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Biological disaster, prevention and rescue

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ABSTRACT: Biological Disaster leads to mass mortality due to the entry of virulent microbes into a ongregation of susceptible people living in a manner suited to the spread of infection. The widespread of infection is caused by spore dispersal in the air. Small Pox spreads by aerosols, Typhus and Plague spread through vectors such as lice, fleas, rodents and mosquitoes. During emergency outbreaks in Laboratory, Hospitals and Health Care Industries, the essential protection against diseases of biological outbreaks (bioterrorism) will include the development of mechanisms for appropriate detection of such outbreaks, rescue of people from the counter places, preparedness of neutralizing the bio-terror agents, and mobilization of investigational and therapeutic counter measures. The spectrum of possible pathogens is narrow in case of deliberately generated outbreaks (bioterrorism) whereas biological outbreaks can have a wide range of pathogenic microbes. However, the mechanism required to face both outbreaks can be similar if the service providers are adequately sensitized. Therefore, novel strategies are essential to face such emergencies through mitigation. Neutralization of the bio-terror pathogens will be the prime step to control the infections in affected regions. Mitigation of the airborne chemical, biological and radiological agents (CBR) will be carried out by employing an ideal Heating, Ventilation and Air-conditioning system (HVAC). In fact, this is often considered to be the best and a first line of defense against bio-terror. Preparedness and HVAC can significantly reduce the toxic release due to CBR. Evacuation of the pathogens can be done through the liberation of CO_2 gas to the contaminated area. Persons in the infected areas must be immediately rescued to a safety area. Every microbial laboratory handling virulent microbes should have a safety area, where it is fully covered with high efficiency particulate air (HEPA) filters provided with dual air cleaning system. One air exhaust system will filter the pathogens and provide sterile air to the rescue room whereas another system will eliminate the pathogen from infected area. This will be vice-versa, when the bioterror happens in *ex situ* and *in situ* environments.

Keywords: Biological Disasters, Rescue, Bio-terror, Pathogens.

Introduction:

The biological and toxic weapons are a big threat for the global society. Currently, many incidences on biological and chemical man made weapons impacted several countries such as Syria, Sri Lanka, Libya, Afghanistan, Israel, Iraq, Brazil, Japan etc. In India, leakage of methyl isocyanine gas at Bhopal, Madhya Pradesh resulted in mass mortality. Numerous workers suffered with massive respiratory shock due to the tragedy and the disaster effects are being carried over to subsequent generations. Such man-made disasters have become a potential threat to the whole world, which necessitate us to develop novel rescue strategies from disasters of chemical, biological and radiation origin. The rescue strategy involves preparedness, mitigation, neutralization and evacuation [1]. The Intentional or accidental biological disaster is caused by the

release of airborne chemical, biological and radiological agents which pose significant threat to the counter places such as hospitals, laboratories, health care units and industries that handle patients, patient samples and other materials. Origin of bioterror outbreaks in healthcare units will subsequently affect public at large, when the agents are released to the surrounding environment. Devising preplanning and emergency response measures is necessary for containing bioterror agents, and most importantly, these agents should be handled in a safe environment equipped with HVAC system.

Preparedness towards facing chemical, biological and radiological hazards and their toxicants are counteracted by HVAC and antidotes systems. A range of biological antidotes are currently in use to evacuate the bioterror agents such as *Anthrax, Yersinia pestis, Francisella tularensis, Botulinum toxins, and viruses such as Ebola, Marburg,etc* [2]. These pathogens can be decontaminated by CO_2, hydrogen peroxide, nitrogen and chlorine dioxide. After decontamination, personnel from the counter place are to be mitigated towards the safety area. The possible suspect areas for intentional or accidental bio-disaster are operation/surgery theaters, diagnostic laboratories, hospitals, cell culture laboratories, microbial and defense research laboratories. Therefore, novel strategies and measures for containing bioterror agents or preventing their diseases need to be devised. The building of bio-terror counter places should be facilitated with air handling units for controlling air pressure, filters for absorbing toxic particulates using HEPA and HVAC systems [3]. The above parameters should be taken into account while preparedness and prevention of biological disaster. In this study, a novel strategy for mitigation from the bio-terror counter places, and effective neutralization and deionization of bio-terror agents are envisaged. Besides, novel solutions to the reduction phase of biological disaster measures were optimized and standardized during emergency situations.

Components and methods of managing biological disasters

Clean room

Clean room provides HEPA which can remove 99.9% of all micro particles in room air by laminar air flow or turbulent flow system to the environment air. In the laminar air flow (LAF), air flows in unidirectional, unimpeded and straight from the environment to *in-house* as shown in the Figure-1. The flow of air filtration requires 80 percent of clean room ceiling to maintain constant air flow processing. LAF filters the air by pneumatic, primary and secondary or air membrane filters. LAF utilizes the HEPA to filter and clean the air entering the environment. Different sizes of HEPA filters are required for filtering various particle sizes and the size ranges from 0.0001 micron to 10,000 micron (Table 1). Biosafety cabinets of 1-4 levels should be employed at counter places for managing biological disasters due to bio-terror agents.

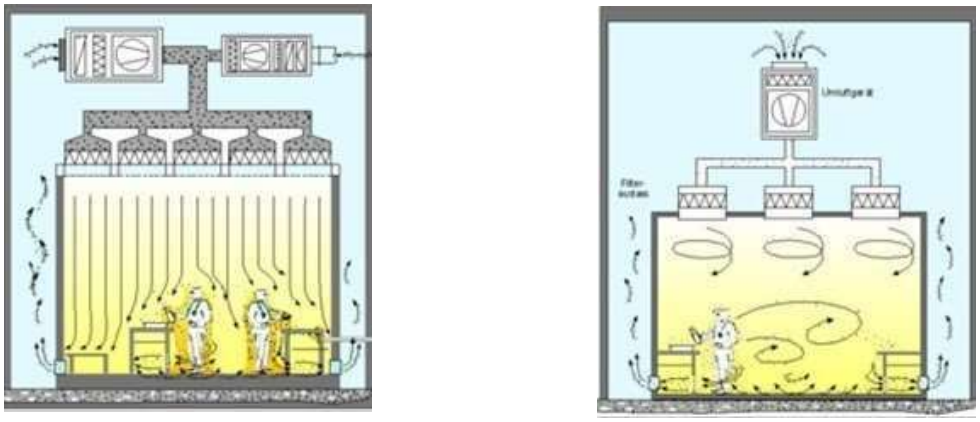


Figure 1. Air flow of turbulent and laminar air flow systems.

HVAC

HVAC system (Figure 1) will maintain good indoor air quality through adequate ventilation with filtration and provide thermal comfort. HVAC systems are among the largest energy consumers in schools. The choice and design of the HVAC system can also affect many other high performance goals, including water consumption (water cooler air conditioning equipment) and acoustics.

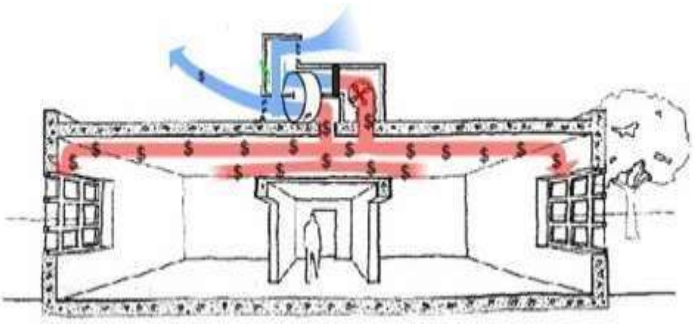


Figure 2. HVAC, HEPA/ULPA Filter system for Safety area to manage bioterror disaster.

HVAC coupled with HEPA/ULPA filter system, permanganate oxidizers and activated charcoal are used as gas removal filters. Some manufacturers offer "partial bypass" carbon filters and carbon impregnated filters to reduce volatile organics in the ventilation air of office environments. Gaseous filters must be regularly maintained (replaced or regenerated) in the system for effective and continuous operation.

Preparedness and Prevention:

Preparedness covers appropriate counter measures of chemical, biological and radiological disasters. The safety and prevention strategies for mitigation should be provided in the suspected counter places. The disaster in the emergency areas such as hospitals, defense departments, highly crowded places such as worship places have the long term mitigation of mass populations. The parameters for preparedness include planning, capacity building, well established medical facilities, trained doctors and medical attendees, workshop for rescue, rescue maps and flowchart indications in buildings. These preparedness parameters help in reducing the morbidity and mortality. The emergency medical division is aware about the existing bio-terror agents that are shown in Table 2. Preventive measures were strengthened by establishment of medical facility, safety and secure areas. The medical doctors, attendees, nurses and other technical persons should be vaccinated for the above bio-terror agents since these people are the first contact persons with bio-terror agents.

Table 2. Microbial pathogens used as bio-terror agents

S. No.	Disease	Agent
1.	Anthrax	*Bacillus anthracis*
2.	Plague	*Yersenia pestis*
3.	Tularemia	*Francisella tularensis*
4.	Q fever	*Coxiella brunetii*
5.	Botulism	*Clostridium botulinum*

6.	Cholera	*Vibrio cholera*
7	Shiegellosis	*Shigella dysenteria* (causes severe disease), flexneri, boydii, sonnei (short clinical course)
8.	Small Pox	Variola virus
9.	Viral Haemorrhagic fever	Ebola virus, Marburg virus, Lassa virus

Detection, Evacuation and Neutralization

The bio-terror agents were detected for the severity, pathogenicity and treatment of patient suspected with the infection. Rapid diagnosis of the pathogens via sensor based detection will be employed during bio-disaster emergency situations since other diagnostic methods such as staining, ELISA, cell culture and other spectrometric assays

are time consuming. Evacuation of viruses, toxic chemicals and gases are rapidly performed by employing the antidotes. Antidotes for neutralizing the pathogens such as hydrogen peroxide, CO_2 and chlorine dioxide fogging are employed in the counter places. Evacuation of the pathogens is carried out for the safety of workers in the counter places. Evacuation will be done through the HEPA filters and HVAC system. Rescue of counter persons will be secured to the safety areas. The safety areas will be furnished with two evacuators system such as HVAC and HEPA.

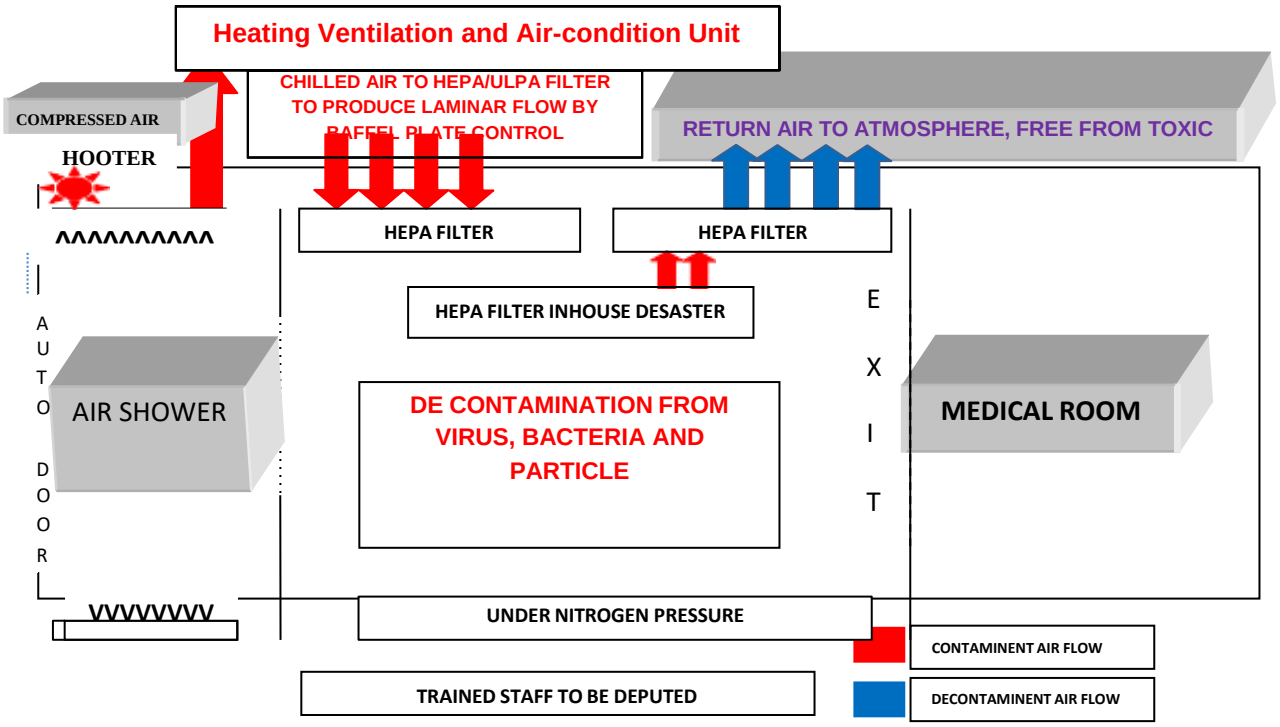
Mitigation

Mitigation involves the rescue of people from the counter areas and relocates them in the safety area. The people are segregated to the clean rooms. The clean rooms will be equipped with the sterile air conditioning. The HVAC system will be constructed with the HEPA filters and different micron pore sizes of various particulates will be employed (Table 1). The chemical agents such as chemical particulates and gases and biological agents such as pathogenic aerosols are filtered in the HEPA filters and radiation is prevented by lead shielding. Mitigation starts from showering sterile air to the counter places and the persons will feel comfort to respire and survive. The sensitive HEPA filter performs evacuation of microbes such as bacteria, fungal and virus from counter places. Then, the neutralization of bio-terror agents by chemical disinfectants will be employed in the counter areas and finally the rescue task should end up with clean room. The two evacuator system will be implemented in the clean room. One evacuator cleans the bio-terror agents, subsequently expelled to the environment and another evacuator filters the air and supplement to the safety area. This will work vice versa from *in situ* to *ex situ* and *ex situ* to *in situ*. The model for mitigation is shown in the Figure 3.

Conclusion

This paper concludes the steps and components required for managing the emergency issues of Bioterrororism. The building of the counter places should have the clean rooms, safety areas, disinfection area, HEPA and HVAC systems to filter the bio-terror agents and evacuation room for the survival under biological disaster. The particulates at different levels of filtration through HEPA filters are standardized, interpreted and recommended for emergency management in this paper. Further, the preparedness and preventive measures are described.

Figure 3. HVAC COUPLED WITH HEPA OR ULPA FILTER FOR MITIGATION



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