ADVANCES IN CARDIAC ARRHYTHMIAS

and

GREAT INNOVATIONS IN CARDIOLOGY

XXVII GIORNATE CARDIOLOGICHE TORINESI

AZIENDA OSPEDALIERO-UNIVERSITARIA
Città della Salute e della Scienza di Torino

UNIVERSITÀ DEGLI STUDI DI TORINO

From Caliper to Catheter

JMC
JOINT MEETING OF CARDIOLOGY

HOW TOOLS ARE CURRENTLY USED IN THE CATHETER LAB

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Centro Congressi
Unione Industriale di Torino

DALL'ANALOGICO AL DIGITALE

I B

FLAT PANEL

DALL'ANALOGICO AL DIGITALE

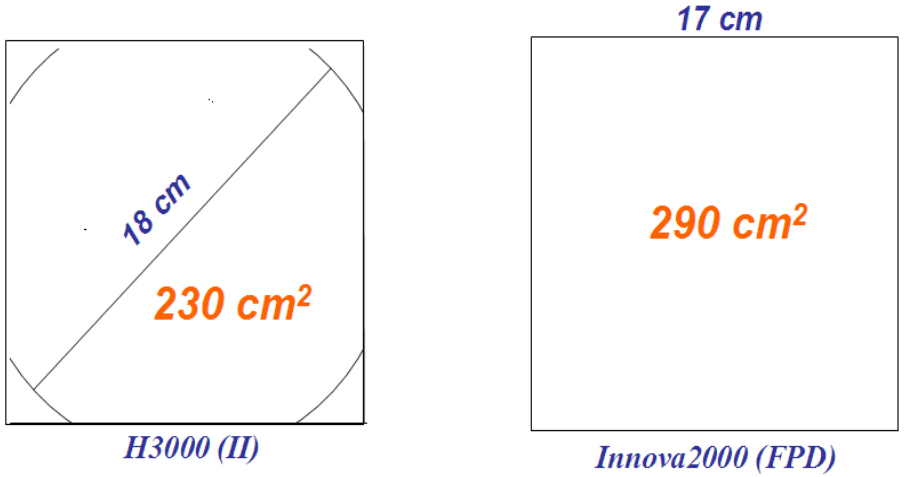
IB → Flat panel

Maggior numero fps

Intervento correttivo
COLLIMAZIONE

IAEA
International Atomic Energy Agency

A FoV (Field of View) simili corrispondono aree irradiate differenti



AREA +26% → DAP +26% !!!

II 12,5 fps / FPD 15 fps

Angiografi Digitali

GE
PHILIPS
SIEMENS
TOSHIBA

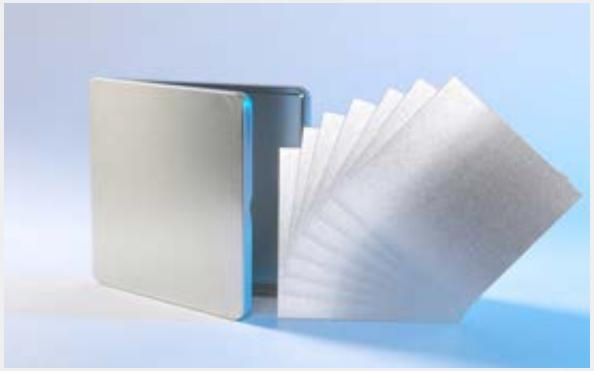
Gli angiografi sono tutti simili,
ma non uguali!

Progettati per vedere molto bene

Angiografi Digitali

Modalità di Lavoro:

- Scopia sempre pulsata (es. 3.75, 7.5, 15 e 30 pps)
- Filtrazione aggiuntiva (0.1 mmCu e 0.9 mmCu)
- Acquisizione road-map
- Angiografia rotazionale
  con acquisizione 3D
- Integrazioni di immagini
- Post processing dell'immagine



DOSE/FRAME VS ZOOM

ZOOM:

in alcuni casi la tecnologia digitale permette di non avere un aumento di dose sostanziale alla cute del paziente, anche impiegando gli zoom mentre in altri casi ciò non è vero

Applicazione	fps	FOV (cm)	mGy/frame a 65 cm
Cardiaca: coronarografia	15 e 30	25	0,2
		20	0,3
		15	0,4

Angiografo digitale PHILIPS FD10

SCOPIA

Gli angiografi permettono di selezionare 3 livelli di scopia per ogni applicazione normalmente denominati:

I - Low

II - Normal

III – High

Le impostazioni previste dalle ditte costruttrici sono però differenti

SCOPIA PHILIPS FD10

Applicazioni: “CARDIACA” e “CARDIO ECO-DOSE” (FOV 25 cm)

Applicazione principale: CARDIACA

Modalità	Filtro	pps	mGy/min a 65 cm
Scopia I Low	0.4 mmCu + 1 mmAl	15	15
Scopia II Normal	0.1 mmCu + 1 mmAl	15	32
Scopia III High	0.1 mmCu + 1 mmAl	30	44

Impostazioni fornite dalla Ditta all’installazione!!

E’ possibile variare pps e filtro, ma solo richiedendolo alla Ditta che provvede a inserire applicazioni ad hoc

Modalità di acquisizione

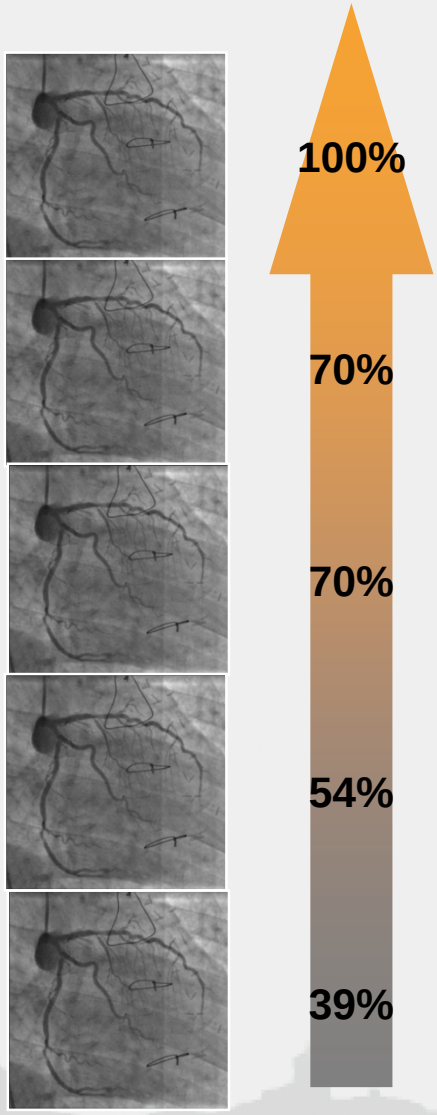
- **IQ Plus**
  Maximize Image Quality

- **IQ Standard**
  Less Noise

- **Smart IQ**
  More Contrast

- **Receptor Dose Limited Plus**
  Optimize Image Quality while keeping dose to a minimum

- **Receptor Dose Limited Standard**
  Minimum Dose



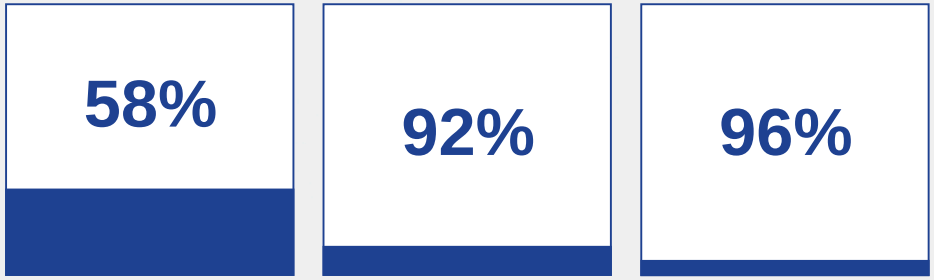
Images & videos acquired on Innova 2100IQ

SCOPIA GE

Minimum Dose

Maximum dose reduction for long & complex procedures

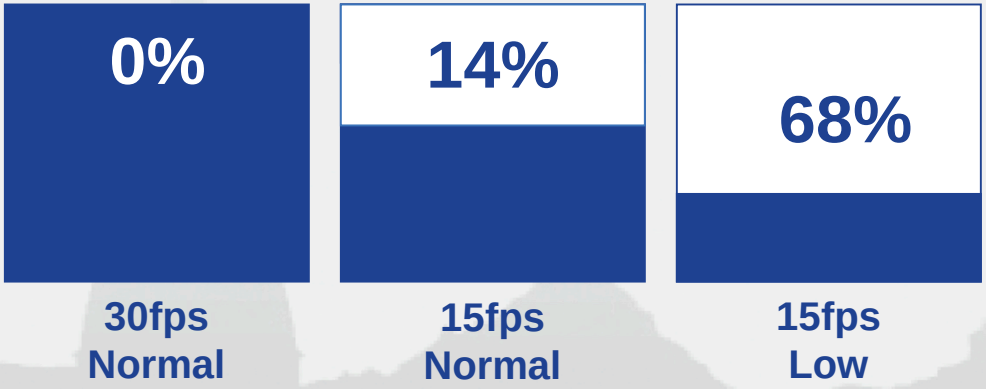
% Dose reduction[1]



1based on Innova 2100^{IQ} Operator Manual Data for FOV20

IQ - Maximize Image Quality

% Dose reduction[1]



1based on Innova 2100^{IQ} Operator Manual Data for FOV20

GRAFIA PHILIPS FD10

Applicazioni: “CARDIACA” e “CARDIO ECO-DOSE” (FOV 25 cm)

Applicazione	fps	mGy/frame a 65 cm
Cardiaca	15 e 30	0,20
Cardiaca ECO DOSE (filtrazione aggiuntiva 0.1 mmCu + 1 mmAl)	7.5 e 15	0,10

Impostazioni fornite dalla Ditta all’installazione!!

POST PROCESSING IMMAGINI

ALLURA CLARITY SYSTEM

- Elaborazione real-time
  (in scopia e grafia fino a 15 fps)
- Riduzione rumore
- *Edge enhancement*

- Riduzione dose
- IQ costante

EFFETTI DETERMINISTICI

- osservabili quando si supera una dose soglia
- l'aumento della dose sopra la soglia aumenta la gravità del danno

Effects	Threshold dose (Gy)	Time of onset
SKIN		
Early transient erythema	2	2-24 hours
Main erythema reaction	6	~1.5 weeks
Temporary epilation	3	~3 weeks
Permanent epilation	7	~3 weeks
Dermal necrosis	>12	>52 weeks
EYE		
Lens opacity (detectable)	>1-2	>5 years
Lens/cataract (debilitating)	>5	>5 years

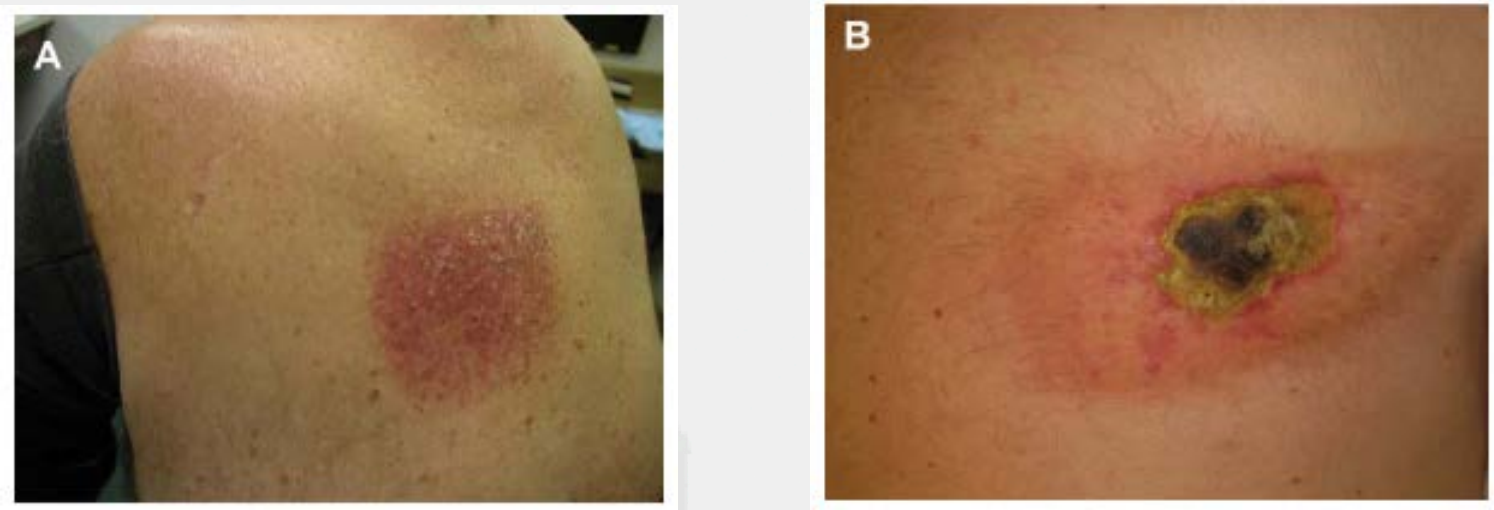
Source: ICRP, 2000

EFFETTI DETERMINISTICI IN EMODINAMICA

Core Curriculum

Radiation Safety Program for the Cardiac Catheterization Laboratory

Charles E. Chambers,[1*] MD, Kenneth A. Fetterly,[2] PhD, Ralf Holzer,[3] MD, Pei-Jan Paul Lin,[4] PhD, James C. Blankenship,[5] MD, Stephen Balter,[6] PhD, and Warren K. Laskey,[7] MD



11 Gy dopo 1 mese

18 Gy dopo 6 mesi

Fig. 1. Radiation skin (deterministic) effects. A. Dry desquamation (Poikiloderma) at one month in a patient receiving ~11 Gy calculated peak skin dose. B. Skin Necrosis at 6 months in a patient who received ~18 Gy calculated peak skin dose.

EFFETTI DETERMINISTICI IN NEURORADIOLOGIA

Fluoroscopically Guided Interventional Procedures:

A Review of Radiation Effects on Patients' Skin and Hair[1]

Radiology: Volume 254: Number 2—February 2010

Figure 1: Radiation injury in a 60-year-old woman subsequent to successful neurointerventional procedure for the treatment of acute stroke. Estimated fluoroscopy time was more than 70 minutes; 43 imaging series were performed during course of the procedure. The head was not shaved. Note focal epilation on scalp and skin injury on neck but not on scalp. No dose estimates were available for this case.

Effetti Deterministici in Interventistica Vascolare

"Radiation injury is a potentially serious complication to fluoroscopically-guided complex interventions"

Ref. LK Wagner_biij, 2007

MONITORAGGIO DOSE

Guidelines for Patient Radiation Dose Management

Michael S. Stecker, MD, Stephen Balter, PhD, Richard B. Towbin, MD, Donald L. Miller, MD, Eliseo Vañó, PhD, Gabriel Bartal, MD, J. Fritz Angle, MD, Christine P. Chao, MD, Alan M. Cohen, MD, Robert G. Dixon, MD, Kathleen Gross, MSN, RN-BC, CRN, George G. Hartnell, MD, Beth Schueler, PhD, John D. Statler, MD, Thierry de Baère, MD, and John F. Cardella, MD, for the SIR Safety and Health Committee and the CIRSE Standards of Practice Committee

J Vasc Interv Radiol 2009; 20:S263–S273

Abbreviations: ACR = American College of Radiology, FDA = Food and Drug Administration

Table 3
Summary of Radiation Monitoring Dose Notification Thresholds

Parameter	First Notification	Subsequent Notifications
Peak skin dose (PSD)	2,000 mGy	
Reference point air kerma ($K_{a,r}$)	3,000 mGy	
Kerma-area-product (P_{KA})	300 Gy · cm^2*	
Fluoroscopy time (FT)	30 min	

* Assuming a 100-cm^2 field at the patient's skin. The val
actual procedural field size.

Table 4
Thresholds for Patient Follow-up

Parameter	Threshold
Peak skin dose (PSD)	3,000 mGy
Reference point air kerma ($K_{a,r}$)	5,000 mGy
Kerma-area-product (P_{KA})	500 Gy · cm^2
Fluoroscopy time (FT)	60 min

MONITORAGGIO DOSE

Core Curriculum

Radiation Safety Program for the Cardiac Catheterization Laboratory

Charles E. Chambers,[1*] MD, Kenneth A. Fetterly,[2] PhD, Ralf Holzer,[3] MD, Pei-Jan Paul Lin,[4] PhD, James C. Blankenship,[5] MD, Stephen Balter,[6] PhD, and Warren K. Laskey,[7] MD

TABLE V. Suggested Values for First and Subsequent Notifications and the Substantial Radiation Dose Level (SRDL)

Dose metric	First notification	Subsequent notifications (increments)	SRDL
$D_{skin,max}$[a]	2 Gy	0.5 Gy	3 Gy
$K_{a,r}$[b]	3 Gy	1 Gy	5 Gy[b]
P_{KA}[c]	300 Gy cm^{-2}[d]	100 Gy cm^{-2}[d]	500 Gy cm^{-2}[d]
Fluoroscopy time	30 min	15 min	60 min

NCRP (2010) National Council on Radiation Protection and Measurements. Radiation Dose Management for Fluoroscopically Guided Interventonal Medical Procedures, NCRP Report No. 168 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).

[a] $D_{skin,max}$ is peak skin dose, requiring calculations by physicist.

[b] $K_{a,r}$ is total air kerma at the reference point.

[c] P_{KA} is air kerma-area product.

[d] Assuming a 100 cm^2 field at the patient's skin. For other field sizes, the P_{KA} values should be adjusted proportionally to the actual procedural field size (e.g., for a field size of 50 cm^2, the SRDL value for P_{KA} would be 250 Gy cm^{-2}).

Catheterization and Cardiovascular Interventions 77:546–556 (2011)

MONITORAGGIO DOSE

Recanalisation of Chronic Total coronary Occlusions: 2012 consensus document from the EuroCTO club

Georgios Sianos[1]*, MD, PhD, FESC; Gerald S. Werner[2], MD, PhD, FESC, FACC, FSCI; Alfredo R. Galassi[3], MD, FESC, FACC, FSCAI; Michail I. Papafaklis[4], MD, PhD; Javier Escaned[5], MD, PhD, FESC; David Hildick-Smith[6], MD, FESC; Evald Høj Christiansen[7], MD, PhD; Anthony Gershlick[8], MD, FRCP, FESC; Mauro Carlino[9], MD, FESC; Angelos Karlas[1], MD; Nikolaos V. Konstantinidis[1], MD; Salvatore D. Tomasello[3], MD; Carlo Di Mario[10], MD, PhD, FRCP, FESC; Nicolaus Reifart[11], MD, PhD, FESC for the EuroCTO Club

1. AHEPA University Hospital, Thessaloniki, Greece; 2. Klinikum Darmstadt, Darmstadt, Germany; 3. Ospedale Ferrarotto, Univ. of Catania, Catania, Italy; 4. Michailideion Cardiac Centre, Univ. of Ioannina, Ioannina, Greece; 5. Hospital Clinico San Carlos, Madrid, Spain; 6. Sussex Cardiac Centre, Brighton & Sussex University Hospital Trust, Brighton, United Kingdom; 7. Aarhus University Hospital, Skejby, Denmark; 8. Univ. Hospitals of Leicester, Leicester, United Kingdom; 9. San Raffaele Scientific Institute, Milan, Italy; 10. Royal Brompton Hospital and Imperial College, London, United Kingdom; 11. Main Taunus Kliniken, Bad Soden, Germany

This paper also includes accompanying supplementary data published at the following website: www.eurointervention.org

EuroIntervention 2012;8:**139-145**

EXPERT REVIEW

CONSENSUS ON PROCEDURAL PLANNING

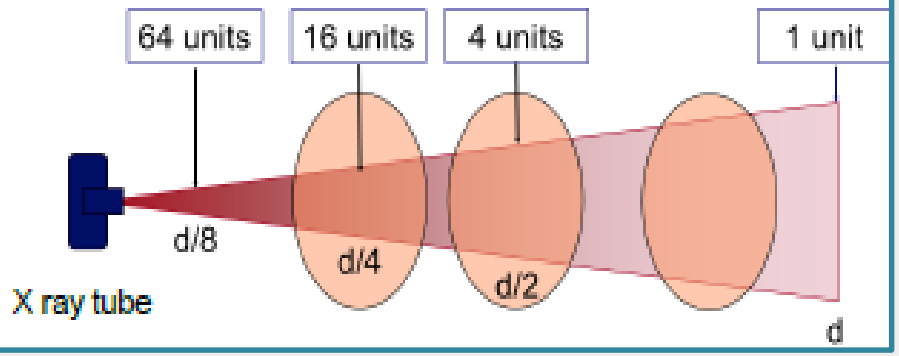
- Operators should select cases according to their experience and expertise in order to achieve a successful recanalisation in about 80% of these cases. More complex cases should be referred to expert operators.
- Repeat procedures should be planned with contemporary techniques and material selection, after understanding the reasons for the initial failure.
- A CTO PCI should be stopped when complications occur, when the volume of contrast reaches 4 x GFR ml or when radiation reaches a maximum of 10 Gy (the operator should be alerted at the level of 5 Gy).

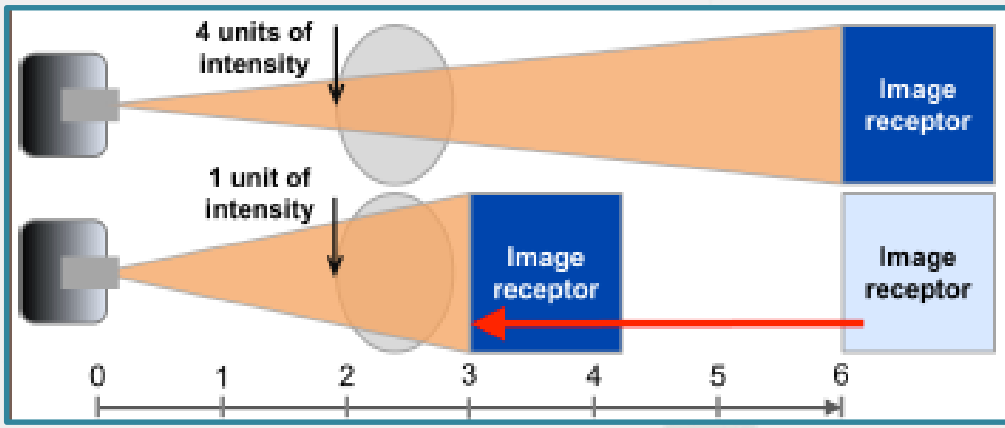
RADIOPROTEZIONE DEI PAZIENTI IN FLUOROSCOPIA

LE 10 PERLE

IAEA International Atomic Energy Agency

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

La dose assorbita diminuisce in modo inversamente proporzionale al **quadrato della distanza** dal fuoco del tubo radiogeno

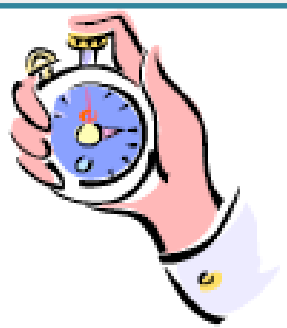
RADIOPROTEZIONE DEI PAZIENTI IN FLUOROSCOPIA

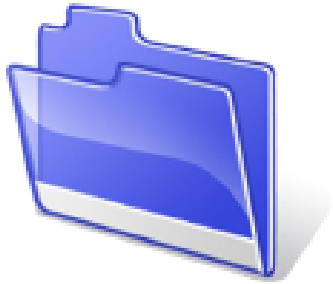
LE 10 PERLE

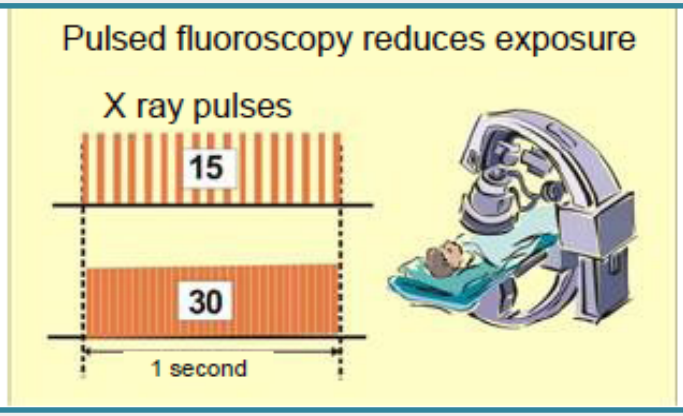
IAEA International Atomic Energy Agency

3. Minimize fluoroscopy time

Keep records of fluoroscopy time and DAP/KAP (if available) for every patient



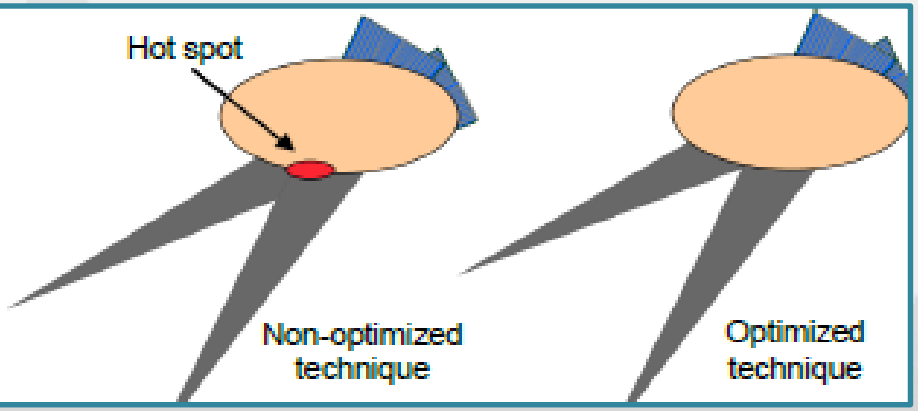




4. Use pulsed fluoroscopy with the lowest frame rate possible to obtain images of acceptable quality

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

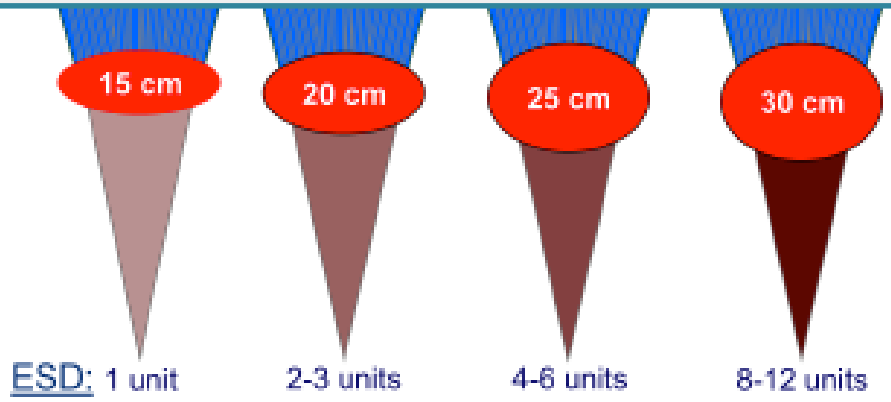
Vary the beam entrance port by rotating the tube around the patient

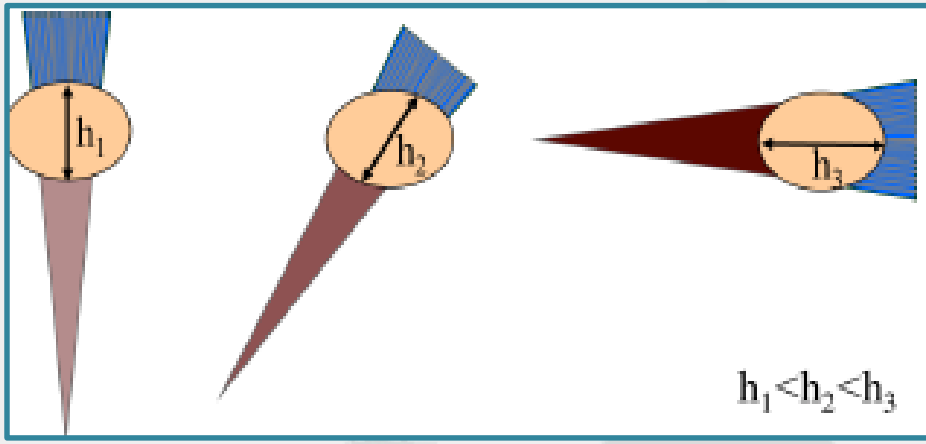


LE 10 PERLE

IAEA International Atomic Energy Agency

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

RADIOPROTEZIONE DEI PAZIENTI IN FLUOROSCOPIA

LE 10 PERLE

IAEA International Atomic Energy Agency

INTENSIFIER Field-of-view (FOV)	RELATIVE PATIENT ENTRANCE DOSE RATE FOR SOME UNITS
12" (32 cm)	100
9" (22 cm)	177
6" (16 cm)	400
4.5" (11 cm)	711

8. Avoid the use of magnification

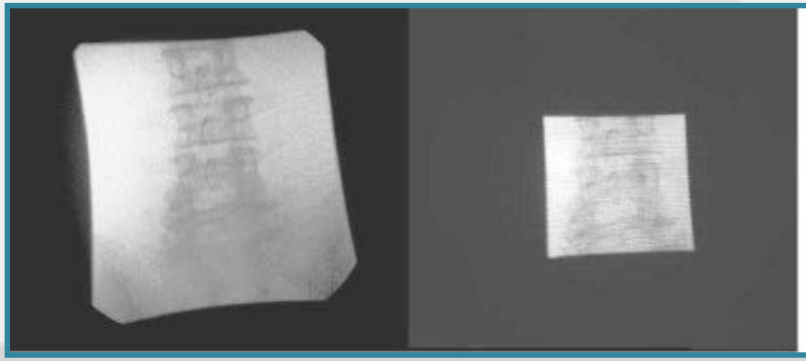
Decreasing the field of view by a factor of two increases dose rate by a factor of four

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

Avoid using the acquisition mode for fluoroscopy

Cine dose rate ≈ (10-60) × normal fluoroscopy dose rate

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

PIANIFICAZIONE MODALITÀ ACQUISIZIONE

Strutturali (TAVI, MitraClip):

procedure "macro", senza necessità di elevata risoluzione spaziale o temporale

Coronariche BMI

- **COMPLESSE/STADIATE: entro 60 giorni dose cumulativa a fini deterministici**
- **RIPETUTE: effetti a lungo termine di procedure ripetute non ben noti**
- **OCCLUSIONI CRONICHE: lunghe e con necessità di "vedere bene" in poche proiezioni**

PIANIFICAZIONE MODALITÀ ACQUISIZIONE

PROCEDURE CORONARICHE

BMI paz. > 25

Modalità	Filtro	pps	FOV (cm)	mGy/min a 65 cm
Scopia I Low	0.4 mmCu + 1 mmAl	15	25	11,5
			20	16,5
			15	22,0
Scopia II Normal	0.1 mmCu + 1 mmAl	15	25	25,8
			20	35,5
			15	47,1
Scopia III High	0.1 mmCu + 1 mmAl	30	25	33,8
			20	45,9
			15	55,0

Applicazione **High Quality**
Grafia: 7.5 fps - 3 mmAl

BMI paz. < 25

Modalità	Filtro	pps	FOV (cm)	mGy/min a 65 cm
Scopia I Low 7.5	0.4 mmCu + 1 mmAl	7,5	25	5,6
			20	8,1
			15	10,6
Scopia II Low 15	0.4 mmCu + 1 mmAl	15	25	11,4
			20	16,0
			15	21,5
Scopia III Normal 15	0.1 mmCu + 1 mmAl	15	25	25,8
			20	34,5
			15	43,3

Applicazione **Cardiac ECO-Dose**
Grafia: 7.5 fps - 0.1 mmCu + 4 mmAl

PROIEZIONI

Kerma in aria cumulativo (AK):

è la somma della dose dovuta a tutte le proiezioni eseguite

Distribuzione della dose legata alle proiezioni:

utilizzando solo poche proiezioni durante la procedura, la maggior parte della dose totale viene concentrata su di una ristretta regione di cute

PROIEZIONI STANDARD

AP

AP CRANIALE

AP CAUDALE

OAS

OAS CRANIALE

OAS CAUDALE

OAD

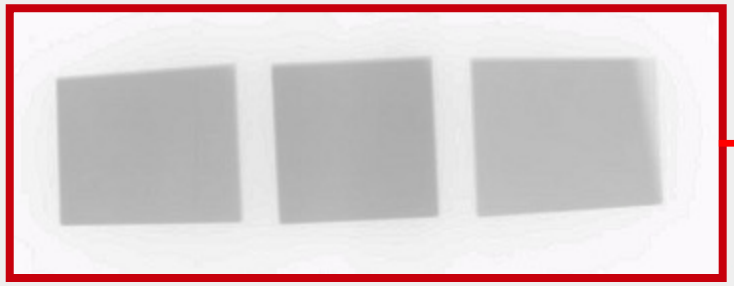
OAD CRANIALE

OAD CAUDALE

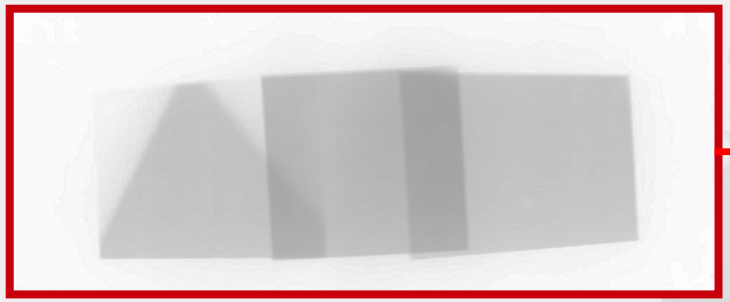
LATERO-LATERALE

PROIEZIONI

Attenzione alla sovrapposizione dei campi durante le procedure complesse



CAMPI SEPARATI
Rot. +/- 34°
FOV 15 cm
Campo su pellicola: lato 7 cm



CAMPI PARZIALMENTE SOVRAPPOSTI
Rot. +/- 34°
FOV 25 cm
Campo su pellicola: lato 11.5 cm

Verifica con pellicole radiocromiche

WARNING

Importanti informazioni sulla dose totale e sulla distribuzione della dose

IN SALA

- Rappresentazione grafica della proiezione in uso
- Dose istantanea in aria in quella proiezione con la modalità in uso
- Stima del tempo necessario per raggiungere la dose di 2 Gy nella proiezione in uso e con la modalità impostata

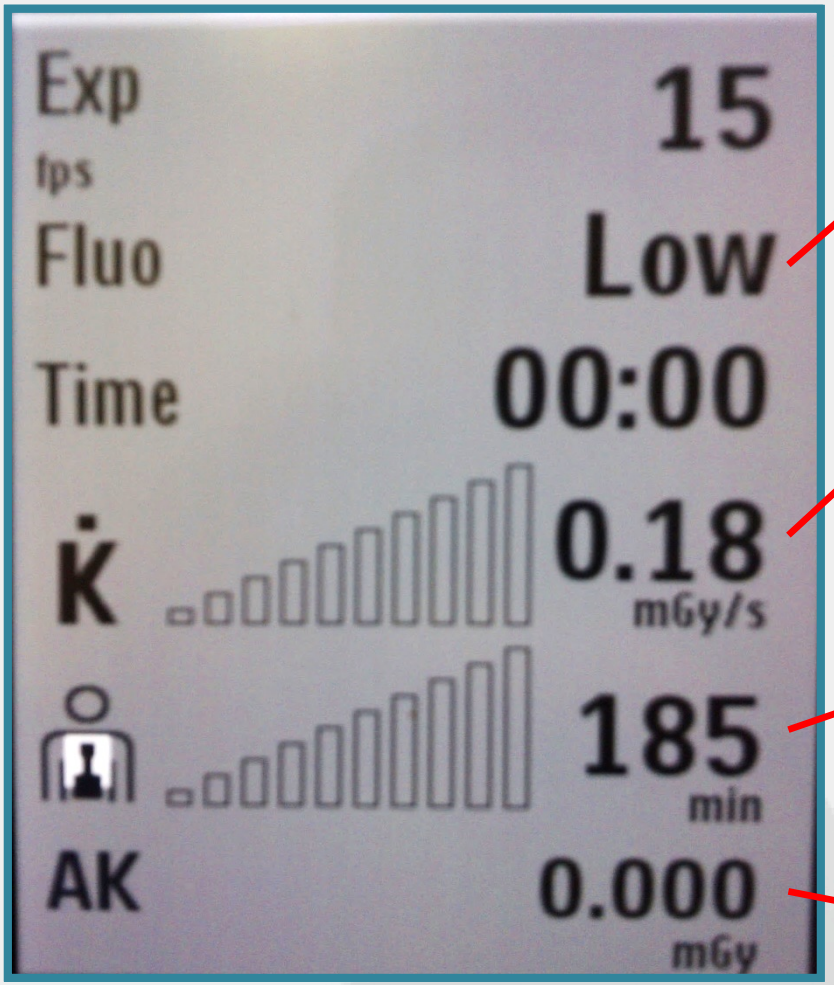
FUORI

- AIR KERMA
- DAP (dose per area)

Indicatori dosimetrici su cui il tecnico di Radiologia può impostare il timing dei warnings

WARNING

IN SALA



TIPO DI SCOPIA IN USO

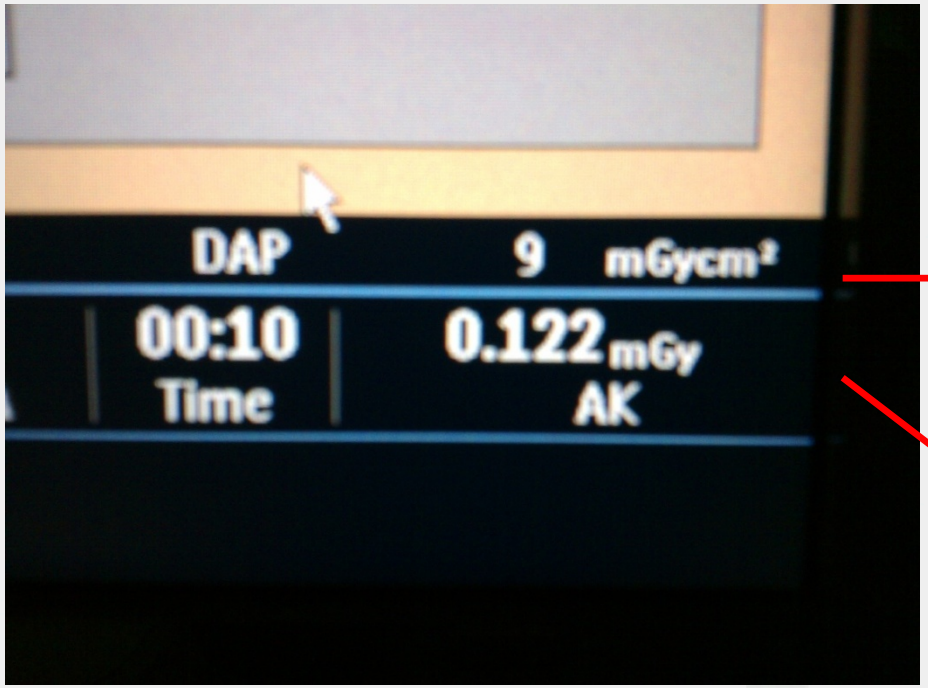
DOSE IN ARIA (KERMA) ISTANTANEA AL PUNTO DI RIFERIMENTO NELLA PROIEZIONE IN USO CON LA MODALITÀ IMPOSTATA

TEMPO RIMANENTE AL RAGGIUNGIMENTO DI 2 Gy DI DOSE IN ARIA NELLA PROIEZIONE IN USO CON LA MODALITÀ IMPOSTATA

AIR KERMA CUMULATIVO

WARNING

AL POLIGRAFO



DAP: SOMMA DEI PRODOTTI DI AIR KERMA ISTANTANEO PER AREA DEL FASCIO DI RAGGI X (DOSE X AREA): STIMA DELLA DOSE TOTALE AL PAZIENTE

AIR KERMA CUMULATIVO

Sulla base di questi parametri,
il tecnico di Radiologia può avvisare l'operatore del raggiungimento delle dosi di attenzione prestabilite

WARNING

Valori soglia suggeriti per il warning e le notifiche successive (NCRP 2010)

TABLE V. Suggested Values for First and Subsequent Notifications and the Substantial Radiation Dose Level (SRDL)

Dose metric	First notification	Subsequent notifications (increments)	SRDL
$D_{skin,max}$ [a]	2 Gy	0.5 Gy	3 Gy
$K_{a,r}$ [b]	3 Gy	1 Gy	5 Gy [b]
P_{KA} [c]	300 Gy cm^{-2} [d]	100 Gy cm^{-2} [d]	500 Gy cm^{-2} [d]
Fluoroscopy time	30 min	15 min	60 min

Durante la procedura non è possibile misurare la reale dose di picco alla cute,
per questo si utilizzano grandezze come il K_{aria}

REPORT & FOLLOW UP

I report delle procedure di cateterismo cardiaco dovrebbero contenere indicazioni sulla dose raggiunta, riportando il tempo di scopia, l'air kerma totale e il prodotto air kerma x area (DAP) cumulativo

Il successivo follow-up dovrebbe essere pianificato in base alla stima di dose alla cute del paziente

Table 4
Thresholds for Patient Follow-up

Parameter	Threshold
Peak skin dose (PSD)	3,000 mGy
Reference point air kerma ($K_{a,r}$)	5,000 mGy
Kerma-area-product (P_{KA})	500 Gy · cm^2
Fluoroscopy time (FT)	60 min

Cumulative fluoroscopy time:	5:24	mm:ss
Cumulative DAP (fluoroscopy):	5,528	$mGycm^2$
Cumulative DAP (exposure):	4,620	$mGycm^2$
Total DAP:	10,148	$mGycm^2$
Cumulative Air Kerma:	143.02	mGy
Total number of acquired runs:	11	
Total number of acquired images:	277	
Total number of acquired exposure images:	277	

How Tools Are Currently Used...

ESSENZIALE LA COLLABORAZIONE TRA LE DIVERSE FIGURE PROFESSIONALI:

MEDICI SPECIALISTI
FISICI SANITARI
TSRM
DITTE FORNITRICI

L'ANGIOGRAFO DIGITALE DEVE ESSERE "CONFEZIONATO IN MODO SARTORIALE"

PER ESEGUIRE AL MEGLIO LE PROCEDURE

OTTIMIZZANDO LA DOSE AL PAZIENTE

Grazie per l'attenzione

ADVANCES IN CARDIAC ARRHYTHMIAS

and

GREAT INNOVATIONS IN CARDIOLOGY

XXVII GIORNATE CARDIOLOGICHE TORINESI

AZIENDA OSPEDALIERO-UNIVERSITARIA
Città della Salute e della Scienza di Torino

UNIVERSITÀ DEGLI STUDI DI TORINO

From Caliper to Catheter

JM
JOINT MEETING
OF CARDIOLOGY

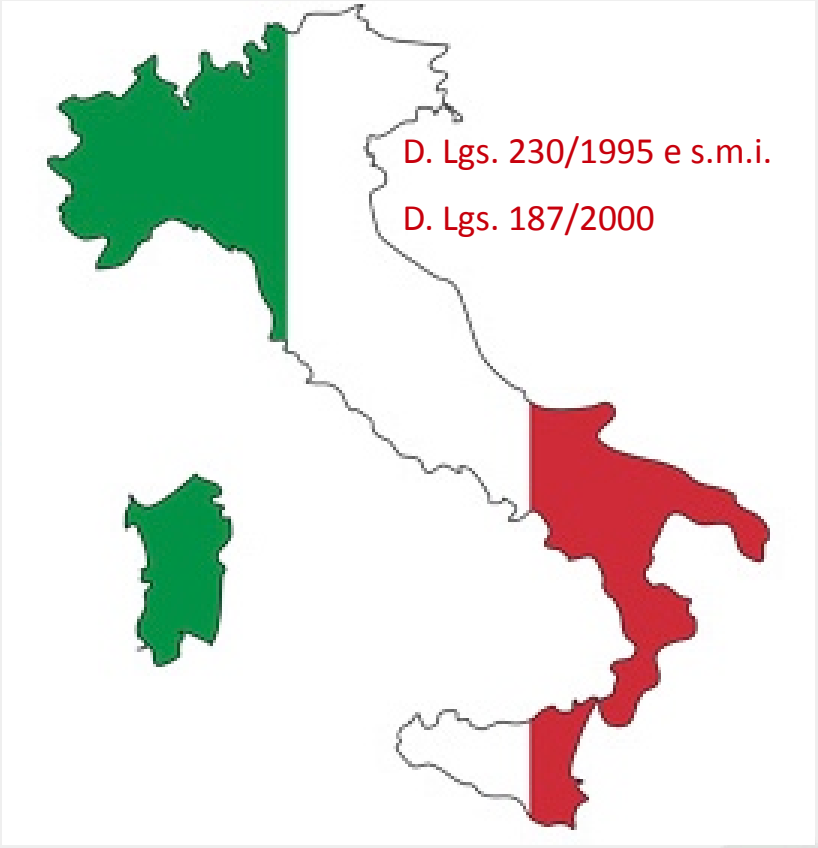
PATIENTS AND OPERATORS PROTECTION

Paola ISOARDI

S.C. Fisica Sanitaria
(Direttore Dott. R. Ropolo)
A.O.U. Città della Salute e della Scienza di Torino

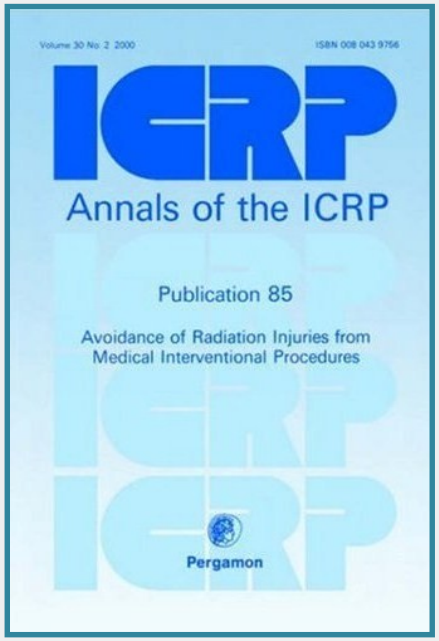
Turin
October 23-24, 2015
Centro Congressi
Unione Industriale di Torino

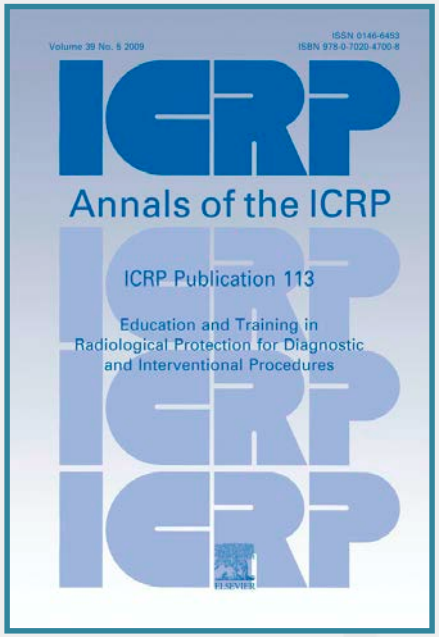
RADIOPROTEZIONE OPERATORI E PAZIENTI

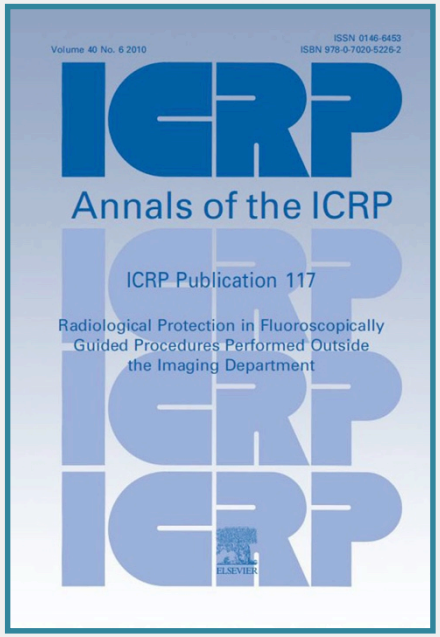


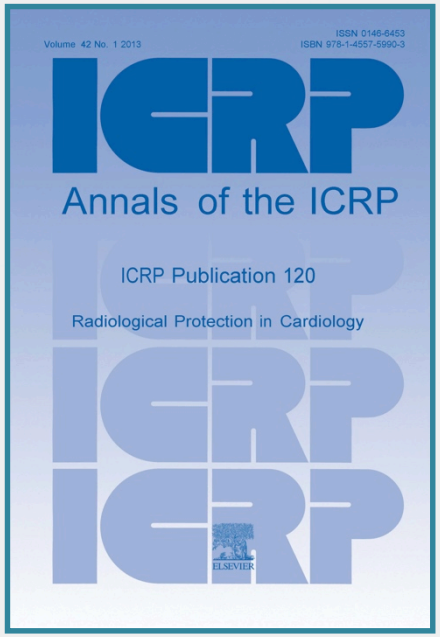
ICRP, 2007. The 2007 Recommendations of the International Commission on Radiological Protection. ICRP Publication 103. Ann. ICRP 37 (2-4).

International Commission on Radiological Protection





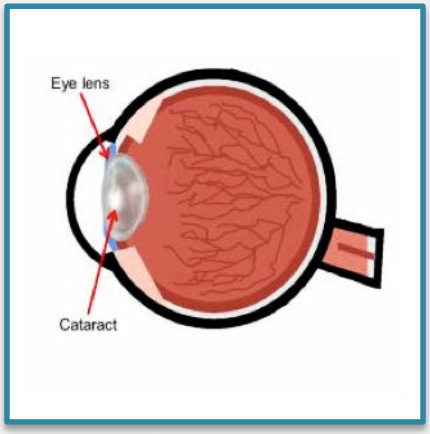




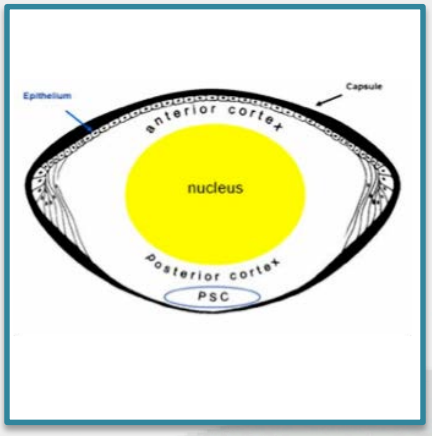
1) ICRP, 2000. Avoidance of Radiation Injuries from Medical Interventional Procedures. ICRP Publication 85. Ann. ICRP 30 (2).
2) ICRP, 2009. Education and Training in Radiological Protection for Diagnostic and Interventional Procedures. ICRP Publication 113. Ann. ICRP 39 (5).
3) ICRP, 2010. Radiological Protection in Fluoroscopically Guided Procedures outside the Imaging Department. ICRP Publication 117, Ann. ICRP 40(6).
4) ICRP, 2013. Radiological protection in cardiology. ICRP Publication 120. Ann. ICRP 42(1).

DOSE AL CRISTALLINO

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION



(2) The Commission has now reviewed recent epidemiological evidence suggesting that there are some tissue reaction effects, particularly those with very late manifestation, where threshold doses are or might be lower than previously considered. For the lens of the eye, the threshold in absorbed dose is now considered to be 0.5 Gy.



(3) For occupational exposure in planned exposure situations the Commission now recommends an equivalent dose limit for the lens of the eye of 20 mSv in a year, averaged over defined periods of 5 years, with no single year exceeding 50 mSv.

Limiti di Dose Lavoratori Esposti

Situazione Attuale

- Limite dose efficace corpo intero: 20 mSv/anno
- Limite dose equivalente cristallino: 150 mSv/anno
- Limite dose equivalente pelle ed estremità: 500 mSv/anno

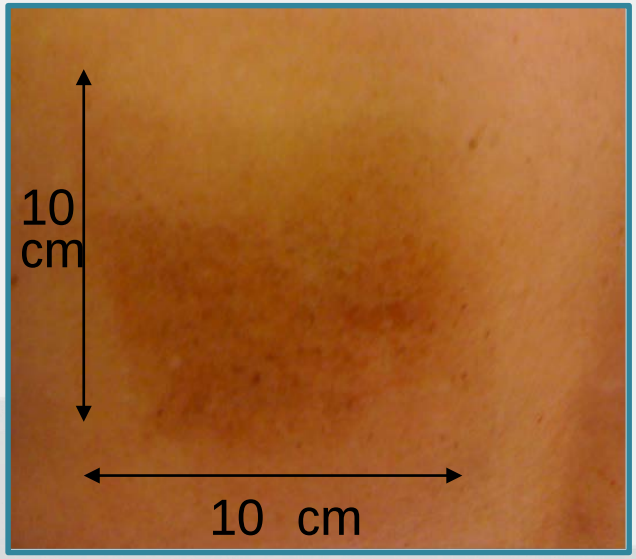
Prossimo Futuro?

- Limite dose efficace corpo intero: 20 mSv/anno
- Limite dose equivalente cristallino: 20 mSv/anno
- Limite dose equivalente pelle ed estremità: 500 mSv/anno

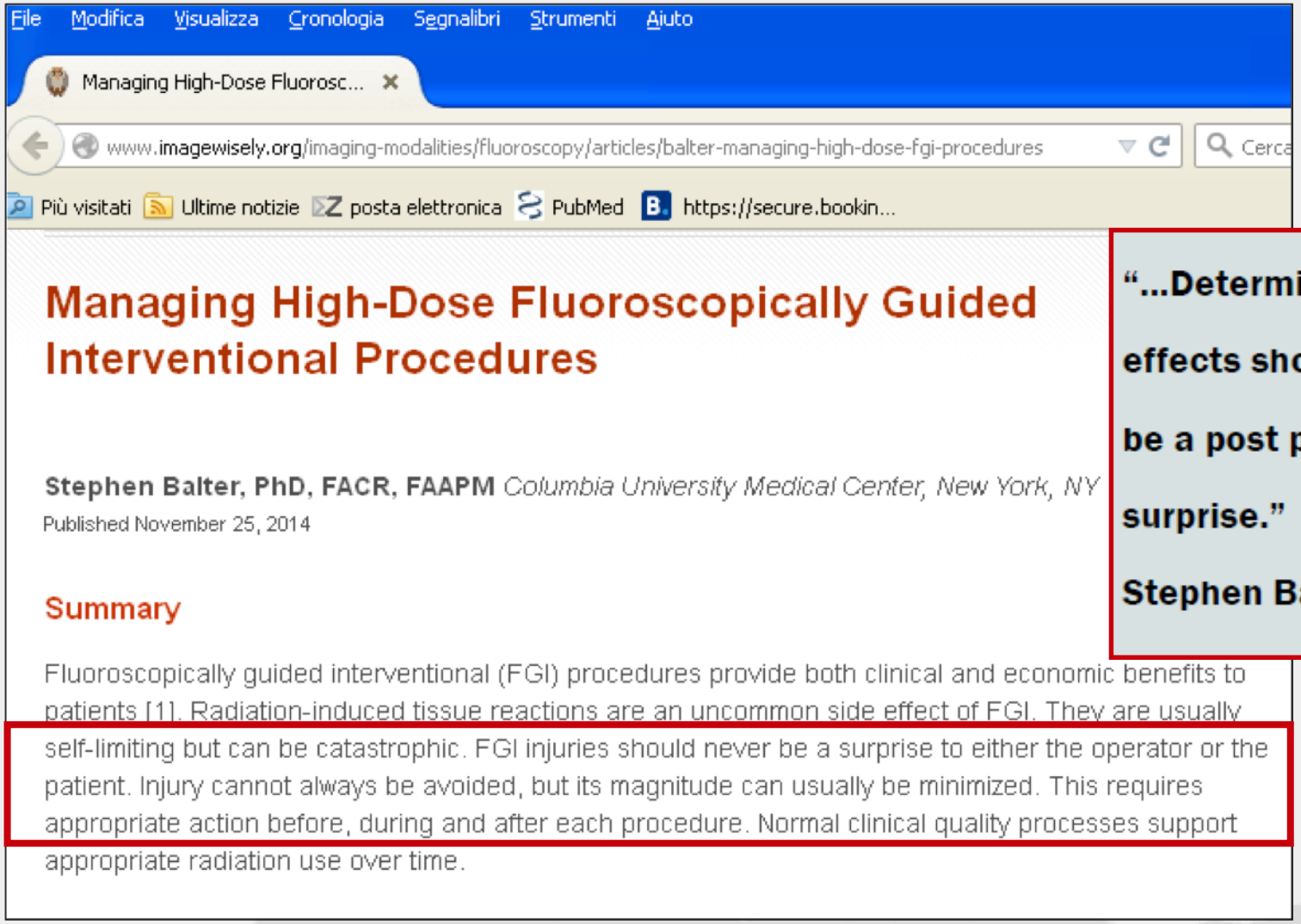
La radioprotezione per i lavoratori esposti garantisce il NON raggiungimento dei danni deterministici e rende accettabili i danni stocastici in funzione di fattori economici e sociali

Effetti Deterministici

Cute Paziente



EFFETTI DETERMINISTICI

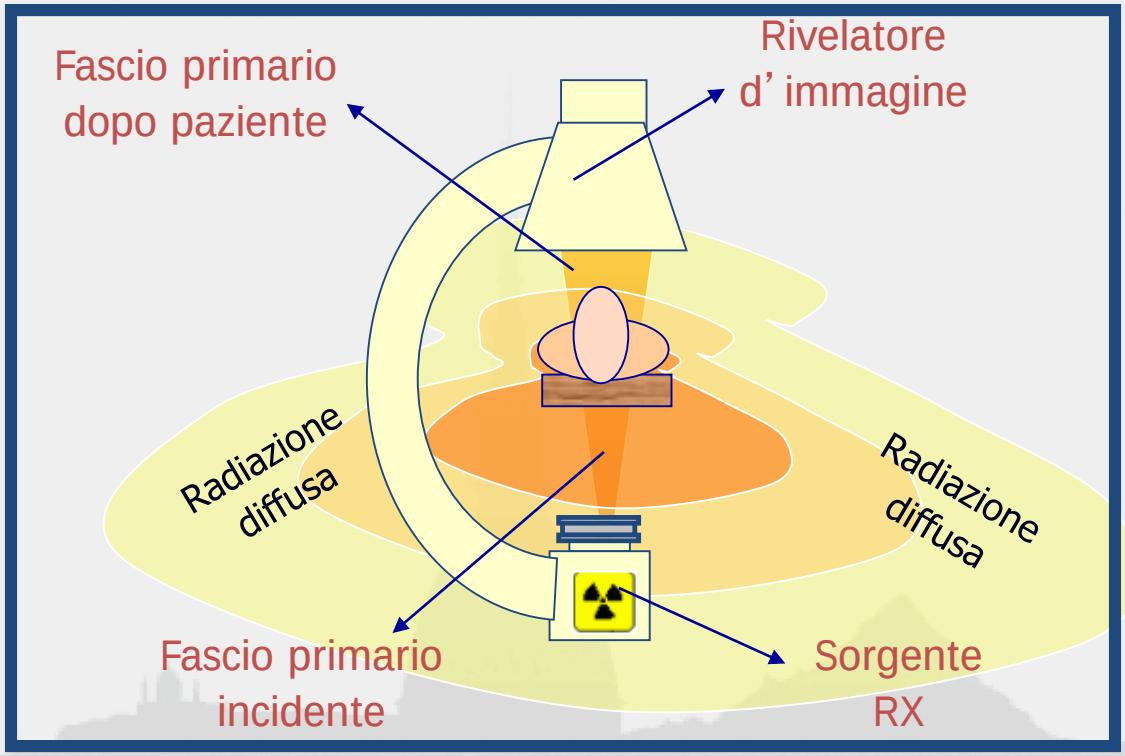


"...Deterministic effects should never be a post procedure surprise."

Stephen Balter, Ph.D.

ESPOSIZIONE DEGLI OPERATORI

La sorgente è costituita da un tubo radiogeno (E<140 kV).
Il rivelatore può essere un intensificatore di brillanza o *flat panel*.
Il paziente è esposto al fascio primario.
Gli operatori sono esposti alla radiazione diffusa prodotta dall'interazione del fascio primario con il paziente stesso.



RADIOPROTEZIONE DEGLI OPERATORI IN FLUOROSCOPIA

LE 10 PERLE

IAEA International Atomic Energy Agency

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

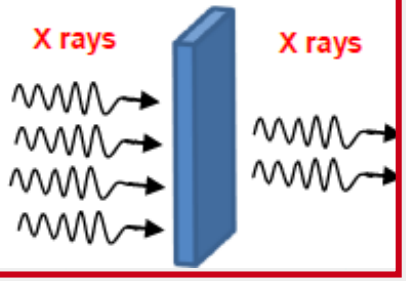
Thyroid protection

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

Minimize time

Maximize distance as much as clinically possible

Use shielding



IAEA RPOP Radiation Protection of Patients

http://rpop.iaea.org

ISEMIR Information System on Occupational Exposure in Medicine, Industry and Research

http://www-ns.iaea.org/tech-areas/communication-networks/norp/isemir-web.htm

Related Poster!

10 pearls! Radiation protection of patients in fluoroscopy

http://rpop.iaea.org/RPOP/RPoP/Content/Documents/Whitepapers/poster-patient-radiation-protection.pdf

RADIOPROTEZIONE DEGLI OPERATORI

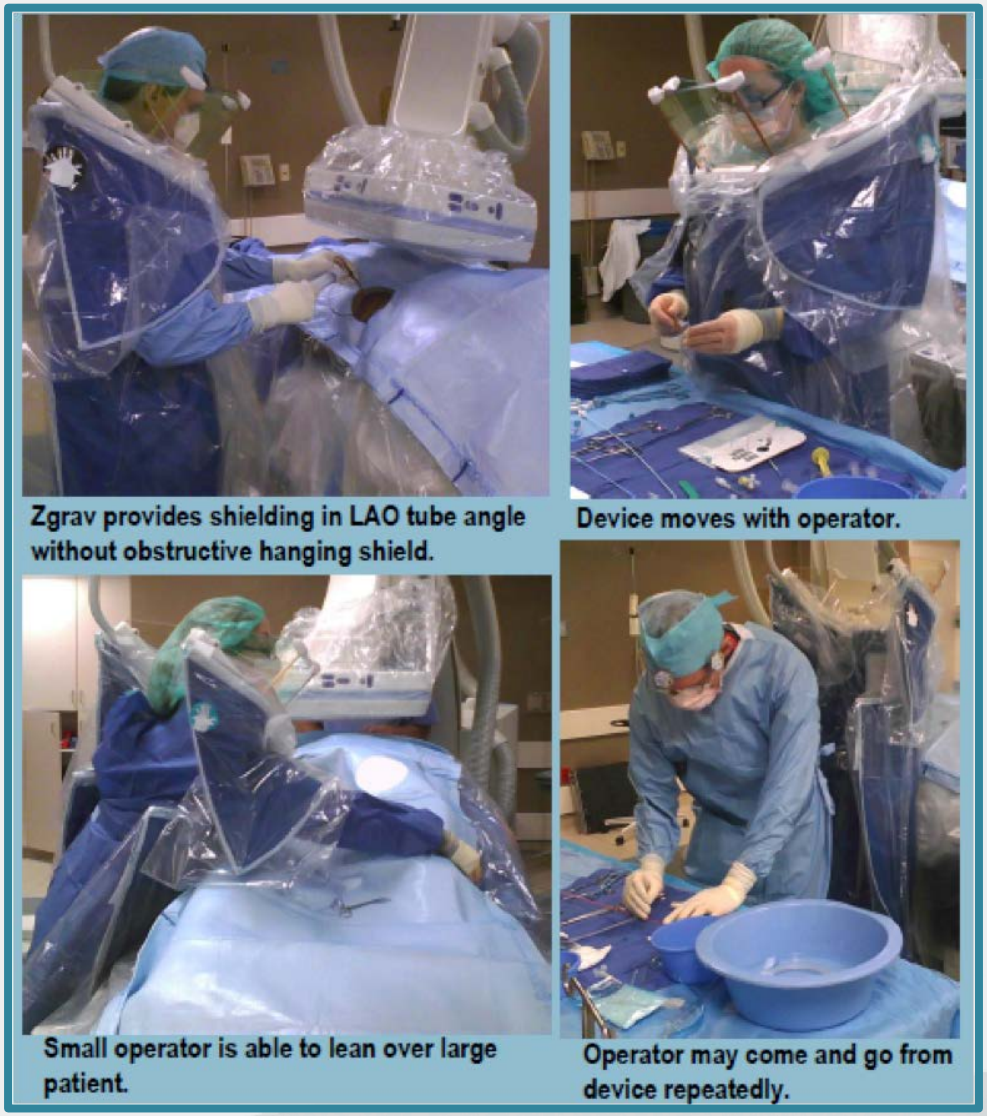
Dispositivi di Protezione Individuale (DPI)

UTILIZZO

CONSERVAZIONE

SMALTIMENTO

RADIOPROTEZIONE DEGLI OPERATORI



LABORATORY INVESTIGATION

Comparison of a Suspended Radiation Protection System versus Standard Lead Apron for Radiation Exposure of a Simulated Interventionalist

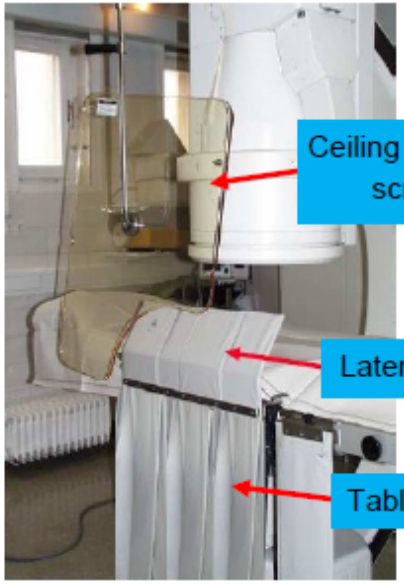
Daniel A. Marichal, MD, Temoor Anwar, MD, David Kirsch, MD, Jessica Clements, MS, Luke Carlson, MD, Clare Savage, MD, and Chet R. Rees, MD

J Vasc Interv Radiol2011; 22:437-442

RADIOPROTEZIONE DEGLI OPERATORI IN FLUOROSCOPIA

LE 10 PERLE

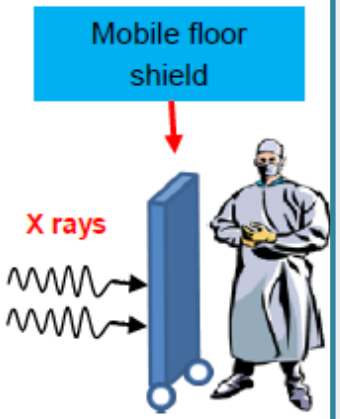
IAEA International Atomic Energy Agency



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

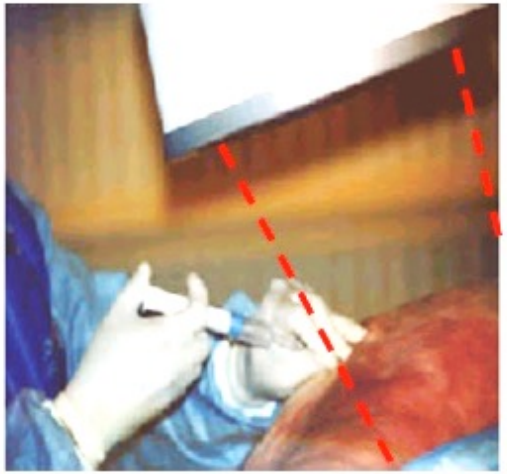
They provide more than 90% protection from scattered radiation in fluoroscopy

Mobile floor shielding is advisable when using cine acquisition



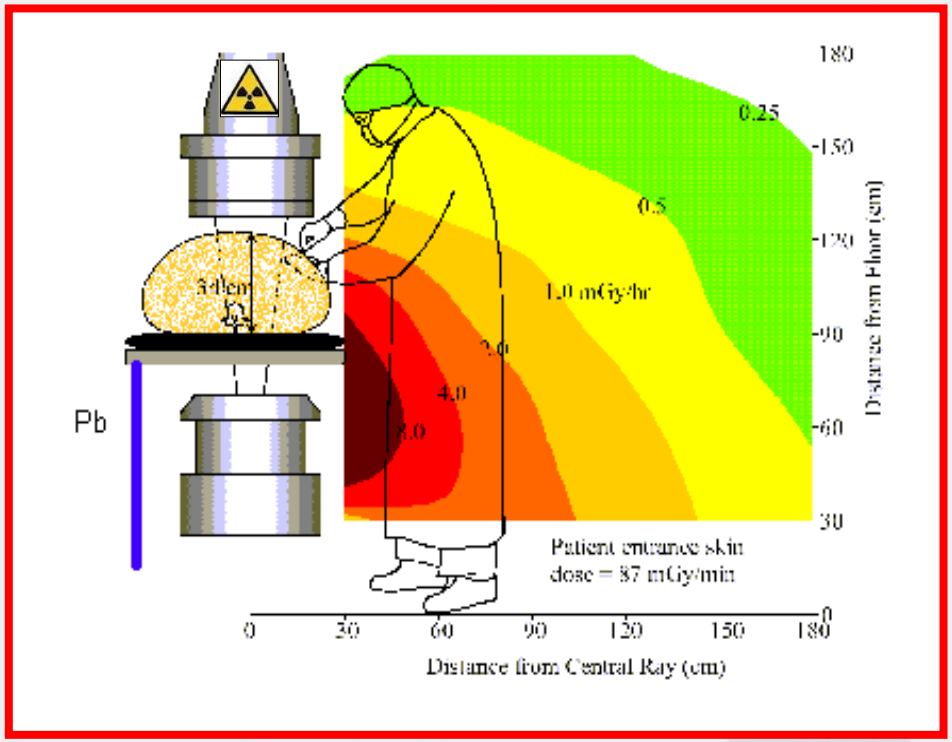
4. Keep hands outside the primary beam unless totally unavoidable

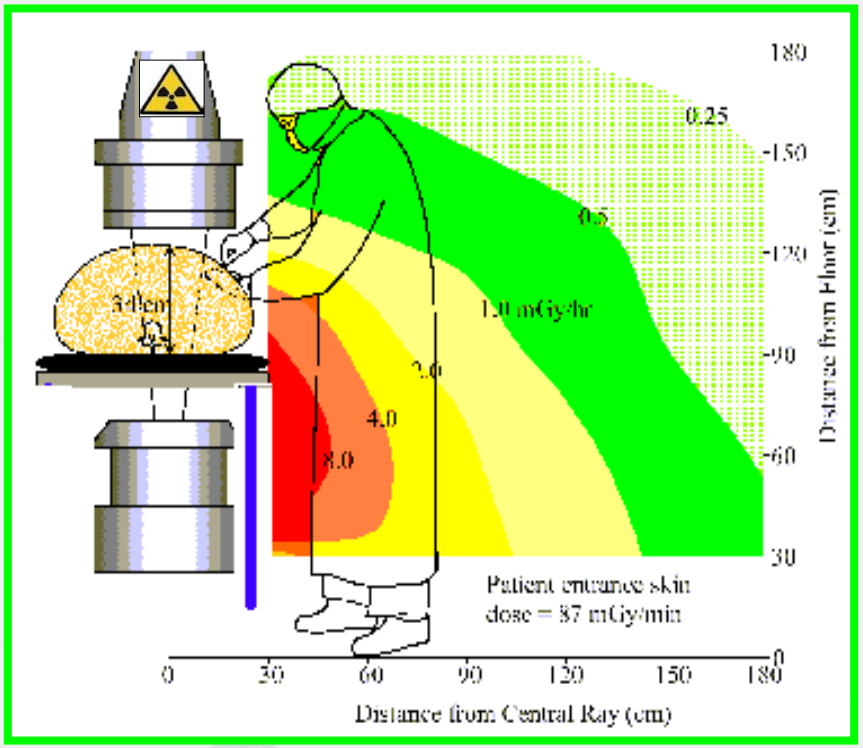
Hands inside the central area of the primary beam will increase exposure factors (kV, mA) and doses to patient and staff



RADIOPROTEZIONE DEGLI OPERATORI

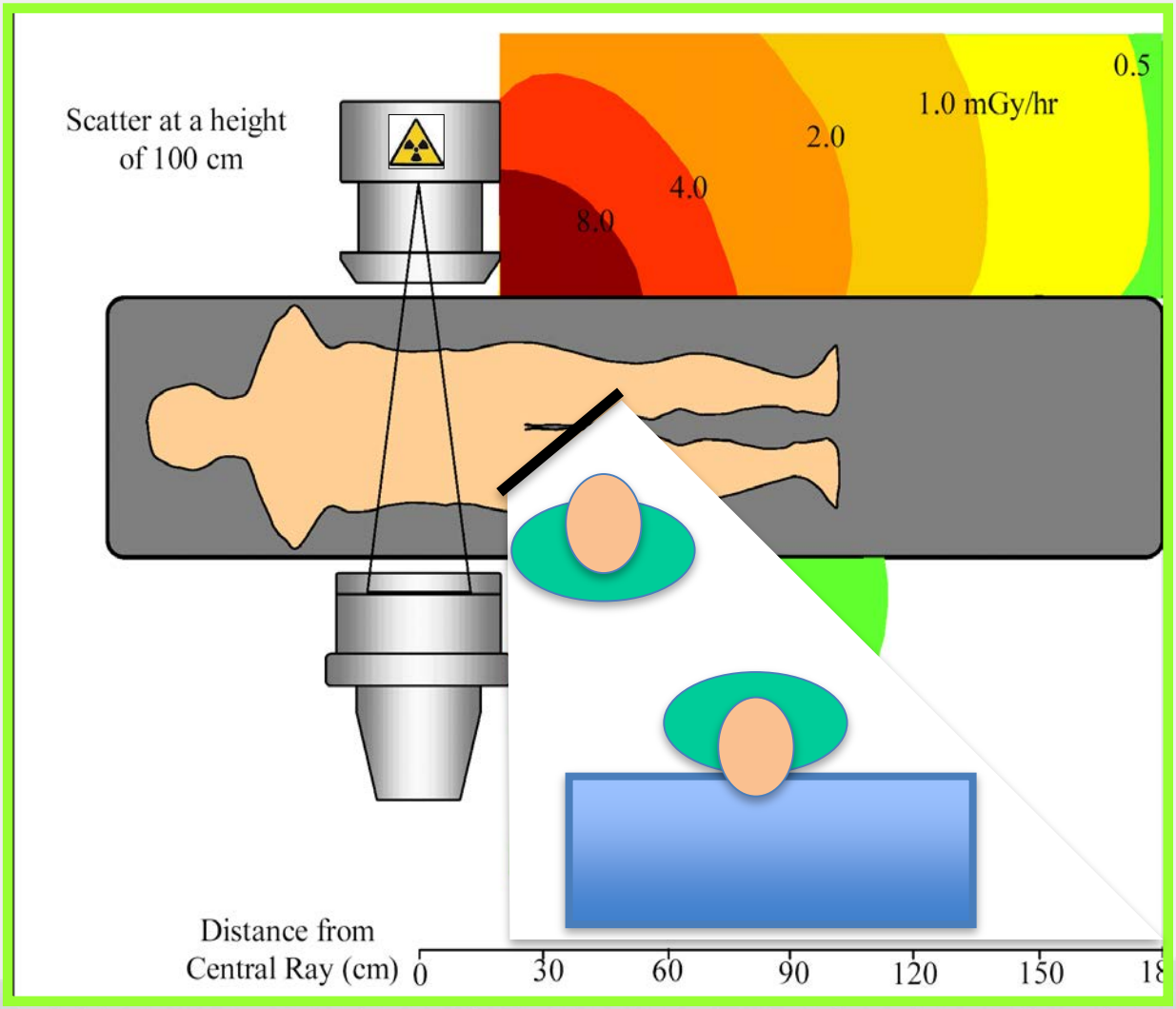
Paratie Lettino





RADIOPROTEZIONE DEGLI OPERATORI

Paratie Lettino e Pensile

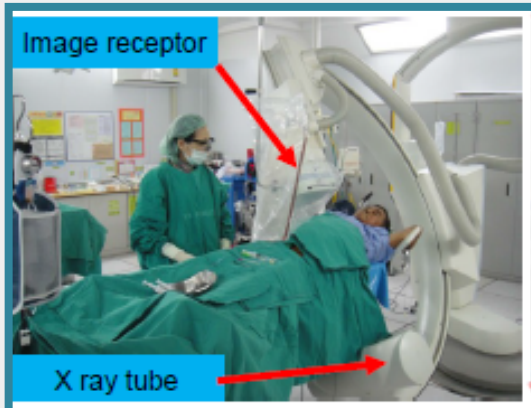


RADIOPROTEZIONE DEGLI OPERATORI

Robotic-Assisted PCI System

RADIOPROTEZIONE DEGLI OPERATORI IN FLUOROSCOPIA
LE 10 PERLE

IAEA International Atomic Energy Agency



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

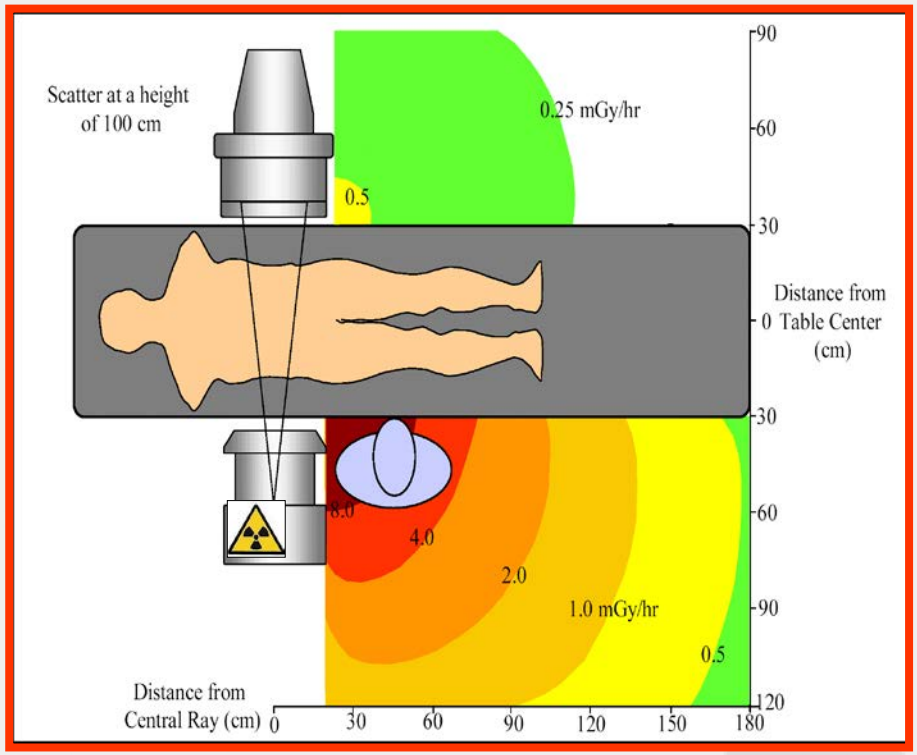
Undercouch systems provide better protection from scattered dose

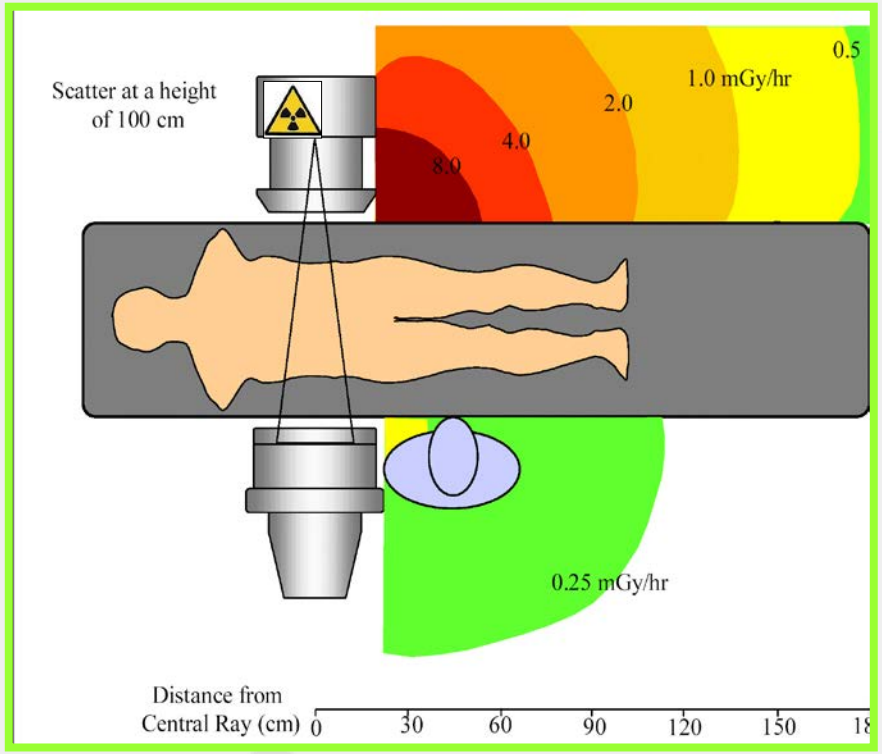
Right!

Wrong!

RADIOPROTEZIONE DEGLI OPERATORI

Posizione Operatore PROIEZIONE LL





RADIOPROTEZIONE DEGLI OPERATORI IN FLUOROSCOPIA

LE 10 PERLE

IAEA International Atomic Energy Agency

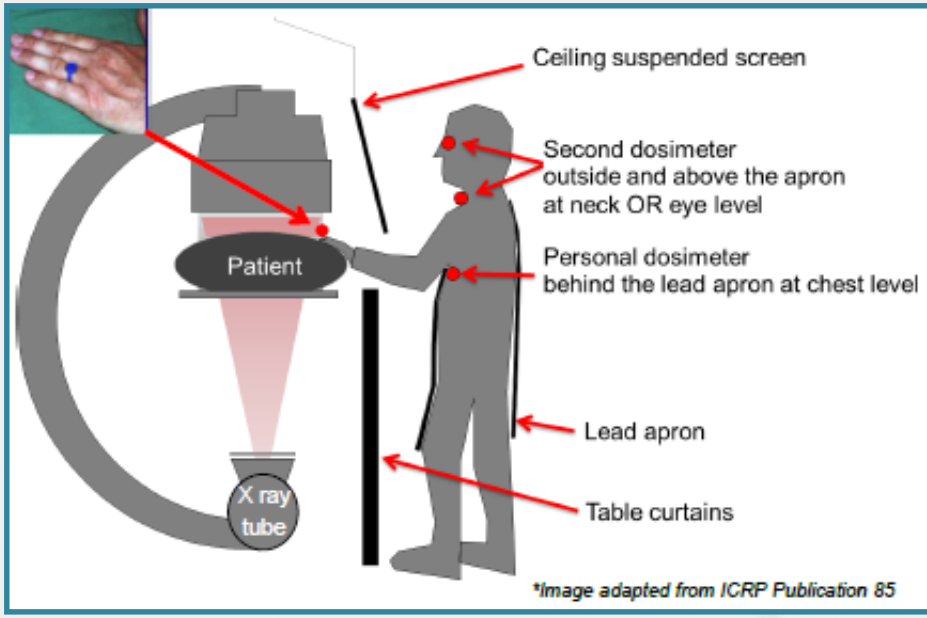


*Image adapted from ICRP Publication 85

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

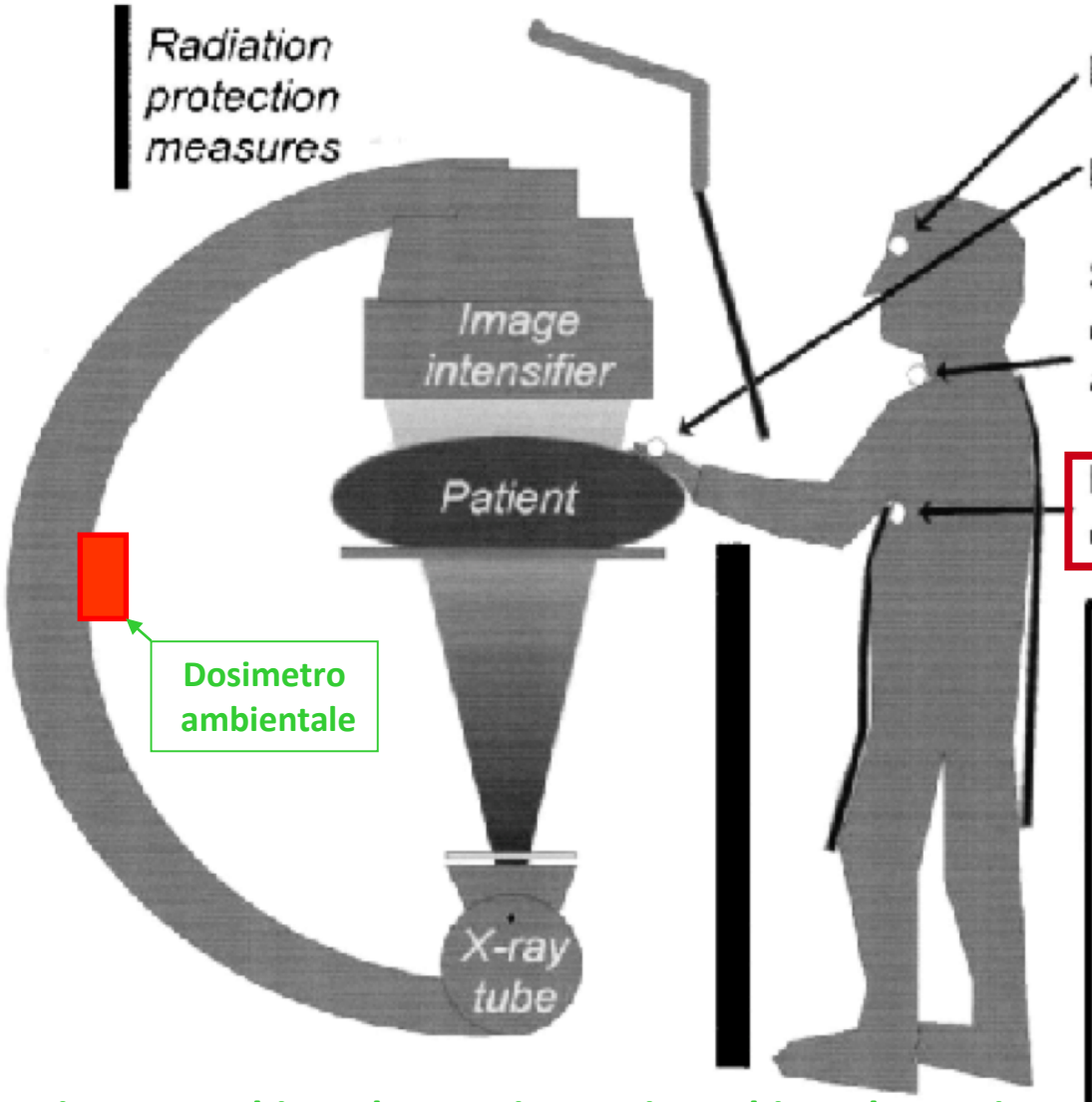
8. Update your knowledge about radiation protection

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

MONITORAGGIO PERSONALE: SCHEMA ICRP 85



Dose limits for occupational exposure
(ICRP *Publication 60*, 1991)

Effective dose 20 mSv in a year averaged over a period of 5 years

Annual equivalent dose in the
lens of the eye 150 mSv
skin 500 mSv
hands and feet 500 mSv

Dosimetro ambientale: monitoraggio ambientale continuo

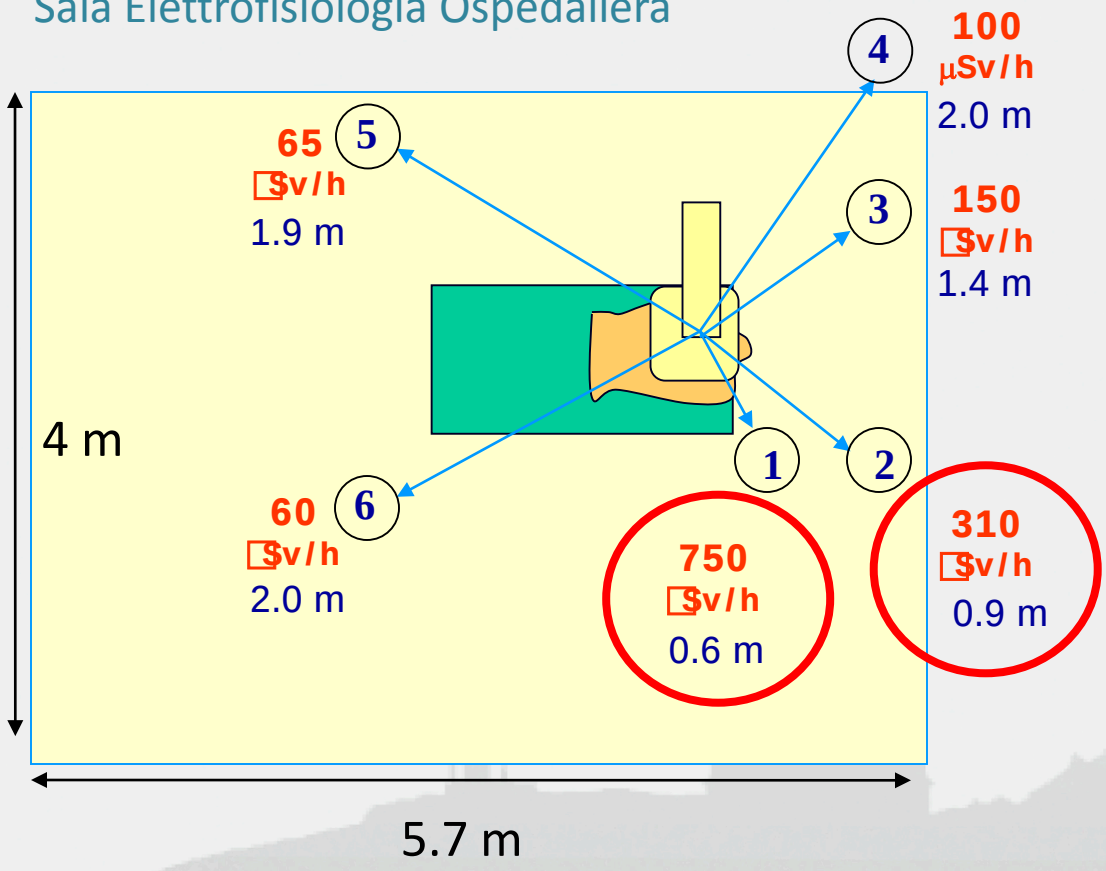
MONITORAGGIO PERSONALE: DOSIMETRIA "REAL TIME"

Utile per l'ottimizzazione del set-up dell'equipe nel caso di introduzione di nuove procedure

Monitoraggio Ambientale

Eseguito periodicamente (o in caso di introduzione di nuove procedure) in posizioni significative

Sala Elettrofisiologia Ospedaliera



RADIOPROTEZIONE DI OPERATORI E PAZIENTI

OTTIMIZZAZIONE DELLE PROCEDURE:

- Scelta e impiego tecnologia
  - 10 perle IAEA,
  - protocolli acquisizione ad hoc,
  - image post-processing, ecc..
- Introduzione soglie di attenzione
- Verifica livelli di riferimento
- Formazione

Azienda Ospedaliera Città della Salute e della Scienza di Torino
Presidio Molinette.

MODULO MFM 007/A

LOCANDINA

Revisione n° 0
Data di emissione: 07 gennaio 2013
Approvato ed emesso in originale

DESTINATARI:

20 tra Medici - TSRM -
Infermieri professionali (operanti presso le strutture sedi di procedure inerenti al corso di formazione)

Progetto formativo

TITOLO

AGGIORNAMENTO IN RADIOPROTEZIONE SU APPARECCHIATURE ANGIOGRAFICHE DIGITALI

DATE

Ediz.1: 14 Maggio 2013
Ediz.2: 4 Giugno 2013

ORARIO

14 - 19

SEDE DEL CORSO

Aula Riunione S.C. Radiologia
Prof Gandini (2° piano)
Via Genova 3 - Presidio Molinette

Corso accreditato su
Sistema ECM Regione Piemonte
COD. 13746 - Crediti calcolati: 6

The British Journal of Radiology, 79 (2006), 383–388

Occupational radiation doses in interventional cardiology: a 15-year follow-up

[1,2]E VAÑO, PhD, [1]L GONZALEZ, PhD, [1,2]J M FERNANDEZ, BSc, [3]F ALFONSO, PhD, MD and [3]C MACAYA, PhD, MD

Table 3. Mean values (and standard deviation) in mSv/year of occupational doses of cardiologists during the periods referred to. The percentage of dose under apron in relation to the dose over apron is indicated in the $H_p(10)$ "under apron" column between brackets

Number of reliable data	Period	$H_p(10)$ over apron	$H_p(10)$ under apron	Effective dose (NCRP, using two dosemeters)	Effective dose (NCRP, using over-apron dosemeter)
15	1989–1992	259 ± 249	10.2 ± 8.6 (3.9%)	11.6	12.3
24	1993–1998	31 ± 15	1.7 ± 1.1 (5.5%)	1.6	1.5
11	1999–2004	18 ± 7	1.4 ± 0.4 (7.7%)	1.2	0.86

VERIFICA LIVELLI DI RIFERIMENTO

Procedura: CA

Valori medi	GISE 2014	Emodinamica 1	Emodinamica 2
t (min)	7.1	8.0	6.6
DAP cine (Gy x cm^2)	38.2	14.6	10.7
DAP (Gy x cm^2)	67.8	27.1	19.6
$K_{aria,cum}$ (mGy)	988	436.9	278.3

Procedura: PTCA

Valori medi	GISE 2014	Emodinamica 1	Emodinamica 2
t (min)	18.8	14.3	17.9
DAP cine (Gy x cm^2)	65.1	31.6	33.5
DAP (Gy x cm^2)	160.6	58.1	72.3
$K_{aria,cum}$ (mGy)	2934	974.6	1160.3

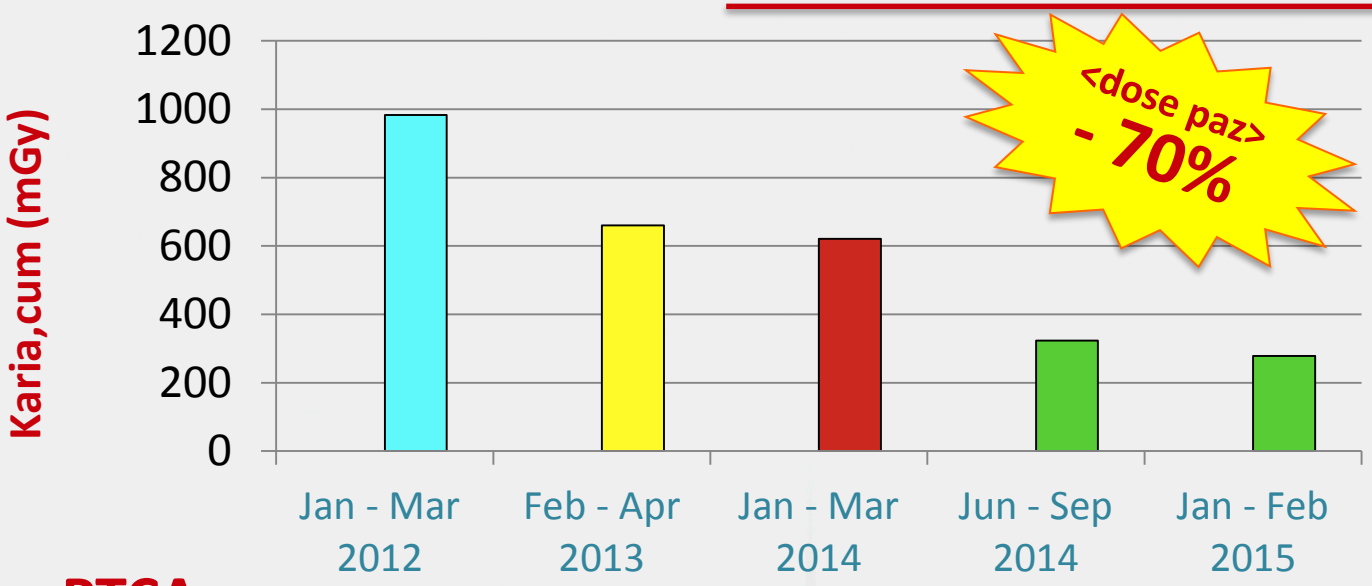
Emodinamica 1: marzo – aprile 2015

Emodinamica 2: gennaio - febbraio 2015

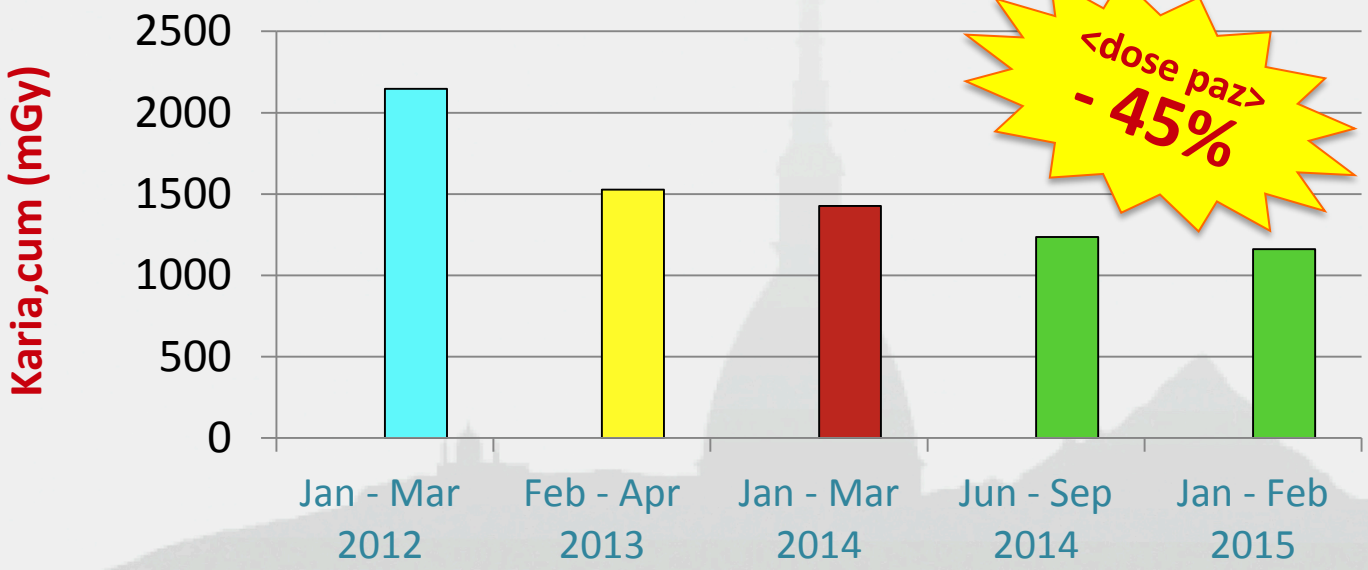
Rif. R. Padovani et. Al. "Proposta di livelli di riferimento nazionali per la dose al paziente nelle procedure diagnostiche ed interventistiche cardiache", 34° Congresso Nazionale Società Italiana di Cardiologia Invasiva, Genova 2014

ANDAMENTO DOSE PAZIENTE

CA



PTCA



Installazione angiografo digitale

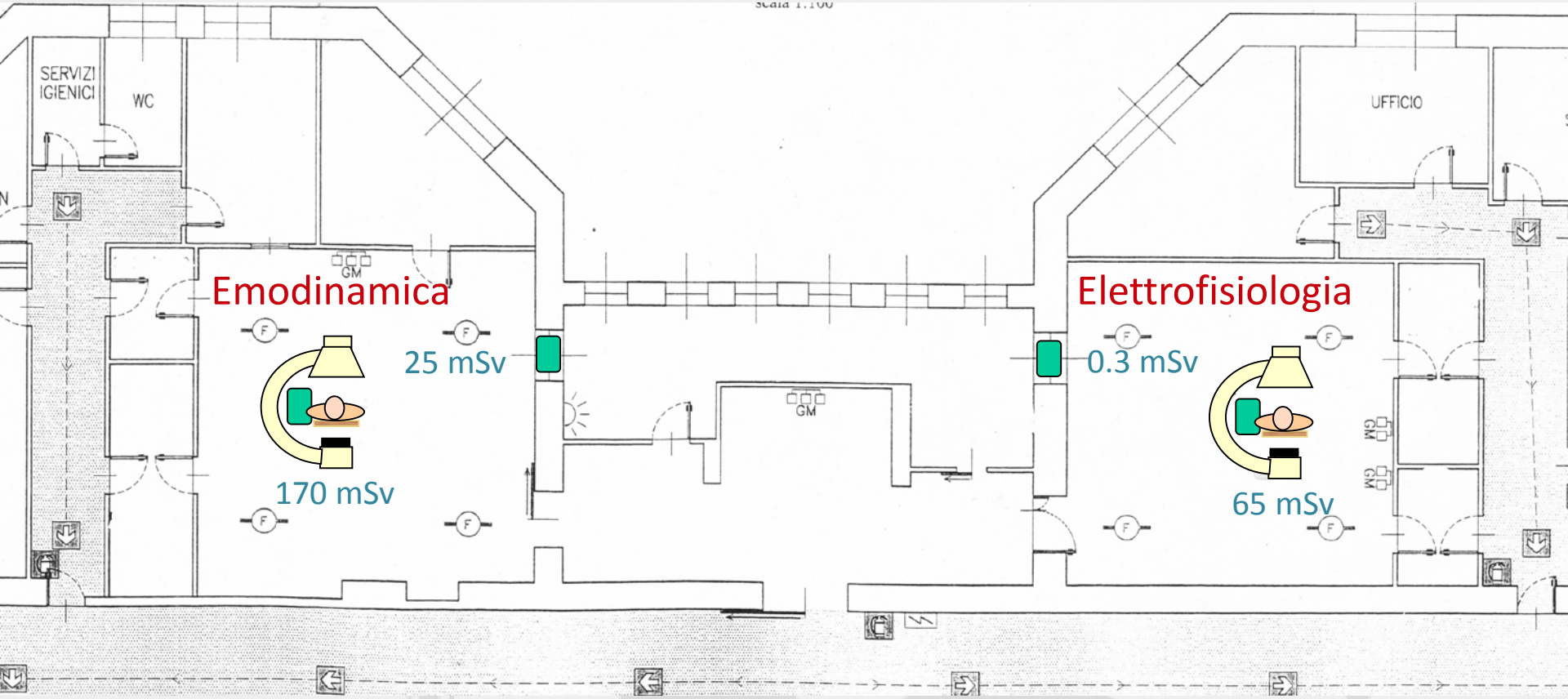
Ottimizzazione pre-Clarity

Installazione Clarity (Normal)

Ottimizzazione Clarity (Low)

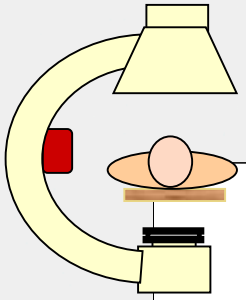
Monitoraggio Ambientale

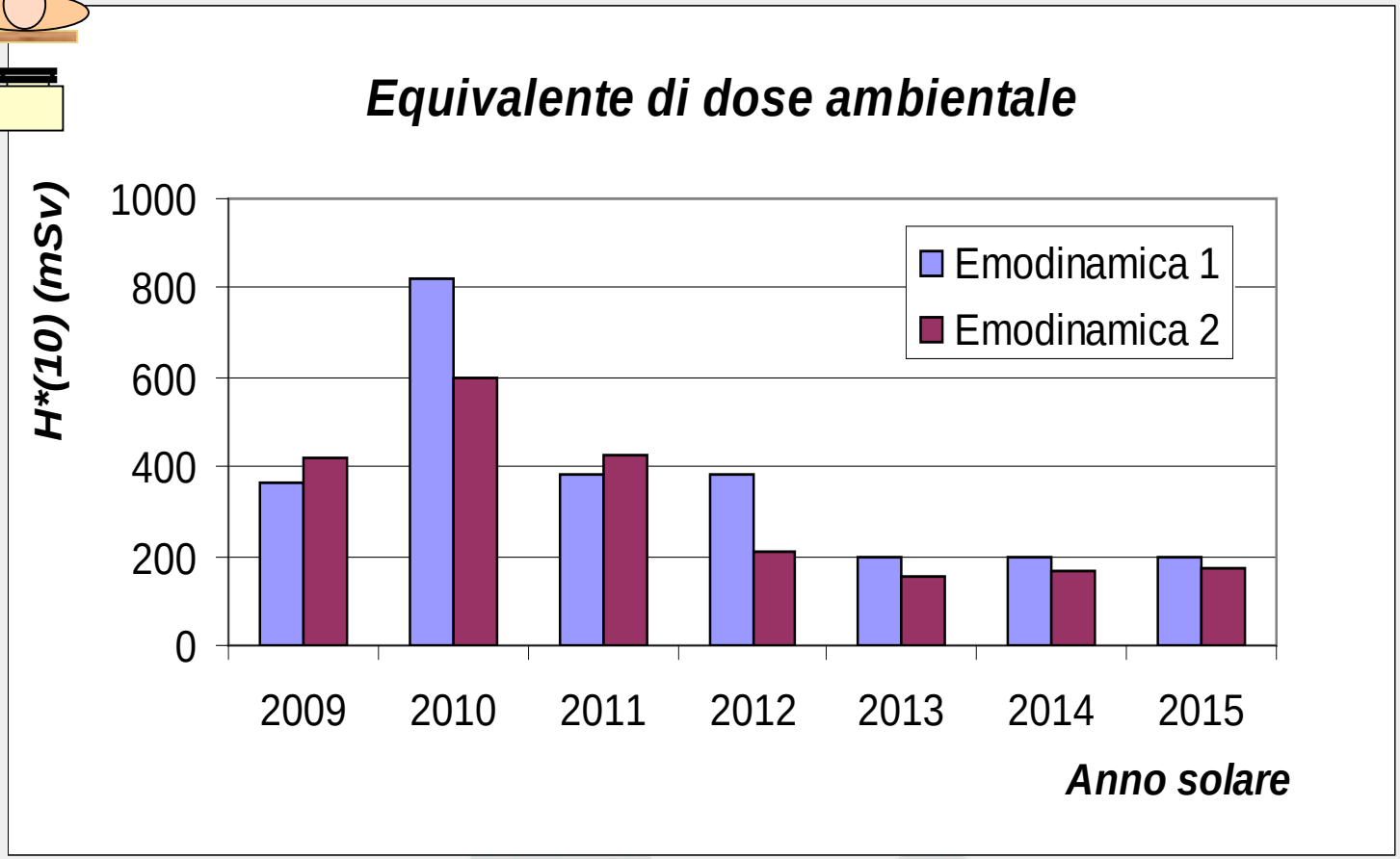
Il monitoraggio ambientale tramite film-badge viene eseguito in modo continuativo in posizioni significative



Equivalente di dose ambientale (mSv): anno 2014

MONITORAGGIO AMBIENTALE





RADIATION SAFETY PROGRAM

Core Curriculum

Radiation Safety Program for the Cardiac Catheterization Laboratory

Charles E. Chambers,[1*] MD, Kenneth A. Fetterly,[2] PhD, Ralf Holzer,[3] MD, Pei-Jan Paul Lin,[4] PhD, James C. Blankenship,[5] MD, Stephen Balter,[6] PhD, and Warren K. Laskey,[7] MD

TABLE V. Suggested Values for First and Subsequent Notifications and the Substantial Radiation Dose Level (SRDL)

Dose metric	First notification	Subsequent notifications (increments)	SRDL
$D_{skin,max}$ [a]	2 Gy	0.5 Gy	3 Gy
$K_{a,r}$ [b]	3 Gy	1 Gy	5 Gy [b]
P_{KA} [c]	300 Gy cm^{-2} [d]	100 Gy cm^{-2} [d]	500 Gy cm^{-2} [d]
Fluoroscopy time	30 min	15 min	60 min

NCRP (2010) National Council on Radiation Protection and Measurements. Radiation Dose Management for Fluoroscopically Guided Interventonal Medical Procedures, NCRP Report No. 168 (National Council on Radiation Protection and Measurements, Bethesda, Maryland).

[a] $D_{skin,max}$ is peak skin dose, requiring calculations by physicist.

[b] $K_{a,r}$ is total air kerma at the reference point.

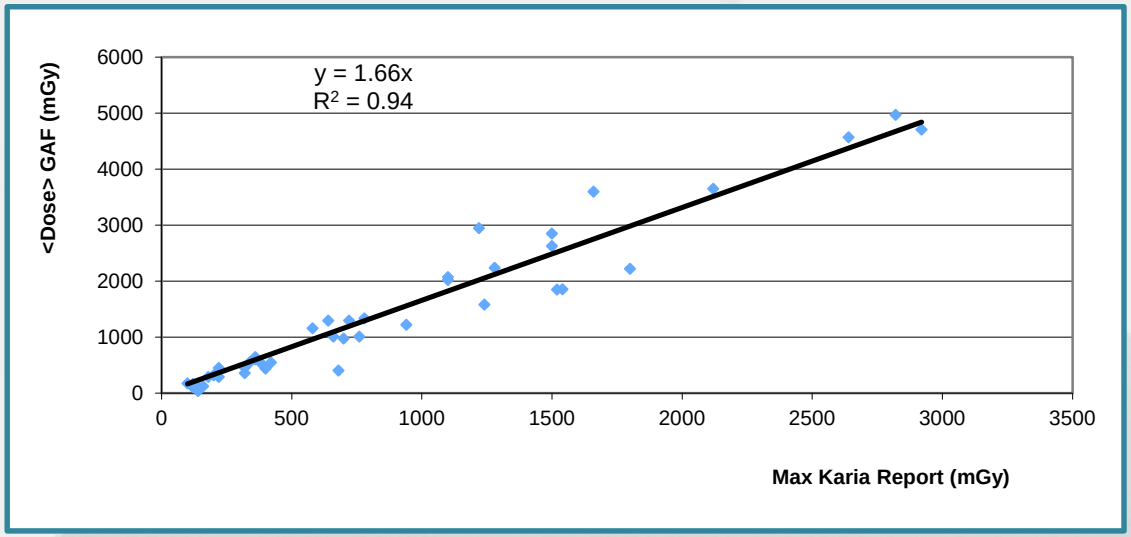
[c] P_{KA} is air kerma-area product.

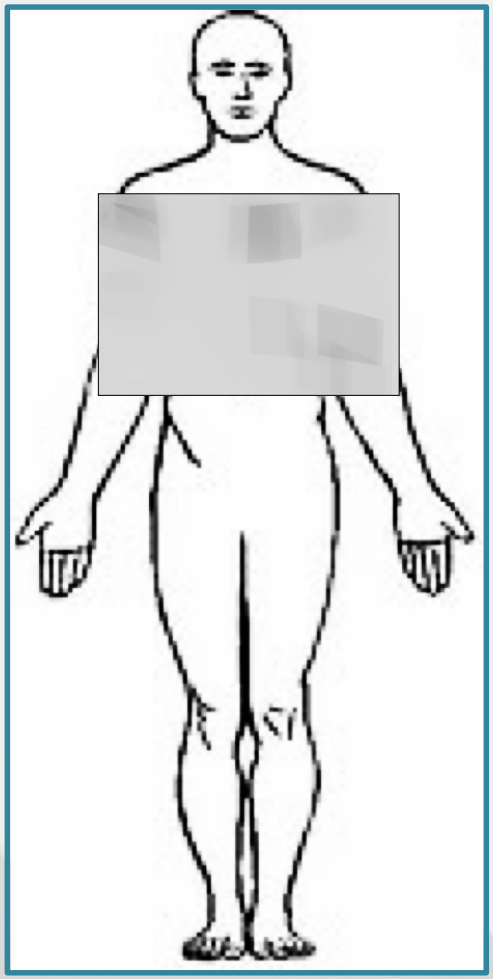
[d] Assuming a 100 cm^2 field at the patient's skin. For other field sizes, the P_{KA} values should be adjusted proportionally to the actual procedural field size (e.g., for a field size of 50 cm^2, the SRDL value for P_{KA} would be 250 Gy cm^{-2}).

Stima Dose alla Cute del Paziente

Per la valutazione della dose alla cute possono essere impiegati diversi sistemi di misura per ricavare fattori di correlazione tra gli indicatori dosimetrici forniti dalle apparecchiature angiografiche e la stima della dose massima.

Cumulative fluoroscopy time:	5:24	mm:ss
Cumulative DAP (fluoroscopy):	5,528	$mGycm^2$
Cumulative DAP (exposure):	4,620	$mGycm^2$
Total DAP:	10,148	$mGycm^2$
Cumulative Air Kerma:	143.02	mGy
Total number of acquired runs:	11	
Total number of acquired images:	277	
Total number of acquired exposure images:	277	





STIMA DOSE MASSIMA ALLA CUTE

Emodinamica 1

Periodo	**Dose cute max (Gy)**	> 3 Gy	N° paz.	%
feb - apr 2013	**3.6**	5 casi	365	1.4
mar - apr 2015	**3.3**	1 casi	190	0.5

Modalità acquisizione: 7.5 pps, BMI < 25 "Cardiac ECO Dose" (0.1 mmCu + 1 mmAl)

Emodinamica 2

Periodo	**Dose cute max (Gy)**	> 3 Gy	N° paz.	%
feb - apr 2013	**8.8** 	19 casi	397	4.8
gen - feb 2015	**4.5** 	8 casi	247	3.2

Modalità acquisizione: 15 pps, "Clarity Normal Dose" (0.1 mmCu + 1 mmAl, 2013), Clarity Low Dose (0.4 mmCu + 1 mmAl 2015)

Grazie per l'attenzione

MONITORAGGIO AMBIENTALE