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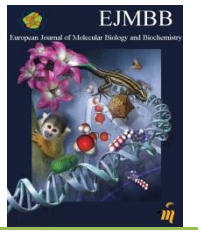

INFECTION CONTROL IN HANDLING OF CADAVERS: A NEGLECTED ISSUE IN INDIAN MEDICAL FRATERNITY!

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ABSTRACT

Cadavers remain a principal teaching tool for anatomists and medical educators teaching gross anatomy. Infectious pathogens in cadavers that present particular risks include Mycobacterium tuberculosis, hepatitis B and C, the AIDS virus HIV, and prions that cause transmissible spongiform encephalopathies such as Creutzfeldt-Jakob disease (CJD) and Gerstmann-Straussler-Scheinker syndrome (GSS). It is often claimed that fixatives are effective in inactivation of these agents. Unfortunately cadavers, even though they are fixed, may still pose infection hazards to those who handle them. Specific safety precautions are necessary to avoid accidental disease transmission from cadavers before and during dissection and to decontaminate the local environment afterward. In this brief review, we describe the infectious pathogens that can be detected in cadavers and suggest safety guidelines for the protection of all who handle cadavers against infectious hazards.Cadaver handling personnels are always at risk to pose infection hazards. Infections and various agents causing infection in the cadavers that present particular risks include tuberculosis, Gp. A streptococcal infection, Gastrointestinal organisms, the agents causing Creutzfeldt- Zakob disease, Hepatitis B and C, Human immunodeficiency virus, meningitis and septicaemia (especially meningococcal). Use of appropriate protective clothing and various precautions should be taken by all who handle cadavers. Key Words: Cadavers, Tuberculosis, Streptococcal, Creutz Feldt, Hepatitis.

INTRODUCTION

The cadaver handling workers are exposed to a number of infectious agents [1]. Most likely infections are those produced by blood born viruses, enteric pathogens and mycobacterium tuberculosis [2]. A strong aversion to dead may represent a natural instinct to protect ourself against the disease [3]. Microorganisms involved in the decay process are not always pathogenic [4].

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The belief that the dead bodies are infectious can be considered as natural reactions by the persons to protect themselves from diseases [5].

How infectious are dead bodies?

Transmission of infection requires the presence of an infectious agent, exposure to that agent, and a susceptible host. It is therefore possible to characterize the infectious risks from dead bodies following a natural disaster by considering these elements. The human body is host to many organisms, only some of which are pathogenic. When the body dies, the environment in which

pathogens live can no longer sustain them. However, this does not happen immediately, and transmission of infectious agents from a cadaver to a living person may occur. Infectious hazards for individuals who routinely handle cadavers include tuberculosis, group A streptococcal infection, gastroenteritis, transmissible spongiform encephalopathies (such as Creutzfeldt-Jakob disease), hepatitis B, hepatitis C, HIV infection, and possibly meningitis and septicemia (especially meningococcal Microorganisms involved in the decay process (putrefaction) are not pathogenic.

Hepatitis Risk of infection depends on infectious status of victim, likelihood and mode of exposure and vaccination status of the exposed individual in case of hepatitis B. In many developing countries, prevalence of chronic hepatitis B is around 8% to 10% [6] and was high for pathologists, surgeons and other exposed to blood. Hepatitis C virus is estimated to infect 3% of world's population. 13% of embalmers were found positive for anti HBV. Exposure occur due to direct contact with non intact skin, percutaneous injury from needles and mucous membrane exposure from blood or body fluid to eyes, nose and mouth [7]. From needle prick, risk of infection for hepatitis B is 6-30% having no prior vaccination, hepatitis C 1.8% and HIV is 0.5% [8].

HIV Infection

HIV can survive in cadaver for a considerable time (16 days after death if stored at 20C) and viable virus is isolated from various viscera six days post mortum [9]. Hepatitis and HIV are transmitted by similar routes and precautions required to prevent transmission of hepatitis B should be adequate to prevent transmission of HIV. HIV is probably about hundred times less infectious than hepatitis B and so risk of those handling the infected cadavers is proportionately less. Most important is exposure to blood (91%) [10]. Cadavers, not all, who died positive for HIV antibodies are known to be infected at the time of death. The virus survives for many years after death in tissue preserved under laboratory conditions (Nyberg et al, 1990). Care should be taken while handling unfixed material from HIV infected cadavers or when undertaking necropsies on cadavers infected with HIV [11]. Embalming of bodies infected with HIV is not recommended and effectiveness of embalming fluids against HIV in cadavers is unknown [12]. Cadavers infected with HIV are after infected with other organisms such as mycobacterium which may be more infectious than HIV infection itself.

Viral Hepatitis

Hepatitis can be seen in many viral diseases such as yellow fever, cytomegalovirus and Epstein-Barr infection, and congenital rubella. However, viral hepatitis is caused by infections by viruses that primarily target the liver. There are six types of hepatitis viruses: A, B, C, D, E, and F types. Hepatitis A is transmitted by the oral route by means of food contaminated with fecal matter. Hepatitis B is extremely infectious. It might be transmitted by blood or blood products, sexual transmission, and skin penetration through contact with infected material. Hepatitis C is transmitted by the same routes as hepatitis B but is probably less infectious. Most of the studies made on cadaveric tissue donors revealed that the availability of cadaveric tissue as a transplantation material is often limited by pathogenic organisms which it may contain. Specific serologic markers of hepatitis B and C viruses can be detected in cadaveric tissue banks (hepatitis B surface ag 18.1% and hepatitis C ab 14.3%) and in postmortem blood tests for body donation programs. The prevalence of HIV and hepatitis C markers has been studied among a cadaver population, and the cases represented a high prevalence of serologic markers for HIV and hepatitis C virus infection. It has been reported that organ transplantation from cadavers can transmit hepatitis. Workers in morbid anatomy also face risk of contamination, which raises serious questions about the infective hazards of cadavers and the effectiveness of fixatives against hepatitis viruses.

Prion Diseases and Transmissible Spongiform Encephalopathies

The transmissible spongiform encephalopathies (TSEs) are degenerative diseases of the central nervous system. Two of these found in humans are Creutzfeldt-Jakob disease (CJD) and Gerstmann-Straussler-Scheinker (GSS) syndrome. GSS is distinct from CJD; GSS is thought to be familial but is known to occur sporadically as well. CJD is characterized by loss of motor control, dementia, paralysis, and death secondary to pneumonia.

The infectious agent that causes CJD has been called a prion and can be defined as small proteinaceous infectious particles resistant to inactivation by procedures that modify nucleic acids. It might be transmitted by diet or after medical procedures such as surgery, cadaver pituitary-derived growth hormone injections, and cadaveric dural grafts or cornea transplants.

Prion is highly resistant to conventional methods of sterilization and disinfection. It has been shown that a related agent that causes scrapie survived interment for 3 years with infectivity. The CJD agent has been shown to survive well in formalinized tissue, and it has been experimentally demonstrated that transmission of prion from formalinized brain tissue to mice is possible. Also, the CJD causative agent has been shown to stay infective in ash at 360°C after formaldehyde fixation. The evidence of risk to those who handle infected tissue has been supported by case reports of this disease in morbid anatomy workers.

Anthrax

Anthrax is also known as Ragpicker's disease/ Wool Sorter's disease. It is an infectious disease due to a type of bacteria called Bacillus anthracis [13]. Infection most often involves the skin, gastro-intestinal tract and

lungs [14]. Differential diagnosis of anthrax includes boil, ulcer, plague, syphilitic chancre, rat bite fever and leishmaniasis [15].

Meningitis (haemorrhagic leptomeningitis) is a serious clinical development which may follow any of three forms of anthrax [16].

Anthrax has worldwide distribution occurring both in the tropical as well as polar regions. The organism can survive for long period in the areas of extreme heat and prolonged flooding. It presents a hazard because it has highly resistant spores which are affected by moisture, temperature and pH but can last for long period in dry conditions. Humans are moderately resistant to anthrax and are less likely to be involved even if in contact with an infected cadaver [17]. Although highly infectious disease, the causative agent is unlikely to survive in the human body for a long time after death.

Tuberculosis

About 1% of world population is infected by tuberculosis every year. Rates are higher in developing countries. Increase in HIV has lead to increase in prevalence of tuberculosis [18]. Incidence of morbidity as well as mortality is higher in United States [19]. Exposure can occur from gurgling at the nose and mouth of the cadaver due to fluid buildup in the chest cavity and putrefaction of tissue and organs. Also the residual air in the deceased's lung may be exhaled when the body is moved [20]. So many cadavers stored together in a temporary mortuary may present an increased risk of infection, once aerosolized; the tubercle bacilli may remain viable for extended period of time. It can be reduced by placing cloth over the deceased's mouth when moving the body and by proper ventilation.

Meningitis and Septicemia

Meningitis can be caused by many organisms but the only ones that present a hazard to those handling the dead are M. tuberculosis and N- meningitidis. Septicaemia is commonly a terminal condition and can be caused by many different organisms. Antibodies has decreased the fatal infection with haemolytic streptococci in general population but the cases still occur in patients as well as from cadaver handling staff and can result from trivial injuries [21].

Gestrointestinal infection, because a corpse will commonly leak faeces, persons handling dead bodies are likely to be exposed to gastrointestinal organism than to blood born viruses. The workers may be exposed through direct contact with the victim body and solid clothes. Transmission occurs via faeco-oral route. Contamination of other equipment such as stretchers and vehicles used for transportation and storage is also possible. However common gastro intestinal organism does not survive long in environment and present little risk of infection. Pancephalopathic type of Creutzfeldt Jacob disease is found to be associated with the cadaver duramater graft [22].

MANAGEMENT

The information given above indicates that a cadaver might be still infectious at the time of arrival in an anatomy department for subsequent educational purposes. Therefore, specific safety precautions are mandatory from the moment of the cadaver's arrival at the facility.

Reducing the Risk of Infection

A number of simple measures can be taken to reduce the risk of infection associated with cadavers. All the workers should have basic instructions about the risks and precautions. Universal precautions for blood and body fluids and enteric precautions should be followed [23]. Other personal protective equipment like eye wear, gowns and masks are only required when large splashes of blood are anticipated. Hands should be washed after handling the cadaver and before eating and all equipment washed with disinfectant. Body bags can also reduce the infection and are useful for transportation of cadavers who are badly damaged. But the body bags reduces the rate of cooling and increase rate of decomposition especially in hot climate. Hepatitis B vaccination prevents infection and is 70-80% effective within a week of exposure. Therefore while dealing with cadavers, covering of cuts or lesions with water proof dressings, careful cleansing of any injuries sustained during embalming, particularly use of appropriate protective clothing will greatly reduce the risk of acquired infection.

Preparation for Dissection

The corpse must have a detailed file, indicating the reason of death and containing previous hospital records if possible. Working on cases known to be infectious with *M. tuberculosis*, hepatitis B and C, HIV, and prions should be avoided. Every cadaver should be regarded as an infectious material.

'Every cadaver should be regarded as an infectious material.'

During the transportation process, disposable body bags must be used. The risk to department personnel of respiratory tract pathogens from the deceased is probably remote, even from the single exhalation of air that occurs when the body is first moved. Covering the face of the body with a cloth would be a simple precaution.

Proper protective clothing must be used by the department personnel for avoiding accidental transmission. Single-use latex examination gloves must be worn whenever handling bodies; they should be used once only and then discarded. Safety gloves (e.g., Teflon-made from spectra, or metallic gloves) should be worn over examination gloves to protect from longer term exposure to chemical hazards and accidental penetrating wounds. Filter masks must be used for respiratory protection from specific

hazards, such as lead dust, fungal spores, and aerosols. Face visors should be worn for protection against hazardous splashes to eyes, nose, and mouth. Disposable aprons or gowns must be used for protection against splashes to the body. Contamination of the dissection table should be avoided by a nonpermeable, disposable plastic sheet or similar material.

Embalming Chemicals

Although embalming is thought to reduce the infectious risks, there is inadequate information about the disinfectant properties of fluids commonly used to embalm cadavers. The embalming fluid used in anatomy departments contains fixatives, disinfectants, surfactants, buffers, glycerol, salts, and water. The most frequently used fixatives and disinfectants are formalin, ethanol, and phenol. Formalin, a 37% aqueous solution of formaldehyde gas, inactivates infectious agents by forming covalent cross-links with several organic functional groups on proteins. Although formaldehyde is known to be a high-level germicide that has the capacity to kill all microbes and viruses, it is ineffective against the CJD agent as mentioned above. Ethanol is one of the most commonly used alcohols to control microbial growth. Its mechanism of action involves protein denaturation and lipid dissolution.

Ethanol can be used alone in concentrations of 60 to 95% or in combination with other antimicrobial agents in lower concentrations. It is known to be effective against bacteria and fungi but not endospores, nonenveloped viruses, or prions. Phenol and its derivative phenolics exert antimicrobial activity by inactivating essential cell enzymes and injuring lipid-containing plasma membranes, which results in leakage of cellular contents. At concentrations above 1%, phenol and phenolics have an antibacterial effect. They have a broad spectrum of activity against bacteria, viruses, and fungi, but they are ineffective against prions. In suspension tests, these fixatives and disinfectants were shown to be effective against most of the bacteria and viruses. However, it is not clear whether they are also effective in cadavers, for several reasons. First, in suspension tests, the cell-free infectious agent is tested, whereas in humans, some infective agents (such as HIV) can localize within cells. Second, the concentration of the embalming fluid components decreases as they diffuse throughout the human body. Third, several classes of products, including formalin, alcohols, and phenolic agents, are partially inactivated by the presence of protein. This sensitivity to organic load suggests that the efficiency of the disinfectants will be much lower in cadavers than in vitro tests. Fourth, although a certain fixative at certain levels may be cidal to a single agent or even a group or class of infectious agents, other agents that co-exist may survive as mentioned above; thus, complete disinfection may not be accomplished.

Post-dissection Decontamination

After the dissection is completed, tissue remnants, cutting debris, the sheet covering the table, and all the disposable material should be discarded within a plastic container as infectious hospital waste. All instruments that came into contact with potentially infectious material must be decontaminated. Although the conventional methods of sterilization and disinfection are effective for most of the infective agents, they do not decontaminate prions. Specific measures must be used for prions, and these measures will also be adequate for other infective agents. One of the most effective procedures is steam autoclaving (instruments, safety gloves, etc.) at 134°C with 30 lbs psi for 60 min (Committee on Health Care Issues, 1986). Chemical decontamination with 2 N NaOH for 1 h or 1 N NaOH for 2 h is an alternative for nonautoclavable materials and surfaces. It is not recommended to use NaOH for aluminium material. Boiling of instruments in 3% sodium dodecyl sulfate (SDS) at least 3 min is another option. Autoclaving can be used either alone or in combination with using SDS or NaOH. Alternatively, 5% NaOCl (at least 20,000 ppm free chloride) can be used for 2 h, but this chemical is very irritating and corrosive to steel.

The environment should be cleaned with a phenolic disinfectant (containing 3–5% active ingredient) daily. This method is preferred to hypochlorite for several reasons: hypochlorite is a corrosive chemical and may damage surfaces or instruments; cleaning large areas with hypochlorite may liberate unacceptable amounts of chlorine; and formaldehyde reacts with hypochlorite to produce a potent carcinogen, bis-chloromethyl ether.

CONCLUSION

The potential infection hazard from human cadavers is one of the risks of being a member of an anatomy department. Special care must be taken to reduce risks to a minimum. Safe working conditions for handling cadavers can be provided through proper education, use of protective clothing, and practice of hygienic measures. Although following the recommendations mentioned can reduce the risk of infectious hazards of cadavers, vaccination of all who handle cadavers against hepatitis B and *M. tuberculosis* (Sterling et al., 1999) is another important precaution that should not be missed. Finally, dissection laboratory directors must stay up to date on the most recent literature in the field to help ensure the safety of all educators, researchers, and students under their charge.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

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