Infection control and Safety in Medical laboratory

A Culture of Safety for Diagnostic Laboratories

By Dr Sneha S Hegadi
Department of Microbiology
Neuberg Anand Reference Laboratory

Objectives

- Routes of Laboratory Infection
- Risk Assessment
- Fundamental Safety Practices in Diagnostic Laboratories
- Waste Management
- Occupational Exposure and its Management
- Spill Management

- A phlebotomist accidentally pricks their finger with a blood collection needle while drawing blood from a patient.
- A lab worker develops symptoms of a respiratory illness after sample collection from patient with suspected influenza. Investigation reveals that samples collection was done without adequate PPE.
- A vial containing a culture of antibiotic-resistant bacteria is accidentally dropped and breaks on the laboratory bench.

Infection prevention and control

Definition :

- Infection prevention and control is: • a scientific approach with practical solutions designed to prevent harm, caused by. infections, to patients and health care workers

- Hepatitis B has been the most frequent laboratory-acquired viral infection, with a rate of 3.5–4.6 cases per 1000 workers, which is two to four times that of the general population
- Early surveys of LAIs found that laboratory personnel were three to nine times more likely than the general population to become infected with *Mycobacterium tuberculosis* .
- In clinical chemistry laboratories, data from 17 New York hospitals listed needle puncture (103 cases), acid or alkali spills (*46*), glass cuts (*44*), splash in eye (*19*), and bruises and cuts (*45*) as the most frequent exposures

Routes of Laboratory Infection

- The most predominant routes of LAIs are
- parenteral inoculations with syringe needles or other contaminated sharps;
- spills and splashes onto skin and mucous membranes;
- ingestion or exposure through mouth pipetting or touching mouth or eyes with fingers or contaminated objects;
- inhalation of infectious aerosols .

A Culture of Safety

A laboratory director needs to assume the responsibility for

- establishing and enforcing a policy for a culture of safety within the laboratory.
- identifying as many hazards as possible and specifying practices and procedures that will minimize or eliminate those hazards.
- ensuring that all personnel are engaged in performing risk assessments.
- providing an avenue for personnel to present risk-mitigation strategies to management; and
- educating clinicians and nurses about safe specimen procurement and transport to ensure their safety and that of the laboratory personnel who receive the clinical samples.

Risk Assessment

Five steps to risk assessment:

- Step one: look for hazards;
- Step two: identify who might be harmed and how;
- Step three: evaluate the risks - consider the existing controls and assess the extent of the risks which remain;
- Step four: record the findings of the assessment - including the controls necessary and any further action needed to reduce risk sufficiently;
- Step five: review, revise and modify the assessment - particularly if the nature of the work changes or if developments suggest that it may no longer be valid.

Identify the hazards associated with an infectious agent or material.

TABLE 1. Laboratory activities associated with exposure to infectious agents

Routes of exposure/transmission	Activities/practices
Ingestion/oral	• Pipetting by mouth • Splashing infectious material • Placing contaminated material or fingers in mouth • Eating, drinking, using lipstick or lip balm
Percutaneous inoculation/nonintact skin	• Manipulating needles and syringes • Handling broken glass and other sharp objects • Using scalpels to cut tissue for specimen processing • Waste disposal (containers with improperly disposed sharps)
Direct contact with mucous membranes	• Splashing or spilling infectious material into eye, mouth, nose • Splashing or spilling infectious material onto intact and nonintact skin • Working on contaminated surfaces • Handling contaminated equipment (i.e., instrument maintenance) • Inappropriate use of loops, inoculating needles, or swabs containing specimens or culture material • Bites and scratches from animals and insects • Waste disposal • Manipulation of contact lenses
Inhalation of aerosols	• Manipulating needles, syringes, and sharps • Manipulating inoculation needles, loops, and pipettes • Manipulating specimens and cultures • Spill cleanup

Source: Sewell DL. Laboratory-associated infections and biosafety. Clin Micobiol Rev 1995;8:389–405 (*18*).

- — Manipulating needles, syringes and sharps,Subculturing positive blood culture bottles, making smears
- Expelling air from tubes or bottles
- Withdrawing needles from stoppers
- Separating needles from syringes
- Aspirating and transferring body fluids
- Harvesting tissues
- — Manipulating inoculation needles, loops, and pipettesFlaming loops
- Cooling loops in culture media
- Subculturing and streaking culture media
- Expelling last drop from a pipette (including Eppendorff pipettes)
- — Manipulating specimens and culturesCentrifugation
- Setting up cultures, inoculating media
- Mixing, blending, grinding, shaking, sonicating, and vortexing specimens or cultures
- Pouring, splitting, or decanting liquid specimens
- Removing caps or swabs from culture containers, opening lyophilized cultures, opening cryotubes
- Spilling infectious material

Consider the competencies and experience of laboratory personnel.

- Genetic predisposition and nutritional deficiencies, immune/medical status
- Education, training, experience, competence;
- Stress, fatigue, mental status, excessive workload;
- Perception, attitude, adherence to safety precautions

Evaluate and prioritize risks.

TABLE 2. Risk prioritization of selected routine laboratory tasks

Task or activity	Exposure risk			
	Potential hazard	**Likelihood**	**Consequence**	**Risk rating**
Subculturing blood culture bottle	Needle stick — percutaneous inoculation	Likely	Infection; medical treatment	High
	Aerosols — inhalation	Moderate	Infection; medical treatment	Medium
	Splash — direct contact with mucous membranes	Moderate	Infection; medical treatment	High
Centrifugation	Aerosols — inhalation	Likely	Infection; medical treatment	High
Performing Gram stain	Aerosols from flaming slides	Moderate	Colonization; infection	Moderate
Preparing AFB smear only	Aerosols from sputum or slide preparation	Likely	Illness; medical treatment; disease	High
Performing catalase testing	Aerosols — mucous membrane exposure	Unlikely	Colonization; infection	Low
AFB culture work-up	Aerosols — inhalation	Likely	Illness; medical treatment; disease	High

Abbreviation: AFB = acid-fast bacillus.

Develop, implement, and evaluate controls to minimize the risk for exposure.

- Engineering controls
  If possible, first isolate and contain the hazard at its source.
  — Primary containment: BSC, sharps containers, centrifuge safety cups, splash guards, safer sharps (e.g., autoretracting needle/syringe combinations, disposable scalpels), and pipette aids
  — Secondary containment: building design features (e.g., directional airflow or negative air pressure, hand washing sinks, closed doors, double door entry)

- Administrative and work practice controls
  — Strict adherence to standard practices
  — Frequently washing hands
  — Wearing PPE only in the work area
  — Minimizing aerosols
  — Prohibiting eating, drinking, smoking, chewing gum
  — Limiting use of needles and sharps, and banning recapping of needles
  — Minimizing splatter— Monitoring appropriate use of housekeeping, decontamination, and disposal procedures
  — Implementing "clean" to "dirty" work flow
  — Following recommendations for medical surveillance and occupational health, immunizations, incident reporting, first aid, postexposure prophylaxis
  — Training
  — Implementing emergency response procedures

Monitoring effectiveness of controls

Risk assessment is an ongoing process that requires at least an annual review because of changes in new and emerging pathogens and in technologies and personnel.

— Review reports of incidents, exposures, illnesses, and near-misses.
— Identify causes and problems; make changes, provide follow-up training.
— Conduct routine laboratory inspections.
— Repeat risk assessment routinely.

Fundamental Safety Practices in Diagnostic Laboratories

Effective standard operating procedures should set out clearly:

- the findings of risk assessments;
- safe working practices, ie what is to be done to ensure that work is done safely;
- who is authorised to perform particular tasks;
- rules of conduct and written guidance for ancillary and maintenance staff, contractors and visitors;
- procedures for disinfection and sterilisation;
- arrangements for disposal of clinical waste;
- requirements of COSHH (including chemicals and biological agents);
- procedures for the maintenance, examination and testing of engineering controls, eg exhaust ventilation systems and microbiological safety cabinets;
- arrangements for maintenance and inspection of other equipment;
- procedures for accident and incident reporting, showing clearly who should be contacted in the event of an accident.

Equipment

- Laboratory risk assessments should consider how to deal with the risks of contamination from automated equipment.
- Staff should treat any spillage that occurs inside the equipment in accordance with the supplier’s instructions for decontamination. At the end of each working day they should disinfect the equipment.
- Effluent from analytical equipment should either be trapped in bottles containing a suitable disinfectant or discharged directly into the waste water plumbing system.

Homogenisers and shakers

- As a result of the nature of their operation, both shakers and homogenisers may give rise to droplet dispersion. Homogenisers and shakers used in the laboratory should provide effective containment .
- always open containers in a safety cabinet, to contain any droplets
- hold handheld homogenisers within a protective jacket to prevent possible breakage;
- deal with all breakages and spillages according to standard operating procedures.

Centrifuges

- use sealed buckets or rotors when processing blood, body fluids or microbial suspensions;
- check that bucket seals are intact so that they provide adequate protection against liquid dispersion in the event of an accident during use;
- only use containers strong enough to withstand the centrifugal forces to which they will be exposed;
- use good handling techniques when filling and emptying the buckets to prevent contamination;
- fill the containers according to the maker’s instructions, normally leaving at least 2 cm space between the fluid level and the container rim;
- open sealed buckets containing known or suspected hazard group 3 biological agents in a microbiological safety cabinet;
- inspect sealing rings (‘O’ rings) regularly and change them if they are damaged.
- Pressures inside overfilled containers can lead to failure of the seal. Overfilled containers also expel liquid droplets when opened.

Microbiological safety cabinets

Staff using safety cabinets need to:

- check that the cabinet work surface is easy to clean and disinfect;
- check the fan is switched on and the air flow indicator is in the safe position before starting work;
- check the airflow regularly during use;
- keep any opening viewing panel closed while working;
- keep the minimum of apparatus and material in the cabinet during operation;
- position apparatus and material so as not to disrupt airflows. In Class I cabinets, larger items should be placed towards the rear, and in Class II cabinets all materials should remain on the work surface and not obscure air vents;
- never place large centrifuges in Class I or II cabinets;
- conduct work well into the inside of the cabinet, away from the opening and view through the screen;
- run the cabinet fan for at least five minutes after completion of work in the cabinet;
- after each work session, wipe the working surfaces with a disinfectant;
- test the airflow with an anemometer at least once every month.

Bunsen burners and other naked flames should never be used inside cabinets, as they distort the airflow and may damage filters.

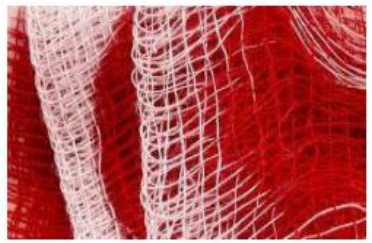
Disinfection

- Environmental cleaning is part of Standard Precautions, which should be applied to all patients in all healthcare facilities
- Ensure that cleaning and disinfection procedures are followed consistently and correctly.
- Cleaning environmental surfaces with water and detergent and applying commonly used hospital disinfectants (such as sodium hypochlorite) is an effective and sufficient procedure.
- Cleaning agents and disinfectants 1. 1% Sodium Hypochlorite can be used as a disinfectant for cleaning and disinfection
- The solution should be prepared fresh.
- Leaving the solution for a contact time of at least 10 minutes is recommended.
- Alcohol (e.g. isopropyl 70% or ethyl alcohol 70%) can be used to wipe down surfaces where the use of bleach is not suitable, e.g. metals

3.5. Waste Management

SCHEDULE I : YELLOW CATEGORY: SOILED WASTE

(a)Human Anatomical Waste: Human tissues, organs, body parts and fetus
(b)Animal Anatomical Waste :
(c)Soiled Waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood



Incineration or Plasma Pyrolysis or deep burial

DRUGS

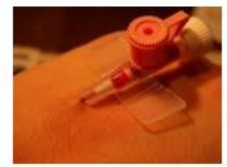
(d) Expired or Discarded Medicines including antibiotics

(d) CYTOTOXIC DRUGS: including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.

Common bio-medical waste treatment facility: Incineration

PLASTIC RECYCLABLE WASTE

(a) Wastes generated from tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and *fixed needle syringes*) and gloves



catheters, urine bags, syringes (without needles and *fixed needle syringes*) and gloves

Autoclaving or micro-waving/hydroclaving followed by shredding or mutilation

INFECTIOUS PLASTIC WASTE

Ward/ individual lab

Sluice room/ common area

GLASS WARE: CARDBOARD BOXES & BOTTLES

- Video of glass bottles intramural transport

LABORATORY WASTE: A SPECIAL FOCUS

Microbiology, Biotechnology and other clinical laboratory waste: Laboratory cultures, stocks or specimens of microorganisms

Slip, Trip, and Fall Hazards

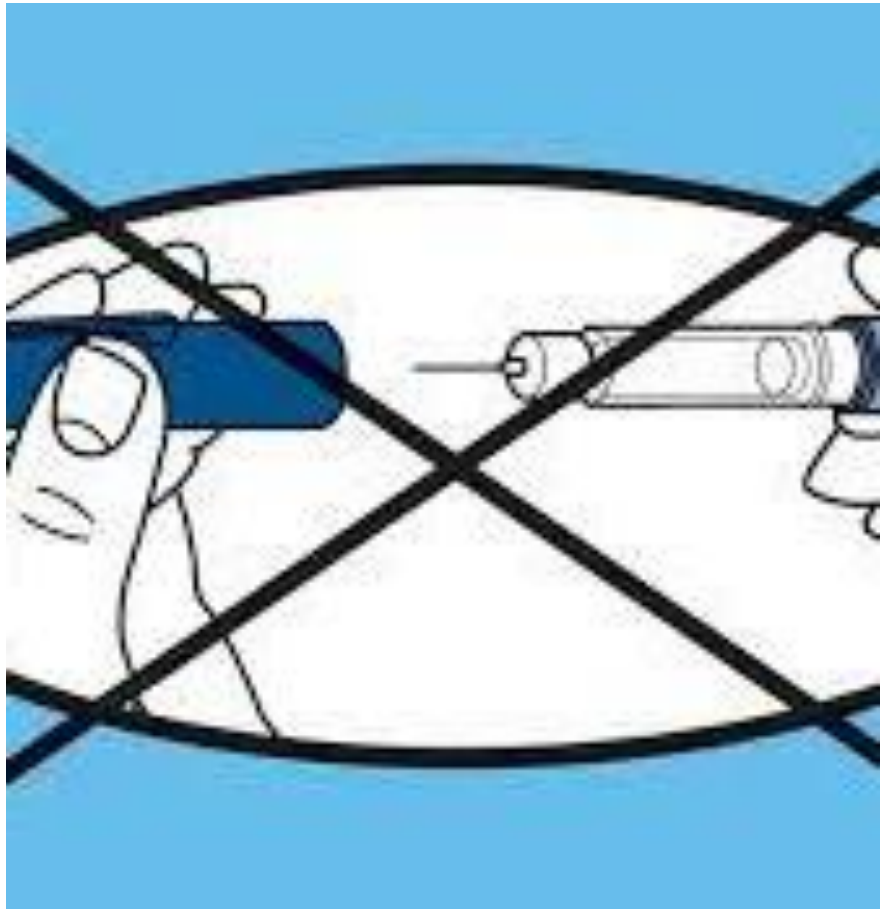
Occupational Exposure and its Management

Potentially Infectious	Non-Infectious (Unless Contaminated with Visible Blood)
1. Blood/ Serum/ Plasma 2. Semen 3. Vaginal Secretions 4. Body fluids—cerebrospinal, synovial, pleural, peritoneal, pericardial, amniotic 5. Any other fluids/ secretions contaminated with visible blood 6. Tissues 7. Laboratory specimens that contain concentrated virus	1. Tears 2. Saliva 3. Urine 4. Stool 5. Sputum 6. Nasal secretions 7. Sweat 8. Vomitus

POST-EXPOSURE MANAGEMENT

- Steps to be followed after accidental exposure to blood/other potentially infectious materials:
- 1. First aid
- 2. Identify the source status if available
- 3. Report to the Infection Control Team immediately
- 4. Risk assessment by Nodal person (based on type of injury and source status)
- 5. Testing for HIV, HBV and HCV for source and HCW
- 6. Decision on prophylactic treatment for HIV and HBV
- 7. Monitoring and follow up of HIV, HBV, and HCV status
- 8. Documentation and recording of exposure

Safe handling of sharps



Prevention of injuries from sharps

- Used needles must not be recapped by hand; if necessary, use the single hand
- Used needles should not be bent or broken after use.
- Used sharps should be disposed of immediately in designated puncture-proof containers
- Sharps should be used only once. A handful of sharp instruments must not be picked up simultaneously.
- While handling sharps, the sharp end of instruments shall be positioned away from oneself and others.
- If injured by sharps, contact the ward, clinic or unit supervisor immediately for further management.

Blood-borne infections in healthcare settings

- Of these, there are two million exposures to HBV, 0.9 million to HCV and 170 000 to HIV. This results in 70 000 HBV, 15 000 HCV and 1000 HIV infections.
- More than 90% of these infections occur in developing countries.

- The challenges faced in preventing these infections are:

1. Limited knowledge on transmission of infections in the workplace
2. Common unsafe practices
3. Lack of standardized procedures
4. Inadequate supplies and use of PPE
5. Lack of regulation and policy to protect HCWs from exposure

- Of the 35 million HCWs worldwide, three million experience percutaneous exposure to blood-borne pathogens every year.

Immunizations

Sign In Here

Sign Up

Username

Username

Password

Password

Forgot your p

Rememb

Injury Assessment Details

Injury Assessment Details

Injury Details

HRID

Employee Name

Department

Place Of Incident

Type Of Injury

Site

Size

Discharge

Drug Allergies

Drug Allergy Details

Tetanus

Hepatitis B

Anti HbsAg Titres

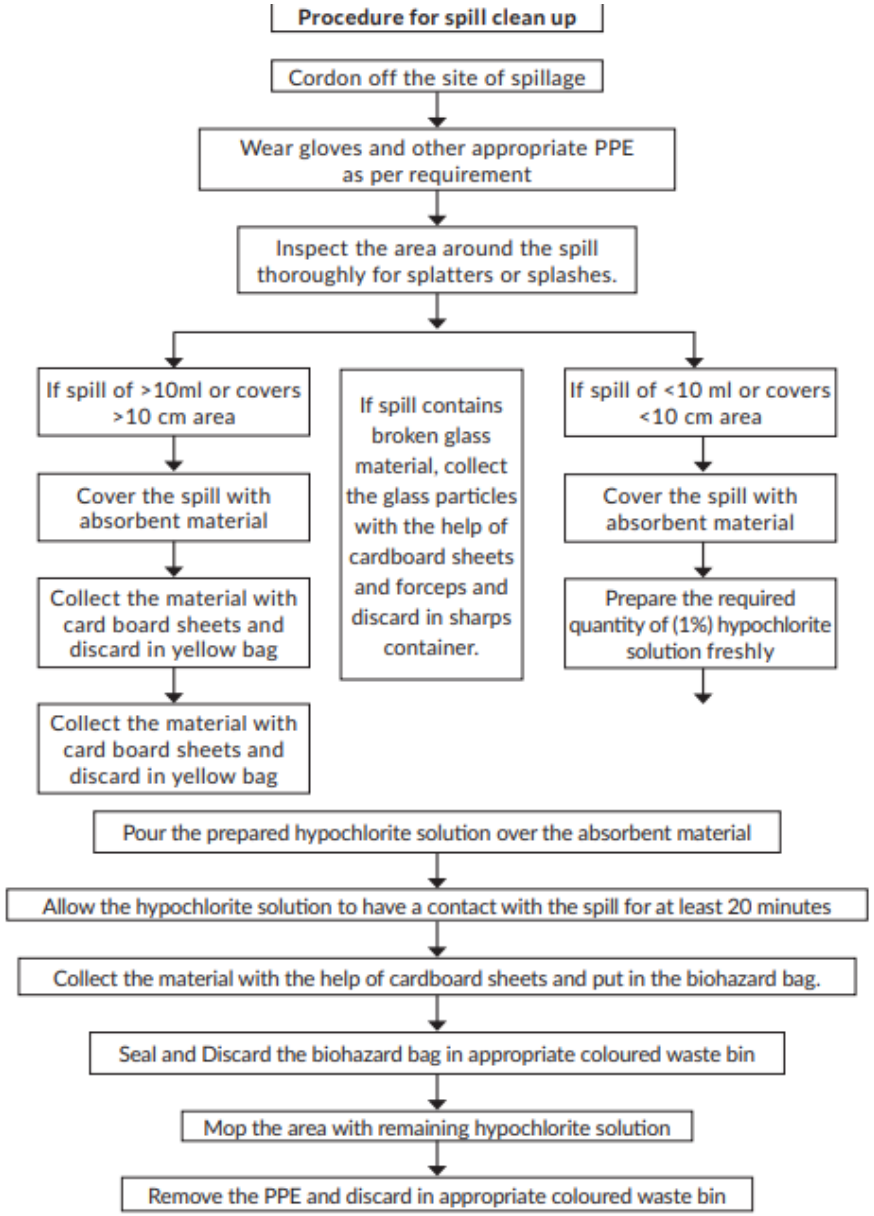
Date Of Incident

Entered By

Back

Save New

Spills


Procedure for spill clean up
Cordon off the site of spillage
Wear gloves and other appropriate PPE as per requirement
Inspect the area around the spill thoroughly for splatters or splashes.
If spill of >10ml or covers >10 cm area
Cover the spill with absorbent material
Collect the material with card board sheets and discard in yellow bag
Collect the material with card board sheets and discard in yellow bag
If spill contains broken glass material, collect the glass particles with the help of cardboard sheets and forceps and discard in sharps container.
If spill of <10 ml or covers <10 cm area
Cover the spill with absorbent material
Prepare the required quantity of (1%) hypochlorite solution freshly
Pour the prepared hypochlorite solution over the absorbent material
Allow the hypochlorite solution to have a contact with the spill for at least 20 minutes
Collect the material with the help of cardboard sheets and put in the biohazard bag.
Seal and Discard the biohazard bag in appropriate coloured waste bin
Mop the area with remaining hypochlorite solution
Remove the PPE and discard in appropriate coloured waste bin

References

- https://isid.org/guide/infectionprevention/laboratory-areas/
- Infection Control in the Clinical Laboratory Environment-By John Russell Forney
- https://www.cdc.gov/mmwr/preview/mmwrhtml/su6101a1.htm