Review Research Paper

Autopsy Practice, Potential Sources of Occupational Hazards: A Review for Safety and Prevention

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Abstract

The mortuary can be a dangerous place. At greatest risk in this environment is the individual who is ignorant of or ignores the potential hazards at necropsy. Such people are a liability to themselves as also to colleagues working in the mortuary, visitors to the mortuary (clinical staff and students), and those involved in handling the body (relatives, undertakers, embalmers and crematoria staff), or material derived from it (laboratory workers) after necropsy. The hazard posed by some material or situation is its potential to cause harm. Risk is the probability or chance that it will actually harm someone. In India, both the mortuaries and their safety norms are lagging behind the expected international standards. The autopsy surgeons are prone to a myriad of occupational risks in the form of contagious diseases which may be due to the faulty mortuary infrastructure like drainage systems, ventilation and biomedical waste disposal. Added to these are the lackadaisical administrative approach and the pathetic implementation of mandatory safety guidelines. This review article focuses on commonly encountered occupational risk in autopsy practice and guidelines to minimize them.

Key Words: Autopsy room, Mortuary, Occupational hazard, Occupational safety & health

Introduction:

The world over autopsy retains its value for determining the cause of death, detecting clinically unknown lesions, identification of unknown/mutilated/decomposed bodies. [1]

The autopsy room has always been a potential source of infection and the autopsy surgeon/Forensic pathologist and other persons engaged directly or indirectly in conducting postmortem examination are at greater risk of exposure to biological hazards like blood borne viruses and other infections including HIV, Hepatitis (A, B, non-A & non-B), Tuberculosis, Creutzfeldt Jakob disease, HTLV-1. [2-6]

With death, there are neither the reticulo-endothelial cells nor the blood-brain barrier to restrict the translocation of microorganisms within the dead human remains. [6] Dead-bodies are often brought for postmortem examination prior to completion of testing, which may reveal advanced infections and deadly diseases or syndromes.

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Apart from this routine risk of exposure, a forensic pathologist frequently works on dead bodies that are in various stages of decomposition. [7]

Hazard and Risk:

'Hazard' is the intrinsic capacity of an agent, a condition or a situation to produce an adverse health or environmental effect. 'Risk' is the probability that a particular adverse event occurs during a stated period of time or results from a particular challenge. An agent may be hazardous but not necessarily result in a risk until exposure occurs and a dose is delivered to target organs. [8]

Transmission of infection requires the presence of an infectious agent, exposure to that agent and a susceptible host, which indisputably is fulfilled by autopsy rooms.

Routes of Infection:

Infections in the autopsy room may be acquired by any one of the following routes:

1. Wound resulting from needle stick injury (e.g. sharp objects) contaminated with blood or body fluids.
2. Splashing of blood or other body fluids onto an open wound or area of dermatitis.
3. Contact of blood or other body fluids with mucous membranes of eyes, nose or mouth.
4. Inhalation and ingestion of aerosolized particles. [9]

Commonly Acquired Pathogens at Autopsy:

The infectious agents are categorized into 4 hazard groups, based on their:

- Virulence as infections.
- Transmissibility & ability to cause epidemics.
- Preventability (by vaccine or prophylactic chemotherapy) and
- Treatability.

1. **Hazard Group 1:** An organism most unlikely to cause human disease.
2. **Hazard Group 2:** An organism that may cause human disease, which might be a hazard to a laboratory worker but is unlikely to spread to the community, exposure rarely producing infection with availability of effective prophylaxis and treatment.
3. **Hazard Group 3:** An organism that may cause severe human disease & present a serious hazard to laboratory workers. It may present a risk of spread to the community but there is usually effective prophylaxis and treatment available.
4. **Hazard Group 4:** An organism that causes severe human disease & is a serious hazard to laboratory workers. It may present a high risk of spread to the community & there is usually no effective prophylaxis and treatment available. [10]

The significant group for mortuary workers is "Hazard group 3" (HG3), caused by biological agents tuberculosis (TB), human immunodeficiency virus (HIV), hepatitis B & C viruses (HBV, HCV) which can cause serious human disease & present a serious risk to employees. In HG4 there is usually no effective prophylaxis or treatment available. This group includes viral haemorrhagic fevers (VHF): Marburg, Ebola, Lassa fever, Congo Crimea hemorrhagic fever & Small pox. [11]

Mycobacterium Tuberculosis:

It has long been known that staffs working in the mortuary are at risk of occupational infection with *M. tuberculosis.* Literature abounds with reported cases of acquired pulmonary and cutaneous infection. Indeed, René Laennec (1781–1826; inventor of the stethoscope) died of the disease, having acquired it from the dissection of tuberculous cadavers. Xavier Bichat (1771–1802), regarded as the "Father of Histology" and performer of some 600 necropsies in the year of his death, also succumbed to the disease.

Pulmonary tuberculosis accounts for approximately 90% of cases and is acquired by inhalation of aerosol or dried material. [12]

Aerosols are generated by aspirators, oscillating saws and water hoses applied to the dead bodies while even compressing and dissecting lungs can give rise to infectious aerosols. [13] Cutaneous infection (paronychia, wart", or verruca) accounts for 5–10% of cases, the bacillus being introduced into previously traumatized skin or via a skin puncture. Muco-cutaneous transmission of tuberculosis at necropsy has not been reported.

The resurgence of tuberculosis, especially in HIV positive patients, and the emergence of multidrug resistant strains reinforce the importance of this disease in any consideration of necropsy health and safety. [11] The increase in cases of multidrug resistant tuberculosis recently is an alarming call for autopsy room workers as well as those who are exposed to it in a professional capacity. Embalmed bodies have yielded active M. tuberculosis for as long as 60 hours after fixation. [14]

Hepatitis:

Hepatitis B virus is the most highly transmissible of all the blood-borne viruses. Infection with hepatitis B can produce a chronic infection that places the individual at risk of death from chronic liver disease or primary hepatocellular carcinoma. The long incubation period of 6 to 24 weeks often masks the association between the event of infection and the onset of symptoms. [15] Among physicians, pathologists have been recognized as high-risk group for occupationally acquired hepatitis B, because of their exposure to blood. [16]

The prevalence of infection is highest in forensic autopsies as they involve bodies of drug addicts, particularly intravenous users. Surveillance of Forensic medicine personnel or staff workers suffering sharp injuries suggests that the overall chance of acquiring infection by this route is about 5%, although if the contaminating blood contains HBeAg, the risk of infection may be up to 30%. [17]

HIV:

The National AIDS committee was constituted in January 1986 after the first AIDS case was registered in the state of Tamil Nadu; The first case of occupationally transmitted HIV infection was reported in medical literature in 1984. [18] HIV serophobia has been documented among staff working in mortuaries handling high risk cases since the 1980s, although there is no evidence that HIV is readily acquired in the mortuary.

Most documented cases of HIV sero-conversion after occupational exposure occurred

after needle-stick injuries. The estimated HIV transmission rate after a single percutaneous inoculation is 0.1 to 0.36 %; this may be underestimated in comparison with the risk associated with accidental deep scalpel injuries. The risk of sero-conversion after occupational exposure will depend upon the viral load, amount of fluid inoculated and susceptibility of the health care worker.

Most health care workers found to be HIV seropositive have a history of behavioral or transfusional exposure. [11]The greatest concern however is the dead body with an undiagnosed disease. According to a report, viable HIV was isolated from blood obtained 16 days after death. [19]

Apart from the above commonly encountered infections an autopsy worker is likely to be exposed occasionally to Hazard Gr.4 infections, Rabies, Dangerous Foreign bodies (hidden sharp objects, exploding bullets), cyanide poisoning, radioactive contaminants.

Autopsies on bodies with Hazard Gr.4 pathogens should only be perform where absolutely necessary. [12] Formaldehyde is a toxic agent to which an autopsy worker is regularly exposed to. Long term exposure has also been associated with increased risk of lung cancer. [20] Mentioned above are the potentially dangerous factors in the mortuary setting. Added to these are the currently increasing outbreaks of SARS and Ebola the world over, which our mortuaries are not yet adequately equipped to handle.

Prevention/ Precautions:

Every dead body should be considered potentially infectious and dealt accordingly as per the recommended precautions, procedural techniques and knowing the principles of pre-exposure prophylaxis. The entire autopsy area and its contents should be designated as 'Biohazard' and appropriate warning signs placed in the mortuary premises. Therefore safety awareness in the mortuary premises is an effective preventive step. [21]

Six categories of potential risks are encountered by the autopsy staff during performing an autopsy and these are; (Table 1, 2 & 3 enlists the risk categories, activities leading to risks & preventive measures.) [21]

1. Mechanical injuries sustained by falling or slipping on the floor.
2. Sharp cutting injuries.
3. Electrocution.
4. Exposure to toxic chemicals (Formalin, Cyanide etc.)
5. Infections.
6. Radiation exposure.

Table 1: Risks and Hazards in Mortuary

Risk Category	Activity	Risks
Physical Risks	1. Use of heavy equipment/loads. 2. Lifting and dragging bodies on a slippery floor	Accidental injuries. Musculoskeletal injury - particularly back strain. Slipping and falling.
Sharp Force Injury	During autopsy, mishandling of a. Scalpel / needle, fragmented bullets with jackets b. Pointed ends of fragmented long bones c. Medical devices such as surgical staples d. Needle fragments in drug-addicts.	Cuts or puncture wounds. Distal thumb, index and middle fingers, are the most frequent injuries sustained by pathologists.
Electrical Injury	1. Electrical instruments (saws) are routinely handled with wet gloves 2. Poorly maintained electrical fittings and connections. 3. Often implanted cardioverter-defibrillator in dead bodies.	Shock and Electrocution
Chemical Exposure	1. Formaldehyde 2. Use as a fixative to preserve tissues for histo-pathological examination. 3. Handling formalin- fixed organs/specimens that have not been thoroughly washed. a. Working in poorly ventilated areas. b. Exposure to highly poisonous aerosol, gases or volatile substances e.g. Organo-phosphates (malathion, parathion) poisoning deaths, hydrogen sulfide, cyanide poisoning while opening stomach/other body cavities.	Irritant effect on mucous membranes of eyes, respiratory tract and skin. Menstrual reproductive disorder, sexual dysfunction. Long-term exposure to the substance has also been associated with an increased risk for all cancers particularly the cancer of lung.
Radiation Exposure	1. Implanted radioactive materials for cancer treatment. 2. X-ray exposure before and during an autopsy taken routinely and frequently.	Potential risk for radiation injuries. Malformation and congenital anomalies in pregnant mortuary workers.
Infectious Disease	Splashing/ Close contact Broken skin Mucosal surfaces. Blood, body fluids and tissues of dead body with infectious diseases, drug addicts etc.	Aerosol: Mycobacterial agents. Blood/body fluid: HIV, Hepatitis B, Hepatitis C & parasitic infections. Intravenous drug abusers: Pose the greatest risk of transmitting viral, bacterial agents like staphylococcus, streptococcus and salmonella.

Table 2: Preventive Guidelines at Mortuary

Injury Category	Prevention or Remedy
Physical Injuries	Proper lifting techniques: 1. Rolling the body instead of lifting. 2. Wearing proper back supports. 3. Hardwearing, impervious, non-slippery floor is essential: a. Mopping the floor to keep surfaces dry. b. Wearing protective shoes. c. Proper ventilation and adequate lighting to keep floor dry and room well-lit.
Sharp Injury	Safe handling of needles and sharp instruments: 1. Should not be left lying around the work area. 2. Habit of putting scalpels on a firm, stable surface (table) by one prosector and then picked up by the second. 3. Do not hold tissues with the fingers of the non-cutting hand. 4. Surgical towels should be placed over the cut edges of the ribs to protect against a scrape injury. 5. Non-pointed (blunt-tipped) scissors should be used wherever possible. 6. Disposal of entire syringe and breaking the needle with needle shredder. 7. Wear cut-resistant gloves (finely woven stainless steel fabric) on the non-dominant hand. 8. Use a thick (3-inch) sponge to stabilize the organ with the non-cutting hand for organ slices. 9. Pre autopsy whole body radiography to locate bullet fragments and irregular bone fragments.
Electrical Injury	1. Properly installed ground fault interrupters (GFI electrical receptors). 2. Implanted cardioverter-defibrillator should be deactivated before manipulation. 3. High-quality latex surgical gloves can protect from inadvertent shock.
Chemical Exposure	Adequate ventilation: 1. Air-exhausted and air-conditioned mortuary 2. Negative-pressure isolation room 3. Wear chemical protective gloves, visors and glasses for protection of face and eye. 4. Mandatory training for employees exposed to formaldehyde above 0.1 ppm.
Radiation Exposure	1. Detailed information of the radioisotope (the amount given and the time of administration) should be attached to the medical record and death certificate. 2. Pathologist and the radiation safety officer to be alerted by the attending physician if the body contains more than 5mCi. 3. Wearing radiation-monitoring badges and Standard procedures for X-ray safety techniques should be followed. 4. Wearing protective rubber gloves can reduce [beta]-radiation very much, but not the [delta]-radiation from the isotopes. 5. A team of pathologists may be required to limit individual exposures to prosector by performing limited portion of the autopsy. 6. Female pathologists and assistants of childbearing age should consult radiotherapist and/or oncologist before commencing the autopsy on a body having implanted radiation materials. 7. Autopsy room should be monitored for radioactive contamination and de-contaminated if necessary.

Table 3: Preventive Measures from Contaminants of Infectious Diseases in Mortuary

Blood borne Pathogens	1. Vaccination against hepatitis B. 2. Prevention of access of immunosuppressed or immune deficient individuals and individuals who have uncovered wounds, weeping skin lesions. 3. 10% formalin should be introduced into the lungs after appropriate microbiological specimens have been taken and before the lungs are examined. 4. Standard universal precautions do not apply to faeces, nasal secretions, sputum, sweat, tears, urine and vomitus unless they contain visible blood.
Agents spread by aerosols e.g. Mycobacterium tuberculosis	1) Adequate ventilation in the post-mortem room. 2) Unauthorized entry & free movement within mortuary should be restricted. 3) Bone surfaces should be moistened before sawing in order to cut down the dispersion of bone dust. 4) Plastic cover or a vacuum bone dust collector attached to the vibrating saw. 5) Immunization with BCG. 6) In case of tuberculosis infection, surgical masks have proven insufficient, in such cases, wearing of N-95 respirators should be made mandatory (High-Efficiency Particulate Air (HEPA) masks.
Exotic agents (both Aerosol transmitted & Blood borne) for which there is no prophylactic or post-exposure treatments	1. Avoids cuts and punctures. 2. Protection against tetanus. 3. All persons in the autopsy room should wear a surgical gown with full sleeves, surgical cap, goggles and shoe covers as recommended safety devices to protect the eyes, skin, and mucous membranes. 4. All the exposed personnel should have access to appropriate health care facilities at the earliest. Information should be given to the authorities and an appropriate medical advice should be sought. 5. Autopsy personnel should have baseline blood tests / serological status of HBV and HIV and tuberculin skin test at the time of employment and a periodic retesting should be undertaken at regular intervals. 6. Training and education of staff in safe working environment and appropriate work practices 7. Use of labels such as **"Danger of infection"** on the dead body is considered appropriate. **Cat. 1** : BLUE label - Standard precautions are recommended. **Cat. 2** : YELLOW label - Additional precautions are recommended. **Cat. 3** : RED label - Stringent infection precautions are recommended.

Recommendation:

1) Identifying Hazards:

a) Carrying out physical inspection.
b) Analyzing accident records.

c) Interacting with the employees.
d) Observing and analyzing tasks and processes.
e) Using consultants.

2) Risk Assessment: It is essential to evaluate the risk of every case entering into the mortuary complex. It is advisable to have an autopsy risk assessment tool in all mortuary setups where autopsies are performed.

3) Hazard Control:

a) **Preparation and planning priorities for control:** Preparation of a written plan of the control measures, in consultation with employees. If control of each hazard is not possible immediately, a priority list should be constructed and the most worrying hazards dealt with first.

1. Elimination of the risk posed by autopsies, both standard and high-risk, is not possible.
2. Isolation of identified high-risk cases to facilities with appropriate work practice controls or isolation of certain procedures within autopsies to areas of effective environment control.
3. Minimization of the risk can be achieved by the institutions, by forming their own policies of work procedures and personal protection along with appropriate training of staff, visitors and contractors.

b) Engineering Controls:

1. Facility design - The mortuary shall be so designed as to allow proper separation of clean and dirty areas by transitional zones.

2. Facility Construction – As per the design, three areas with minimum standards should be constructed.

a) The 'Clean area' includes offices, changing areas, viewing room and reception.
b) The 'Transitional area' constitutes risk assessment area, vehicle bay and body storage. It is important that all workers and visitors to dirty areas move through the transition areas, and are provided with adequate information about personal protection, safety issues and emergency evacuation procedures prior to their entry. These transition areas need to provide adequate cleaning, showering, hand washing and toilet facilities.
c) 'Dirty areas' – Post mortem room, dirty storage for sorting and discarding disposable material (medical waste, disposable instruments and equipment) and the cleaning and preparation of reusable equipment (non-disposable dissection tools, gum boots, face shields). International standards suggest a minimum 2 dissecting tables to allow for efficient work practice. Post-mortem rooms need to have adequate flooring, lighting, electrical fittings, surface finishes, water supply, drainage control, ventilation, emergency showers & eyewashes, work surfaces, and communication equipment.

4) Personal Protective Equipment (PPE) – The concept of universal protection is well known in health facilities. PPE is the final barrier to preventing hazards, known or unknown, from causing personal injury.

5) All employees of mortuary facilities should be educated to identify the hazards likely to be encountered, steps to minimize them and supervised training in the safe use of equipment. Mortuary facilities must have in place a programme which ensures that staffs are suitably vaccinated. [22]

6) Mortuary facilities are maintained as per the laboratory guidelines, which are inadequate considering the multitude of autopsies performed and the bio-hazardous material preserved & discarded every day.

7) All mortuary employees should be covered by appropriate comprehensive health schemes, compensation benefits and expenses incurred due to occupationally acquired diseases.

8) Most mortuaries across the country are in a state of neglect and constant shortage of funds to procure minimum prescribed materials, leading to unhygienic work conditions thereby predisposing both the management and staff to a host of contagious and infectious diseases. The government should take genuine note of this and allocate more funds towards improving the work environment of all mortuaries.

Conclusion:

Mortuaries in India now need to have standards that are stringent enough to cope with the advent of the new or re-emerging infections which pathologists are increasingly confronted with. Of particular concern is the development of the multi-drug resistant strains of tuberculosis and the recognition of the major transmissible viral illnesses. In India, both the mortuaries and their safety norms are lagging behind the expected international standards.

Mortuaries and autopsy rooms across India lie neglected not only by the concerned administration but also by the government (both central & state) with little or no attempt to uplift them; the workers are exposed to the hazardous environment of mortuary. The directive principles of the Constitution of India provide for securing health and strength of employees, men & women, that the citizens are not forced by economic necessity to enter a vocation unsuited (Article 39), which therefore necessitates the introduction of an Act/ Rules by the Government of India and enact the statutes related to occupational safety and health for mortuary employees.

Ministry of labour and employment, Govt. of India and labour department of states who are responsible for the safety and health should notify mortuary environment as hazardous and prepare safe working guidelines as per international standards on OSH (occupational safety and health).

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