ANTICIPATING BIOSECURITY HAZARDS: DISTRIBUTION AND RECOGNITION OF BIOLOGICAL THREATS

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Understanding the potential biological weapons that can be created, the technologies involved, and the entities capable of producing them is crucial for biosecurity. Equally important is comprehending the various targets a biological weapon might be aimed at, the deployment methods, and available detection strategies to counteract illegal biological threats. This chapter delves into these aspects, starting with methods of deployment. The Center for Disease Control and Prevention (CDC) categorizes disease transmission into direct and indirect modes. Direct transmission involves contact with an infected person or environmental reservoir, including droplet spread, proven highly effective in densely populated areas. Indirect transmission occurs through contaminated objects or vectors. Vehicle-based transmission involves contaminating inanimate objects like food, water, and biological products. Vector-based transmission involves organisms carrying and transmitting pathogens. Airborne transmission, receiving significant attention for its potential in biological attacks, involves pathogens suspended in the air, posing significant risks, especially in crowded areas.

Biological weapons could target humans, agriculture, technology, and the environment. Attacks on humans, often the focus of biosecurity efforts, pose catastrophic outcomes. State-sponsored programs often focus on human pathogens like Bacillus anthracis and Yersinia pestis. Agroterrorism, targeting agriculture and livestock, can lead to economic losses and social instability. Attacks on technology, utilizing synthetic biology, have shown the potential to manipulate DNA to store and deploy malicious code, highlighting vulnerabilities in sequencing systems. While attacks on the environment remain theoretical, advancements in gene drives raise concerns about manipulating ecosystems.

Effective biosecurity involves pre- and post-deployment screening techniques. Pre-deployment screening, particularly gene synthesis, focuses on preventing the acquisition of DNA fragments for weapon production. Current measures involve background checks and screening against pathogen lists, yet gaps exist, including inadequate international policies and the potential to hide malicious sequences within longer ones. Post-deployment detection relies on traditional molecular diagnostic methods, but synthetic pathogens may evade detection, necessitating ongoing advancements in detection techniques. Real-time sensors and biosensors offer promising avenues for quick and accurate pathogen recognition, although challenges remain in detecting novel pathogens against a natural background.

In conclusion, understanding the range of biological weapons, their potential targets, deployment methods, and detection strategies is essential for effective biosecurity. Continued research and advancements in detection technologies are crucial to staying ahead of evolving biological threats, ensuring a safer and more secure future.