When to Stop CTO PCI? Preventing Radiation and Contrast Injury?

Seung-Woon Rha, MD, PhD,

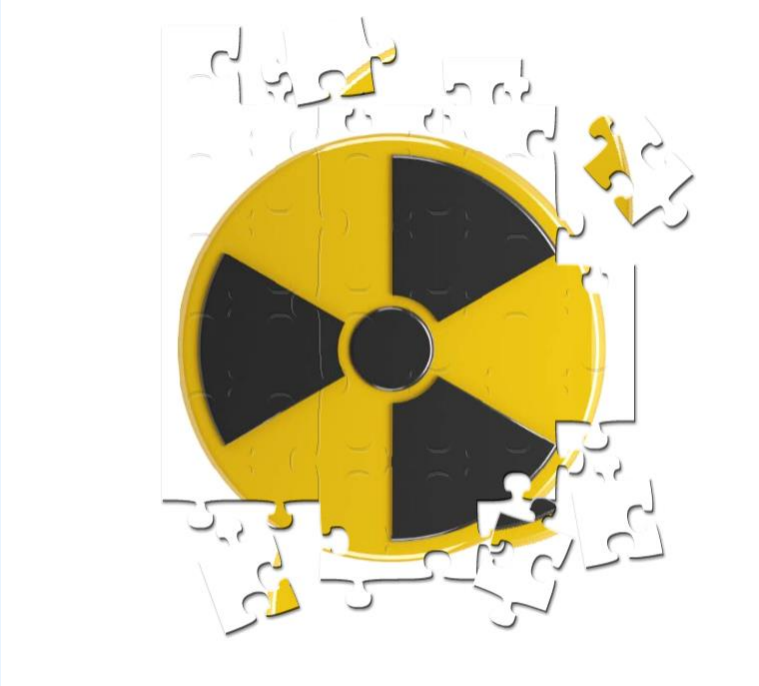
Cardiovascular Center,
Korea University Guro Hospital

CTO PCI; How long should we continue to try? When is it time to stop?

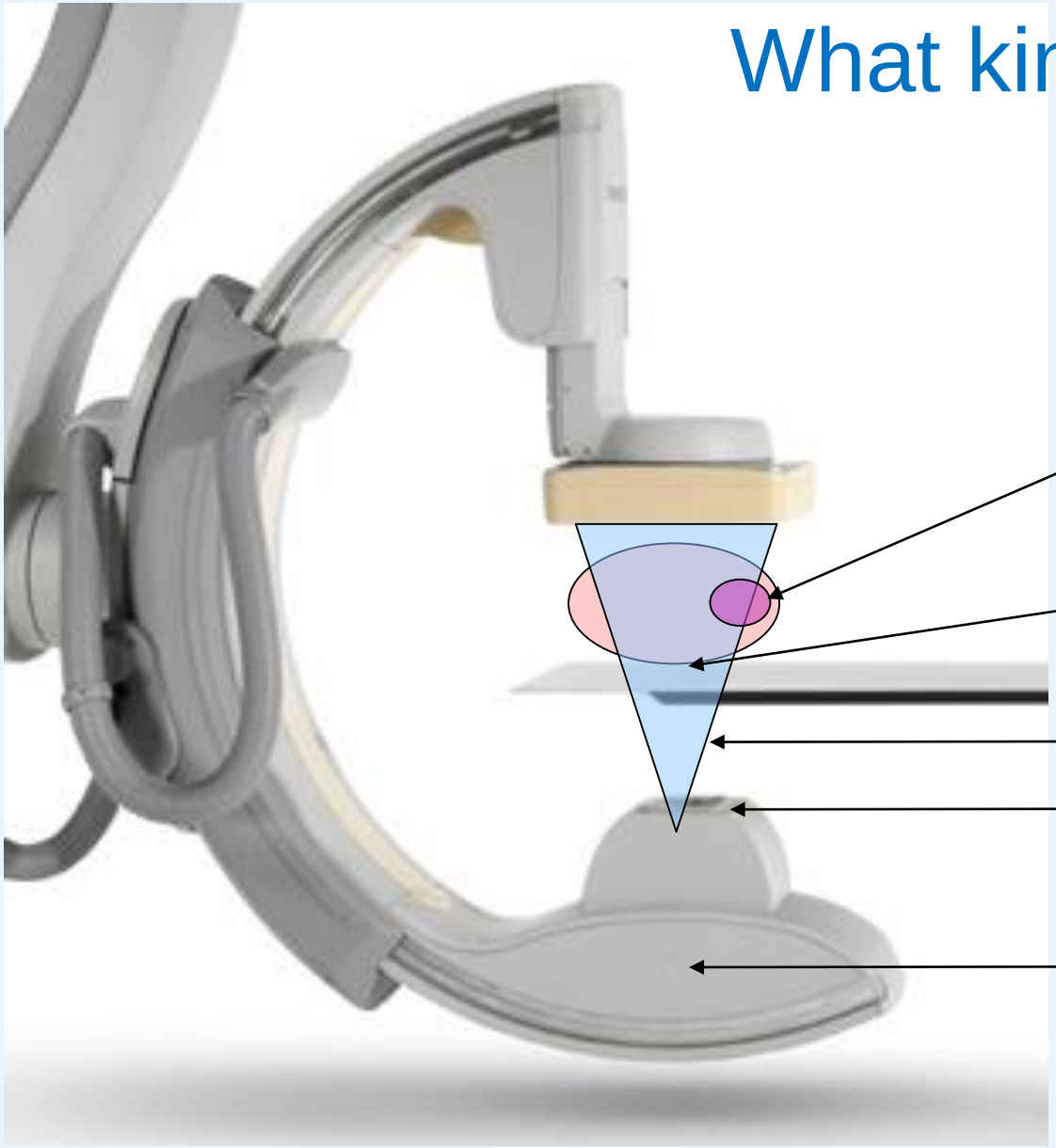
Every case is different and decisions must be individualized, but the decision about when to stop is generally based on the following five parameters:

1. Radiation
2. Contrast
3. Complications
4. Futility
5. Risk > Benefit.

Warning!!



What kind of Doses?



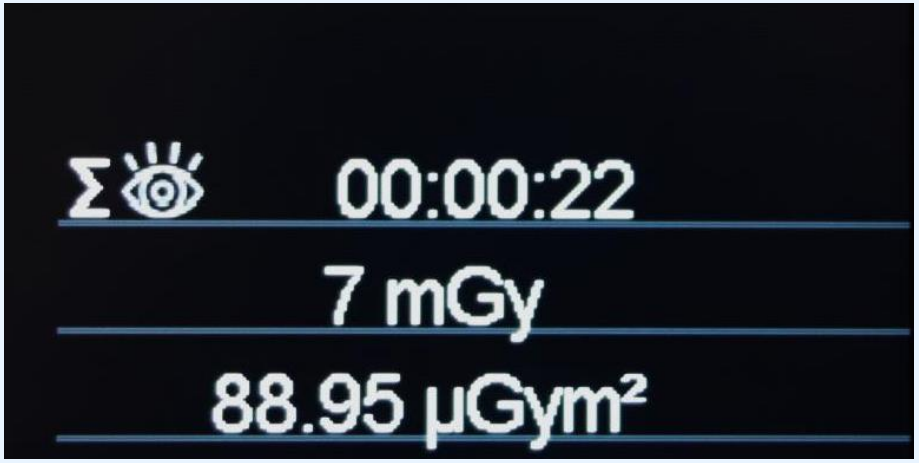
What kind of Doses?

- Dose Area Product (**DAP** – $Gycm^2$)
- Air Kerma (**AK** – Gy)
- Exposure dose (**X** – R or C/kg) 조사선량
- Absorbed dose (**D** - Gy) 흡수선량

- Diagnostic radiology : Kerma and Absorbed dose (D) are equal.
- D [mGy]. = $f_{(air)}$. X R [$C\ kg^{-1}$] **f= 8.69**
- Dose in soft tissue = **1.06** X Dose in air

- Ex) 100 kV X Rays that produce an exposure of 1 R at a point will also give an air kerma of about 8.69 mGy (0.869rad) and a tissue kerma of about 9.5 mGy (0.95 rad) at that point.

Monitor dose in real time



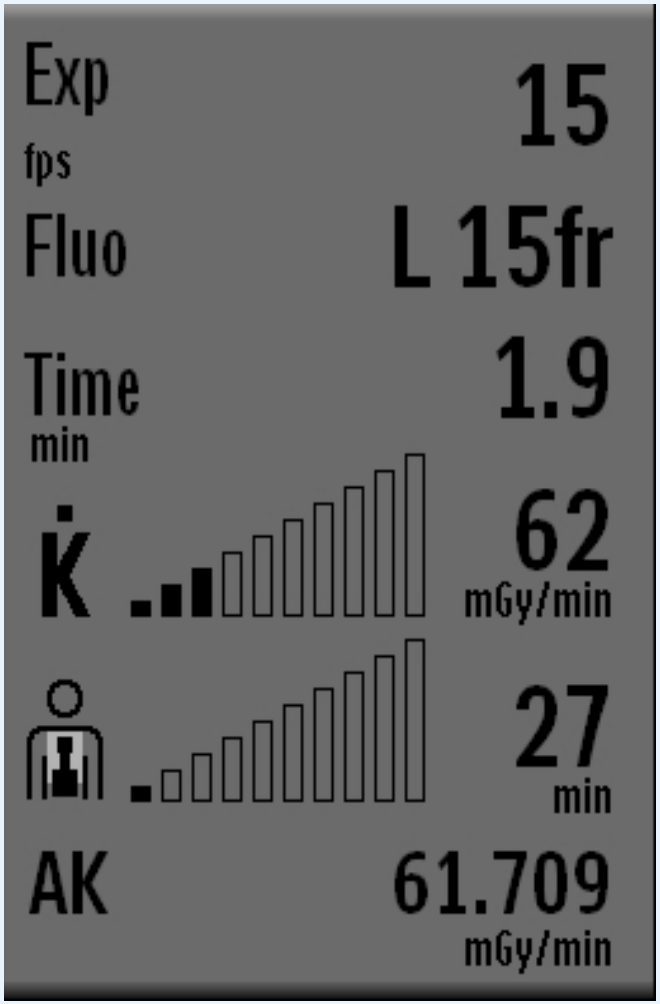
Fluoroscopic time

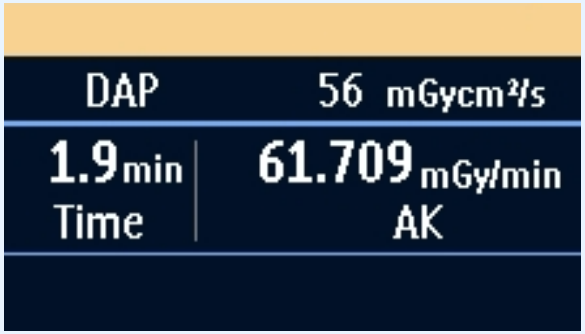
AK(air kerma)

DAP(dose area product)

AK > 5Gy :skin lesion

Radiation Dose Interpretation





← Actual FL/Exp AK Rate

← Remaining time at actual rate until 2Gy limit is reached

Note: This is per “Zone” when in Thorax or Cardiac. Each bar is 10% of the 2Gy limit.

← Actual FL/Exposure AK Rate

Radiation Hazard for Interventional Cardiologists

1. Radiation induced cancer; Breast, BM, Ovary, Testes, Thyroid, Brain
2. Cataracts

Breast, bone marrow, colon, lung, stomach

Ovaries, Testes

Thyroid, Bladder, Esophagus

Bone, Brain, skin

Heart, Kidney

Radiation sensitivity

Radiation Protection

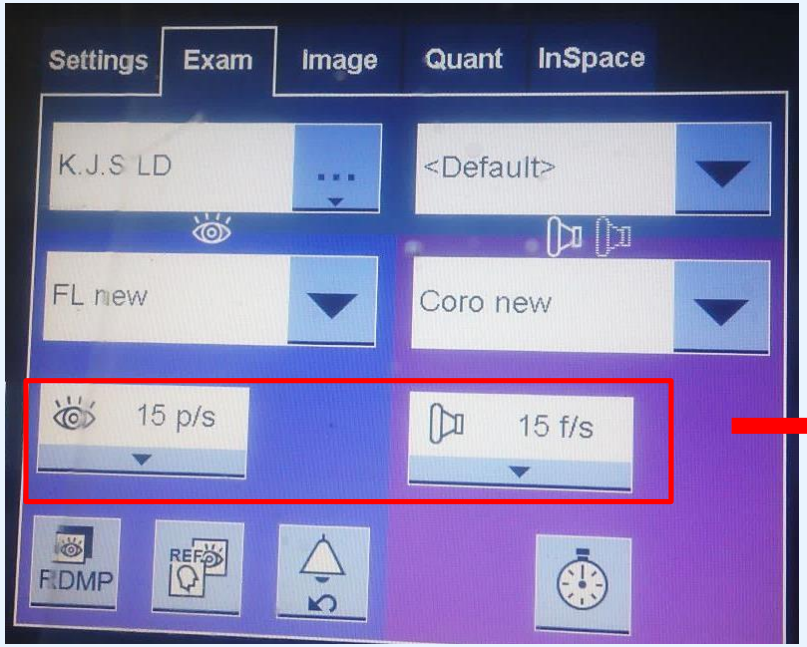
Three Principles

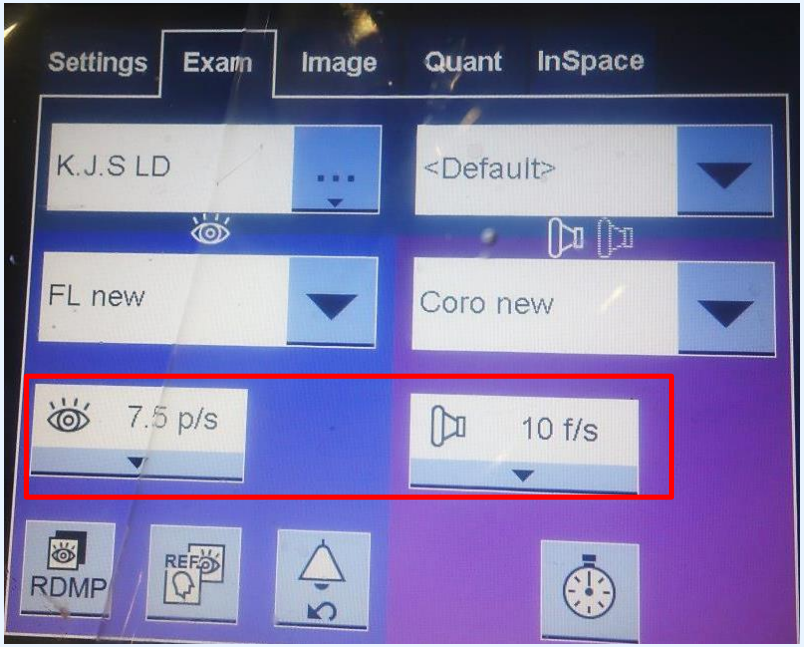
1. Distance : $1/r^2$

2. Exposure Time : shorter the better

3. Shield : Multiple Protectors

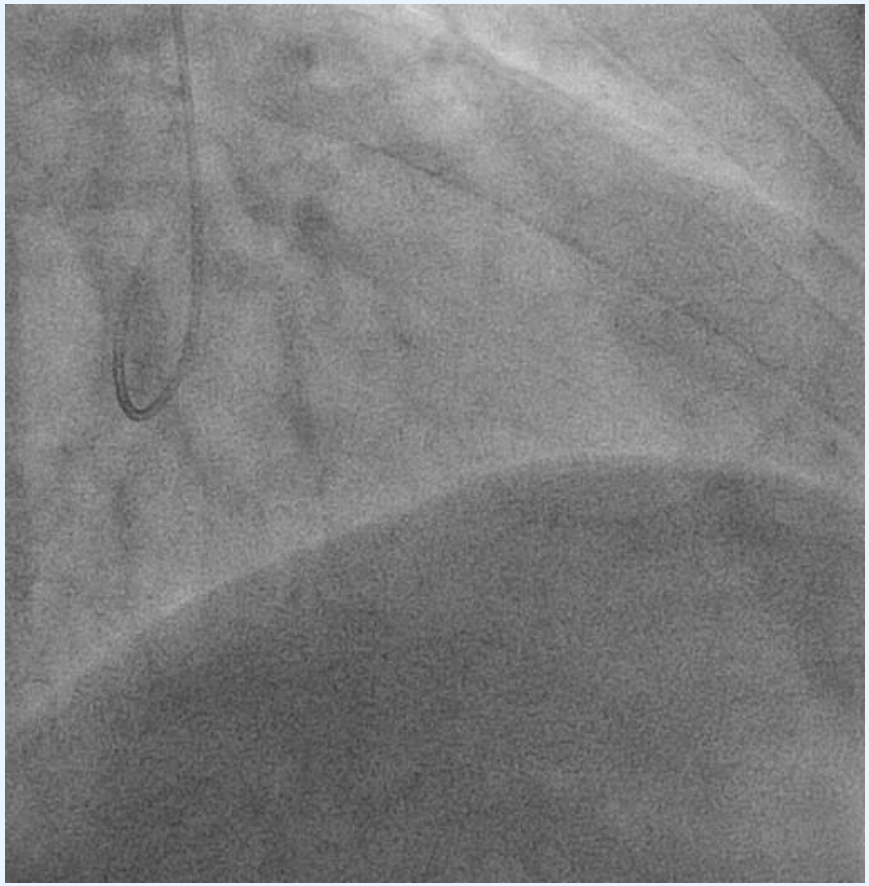
Adjust Frame Rate



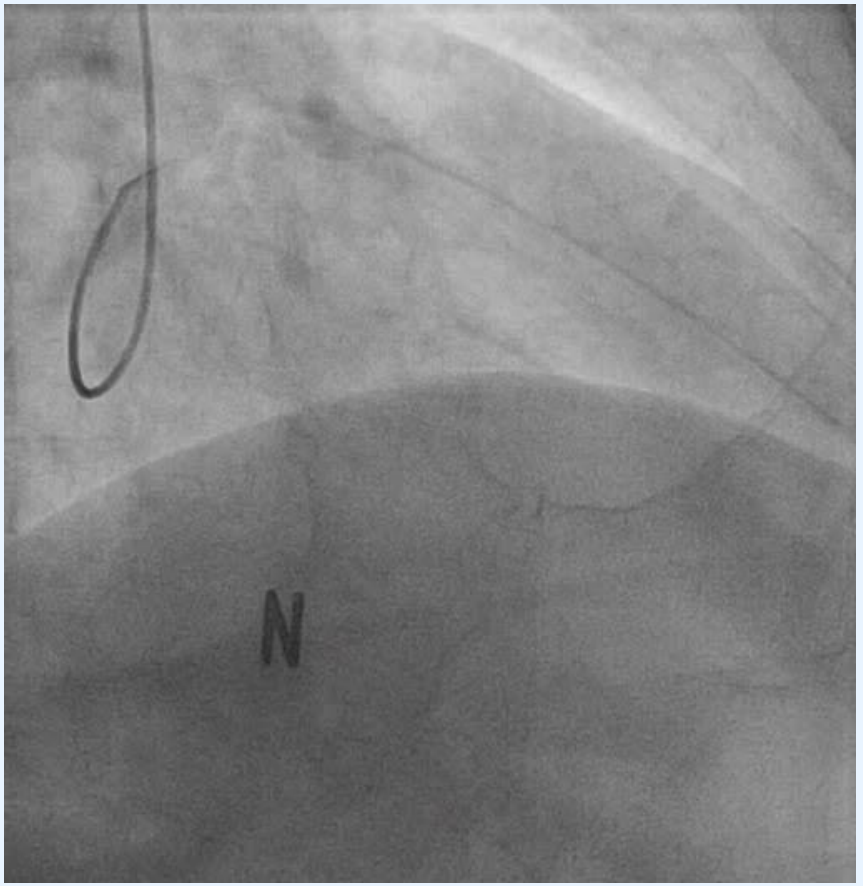


1. CAG and Routine PCI; 15F/sec
2. Coronary CTO and Peripheral Angioplasty; 7.5F/sec
3. No Cineangiography recording
4. Fluoroscopy recording

Fluoro image vs. Cine (15 fps)

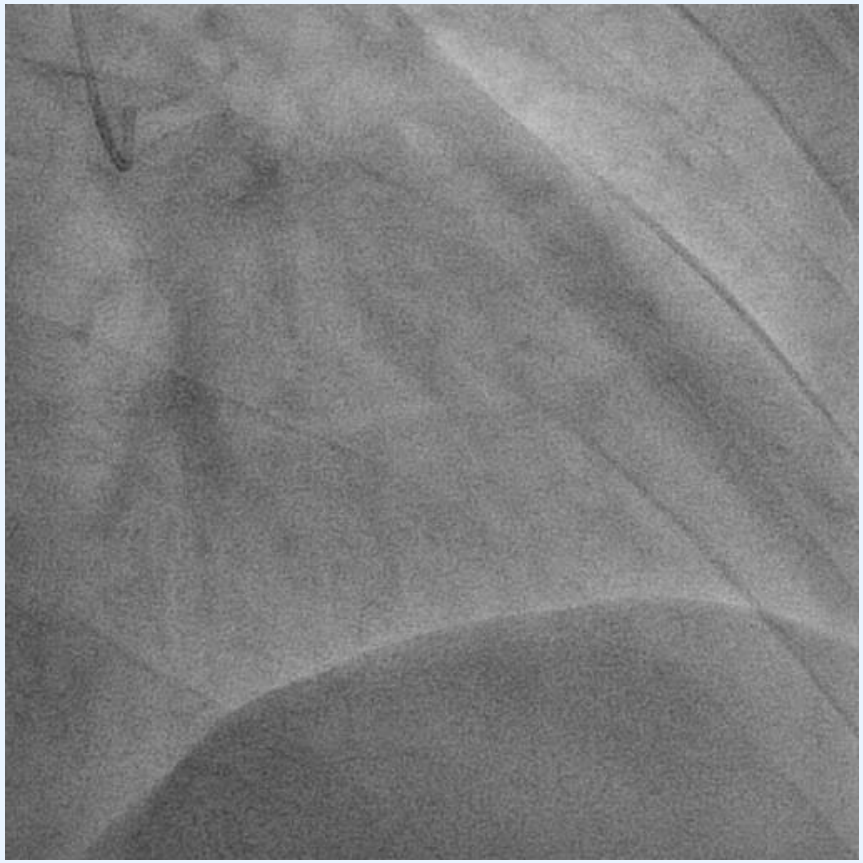


314 mGycm2

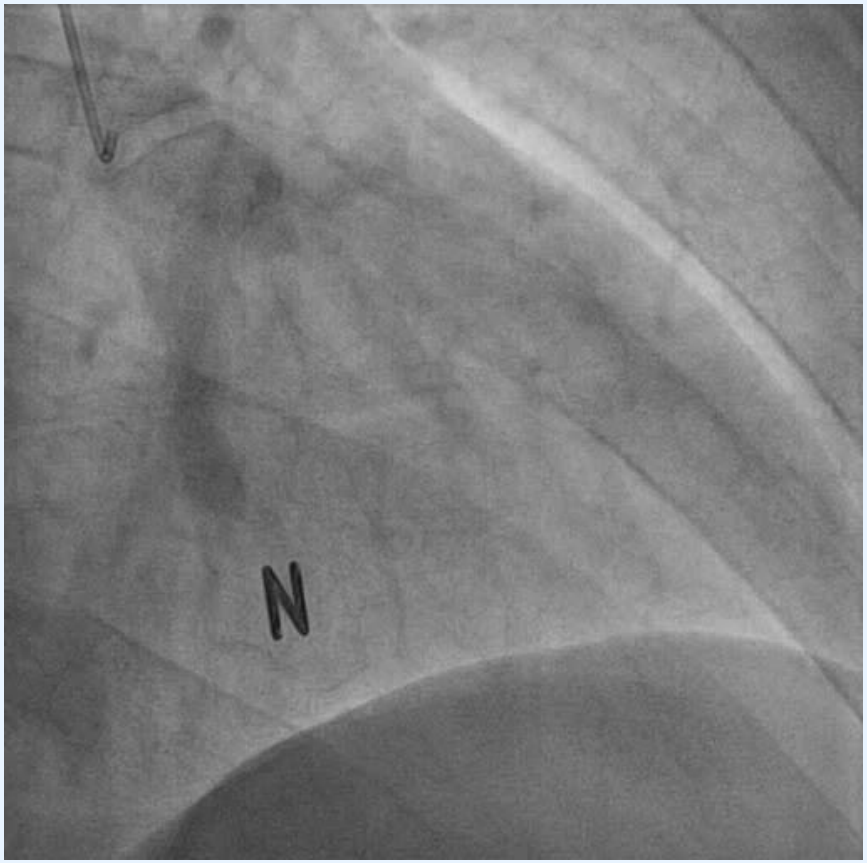


2982 mGycm2

Fluoro image vs. Cine (15 fps)

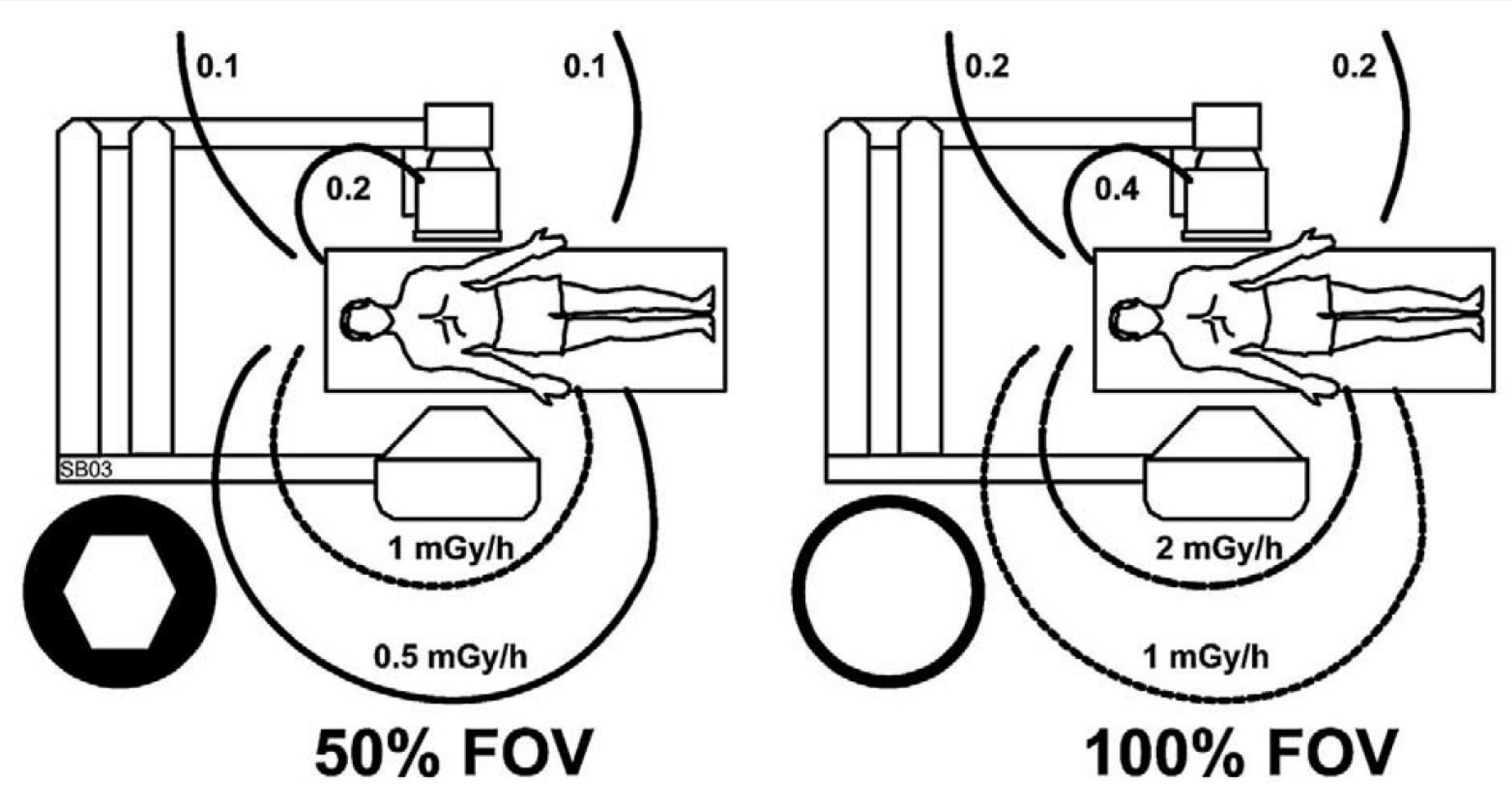


185 mGycm2



1107 mGycm2

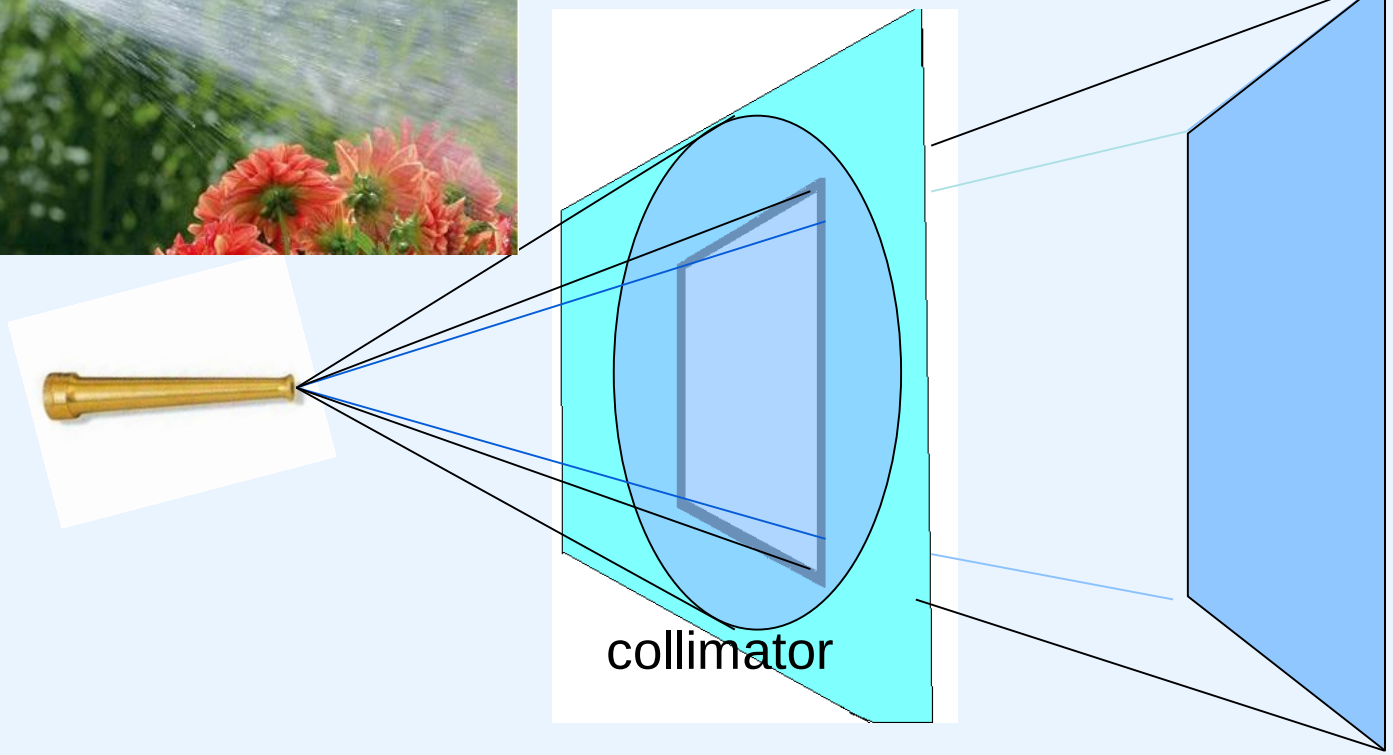
Use collimation



FOV; Field of View

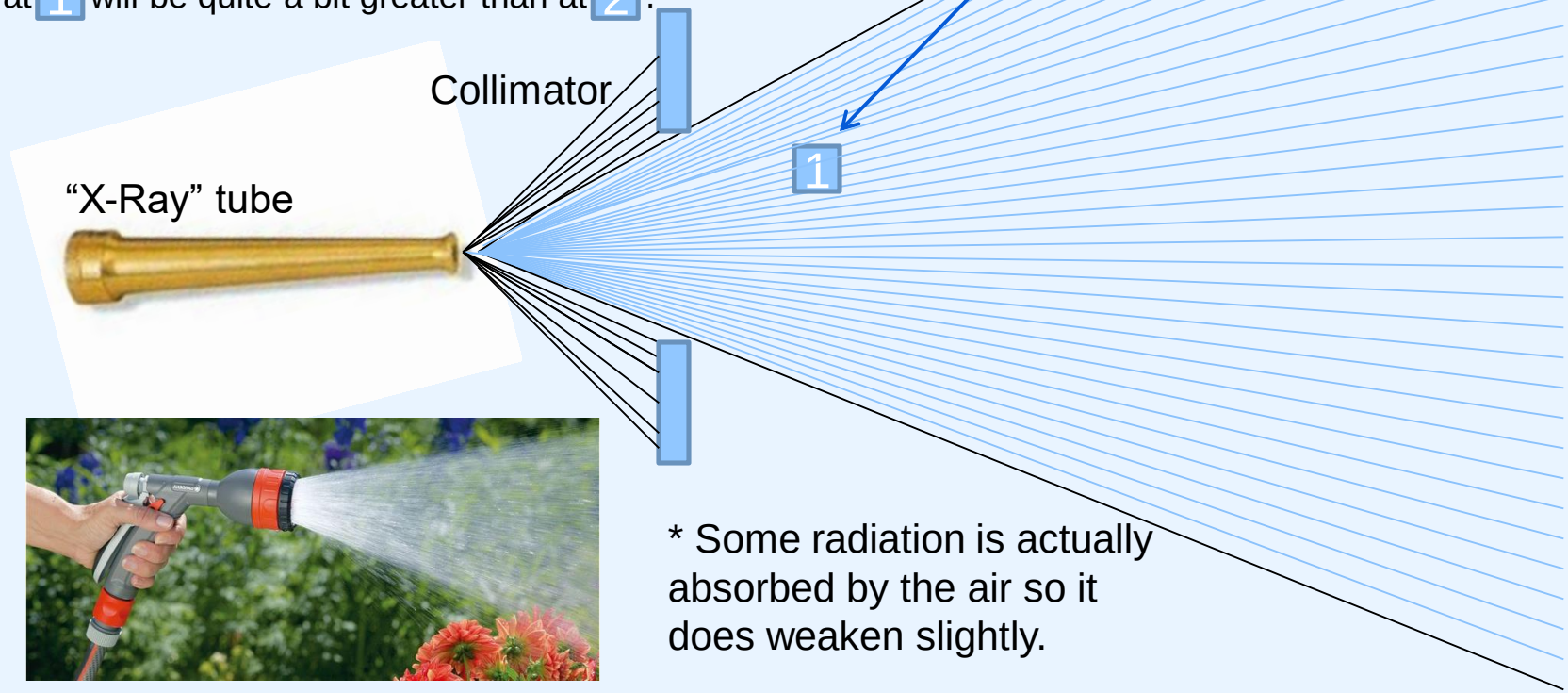
Garden Hose Analogy

- Where….
  - A garden Hose = X-Ray tube
  - A window = The collimator
  - Water represents = the radiation



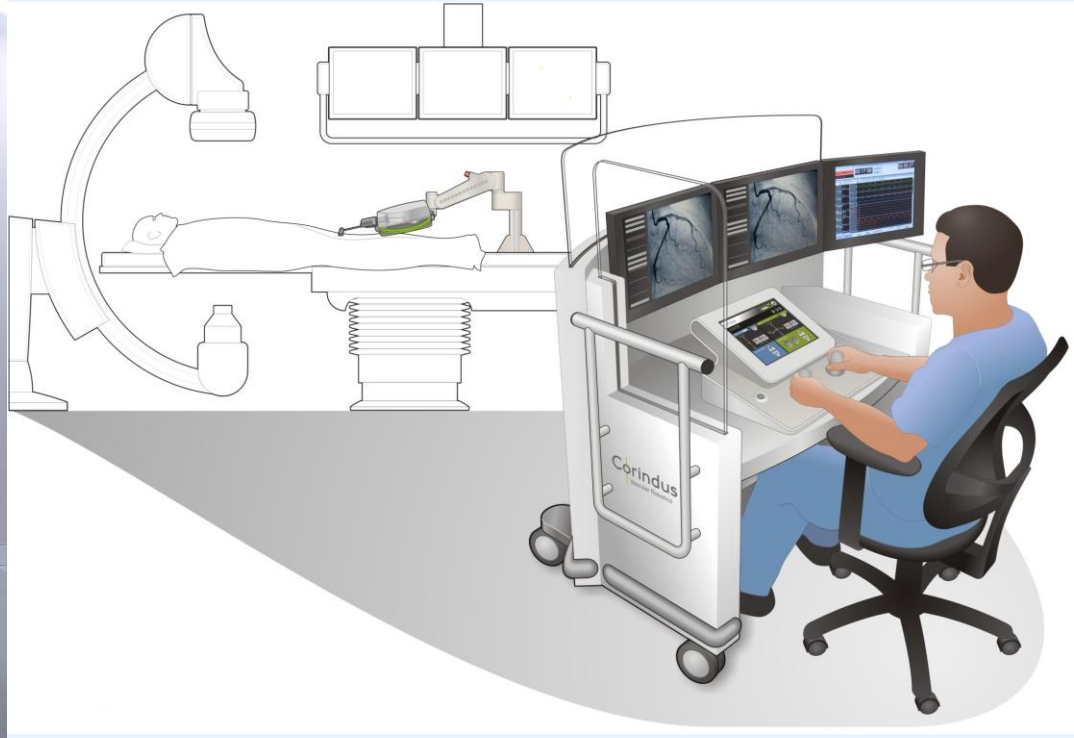
AK – Air Kerma

AK is a (calculated) dose/dose rate measurement of a $1cm^2$ area at a reference point.
Like the hose spray, the closer to the source, the more intense. Dose value decreases by the “Inverse Square law” as distance increases. This is a function of geometry not a weakening of the radiation*. It simply gets more spread out. So, a measurement at 1 will be quite a bit greater than at 2.

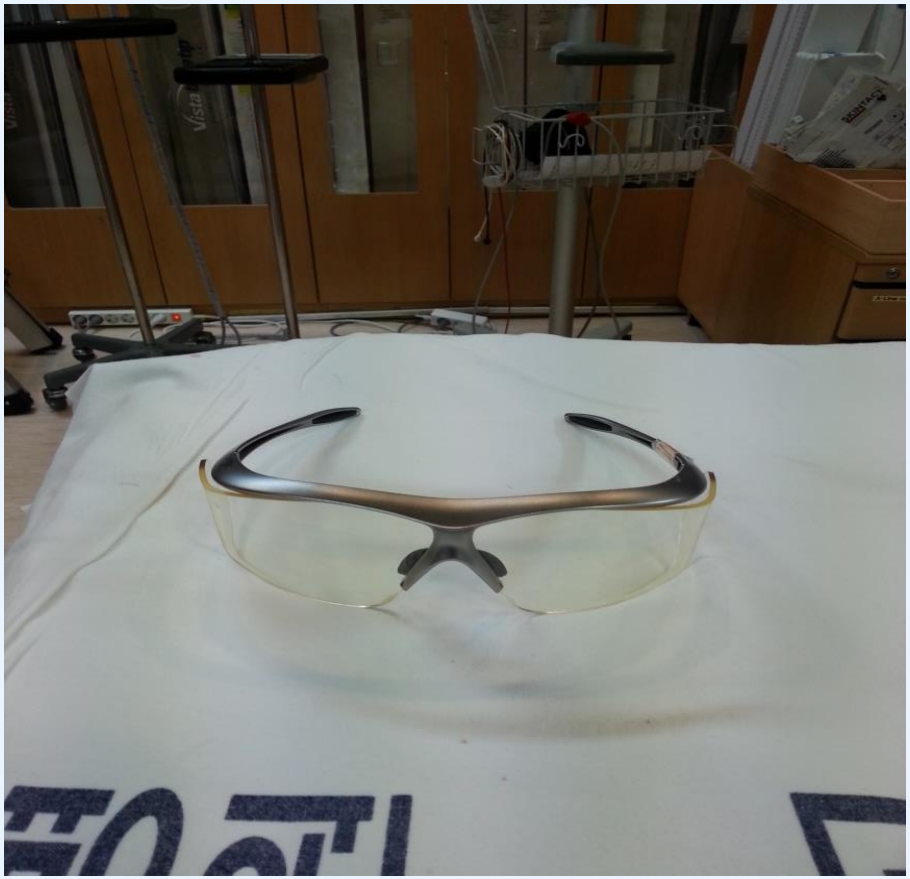


* Some radiation is actually absorbed by the air so it does weaken slightly.

Shields & Protectors



Lead Glasses and Thyroid Protector



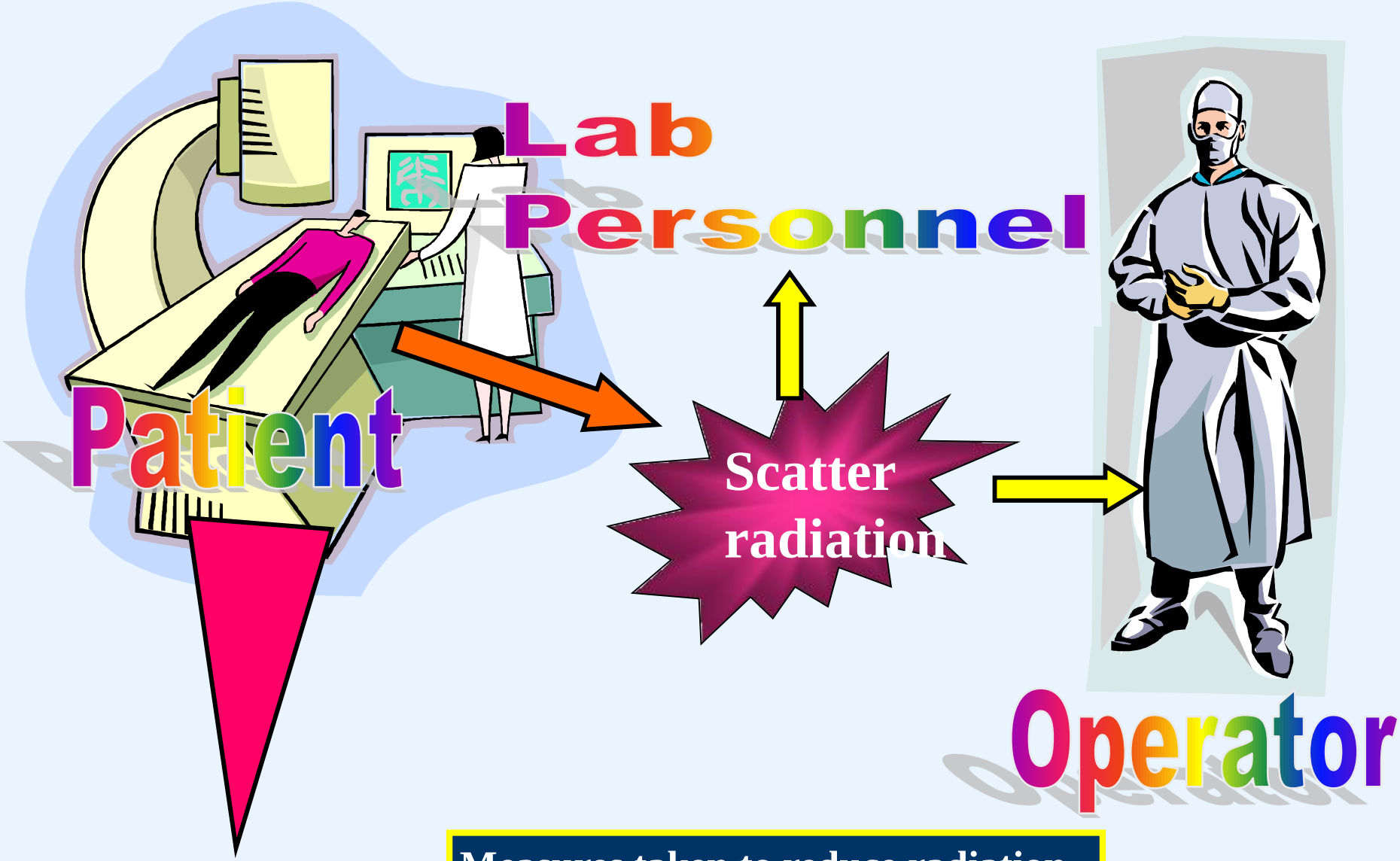
Lead glass

Thyroid protector

Protection + Sweating??

Apron protector

Panty protector
;intended for BTK PTA



Measures taken to reduce radiation exposure to patient will also benefit the operator/cath. lab. staff

ALARA

As **L**ow **A**s **R**easonably **A**chievable

Benefits outweigh risks?

; radiation hazard will be negligible!

Lower Dose =
Lower Risk

Routine errors in the Cath Lab

- No lead glasses
- Loose thyroid shield
- No leaded apron
- Place operator’s hand in the radiation field
- No radiation badge
- No front shield

시술자의 근 골격계 질환의 예방

1. 올바른 자세 유지
2. 근 골격 강화훈련
3. 적절한 휴식 (Radiation으로부터 조직 회복)

Limiting Radiation Dose during CTO PCI (1)

1. High radiation dose can have severe adverse consequences, potentially leading to radiation skin injury or increased risk for cancer.

2. In general, deterministic effects (skin injury) do not appear until after 5-Gy air kerma dose has been administered.

3. In most laboratories, the procedure is stopped after 7 Gy to 8 Gy has been reached, unless it is close to completion.

(Reference; J-CTO registry; Median fluoro time 45min, 10%>120 min)

Limiting Radiation Dose during CTO PCI (2)

1. With meticulous attention to radiation protection (low-dose fluoroscopy, image intensifier "in contact" with patient, not using X-ray when not needed and using the "fluoro-store" function instead of cine-angiography to document balloon/stent inflation), radiation dose has been steadily decreasing.
2. Moreover, use of newer X-ray systems further reduces radiation dose. In our laboratory, we recently started using a *Philips Clarity system* and have not exceeded 3-Gy air kerma dose despite doing some highly complex procedures with more than 100 minutes of fluoroscopy time. Indeed, with use of these newer systems, radiation is rarely, if ever, the limiting factor for CTO PCI attempts.

How Do We Reduce Radiation?-Summary

1. Limit fluoro and exposure time and select lowest “acceptable image quality ” dose setting for fluoro and exposure if available.
2. Keep the SID down!! Patient at isocenter

   ; Minimize angles – steeper angles can force SID up
3. Use the Collimate – Greatly reduces scatter too!
4. If acceptable increase FOV AND collimate (must do both) if not, AK goes down but DAP goes up.
5. Do NOT lower table below isocenter if not necessary

   ; Again Minimize angles – steeper angles put tube closer to patient.
6. Always keep detector as close to the patient as reasonably possible.
7. If you can’t reduce it…Move it! …Burns can be avoided!!

Contrast Hazard

1. Contrast nephropathy remains of concern, especially for patients with decreased renal function.
2. Excellent preprocedural hydration and minimizing the volume of contrast are important preventive measures.
3. Keeping the ratio of volume of contrast to creatinine clearance less than *3.7 x estimated glomerular filtration rate (eGFR)* markedly reduces the risk for contrast nephropathy.
4. With use of newer X-ray systems described earlier, contrast volume is becoming the more common limiting factor for CTO PCI.
5. Although the retrograde approach has been proposed as a *contrast-sparing crossing technique*, it may actually require large volume of contrast to cross the collateral, although after collateral crossing the need for contrast injections is low.

– Reference; 250cc for Paris SudCTO's, 293cc for J-CTO registry

Dr Rha's Tips and Tricks to Save Contrast during CTO PCI (Antegrade and Retrograde)

1. No multiple diagnostic angiography at index CTO PCI.
2. Contralateral injection by smaller catheter.

   ; 4F diagnostic catheter or Microcatheter for selective collateral angiography
3. Bilateral angiography; just one image at the best angle.
4. If possible, injection with small amount (2-3 cc) or diluted contrast with saline if good collaterals.
5. If needed, more image guided PCI (IVUS and OCT) to minimize contrast amount.
6. Implication of best baseline images (mapping images) not to do repeat angiography to reduce contrast.
7. Best final image, just one…(Not to do multiple final image to show your performance…)

Thank you for your attention

2020

THE 7TH CCI GURO LIVE

COMPLEX CARDIOVASCULAR INTERVENTION
FOR YOUNG AND AMBITIOUS DOCTORS

Date OCT 29(Thursday) ~ 31(Saturday), 2020

Course Director
Seung-Woon Rha (Korea Univ.)

Course Co-Director
Cheol-Ung Choi (Korea Univ.)
Yong Hoon Kim (Kangwon National Univ.)
Ju-Yeol Baek (Cheong-Ju St. Mary's Hosp.)
Yun-Hyung Cho (Senam Univ. Myeongji Hosp.)
Woong Gil Choi (Konkuk Univ.)
Sang Ho Park (Soonchunhayng Univ.)
Ji Young Park (Eulji Univ.)
Ae-Young Her (Kangwon National Univ.)
Wonho Kim (Eulji Univ.)
Ji-Hoon Ahn (Soonchunhyang Univ.)

Honorary Course Director
Dong Joo Oh (New Korea Hosp.)
Won Heum Shim (Good Morning Hosp)
Tae Hoon Ahn (Gachon Univ.)
Myung-Ho Jeong (Chonnam National Univ.)
Junghan Yoon (YeonSei Univ. Wonju Hosp.)

Organized by CIRI (Cardiovascular Intervention Research Institute), Korea University Guro Hospital, Seoul, Korea
Sponsored by Cardiovascular Center, Korea University Guro Hospital, Seoul, Korea

CCI Secretariat | Hompage: CCIGURO.COM e-Mail : info@cciguro.com Tel: 02-3144-2227

THE 7TH CCI GURO LIVE 2020

COMPLEX CARDIOVASCULAR INTERVENTION
FOR YOUNG AND AMBITIOUS DOCTORS

Date : OCT 29(Thursday) ~ 31(Saturday), 2020
Venue : Korea University Guro Hospital

Welcome Address

It is our great pleasure to inform you that the 7th Complex Cardiovascular Intervention Guro Live 2020 (CCI Guro Live 2020) will be held from **OCT 29 ~ 31, 2020 at the Korea University Guro Hospital, Seoul, Korea.**

Since June, 2011, the regular CCI program has been conducted at the Cardiovascular Center, Korea University Guro Hospital, Seoul, Korea every Tuesday. As a result, over 100 of young practitioners, interventionists and researchers from different Korean and international centers joined this creative joint intervention and research activities on regular or non-regular basis.

Now we held annual Two-days meeting of complex coronary and peripheral intervention focused on newer devices & fine techniques not published nor reported up to date.

Meeting will be held during OCT 29 ~ 31, 2020
1) OCT 29: International Evening Symposium
2) OCT 30-31: CCI Guro Live Symposium

These are the basic structure and focus is to give tips and tricks for complex intervention.

This meeting's concept is totally different with other usual international meeting or symposium, because Target audience is **"Young and Ambitious doctors from Global"** and formal language is "English".

We also hope that this will be a good opportunity for you, a promising leader in the same field in your country, to obtain current knowledge and technique for this challenging field in a short period. We are looking forward to see you, soon.

S. W. Rha

Seung-Woon Rha MD.
CCI Guro Live Coures Director

Special session

- **Asia-Pacic session**
  - **Complex Coronary, Peripheral and Structural Intervention**
- **Complex Coronary Intervention Live & Review**
  - **CTO & Non-CTO Lesions**
- **Complex Peripheral Intervention Live & Review**
  - **Aorta, Ilio-femoral, SFA and BTK CTO**

Complex Cardiovascular Intervention