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Biosecurity: understanding, assessing, and preventing the threat in laboratory environments

This work provides an overview of the phenomenon of laboratory biosafety, posing it as a potential precursor to biological attacks. Importance of defined roles and responsibilities of laboratory personnel are outlined with sensitivity to threat level.

Biosecurity is a strategic approach to analysing and managing relevant risks to human, animal, plant life and the environment. Biological agents have been an important component of warfare and terrorism for millennia, and we need to outline clear yet flexible methods for protection of valuable bio material both in laboratory spaces and outside of them.

Such actions are commonly referred to as "bioterrorism," which is defined as "the threat or use of biological agents by individuals or groups motivated by political, religious, environmental, or other ideological motives".

Bioterrorism, in addition to intimidating governments and societies, has the mass destruction of life as the primary goal. The intent of biological weapons is crucial, as its choice often directly correlates with how it will be used. Will the weapon be used to infect a small, large group of people, or group that could infect others? The onset of an attack may not be noticed until the biological agent has spread significantly, depending on the principal hazardous characteristics of said agent. They will rrr5e5einclude:

- its capability to infect and cause disease;
- its virulence as measured by the severity of disease;
- the availability of preventive measures and treatments;

To illustrate this point- toxins such as anthrax only affect the exposed person and there is usually no secondary transmission. Like all infectious biological agents, B. anthracis occurs naturally and is easily found in the environment. Having said that, a handful of farm soil containing this bacterium is not weapon grade. Significant manipulation of the bacterium, such as culturing, mass production, and purification, is necessary for the development of large numbers of B. anthracis spores [1]. Furthermore, one should not forget that biological agents do not have to be used as weapons in order to create a successful bio crime or bioterrorism event. For example, the illegal introduction of naturally occurring Salmonella into a public salad bar is not by any means considered weapon-grade, but can negatively affect the population and cause significant panic [2]. Hence, even though certain bio agents may be suitable for infecting large numbers of people, the effect is limited to those initially exposed or is easily mediated. Another point related to naturally occurring substances is that it may not be possible to determine whether the release of organisms was deliberate. This occurs largely because the sources and vectors of biological agents such as wind borne

or foodborne contaminants are very difficult to trace [3].

Population density and consumption growth are changing the landscape and the global climate in unprecedented ways. In particular, emerging infectious diseases require close attention, as they can cause significant harm and are relatively unpredictable. Recently, both in the health sector and in agriculture, concern has increased about the use of new pathogens of infectious diseases as biological weapons. For example, the recent spate of West Nile virus infections in the United States has raised suspicions of bioterrorism in some quarters, but all available evidence points to the accidental introduction of the virus.

It is known that ecologists advocate that the release of GMOs should be considered analogous to the introduction of non-native species. It is not known whether GMOs introduced into agricultural systems will invade natural ecosystems and hybridize with related species or otherwise threaten native populations and communities, but they should be prevented in any case. Personnel working with such organisms must be especially careful because the identification of genetically modified organisms without direct testing is often impossible, and even more often they do not cause direct and immediate harm.

Gaining access to biological agents has never been a significant limiting factor. Alternatively, criminals may prefer to obtain cultures from standardized sources to ensure purity of used specimens. Despite efforts to curb the illegal acquisition of biological agents, it is likely that terrorists and criminals will be able to get the agent they need, whenever they want. If they cannot get them from a legal culture collection or from a medical supply company, they can steal them from the laboratory, or acquire illegally using connections. If a group with the right experience can cultivate the agent from samples obtained in nature [4].

A biological laboratory is a facility in which microorganisms, their components or their derivatives are collected, processed and/or stored. Along with their diagnostic, research and pharmaceutical capabilities, those who work in biological laboratories share responsibility for the accounting and safety of the materials they work with. Ensuring the safety of biological material is a delicate task due to a number of complications. Unlike many traditional security applications, the most valuable resource of the institution- people pose the greatest potential threat. We have had too few cases of theft, loss or leakage of valuable material to actually create reliable models to quantify risk. Personnel account for safety of the materials they work with, and therefore protect global public health. Some instances when lab staff abused their position and breached the biosecurity measures are known:

- Thomas Campbell Butler, an American scientist specializing in infectious diseases, including cholera and bubonic plague, from Texas Tech University since 1987. He was arrested in 2003 and prosecuted by the US Department of Justice for, among many other charges, illegal transport of plague specimens.
- The anthrax letters of 2001, carried out by Bruce Ivins, a US Army biodefense expert. Federal prosecutors identified Ivins as the sole culprit on August 6, 2008, based on DNA evidence that found a vial of anthrax in his laboratory.

  In biological laboratories, responsibility of securing the equipment rests

with facility managers and laboratory staff: all laboratory personnel are required to take reasonable precautions against theft or misuse of such equipment. Certain equipment such as bioreactors, incubators, aerosol dispensers or aerosol test chambers can be used for both legal and illegal purposes. Obviously, not all pieces of laboratory equipment have comparable sensitivity or the same potential for dual use.

Personnel management procedures should define the roles, responsibilities and authorities of laboratory workers who will use, store, transfer and transport valuable biological material. Organizations must ensure that members of the workforce have appropriate qualifications and skill, and provide, depending on the type of bio material they are working with, identity verification and the use of a polygraph. These means are considered necessary in order to identify the intentions of the interviewed person and prevent any potential harm. Staff managers should also cover procedures and training for visitors, contractors, subcontractors, suppliers, cleaning and maintenance personnel.

It is important to establish practical realistic steps that can be taken to safeguard and track bio agents. Information may be confidential but should be available for use in the future.

Overdoing or exaggerating the sensitivity or level of suspicion can also have unintended negative repercussions. The higher the level of risk associated with a valuable biological material stored in an institution, the more protection the information associated with the security system will need. This is a complex process that may require careful consideration and reflection. Therefore, laboratory management and relevant authorities should develop appropriate policies that govern the labelling and handling of information, and how the information is collected, maintained, distributed, documented, accessed, shared and stored within the facility and with appropriate partners.

Research on selected agents now requires stringent security measures, including background checks on staff by competent authorities, limited access to laboratories, and guards at some facilities. Such measures can weed out scientists from their peers and complicate recruitment efforts. Laboratory biosecurity measures should be tailored to the needs of the institution they are applied on. Their identification should be the result of a biosecurity risk assessment that includes input from scientific and laboratory management, biosafety officers, maintenance personnel, administrators and law enforcement officials. Some institutions receiving samples for diagnosis or other testing may not have full control over the materials processed, but should have a mechanism for storing and disposing of samples under appropriate conditions.

Personnel management procedures should define the roles, responsibilities and authorities of laboratory personnel who will interact with the materials, as well as the way in which the organization ensures that employees have the appropriate qualifications and skills. Staff management provisions should also cover procedures and training for visitors, contractors, subcontractors, suppliers, cleaning and maintenance personnel [5].

If by some means the valuable bio-material got out, it is important to establish practical and realistic steps that can be taken to safeguard and track it. Once a harmful organism has been identified, mechanisms must be put in place to promptly

alert appropriate personnel to implement the most effective interventions, using the technical knowledge, adequate information for decision-making, and immediate access to adequate technology and financial resources.

Meaning, a rapid response program, in close collaboration with state and local authorities.

This requires governments and institutions to:

- Create an easily accessible funding mechanism for emergency response, development or change policies and regulations to support rapid response and improve environmentally sound pest eradication and control methods.
- Increase the capacity for taxonomic identification of bio agents, using available new technologies for molecular analysis where necessary;
- Develop inventory and monitoring programs to detect organisms of concern, prioritizing potential invasion pathways and locations that pose a particularly high risk;
- Create mechanisms for interdepartmental exchange of information, coordination and cooperation between all levels of government and the private sector;
- Review at all levels of relevant policies, legislation and institutions, with intent to identify conflicts, gaps and inconsistencies;

Improved understanding of how and why microorganisms emerge and spread, which species are most likely to be harmful, and how the consequences can be identified, evaluated and mitigated. develop new environmentally friendly methods to quickly respond to pests and eradicate them. Creation of programs to build community support for prevention, eradication and control programs is also advised. Importance of education and outreach cannot be underestimated [3].

Laboratory-related infections caused by exposure to disease-causing biological agents are uncommon, but it is compulsory that the microbiological and biomedical community remains vigilant, as there is no room for complacency in this issue. An understanding of biosafety, specimen containment and safety practices will help create a safer and healthier work environment for laboratory and surrounding staff, as well as the community as a whole.

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