2. Laboratory Safety

Why a Clinical Practice Guideline?

The nature of possible hazards that a laboratory worker would be exposed to is microbiological, chemical, fire, electrical, ergonomic, psycho-social and radiation. Every staff member should be aware of the potential risks and be able to adopt measures to minimize them. This guideline is prepared to help the staff members in the process of adopting suitable laboratory safety measures.

For whom is this guideline intended?

This guideline is intended for Health planners, laboratory staff and hospital administration.

Objectives

- The objective of this guideline is to provide evidence based recommendations to laboratory staff on work related infection risks and safety measures to be adopted to minimize such risks.
- To provide recommendation to the administration to help in the improvement of quality in service delivery.

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Contents

Laboratory Safety

This guideline will contain 6 sections described under the following headings.

1. Safety control levels
2. Classification of organisms on hazardous level
3. Use of devices to ensure safety
4. Routine procedures to ensure safety
5. Electrical safety
6. Maintenance of equipment

2.1. Safety control levels

To ensure safety certain control measures have to be in place. They would be discussed under the following headings

- Administrative control
- Personal Control
- Work Practice or Procedural Control
- Engineering Controls

2.1.1 Administrative controls

Administrative controls have to be planned and implemented by the Laboratory Head. For successful implementation of the plan full support of the Hospital administration is essential. The following areas need to be considered in the administrative control plan.

A. Safety Manual

- Should be prepared by the head of the laboratory listing the guidelines and policies. X

B. Training

- Training on safety orientation should be done for all staff members on a regular basis.
- Fire evacuation plan should be prepared and regular training on this should be carried out to train the staff.

C. Occupational Health measures

- Immunization and post-exposure follow up of all staff members should be done and the records maintained. X
- Identified staff category (eg. Infection Control Unit) should be made responsible to supervise this activity.

D. Safety audits

- Should be carried out on a regular basis by the designated Safety Officer or the Laboratory Head.

E. Inspection

- Workplace and pre-work inspection.

2.1.2 Personal Control

These are control measures made effective through the correct practices of the laboratory staff. For effective implementation of personal control the following areas need to be considered.

A. Personal protective equipment (PPE)

- PPE such as gloves, laboratory coats, safety goggles, face shields and aprons need to be supplied in adequate quantities.

- The staff members should be trained to choose the appropriate PPE to minimize the risks associated with a procedure. For example, wear safety glasses for general duty OR wear protective goggles for work involving a significant risk of small splashes of hazardous chemicals or infectious agents OR wear a face shield in addition to protective goggles for work with a significant risk of splashes or projectiles.
- The staff should follow the safety manual instructions in using the PPE.
- Safety officer or a designated officer should do regular supervision on the use of PPE by the laboratory staff.

2.1.3 Work practices or procedural controls

Work practices or procedural controls are steps taken to ensure safety in the performance of a procedure or in the operation of equipment. The following areas are important in ensuring procedural controls.

A. Universal precautions.

- Details of this are given in the Guideline on Standard Precautions and Hand Washing of the Sri Lanka College of Microbiologists.

B. Work instructions

- Should be strictly followed.

C. Access to equipment

- Tagging and lockout procedures should be placed to ensure that only authorized personnel use the equipment.

D. Pre-work checklists

- These would minimize the chances of accidents due to disruptions of the work.

E. Good housekeeping can be maintained by the following procedures i).-iv). given below

iii. Laboratory space and equipment

- Keep aisles, passageways and doors unobstructed.
- Secure all equipment.
- Maintain a clean work area. When cleaning floor and other surfaces avoid aerosol generation by using damp cloth and mop.
- Maintain an orderly work area.
- Ensure that the area is free of insects or rodents.

iv. Storage and labeling

- Store the reagents, waste receptacles and other supplies properly with labels.
- Hazardous items should be properly labeled.

v. Decontamination

- Decontaminate and / or clean up all surfaces and any spills.
- Decontaminate equipment
- Flush and /or decontaminate sinks

vi. Segregation and Disposal

- Separate sharps and broken glass for disposal.
- Segregate and label the chemical, infectious and routine waste.
- Dispose unused and expired chemicals

2.1.4 Engineering Controls

Engineering controls include items or equipment used to reduce exposures to harmful substances. Some examples are given below.

- Closed tube system in automated equipment.
- Bio-Safety Cabinets and chemical fume hoods.
- Safety carriers for chemicals.
- Pipette plugs.
- Emergency eye / face wash devices – located within 100 ft and 10s of all work stations in the laboratory, 2 spray heads, hands free and single activation operation.
- Overhead safety showers or any showering equipment – located within 100 ft and 10s of all workstations in the laboratory, pull-chain or swing-lever single action activation operation. These devices to be tested annually.

2.2 Hazard groups of organisms

Infectious micro-organisms have been classified into one of four hazard groups (HG). The classification is based on the following criteria.

- Is the organism pathogenic to man?
- Is it a hazard to workers?
- Is it transmissible to the community?
- Is effective prophylaxis or treatment available?

This does not allow for any additional risk caused by pre-existing disease, the effects of medication, compromised immunity, pregnancy or breast feeding. This also does not take into account, the allergic effects or toxic effects of the microorganism or its products.

2.2.1 Hazard Group 1

- A biological agent unlikely to cause human disease.

2.2.2 Hazard Group 2

- A biological agent that can cause human disease and may be a hazard to employees; it is unlikely to spread to the community and there is usually treatment available that can prevent or control the onset of disease. Eg: Legionella.

2.2.3 Hazard Group 3

- A biological agent that can cause severe human disease and represents a serious hazard to employees; it may present a risk of spreading to the community but there is usually treatment that prevent or control the onset of disease. Eg. *Mycobacterium tuberculosis*.

2.2.4 Hazard Group 4

- A biological agent that causes severe human disease and is a serious hazard to employees; it is likely to spread to the community but there is usually no treatment that can prevent or control the onset of disease. Eg. Ebola.

Work involving HG1 and HG2 micro-organisms are considered as negligible and low risk activities respectively. Work involving HG3 and HG4 micro-organisms are considered as medium and high risk activities respectively. Hazard group classification is given in the annexure.

2.3 Use of devices to ensure safety

2.3.1 Safe use of Biological Safety Cabinets

Biological safety cabinets (BSC) are designed to provide personal, environmental and product protection when appropriate practices and procedures are followed.

A. Types of BSC

There are 3 types of cabinets of which Classes I and II are used in the microbiology laboratory.

i. Class I BSC

- Provides personnel and environmental protection but not product protection. The air movement is similar to a chemical fume hood.

ii. Class II BSC

- Provides personnel, environmental and product protection.

2.3.2 Work practices to be followed in using BSC:

A. Attire

- When working at the BSC, laboratory coats and gloves should be worn.

B. Air current control

- Sudden movements which would disrupt the air flow of the cabinets and rapid personnel activities in the room like opening and closing of doors should be minimized.

- Cabinet blowers should be turned on for 3 – 5 minutes before starting work.
- The front grille should not be covered and all equipment must be placed at least 4 inches from the grill.
- Flames are not allowed inside the cabinet as it disrupts air flow.

C. Working at the cabinet

- Only the essential equipment should be placed inside the cabinet.
- The cabinet surface must be wiped with a suitable disinfectant before and after use. (eg 70% ethanol, 0.05% Sodium Hypochlorite – When Sodium Hypochlorite is used a second wiping with sterile water is necessary to remove residual chlorine.
- Good microbiology practices must be observed to minimize splatters and spills.
- Any spills should be decontaminated appropriately.
- UV lamps should not be turned on when the laboratory is occupied to minimize corneal burns and skin cancer. The UV lamp should be turned on after work and kept overnight.

D. Periodic checks

- UV light must be cleaned once a week as dust will reduce germicidal activity.
- The BSC must have periodic checks for air velocity, airflow patterns and integrity of HEPA filters.

2.4 Routine procedures to ensure safety

2.4.1 Hand washing

- Whenever possible, suitable gloves should be worn when handling bio-hazardous materials. X
- However, this does not replace the need for regular and proper hand-washing by laboratory personnel.
- Hands must be washed before wearing gloves, moving to uncontaminated surfaces after handling samples or contaminated items and leaving the laboratory.
- Hand washing must be done after removal of gloves, handling bio-hazardous materials and animals. X
- In most situations, thorough washing of hands with ordinary soap and water is sufficient to decontaminate them, but the use of germicidal soaps is recommended in high-risk situations.

A. Use of soap in Hand-washing

- Liquid soap is recommended.
- When bar soap is used, soap racks that facilitate drainage and small bars of soap (sufficient for a day) should be used.
- Antiseptics – 2-4% chlorhexidine gluconate or 7.5% povidone iodine.

B. Technique of Hand-washing:

- Nails must be kept clean and short.
- All jewelry and watches must be removed before washing.
- Wet hands under running water.

- Hands should be thoroughly lathered with soap, using friction for at least 10 seconds, covering all surfaces of the hands and fingers.
- Rinse hands under clean water.
- Dry using a single use, clean or sterile paper or cloth towel (if available, warm-air hand-dryers may be used). Multiple-use cloth towels of the hanging or roll type are not recommended for use in health-care settings.
- Foot- or elbow-operated faucets are recommended. Where not fitted, a paper / cloth towel should be used to turn off the faucet handles to avoid re-contaminating washed hands.
- A foot-operated bin should be used for collection of discarded towels.

C. Using alcohol hand rubs

- These are used as an alternative to hand washing with soap and water.
- These should not be used for visibly soiled hands.
- Apply product to palm of one hand and rub hands together, covering all surfaces of hands and fingers, until hands are dry.
- Follow the manufacturer's recommendations regarding the volume of product to use.
- This does not require drying with a towel.
- Commercial preparations are available.
- An in-house preparation using 97 ml of 70% alcohol and 3 ml of glycerol is a cheaper alternative.

2.4.2 Disposal of laboratory sharps

A. Types of sharps

Different sharps have to be handled in a specific way as described below. All sharps should be collected into a sharps disposal bin before disposal.

i. Definition of Sharps:

A sharp is any device / item having acute corners, edges, or projections capable of cutting or piercing the skin.

ii. Infectious waste and used sharps:

The following items used at medical, research or industrial laboratories should be considered as sharps and infectious waste.

- Hypodermic needles, syringes, (with or without the attached needle)
- Pasteur pipettes
- Scalpel blades
- Blood vials
- Needles with attached tubing
- Culture dishes
- Suture needles
- Slides, cover slips
- Other broken or unbroken glass
- Plastic-ware that have been in contact with infectious agents or that have been used in animal or human patient care or treatment

ALWAYS dispose these items in approved plastic sharps disposal containers. The sealed containers should be autoclaved before disposal.

Note: Do not remove or recap needles from syringes prior to placing into sharps container.

iii. Non-infectious Sharps:

These also must be disposed in a sharps container through the infectious waste stream. Containers of non-infectious sharps may be discarded as ***infectious waste without prior autoclaving if the label is defaced.***

iv. Sharps contaminated with radio-active material:

A sharps container as described below should be properly labeled as sharps contaminated with (isotope name) and disposed of as recommended for radio-active material.

v. Carcinogen-contaminated sharps waste:

Segregate from other sharps into special sharps containers and label as:

"Carcinogen Contaminated Sharps Waste - Do Not Autoclave"

B. Sharps bins

i. Essential features of sharps containers:

- Puncture resistant
- Clearly marked with a biohazard symbol
- Within easy reach of the work station
- Filled to no more than 3/4 capacity
- Sealed (i.e. capped or taped) prior to transport

C. Safety rules to be followed in handling sharps

- Never bend, shear, break, or recap disposable needles.
- Avoid removal of needles from disposable syringes.
- If the procedure you are performing requires that you recap a needle, use a one-handed technique.
- Immediately following use, place the item into the sharps disposal container.
- Never reach into the sharps disposal container.
- Never empty the contents of the sharps disposal container into another container.
- Never remove the lid from the container.
- Never overfill a sharps disposal container
- No materials should be sticking out at the top.
- Never force materials into a sharps disposal container.

2.4.3 Waste Disposal (please refer to the guideline on Waste Disposal of the Sri Lanka College of Microbiology for more details)

A. Segregation of waste

i. It is important to segregate the different types of waste in to different colour coded bags at the time of generation of waste.

ii. All infectious waste should be rendered non-infectious prior to disposal.

- Waste is classified as: General and laboratory waste.
- General Waste
  a) Paper
  b) Plastic & Polythene - Uncontaminated
  c) Broken Glassware - Uncontaminated
  d) Food

iii. Laboratory waste

- Infectious waste
- Non-infectious waste
- Chemical waste
- Radio active waste

B. Disposal of different types of waste

i. Liquid Infectious Waste

- Collect into a leak proof non-breakable receptacle and add disinfectant – eg. 1% Sodium Hypochlorite or 2% Phenolic disinfectant (Lysol) – leave for a minimum period of 30 min. Thereafter it could be poured into a drain.
- Steam sterilization before disposal should be done for the following
  a) BHI Broth
  b) Selenite Broth
  c) Alkaline Peptone water
- In the absence of autoclaving or incineration facilities the specimen containers with blood, serum or body fluids need to be immersed in a bucket containing Hypochlorite (TCL) to have a final concentration of 1% and leave it overnight before discarding or washing it for reuse.

Preparation of Sodium hypochlorite

1. 30 g of TCL in 1litre of water – 1% hypochlorite
2. Sodium hypochlorite need to be made daily

- Specimen containing pus, sputum for TB need to be immersed in a bucket containing 5% Lysol and leave it overnight before discarding or washing it for reuse.

ii. Solid Infectious Waste

- **Discard jars:** Separate discard jars for slides, pipettes, tubes, swabs and toothpicks etc. should be available. When pipettes are discarded into discard jars, disinfectant should be drawn up into the pipettes.

- **Boiling**: Slides can be boiled in soapy water.

- **Steam Sterilization**: The culture media has to be autoclaved before discarding. After autoclaving, the culture media containing fluid may be poured into the drain while still hot and with plenty of running water to prevent clogging of the drain.

- **Incineration:** Histology specimens should be discarded into yellow bags for incineration or burial.

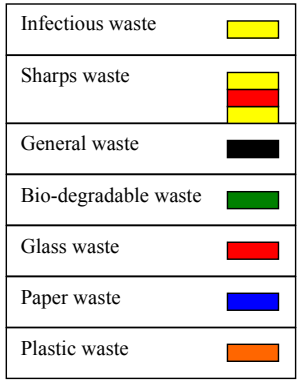
iii. Disposal of Sharps

- Used syringes and needles should be discarded into a sharps bin.
- Once the sharps bin is 3/4th full it should be sent for disposal.
- Sharps can be disposed by incineration, or burial

iv. Disposal of Radioactive waste

- Collect in appropriate containers and store as required by nuclear authority for a suitable time period.

v. National colour code for segregation of hospital waste



2.5 Electrical safety guidelines in the medical laboratory

Various types of electrical equipment and systems are used in medical laboratories that carry hazards of accidental electrical injury to laboratory workers, damage to apparatus and damage to the environment. Electricity flowing through the human body can cause shock, involuntary muscle twitching, paralysis of muscles, burning of tissue and organs and fatalities while faulty electrical circuits can cause electrical fires in the laboratory.

In order to prevent such electrical hazards all electrical equipment and systems should be of good

quality, properly installed and used safely. Regular inspection and servicing for electrical safety is mandatory. All users should be aware of electrical properties of apparatus, knowledgeable on potential electrical hazards and emergency aid to victims. The laboratory should be equipped with dry powder chemical fire extinguishers to contain accidental electrical fires.

Conformance to the following safety measures is recommended for electrical equipment and systems in the laboratory.

2.5.1 Quality of electrical equipment and systems:

- All items of equipment should conform to internationally approved standards for their intended purpose and be of reputed brands.
- Procedure manuals should be in a language understood by the users, if not accurate translations should be available.
- Custom-made equipment, including extension cords, should conform to approved specifications and be used only on approval by local electrical authorities.

2.5.2 Positioning & Installation of apparatus:

- Equipment should be installed by a qualified electrician, following the manufacturer's instructions explicitly, adhering to specified voltage, power supply, fuses, wiring and other electrical specifications.
- Equipment should not be placed near water, under direct sunlight or close to chemicals and reagents.

- When placing equipment clear working space should be allowed with adequate illumination on all sides for safe operation and access for maintenance work.
- Easily understood instructions and safety precautions should be displayed near the equipment.
- Work area close to the equipment should be covered with rubber floor matting.

2.5.3 Operation:

- Only authorized persons should be permitted to operate equipment.
- They should have the required knowledge and skills to perform work safely and be aware of hazards and environmental aspects associated with electrical work.
- Whenever possible, all circuits or equipment shall be de-energized before beginning any work.
- Use personal protective clothing and safety measures such as rubber footwear.
- Ensure that the hands and floor underfoot are dry before use of equipment.
- Switch off equipment from the plug base at the end of the day.
- Ensure safety of equipment during electric storms.
- In case of malfunctioning, stop the use of the equipment, switch off power and report to superior.
- Keep accurate records of equipment malfunction, maintenance and repairs.
- Maintain a user register for major equipment.

2.6 Maintenance and servicing:

- Laboratory electrical systems checks should be carried out at regular intervals.
- Equipment should be serviced as recommended by the manufacturer.
- Repairs and servicing should be carried out only by qualified electricians.
- Prepare Standard Operating Procedures (SOP) and written maintenance schedules for each item of equipment with checklists for tasks to be performed on a time schedule by identified staff members.
- Hold stocks of essential spare items for equipment.
    a) Ensure availability of dry chemical fire extinguisher and train staff in its use.
    b) Hold annual / biannual workshops with trained resource persons for the users of equipment.

2.7 References on BSC:

1. Bio-safety in Microbiological and biomedical laboratories, 4th Edition, National Institute of Health / Centers for Disease Control and Prevention, 1999
2. Primary Containment of Biohazards: Selection, Installation and use of Biological Safety Cabinets, 2nd Edition, National Institute of Health / Centers for Disease Control and Prevention, 2000
3. Bio-safety Manual for Medical Laboratories, Medical Research Institute, 2004
4. Laboratory Bio-safety Manual, 3rd Edition – World Health Organization, 2004

References on Hand washing:

1. Hospital infection control manual – Sri Lanka College of Microbiologists, 2005
2. Bio-safety Manual for Medical Laboratories - Medical Research Institute, 2004
3. Laboratory Bio-safety Manual, 3rd Edition – World Health Organization, 2004

2.8 Annexure

1. Hazard group 2

a. Bacteria

Actinobacillus, Actinomadura, *Bacillus cereus*, Bacteroides, Bartonella, Bordetella, Borrelia, Campylobacter, *Chlamydia pneumoniae*, *Chlamydia trachomatis Clostridium botulinum, Clostridium perfringens, Clostridium tetani , Corynebacterium diphtheriae,* Enterobacter, Enterococcus spp 2, *Escherichia coli, Gardnerella vaginalis,* Haemophilus, *Helicobacter pylori,* Klebsiella, Legionella, Leptospira, Listeria, *Mycobacterium bovis* (BCG strain), Mycoplasma, *Neisseria gonorrhoeae, Neisseria meningitides,* Nocardia, Pasteurella, Proteus, *Pseudomonas aeruginosa*, Rochalimaea, Salmonella (except typhi and paratyphi), Shigella (except *Shigella dysenteriae* (Type 1), *Staphylococcus aureus, Streptococcus pneumoniae, Streptococcus pyogenes, Treponema pallidum, Vibrio cholerae* (including El Tor 2).

b. Viruses

Adenovirus, Cytomegalovirus, Epstein-Barr virus, Herpes simplex types 1 and 2, varicella-zoster, Influenza types A, B and C, Measles, Mumps, Parainfluenza (Types 1 to 4), Respiratory syncytial virus, Human parvovirus (B19), Enteroviruses, Hepatitis A, Human rotaviruses, Rubella.

c. Parasites

Ancylostoma duodenale, Ascaris lumbricoides, Brugia, Dracunculus medinensis, Entamoeba histolytica, Enterobius vermicularis, Fasciola hepatica, Giardia lamblia, Necator americanus, Schistosoma haematobium, Taenia saginata, Toxoplasma gondii, Wuchereria bancrofti,

d. Fungi

Aspergillus fumigatus, Candida albicans, Cryptococcus neoformans.

2. Hazard group 3

a. Bacteria

Bacillus anthracis, Brucella, *Burkholderia mallei*, *Burkholderia pseudomallei*, *Chlamydia psittaci* (avian strains), *Coxiella burnetii, Escherichia coli*,O157:H7, *Francisella tularensis, Mycobacterium bovis, Mycobacterium leprae, Mycobacterium tuberculosis*, Rickettsia, *Salmonella paratyphi* A,B,C, *Salmonella typhi, Shigella dysenteriae* (Type 1), *Yersinia pestis*.

b. Viruses

Lymphocytic choriomeningitis, Hantaan (Korean haemorrhagic fever), Hepatitis E, SARS, Dengue, Japanese B encephalitis, West Nile virus, Yellow fever virus, Hepatitis C, Hepatitis B, Human immunodeficiency viruses (HIV), Rabies, BSE, Creutzfeldt-Jakob disease.

c. Parasites

Echinococcus, *Leishmania donovani*, *Plasmodium falciparum, Taenia solium.*

d. Fungi

Coccidioides immitis, Histoplasma capsulatum.

3. Hazard group 4

Lassa fever, Junin, Machupo, Crimean / Congo haemorrhagic fever, Ebola, Marburg, Variola (major and minor).