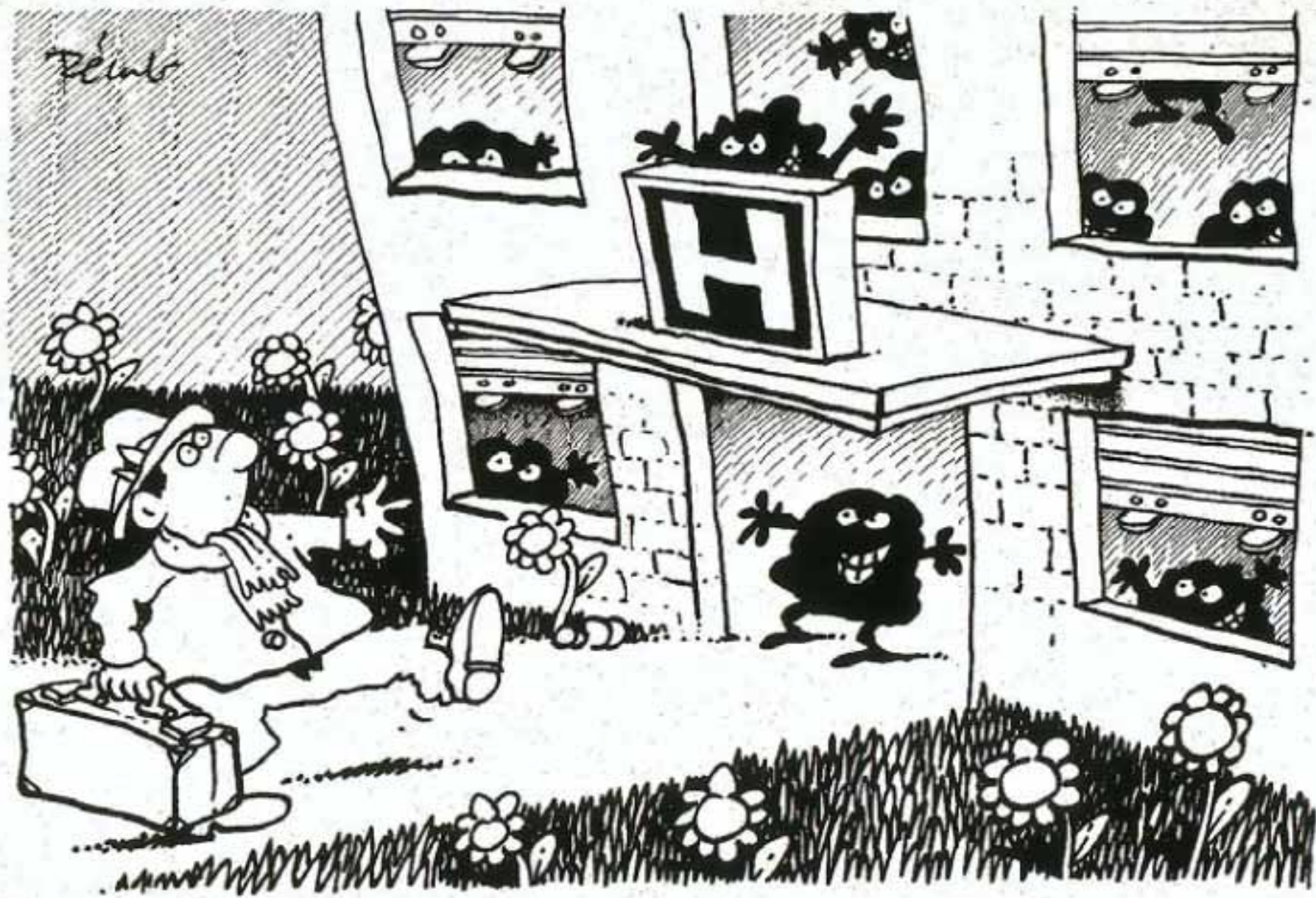


Use of Fluorescence Photography Method in Identifying Risks and Optimum Sequence of Removing Personal Protective Equipment for Infection Control Purpose

Ralph K Y Lee
Occupational Hygienist
Infection Control Branch
Centre for Health Protection
Department of Health
Hong Kong SAR Government





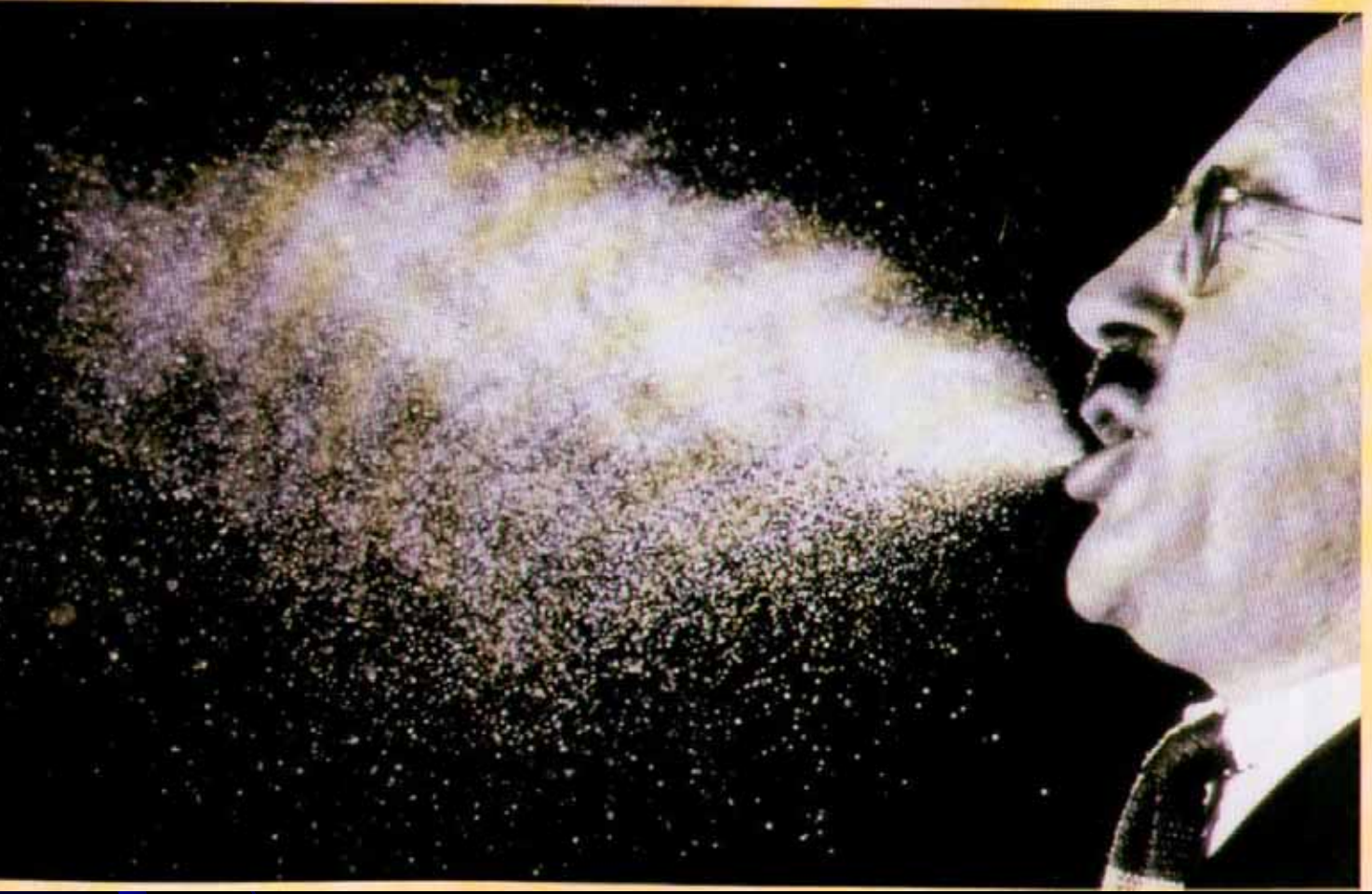


New York

The battle against disease has been helped by understanding the relationships between micro-organisms, humans and other species, and how they are affected by environmental changes.

'Epidemic! The World of Infectious Disease' provides an imaginative, graphic, lively and interactive history of various infections.

Ongoing
at the American
Museum of
Natural History.
Tel 769 5800.



Cumulative Number of Confirmed Human Cases of Avian Influenza A/(H5N1) Reported to WHO

18 March 2008

Country	2003		2004		2005		2006		2007		2008		Total	
	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths
Azerbaijan	0	0	0	0	0	0	8	5	0	0	0	0	8	5
Cambodia	0	0	0	0	4	4	2	2	1	1	0	0	7	7
China	1	1	0	0	8	5	13	8	5	3	3	3	30	20
Djibouti	0	0	0	0	0	0	1	0	0	0	0	0	1	0
Egypt	0	0	0	0	0	0	18	10	25	9	4	1	47	20
Indonesia	0	0	0	0	20	13	55	45	42	37	12	10	129	105
Iraq	0	0	0	0	0	0	3	2	0	0	0	0	3	2
Lao People's Democratic Republic	0	0	0	0	0	0	0	0	2	2	0	0	2	2
Myanmar	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Nigeria	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Pakistan	0	0	0	0	0	0	0	0	1	1	0	0	1	1
Thailand	0	0	17	12	5	2	3	3	0	0	0	0	25	17
Turkey	0	0	0	0	0	0	12	4	0	0	0	0	12	4
Viet Nam	3	3	29	20	61	19	0	0	8	5	5	5	106	52
Total	4	4	46	32	98	43	115	79	86	59	24	19	373	236

Updates from WHO on 28 March 2008

Weekly consultation of influenza-like illness reported by GOPC and GP in 2007 and 2008

Weekly consultation rates of influenza-like illness reported by General Out-patient Clinics (GOPC) and General Practitioners (GP) 2007

For the week ending	Rate (per 1000 consultations)	
	GOPC	GP
6/1	3.2	41.1
13/1	2.8	42.7
20/1	3.9	39.5
27/1	4.3	42.2
3/2	5.2	50.6
10/2	6.5	55.5
17/2	4.2	58.0
24/2	6.5	52.0
3/3	5.6	52.9
10/3	5.2	58.8
17/3	5.5	56.2
24/3	6.7	55.3
31/3	4.0	55.8
7/4	5.2	61.5
14/4	5.6	43.2
21/4	4.5	39.6
28/4	5.7	43.3
5/5	3.5	42.2

Weekly consultation rates of influenza-like illness reported by General Out-patient Clinics (GOPC) and General Practitioners (GP) 2008

For the week ending	Rate (per 1000 consultations)	
	GOPC	GP
5/1	3.7	44.6
12/1	3.5	43.7
19/1	3.7	44.5
26/1	3.8	50.7
2/2	4.4	51.3
9/2	5.4	28.6
16/2	6.6	35.2
23/2	7.0	63.4
1/3	8.9	57.5
8/3	10.1	75.9
15/3	12.3	76.1
22/3	7.0	53.7
29/3		
5/4		
12/4		
19/4		
26/4		
3/5		

Updates from CHP on 28 March 2008



**Exercise Cypress
28 September 06**





Types of PPE Used in Healthcare Settings

- Gloves – protect hands
- Gowns/aprons – protect skin and/or clothing
- Surgical masks and respirators – protect mouth/ nose
- Goggles – protect eyes
- Face shields – protect face, mouth, nose, and eyes
- Optional use:
 - Boots, cap



隔離病房
ISOLATION ROOM



High Risk Procedures

- Bronchoscopy
- Nasal pharyngeal aspiration
- Tracheal tube insertion
- Open circuit suctioning
- Use of nebulizers or puff
- Other cough producing or aerosol generating procedures

Aerosol-Generating Procedures

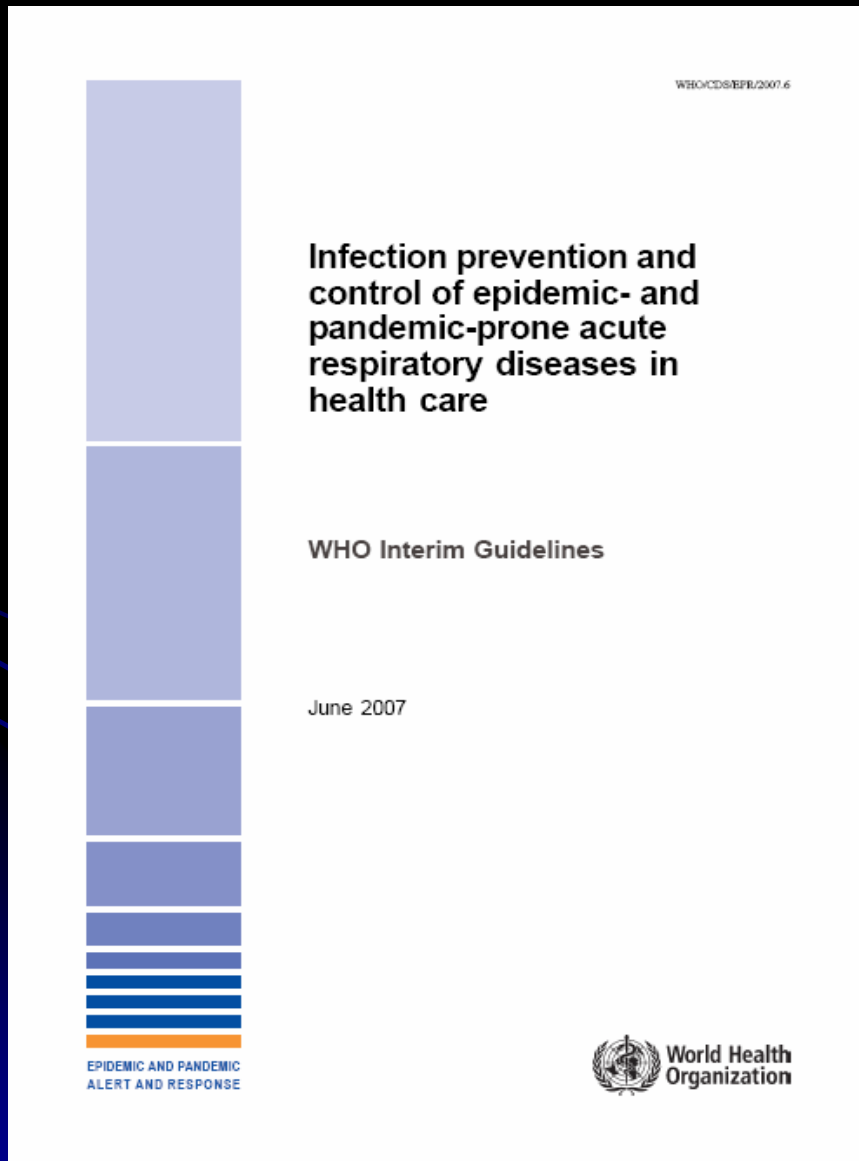


Pandemic Influenza Preparedness and Response Guidance for Healthcare Workers and Healthcare Employers

OSHA 3328-05 2007

- OSHA
 - Endotracheal intubation
 - Aerosolized or nebulized medication administration
 - Sputum induction/collection
 - Bronchoscopy
 - Airway suctioning
 - +ve pressure ventilation via face masks
 - High-frequency oscillatory ventilation

Aerosol-Generating Procedures



- Documented increase in risk of respiratory pathogen transmission
 - Intubation, CPR
 - Bronchoscopy
 - Autopsy / surgery
- Controversial / possible increase in risk of respiratory pathogen transmission
 - Non-invasive +ve pressure ventilation and bilevel +ve airway pressure
 - High-frequency oscillating ventilation
 - Nebulization





Personal Protective Equipment (PPE) Removal

Before LEAVING Negative Air Space

Note: Discard used items in red bag.

STEP 1

Faceshield

Remove and discard.



STEP 2

Headcover

Remove and discard.



STEP 3

Shoe covers

Remove and discard.



STEP 4

Gown & Gloves

Grasp shoulders of gown and pull forward. Roll outside of gown inward, folding contaminated outside layer away from your body.



Remove gloves while rolling gown off arms; roll gloves into gown. Avoid contaminating hands. Keep hands on clean side of gown. Discard gown and gloves.



STEP 5

Hand Hygiene

Clean hands with antimicrobial soap and water or alcohol-based hand rub.



LEAVE Negative Air Space, CLOSE Door

STEP 6

N95 Respirator

Front of respirator is contaminated. Handle only the bands. To remove, pull lower band over the head first, then remove upper band. Discard.



STEP 7

Hand Hygiene

Clean hands with antimicrobial soap and water or alcohol-based hand rub.



Note: If Powered Air Purifying Respirator (PAPR) is used, follow facility procedures for applying, removing, and processing equipment. PAPR or tight-fitting goggles should be worn for high-risk aerosol-generating procedures.

SEQUENCE FOR REMOVING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Except for respirator, remove PPE at doorway or in anteroom. Remove respirator after leaving patient room and closing door.

1. GLOVES

- Outside of gloves is contaminated!
- Grasp outside of glove with opposite gloved hand; peel off
- Hold removed glove in gloved hand
- Slide fingers of ungloved hand under remaining glove at wrist
- Peel glove off over first glove
- Discard gloves in waste container



2. GOGGLES OR FACE SHIELD

- Outside of goggles or face shield is contaminated!
- To remove, handle by head band or ear pieces
- Place in designated receptacle for reprocessing or in waste container



3. GOWN

- Gown front and sleeves are contaminated!
- Unfasten ties
- Pull away from neck and shoulders, touching inside of gown only
- Turn gown inside out
- Fold or roll into a bundle and discard



4. MASK OR RESPIRATOR

- Front of mask/respirator is contaminated — DO NOT TOUCH!
- Grasp bottom, then top ties or elastics and remove
- Discard in waste container



SECUENCIA PARA QUITARSE EL EQUIPO DE PROTECCIÓN PERSONAL (PPE)

Con la excepción del respirador, quítese el PPE en la entrada de la puerta o en la antesala. Quítese el respirador después de salir de la habitación del paciente y de cerrar la puerta.

1. GUANTES

- ¡El exterior de los guantes está contaminado!
- Agarre la parte exterior del guante con la mano opuesta en la que todavía tiene puesto el guante y quíteselo
- Sostenga el guante que se quitó con la mano enguantada
- Deslice los dedos de la mano sin guante por debajo del otro guante que no se ha quitado todavía a la altura de la muñeca
- Quítese el guante de manera que acabe cubriendo el primer guante
- Arroje los guantes en el recipiente de desechos

2. GAFAS PROTECTORAS O CARETA

- ¡El exterior de las gafas protectoras o de la careta está contaminado!
- Para quitárselas, tómelas por la parte de la banda de la cabeza o de las piezas de las orejas
- Colóquelas en el recipiente designado para reprocesar materiales o de materiales de deshecho

3. BATA

- ¡la parte delantera de la bata y las mangas están contaminadas!
- Desate los cordones
- Tocando solamente el interior de la bata, pásela por encima del cuello y de los hombros
- Voltee la bata al revés
- Dóblela o enróllela y deséchela

4. MÁSCARA O RESPIRADOR

- La parte delantera de la máscara o respirador está contaminada — ¡NO LA TOQUE!
- Primero agarre la parte de abajo, luego los cordones o banda elástica de arriba y por último quítese la máscara o respirador
- Arrójela en el recipiente de desechos

PERFORM HAND HYGIENE IMMEDIATELY AFTER REMOVING ALL PPE

EFFECTÚE LA HIGIENE DE LAS MANOS INMEDIATAMENTE DESPUÉS DE QUITARSE CUALQUIER EQUIPO DE PROTECCIÓN PERSONAL

Order for Removing PPE

- Upon leaving the room, HHS/CDC recommends that PPE be removed in a way to avoid self-contaminations, as follows:
 - Gloves
 - Faceshield or goggles
 - Gown
 - Respirator or mask

(OSHA, 2007)

Order for Removing PPE



- 1
- Avoid contamination of self, others & the environment
 - Remove the most heavily contaminated items first

Remove gloves & gown:
- peel off gown & gloves and roll inside, out
- dispose gloves and gown safely



- 2 **Perform hand hygiene**



- 3
- Remove cap (if worn)
 - Remove goggles from behind
 - Put goggles in a separate container for reprocessing



- 4 Remove respirator from behind



- 5 **Perform hand hygiene**

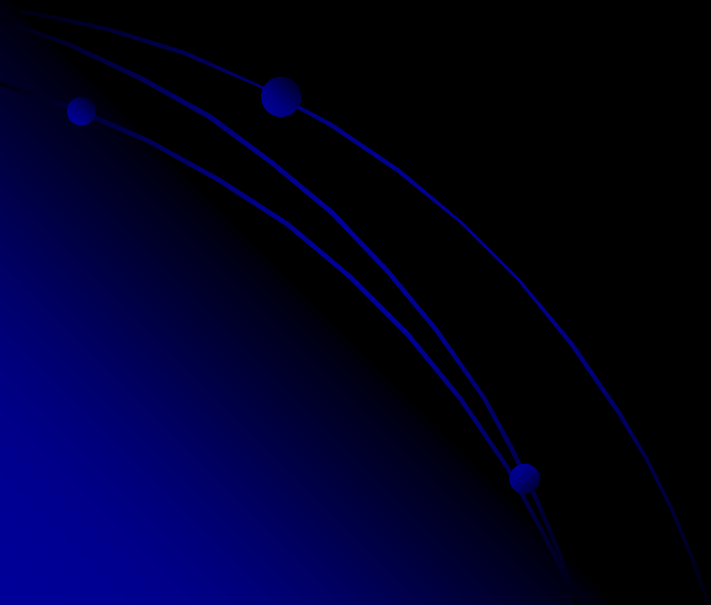
1. Remove and dispose gloves & gown
2. Hand Hygiene
3. Remove and dispose cap (if worn)
4. Remove goggles
5. Remove respirator
6. Hand hygiene

(WHO, 2007)

Local Recommendations by CHP



Methods



Fluorescent Dye

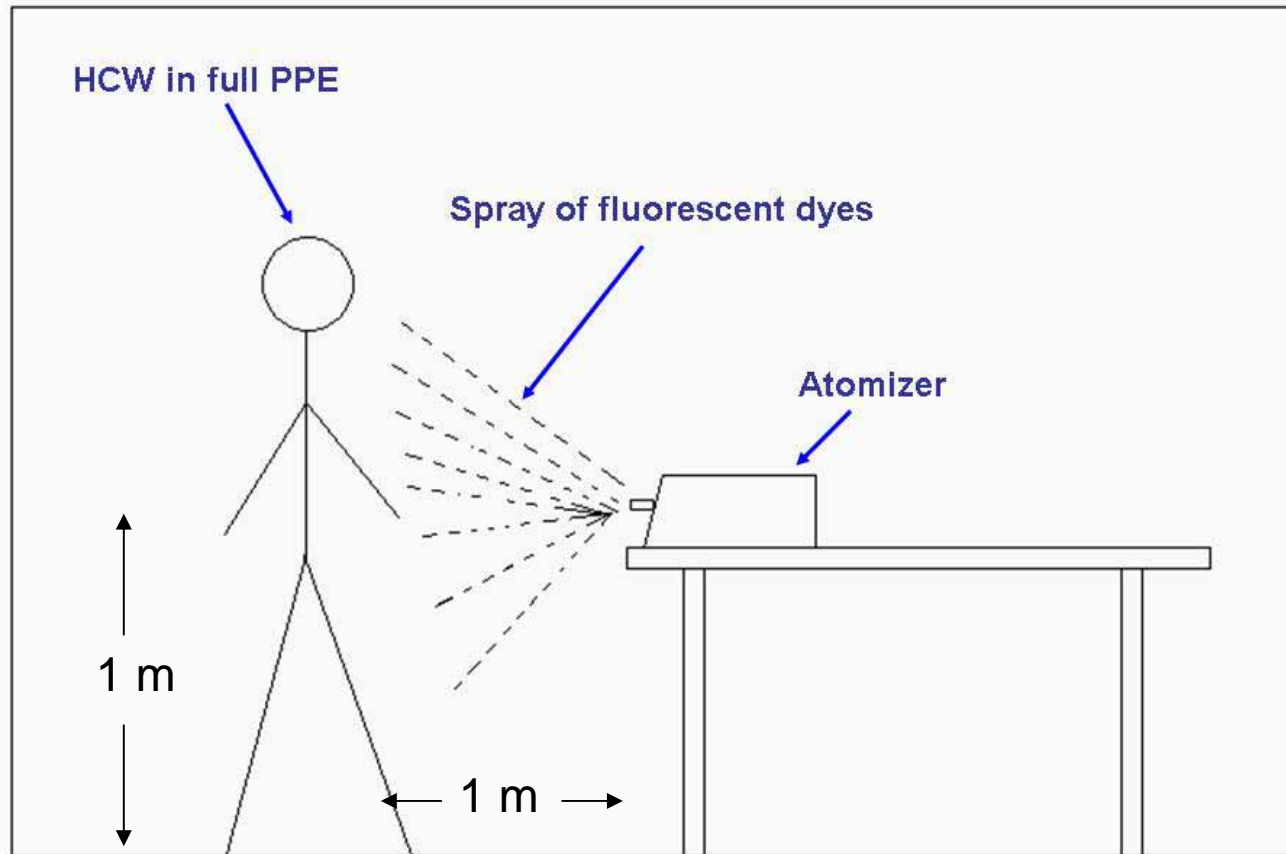


Fluorescein sodium:
113.2 mg/mL

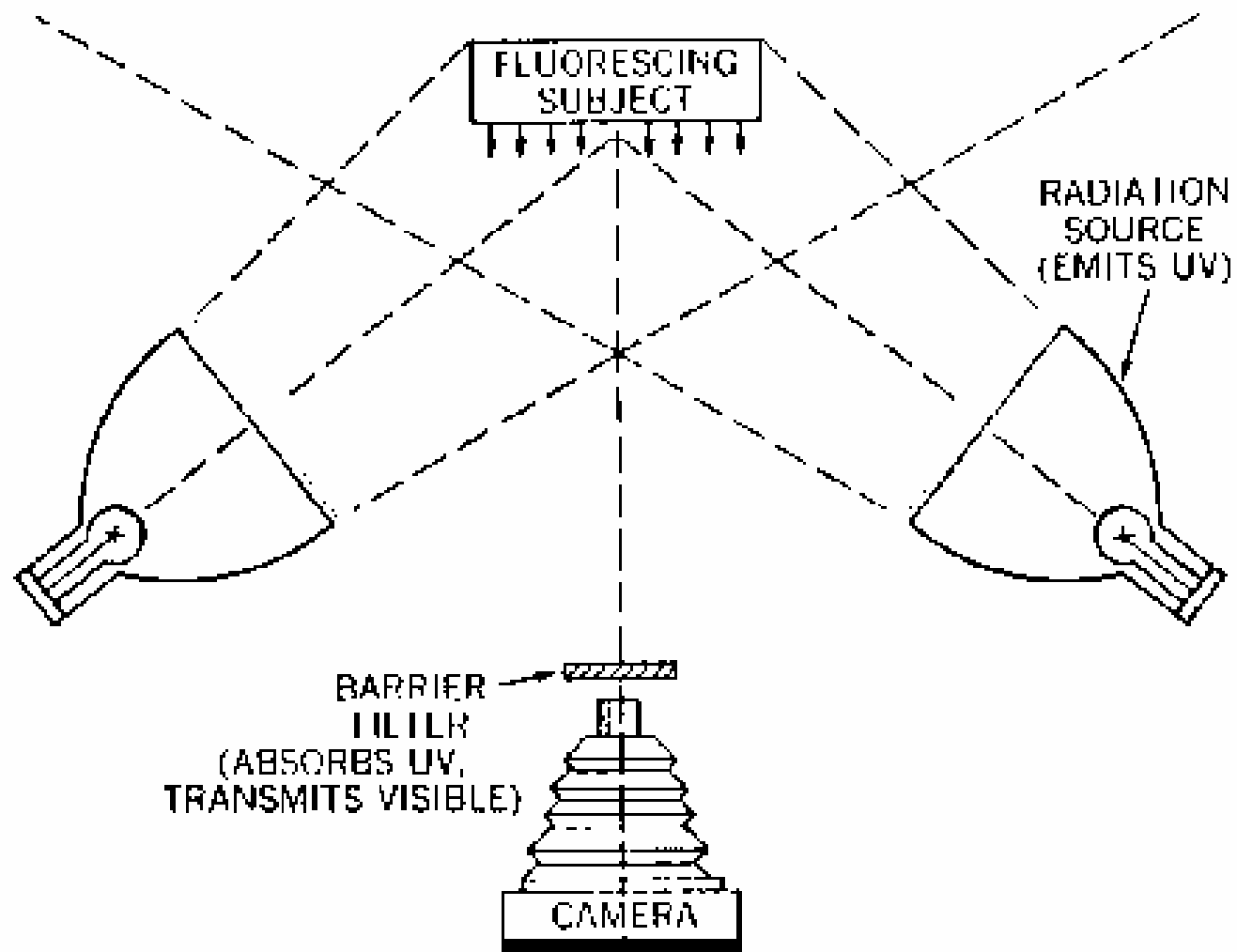


Dilution of 10% Fluorescein sodium: 1 in 500

Fluorescent Spraying



FLUORESCENCE PHOTOGRAPHY



MeterJet™ Spray Gun



Adjustment for volume of each spray



MeterJet Spray Gun Connected to a Pressure Tank

Whole Set Up





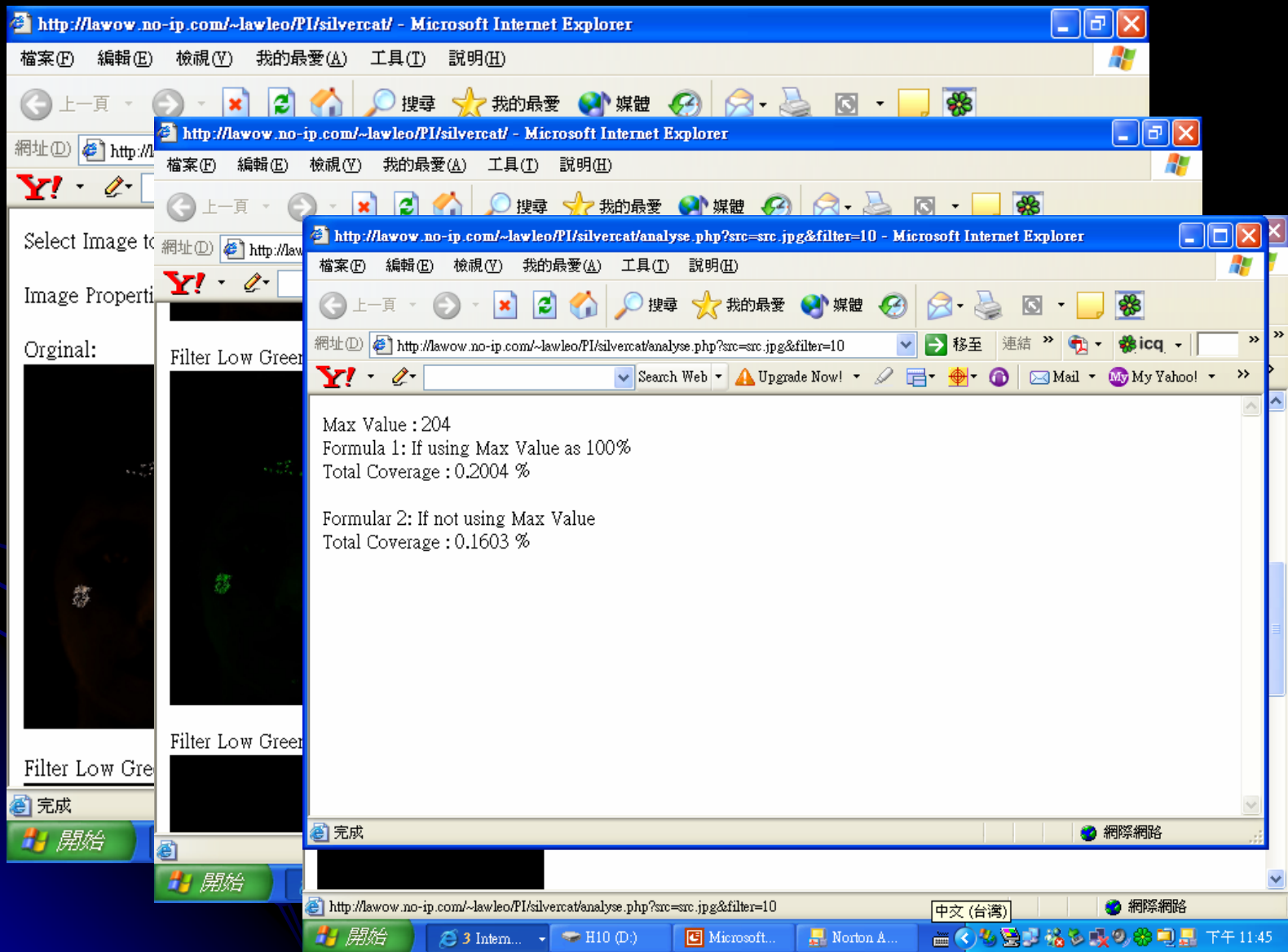
Volume: 2 mL
Pressure applied: 75 psi

Photographic parameters



Camera: Nikon D200 DSLR
Lens: Nikon ED 28-70 1:2.8D
Shutter Speed: 1.3s
Aperture: f/2.8
ISO Value: 1600
White Balance: 6000K
UV Filter

Image Analyzing Applications



Baseline



Total Coverage : 0.0000%

Methods

- 10 Subjects recruited assuming the effect size was 1.25 and the power was 0.746
- Fluorescent dye sprayed
- Sequence A (glove>gown>cap>face shield>goggle>respirator)
- Sequence B (face shield>goggle>cap>gown+glove>respirator)
- Remove full-gear PPE four times
 - Sequence A (nice and slowly – 3 minutes)
 - Sequence A (roughly – 1 minute)
 - Sequence B (nice and slowly – 3 minutes)
 - Sequence B (roughly – 1 minute)
- Fluorescence photos taken under UV lights



Nikon D200 DSLR Camera + Nikon ED 28-70 1:2.8D
Shutter Speed: 1/60s; Aperture: f/2.8; ISO Value: 1600 White Balance: auto -3



Fluorescent dyes: 3 strokes applied to head, chest and trunk from 3 feet
Shutter Speed: 1.3s; Aperture: f/2.8; ISO Value: 1600 White Balance: auto -3



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Nice and
slow (3 minutes)

Total Coverage : 0.1528 %



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Roughly (1
minute)

Total Coverage : 0.1612 %



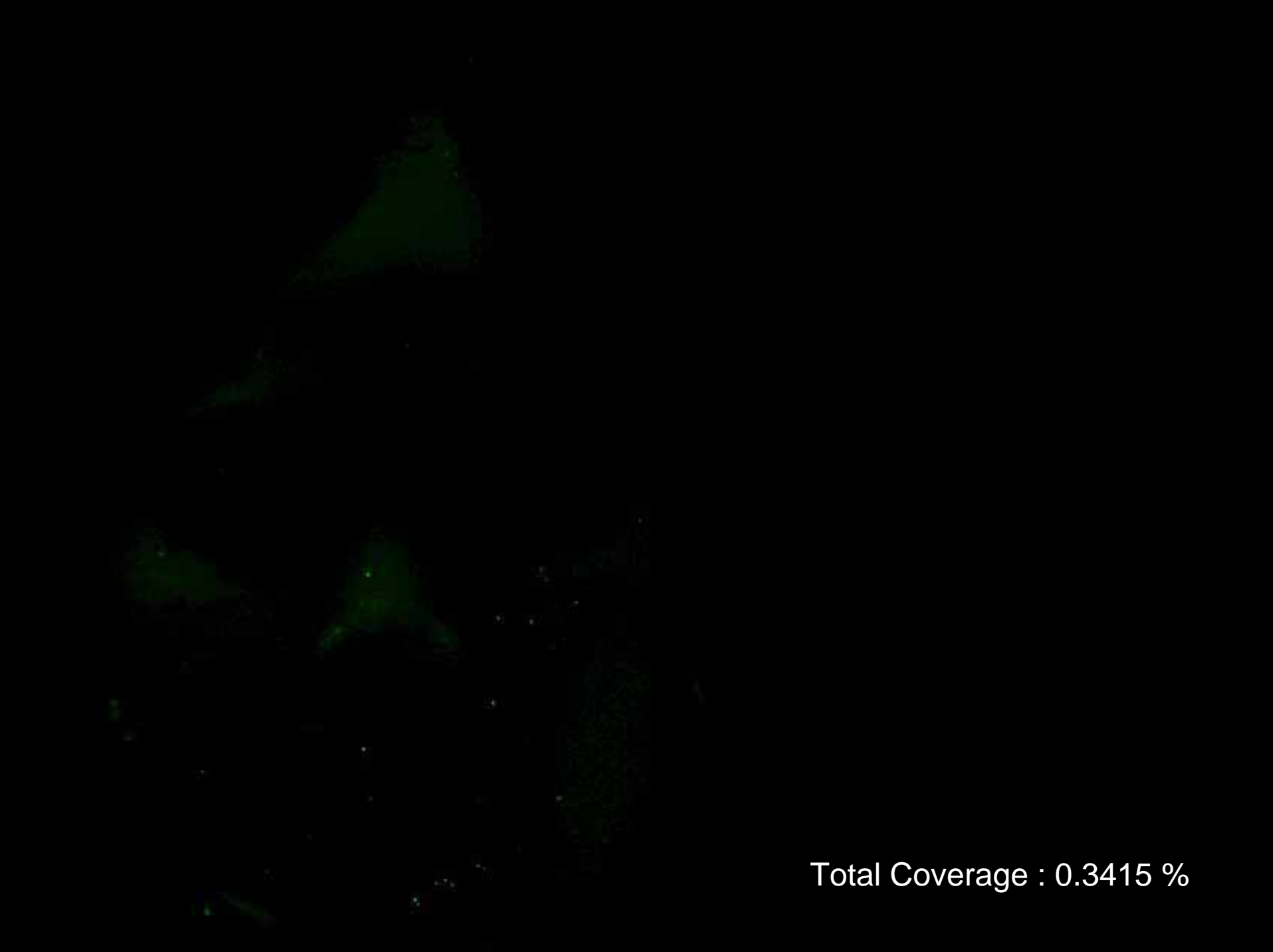
Degowning sequence: (B) face
shield>Goggles>cap>gown and
gloves>respirator
Time consumed: Nice and slow
(3 minutes)



Total Coverage : 0.1875 %



Degowning sequence: (B) face shield>Goggles>cap>gown and gloves>respirator
Time consumed: Roughly (1 minute)



Total Coverage : 0.3415 %



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Nice and
slow (3 minutes)



Total Coverage : 0.0343 %



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Roughly (1
minute)



Total Coverage : 0.0551 %



Degowning sequence: (B) face
shield>Goggles>cap>gown and
gloves>respirator
Time consumed: Nice and slow
(3 minutes)



Total Coverage : 0.5492 %



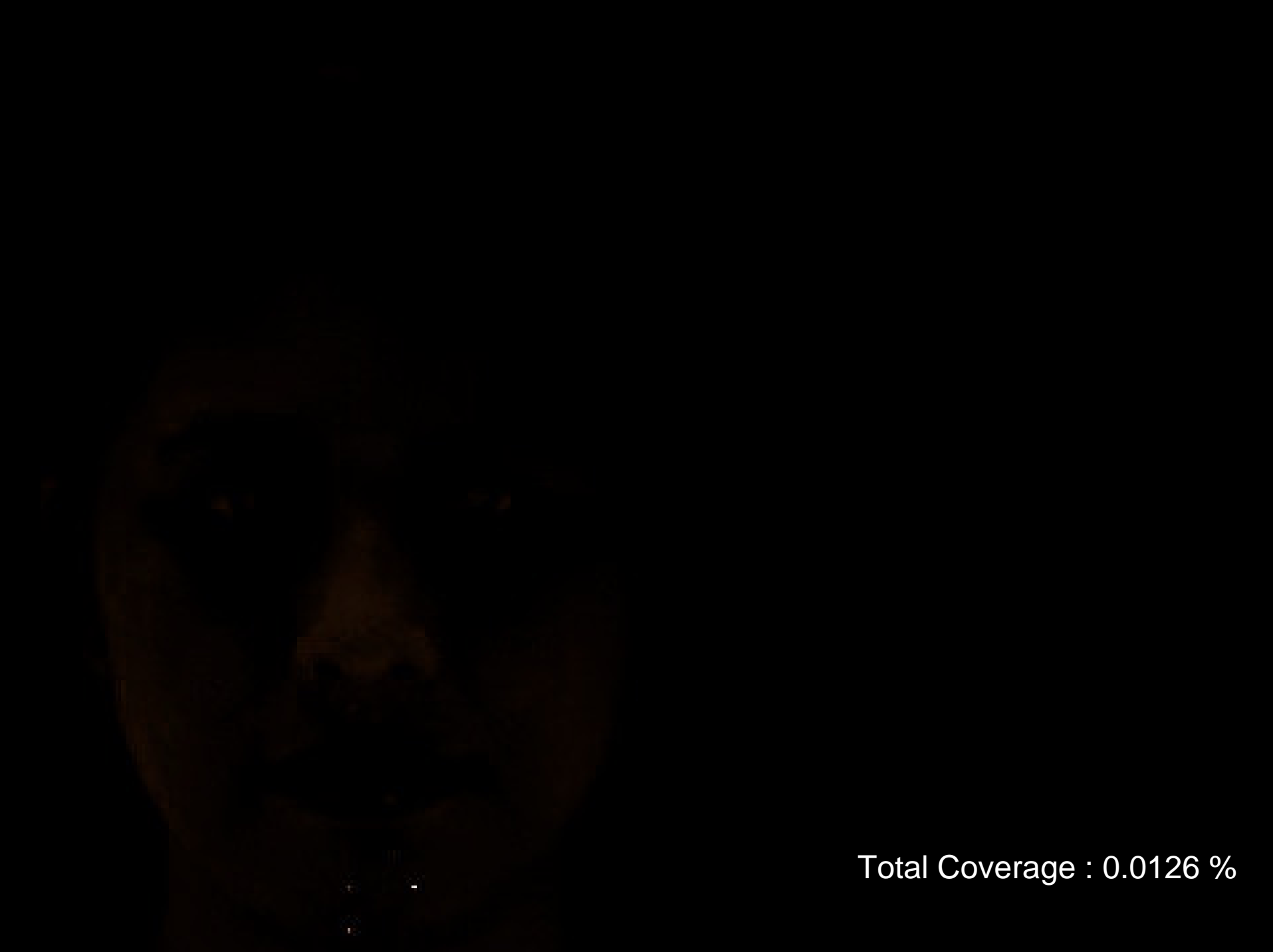
Degowning sequence: (B) face
shield>Goggles>cap>gown and
gloves>respirator
Time consumed: Roughly (1
minute)



Total Coverage : 0.6198 %



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Nice and
slow (3 minutes)



Total Coverage : 0.0126 %



Degowning sequence: (A)
glove>gown>cap>face
shield>goggles>respirator
Time consumed: Roughly (1
minute)

Total Coverage : 0.0211 %



Degowning sequence: (B) face
shield>Goggles>cap>gown and
gloves>respirator
Time consumed: Nice and slow
(3 minutes)



Total Coverage : 0.0281 %



Degowning sequence: (B) face
shield>Goggles>cap>gown and
gloves>respirator
Time consumed: Roughly (1
minute)

Total Coverage : 0.4137 %

Experimental Design

- 2x2 factorial design with repeated measures
- 2x2
 - 2 factors, each with 2 levels
- Factorial design
 - Evaluate effects of 2 independent variables in one experiment
- Repeated measures
 - Same subjects participate in all conditions of an experiment

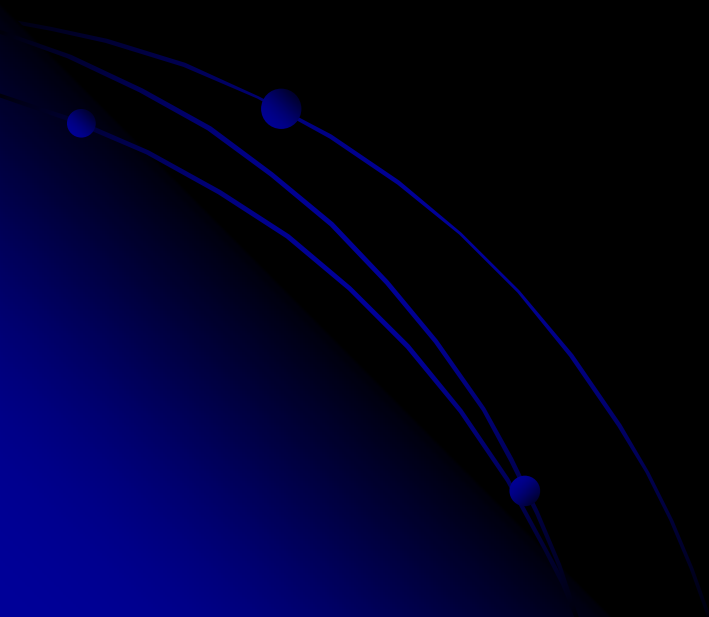
Correlation between sequences, carelessness of PPE removal and percentage of exposures on face

	Carelessness	
	Nice and Slow	Roughly

Removal Sequence (A)	0.1528%	0.1612%
Removal Sequence (B)	0.1875%	0.3415%

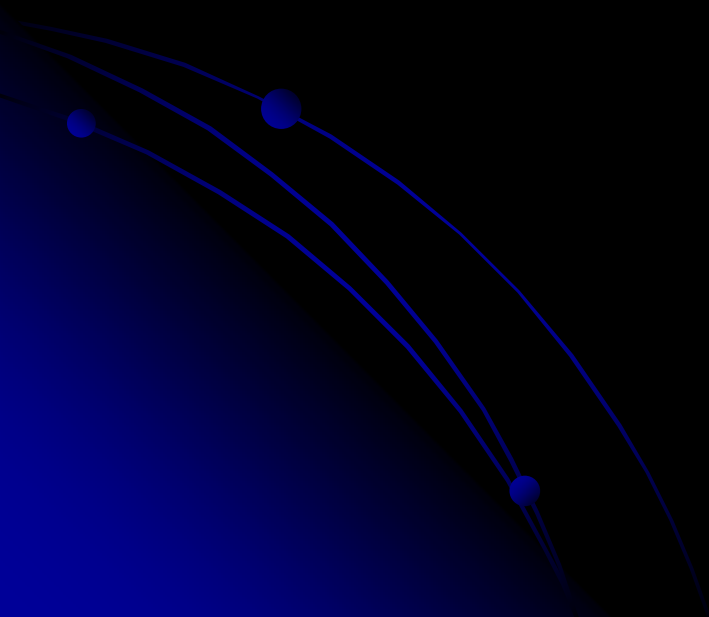
Statistical Analysis

- Repeated measures ANOVA

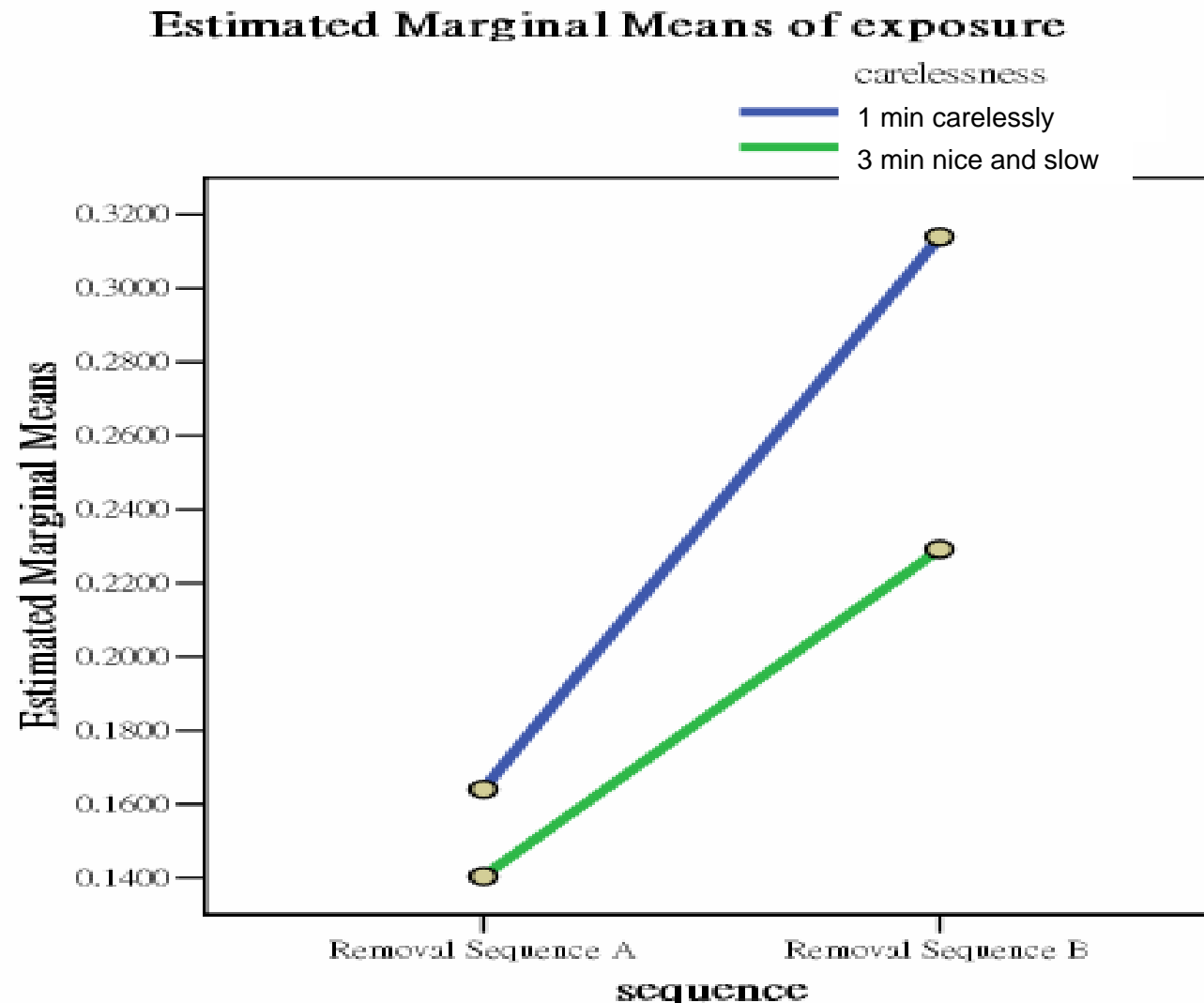


Diagnostics

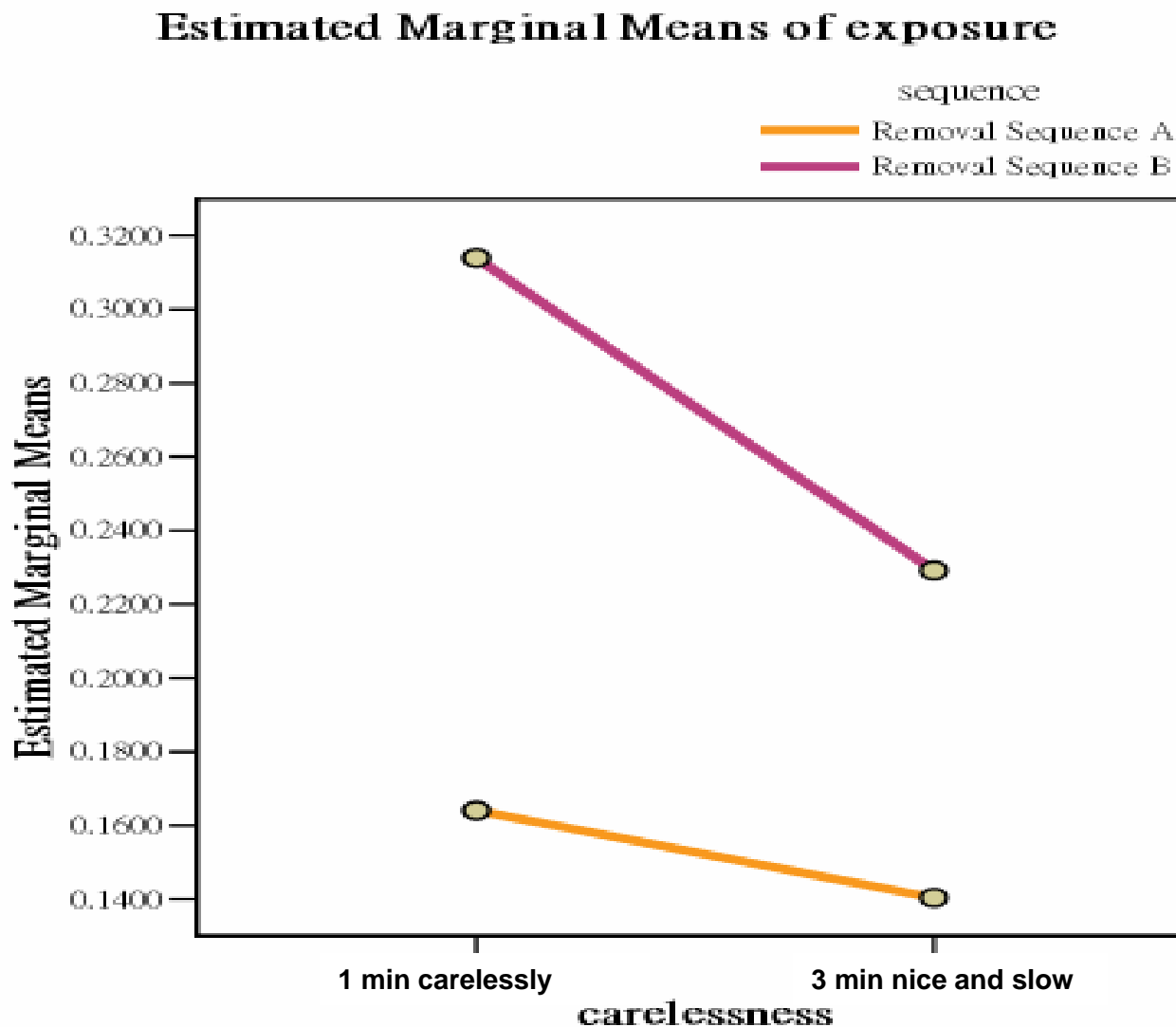
- Sphericity (circularity)
 - Mauchly's test
 - Constant variances of differences between any two measurements within a subject



Results



Results



Results

- Main effects
 - Sequence: $p\text{-value}=0.0031^*$
 - Carelessness: $p\text{-value}=0.0070^*$
- Interaction effect
 - Sequence*Carelessness: $p\text{-value}=0.1168$

Conclusion

- Use of gloved hands in removing face shield and goggle causes substantial contamination on face and especially on forehead.
- When the cap was put outside of both face and eye protection, less forehead contamination was noted.
- Early removal of eye protection and potential aerosolization of dyes while removing the gown
- It makes difference when removing PPE carefully.
- Removing PPE carefully in sequence A incur less self facial contamination.

Acknowledgements

- Thanks to SEPO of HKUST
- Thanks those who sacrificed their beautiful faces to make this experiment successful!

THANK YOU



Ralph K Y Lee
Centre for Health Protection
Department of Health
Hong Kong SAR Government
Email: oh_icb@dh.gov.hk

