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Impact of Social Sciences on Nanovaccines Awareness in attaining Sustainability against Biological Warfare Agents

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Manzoor Khan Afridi * | Rubina Ali † | Inamullah Jan‡

Abstract *The Health system has witnessed numerous catastrophic outbreaks, epidemics, and pandemics. A biological outbreak can be natural, accidental or intended factors are responsible for the emergence of health threat. Threats can be genetics or biological; ecology; social, economic or political, and environmental based. Conventional technologies for the detection of these threats fail to adequately resolve the issues like imperfect detection, time-consuming procedures, high cost, and relatively reduced sensitivity. Conventional vaccines have limited efficacy, teratogenicity, high toxicity, and limited biosafety. Rapid developments in functionalized nano detectors and nano vaccines have revolutionalised the design of compatible nano-agents with improved on-site detection, decontamination, and rapid elimination of chemical, biological and infectious agents. This paper provides key insights into nanotechnology-based approaches and challenges related to the monitoring, detection, and targeting of these agents. Innovative nanotechnology-driven approaches with high sophistication may open up new opportunities in addressing the threats of biological and chemical warfare concerning homeland security.*

Key Words: Infectious Agents, Chemical and Biological Threats, Detection, Vaccination, Nanotechnology, Homeland Security

Introduction

Social sciences are helpful in rendering the social scientists for enabling the improvement in public health and socioeconomic issues via mitigating sufferings of pandemics. Social scientists tend to highlight the major issues in the degradation of the health system understaffed local newspapers and communities for bypassing communication barriers in developing the preparedness of sudden calamities like biological warfare agents. Coronaviruses are associated with a group of RNA viruses that produces disease (Daga et al., 2019). The National Science Foundation (NSF) and National Institutes of Health (NIH), other essential funding cradles, have accepted the significance of COVID-19-related in the field of social science. The NIH is also doing funding in the emergency research on themes containing the impacts and mechanisms of social isolation and connectedness of the societies. The NSF's "Division of Social and Economic Sciences" is assisting a study on media use, risk perception, stress and defensive behaviors inside the US population, "via a $200,000 Rapid Response Research grant" (Wagner & Alexander, 2013).

* Associate Professor, Department of Politics & International Relations, International Islamic University Islamabad, Pakistan. Email: manzoor.afridi@iiu.edu.pk
† PhD Scholar, Department of Politics & International Relations, International Islamic University Islamabad, Pakistan. and Visiting research Scholar at CSSS, Department of War Studies, and King's College London.
‡ Lecturer, Department of Politics & International Relations, International Islamic University Islamabad, Pakistan.

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Biological infectious and chemical contamination – whether natural, accidental, or intentional– poses a threat and conflict among millions of lives. These threats may also prove to be the key factors of economic and political instability. The ongoing natural outbreak of coronavirus disease 2019 (Hogendoorn, 1997) (Titus, Lemmer, Slagley, & Eninger, 2019) showed that no country is fully prepared to respond to large-scale public health emergencies. Chemical and biological warfare agents (CBWA) have been employed as weapons of mass destruction (Imshenetsky, 1960) (Titus et al., 2019) for their tendency to kill masses. As the number of potential CBWA increases, the need for their detection and decontamination has increased (Hamilton & Lundy, 2007; N. H. Lee, Nahm, & Choi, 2018). However, the most available conventional methods employed for detecting CBWA threats (Walper et al., 2018) are insufficient, slow, expensive, and complex require sophisticated sample preparation procedures and laboratory conditions (such as temperature and incubation). While in the battlefield or other remote emergency conditions, access to laboratory-grade instrumentation is not possible, yet detecting these CBWA threats is of utmost required (Zhang, Yuan, & Zhang, 2019). Similarly, life-threatening biological warfare agents (BWA) are countered by conventionally by vaccination. Yet, vaccines are restricted by their efficacy limited to only known BWA and suboptimal immunogenicity and protection issues

(Arora, Sindhu, Dilbaghi, & Chaudhury, 2013; Berger et al., 2016; Feng, Li, & Varma, 2011; Kwon, Song, Park, & Jang, 2018).

The vaccines are developed against biological agents, usually viruses, that have been identified to infect humans or animals. The vaccine may become less effective or ineffective if the virus mutates or the disease is caused by a new viral strain. The present COVID-19 pandemic instigated by SARS-COV-2 is an instance of the disease caused by the stated strain of an old virus SARS-COV-1, which caused the disease in the outbreak in 2002-2004 (Bradley & Bryan, 2019). Unfortunately, certain viral infections still exist for which vaccines cannot be developed, such as the Hepatitis C virus infection (Zingaretti, De Francesco, & Abrignani, 2014). Nanotechnology has revolutionized the biomedical field, including diagnosis, treatment, and theranostic applications. Nanovaccines are the next generation of vaccines (Tao et al., 2018), and nanoscale devices represent their potential for addressing the threats to human security. Therefore, nanoparticles -based vaccines are very minute particulates ranging from 20-100 nm and possess the capability of targeting the immune system of the body to trigger host immune responses.

Nanovaccines possess unique characteristics of improved efficacy and regulated in-vivo immune responses via optimized methods and synthesis conditions by varying surface charge, size, shape, hydrophobicity, and antigens loading. Specified antigens can be conjugated to the surface or core of the nanoparticles in the form of vesicles and micelles (Li, Li, Gong, Zhang, & Sun, 2017; Liu et al., 2017). Nanovaccines are the great substitute of simple subunit vaccines, which only consist of some pathogenic components and possess weakened immune response. Nanovaccines result in extended antigen release and circulation time for use in immunotherapy. Nanovaccines mechanistic approach lies in the low pH endosomes and lysosomes for helping endosomal escape because at low endosomal pH, the protonation of nanoparticles core results in the swelling of nanoparticles as well as rupturing the endosomal membrane through proton sponge effect. The proton sponge effect of nano vaccines causes proficient transfer of antigens into the cytosol of the dendritic cells with no cytotoxicity (Luo, Samandi, Wang, Chen, & Gao, 2017).

It has been discussed that nano vaccines are considered preferred for mitigating the onset of various pathogenic diseases. Their optimized use and awareness is still the stigma of developing and under-developed countries. Social scientists have the capability to sort out the stigma on the usage of nano vaccines via collecting the data online properly and collecting on phone surveys too. Moreover, after the usage of nano vaccines, some more precautions are necessary for maintaining the distance, cognitive biases, risk management and decision-making processes.

Chemical and Biological Warfare Agents Disasters and Preparedness of Social Scientists

Terrorism through CBWA is politically inspired violence or the hazard of such violence, particularly against civilians, intending to impart fear, harm, or both (Hamilton & Lundy, 2007; Ilchmann & Revill, 2014; Ramasamy et al., 2010; Sydnes, 2013). The first reported use of chemical warfare agents (CWA) (Ilchmann & Revill, 2014) when Emperor Barbosa poisoned water wells with human bodies in Italy in 1155. The most recent usage of CBWA for the mass killing was done by Japan in World War II, wherein they infected 10,000 water wells in Chinese territories (Riedel, 2004). Similarly, the United States has been constantly under threat of CBWA and many attempts were made, although with low success. These attacks made individuals comprehend that CBWA attacks could occur in a nation that was believed to be one of the most secure nations (Ellison, 2007) . CBWA was used during 1347 in the Crimea; British in 1763 during the French and Indian War; Germany during World War I (WWI) and World War II (WWII); and by Japanese soldiers during the 1930s and in WWII. USA and Britain has created Bacillus anthracis spores during WWII, yet they didn't utilize them. After WWII, the US ran a BWA program until the late 1960s and didn't authorize the Biological Weapons Convention till 1975 (Ilchmann & Revill, 2014). The Soviet Union also had related projects. An accidental arrival of Bacillus anthracis spores from a Soviet BWA production line in 1979 caused an episode of inhalational Bacillus anthracis. In 1984, the primary bioterrorist assault happened in Oregon executed by members of a religious cult using Salmonella bacteria(Compton, 1988). Bioterrorism was regarded as a more prominent danger in the US after the 9/11 attacks.

Indeed, it was followed by the spread of Bacillus anthracis spores by means of the mails the same year (Know). In light of these episodes, the US Center for Disease Control and Prevention (CDC) created three levels of emerging infectious agents based on the potential use in bioterrorism and the seriousness of the infection. Class A contains the most lethal pathogens such as Anthrax, Botulinum, Plague, Smallpox, Tularemia and pneumonic fever agents. Class B includes Salmonella typhi, Brucellosis, Staphylococcal enterotoxin and Ricin toxin. Emerging pathogens, poisons and toxins are included in class C. Biological warfare agents are often designated as bacterial spores, viruses, algae, and plants (Ellison, 2007). Furthermore, they are separated into three tiers, A, B, and C. Bacillus anthracis, and Clostridium botulinum is tier-A agents that resulted in massive mortality cases. Bacillus anthracis causes anthrax which was the most excessively used notorious BWA in the US in 2001(Szinicz, 2005). The detail of emerging infectious agents is mentioned in Table 1. CWA offers diverse properties and unique physiochemical and physiological characteristics. They can be categorized into persistent or non-persistent. Choking agents and blood are non-persistent or non-volatile CWA, whereas, blister agents, nerve agents and vesicants fall under the category of persistent CWA due to their volatile nature (Ganesan, Raza, & Vijayaraghavan, 2010). Generally, researchers use non-toxic CWA parts or analogs in research for the detection and removal of these agents (Compton, 1988; Ganesan et al., 2010; Know; Szinicz, 2005). Various major issues such as threatening of chemical as well as biological wars, the burden of infections, re-emerging infections, and bacterial multidrug resistance are major concerns of national security and public health (Black, 2010; Pitschmann, 2014). Therefore, efficient defensive strategies against bioterror attacks are urgently needed for public health. Arise in the bioterrorism of government legislation and political conspiracy was highest after the 9/11 attack (Hamilton & Lundy, 2007). Pre- and post-attack strategies were followed for the manufacturing of CBWA weapons. Pre-attack defensives events included (J. S. Lee, Hadjipanayis, & Parker, 2005; Ramasamy et al., 2010; Walper et al., 2018). Substantially destroying terrorist individuals or groups to cease the CBWA (Berger et al., 2016). The implementation of this approach required vigilance and intelligence on the proper utilization of weapons and their reservation. The next important step was the involvement of the political powers to regulate the use of weapons. Owing to the difficulties intrinsic in recognition of biological weapons, the main attention is given to the post-attack scenarios i.e., a synchronized response and effective management skills to protect people from the pandemic. Sufficient reserves including potent drugs, efficacious vaccines, prophylactic medicines, and chemical antidotes are of utmost importance to tackle a bioterrorism attack incident. Existing vaccines, detection, and monitoring systems need to be optimized to lower the probability of fast spread and contamination (Rowland, Brown III, Delehanty, & Medintz, 2016). Social scientists, including numerous sociologists, possess the unique quality of uniting for maintaining the defense of national security. Teams of social scientists are highly useful in managing the national security against disasters via connecting with the other scientists via focusing on the specific goals. These goals can be achieved through capacity building, pre-impact, reconstitution, restoration and managing emergency situations as shown in Figure 1. However technical aspects can also be added to social work system by measurement of monitoring, implication of software and hardware, external rules and regulations, internal organizational features, work flow communication, and human-computer interface.

Table 1. Characteristics Features of Pathogens Employed as Biological Warfare Agents

Biological warfare agents	Characteristic Features	Associated disease	Possibility of transmission
Bacteria			
Bacillus anthracis	Gram-positive, spore-forming, rod-shaped bacillus	Anthrax	None
Francisella tularensis	Gram-negative, spore-forming, aerobic coccobacillus	Tularemia	Moderate
Burkholderia mallei	Gram-negative, spore-forming, aerobic bacteria	Melioidosis	Moderate
Viruses			
Ebola virus	Family Filoviridae, negative-sense RNA virus	Hemorrhagic fever	High
Marburg virus	Family Filoviridae, negative-sense RNA virus	Hemorrhagic fever	High
Foot and mouth virus	Family Filoviridae, positive-sense RNA virus	Foot and mouth disease	High
Rinderpest virus	Family Filoviridae, negative-sense RNA virus	Rinderpest	High
Toxins			
Botulinum toxin	Neurotoxin	Botulism	None

Figure 1: Preparedness of Social Scientists for the Management of Disasters

Nanodetectors for Security Monitoring

The detection of chemical, biological, radiological, and other hazardous agents has imperative significance for both the military and homeland security endeavors. Detectors are a serious part of the defense technologies as these offer solutions to the whole defense ecosystem with complex controls, monitoring, measurements, and implementation. Military and defense systems contain drones, space crafts, rockets, military automobiles, ships, satellites, marine systems and missiles. These systems are employed in varying environments of normal as well as in the wars. External and internal security systems depend on smart intelligence, smart detector technology for surveillance, and modern warfare operations (Gould, Walker, & Yoon, 2017). The detectors are installed on land, aerial, marine and space stations to keep constant watch over a specifically targeted zone. Recent research has validated the adaptability of small, lightweight, moveable, and highly sensitive nanodetectors in defense monitoring applications (N. H. Lee et al., 2018). Such implications also profit from the capability of new submarines to infiltrate otherwise remote sites, for installation and functionalization of the nanodetectors in remote areas (Saito et al., 2018) . In CBWA scenarios, the main aim of detectors is to inform about abrupt variations and risks to allow satisfactory defensive measures at the right time. Consequently, the development of a consistent detection system for these CBWA is key research focuses worldwide. Conventional detection systems used for the identification of CWA rely on flame photometry principle, Raman spectroscopy, ion mobility spectrometry, infrared spectroscopy, colorimetry, flame ionization, fluorogenic, and enzymatic methods (Black, 2010). Some of these techniques are costly and intricate, and their activity is also not reliable and proficient at times. Moreover, humidity and temperature also impart substantial influence on the performance of these detectors. On the other hand, the nanocargoes for CBWA sensing offer discrete proficiencies, accessibility to distant sites, and rapidly targeted associations (Arora et al., 2013). Particularly, researchers have associated natural receptors present in the human body with nano assemblies to get benefits of the high target specificity of the natural receptors. When the natural receptor bounds the target, the signal can be detected by electrochemical impedance spectroscopy, quartz-crystal microbalance, surface acoustic waves, or surface plasmon resonance (Kwon et al., 2018). The invention of the self-propelling nanocargo has dragging force to transport nanocargoes nanodetectors to inaccessible sites. Therefore, self-proficiency and innovative construction technologies employed in designing nanodetectors fast targeted interactions and sensing in the complex matrices.

Advanced Nano-sensors for Selective Detection of a Bacterial and Viral Strains

Among biological infectious agents, Bacillus anthracis (B. anthracis), a Gram-positive bacteria, is a potential BWA military or terrorists and demands sensitive, rapid, and cost-effective detection and deactivation approaches (Cirino, Musser, & Egan, 2004). The aptitude of sporulation and resistance of the spores to severe environmental conditions makes anthrax the most significant BWA. Conventional approaches of decontamination comprise chlorine dioxide, bleach, and hydrogen peroxide treatment for the killing of B. anthracis cells. To address shortcomings related to current technologies, nanocargoes-based approaches are reported for the fast screening, detection, and inactivation of anthrax spore. B. globilli antibody-surface modified micro-cargoes were prepared as 'on-the-fly' spore screening tool. These micro-cargoes can identify, capture, isolate and transport B. globigi spores in the environment (Orozco, Pan, Sattayasamitsathit, Galarnyk, & Wang, 2015) whereas displaying no interaction with an excess of non-target bacteria such as Staphylococcus aureus (S. aureus) and Escherichia coli (E. coli). The self-propulsion capability of micro-cargoes influenced efficient fluid mixing, at the microscale level, and this mixing was presented to be very effective in accelerating both spore-receptor associations and detection. This nano-cargo-based strategy, thus, offers significant promise for the development of effective detector systems by adopting the mechanisms of plasmonic colorimetric assays as shown in **Figure 2.**

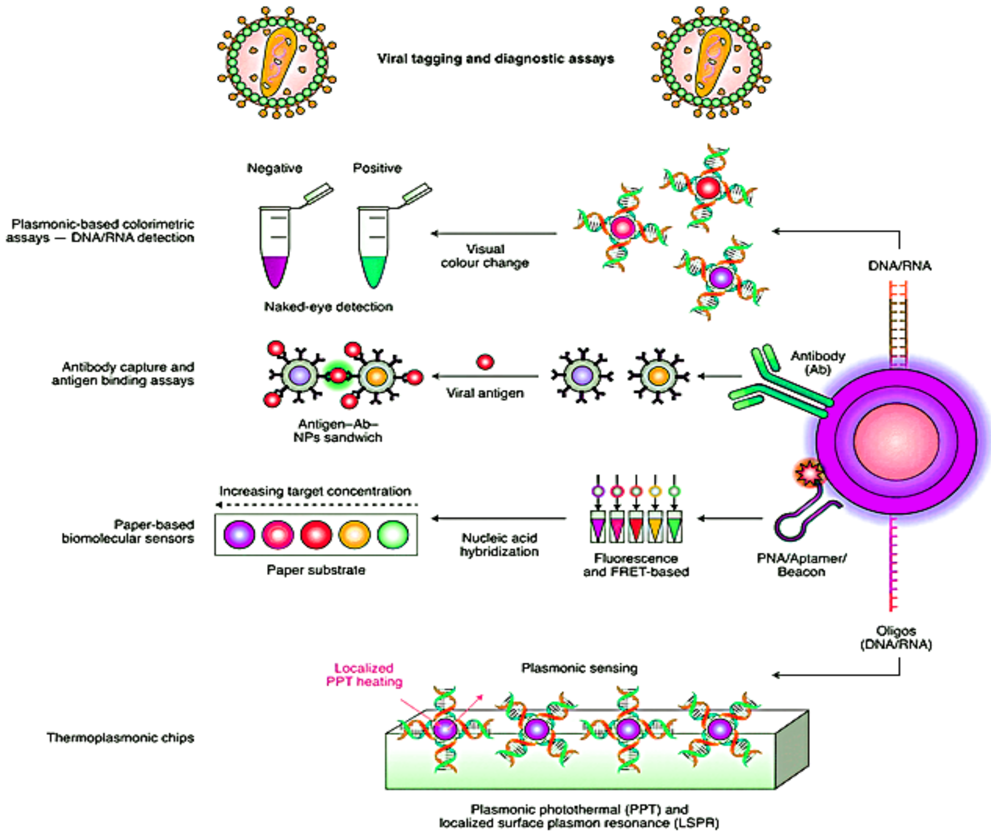

Figure 2: Plasmonic Calorimetric Assays for Detection of Bacterial and Viral Strains

Nanovaccines against Biological Threats

Bioterrorist attack has low-risk, high-impact incident, efficient and persistent preparedness is a crucial element in the control of a CBWA outbreak. Although a significant amount of resources have been employed to encounter the challenges of chemical and biological threats, considerable gaps have been observed in the preparation for epidemics triggered by vastly pathogenic organisms, for example, the severe acute respiratory syndrome (SARS) (Feng et al., 2011), H1N1 influenza virus (Rudge et al., 2012), Ebola virus(Rajakaruna, Liu, Ding, & Cao, 2017) and now (COVID-19) disease. The local and international responses against coronavirus disease 2019 caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) revealed inadequacies that bioterrorists might exploit when deliberately initiating an epidemic in the future. Consequently, there is an immediate need in almost every country of the world for prophylactic vaccines that can provoke rigorous cellular and humoral immune responses and offer defensive immunity against COVID-19 and other biological infectious agents.

The prophylaxis may comprise both vaccines and antimicrobials. Vaccines during pre-exposure prophylaxis episodes are confined for health-care workforces, armed forces, and emergency response teams. Post-exposure prophylaxis comprises of vaccines and antimicrobials for a deliberate or natural outbreak would embrace both those people recognized to be exposed during the event and those people who were sick by others. Monoclonal antibody formulations are now being deliberated for prophylaxis in specific, high-risk groups(Gronvall et al., 2013). Table 2 provides an overview of pre-and post-exposure prophylaxis for category-A infectious agents.

Notwithstanding their robust immunostimulatory efficacy, pre-clinical and clinical trials conducted with the conventional immunizations have raised questions over reactogenicity and pathogenic contaminations in attenuated pathogen vaccines (J. S. Lee et al., 2005; Rudge et al., 2012; Sugawara, Ohkusa, Kawanohara, & Kamei, 2018). Conversely, molecular subunit antigens isolated from entire pathogens are more secure options, yet they are far less immunogenic than attenuated pathogen vaccines. Therefore, research has been focused on the delivery of vaccines by using NPs, named as nano vaccines, and solve the problems with attenuated pathogen or subunit vaccines (Tao et al., 2018) [20, 54-57]. Various biomaterials based nanoparticulate delivery systems have been reported to shield epitomized antigens from enzymatic inactivation and codelivery of adjuvants to lymphatic tissues. Interestingly, these nanomachines can be delivered to affected area in normal storage conditions without requiring cold-chain as for most conventional vaccines (Vijayan, Mohapatra, Uthaman, & Park, 2019; Yue & Ma, 2015). Nanovaccines recruit macrophages, dendritic cells and antigen-presenting cells to prompt cell-mediated and humoral immunity after easily intake from lumen of intestine through microfold cells and enterocytes to the Peyer's patches (PPs) Charge, double-layered structure, size of vesicles, lamellarity, and lipid transition temperature are the numerous parameters of nano vaccines that may have impact on the response from immune system as shown in Figure 3.

Table 2. Available Medical Countermeasure (Pre-and Post-exposure) for Category-A Pathogens Employed as Biological Warfare Agents

Biological agent	Vaccine		Medications	
	Pre-exposure	Post-exposure	Pre-exposure	Post-exposure
Smallpox	Yes	Yes	No	No
Pneumonic plague	Yes	No	No	Yes
Tularaemia	No	Yes	No	Yes
Haemorrhagic fever	Yes	No	No	No
Inhalation anthrax	Yes	Yes	No	Yes

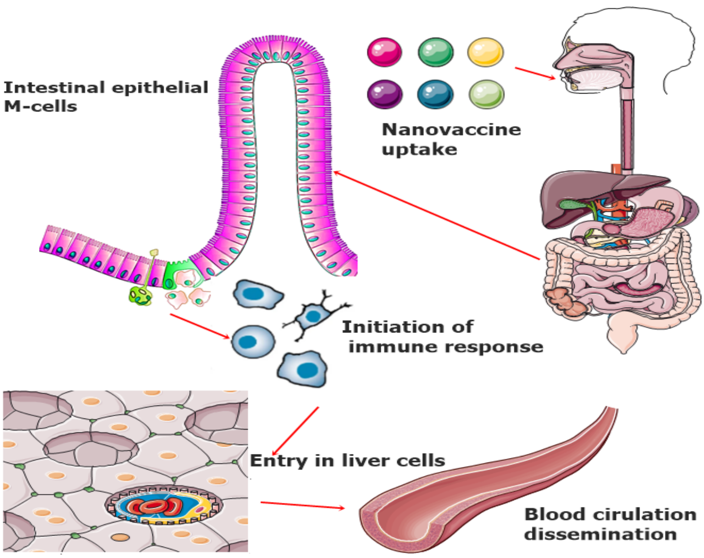

Figure 3: Nanovaccines Entry in Human Body through Intestinal m-cells and Initiation of Robust Immune Responses

Nanovaccines provide targeted delivery along with prolonged-release while performing its prime role of enhanced antigen stability as well as immunogenicity. Different NP-based vaccines with varying physicochemical features can be useful in clinical settings. The main feature of nano vaccines is to augment the antigen circulation life and antigen uptake by dendritic cells, leading to direct stimulation of dendritic cells and promoting cross-presentation. Moreover, NPS protect the antigen and adjuvant from premature enzymatic degradation. Antigens can be transported to the target site by encapsulation inside nanoparticles or by attaching onto the surface of the nanoparticle. Nanoparticles favor loading multiple components inside one carrier that enable prolonged, targeted, and simultaneous delivery of one or more of the biological agents such as antigens, DNA plasmids, deactivated bacterial toxins, and adjuvants (Tao et al., 2018). The important factors governing the development of a candidate as a vaccine are low immunogenicity, simple composition, and potential to boost antigen effectiveness. Nanoparticles possess exclusive physicochemical characteristics like the large surface area to volume ratio, controllable size and shape, and tuneable surface charge (Yue & Ma, 2015). Hence, they can be surface engineered to develop into versatile vaccine formulations by attaching protein, peptides, cell-penetrating peptides, polymers, and other ligands on the surface of NPs. These nano vaccines can be tracked inside our body, thus, assisting multimodal imaging that can further improve therapeutic outcomes (Vijayan et al., 2019). Above mentioned NPs pose some disadvantages, as well as they may lack colloidal stability inside a physiological system because of protein corona formation and unwanted interactions with the immune system (Moon, Huang, & Irvine, 2012) .

The colloidal instability and undesired interaction with the reticuloendothelial system can be prevented and circulation in the blood can be enhanced by the utilization of a novel class of NPs known as biomimetic NPs (Moon et al., 2012) . These nano vaccines contain NPs mimicking biological membranes such as liposomes that can be obtained by dispersion of phospholipids in an aqueous system(Chen et al., 2012). Liposomes have the advantage of high loading capacity and the ability to deliver hydrophobic and hydrophilic agents simultaneously (Chen et al., 2012).

Nanovaccines provide a structural design as an opportunity to package antigens in a feasible manner. Leishmaniasis is an intracellular protozoan disease "affecting 12 million people in the world" (Saleem, Khursheed, Hano, Anjum, & Anjum, 2019). Several chemotherapeutic have the capability of treating disease but due to limiting efficacy, long term therapy and development of drug resistant virulent strains, its treatment remains the major challenge (Saleem et al., 2019). Therefore, MA Danesh-Bahreini et al (2011) developed nano vaccines for leishmaniasis includes recombinant Leishmania superoxide dismutase (SODB1), which was then loaded into chitosan nanoparticles via ionic gelation method. Tuberculosis (TB) is the leading cause of death in the world and the most common vaccine used against TB is Bacillus Calmette–Guérin (BCG). BCG is highly effective for the treatment of TB in children.

Botulinum toxin is another potential BWA which is produced by Clostridium botulinum. It causes very potent and lethal neuro paralytic, and it is believed that proper inhalation of one gram of crystalline botulinum toxin can kill around one million people (Dhaked 2010). Botulinum vaccination is recommended for people at risk, first responders, and the army. In the past, many vaccines for botulinum, i.e., pentavalent vaccines and inactivated toxoids, have been developed. But all these previously developed vaccines lack stability and elicited a strong immune response or reactogenicity. Moreover, a booster dose was also required, which may also be associated with its adverse reactions (Simpson, 2004). But all these shortcomings of previously developed vaccines can be overcome due to the synthesis of non-toxic botulinum toxin as a nanogel system. This nanogel system is decorated with the self-assembly of polysaccharides conjugated with cholesteryl and amino groups. This nanogel based nanovaccine remarkably enhances the retention of antigen in the nasal epithelium upon intranasal vaccination and strong immune response (Grimm & Ackerman, 2013).

Similarly, immunization against cholera has been practiced with previously marketed oral vaccines. But these marketed vaccines give brief and temporary protection and require another booster dose. So these vaccines are only applicable in the case of travelers but not for the high-risk population in endemic areas. To overcome all these obstacles nanoparticles/microparticles vaccines encapsulated with polymers as a delivery system have been investigated intensively (Moon et al., 2012; Vijayan et al., 2019). In 2002, Yeh reported the synthesis of a killed whole-cell of Vibrio cholera embedded in PLGA NPs with high immune responsiveness (Yeh, Chen, & Chiang, 2002). More recently, vesicles derived from the outer membrane, termed as outer membrane vesicles (OMV), of Vibrio cholera were used as antigens for oral administration that elicited strong immune response for a long period (Sedaghat 2019). Shigella is another notorious Gram-negative bacterial pathogen and bioterror war agent. It transmits shigellosis by inducing diarrhea and dysentery through the fecal-oral route. Currently, no vaccines are available for the prevention of adversities of shigella (Szinicz, 2005) . But several novel and intriguing strategies for synthesizing vaccines against shigella are under clinical trial. Arif et al. in 2017 mentioned some approaches regarding shigella vaccines by utilizing OMV from shigella and encapsulating these OMV into polymeric nanoparticles as a vaccine subunit for mucosal vaccination against shigella (Mani, Wierzba, & Walker, 2016). Salmonella infections are caused by notorious Gram-negative pathogenic Salmonella typhi. Salmonella causes endemic typhoid fever which is a water and foodborne disease and is a prominent cause of mortality and morbidity in humans. Its strains are also the potential source of bioterrorism for endemic populations. Salmonella infections are difficult to treat because antibiotics lack the property of penetration into intracellular regions of macrophages where this bacterium reside (Elbi et al., 2017). So, vaccination against salmonella is the need of the hour. Various studies depicted that extracts of salmonella subcellular compartments can be enveloped into polymeric NPs. These nanovaccine product releases strong immune responses when injected in experimental mice and give them protection against this deadly infectious disease (Fan & Moon, 2017).

Some attempts of utilizing vaccines in nanocarriers were carried out by delivering the inactivated staphylococcus strains into PLGA NPs to elicit humoral responses comparable with soluble vaccines. In another approach, PLGA NPs were coated with erythrocytes membrane, which tends to attract the hemolysin of streptococcus, which seemed to be a great opportunity for vaccination against deadly staphylococcus infections (Fan & Moon, 2017). Nanovaccines can therefore initiate immune response and activates pain receptors as shown in Figure 4.

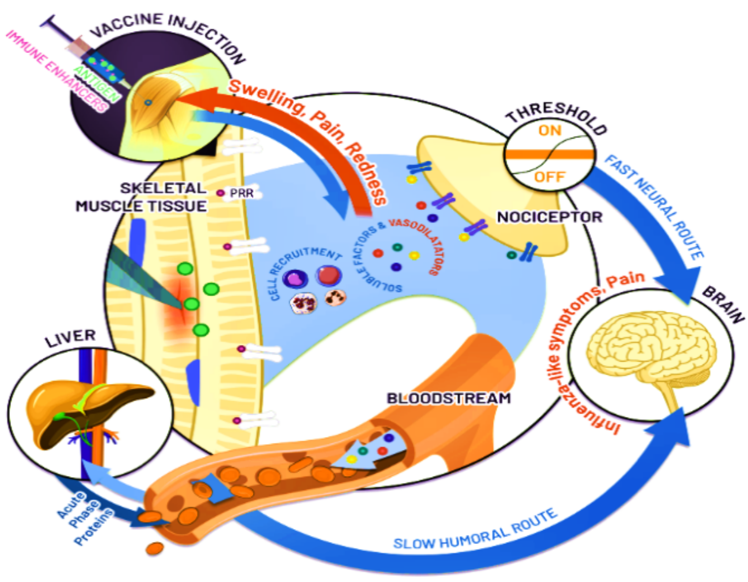

Figure 4: Scheme for the Incorporation of Vaccines into Human Body against Infections

Summary and Future Perspectives

Historically, the role of social scientist in the field of diseases, its contemporary effects, extensive contributions and interests for upcoming events are the emphasis in this article. Instead of compassion for vulnerabilities, inequalities, misery and deprivations, or bad fate, emphases such as social preparedness, integrity, and empowerment are of greatly significant. Currently, the situation for joining the division between scientific disciplines has been powerfully ended by the scholars and external of academic organizations. Equally accepting the significance of interdisciplinary science and expecting the essential for funded multidisciplinary research. Multidisciplinary researches encouraged for enlargement of the expertise required to counter these multidimensional infirmities. Though, it should also call for a vigilant enthusiasm. Despite the chemical weapons convention and biological weapons convention, rapid developments in modern medicine, improved immunization patterns, and innovative detection system, the current outbreaks of COVID-19, SARS coronavirus, Ebola virus, and H1N1 influenza virus revealed that the world is not prepared to overcome these challenges. The new security threats must open political discussion and propose processes that set up various security strategies for the safety of the public, especially in response to the new threat of bioterrorism. Hence, it is critical to continue to sustain and strengthen one's national public health infrastructure. Chemical and biological agents' threat reduction demand the development of innovative and improved detection strategies for surveillance, prevention, protection, and early vigilance for natural or deliberate attacks. Conventional detection systems for chemicals and biological agents are not precise, have limited selectivity and sensitivity, and may give false-positive readings, Current procedures for the removal and decontamination of chemical agents involves the use of photocatalytic, incineration, strong oxidants or bleaching agents, enzymatic biodegradation, and atmospheric pressure plasma. Traditional approaches of detection usually use electrochemical interaction, mass spectrum, high-performance liquid chromatography, interferometry, and nuclear magnetic resonance to detect the weapon of mass destruction. Nanotechnology offers a new class of materials and molecular contrast agent sensors to permit earlier and more accurate detection, diagnosis as well as persistent monitoring of homeland security. Nano-enabled sensors/detectors are capable of high sensitivity, specificity, and multifacet measurements. Further progress in nano detector utilizes biological receptors for the detection of BWA with high selectivity and specificity.

Moreover, the prevention and protection of personnel require immunization and vaccination. From a biosecurity context, vaccination as a permanent and specific immunization process for public health is at the heart of these efforts to secure individuals at high risk, including the public, first responders, and the army. Therefore, it is essential to manufacture vaccine products that are efficacious, potent, and stable over an extended period without the cold-chain transportation. Nano vaccines have displayed great promise to overcome current limitations in vaccine technologies against emerging infectious agents and bioterrorism. To overcome the chemical and biological challenges, future endeavors will be made to a rapid translation of the next generation nanovaccine/nano detector research activity into practical defense tools in realistic environments. Moreover, for enhanced preparation for natural and bioterrorist outbreaks, international collaboration should contain cooperative exercises comprising numerous countries and persistent enhancement in the exchange of information about immunization and detection capability for potential bioterrorism threats management. Provided cutting-edge research in the field, we expect the emergence of new ideas and an important role of nanodetectors and nano vaccines in defense applications to counter major homeland security threats.

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