

Need for Unambiguous, Multiplex Detection Platforms for Biothreat Agents

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Earthen pots full of venomous snakes fired on enemy ships, arrows dipped in potent neurotoxins for hunting, use of blankets of small pox patients to spread disease; man has known the potentials of biological agents since ancient time. Pathogenic microbes and the toxins of biological origin were long considered the natural enemies of human beings and their therapies or antidotes were searched in rituals and herbs. Our understanding of the disease causing microbes dramatically grew in the 20th century and we learnt to cultivate most of them axenically. The miseries of influenza pandemics and 'black death' made indelible mark on human psychology and left haunting memories of the ordeal for generations to come. It triggered formation of loci of activities across the globe with committed researchers and physicians who worked relentlessly to develop prophylactic and therapeutic regimens for infectious diseases.

The end of 20th century and the onset of 21st century saw advent of a new evil when groups of insane people realized the potentials of infectious and toxin agents for clandestine uses and the shadows of biothreat had never been as dark in the history of mankind as it is today. In order to mitigate this eminent threat, the civilized population started thinking rationally and looked at the same set of researchers and physicians to seek answers. These researchers were busy developing prophylaxis, diagnostics, and therapeutics in order to handle the menace of infectious disease in society. Small pox was eradicated, polio was largely controlled and vaccines for many more infectious diseases were developed. Unfortunately, the intricacies of biothreat scenario are starkly different from the public health problems that has so far been the focus of most of the government sponsored and private health agencies worldwide. The key differences arise from the facts that in a BTW scenario, the geographical boundaries for infectious diseases become porous, the herd immunity and endemicity become irrelevant, the type of agents likely to be used are distinct from the major public health related organisms, and the envisaged route of infection or intoxication is inhalation of artificially and deliberately generated bio-aerosol. Apart from several others, the criteria to prioritize agents include their ability to cause disease through inhalation route of exposure, stability in the environment, and lack of appropriate medical countermeasures to handle mass casualties.

The biothreat mitigation involves an amalgamation of several agencies and a harmonious interplay of all. We need early warning systems such as LIDAR, detection platforms for select agents including capability to handle environmental samples and proximal fluids which entails role of forensic scientists, prophylactic/therapeutic medical countermeasures, local administration, disaster management team, hospitals with trained professionals to handle BTW scenario, and technologies to address specific needs in each area. Early detection of biothreat agent is of paramount importance in order to implement medical countermeasures effectively. The incubation period between the time of infection and onset of disease varies from one agent to the other and is also governed by the dose received; the biological toxins generally act rapidly as compared to microbial agents. As against chemical and nuclear weapons, this inherent time span associated with biothreat agents provides leverage for mitigation protocols. However, if the bioattack remains latent, we'll get to know the seriousness of the situation only after the disease has set in the population, leaving

hardly any time to take remedial steps. A 24×7 surveillance system for biological agents can be of immense value to take maximum advantage of this incubation period and implementing Standard Operating Procedures (SOPs) for medical countermeasures. Online monitoring for biological cloud has become plausible with the advent of newer technologies; however, sample collection, processing, and unambiguous identification of select agent remains a major challenge in a biothreat scenario. Malicious uses of select agents includes release of a biological cloud containing a threat agent embedded in aqueous or solid particles of breathable size range (generally <10 μm) or contamination of water and food sources, the former being more catastrophic in effect. Once a threat is perceived, a sample collection and processing shall immediately ensue either with the help of an aerosol collector (a cyclone collector or impactor) or in the form of suspected environmental or food samples. The daunting task of unambiguously identifying the threat agent is addressed using several technologies largely employing immunodetection or the revolutionary technology of polymerase chain reaction (PCR) in one form or the other. Notably, identification of toxin lacks the PCR equivalent for the pathogens to amplify the target and needs alternative strategies to achieve required sensitivity and specificity. Unfortunately, the responsibility to develop detection methodologies for biothreat agents was given to researches dedicated to develop diagnostics for various infectious diseases of public health importance, without realizing the fact that the two scenarios need different approaches to answer the questions. This lead to one agent one system kind of approach with little applicability in a biothreat scenario; the samples are collected before the onset of the disease and carries no symptomatic or endemicity clue about the agent. The mixing of issues of disease diagnosis and agent detection in bioattack was crippling to the needs of biothreat mitigation. Recent developments in the genomic and proteomic technologies have brought hopes for universal platforms for unambiguous, multi-agent detection [1-3]. The principles of microarray, PCR, and/or mass spectrometry form the core of most of these multi-pathogen detection platforms and are remarkable in their specificity and sensitivity. Mass spectrometry is especially important for toxin agents where directed multi-analyte detection can be achieved from unknown samples [3]. These systems are expected not only to provide accurate and sensitive identification of microbial or toxin agents but also to discriminate them from their close phylogenetic and phenotypic neighbors. Developments in the field of biosensors, especially SPR based biosensors, with sensor surface coated with array of specific capture molecules is another area of significant impact in this regard.

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Despite all the advantages of technology centric, multi-agent detection platforms; their applicability in real time field conditions is questioned and the 'time to result' remains a major bottleneck for many of these techniques. Collection of aerosol samples using unmanned aerial vehicle equipped with collectors and bringing these samples to reference centers (preferably spread over the population loci) is envisaged to shorten this time span with sample processing methodologies involving automated microfluidics based devices. Converting some of these technologies into a field friendly format is of utmost importance which is already in offing for mass spectrometers and other sensing devices. In the days to come, we shall see a metamorphosis of research pertaining to Biodefense with delineation of groups from those working in the area of medical diagnostics;

these differentiated domains are already clubbing with technologists, physicians, and strategists to build the foundations of a sustainable development to protect our future generations from this hiding demon.

References

1. Sampath R, Mulholland N, Blyn LB, Massire C, Whitehouse CA, et al. (2012) Comprehensive biothreat cluster identification by PCR/electrospray-ionization mass spectrometry. *PLoS One* 7: e36528.
2. Janse I, Bok JM, Hamidjaja RA, Hodemaekers HM, van Rotterdam BJ (2012) Development and comparison of two assay formats for parallel detection of four biothreat pathogens by using suspension microarrays. *PLoS One* 7: e31958.
3. Alam SI, Kumar B, Kamboj DV (2012) Multiplex detection of protein toxins using MALDI-TOF-TOF tandem mass spectrometry: Application in unambiguous toxin detection from bio-aerosol. *Anal Chem* 84: 10500-10507.