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Local Law Enforcement's Role in Biosecurity: Expanding Biological Education to Improve Biosurveillance

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Background on Author:
I joined the Los Angeles County Sheriff's Department's Explorer Program (LASD) in August of 2012. After graduating from LASD's North Academy, I worked Uniform Patrol at the Lost Hills Sheriff Station and at Transit Services Bureau (formerly Transit Policing Division). Having the opportunity to attend Stanford, while also having this background, has demonstrated that the sciences can have a major role in Law Enforcement, especially in the field of Biosecurity. This research paper serves to bridge the gap between science and local Law Enforcement.

Introduction:

The dynamic role of Law Enforcement forces Officers to become proficient in numerous fields outside of law, such as psychology, social work, tour guiding, navigating, negotiating and much more. Very rarely, however, are Law Enforcement Officers expected to approach the world through the lens of a biologist, which can be problematic, since the field of synthetic biology is rapidly developing and can provide individuals with the tools to develop biological weapons. The Law Enforcement Community agrees that education and thorough training regarding a biological incident are key to improving responses. Yet, these trainings do not examine the exact technologies that are available, how bioterrorism is different from a regular pandemic, and what Law Enforcement should be aware of, while searching for or encountering biological weapons.

A new biological perspective aligns with the fundamental belief that Law Enforcement must adapt. For example, Law Enforcement Officers have recently adopted tactical EMS training and have incorporated the subject into their curriculums (Morrissey, 2013). A majority of cops on patrol can be spotted carrying a tourniquet or a drop kit on their leg. Occasionally, a patrol officer may have an Emergency Medical Technician pin clipped to their shirt pocket. Tactical EMS provides Officers with the skills to perform "self-care" or "buddy medicine," and helps prepare Officers for worst-case scenarios, such as explosions, active shooters, and other violent incidents (Morrissey, 2013). Officers providing medical aid used to be considered uncommon, yet, the current threats have shifted normal operations and opinions. Once again, operations will need to accommodate the looming threat of biological incidents, by developing each Officer's biosurveillance abilities.

Background on Biological Risks and Bioterrorism:

Historically, pathogenic microscopic organisms have always been a threat, which demonstrates the need for Law Enforcement to understand the nature of this invisible foe. Numerous historical incidents highlight the catastrophic results of diseases. In 1918, the Spanish Influenza strain killed between twenty and fifty million people (Klein, 2015). As noted by Bill Gates, this death toll was larger than all of WWI, and matched the number of deaths in WWII (Klein, 2015). Besides these two major conflicts, disease alone, as researched by Marcia Inhorn and Peter Brown, is estimated to have killed more humans than all wars in human history combined (Inhorn, 1999, p. 89). To this day, many still suffer from common pathogens, including in developed countries, such as the United States. Just recently, more than one-thousand U.S. children perished during the H1N1 outbreak in 2009 (Klein, 2015). As witnessed, the war on disease has not been won.

Law Enforcement may not be aware that the world has also entered a time of false security. Since the 1950s until now, humans have developed numerous vaccines and antibiotics, eradicated Smallpox and Polio, and continue to make discoveries. However, the progress made may not match the arrival of new pathogens and the resurgence of old diseases. Dr. John C. Mirsalis (2018), the Vice President of Translational Development, reported to a Stanford biosecurity class that developing effective biodefense drugs are very difficult for numerous reasons. Some examples are viruses mutating quickly and rendering vaccines useless or bacteria and parasites becoming antibiotic resistant (Mirsalis, 2018). Primarily, the biggest challenge in countering infectious diseases is a lack of funding. Pharmaceutical companies spend between $1.5 and $5 billion dollars to approve a new drug (Mirsalis, 2018). In addition, these biodefense drugs do not bring the maximum amount of profits after a significant initial investment (Mirsalis, 2018). As a result, these companies cut their infectious disease research or downsize their projects (Mirsalis, 2018). Over the last twenty years, the average annual number of new and approved antibiotics dropped from sixteen in 1981-1983 to one or two antibiotics in 2008-2011 (Mirsalis, 2018). Dr. Mirsalis and others in the field are looking for solutions and new incentives to increase biodefense research, such as cutting taxes and increasing government subsidies. Until economics and motives of pharmaceutical companies change, Law Enforcement must understand that pandemics will continue to be the most predictable catastrophe humanity will face.

A consequence of stagnant infectious disease research is the potential for a highly successful and fatal release of a biological weapon. Due to the lack of new drugs, fewer people getting vaccinated, and better biotechnologies, humans are still susceptible, even with "modern" medicine to an attack. Knowing the broad history of bioterrorism will allow Officers to prevent the use of bioweapons, address suspects, and identify its many forms.

Bioweapons have been dispersed in many ways throughout history. For example, the initial outbreak of plague in Europe can be traced to the Mongol Army catapulting corpses infected with Bubonic Plague over the city walls of Caffa (Wheelis, 2002). A secondhand account was described by Genoese Gabriele de' Mussi in his 14th Century Manuscript, which remains a reliable source to this day (Wheelis, 2002). Infected Genoese sailors from Caffa apparently fled the city by ship, and their short docking in Italy was enough to spread the disease into Europe (Wheelis, 2002). This was a very primitive method of dispersal, yet, it worked. Plague decimated half of the population of Europe in the 14th Century and continued to do so for hundreds of years. During WWII, Unit 731 of the Japanese Imperial Army utilized pathogens for weapons (Sidell, Takafuji, & Eitzen, 1997, p. 417). Under the direction of Lt. General Shiro Ishii, a factory was built with fourteen autoclaves, which could each produce 30 kilograms (sixty-six pounds) of plague, cholera, typhoid and paratyphoid, dysentery, anthrax, gas gangrene, tetanus, and glanders (Ziegler, 2017). The facility also had the capacity to produce fleas to help disperse agents (Ziegler, 2017). Throughout the war, these diseases were used on the Chinese population, leading to a high death toll. The Japanese even planned to drop bubonic infected fleas on San Diego in September of 1945, before the war came to a halt in August (Fishel, 2016). In addition, developing bioweapons continued to become deadlier under Japanese research. Recently declassified videos of Unit 731, showed the dispersal of aerosol bioweapons, demonstrating that a second generation of weapons had been developed (Larsen, 2018).

After WWII, most nations developed bioweapons programs, including the United States. After seeing the potential for annihilation of populations by these weapons, U.S. President Nixon abruptly banned the program in 1969 (Larsen, 2018). However, even after signing an international treaty in 1972, the Russians kept their program, and developed weapons in secret (Sidell, et. al, 1997, p. 419). For nearly twenty years, they employed sixty-thousand people in forty facilities to develop some of the most dangerous diseases and advanced weapons, such as smallpox and anthrax (Goldman, 2014). Once the Soviet Union fell, these facilities were reported to be in disarray by an American Doctor, Milana Boukhman Trounce, an expert in biosecurity response (Goldman, 2014). Dr. Trounce and others were sent to repurpose the scientists' research and secure these weapons (Goldman, 2014). With the Russians burying tons of anthrax into the soil to hide their conduct, and with stores of smallpox still being found in the U.S., it is disheartening to think about the samples that may have gone missing from Russia. Yet, new technologies, as will be discussed, can soon give bioweapon access to any individual with a basic background in biology. What used to be available to only nations now has the ability to enter the hands of anyone.

History shows the progression of biological weapons; they started as simple transmission through vectors (corpses to people or animals to people), evolved to a crude aerosol, and then were developed to be incredibly small and easily distributed, such as anthrax powder. The next generation of bioweapons will revolve around access to pathogens. Synthetic biology and cheap laboratory equipment will provide individuals with the capability to build an effective lab in a reduced space. In addition, unlike radiation, such materials would be challenging to trace, and can blend in with normal lab equipment purchases.

Law Enforcement's Current Preparation:

The threat of a biological incident (natural or nefarious) has led to numerous research studies and policy suggestions, such as articles written by the Bureau of Justice Assistance, a branch of the U.S. Department of Justice, and the President's Council of Advisors on Science and Technology (PCAST), but the standard Law Enforcement curriculum still needs to do more to incorporate these suggestions. A realistic and case-by-case approach has been taken on a national level to integrate Law Enforcement into the current emergency management system, if a biological incident were to occur. However, the average Law Enforcement Officer receives a very basic amount of training on biological incidents. Mr. Don Lane, a senior regional consultant for the California Commission on Peace Officer Standards and Training for Region 5, explained that the Basic POST Police Academy, which certifies all Law Enforcement in CA, places all biological training in a small subunit within the eight hours of terrorist training (Don Lane, personal communication, March 2, 2018). POST takes the approach of providing a lay level understanding of biological incidents and focuses on the proper protection during an attack (Lane, 2018). Mr. Lane also stated that additional available trainings are supported by grants from the Federal Government or at other facilities, such as the CA Specialized Training Institute or through the CA State Emergency Management. Yet, these trainings are usually costly, and only certain individuals are sent from a department to become certified (Lane, 2018). To get all Officers from a local department certified would take days, require overtime, and can be expensive (Lane, 2018). As a result, most field Officers will have to settle for a layman's knowledge on biological incidents provided by his or her state's respective POST Basic Police Academy.

Currently, a cursory understanding of a biological incident may not be enough for a patrol Officer to identify a threat. The PCAST (2016) stated that the first challenge to improve biosecurity "is to maintain an awareness and understanding of technological capabilities and their impact on offense and defense" (p. 4) Without threat awareness, and if a perfect attack was coordinated, a "well-executed attack might go unnoticed for days or weeks" (PCAST, 2016, p. 4). These technologies are vast, evolving, and can provide an individual with a significant amount of power. This type of awareness can be integrated with the suggestions of the Bureau of Justice, which recommends an all hazards approach that increases education and planning regarding infectious disease (Richards, Rathbun, Brito, & Luna, 2006, P. 2). They claim the following:

> officers need basic education about infectious disease biology, modes of transmission (such as person-to-person and vector borne), and routes of entry of communicable diseases (eyes, nose, and so forth). Ways to provide this education include forming a partnership with a local hospital or an occupational health and safety program. (P. 7)

Many departments have adapted to this concept and may offer general training and planning for its Officers when responding to an incident. While preparing for an all hazards approach may seem practical, it remains crucial to separate bioterrorism from a natural pandemic. Laboratory equipment techniques have helped pathogens evolve to be deadlier than the diseases in nature. A bioweapon that utilizes highly pathogenic particles that are only one to five microns (extremely tiny) can be synthesized, and these particles can be more effective than the particles found in nature (Boukhman Trounce, 2018). Higher mortality rates can be achieved because a small virulent strain can enter deeper into the human respiratory track (Boukhman Trounce, 2018). As a result, developing biosurveillance is as important as knowing how to respond. Therefore, a nefarious attack requires different preparation when compared to a naturally occurring outbreak, which is why Officers should familiarize themselves with new scientific techniques and trends, such as the ones described in the next section.

Current Scientific Developments and their Implications:

Unless speaking to an individual well versed in biology and bioweapons, most local Law Enforcement Officers are unaware of CRISPR/CAS9 technology and synthetic biology, and the devastation that can be accomplished if misused. Synthesizing an organism with the desired genetic material (DNA) used to be a difficult process. DNA codes for proteins in a cell, and these proteins determine the function of a cell. The cell, which is the smallest living subunit, could be changed completely depending on the DNA template it contains. The old method to modify this template required scientists to try and target this DNA within an organism and force a mutation, which was often inaccurate. That all changed with the development of CRISPR/CAS9 technology and new DNA synthesis techniques. CRISPR/CAS9 technology uses a natural system that occurs in living cells (PCAST, 2016, p. 2). This system allows one to accurately target DNA in numerous types of cells, including human, animal, and plants cells (PCAST, 2016, p. 3). With the development of this technology, genomes (sets of DNA in an organism) can be cleaved, modified to possess new sequences, or can be bound to regulatory proteins (PCAST, 2016, p. 3).

What used to take months or years of lab work can now can be accomplished in days to weeks (PCAST, 2016, p. 3). In addition, there are new DNA synthesis techniques, which combine fragments of DNA (PCAST, 2016, p. 3). These combined DNA fragments can form a fully functional strand of DNA. Coupled with CRISPR/CAS9 technology, and a better understanding of gene regulations, an individual can create a new cell, virus, or bacteria. There are many benefits to this technology, such as new drug and therapy discoveries and production. This gargantuan progress in healthcare does face a few challenges, such as the potential for misuses.

The PCAST (2016) acknowledged that possible misemployment may include developing drug resistant pathogens, recreating old pathogens, or using genetic material to develop a novel pathogen, which is a new type of disease that currently does not exist (p. 3). However, a novel pathogen would be a very hard goal to accomplish, since most existing pathogens possess complex pathways and regulatory methods (PCAST, 2016, p. 3). As biotechnology continues to grow, the risk will only increase. So far, the re-creation of old pathogens continues to be the common danger. This was verified by the World Health Organization (WHO) (2015), which reported the conclusion of the Scientific Working Group (SWG) in 2015 (p. 5). The WHO (2015) reported the following:

> With the increasing availability of DNA fragments that can be synthesized from simple chemicals, it would be possible to recreate variola virus, and that this could be done by a skilled laboratory technician or by undergraduate students working with viruses in a relatively simple laboratory. (p 8)

Simple laboratories and basic equipment would be enough to reconstruct diseases, such as small pox (aka variola virus). As a result, what used to take years of graduate school, can now be accomplished by a simple technician or young student. Most students at major universities are able to gain easy access to a lab with very little screening. Under the direction of a lab or project manager, a student can learn the basic skills needed to manipulate DNA and use this experience elsewhere. Eventually, viruses may be synthesized by assistants to a primary researcher, instead of the highly-educated researchers themselves, like the employed bioweapon producers at the national level.

To date, dangerous viruses have been recreated in the lab by skilled researchers. For example, Canadian researchers in 2016 published an article in Nature about how they synthesized an extinct pox virus, specifically horsepox, with only $100,000 worth of resources (Kupferschmidt, 2017). Synthesis of this virus could have easily been designed to reproduce smallpox, which was eradicated. The possibility of this technology was predicted since the first synthesis of the polio virus back in 2002 (Dieuliis, 2017, p. 7). Yet, the science community did not expect a researcher to publish an article that gives the blueprints to creating such deadly diseases. Following the prediction of the SWG above, it is a matter of time until an individual with a minimal amount of training, follows published blueprints, like the horsepox article, and recreates a deadly pathogen.

It should be noted that the researchers in Canada followed safety protocols, had the steps of their project reviewed thoroughly, and took an academic approach to receive clearance to obtain sequences of high risk DNA. It is estimated that the researchers began in 2003 and took a long time to complete the project (Dieuliis, 2017, p. 3). That leaves years for new discoveries to be made in the field of biology. Obtaining DNA becomes easier, and the techniques available will allow individuals to modify sequences any way they would like. Therefore, current safeguards may soon be bypassed.

In 2012, the DNA market was worth $3.5 billion (Al-Rodhan, 2015, p. 2). Members of the Network of Global Agenda Councils estimate that this market would raise to nearly $12 billion by 2018 (Al-Rodhan, 2015, p. 2). While the market is increasing, the actual cost of DNA has been on the decline. Local Law Enforcement should be aware that many people have the ability to purchase DNA and lab equipment with ease. A simple search on Google will reveal CRISPR/CAS9 kits available on Amazon for a few hundred dollars. They come with test-tubes, pipettes, petri dishes, chemicals, agar, and instructions on how to manipulate DNA. The ODIN project offers a complete home kit for only two thousand dollars (Genetic Engineering Home Lab Kit, N.D.). Other equipment searches, such as fermenters, which are needed to grow bacteria, reveal many different available sizes and brands. Institutions and companies from around the world use this equipment, and orders have the ability to blend together or appear to be justified. A new movement also calls for access to this equipment.

A recent phenomenon called “Do-it-yourself biology” has risen across the world, which sees individuals also performing projects in their own homes (Landrain, 2013 p. 125). The goal is to give access to biological technologies to anyone interested in working with these materials. The community intends to foster a relationship between professional and amateur scientists and allows for information to be shared so that they can collaborate (Landrain, 2013 p. 115). This shared information is more important than ever to the amateur community, since synthetic biology is adapting to allow users to view cell editing like following a recipe. For example, researcher Dr. Thomas Landrain (2013), who was sponsored by the AXA Research Fund, wrote that one of the goals of this movement is to make biology easier to engineer, and allow one to view it like a genetic device (p. 116). Landrain stated in his article, “this abstraction hierarchy enables scientists to visualize a genetic device as a set of simpler components, each identified by their functional characteristics and not anymore by their pure sequence" (p. 116). As a result of this movement, people are able to follow complex biological manipulations with even less formal education than before. Currently, their projects are modest, and amateur biologists usually are developing research that is similar to high school labs. Yet, this growing community has access to resources, online information, and they are pushing for more available DNA kits (Landrain, 2013, p. 123). The potential for these individuals to develop weapons remains low, even as synthetic biology is simplified. Not identified by Landrain, however, is the capability for an individual with the proper skills, to blend into this community. After receiving the education necessary, an "investment" terrorist could use the numerous resources present in society to build the perfect weapon. All it could take is one or two biologists to coordinate a massive attack in multiple locations.

These biohacking communities have been growing throughout the world, and most cities do not have restrictions on what people do with their properties. Individuals could convert their garages into a makeshift laboratory, and glass panels, plastics, test-tubes, chemicals, and more could all be acquired and configured into the right setup within a person's home (Schauenberg, 2018). Without the proper warrants, local Law Enforcement would be completely unaware of a biological lab within a person's property. It should not be forgotten, however, that nations with resources and facilities can also use these new technologies, such as CRISPR/CAS9 and DNA splicing, to produce sophisticated and superior microbes.

How a Local Law Enforcement Officer's Understanding of Biology Can Impact Policing:

Law Enforcement has been looking for the wrong things when screening for bioweapons, but with a proper understanding of the above technologies, they will be able to improve their education and ability to screen individuals. For example, some of the best security in the country still missed indicators of a biological weapon. This happened after 9/11, when retired Air Force Colonel Randall Larsen smuggled a test tube filled with weaponized powder *Bacillus gobigii* into a meeting with Vice President Cheney at the White House to demonstrate the danger of bioweapons (Hylton, 2011). Colonel Larsen had passed through radiation and explosive detectors, pat-downs and a mandatory search of all belongings, where security even found a respirator mask but still let him through (Hylton, 2011). Larsen claimed, "'They were looking for the wrong things. . . They still are'" (Hylton, 2011)

The hope is that Law Enforcement will start to identify the components of bioweapons, by utilizing trainings similar to the ones made available for identifying fentanyl, an opioid, that shares many similarities to how a bioweapon should be handled. The horrible opioid issue the United States faces has led to new trainings, bulletins, and reports by local and federal agencies, such as the Drug Enforcement Administration (DEA). Of the thirty-three thousand deaths in 2015 alone, nine-and-a-half thousand were a result of synthetic opioids, which includes fentanyl (DEA, 2017, p. 4). Like the recommendations produced for bioweapons, fentanyl may be handled in different ways, since it can be in powder, pill, capsule, and liquid form and is fifty to a hundred times more potent than morphine, and thirty to fifty times more potent than heroin (DEA, 2017, p. 5, 7). A similar compound, carfentanil, is ten thousand times more potent than morphine, demonstrating how powerful the drug can be, while in a mixed or pure form (DEA, 2017, p. 5). Exposure to trace amounts can cause overdoses. Fentanyl is considered a real threat to Law Enforcement, and resulted in two New Jersey Officers overdosing in August of 2015, while performing their normal duties (DEA, 2016, p. 2). This is why Officers are recommended to take PPE (personal protective equipment) precautions if the drug is identified and should request HAZMAT resources.

If an Officer searches a suspect and discovers a test tube filled with a white powder, the situation may require similar precautions to discovering fentanyl, and an informed response may include considering the tube to contain a bioweapon. One may deem it a biological threat if an individual is a student, near a university, and/or is carrying personal protecting equipment. Alternatively, an Officer may consider whether the individual is near a target site, such as a train station or airport, or if they appear to be under the influence of narcotics. There are numerous other considerations. For example, an individual might use simpler methods to disperse an agent, such as self-infecting themselves and purposefully sneezing and coughing around a population. An attack could also be the work of a nation or one person. Following biological technologies can help Officers judge whether a nation or person may have the capabilities to make a bioweapon, whether they should dawn PPE, evacuate the area, and/or call HAZMAT. Another scenario may include Officers serving a warrant and discovering a biological "Do-It-Yourself" lab. A better quarantine response may stem from an Officer thinking they were exposed to a pathogen, and/or on their ability to judge whether a person may be working on a dangerous agent in their home. The scenarios above are examples of improved Law Enforcement decisions due to increased awareness.

Future Tools for Law Enforcement and Conclusion

Increasing available trainings can assist local agencies with expanding biological knowledge. This can be accomplished by partnering with a local hospital or local public health department to provide agencies with the necessary resources to inform them of new biotechnologies, flu trends, and biosurveillance results. Additional partnerships could also include local and regional universities with biology programs. Periodic updates can increase awareness of biotechnologies and the increasing threat of a bioweapon. Small trainings and bulletins put on by any of the above listed resources and HAZMAT teams can also serve to educate officers. As demonstrated, the dissemination of knowledge is more important than focusing on high cost trainings and can be achieved with these recommendations and partnerships.

In conclusion, these incidents require extensive preparation and resources; pathogens are historically responsible for the largest number of human deaths, and the potential risk increases daily. In addition, biological incidents may involve pathogens that can naturally be transmitted between people with ease, and/or can be catalyzed by people coordinating a nefarious attack. Training and diving into more depth to understand a pandemic, scientific advancements, and possible misuse of technology, can improve biosurveillance conducted by local Law Enforcement. A scientific background can assist with spotting potential terrorist threats, setting up containment and/or quarantine, and selecting the proper safety equipment for an incident response. All of these combined skills can make Law Enforcement responses more effective.

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