be a priority.

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