



FAS | Use of Microbial Forensics in the Middle East/North Africa Region

An analysis prepared for the Department of State Bureau of Arms Control and Verification

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About FAS

Founded in November 1945 by many of the scientists who built the first atomic bombs, the Federation of American Scientists (FAS) is devoted to the belief that scientists, engineers, and other technically trained people have the ethical obligation to ensure that the technological fruits of their intellect and labor are applied to the benefit of humankind. The founding mission was to prevent nuclear war. While nuclear security remains a major objective of FAS today, the organization has expanded its critical work to address urgent issues at the intersection of science and security. FAS publications are produced to increase the understanding of policymakers, the public, and the press about urgent issues in science and security policy. Individual authors who may be FAS staff or acknowledged experts from outside the institution write these reports. Thus, these reports do not represent an FAS institutional position on policy issues. All statements of fact and expressions of opinion contained in this and other FAS Reports are the sole responsibility of the author or authors.

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Introduction

This report is informed by a project undertaken by the Federation of American Scientists (FAS) that seeks to understand and address the challenges of biosecurity. More specifically, in this report, FAS will look at the potential use of microbial forensic science as a tool for cooperation and analysis of biological and threats in the Middle-East/North Africa (MENA) region.¹ Focusing on the MENA region is prudent, as the region has been forced to deal with multiple instances of both naturally-occurring and man-made biological threats over the last 10 years, including H5N1 (Avian Bird Flu), MERS-Corona virus, and allegations of Ricin production and use. The naturally-occurring spread of disease has been a much more frequent and salient event. These biological incidents (and/or suspected events) have all caused significant social disruption and economic weakness.

A major challenge in addressing the aforementioned concerns is the fact that the MENA region is in a state of perpetual instability and regional conflict. However, in spite of these political realities, what states in the region have discovered and can agree on is that microbes and pathogens are no respecters of political borders or religious differences. Policies and procedures to address these threats in one country are therefore ineffectual without cross-border cooperation. In this paper, the authors explore the use of microbial forensics as a tool for creating a common base line for understanding biologically-triggered phenomena, as well as one that can promote mutual cooperation in addressing these phenomena, both end states being highly desirable.

Understanding the source of a biological incident is significant because the key pre-condition that determines how a country will respond to a biological event, or take action in order to interrupt a potential emerging threat, ultimately centers around the ability to properly attribute the culpable sources (pathogens); in other words, governments need to determine the return address of the culpable microbe(s), be they from countries, individuals, or nature itself. Without such attribution, there would be no basis for marshaling a response. Unfortunately, microbial forensic evidence can be easily misinterpreted or put in an incorrect circumstantial framework, causing policy leaders to respond to threats that may not actually exist, or miss those that do – either condition leading to an increased likelihood of an undesirable policy outcome. Working through the decision process in this area is simultaneously a technical, as well as a political, challenge. This project has endeavored to address these challenges in the MENA region by drawing attention to them and making recommendations on how best to address them.

¹ For purposes of this analysis, the author uses the Department of State's description of the MENA Region which includes the following countries: Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Somalia, Sudan, Syria, Tunisia, United Arab Emirates and Yemen.

Background

What is meant by the term “Microbial Forensics”?

Microbial forensics is a sub-discipline of the general discipline, forensic science. Forensic science is best described as “the science of matching statistical probabilities, as opposed to the pursuit of pure empirical truths.” It has also been described as “science for the courtroom.” In his June 2015 article on bio attribution, Dr. Randall Murch of Virginia Tech University identified several core examples of techniques from forensic science. Classical forensic disciplines include pattern analysis (e.g., fingerprint), biology (e.g., human DNA analysis), trace evidence (e.g., hairs and fibers), toxicology (i.e., drugs and poisons), digital evidence (e.g., computer media), and pathology (i.e., manner and cause of death).² Most people are familiar with classic forms of forensic science, such as fingerprint analysis or hair analysis. These disciplines work on the assumption that each fingerprint or hair sample (marker) is unique and that no two markers will match unless they come from the same individual. The assumption is based on a statistically very high level of probability, but may not be absolute.

In recent times, deoxyribonucleic acid (DNA) analysis has been used as one of the most accurate markers and is often considered the “gold standard” of the forensic science discipline. Similar to human DNA analysis, microbial forensic practitioners would highlight particular loci at which individual strains among larger families of infectious agents differ in nucleotide sequence, and use that information to infer common identity and/or lineage. A 2007 article published in the *Environmental Forensics* journal explains that this technique is “analogous to chemical fingerprint analysis, but is applied for microbial agents that are known bioweapon agents and is intended for attribution purposes.”³ Consequently, use of microbial forensics is a tool that significantly increases the probability percentages of obtaining an evidence match over many other forensic techniques. In forensics, a “match” will often turn out to be but one critical element of proof that places an individual in a given location – often as an element of proof in a criminal trial, or as an evidentiary fact supporting a policy discussion on attribution between countries.

History of “Microbial Forensics”

Microbial forensics capabilities in the United States were established in 1996. In several countries (mostly western), it has become integral to the investigation of suspicious infectious disease events or actual bioattacks over the last 20 years. This scientific discipline and its associated investigative support capabilities seek to provide for the identification and characterization of relevant scientific evidence to inform critical investigative and legal questions and decisions. Microbial forensics is used in combination with other methods and sources of information to shape investigations, intelligence

² Murch, Randall. “Bioattribution needs a coherent international approach to improve global biosecurity.” *Frontiers in Bioengineering and Biotechnology*, Volume 3, Article 80; 01 June 2015.

³ Priyabrata Pattnaik, Asha Mukul Jana. “Microbial Forensics: Applications in Bioterrorism.” *Environmental Forensics* Vol. 6, Iss. 2, 2005.

operations and analysis, and legal and policy actions and decisions. Ideally, the conduct of and outcomes from microbial forensics are objective, accepted, accurate, reliable, repeatable, defensible, and adhere to expectations for “good science,” as well as the requirements of criminal jurisprudence.

Since 1996, a complex multiagency enterprise has developed within the U.S. Government, supported by high-level expertise and advanced science and computation from national laboratories, universities, and companies. This enterprise is still evolving and incorporating new methods, technologies, and capability configurations to meet emerging needs and requirements. Several other countries have developed microbial forensics capabilities which are tailored to meet their needs; however, none currently exist within the MENA region. Given the number of naturally-occurring disease outbreaks in the MENA region, coupled with the number of accusations of possession and use within the region, it is a viable focus area for increasing use and awareness of microbial forensic capacities. The importance of microbial forensics and attribution is on the rise as a potential critical component of new initiatives within the Biological Toxins and Weapons Convention construct.

Using “Microbial Forensics”

Microbial forensics can be used to help determine the cause, source, and/or perpetrator of an actual or suspected biological attack, or preparations for such, regardless of the agent, method, pathway, or target. It was created to be an integral part of collaborative law enforcement – public and agricultural health - security investigations of such events, to be used with other sources of information to help answer key questions, shape investigations, and ultimately inform legal and policy decisions. Infectious disease agents, biological toxins, and the personnel, equipment, facilities, environments, and effects associated with such events are the foci of microbial forensics. The microbial forensic process can support determinations regarding the cause, nature, and source of an illicit biological event, the identification of suspected perpetrators, and the methods, means, instruments, and locations involved. The results of an investigation enhanced by the use of microbial forensics can subsequently lead to the prosecution, or perhaps more importantly, the exoneration, of any individuals, organizations, and/or countries suspected of being involved. Commonly, other forensic endeavors, such as pattern analysis (e.g. fingerprint and documents), DNA analysis, chemistry and toxicology, trace evidence, computer forensics, crime scene reconstruction, and forensic pathology are leveraged with microbial forensics throughout the entire investigatory process involving a biological event; the significance being that such forensic science contributions often end up being an integral part of the legal and policy decision making processes.

Microbial forensics is still a relatively “young” science that emerged from the creation of the U.S. program that is focused on supporting the investigation and resolution of suspected acts of bioterrorism involving the illicit acquisition, possession, development, testing, and use or threats of use of infectious disease agents and/or biological toxins. It also incorporates classical forensic evidence analysis requirements, perspectives, and processes. Microbial forensics leverages the existing and emerging science from numerous disciplines beyond the forensic sciences. In the U.S., all microbial forensic methods and processes are validated to meet legal requirements, which is not necessarily the case for many other scientific methods used solely within their respective narrowly

focused disciplines. From its origin, microbial forensics was intended to support both policy and legal decisions. But, even if it and other science used in conjunction with a suspect or actual event does not meet legal stringencies, it may be highly informative in a policy decision setting.

Microbial forensics can be of considerable assistance to investigations and decision making. However, microbial forensic analysis has its limitations due to the considerable lack of sufficiently detailed scientific knowledge about many of the microbes that could be used as weapons against humans, animals, and plants, how microbes exist in the environment, microbial diversity, the complexity and uncertainty of microbial and related sciences, and the value and weight of the data the biotoxin analysis can provide. Microbial forensics is still a young field with many needs for basic and applied research, development technology, and knowledge transfer. Furthermore, unlike other forensic methods, such as human DNA analysis or fingerprint comparison, microbial forensics generally cannot produce results that attribute samples to a unique source. However, through microbial forensics, various hazardous agents can be identified and understood and deeply characterized so potential sources can be eliminated, or at least the number of alternative possibilities can be narrowed.

Building Confidence in Microbial Forensic Results

The credibility of microbial forensics in determining the cause or source of a biological event is determined by three key factors. One is the science itself: Does the result obtained from microbial forensic processes rest upon valid scientific principles (consistency, reliability, and non-arbitrary)? Secondly, do the forensic methods and analysis used accurately answer the question posed, i.e., attribution to a country, group, or individual? These two challenges can be overcome. However, even more important than the first two factors is the question of whether or not the interpretation of the results will be trusted. This trust is the precondition upon which policy decisions will be made.

Trust is not something that is easily manufactured. It is normally built through engagement and confidence building measures. Building trust requires investments which often do not have immediate tangible or measurable outcomes other than the acts of engagement themselves. This is a challenge for policy leaders who are attempting to make a decision on where best to allocate taxpayer dollars.

Science diplomacy is crucial in this area. But it is more than sharing scientific results; it is also about communicating the science. Gary Machlis, who has practiced in this area for years, puts it this way: “This sort of work requires several distinct skills, including the ability to communicate the uncertainties of science to policy makers.” This is “both essential and part an art form.”⁴

⁴ <http://www.aaas.org/news/science-cooperation-under-tense-conditions-requires-patience-trust-experts-say-science>

Machlis goes on to say that when scientists get called in during an international crisis, they end up practicing “tensive science.” Machlis puts forth five proposals for improving tensive science: researching best practices; investing in pre-crisis protocols; nurturing “back channels;” training skilled science diplomats; and creating an international, neutral site where scientists can collaborate. Furthermore, Frances Colón, acting Deputy Science and Technology Adviser to the U.S. Secretary of State, highlights the power of relationships in the scientific arena. She notes: “The science has to be solid, but the relationships must be in place;” furthermore, these relationships “should not just be nurtured at the time of a crisis but...we have to have the foresight of maintaining and nurturing them over the long term.”⁵

In thinking about how the use of microbial forensics may be of value as an attribution tool, especially in times of crises, one must account for how well the science has been accepted and understood by the general scientific community in the Middle East. If the science advisor to a MENA leader that the United States Government, or any other government for that matter, seeks to influence is not familiar with the methodologies and science behind any scientific evidentiary support offered, then the chances of achieving cooperation are diminished.

The MENA region may provide fertile opportunities for bilateral and multilateral collaboration on microbial forensics and attribution issues to augment or extend existing public health, law enforcement, and biosecurity capabilities at national and regional levels.

⁵ Ibid

Project Methodology

The goal of this project was to gather support for the use of microbial forensics as a tool for enhancing bio security throughout the Middle East region. In working to introduce the expanded use of microbial forensics in the Middle East, the study team examined current national capabilities which could be used. The work plan was broken down into four elements:

1. ***Reviewing documents and websites for indications as to where capabilities currently exist in the region.*** The PI and his team reviewed multiple websites, looking for appropriate organizations and institutions that would have the requisite capacity to absorb and understand the significance of microbial forensics and be a constructive part of the architecture of processing microbial forensics capabilities. In addition to extensive web searches, the team looked at World Health Organization (WHO) reporting, paying particularly close attention to Country Cooperation Strategy Reviews, United Nations (UN) reporting (including UN 1540 reports), and Biological Weapons Convention (BWC) membership and participation. Taking this research and using a truncated Monte Carlo analysis process, the team reviewed the data and made some judgment calls as to where would be the most lucrative MENA countries for the United States to engage with on the promotion of microbial forensics.
2. **Gathering regional support for expanded use of microbial forensics in the Middle East through attendance and presentations at Track 1.5 dialogues and BWC meetings.** The PI took advantage of his position as the co-chair of the Nonproliferation Technical Working Group for a broad Middle East Track 1.5 dialogue to introduce the concept of using microbial forensics as a nonproliferation tool in the biological arena. There were two meetings of this group in 2015. At the first session in February, the PI and Co-PI went through an explanation of microbial forensics (See [Annex A](#)) and worked through two table-top exercise scenarios to reinforce the point (See [Annex B](#)). At the follow-on August meeting, a working group was formed that received further briefings on the use of microbial forensics and then worked through additional tabletop exercises. The working group participants, many of whom were part of a sub group within the track 1.5 meeting (The Middle East Next Generation of Arms Control Specialists Network ([MENACS])), then participated in a general session debate about preparing statements for the next BWC meeting on the idea of promoting robust microbial forensic capabilities in the MENA region. The PI noted that this same Track 1.5 dialogue process had birthed a non-paper at the 2010 BWC REVCON on the importance of cooperation in the biological arena and thus was well suited to make an appeal for better cooperation using microbial forensics as a tool to support BWC objectives. The PI used this previous experience as a model for this project.
3. **Preparing a statement from various Middle East leaders for a presentation as a non-paper at a Biological Weapon's Convention meeting of State's Parties.** The group worked through a draft statement (See [Annex C](#)) and gave consensus approval for presenting a statement at the next BWC meeting. The PI read and distributed copies of the statement at the BWC Meeting of State's Parties on December 15 in Geneva. In addition, a

representative from MENACS read a statement discussing the work that had been done at the Track 1.5 meetings (See [Annex D](#)). Prior to the December meeting, the PI and Co-PI attended the BWC Meeting of Experts in August 2015 in Geneva and were invited to give a two part presentation on “Microbial Forensics from a Policy and Scientific Perspective,” (See Annexes [E](#) and [F](#)). This event was well attended and was designed to be a precursor for the statement that was delivered in December.

4. **Additional impact – developing the next generation of Middle East Arms Control experts.** As this project developed, the PI in consultation with the PM agreed to add an additional objective to the project – supporting next generation Arms Control experts from the region. This was not envisioned in the original project, but was seen as a significant opportunity to increase participation from the Middle East in BWC activities. Three members of the MENACS (one from Iraq, one from Saudi Arabia, and one from Turkey) had all attended the two Track 1.5 dialogues, as well as the BWC Meeting of State’s Parties, in December of 2015. This support paid a valuable dividend as the Saudi Arabian member pushed ahead in his development as a BW arms control expert; he is now an intern at the Implementation Support Unit (ISU) of the BWC in Geneva.

Findings and Recommendations

Microbial forensics is not a science in and of itself, but an application of scientific disciplines to problems encountered in many fields, most notably law and international relations, especially when used as a tool for attribution purposes. The challenge in introducing microbial forensics as a viable policy tool in the MENA region may not be one of building a wholesale microbial forensic capacity in the MENA region, which does not currently exist, but rather one of smart resource allocation, bureaucratic organization, and training using existing national infrastructures. The challenge for the U.S. Government in wishing to use microbial forensics as a viable attribution tool is for it to have general acceptance in the MENA region as a viable methodology that accurately links microbes to their original source. This does not necessarily involve building capacity in each and every country; selective focus on a few regional leaders may be enough. To its credit the U. S. Government is already funding engagement programs in the regional that can help build the foundations for the acceptance of microbial forensic analysis by regional leaders. However, given that no identified microbial forensics and attribution capabilities currently exist within the MENA region, the authors opine that the most viable initiatives to achieving the policy goals at this point are to:

- Increase scientific knowledge and operational applications of microbial forensics science through one or more symposia and conferences;
- Conduct national or regional workshops to determine the key MENA institutions and pertinent experts, indigenous and external resources available, national and regional needs, requirements and opportunities for building an understanding of microbial forensics, and a capacity to perform microbial forensic analysis;
- Provide expert assistance to each entity which expresses interest in establishing a capability to conduct assessments, and to develop and validate strategic plans to establish, validate, and exercise new capabilities;
- Provide training for MENA scientists, technicians, law enforcement, military, and policy personnel within interested MENA countries or partnerships;
- Conduct national or regional symposia to discuss (or perhaps establish) technical guidelines/standards, best practices, methods, and investigative protocols for microbial forensics within MENA; and
- Collaboratively identify priority technical “pilot” projects with MENA partners and others to help advance microbial forensics in the region, as well as establish robust respective capabilities; academia and government laboratories should be leveraged.

Each point is explained in more detail below.

Increase scientific knowledge and understanding of operational applications of microbial forensics science

For interested MENA governments and their agencies, academic and scientific institutions, or even professional organizations, there are at least two mechanisms that can be put in place to increase awareness of microbial forensics and how it can be used. First, websites can be set up, which

provide access to a complete library of published documents or publicly available presentations that cover fundamental science, relevant applied science, forensic validation, microbial forensics, scenarios, and the use of microbial forensic evidence in legal and policy decision making. With support, an international team of experts, along with a web designer, can establish a site and assemble and deposit these documents. Concomitantly, key points of contact can be identified in the organizations noted above to facilitate awareness of, access to, and use of the information in the site. The consortium of international experts and MENA POCs could then maintain and add to this resource.

In addition (or alternatively), one or more national-level or regional conferences could be convened, which would host leading international experts, as well as an appropriate mix of scientists and technicians from the most pertinent sectors (such as law enforcement, public health, government laboratories, the military, and academia), investigators, managers, and legal and policy experts. In addition to educating and informing those newly introduced to the subject, these convocations can set the stage for developing communities of interest, collaborations, and next steps, as well as understanding the requirements for and the process of capacity building.

For either or both of these approaches, it would be most helpful to identify and fund an organization that is capable of proper planning and execution.

With key country or regional leaders, organize conferences within MENA to assess needs, requirements, and opportunities for microbial forensics capacity building

From or in addition to the event(s) mentioned above, leading technical, operational, and management experts can be identified by interested countries, or within the region among cooperating countries, to convene one or more conferences to assess needs, requirements, resources, and opportunities for capacity building and collaboration. The communities from which these individuals would be drawn were noted above. In a structured manner, those involved would critically work through their existing and required capabilities for investigation, field evidence collection, transport and security, laboratory analysis, interpretation and reporting, quality management, infrastructure and personnel, research and development support, and informing legal and policy decision making. Depending on the results, countries or consortia could agree to develop strategies and plans for collaborative or individual pursuit of the desired capabilities in subsequent engagements and processes. Initial development of measures of effectiveness could also be framed out.

Government and non-government experts from non-MENA countries could be available to assist MENA partners with the design and execution of these conferences, and analyzing the results and “lessons learned,” to help maximize the return on investment. Should the MENA leadership choose to enlist such external expertise, they should carefully vet these individuals for tangible credentials and evidence of expertise and experience. It would be with the MENA country or regional leaders that the responsibility would rest for organizational engagement and collaboration, strategic planning, and resource acquisition going forward.

If desired, engage outside expertise available to assist with the design and conduct of assessments to inform strategic plans for MENA nations or partnerships

MENA countries or regional consortia do not necessarily need to establish their respective microbial forensic capabilities in isolation. A number of countries and their institutions have recognized, established, or exhibited various areas from which government and non-government expertise could be drawn to assist the assessment or strategic planning processes. Such countries include the United States, Canada, the United Kingdom, Sweden, and France, all of which have well developed microbial forensic capabilities. Interpol ostensibly has expertise that could be leveraged as well. As noted above, the pool of experts and their perspectives from which assistance is drawn should be carefully vetted to ensure that those identified do indeed possess and have demonstrated the expertise and experience stated and sought. Technical and operational, as well as strategic planning, change, and organizational management, expertise would be most advantageous to acquire for specific tasks or phases or the overall “systems analysis.”

MENA planners could appropriately identify gaps, needs, and opportunities to then match the external expertise required for such priorities and those for which it is not available within MENA. Once these are completed, planners could confer with the appropriate in-country senior leaders/decision makers and determine whether commitment exists to move forward to establish a capability, what resources are available, and how best to configure it at the country level or through bilateral partnerships/consortia.

Provide tailored expert planning and training resources for committed MENA consortia or governments, key agencies, and respective critical categories of personnel

Based on articulated requirements, gaps, or needs by MENA participants, recognized expert assistance can be provided to resulting organizational constructs to develop and validate tailored strategies and plans which describe the desired outcomes and how they will be achieved at the appropriate level of detail. “Customer” and stakeholder requirements and expectations should be addressed, not simply technical and operational considerations. Once strategies or plans at the appropriate level of fidelity are produced, training can then be planned, delivered, and measured for effectiveness.

Field technical training should be provided for personnel protection and safety, scene investigation, interagency coordination, biological and chemical hazardous materials, presumptive testing, evidentiary sample collection, packaging and transport, and chain of custody. Training for laboratory managers and analysts should include personnel protection and safety; facility configuration, safety and security; evidence control, security, and handling; handling and storage of evidentiary biological and chemical hazards and contaminated physical evidence; forensic analysis of priority bioterror agents (microorganisms and toxins) and forensic exploitation of contaminated objects for traditional forensic evidence; interpretation of results and communicating conclusions and opinions. Training should also be provided for key decision maker groups with respect to the use of information

derived from microbial forensic evidence in investigative, command, legal, and policy decisions, to ensure that it is properly understood, tested, and used, for best value and return on investment.

Convene workshops to discuss, and perhaps establish, technical standards or guidelines, and best investigative and analytical practices, methods, and protocols, and best constructs to share or leverage resources and facilities within MENA

As MENA nations or consortia make commitments to developing and implementing microbial forensics capabilities, sponsorship can be provided to convene a series of workshops during which participants methodically explore and establish a body of technical guidelines, standards, and best practices. This would accomplish two objectives: To create a multinational microbial forensics community of interest; and establish common goals and objectives for the quality of science and practice of microbial forensics across the region. This could result in the creation of one or more “scientific working groups” (SWGs, pronounced “swigs”), similar to what has existed in the U.S. and elsewhere for various forensic disciplines beginning nearly two decades ago.

While there are no “gold standards” for any aspect of microbial forensics, existing guidelines, best available practices, methods, and protocols from external sources can be leveraged to provide MENA a foundation for moving forward to establish its own “standards” or similar. Further, important resources can be designed, acquired, or pursued that could be collaboratively established and shared, such as a “reference laboratory” or “repository” for the archiving and subsequent availability of high quality, standardized materials for laboratory analysis, e.g., certified reference strains. Should the initial set of workshops be successful, they could be perpetuated through regular SWG meetings, which focus on particular topics and issue reports for the benefit of the community of interest, from performers through stakeholders. Leadership within MENA and some resources to prepare for and convene the meetings would be necessary to make this activity successful and sustainable.

Identify, fund, staff, and manage a limited number of “pilot” (demonstration) projects to catalyze action and result in beneficial outcomes for articulated priorities

From workshops, a newly created SWG, or existing publications, MENA nations or consortia could identify technical or otherwise foundational “pilot” projects to collaborate on to advance the science, practice, understanding, and use of microbial forensics. These would also anneal, strengthen, and likely expand the microbial forensics community of interest within MENA. Each project would have a clearly defined purpose, a set of goals and objectives, actionable outcomes, timeline, and project management structure and responsible parties. Successful pilot projects could lead to follow on projects which expand, solidify, and advance capabilities or deepen exploration and discoveries.

Examples of pilot efforts are, but are not limited to: more extensive training on advanced technical methods and protocols; collaborative pursuit of one or more “microbial forensics grand challenges,” as published in an international workshop report by the U.S. National Research Council in 2014,

from which fundamental leaps forward in science would result for microbial forensics and related disciplines; developing a process to pursue and achieve laboratory accreditation under the auspices of international standards; and developing and testing attribution decision frameworks which would require dialogue between leading scientists, and investigative, operational, legal, and policy experts. Undertakings of these sorts would be iconic for other regions of the world, and possibly international organizations, which might be interested in establishing and sustaining a community of interest and “path forward” for microbial forensics and attribution for regional and global security.

In thinking about where to start with regard to pilot efforts, the team looked at several criteria for determining where the best opportunities lay based on several factors. The top three choices and the justifications behind those choices are as follows:

Jordan. Jordan is a top choice due to the fact that it has a strong biosecurity/biosafety infrastructure in place, beginning with the Middle East Scientific Institute for Security at the Royal Scientific Society (MESIS) that publishes regularly on biosafety and biosecurity issues. Furthermore, MESIS is involved in a three way consortium with Israel and the Palestinian Authority on mutual cooperation to eliminate cross border disease threats. It has actively participated in the World Health Organization’s (WHO) strategic planning process and has shown measurable progress in improving the nation’s health. Jordan is also up to date with its UNSCR 1540 compliance efforts. It has hosted several regional workshops on biosecurity and has been a regional lead for United Nations initiatives in biosecurity; the Middle East Regional Secretariat for CBRN Centers of Excellence was established at MESIS in Amman.

Egypt. Egypt is also a top choice due to the fact that it has a well-established vaccine industry, one of the largest in the region and can be leveraged. It is one of tow countries in the region that has joined the International Federations of Biosafety Associations. Furthermore, The United States Government has established NAMRU-3 as one of the largest medical research laboratories in the MENA region, which means that many ties are already established. Egypt is also the regional influenza reference laboratory for the WHO, with close ties to the influenza laboratory at the U.S. Centers for Disease Control and Prevention (CDC). It is also working with Sandia National Laboratory on building a biological reference library. Egypt has signed but not ratified the BWC. On a political level engaging with them on a microbial forensics education and capacity building program could encourage ratification.

UAE. The case for UAE rests on the fact that it is committed to building a pharmaceutical industry within the country. More importantly, it has the financial resources to sustain this long term investment. Its public medical system is also considered world class. UAE is up to date with its UNSCR 1540 compliance efforts and has participated in Confidence Building Measures in the past. All of these factors combined make UAE a viable partner.

Conclusion

Establishing a microbial forensics capability in the MENA region is still many years away and it is unlikely that many countries will ever have a robust capability. However, establishing credibility of the results offered by microbial forensic analysis performed by western states and/or made today in workshops and training have the ability to prepare the policy landscape for the day in which the source of a bio attack, either man-made or from nature, needs to be accurately attributed. It is during a crisis or suspected attack when trust in and understanding of the science is critical. If the trust has not been built prior to the incident, it won't be there at the time of the incident when it is needed.

Convincing = Investment = Trust

Appendix A

1. Annex A, “Forensic Science & Microbial Forensics in Bioterrorism & Bioproliferation Investigations and Decision Making.” Available at: <https://fas.org/wp-content/uploads/2016/03/DOS-annex-A.pdf>
2. Annex B, “UCLA Middle East Regional Security and Cooperation Meeting.” Available at: <https://fas.org/wp-content/uploads/2016/03/DOS-annex-B.pdf>
3. Annex C, “Overview of Middle East Track II Technical Discussions on Regional Cooperation in the Biological Sciences.” Available at: <https://fas.org/wp-content/uploads/2016/03/DoS-annex-C.pdf>
4. Annex D, “Statement by the Middle East Next Generation of Arms Control Specialists Network (MENACS) to the 2015 Meeting of States Parties to the 1972 Biological And Toxin Weapons Convention.” Available at: <https://fas.org/wp-content/uploads/2016/03/Dos-Annex-D.pdf>
5. Annex E, “Attribution Use of Microbial Forensics in Cases Involving Illicit Programs and/or Use.” Available at: <https://fas.org/wp-content/uploads/2016/03/DoS-annex-E.pdf>
6. Annex F, “Science Supporting Attribution in the BWC Context.” Available at: <https://fas.org/wp-content/uploads/2016/03/DoS-annex-F.pdf>