
*Infection Control Related to
Laboratory Safety*

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Certificate Course in
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Classification of risk groups

	Group 1	Group 2	Group 3	Group 4
Pathogenicity	Low	Moderate	High	High
Infectiousness	Low	Low	Low	High
Treatment and prevention	A/V	A/V	A/V	Not A/V
Examples		Most agents in diagnostic laboratory	MTB, SARS CoV, HPAI	Viral haemorrhagic fever, smallpox

Classification of biosafety level

BSL	Agents
1	Not known to consistently cause disease in healthy adults
2	Associated with human disease, hazard from percutaneous injury, ingestion, mucous membrane exposure
3	Indigenous or exotic agents with potential aerosol transmission; may have serious or lethal consequences
4	Dangerous/exotic agents with high risk of life-threatening disease, aerosol-transmitted infections; or related agents with unknown risk of transmission

Risk groups, biosafety levels, practices & equipment

BSL	Laboratory type	Laboratory practices	Safety equipment
1	Basic teaching, research	Good microbiological techniques	None Open bench work
2	Primary health services; diagnostic services, research	Good microbiological techniques, protective clothing, biohazard sign	Open bench PLUS biological safety cabinet for potential aerosols
3	Special diagnostic services, research	As BSL 2 PLUS special clothing, controlled access, directional airflow	Biological safety cabinet and/or other primary devices for all activities
4	Dangerous pathogen units	As BSL 3 PLUS airlock entry, shower exit, special waste	Class III biological safety cabinet, positive pressure suits, double ended autoclave (through the wall), filtered air

Source: WHO

遇到下列情況，必須遵守

標準防護措施

Standard Precautions

must be taken in the following situations

接觸血液、體液、分泌物、
排泄物、黏膜或傷口

必須戴上手套



Wear Gloves

when handling blood,
body fluids, secretions,
excretions, mucous
membrane or
non-intact skin

若有可能接觸濺出
血液或體液

必須戴上

口罩、眼罩

及穿上保護衣



**Wear a Mask,
Protective Eyewear
and a Gown**

to protect yourself
from splashed
blood or body fluids

**切勿套回
已使用的針咀**



No Recapping

**小心處理
針咀及利器**



**Handle Sharps
Carefully**

接觸血液、體液、
分泌物、排泄物、
黏膜、傷口、
或除下手套後

應立即潔手



**Perform
Hand Hygiene
Immediately**

after taking off gloves or
handling blood, body
fluids, secretions,
excretions, mucous
membrane or non-intact skin



醫院
HOSPITAL

Standard lab practices

- Restrict access to lab
 - No eating, drinking, smoking, application of cosmetics & handling contact lenses in work areas
 - No sandals or open-toed footwear in lab work areas
 - Long hair must be tied back off the face
 - Hand washing
 - Decontaminate work surface & equipment after use
 - Use mechanical pipetting devices
 - Minimize splashes and aerosols
 - Proper decontaminate of lab wastes
-

Protective clothing in lab area (1)

- Lab gown (solid front or wrap around gowns with cuffed sleeves) should be worn for performing lab activities
 - Other PPE are worn according to risk of aerosol generation and exposure when performing specific manipulation
 - PPEs should not be worn in non-laboratory areas
 - Remove PPE and wash hands after use
-

Protective clothing in lab area (2)

- **Disposable gloves**

- For procedures with direct or accidental contact with blood, body fluids and other potentially infectious materials
- No gloves for non-lab tasks, e.g. computer data entry, using phones, photocopying machine, fax machine

- **Eye/face protection**

- E.g. visors, surgical mask, face shields, goggles
 - For activities likely to generate splashes or sprays
-

Surgical masks/ N95 Respirators

- Choice of mask and respirator depends on the type of hazard
 - Wear surgical mask if droplet exposure is likely
 - N95 respirators
 - For aerosol generating procedures e.g. cleaning up spillage of infectious materials
 - Should choose the right size and perform fit check before each use
-

Use of surgical mask



Use of N95 respirator

1



2



3



4



5



6



Donning and removal of PPEs

穿戴個人保護裝備要領次序

Put on Personal Protective Equipment (PPE) Step by Step

1  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

2  **除外科**
口罩
Remove
Surgical Mask

3  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

若外科口罩需清洗，步驟1-3可變。
Step 1-3 can be modified if surgical mask is reusable. (to change)

4  **戴 N95 口罩**
或
外科口罩
Put on N95 Respirator
or Surgical Mask

5  **戴帽**
Put on Cap

6  **戴護目裝備**
Put on Eye Protection

7  **穿保護衣**
Put on Gown

8  **戴手套**
Put on Gloves

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卸除個人保護裝備要領次序

Remove Personal Protective Equipment (PPE) Step by Step

1  **除手套**
Remove Gloves

2  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

3  **除保護衣**
Remove Gown

4  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

5  **除護目裝備**
Remove Eye Protection

* 選擇性 Optional

6  **除帽**
Remove Cap

7  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

8  **除 N95 口罩**
或
外科口罩
Remove N95 Respirator
or Surgical Mask

9  **洗手或**
用酒精擦劑擦手
(若手部無可見污漬)
Wash Hands or
Use alcohol hand rub
(if no visible soiled hand)

10  **戴新**
外科口罩
Put on **NEW** Surgical Mask

* 選擇性 Optional

注意：手套、保護衣、面罩、口罩，均須於卸除後妥善存放於指定位置。
NB: Goggles, gown, cap, face shield must be stored in specified location after use.

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Removal of PPEs

- Perform at designated areas
- Do not gown down together in close proximity to another person
- Avoid touching the outer surface
- Wash hands after removal of PPEs
- Items should be properly disinfected before reuse

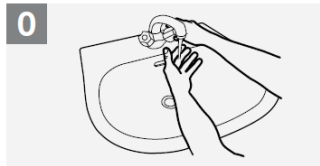


Hand washing

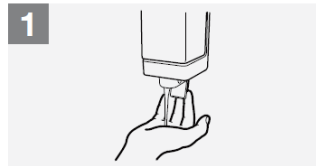


- After handling infectious materials, when contaminated, after removal of gloves, before leaving laboratory
- How?
 - Wet hands with water, apply antimicrobial soap, rub hands together for at least 20 seconds
 - Rinse and dry with paper towel

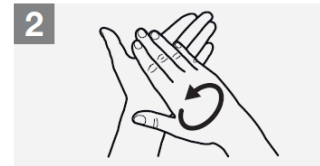
How to wash your hands??



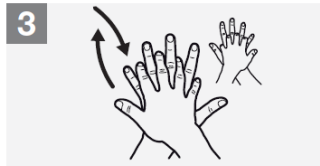
0 Wet hands with water;



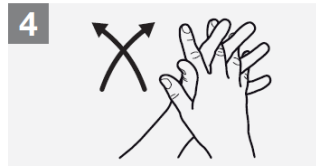
1 Apply enough soap to cover all hand surfaces;



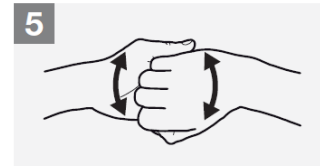
2 Rub hands palm to palm;



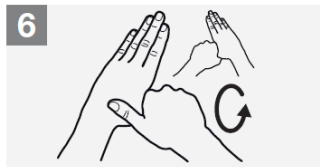
3 Right palm over left dorsum with interlaced fingers and vice versa;



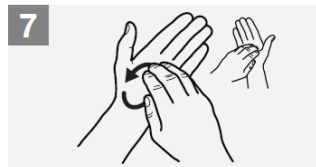
4 Palm to palm with fingers interlaced;



5 Backs of fingers to opposing palms with fingers interlocked;



6 Rotational rubbing of left thumb clasped in right palm and vice versa;



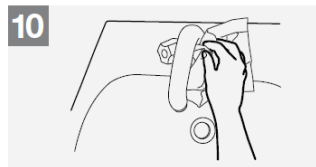
7 Rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa;



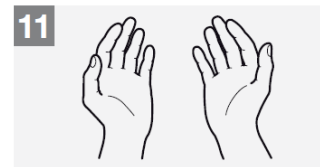
8 Rinse hands with water;



9 Dry hands thoroughly with a single use towel;



10 Use towel to turn off faucet;



11 Your hands are now safe.



World Health
Organization

Patient Safety

A World Alliance for Safer Health Care

SAVE LIVES
Clean Your Hands

The image shows two hands, palms facing forward, against a dark background. The hands are illuminated with a bright, glowing yellow light that highlights specific areas: the tips of the fingers, the web spaces between the fingers, and the central palm. This glowing effect is used to identify areas that are commonly overlooked during handwashing. A white rectangular box with blue text is overlaid at the bottom center of the image.

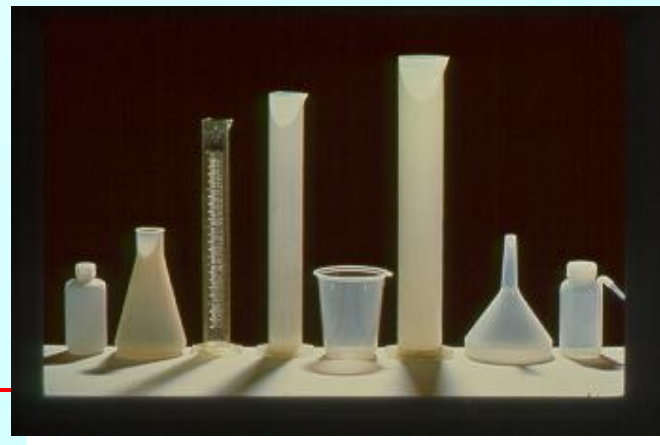
**Easily missed areas
during hand hygiene**

Risks of transmission after exposure to certain bloodborne pathogens

- Hep B (needle stick / cut) 6 - 30 %
 - Hep C (needle stick / cut) 1.8 %
 - HIV (needle stick / cut) 0.3 %
 - HIV (mucous membrane) 0.09 %
-

Sharps precautions

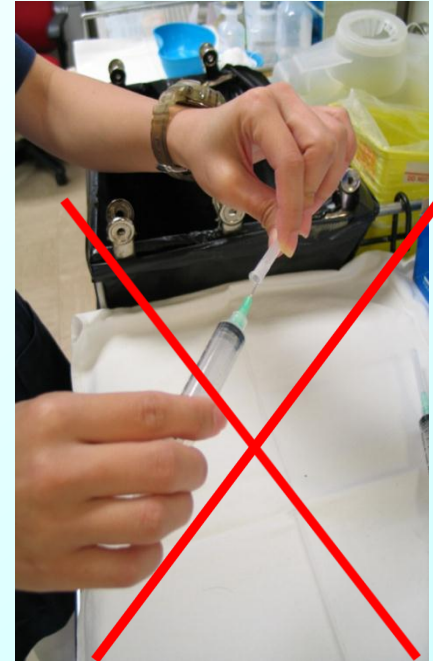
- **DON'T** touch broken glass with hands
- **DON'T** use plastic ware



Sharps precautions

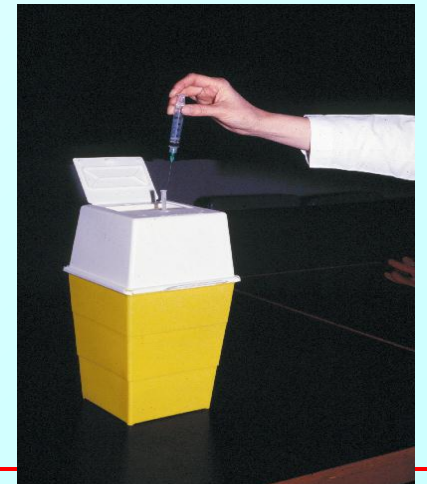
DON'T

Break, bend, recap or reuse syringes or needles



DO

Use sharps containers



Seal the sharps box when $\frac{3}{4}$ full. Place in red bag and tag with “Biohazard labeling”



Post-exposure management

- ❑ Rinse wound or exposed skin/ mucous membrane with copious water
- ❑ Wound dressing
- ❑ Report to in-charge personnel
- ❑ Seek advice from AED



Aerosols produced by blowing out the last drop in a pipette



Minimize aerosol generation

Use of pipettes

- No mouth pipetting
 - Avoid mixing by alternate suction and expulsion
 - Mark-to-mark pipettes preferable to avoid expulsion of the last drop
 - Submerge contaminated pipettes completely overnight in disinfectant before disposal
 - Consider pipettes with cotton plugs or aerosol-barrier pipette as appropriate
-

Minimize aerosol generation

■ Centrifuge

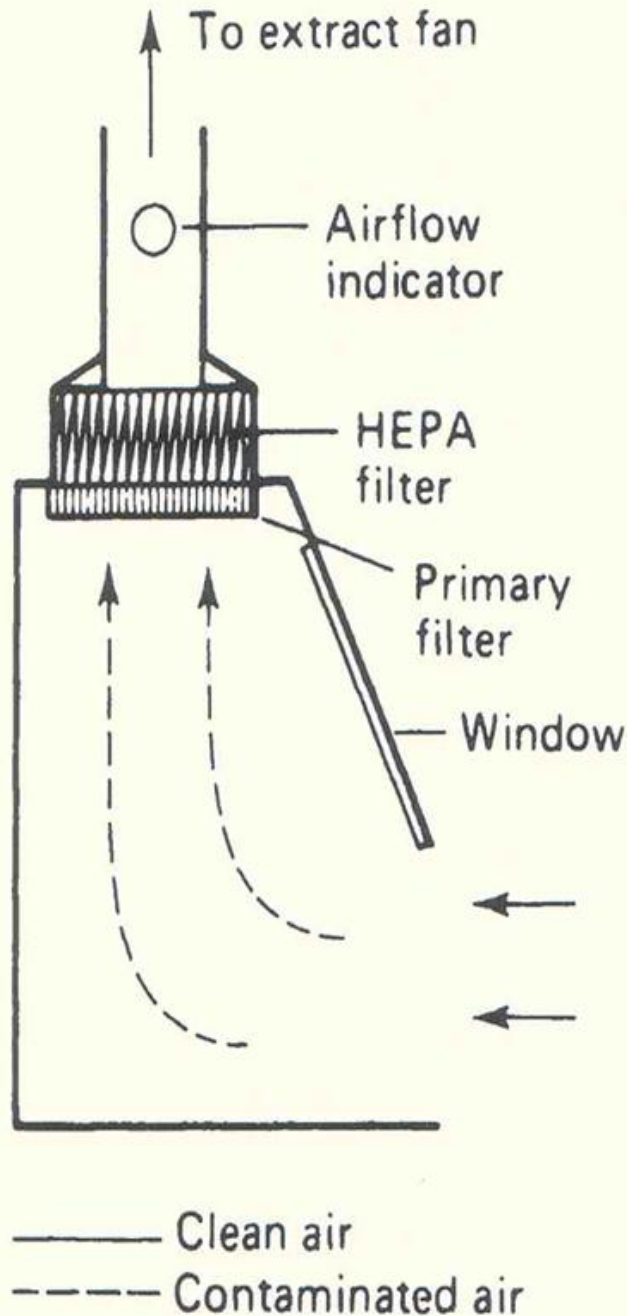
Use sealable buckets

Open buckets after aerosols have settled (30min) or in safety cabinet

■ Tissue grinders, homogenizer

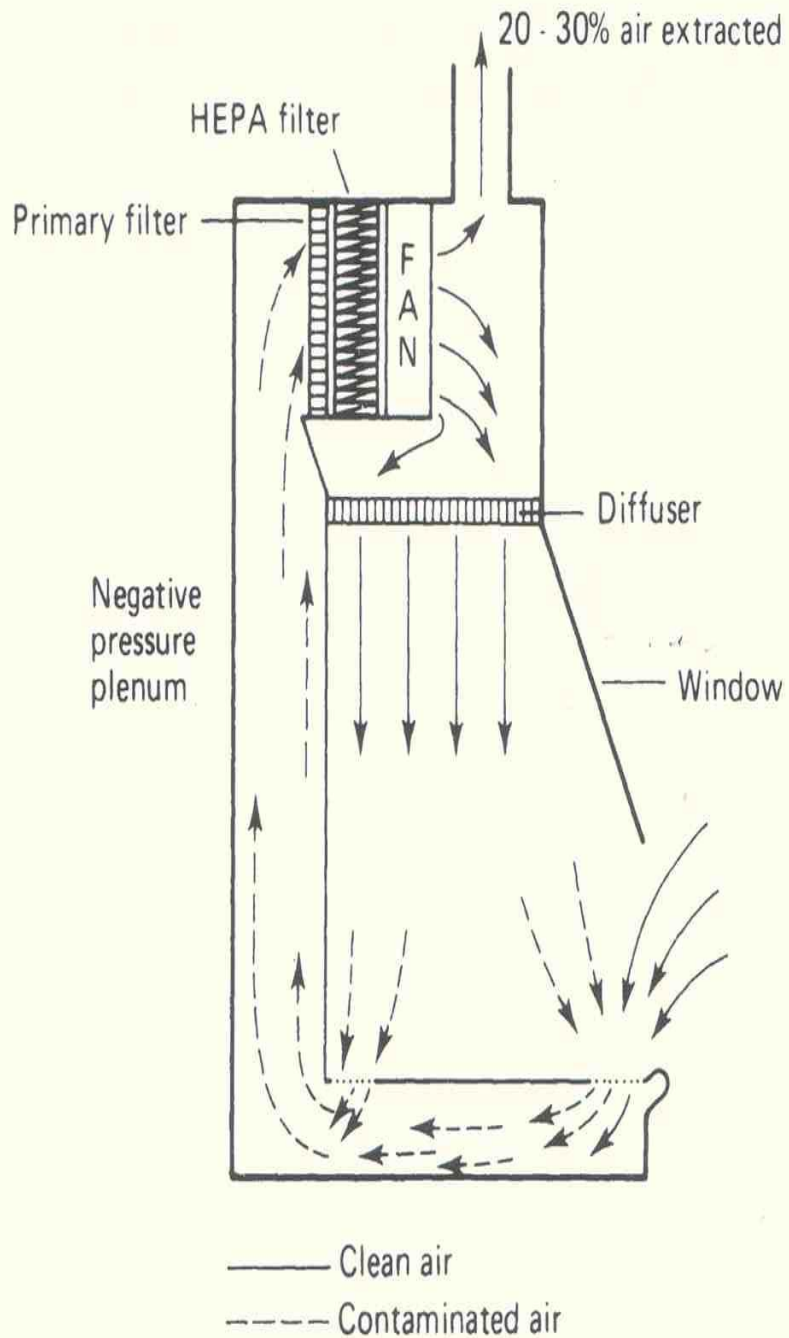
■ Opening ampoules of freeze-dried material

- Wrap the ampoule in alcohol-soaked cotton wool before breaking, in safety cabinet
-



Class I BSC

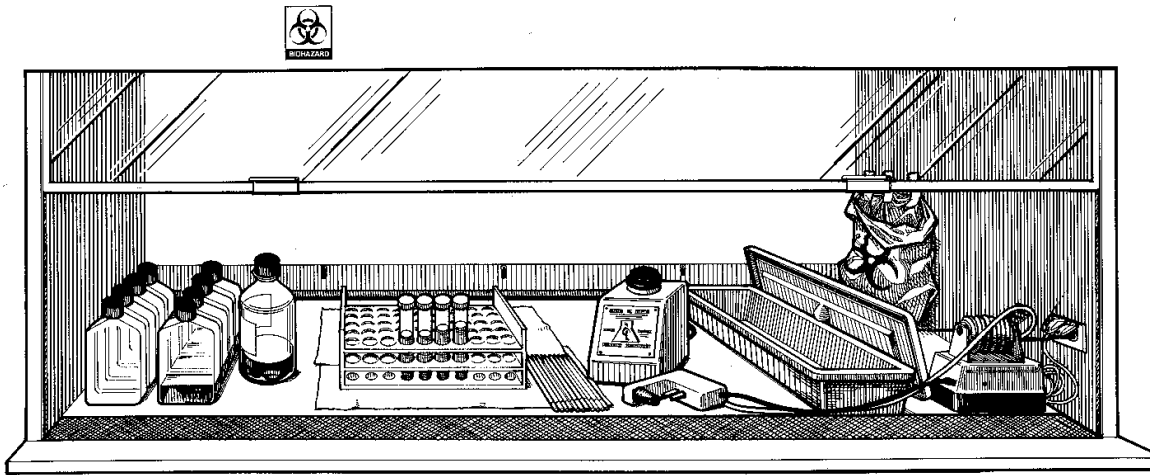
- “Fume hood + HEPA-filtered exhaust”
- Protect staff, not specimens



Class II BSC

- Unidirectional downward flow of filtered air
- Protect staff & specimens
- Use for work with infectious agents involving:
 - Aerosols and splashes
 - Large volumes
 - High concentrations

Class II Biological Safety Cabinets



Layout & technique



Use of Biological safety cabinets

- Minimal apparatus and materials
 - Work carried out in the middle or rear part of the working surface, not on front grill
 - Place discard jar within cabinet
 - Avoid disruptions of laminar air flow
 - No Bunsen frame inside
 - distort air flow, damage filters
 - use disposable transfer loops or micro-incinerator
 - Decontaminate materials before removal from cabinet
-

Use of biological safety cabinets

- **Position of operator**
 - See through the viewing screen, not under it
 - Reach all area without contortions
 - **Minimise traffic behind the operator**
 - **Check airflow – anemometer / built-in device**
 - **Allow to run for 10-15 min before shut off**
 - **Regular service and maintenance**
-

Decontamination of BSC

- ❑ Wipe surface with appropriate disinfectant after work and at the end of the day
- ❑ Avoid metal corrosive agents, e.g. chlorine-based materials

Fumigation

- At regular interval before maintenance, filter changing/testing
 - After major contamination
-

醫療廢物 Clinical Waste

- 利器盒 Sharps boxes
- 滴血及凝有血塊的敷料
Dressing and other waste dribbling caked with blood

未經滅菌化驗室病菌的培養基
Unsterilized cultures & stocks from laboratory

具傳染性物料, 如伊波拉病毒、沙士病毒

Infectious materials, eg. Ebola virus, SARS

人體和動物組織及器官胎盤、斷肢及動物屍體

Human and Animal Tissues, Organs and body parts

一般廢物 Municipal waste

醫療廢物分類及處置 Segregation and Disposal of Clinical Waste

紅袋 盛載的 醫療廢物 RED BAGS for Clinical Waste



- Sharp boxes (containing used or contaminated sharps including syringes)
利器收集箱 (內載經使用或受污染利器包括針筒)
- Unsterilized cultures or stock from laboratory
未經滅菌的化驗室病菌培養基或儲用培養基
- Infectious Materials e.g. Ebola virus, Severe Acute Respiratory Syndrome Coronavirus, and other contaminated materials assessed to be of significant infectious risk by health care personnel
具傳染性物料, 如伊波拉病毒、嚴重急性呼吸系統綜合症冠狀病毒相關的病毒, 及其他經醫護人員評定為具相當傳染性風險的污染物料
- Dressing and other waste dribbling and caked with blood
滴血及凝有血塊的敷料及其他廢物

黃袋 盛載的 醫療廢物 YELLOW BAGS for Clinical Waste



- Human and animal tissues, organs and body parts
人體和動物組織、器官及身體部分

黑袋 盛載的 一般廢物 BLACK BAGS for Municipal Waste

Examples 例如



- Sterilized cultures or stock from laboratory (Autoclaved)
已滅菌的化驗室病菌培養基或儲用培養基 (高溫滅菌)
- Paper hand towels
擦手紙
- Nappies / incontinence pads
尿片
- Wrappers
包裝紙
- Urine bags / stomal bags
尿袋及造口袋

Laboratory waste disposal

- **Proper segregation**

- **Package**

- Bags are sealed when $\frac{3}{4}$ full (Don't use staples)
- Properly labeled

- **Storage**

- No accumulation in corridors, other places accessible to public (or pests and rodents)

- **Transport**

- Dedicated bins which are cleaned regularly and after spillage
-

Proper packing of clinical wastes

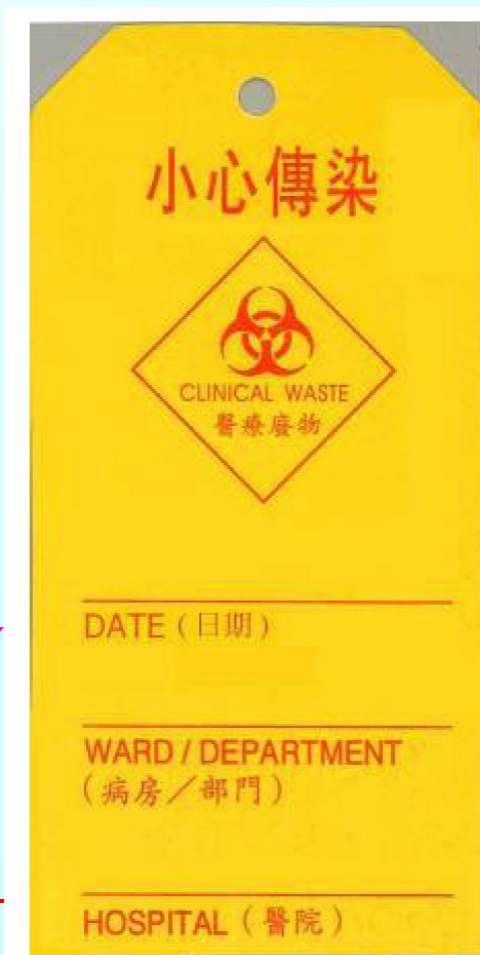
- When clinical waste bags are filled to the warning line, the “Swan-neck” method of sealing should be used before transfer to collection point
- Never use staple or unprotected metallic wire tie for sealing or tagging
- May cause injury to waste handlers or damage to bags



Clinical Waste Tag

- Every clinical waste container must bear the label “Clinical Waste”
- Labels should be securely attached to the containers, and info in the clinical waste tag clearly marked using BLACK indelible ink with information showing the origin of the waste:

- 醫院名稱	Name of hospital
- 部門/病室/診所名稱	Dept / Ward / Clinic
- 包裝日期	Packaging Date



Effluent from analytical equipment

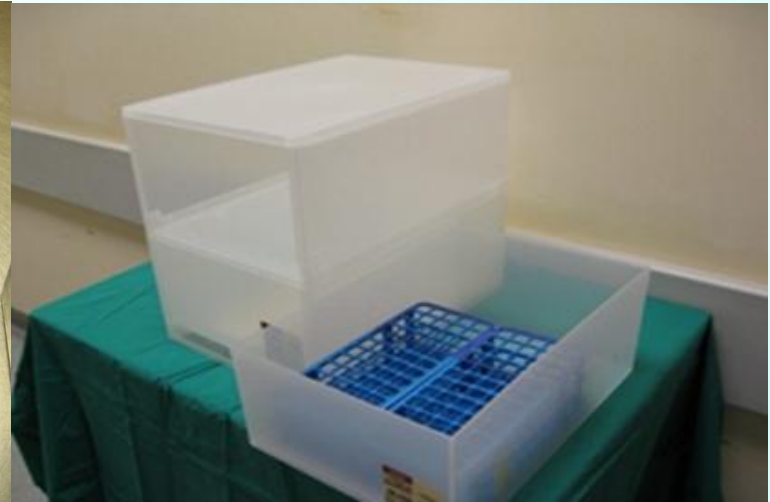
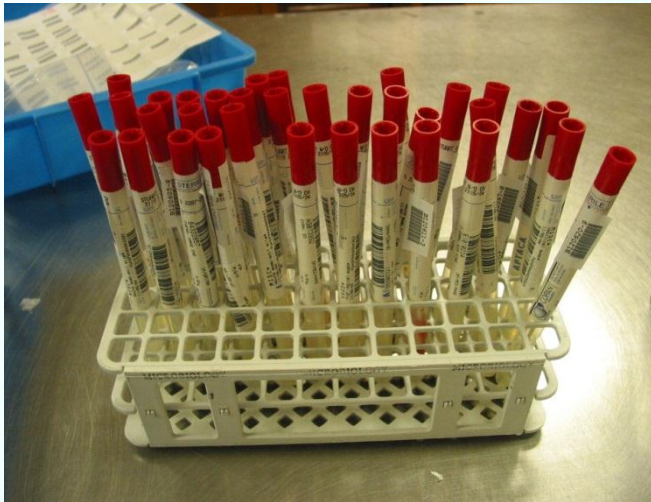
1. **Trapped in bottles containing hypochlorite**
2. **Discharged directly into the waste plumbing system**
 - ❑ **A discharge tube shall project at least 25 cm into the pipe-work to avoid splashing**
 - ❑ **Water flow down the waste-pipe while the machine is operating**
 - ❑ **Waste system treated with 250 mL of hypochlorite (0.25% available chlorine) when the work is finished**

Specimen transport (Triple packaging system)

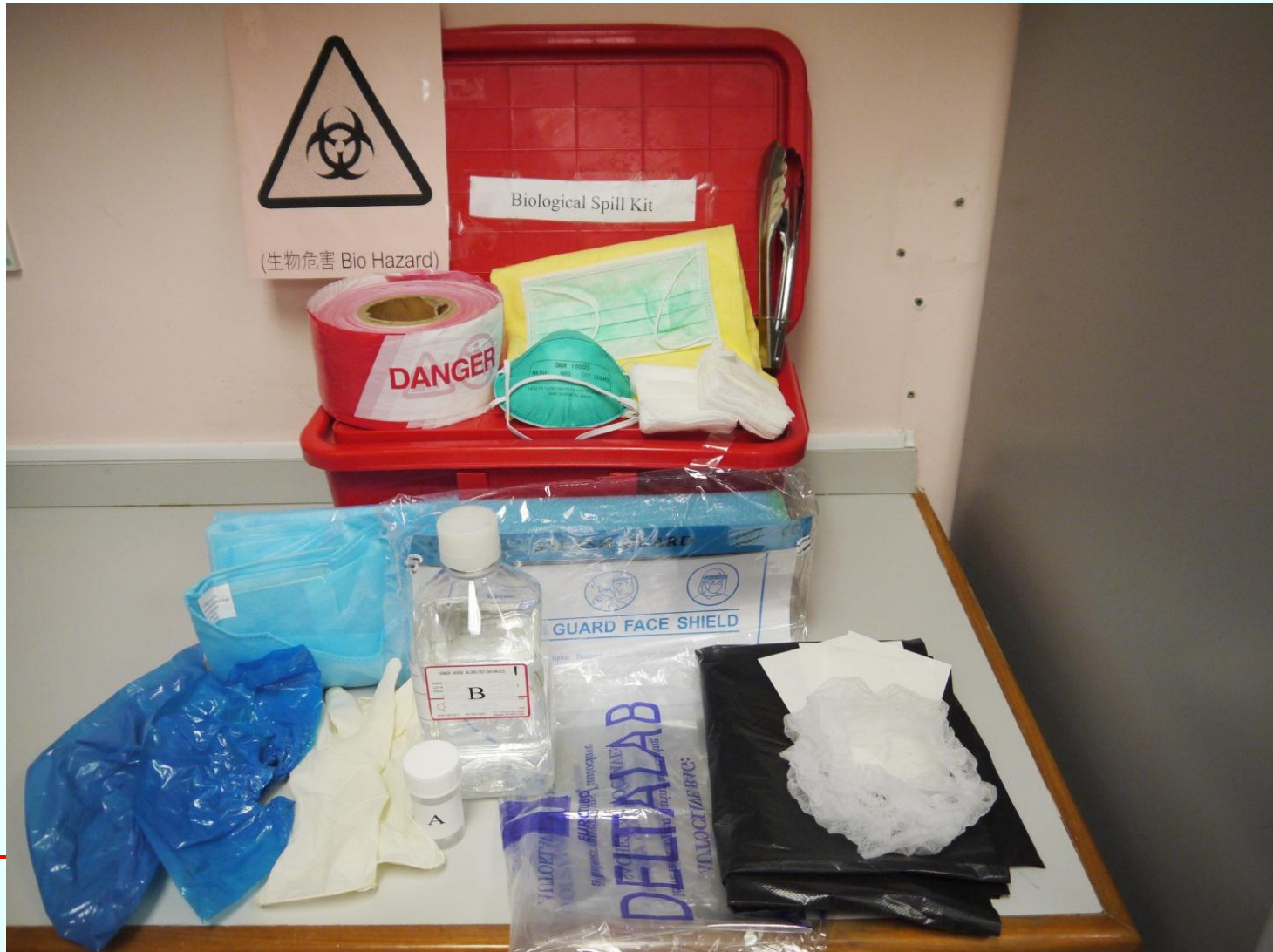
- **Primary (1°) container**
 - should be properly capped, watertight and leak proof
- **Secondary (2°) container**
 - Request form in the pocket of the zip-lock bag
- **Outer (3°) container**
 - Regularly cleansed and disinfected
 - Biohazard warning label on the outside



Intra-hospital specimen transport (routine specimens only)



Contents of biological spill kit



Contents of biological spill kit

- Water repellent solid front gown
 - N95 mask: 3M 1860S, 3M 1860, 3M 1862, 3M 8210
 - Surgical mask
 - Shoe cover
 - Cap
 - Face shield
 - Latex gloves
 - Warning sign
 - Warning tape
 - Virusolve+ soln (40ml) & DW (760 ml) to prepare 5% soln
 - Absorbent pads & Gauze
 - Forceps
 - Cards
 - Garbage bag (black)
 - Autoclave bag
-

Activity spectrum of select detergents and disinfectants

	BG+	BG-	MycoB	Spores	Yeast	Virus	Prions
Alcohol 70°	++	++	++	0	+	+	0
Aldehydes	+++	+++	++	+	+++	++	0
Ammonium IV	+++	+	0	0	+	+	0
Anilides	+	0	NP	NP	0	NP	0
Chlorhexidine	+++	++	0	0	+	+	0
Cl compounds	+++	+++	++	++	++	++	+ (a)
Iodine (+ der.)	+++	+++	++	++	++	++	0
Hg compounds	++	++	0	0	+	0 ou +	0
Phenols :	Variable activity depending on components ^(b)						
Hexachlorophene	+++	+	0	0	+	0	0
^(a) Bleach (6%) during 60 min at 20° C ; ^(b) discussion on efficacy of phenol on prions							

Virusolve+ : spectrum of activity

■ Bacteria

- *Acinetobacter species*
- *Bacillus species*
- *Campylobacter jejuni*
- *Clostridium difficile*
- *Escherichia coli*
- *Legionella pneumophila*
- *Salmonella typhimurium*
- *Staphylococcus aureus*
- *Vibrio cholerae*
- *Yersinia enterocolitica*

■ Mycobacterium

- *M. avium*
- *M. tuberculosis*

■ Viruses

- Avian flu (H5N1)
- Hepatitis B and C
- HIV-1
- Polio virus
- Influenza virus
- Vaccinia virus

■ Spores

- *Bacillus cereus, B. subtilis*
- *Clostridium difficile*

■ Fungi

- *Aspergillus species*
- *Candida albicans*

Virusolve+ solution

- Non-flammable, Non-irritant
- Potential skin and eye irritant
- Not corrosive to metal
- A combination disinfectant & cationic surfactant
- Contains alkyl triamine to disrupt membrane and cause cell lysis
- Store upright in a cool, dry, well-ventilated area. Avoid exposure to direct sunlight or sources of heat



Handling of minor spillage

- For Group 1 and 2 pathogens (e.g. dropped swabs, drops of culture broths, slight spills of specimens)
 - Pick up broken pieces of glass/sharps using forceps with gloved hands, dispose into sharps box
 - Wipe spill with disposable absorbent materials wetted with freshly prepared 1% hypochlorite (e.g. 1 in 5 bleach) or 5% Virusolve+ solution, rinse with water after 1 min
 - Discard used gloves and soaked cloth or paper towels as contaminated materials
-

Handling of spillage during centrifugation

- **Switch off the machine**
 - **For non-sealable buckets**
 - Close the lid for 30 min to allow aerosols to settle before opening
 - Use forceps to pick up glass debris
 - **For sealable buckets**
 - Open the centrifuge after it has stopped
 - Remove the buckets /contents to a BSC
 - **Immerse all broken tubes, glass fragments, buckets, trunnions , rotor in 5% Virusolve+ solution for 15 minutes, rinse with water**
 - **Swab the bowl with 5% Virusolve+ solution, swab dry**
-

Handling of major spillage

(e.g. spillage and/or breakage of laboratory cultures)

■ Persons involved

- ❑ Inform other workers for temporary evacuation
 - ❑ Remove contaminated PPE
 - ❑ Leave the room, close door and put a warning sign on the door
 - ❑ Report to safety officer/ supervisor
 - ❑ Self-decontamination: wash, flush
 - ❑ Seek advice from ICT as appropriate
-

Decontamination of major spillage

- Carried out **ASAP** (except in negative pressure room) by trained personnel
 - Put on PPE : water-resistant gown, gloves, N95 respirator, face shield
 - Cover contaminated area with lint clothes, flood them with 5% Virusolve+ solution (1 in 20) for 15 min
 - Wipe clean and dry surfaces with paper towel
 - Gather materials into waste bags and autoclave **ASAP**
-

Handling of major spillage inside BSC

- Allow the cabinet to continue operation to contain and exhaust the aerosols
 - Do not remove items from the cabinet
 - Cover contaminated area with disposable absorbent materials, flood them with 5% Virusolve+ solution (1 in 20) for 15 min, swab with water and air dry. Avoid using metal corrosive disinfectants like hypochlorite.
 - If the cabinet incorporates a catch basin beneath the work surface, this should be flooded with the disinfectant.
 - Disinfect or autoclave contaminated items as appropriate
 - Fumigate the cabinet before activity is resumed.
-



Handling of specimens suspected of highly pathogenic micro-organisms

Activities performed in BSL-2 facilities with BSL-2 practice

- Routine diagnostic testing of serum, blood and urine specimens
 - Routine staining and microscopic analysis of fixed smears
 - Routine examination of mycotic and bacterial cultures
 - Pathological examination and processing of formalin-fixed / inactivated tissue
 - EM studies with glutaraldehyde-fixed grids
 - Molecular analysis of extracted nucleic acid preparations
-

Activities performed in BSL-2 facilities requiring BSL-3 practices

- Aerosols or splash generating procedures
 - e.g. sonication, vortexing, grinding or blending
 - Aliquot and/or dilute specimens
 - Manipulation of untreated specimens
 - Inoculation of bacterial or mycological culture media
 - Preparation of chemical- or heat-fixing of smears for microscopic analysis
 - Nucleic acid extraction procedures involving untreated specimens
-

BSL-3 practices

- **Conduct procedures within BSC**
 - **Wear appropriate PPE**
 - Disposable gloves, solid front or wrap around gowns with cuffed sleeves, and a surgical mask or full-face shield
 - **Centrifugation in sealed centrifuge rotors/ cups and unloaded inside BSC**
 - **Decontaminate work surfaces and equipment after use e.g. diluted bleach (1 in 50)**
-

Smear preparation

- **Fresh respiratory specimens for cytological examination:**
 - Prepare smears inside the BSC
 - Fix in 95% ethanol for 30 minutes + fix in 70% ethanol or isopropyl alcohol for 15 minutes (for disinfection) or
 - Fix in equal volume of 10% formalin for 2 hours before smear preparation and staining

 - **Peripheral blood**
 - Smears can be incubated on a hot plate heated up to 56°C for 15-30 minutes before methanol fixation and Romanowsky staining.
-

Enhanced PPE

- **Use when the procedure cannot be conducted within a BSC**
 - **Includes the followings as appropriate**
 - Disposable gloves
 - Solid front or wrap around gowns with cuffed sleeves
 - N95 respirator
 - Full face shield
 - Head covering , shoe cover and other physical containment devices
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BSL-3 Laboratory

- For diagnostic tests that involve
 - Cell culture for virus isolation
 - Initial characterization of viral agents recovered in cultures (e.g. specimens for avian influenza)
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	BSL-2 standard + BSL-2 Practice	BSL-2 standard + BSL-3 Practice	BSL-3 standard + BSL-3 Practice
Requirement	Open Bench	BSC	BSC
PPE	Gloves, Gown, Surgical Mask	Gloves, Gown, Surgical Mask	Following individual laboratory's guideline
Enhanced PPE For exceptional BSL-3 practice	N/A	Gloves, Gown, Goggles, N95 respirator, Head covering and Dedicated shoes/Shoes cover as appropriate	N/A

Immunisation for lab staff

- Hepatitis B vaccine
 - Influenza vaccine
 - MMR vaccine
 - Tetanus vaccine
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Thank You
