**KUCE 2020**

**Session 5. Must-know facts for doctors' well-being**

# 의사의 건강을 위협하는 수술실 상황

김형준 (건양의대)

**2020년 7월 31일(금)**
**스위스 그랜드 호텔 제 1회의장 Emerald A**

# Safety in OR

**#Safety**
**#Operating Room**
**#Hazard**

## 환자안전
Patient Safety


## 의료진안전
Healthcare provider Safety

**Surgeons**
Surgical technologist,
Nurses,
Anesthesiologists,
Assistants
and other professionals

**Surgical Safety Checklist**

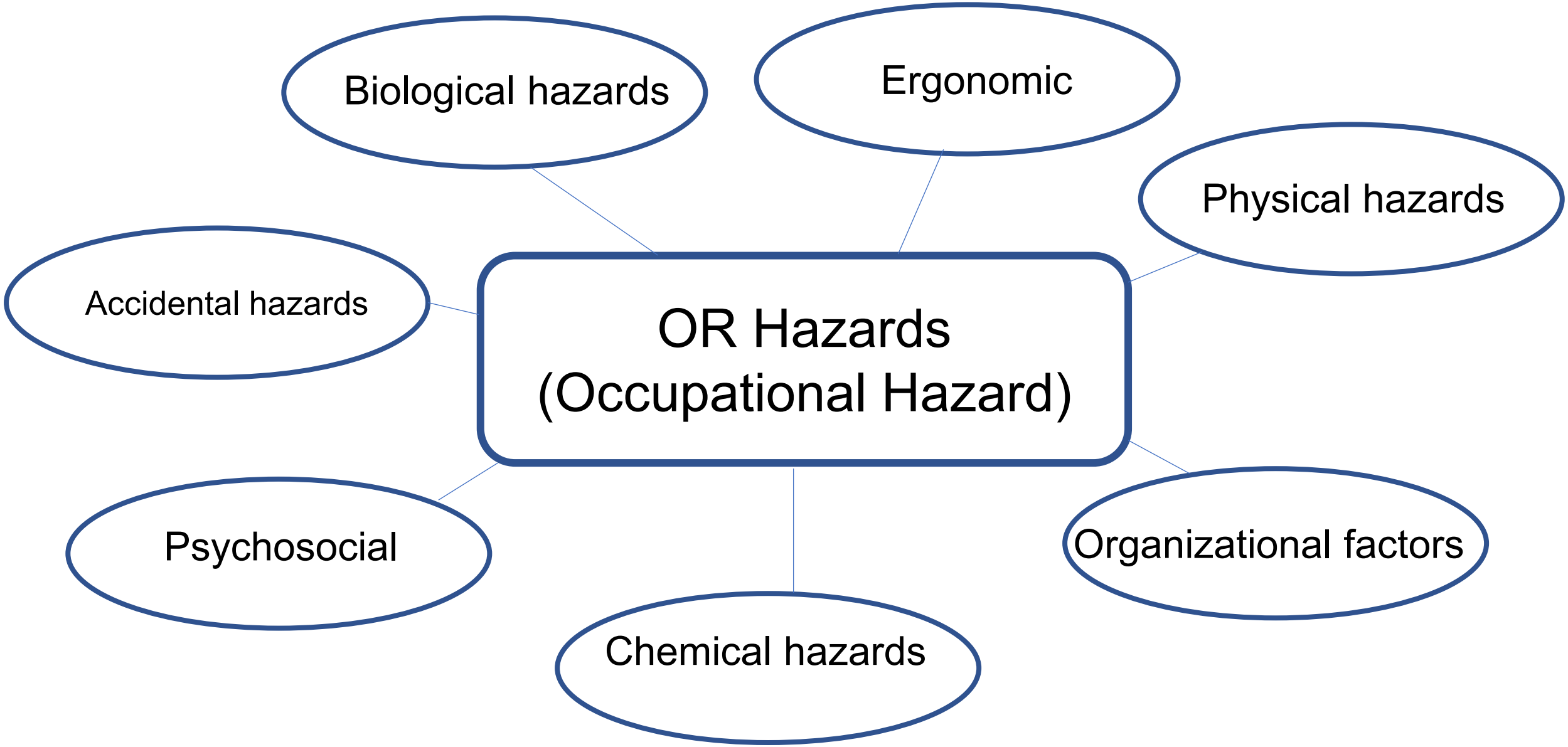
World Health Organization | Patient Safety
A World Alliance for Safer Health Care

| Before induction of anaesthesia (with at least nurse and anaesthetist) | Before skin incision (with nurse, anaesthetist and surgeon) | Before patient leaves operating room (with nurse, anaesthetist and surgeon) |
|---|---|---|
| **Has the patient confirmed his/her identity, site, procedure, and consent?** ☐ Yes | ☐ **Confirm all team members have introduced themselves by name and role.** | **Nurse Verbally Confirms:** |
| **Is the site marked?** ☐ Yes ☐ Not applicable | ☐ **Confirm the patient's name, procedure, and where the incision will be made.** | ☐ The name of the procedure |
| **Is the anaesthesia machine and medication check complete?** ☐ Yes | **Has antibiotic prophylaxis been given within the last 60 minutes?** ☐ Yes ☐ Not applicable | ☐ Completion of instrument, sponge and needle counts |
| **Is the pulse oximeter on the patient and functioning?** ☐ Yes | **Anticipated Critical Events** | ☐ Specimen labelling (read specimen labels aloud, including patient name) |
| **Does the patient have a:** | **To Surgeon:** | ☐ Whether there are any equipment problems to be addressed |
| **Known allergy?** ☐ No ☐ Yes | ☐ What are the critical or non-routine steps? | **To Surgeon, Anaesthetist and Nurse:** |
| **Difficult airway or aspiration risk?** ☐ No ☐ Yes, and equipment/assistance available | ☐ How long will the case take? | ☐ What are the key concerns for recovery and management of this patient? |
| **Risk of >500ml blood loss (7ml/kg in children)?** ☐ No ☐ Yes, and two IVs/central access and fluids planned | ☐ What is the anticipated blood loss? | |
| | **To Anaesthetist:** | |
| | ☐ Are there any patient-specific concerns? | |
| | **To Nursing Team:** | |
| | ☐ Has sterility (including indicator results) been confirmed? | |
| | ☐ Are there equipment issues or any concerns? | |
| | **Is essential imaging displayed?** ☐ Yes ☐ Not applicable | |

This checklist is not intended to be comprehensive. Additions and modifications to fit local practice are encouraged.

Revised 1 / 2009




Biological hazards
Ergonomic
Physical hazards
Accidental hazards
OR Hazards
(Occupational Hazard)
Psychosocial
Organizational factors
Chemical hazards

# Physical Hazards

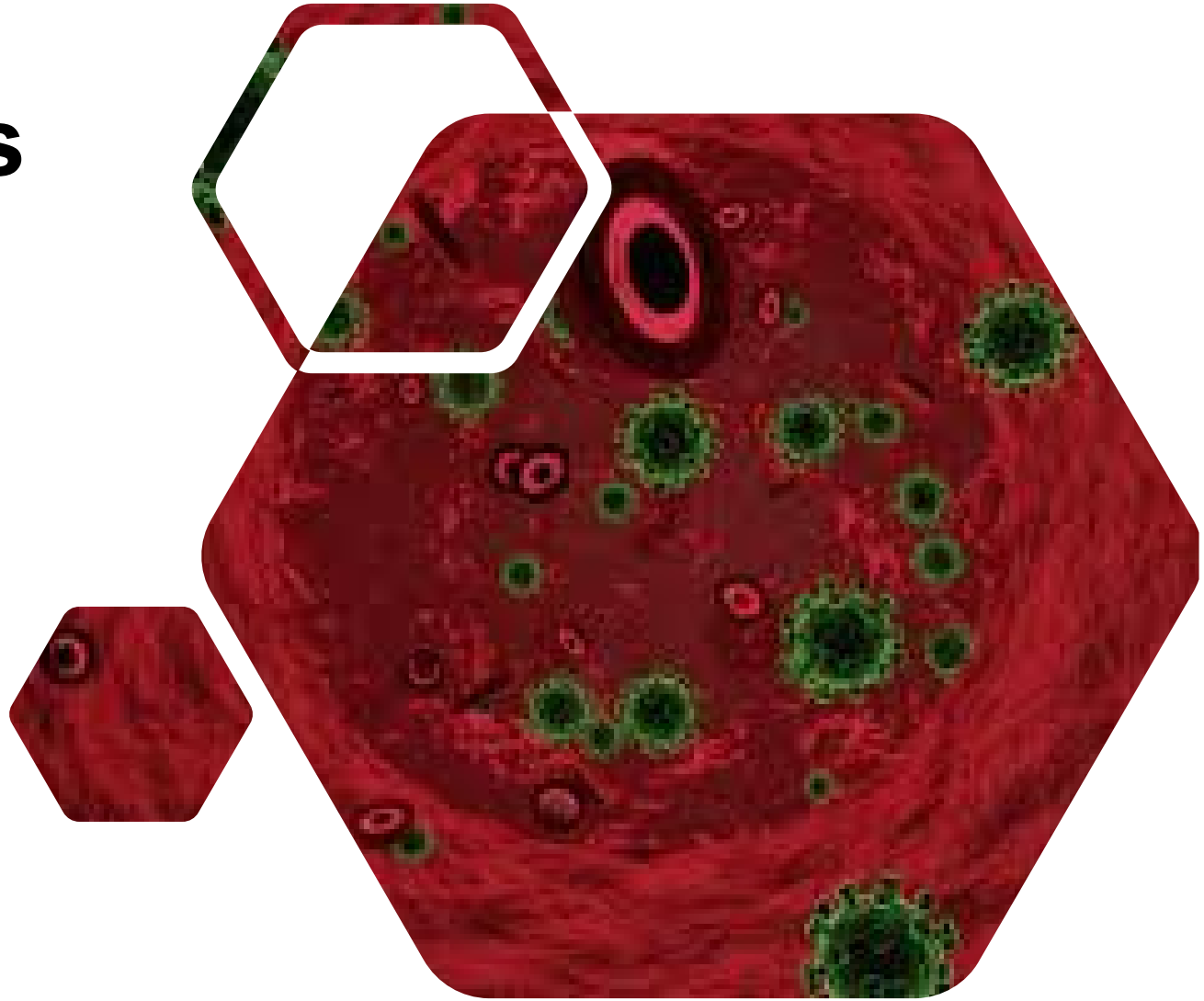
- ✓ Stabs and Cuts from sharp objects, especially needle-sticks, blades (m/c)
- ✓ Burns and scalds from laser, electrocautry, hot water and steam used in sterilizing equipment, or from machines that supply hot air for the purpose of drying
- ✓ Electrical shock from faulty or improperly grounded equipment, or equipment with faulty insulation
- ✓ Head injuries :  Lights above the operating table
- ✓ Slips and Falls : Wet floor, Lines on the floor, wear slip-resistant footwear

# Biological Hazards

- Contact with blood and other body fluid
- Cut or prick from a sharp surgical tool

→HIV and hepatitis

- Exposure to released particles (e.g. **Surgical Smoke**)



# Chemical Hazards

- **Anesthetic equipment malfunction**

→Leaks in the connective tubing

→Anesthetic gases exposer everyone in the operating room

→Harm a person's motor skills, reflexes and alertness

- **Disinfectants and other cleaning and sanitizing agents**

# Surgeon Hazards

- **Physical Health-related problems**

- Musculoskeletal conditions

- Orthopedic complications, e.g. spinal misalignment, disc degeneration.

38% of occupations injuries reported by surgeons involve cervical spine pain (MD Edge)

Acute back pain resulting from awkward body position during the operation

- Noise-induced hearing loss.

- **Mental health related problems**

Psychosocial stress, anxiety, depression and burnout.

# Radiation

# Radiation exposure and its effect

- 600% increase in medical radiation exposure  to the United States (U.S.) population since 1980

- Arises due to scattered radiation produced from the interaction of the primary radiation beam with the patient and the operating table.

- International Commission on Radiation Protection (ICRP) recommends a safe limit of **20 mSv** for medical personnel **annually**. The maximum duration for which this level of RE is permitted is 5 years and hence a total of 100 mSv over the 5-year period

- High exposure to radiation may result in skin damage and cancer risk
  The European Commission on Radiological Protection suggested one of 1000 people is prone to solid cancer or leukemia during their lifetime when exposed to radiation of **10 mSv**

- Risk to the operating staff from endourological procedures and although doses are relatively low, these can accumulate during a lifetime of operating

Ferrandino et al. Urol 2009

J Urol. 2005

# Percutaneous nephrolithotomy & Radiation Exposure

| Variable | Pearson correlation coefficient | P |
|---|---|---|
| Number of stones | 0.28 | 0.001 |
| Stone volume | 0.5 | <0.001 |
| HU | −0.11 | 0.11 |
| BMI | 0.17 | 0.02 |
| Number of tracts | 0.53 | <0.001 |
| Mode of access | 0.29 | <0.001 |
| Sheath size | 0.45 | 0.001 |

**The mean (SD) RE per procedure was 0.21 (0.11) mSv.**

Increasing size and low HU of stone, increasing number of tracts, fluoroscopic access to PCS, increasing sheath size and kV were found to increase RE.

Although the exposure levels are within safety limits, serial monitoring and constant vigilance are mandatory to inform surgeons.

| Type of PCNL/sheath size and RE<br>Type of PCNL | Sheath size, F, mean (SD) | RE, mSv, mean (SD) |
|---|---|---|
| Standard PCNL | 26.5 (1.6) | 0.29 (0.12) |
| Miniperc | 21.2 (1.7) | 0.18 (0.1) |
| MIP-M | 15.7 (0.8) | 0.21 (0.08) |
| MIP-S | 10.7 (0.6) | 0.16 (0.08) |
| Total | 18.2 (6.1) | 0.21 (0.11) |

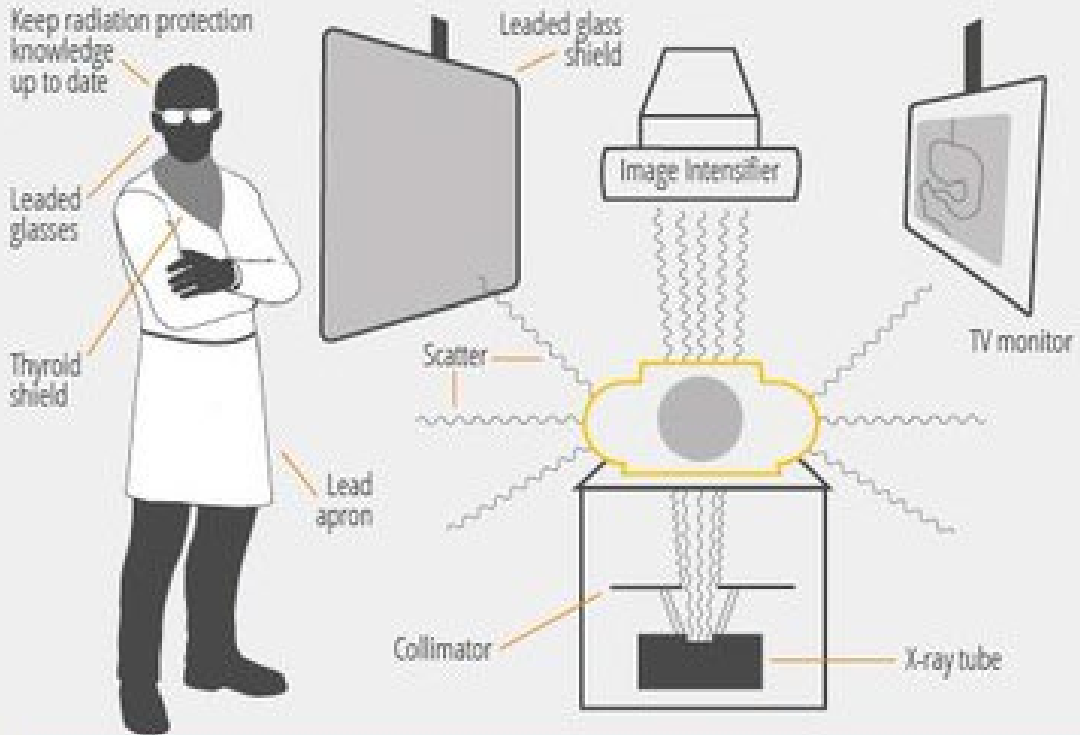
| Stone location and RE<br>Location of the calculus | N (%) | RE, mSv, mean (SD) |
|---|---|---|
| Pelvis | 79 (37.3) | 0.2 (0.06) |
| Lower calyx | 45 (21.2) | 0.17 (0.1) |
| Middle calyx | 14 (6.6) | 0.18 (0.08) |
| Upper calyx | 12 (5.7) | 0.21 (0.09) |
| Upper ureter | 9 (4.2) | 0.17 (0.1) |
| Multiple (in different calyx) | 53 (25) | 0.25 (0.12) |

Baladji et al. BJU Int 2019; 124: 514–521

# Factors to Reduce Radiation (1)

## ATTENTION TO PROTECTION

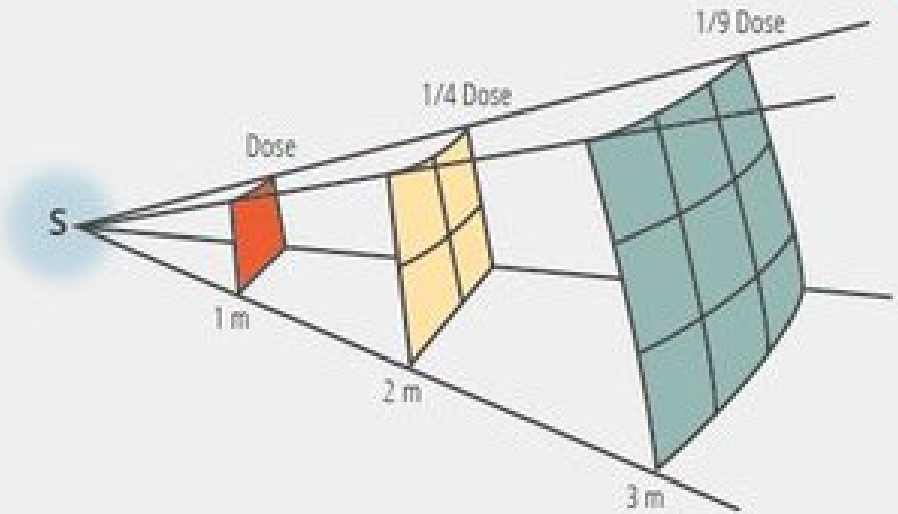
- Use personal lead shields. Use protective gear.
- Use a dosimeter.
- Use table shields.
- Use leaded plastic barriers.
- Use leaded glass barriers and glass panels.




## ATTENTION TO INVERSE SQUARE LAW

### SCATTERING AROUND THE PATIENT

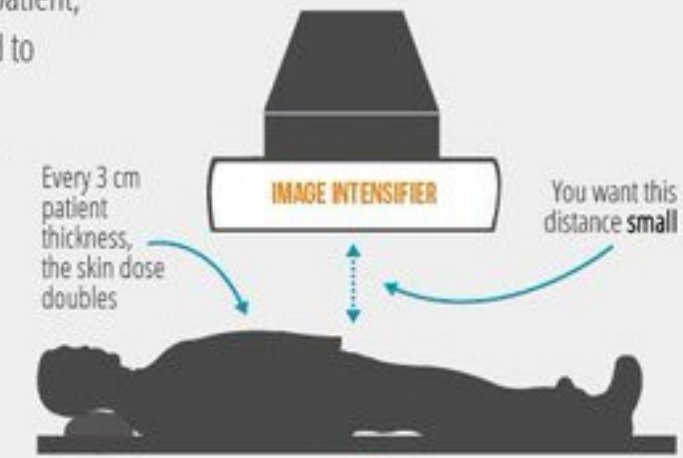
- Doubling your distance from an X-ray source decreases your dose by a factor of 4!

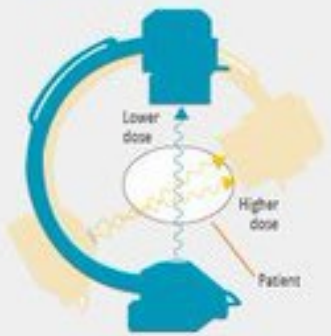
# Factors to Reduce Radiation (2)

## ATTENTION TO C-ARM POSITION

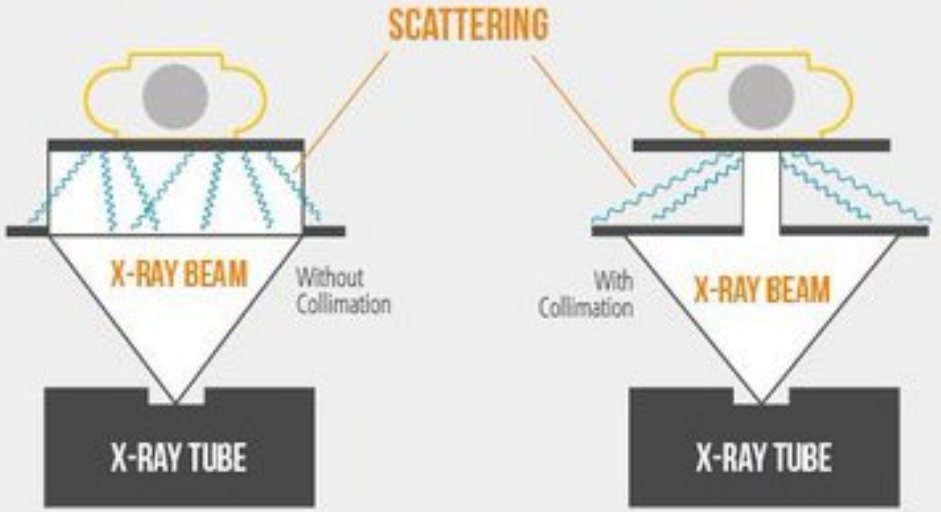
- Image intensifier as close to the patient as possible.
- Maximise distance between the X-ray tube and the patient, angio table elevated to maximum.
- Be aware of hostile C-arm angulations which generate higher dose.




### X-RAY PATHS

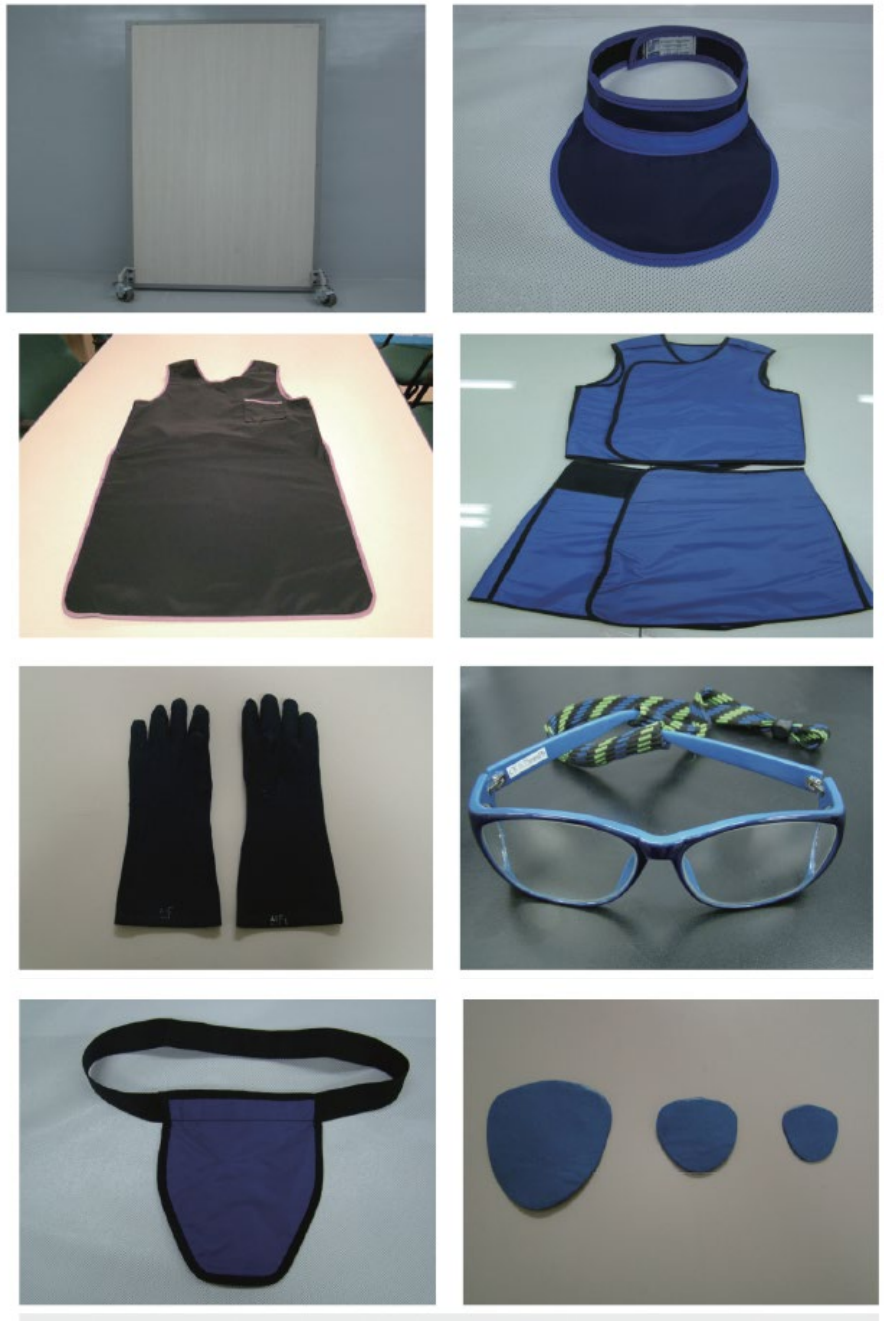


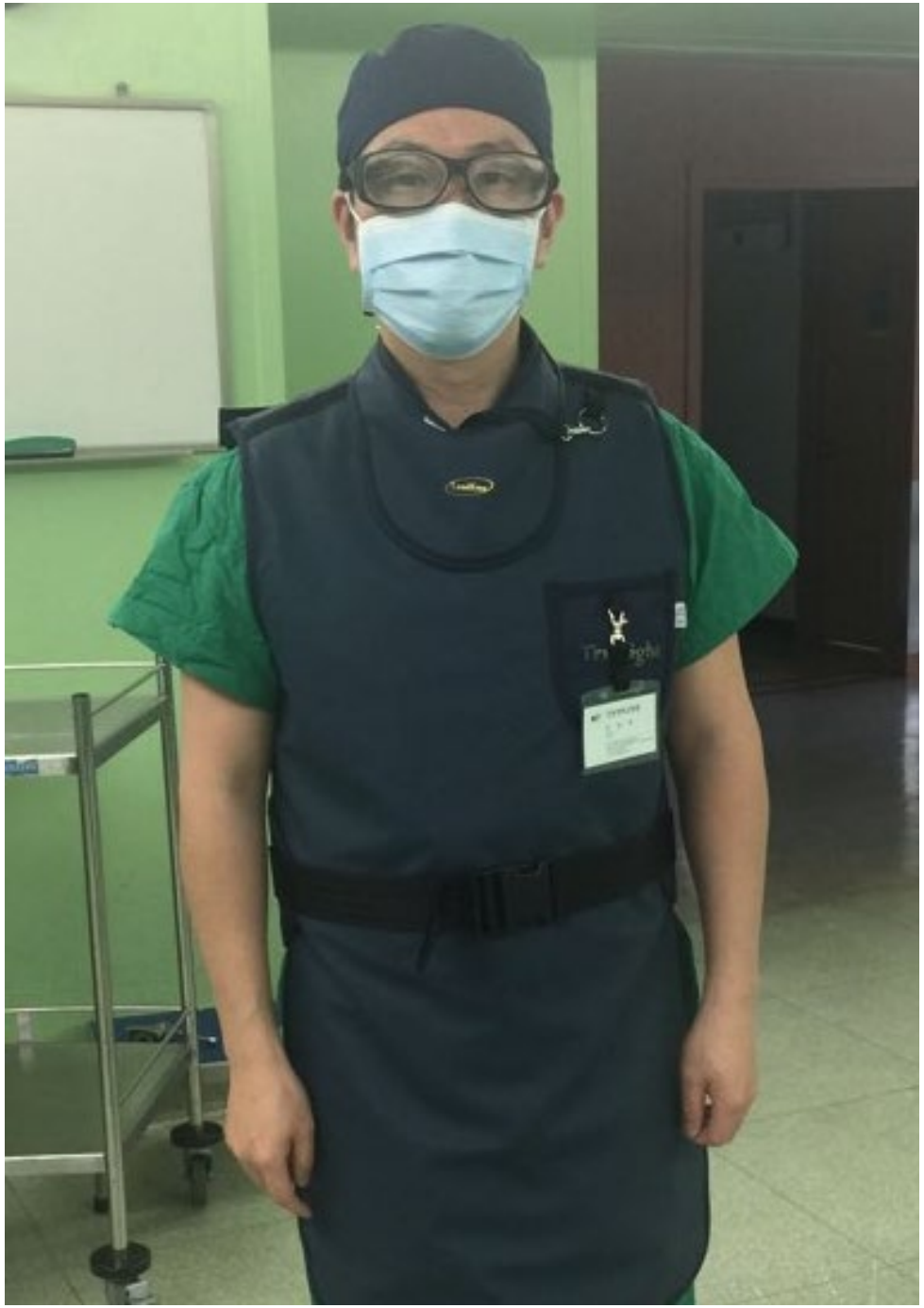

## ATTENTION TO IMAGE ACQUISITION



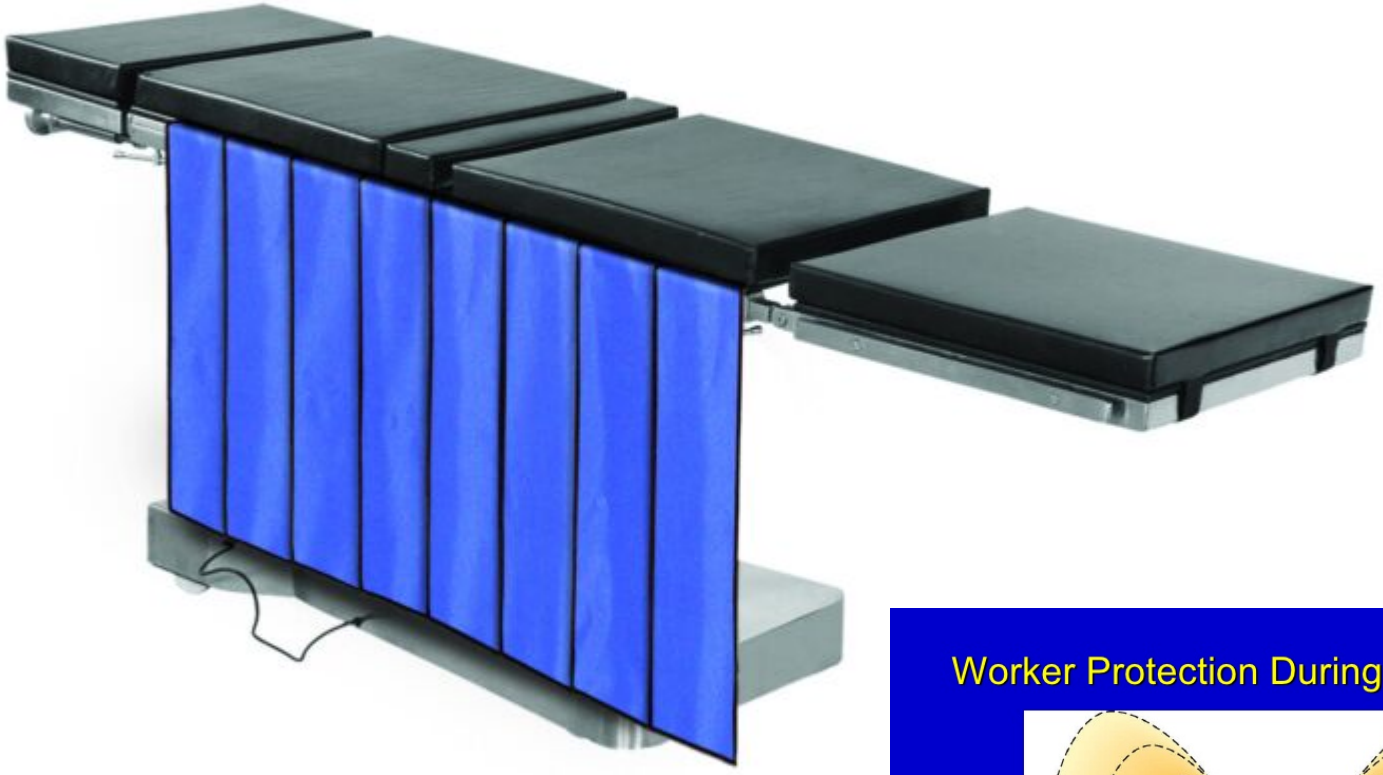

1. Use collimation. Reduces scatter to operator! Reduces irradiated volume on patient!
2. DSA is associated with a much, much higher dose than fluoroscopy.
3. Reduce magnification.
4. Plan C-arm angles prior to procedure.
5. Pulsed fluoroscopy and cine/DSA with frame rate as low as diagnostically acceptable.

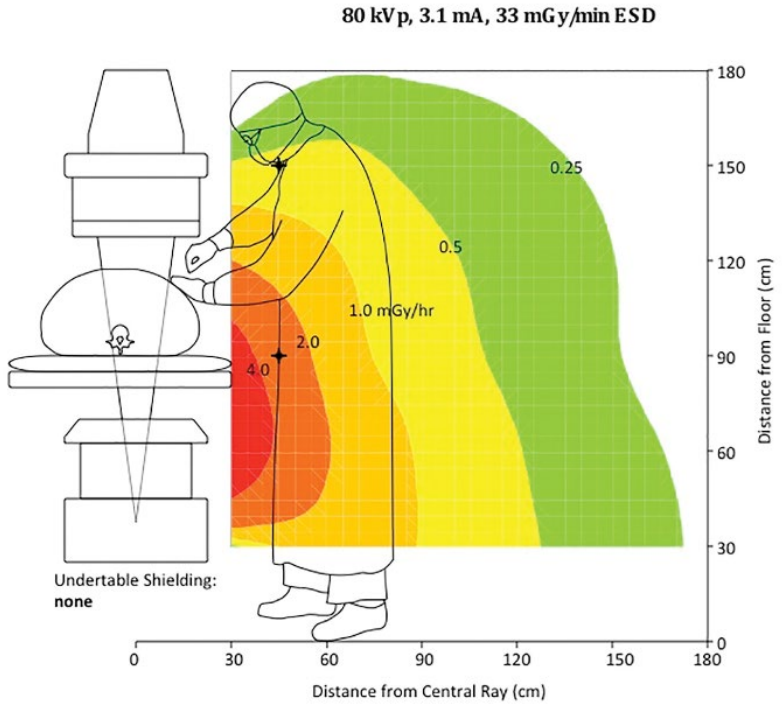
# Protective Gears



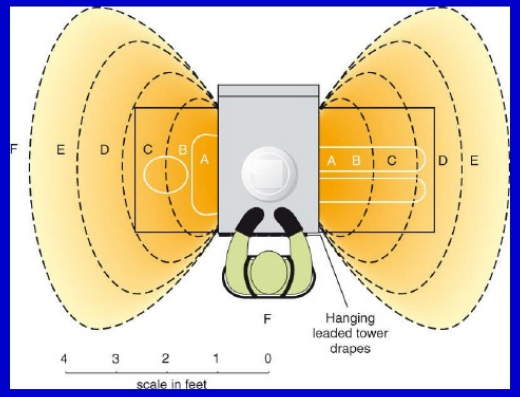


# Table Shield





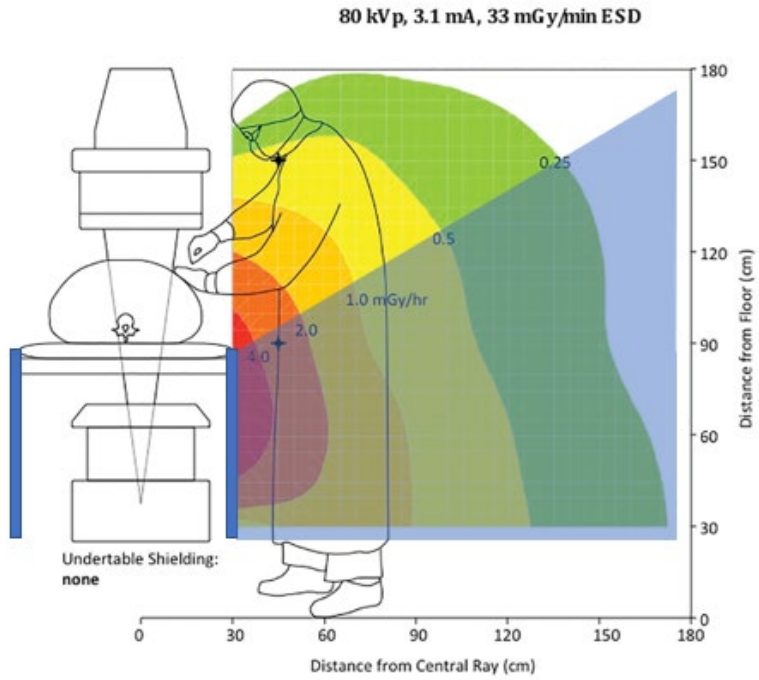

## Worker Protection During Fluoroscopy




Fluoroscopy exposure patterns
(with tower drape shields in place)





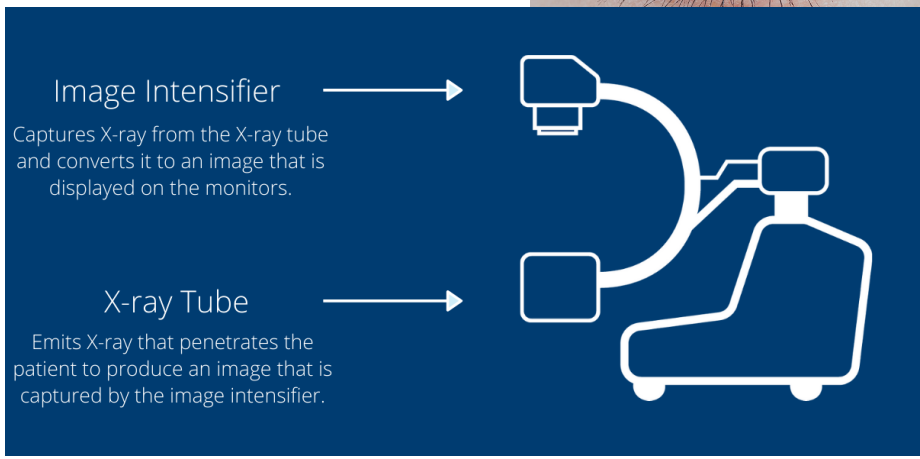


World Journal of Urology (2019) 37:2639–2647
https://doi.org/10.1007/s00345-019-02667-0

REVIEW

# The eye of the endourologist: what are the risks? A review of the literature

Steeve Doizi[1,2] · Marie Audouin[1,2] · Luca Villa[1,2] · Maria Rodríguez-Monsalve Herrero[1,2] · Vincent De Coninck[1,2] · Etienne Xavier Keller[1,2] · Olivier Traxer[1,2]

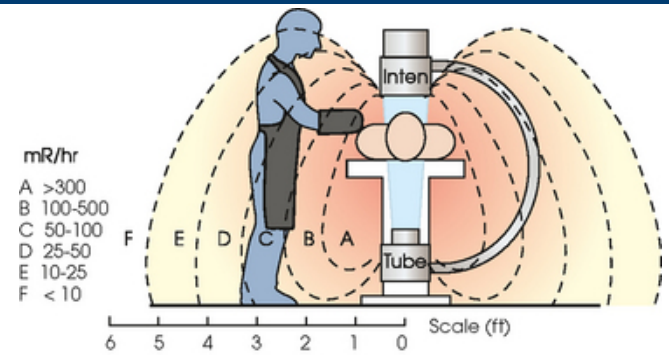


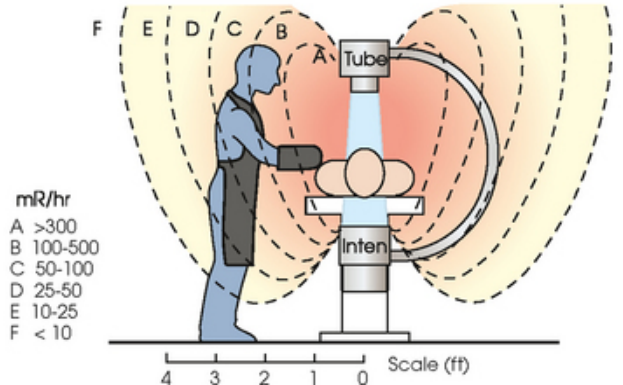

## The risk of X-ray radiation damages to eyes

### Eye lens dose (ELD) (per procedure)

URS : 2.97 to 100 µSv (fluoroscopy time: 1.0 to 1.45 min)
PCNL : 0.04 µSv to 1600µSv (fluoroscopy time: 2.0 to 21.9 min)

**X-ray source location** : Over-couch > Under-couch
**Patient position** : supine position (92 µSv) vs. prone position (62 µSv)
**Surgeon Position**: Standing position (575 µSv ) vs.
seating position (when patient is in lithotomy)




Annual dose to the lens of the eye : 13-29 mSv in interventional endourology

***Lifetime eye lens dose (ELD) threshold for radiation-induced cataract: 0.5 Sv**
**Annual ELD limit : 20 mSv/year ← 150 mSv/year**

# Eye contact with body fluids and irrigation solutions

Risk exposure during cystoscopy : 42.8% (6/14) of eye exposure to blood droplets
29% (129/442) patient body fluids

Risk exposure during transurethral prostate (TURP) and bladder resection of tumor (TURBT) :
splashes occurred in 67% of all cases (20/30)
37.5% (9/24) of eye exposure to blood droplets

Risk exposure during ureteroscopy (URS)
overall incidence of eye exposure to blood droplets reached 50% (23/46).
The rate of visible blood droplets was 8.7% (4/46) and an additional rate of 41.3% (19/46)

**Recommendation: Wear eye and face protection during endoscopic procedures to prevent eye contact with potentially contaminated fluids**

# Laser-associated eye injuries

❖ **Adverse events resulting from the use of lasers already in place**

Based on 2 Database : Manufacturer and User Facility Device Experience (MAUDE)
Rockwell Laser Industries (RLI)

**Eye injuries (mild corneal abrasions ~ total vision loss)** were reported in 37.9% (164/433)
Nd:YAG (69%) > Diode lasers (20.1%) > KTP (11%) with improper eye protection
**None with Ho:YAG and Tm:YAG lasers**

❖ **Potential harmful effects of Ho:YAG laser to the eyes**

- In vitro using pig
- Settings : 0.5 J–20 Hz with long pulse mode, 1 J–10 Hz with short pulse mode, and 2 J–10 Hz with short pulse mode
  Distances between laser fiber tip and cornea : 0, 3, 5, 8, 10, and 20 cm
  Laser safety glasses, Eyeglasses, and Without any eye protection

With laser safety glasses or eyeglasses : No lesion
Without any eye protection : ≥5cm → No lesion
<5cm → correlates with pulse energy and time of exposure
inverse correlation with the distance from the eye

# Summary I: Reducing Radiation Exposure

## Be equipped

✓ Personal protective equipment : Compliance in wearing a lead apron and thyroid shield must be 100%.

## Understand the physics

## Follow the ALARA (As Low As Reasonably Achievable) principal

✓ Reduced radiation procedures

✓ How?

- Pulsed Mode (1-8Frame/sec)

→ 1 Pulse/sec : 64% dose reduction

- Low Dose (50% Dose Reduction)

- More Spot/Less Live
- Use Tactile feedback
- Use Foot Pedal
- C-arm Laser Guide
- Use Collimation

✓ Zero-radiation procedures
- US only puncture

✓ Digital Flat Panel X-ray if possible
- Digital X-rays produce 80% less radiation than traditional ones

# Surgical Smoke

# Surgical smoke?

- **Causative Devices** : Electrocautery, harmonic scalpel tissue dissection

- Two distinct particle populations that compose Surgical Smoke

  Small particles (mean 68.3㎚) caused by the nucleation of vapors as they cool

  Large particles (mean 994㎚) entrainment of tissue secondary to mechanical aspects

- Surgical smoke is usually composed of chemicals, blood and tissue particles, viruses and bacteria, bringing potential harmfulness to the health of operating room personnel

- **Component** : Carbon monoxide and carcinogenic compounds such as acrylonitrile, hydrogen cyanide, formaldehyde and benzene and many more

Int Urol Nephrol (2015) 47:1671–1678

# Toxic components of Surgical smoke

- Increase the risk of **acute and chronic pulmonary conditions**

  cause acute headaches; irritation and soreness of the eyes, nose and throat; dermatitis and colic

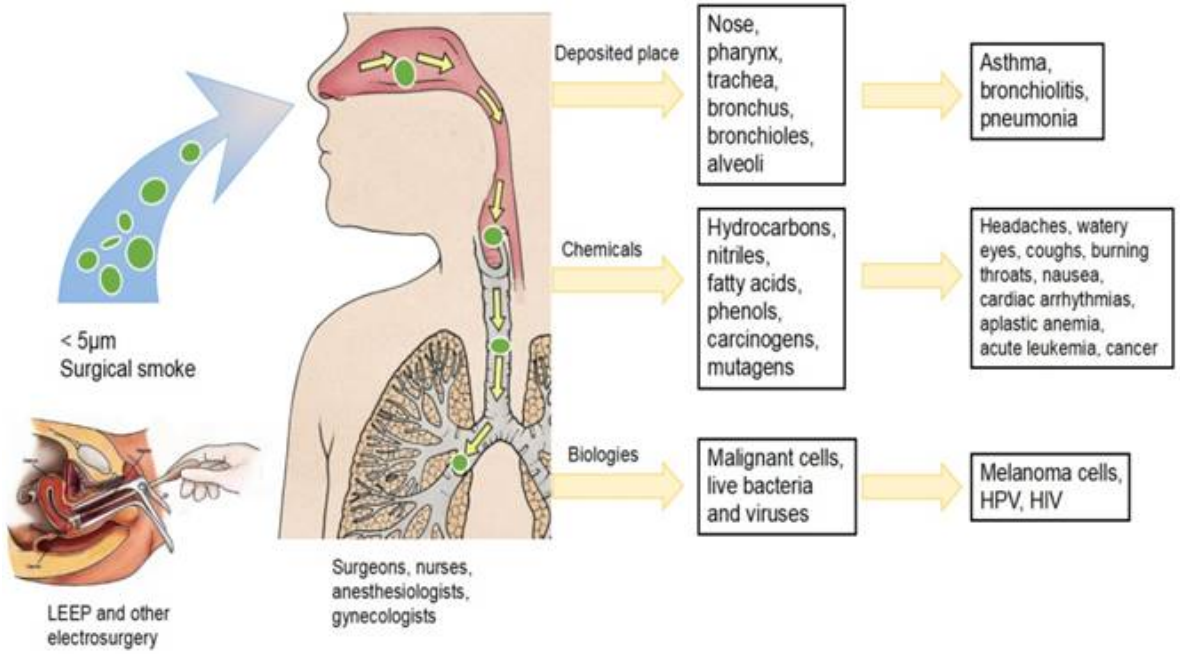
- Transmission of infectious disease may occur if bacterial or viral fragments present in the smoke are inhaled.

  - **HPV** (mainly genital warts, laryngeal papillomas, or cutaneous lesions) may be transmitted by surgical plume

  - **Hepatitis B** virus was identified in the surgical smoke collected during different laparoscopic surgeries (colorectal resections, gastrectomies, and hepatic wedge resections)

- The presence of carcinogens in surgical smoke and their mutagenic effects

| | |
|---|---|
| Respiratory system | |
| | Nasopharyngeal lesions, sneezing, throat irritation, acute and chronic inflammatory changes in respiratory tract (emphysema, asthma, chronic bronchitis) |
| Eyes | |
| | Eye irritation, lacrimation |
| Skin | |
| | Dermatitis |
| Gastrointestinal system | |
| | Nausea, vomiting, colic |
| Blood disorder | |
| | Anemia, leukemia |
| Infection | |
| | Human immunodeficiency virus, hepatitis, human papilloma virus [20, 23, 27, 36] |
| Others | |
| | Carcinoma, lightheadedness, hypoxia, dizziness, headache, weakness, anxiety |



# Surgical smoke may be a biohazard to surgeons performing laparoscopic surgery

Seock Hwan Choi · Tae Gyun Kwon ·
Sung Kwang Chung · Tae-Hwan Kim

- Transperitoneal Radical Nephrectomy (n= 20)
- 5-L gas sample was collected 30 min after the electrocautery device was first used and was analyzed by gas chromatography and mass spectrometry
- Cancer risk was calculated for carcinogenic compounds and hazard quotient was calculated for noncarcinogenic compounds using US Environmental Protection Agency guidelines

Ethanol
**1,2-dichloroethane**
**Benzene**
Ethylbenzene
Styrene

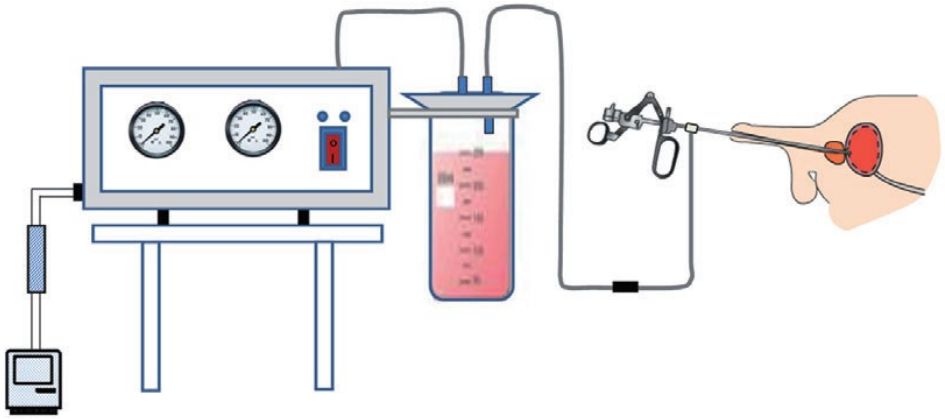
Surg Endosc (2014)

INTERNATIONAL JOURNAL OF UROLOGY
The Japanese Urological Association
affiliated with Urological Association of Asia

# Harmful gases including carcinogens produced during transurethral resection of the prostate and vaporization

Yun Jo Chung,[1] Sang Kyi Lee,[2] Suk Hee Han,[2] Chen Zhao,[3] Myung Ki Kim,[3] Seung Chul Park[4] and Jong Kwan Park[3,5,6,7]

- TURP and vaporization (n=12)
- Gas chromatography-mass spectrometry (GC-MS) equipped with a purge and trap sample injector



1,3-butadiene,
Vinyl acetylene
Acrylonitrile

International Journal of Urology (2010)

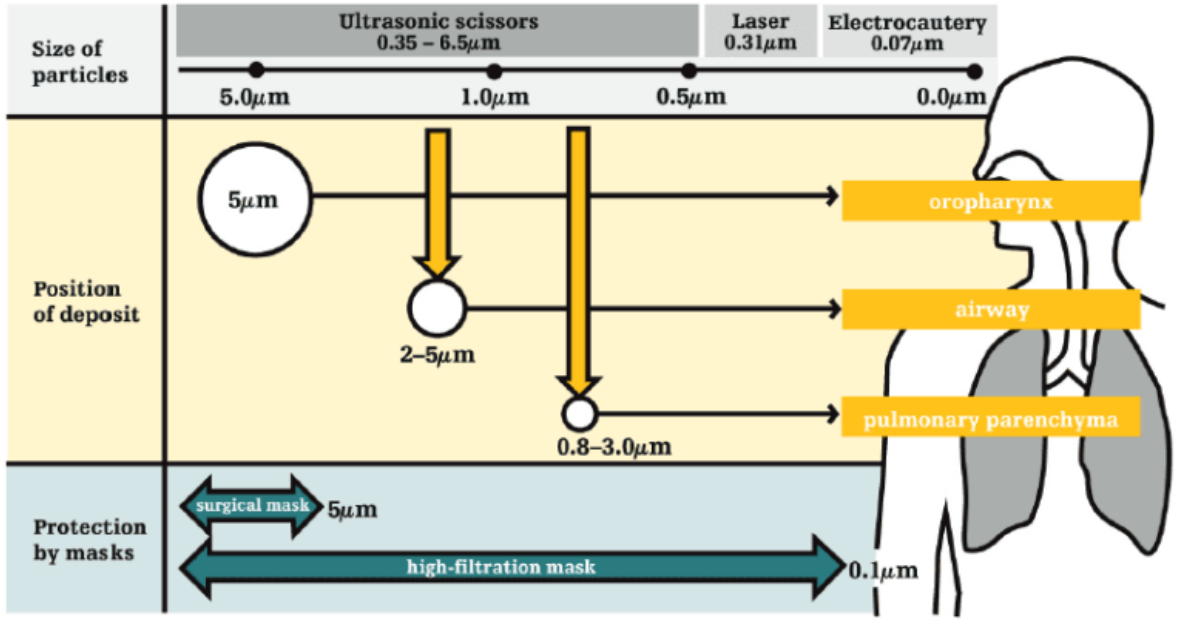
# Summary II: How to avoid harms from surgical smoke

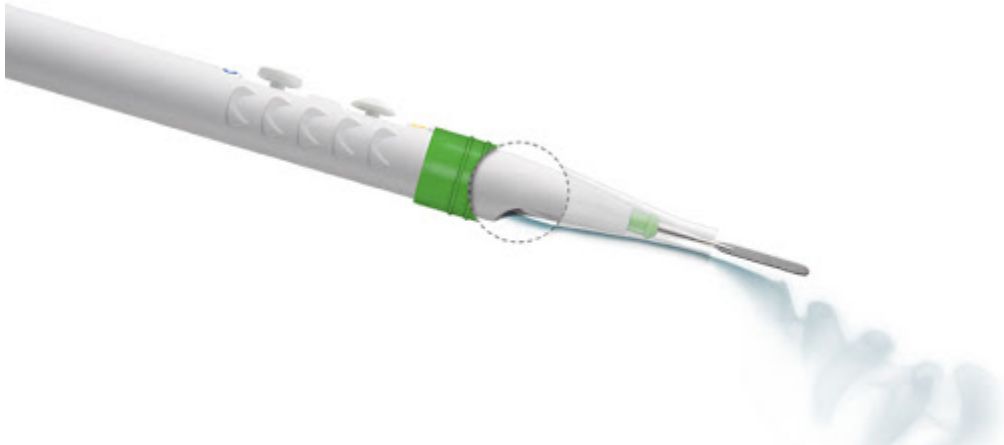
- Minimizing the use of electrocautery
- Continuous irrigation and suction system during transurethral surgeries
- Reduction of pneumoperitoneum pressure
- Generous use of suction devices to remove smoke and aerosol during operations, especially before converting from laparoscopy to open surgery or any extraperitoneal maneuver
- Prevent the spewing of abdominal contents into the faces of surgical team members

- Masks should be worn snugly and changed often

*Surgical Mask are designed to filter particles that are ≥5μm*
*(Do not provide protection against airborne (aerosol) particles)*
→ Use of Higher quality filter masks should be considered

- Surgical smoke evacuation systems and/or smoke filters






PALL

# Ergonomics

# Minimal invasive versus open surgery

| Variable | More endoscopic ($n = 74$) | More open ($n = 33$) | $p$ value |
|---|---|---|---|
| Sex (male) | 46 (62.2 %) | 27 (81.8 %) | 0.047 |
| Age (years) | 47.0 (35.0–62.0) | 50.0 (37.0–63.0) | 0.056 |
| Height (cm) | 180.0 (156.0–204.0) | 182.0 (165.0–198.0) | 0.130 |
| Weight (kg) | 79.0 (52.0–118.0) | 81.0 (53.0–113.0) | 0.299 |
| Specialism | | | 0.803 |
| General surgeon | 58 (78.4 %) | 23 (69.7 %) | |
| Urologist | 5 (6.8 %) | 3 (9.1 %) | |
| Gynaecologist | 9 (12.2 %) | 6 (18.2 %) | |
| Paediatric surgeon | 2 (2.7 %) | 1 (3.0 %) | |
| Hospital (academic/district) | 26/48 (35.1 %/64.9 %) | 11/22 (33.3 %/66.6 %) | 1.000 |
| Dominant hand | | | 0.737 |
| Right | 63 (85.1 %) | 29 (87.9 %) | |
| Left | 5 (6.8 %) | 1 (3.0 %) | |
| Ambidextrous | 6 (8.1 %) | 3 (9.1 %) | |
| Glove size | 7.5 (6.0–9.0) | 7.5 (6.5–8.5) | 0.424 |
| Years of practice | 13.0 (0.0–33.0) | 16.0 (2.0–30.0) | 0.635 |
| Medical history | | | 0.657 |
| None | 47 (63.5 %) | 25 (75.8 %) | |
| Operating hours | 16.0 (3.0–45.0) | 15.0 (8.0–30.0) | 0.437 |
| >3 hours | 2.0 (0.0–4.0) | 2.0 (0.0–6.0) | 0.258 |
| Complaints[a] | 54 (73.0 %) | 22 (66.7 %) | 0.500 |
| Localizations[a] | | | |
| Neck | 25 (46.3 %) | 6 (27.3 %) | 0.198 |
| Erector spinae | 15 (27.8 %) | 9 (40.9 %) | 0.278 |
| Right deltoid muscle | 9 (16.7 %) | 4 (18.2 %) | 1.000 |
| Right latissimus dorsi | 7 (13.0 %) | 7 (31.8 %) | 0.099 |
| VAS | 4.0 (1.0–10.0) | 4.0 (2.0–8.0) | 0.721 |
| Treatment[b] | 13 (24.1 %) | 8 (36.4 %) | 0.789 |
| Sick leave | 9 (16.7 %) | 2 (9.1 %) | 0.494 |

- **Online Survey**

- **Pain Site (of MIS)**

Neck (46.3 %),

Erector spinae (27.8 %)

Right deltoid muscle (16.7 %)

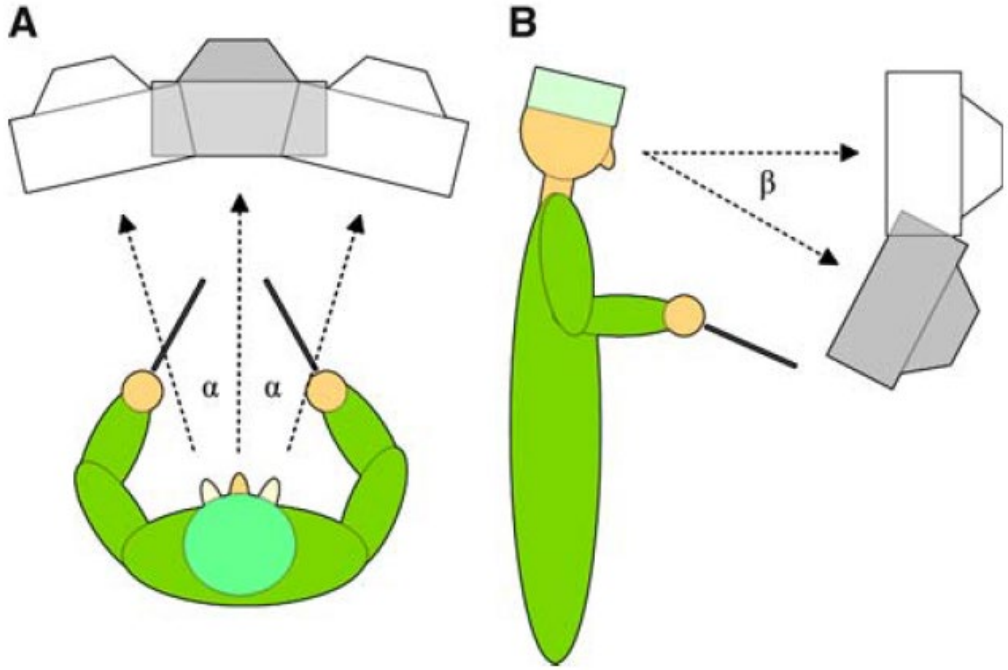
Right latissimus dorsi (13.0 %).

Janki et al. Surg Endosc 2016

# Ergonomic drawback during MIS

- Misalignment in the eye–hand–target axis

- Limited freedom in monitor positioning is recognized as an important ergonomic drawback during MIS




**Monitor positioning**

In the horizontal plain, the monitor should be straight ahead of each person in line with the forearm– instrument motor axis, avoiding **axial rotation of the spine**

In the sagittal plain, the monitor should be positioned lower than eye level to **avoid neck extension**

Van Det et al. Surg Endosc (2009) 23:1279–1285

Surgical Endoscopy (2019) 33:1938–1943
https://doi.org/10.1007/s00464-018-6478-4

# Ergonomic analysis of laparoscopic and robotic surgical task performance at various experience levels

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- TLS is associated with higher muscle activation in all muscle groups except for trapezius muscles, suggesting greater strain on the surgeon

- Increased trapezius muscle activation on RALS has previously been documented and is likely due to the position of the eye piece.

- The differences seen in muscle activation diminish with increasing levels of expertise.

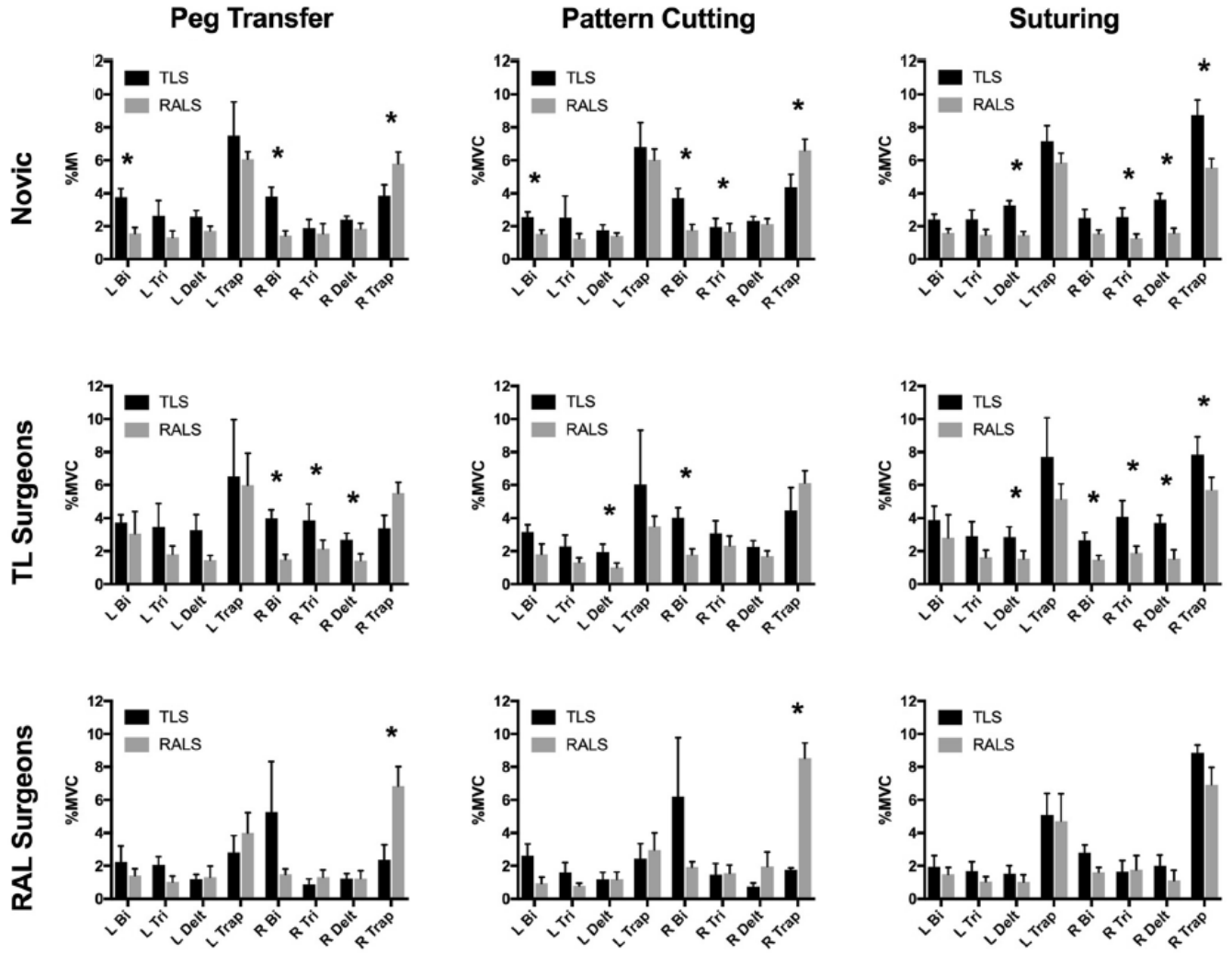


Fig. 1 Mean muscle activation, as quantified by %MVC during traditional laparoscopic surgery (TLS), and robot-assisted laparoscopic surgery (RALS), by muscle group and surgical task. *$p < 0.05$

# Summary III: Effective ways to avoid ergonomic problems

◆**In general,**

✓Neutral body posture

✓Adjustability of the table height

✓ Optimal placement of the monitor

- The most efficient monitor position is near the operative field
- Viewing distance is highly dependent on monitor size
- The most comfortable viewing direction is approximately downward

✓Redesign of endoscopic instruments

◆**When operating with two surgeons,**

✓ Place a second monitor

✓ Small bench for one of the two surgeons if there is a mismatch in height


# Have a Safe Surgery
# For the Patient and For You