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E-NOTES

"A nation must think before it acts." - Robert Strausz-Hupé

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WEAPONIZING EBOLA?

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"Everybody knows that pestilences have a way of recurring in the world; yet somehow we find it hard to believe in ones that crash down on our heads from a blue sky. There have been as many plagues as wars in history; yet always plagues and wars take people equally by surprise."

- **Albert Camus, *The Plague* (1947)**

A number of public domain commentaries have appeared in recent days on the theme *Ebola as a biological weapon*.[1] This is, to state the obvious, an important matter that merits judicious consideration. It is not, however, a new one: we have known for some time that the Soviet Union acquired Ebola virus strains in the mid-1980s from a Belgian research institution[2] and commenced work to weaponize them.

Two important claims are made with respect to the Ebola virus (EBOV). The first claim is that the weaponization of EBOV for use as an instrument of biological warfare or terrorism is so unlikely as to dismiss it from serious consideration. The second claim is that secondary transmission of EBOV in human populations occurs only by direct contact with infected persons, or with infected blood and other bodily fluids or tissue, and not by aerosol transmission (in ambient air).[3]

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[1] For example, Marc A. Thiessen (2014). "A 'Dark Winter' of Ebola terrorism?" *The Washington Post* [online edition, 20 October 2014]. http://www.washingtonpost.com/opinions/marc-thiessen-a-dark-winter-of-ebola-terrorism/2014/10/20/4ebfb1d8-5865-11e4-8264-deed989ae9a2_story.html. Last accessed 26 October 2014. Josh Sanburn (2014). "Here's What Would Happen if Ebola Was Stolen From a Lab." *Time* [online edition, 22 October 2014]. http://time.com/3532057/ebola-bioweapon-terrorism/. Last accessed 26 October 2014.

[2] The Antwerp-based Instituut voor Tropische Geneeskunde, which supplied an EBOV variant to the Byelorussian Research Institute of Epidemiology and Microbiology located in Minsk. See: Milton Leitenberg & Raymond A. Zilinskas (2012). *The Soviet Biological Weapons Program: A History*. (Cambridge, MA: Harvard University Press), p. 93.

[3] For example, "Ebola virus is not transmitted from person to person through the air, water, or food." Kansas Department of Health and Environment (2014). *Ebola Virus Preparedness and Response Plan*, Version 2.0 (21 October 2014), p. 4. http://www.kdheks.gov/ebola/download/KDHEEbolaPreparednessPlan2.0.pdf. Last accessed 26 October 2014.

One objective of this paper is to test these claims. With respect to the one about the weaponization of EBOV, part of that claim can be conceded upfront, *viz.*, that practical barriers to manufacturing an EBOV bioweapon make it unlikely that a malevolent group such as Islamic State (or for that manner, most nation-states) could do so beyond possibly fabricating a very small number of improvised dispersal devices. With respect to an EBOV *biohazard* weapon, however, the claim is much more contestable. EBOV's purported non-transmissibility in ambient air, too, is subject to serious challenge; the opposite has in fact been demonstrated experimentally in environmental conditions that may have special salience here. It is the intersection of these contested claims—a biohazard weapon intended to transmit EBOV to human populations through aerosol dispersal into ambient air—that poses the greatest concern.

In this sense EBOV has symmetries with, for example, nuclear (fissile) and radiological materials, which along with lethal biological material comprise three legs of the four-legged *weapons of mass disruption* stool. As argued elsewhere, the intent of detonating an improvised nuclear or radiological device is to cause coercive, wide-scale social, political and economic disruption. This in some ways makes them more problematic than military-grade mass destructive weapons because the former are more likely to be used by a malevolent group that came to possess them. So, too, improvised biohazard devices since practical barriers to their fabrication and use are substantially lower than those faced even by improvised bioweapons let alone military-grade ones.

EBOLA, WARFARE & TERROR

The emergence of *Ebola* as a meme has distracted from semantic overlaps and lingering imprecision in how the term is used. *Ebola virus disease* (EVD) is a severe viral infection characterized by fever, shock and coagulation defects. EVD is caused by exposure to EBOV, a filovirus[4] discovered in 1976 after the first known outbreak of EVD, in the Democratic Republic of Congo (then Zaire). EVD belongs to a class of *zoonotic diseases*—those in which a virus that is transmissible to humans has a primary reservoir in an animal species, where it resides and causes little or no damage—also known as *host-swapping diseases*. EBOV's reservoir is thought to be one or more species of bat.[5] There are five known EBOV species, *viz.*, Bundibugyo, Cote d'Ivoire, Reston, Sudan, and Zaire. Their relative virulence varies greatly among infected humans and other mammalian species: *Zaire* and *Sudan* are associated with mortality rates of 50-90 percent in humans while *Côte d'Ivoire* has only been reported from a non-fatal human case, and *Reston* is only associated with asymptomatic infections in humans.[6]

We should take a moment to frame the discussion by defining some key terms. EBOV and other pathogens are incorporated into biological weapons or *bioweapons* to enable their deliberate release into the environment for the express purpose of causing disease—here, EVD—in a target human population. The United Nations defines bioweapons as "complex systems that disseminate disease-causing organisms or toxins to harm or kill humans, animals or plants."[7] Their military use is labeled biological warfare or *biowarfare*; their non-military use is labeled biological terrorism or *bioterrorism*.

Biowarfare is not new, nor for that matter may be Ebola: a group of United States Navy epidemiologists suggest that Thucydides' "plague of Athens" (430-427/425BCE) was actually EVD.[8] A poisoned arrow wounds the eponymous main character in Sophocles' 404 BC play, *Philoctetes*. It comes as no surprise, therefore, that the English word *toxin* is derived from the Greek word *toxicon*, which in turn is derived from *toxon*, the Greek word for arrow. A derivative term, *toxic warfare*, is sometimes used to describe the malevolent use of toxic waste (e.g.,

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[4] EBOV and a second filovirus, Marburg, are classified as *Category A* biowarfare agents by the United Center Centers for Disease Control because of their high virulence, demonstrated aerosol infectivity in the laboratory, and capacity for inducing fear and anxiety. Marburg and Ebola are respectively, the first and second known filoviruses. See: Lisa D. Rotz, et al. (2002). "Public health assessment of potential biological terrorism agents." *Emerging Infectious Diseases*. 8:2, pp. 225–229.

[5] Roman Biek, Peter D. Walsh, Eric M. Leroy & Leslie A. Real (2006). "Recent Common Ancestry of Ebola Zaire Virus Found in a Bat Reservoir." *PLoS Pathogens*. 2:10. http://www.plospathogens.org/article/fetchObject.action?uri=info%3Adoi%2F10.1371%2Fjournal.ppat.0020090&representation=PDF. Last accessed 24 October 2014. These are known to include three species of the *Pteropodidae* family fruit bats, *Hypsignathus monstrosus*, *Epomops franqueti*, and *Myonycteris torquata*.

[6] Meg L. Flanagan, Terrance J. Leighton & Joseph P. Dudley (2011). *Anticipating Viral Species Jumps: Bioinformatics and Data Needs*. (Washington, DC: Defense Threat Reduction Agency), p. 12.

[7] http://www.unog.ch/80256EE600585943/(httpPages)/29B727532FECBE96C12571860035A6DB?OpenDocument. Last accessed 24 October 2014.

[8] Patrick E. Olson, MD, *et al.* (1996). "The Thucydides Syndrome: Ebola Déjà Vu? (or Ebola Reemergent?)." *Emerging Infectious Diseases*. 2:2 (April-June 1996), pp. 155-156. http://198.246.112.54/pub/EID/vol2no2/adobe/vol2no2.pdf. Last accessed 25 October 2014.

infectious medical waste) as a bioweapon:

> **"Such 'toxic weapons' provide a means for hostile state or nonstate actors to improve their capabilities within the context of asymmetrical warfare. In basic terms, toxic warfare refers to the use of chemicals or industrial waste to harm or alter the behavior of an opponent during military operations. Toxic warfare does not, however, require the use of traditional weapons..."**
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> **"Toxic warfare can cause casualties among opposing militaries by incapacitating and, in some cases, killing the adversary. [It] can also halt or force delays in military logistics flows or operations and can disrupt the functioning of the urban infrastructure through contamination or corrosion. Toxic weapons, moreover, derive power from the uncertainty that stems from their potential use. Toxic substances often represent an unknown threat, and the level of uncertainty surrounding the potential damage these substances might cause can increase their impact even when little or no physical harm has been done."[9]**

This serves as a foundation for distinguishing a related, but separate class of weapon, *biohazardous weapons*.[10] They have long been effective weapons of terror: the Tartar army besieging the city of Kaffa (present day Fedosia, Ukraine) in 1346 CE catapulted the bodies of plague victims over the city walls to cause Kaffa's defenders to abandon the city. In the case of EVD, bodily fluids from diarrhea, vomiting, and bleeding represent an extreme biohazard:

> **"Based on US hospital experiences to date, one Ebola patient will likely generate eight 55-gallon barrels of medical waste per day, making storage, transportation, and disposal of the waste a major challenge for hospitals..."[11]**

For example, while the United States Centers for Disease Control and Prevention recommends autoclaving (a form of sterilizing) or incinerating waste, the latter is effectively prohibited in California and banned in at least seven other states. Moreover, there are basic unresolved questions about whether EBOV-infected human waste may enter sanitary sewer systems: the USCDC says that it can, but other sources say the waste must first be sterilized.[12] This ambiguity is puzzling in the face of long-available scientific findings. For example, a 1996 study by scientists at USAMRIID's National Centers for Infectious Diseases concluded:

> **"All bodily excretions from a patient with VHF should be considered infectious and should be inactivated prior to disposal to prevent subsequent accidental infections. All effluent should be disinfected prior to disposal into a municipal sewer system or septic tank by adding disinfectant prior to use of using chemical toilets. This level of precaution should continue for 6 weeks of convalescence or until the patient is virologically negative."[13]**

DISTINGUISHING BIOWEAPONS AND BIOHAZARDOUS WEAPONS

The United States and other signatory nations to the 1972 Biological and Toxin Weapons Convention[14] agree not to "develop, produce, stockpile or otherwise acquire or retain":

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[9] Theodore Karasik (2002). *Toxic Warfare*. (Santa Monica: RAND), ix-x.

[10] Medical waste as a potential toxic weapon can include human blood and blood products; cultures and stocks of infectious agents; pathological wastes; contaminated wastes from patient care; discarded biological materials; and contaminated body parts, bedding, and equipment. Karasik (2002), p. 25.

[11] "Hospitals Face Ebola Waste Challenges." *Environmental & Energy Management News* [online edition, 24 October 2014]. http://www.environmentalleader.com/2014/10/24/hospitals-face-ebola-waste-challenges/. Last accessed 26 October 2014. EBOV waste must be packaged inside rigid plastic 55-gallon drums or larger over-pack plastic drums that can be incinerated with the contained waste. There is a 90-day time limit on how long EBOV waste can remain stored in one of these drums before being incinerated. For reference, the estimated daily quantity of medical waste produced by a single EVD patient equates to 440 gallons.

[12] *Ibid.*

[13] C. J. Peters, *et al.,* (1996). "Patients infected with high-hazard viruses: scientific basis for infection control." *Archives of Virology*. 11, pp. 163-164.

[14] Formally, "Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction."

"(1) Microbial or other biological agents, or toxins whatever their origin or method of production, of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes;"

"(2) Weapons, equipment or means of delivery designed to use such agents or toxins for hostile purposes or in armed conflict."[15]

A bioweapon consists of two parts, a *weaponized agent* and a *delivery mechanism*.[16] While a theorized bioweapon delivery mechanism could use active (explosive) means, passive (aerosol) ones are much preferred for reasons discussed later. Bioweapon manufacture and use has three distinct phases, *agent production*, *agent stabilization*, and *agent dissemination*. The first two involve selecting a pathogen and obtaining a starter culture, which is then mass-produced and stabilized. At this point, the bioweapon consists of a liquid suspension (in our example, of EBOV) and a chemical stabilizer. A canister holding the liquid suspension is then placed in a disseminating device (e.g., a sprayer) or explosive munitions,[17] in either case to deliver the suspension as an aerosol since airborne EBOV and other filoviruses are known to be highly infectious.[18]

A biohazardous weapon in many important ways is much simpler, and in its simplicity, a much more threatening device. The most rudimentary form of EBOV biohazardous weapon would use liquid[19] (fluids) medical waste acquired from an EVD patient and disseminate it by means of a sprayer to aerosolize the waste. For example, it has been reported "undessicated blood from acutely infected Ebola patients may be infectious for up to 1 month at ambient temperature."[20] It would pose no special engineering challenge to start with other medical waste[21] and reach the same end. While practical considerations might argue against using explosive munitions to disperse EBOV-contaminated waste—explosives generate heat that may render a biological agent inactive—the shock effect of a known detonation in an urban area might well have all the disruptive effect a malefactor intended.

As stated earlier, biohazardous weapons share many characteristics of improvised nuclear and radiological devices, especially the latter since biohazardous and radiological materials are fairly easy to come by for a determined malefactor and simple to weaponize. This might well carry over to consideration of how a malefactor would deploy these weapons, since all are far most effective when detonated (or in the case of a biohazardous weapon, dispersed) in a contained environment such as a large building, for the common objective is to disperse the material in question as an aerosol rather than rely on the destructive kinetic effect, which is of secondary interest.

AEROSOLIZED EBOLA?

Beyond the socially, politically and economically disruptive effects of dispersing EBOV-contaminated medical waste, there is a question whether aerosolized EBOV presents a meaningful health risk to an exposed human population. Governmental health officials have repeatedly assured the public that the only cause of secondary, human-to-human EBOV transmission is infectious blood (where the highest EBOV concentrations are found) or other body fluids, direct contact with which allows EBOV to invade the body through the conjunctiva, gastrointestinal tract, and/or breaks in the skin. These officials steadfastly maintain, "Ebola is not spread through the air."[22]

This is not strictly so, however, in the case of intentional direct aerosol exposure of the sort intended from the use of an EBOV biohazardous weapon (or bioweapon). A 2012 study by the United States Army Medical Research

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[15] *Ibid.*, Article I. See: http://www.opbw.org/convention/documents/btwctext.pdf. Last accessed 24 October 2014.
[16] http://www.unog.ch/80256EE600585943/(httpPages)/29B727532FECBE96C12571860035A6DB?OpenDocument. Last accessed 24 October 2014.
[17] Steven C. Drielak (2004). *Hot Zone Forensics: Chemical, Biological, and Radiological Evidence Collection*. (Springfield, IL: Charles C. Thomas Publisher, LTD), p. 172. Common to what is sometimes assumed, the use of explosive munitions as a dissemination device is problematic insofar as the heat generated by the explosive may render the biological agent inactive.
[18] Mike Bray (2003). "Defense against filoviruses used as biological weapons." *Antiviral Research*. 57, p. 54.
[19] EVD patient bodily fluids like vomitus and stool, and blood.
[20] C. J. Peters, *et al.,* (1996), *op cit.,* p. 163.
[21] For example, EBOV contaminated "medical equipment, sharps, linens, and used health care products (such as soiled absorbent pads or dressings, kidney-shaped emesis pans, portable toilets, used personal protection equipment (gowns, masks, gloves, goggles, face shields, respirators, booties, etc.) or byproducts of cleaning contaminated [...] substance." See: Kansas Department of Health and Environment (2014), *op cit.,* p. 13..
[22] United States Centers for Disease Control website. http://www.cdc.gov/vhf/ebola/transmission/index.html. Last accessed 26 October 2014.

Institute of Infectious Disease (USAMRIID) concluded that while "there is no strong evidence of secondary transmission by the aerosol route in African filovirus outbreaks":

> **"[A]erosol transmission is thought to be possible and may occur in conditions of lower temperature and humidity which may not have been factors in outbreaks in warmer climates. At the very least, the potential exists for aerosol transmission, given that virus is detected in bodily secretions, the pulmonary alveolar interstitial cells, and within lung spaces. [...] Filoviruses in aerosol form are therefore considered a possible serious threat to the health and safety of the public."[23]**

An earlier peer-reviewed study[24] established the potential of aerogenic infection of EBOV. It is important here to distinguish two different points: (a) the *potential* for aerogenic infection of EBOV through aerosol transmission; and (b) the probability that aerogenic infection is a significant infection pathway during human EVD outbreaks. As the 2012 USAMRIID study noted, there is no strong evidence to indicate that the probability of (b) is especially high, which means that aerogenic infection has not been significant in EBV outbreaks in Africa. However, as the 2012 USAMRIID and earlier studies concluded, that does not mean aerogenic infection is impossible.

With particular attention to the question of weaponizing EBOV in one form or another, and accepting the first condition—that aerogenic EBOV infection is possible—what factors might affect why it has not been observed to be a significant pathway during human EVD outbreaks in Africa? Two factors—ambient temperature and relative humidity—are of particular interest since elevated levels in each have long been shown to reduce the aerosol stability of viruses. When scientists controlled these levels:

> **"Our experiments were conducted at 24°C [≅75°F] and <40% RH, conditions which are known to favor the aerosol stability of at least two other African hemorrhagic fever viruses, Rift Valley fever and Lassa."[25]**

The results were unambiguous— EBOV "can be transmitted by aerosol"[26] subject to:

> **"[L]ower temperature and humidity than that normally present in sub-Saharan Africa. Ebola virus sensitivity to the high temperatures and humidity...in southern Sudan and northern Zaire may have been a factor limiting aerosol transmission of Ebola virus in the African epidemics."[27]**

A 2004 paper assessing the results of this and similar studies concluded:

> **"The high mortality rates, coupled with the knowledge that these viruses possess properties considered desirable in biological weapons, explains the considerable concern about their potential use. However, this concern must be couched with an understanding of the paucity of data concerning that potential. Without data there can be little understanding of the level of threat that filoviruses present. For example, it is not clear from the available data whether filoviruses would cause large-scale infections and deaths if disseminated by aerosol over a city without extensive preparation or modification ('weaponization')."[28]**

In the context of considering the malevolent dispersion of biohazardous material, it has been understood for some time that small-particle aerosols present a far greater danger than large droplets:

> **"When liquid suspensions containing viruses are dispersed in the air, the sizes of the particles formed are extremely important in their subsequent behaviour. Larger droplets (>5-10μm) settle out rapidly and under ordinary circumstances travel no further than one or perhaps 3 meters, during**

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[23] Elizabeth E. Zumbrun, *et al.* (2012). , p. 2116. " A Characterization of Aerosolized Sudan Virus Infection in African Green Monkeys, Cynomolgus Macaques, and Rhesus Macaques." *Viruses.* 2012:4, p. 2116.

[24] E. Johnson, N. Jaax, J. White & P. Jahrling (1995). "Lethal experimental infections of rhesus monkeys by aerosolized Ebola virus." *International Journal of Experimental Pathology.* 76:4, pp. 227-236.

[25] Johnson, *et al*., p. 233.

[26] *Ibid.,* p. 234.

[27] *Ibid.,* 233.

[28] Elizabeth K. Leiffel & Douglas S. Red (2004). "Marburg and Ebola Viruses as Aerosol threats." *Biosecurity and Bioterrorism: Biodefense Strategy, Practice and Science*. 2:3, p. 189.

which they may contact skin or mucous membranes and their presence may actually be felt as moisture or another sensation. If air containing such droplets is inspired, they are largely trapped in the turbinates or impinge on the posterior pharynx."

"Smaller partides (1-5μm) have markedly different properties and will be referred to here as small-particle aerosols or simply aerosols. They will remain dispersed in the air and circulate as airborne particles for long distances without settling. If inspired, they will penetrate deep into the lung, and Brownian motion, sedimentation, and turbulence will result in retention of about half of them in the lower respiratory passages or alveolae. These particles are not efficiently filtered from air by ordinary surgical masks and therefore enhanced respiratory protection must be used."[29]

There are two important factors to weigh in assessing the issues raised here: first, whether EBOV is stable in small-particle aerosols; and second, whether this mode of spread is observed clinically. The answer to both questions is yes, with an important caveat regarding incidence:

"The data on formal aerosol experiments leave no doubt that Ebola and Marburg viruses are stable and infectious in small-particle aerosols, and experience of transmission between experimental animals in the laboratory supports this. Indeed, during the 1989–1990 epizootic of the Reston subtype of Ebola, there was circumstantial evidence of airborne spread of the virus, and supporting observations included suggestive epidemiology in patterns of spread within rooms and between rooms in the quarantine facility, high concentrations of virus in nasal and oropharyngeal secretions, and ultrastructural visualization of abundant virus particles in alveoli. However, this is far from saying that Ebola viruses are transmitted in the clinical setting by small-particle aerosols generated from an index patient. Indeed patients without any direct exposure to a known EHF case were carefully sought but uncommonly found. The conclusion is that if this mode of spread occurred, it was very minor."[30]

This might explain the seeming disconnect between on the one hand, scientific data indicating EBOV transmission can occur by means of small-particle aerosol; and on the other hand, public statements by governmental officials and other that the risk of secondary human-to-human transmission by this mode is unlikely. It is the former, however, that has bearing in the context of a theorized biological or biohazardous weapon. Another set of factors become relevant, for example, the question of EBOV's persistence in the environment; and the presence of factors that affect the aerosol's decay (e.g., relative humidity, the composition of the fluid in which the virus was suspended, ultraviolet light from the sun, and dilution by diffusion and wind currents).

NEAR AND LONGER TERMS RISKS & CONCERNS

Near-term fears about an EBOV-based bioweapon are something of a false flag. The production and stabilization of pathogenic agents, and the fabrication of an effective delivery mechanism to disperse a now-weaponized agent on a target human population are tasks that collectively (and thankfully) lie beyond the understood capacity even of sophisticated malefactors among today's terrorist organizations and rogue states.

Lamentably, the same confidence does not extend to biohazardous weapons intending widespread disruption, and possibly, secondary EBOV transmission within a target human population. Avoiding such a contingency requires scrupulous, inerrant chain-of-custody control and disposal of EBOV-tainted medical waste. That standard should be achievable in the United States; whether it is in nations that are at the epidemic's epicenter is another question entirely. The decidedly unglamorous end of an effective response to the EVD epidemic, the control of EBOV-tainted material is nonetheless critical to thwarting opportunistic malefactors seeking feedstock for biohazardous weapons.

The historic example of the Soviet biological weapons program advises long-term vigilance. Kanatzhan Alibekov *aka* Kenneth Alibek, is the former chief scientist and first deputy director of the Soviet-era *Biopreparat*[31] biowarfare

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[29] C. J. Peters, *et al.,* (1996), *op cit.,* pp. 152-153.

[30] C.J. Peters & J.W.Peters (1999). "An Introduction to Ebola: The Virus and the Disease. *The Journal of Infectious Diseases.* 179 (Supplement 1). http://jid.oxfordjournals.org/content/179/Supplement_1/ix.long. Last accessed 27 October 2014.

[31] Biopreparat is the Russian transliteration of Биопрепарат, an acronym which when expanded translates as "biological material preparation")

agency. He has written extensively on Soviet-era bioweapons programs, including one to weaponize EBOV that remained active into at least the early 1990s.[32] It included a research-stage effort to create a recombinant EBOV-smallpox chimera virus, building on earlier work to insert EBOV genes thought to be virulence factors into the *vaccinia* virus, the genetic structure of which closely resembles the smallpox virus.[33] The objective, according to Alibekov, was to "produce the form of smallpox called blackpox," *aka* hemorrhagic smallpox, the most severe type of that disease. "As a weapon, the Ebolapox would give the hemorrhages and high mortality rate of Ebola virus, which would give you a blackpox, plus the very high contagiousness of smallpox," Alibek said.[34] Nor are efforts to weaponize EBOV limited to state actors: in 1995, Japanese authorities seized EBOV cultures in a raid on the headquarters of the Japanese cult *Aum Shinrikyo*, which may earlier have acquired EBOV samples under cover of an October 1992 "medical mission" in Zaire.[35] In 1998, the MIT-educated neuroscientist Aafia Siddiqui was arrested in Ghanzi, Afghanistan, in possession of a detailed plan for a "mass casualty attack" in the United States using an EBOV dirty bomb.[36]

To conclude, there is a clear danger posed by the potential to weaponize Ebola-related biohazardous material, especially given the large volume of it produced by a single infected patient. It is a cause for vigilance, however, not panic. That being said, the actual or credibly claimed possession of Ebola-infected biohazardous material by a known malefactor would have an obvious and potentially severe disruptive effect, let alone the destructive effect on a target human population were a malefactor successfully to disperse aerosolized Ebola virus. The only way to preclude potential malefactors from coming into actual possession of such material, or from making a credible claim to have done so, is to institute and execute scrupulous methods to control and dispose of these materials. As Camus wrote, doing nothing is not an option:

> **"A pestilence isn't a thing made to man's measure; therefore, we tell ourselves that pestilence is a mere bogy of the mind, a bad dream that will pass away. But it doesn't always pass away, and, from one bad dream to another, it is men who pass away."**

[32] EBOV was part of a concerted Soviet effort to develop highly virulent viruses. An RNA virus, EBOV has evolved complex mechanisms of transcription and translation, requiring Soviet scientists to develop methods to insert foreign gene fragments that were difficult for the host virus to expel. See: Leitenberg & Zilinskas (2012), *op cit.,* p. 248.

[33] COL Michael J. Ainscough, USAF (2002). "Next Generation Bioweapons: The Technology of Genetic Engineering Applied to Biowarfare and Bioterrorism." Counterproliferation Paper No. 14. USAF Counterproliferation Center. (Maxwell AFB, AL: Air War College), pp. 6-7.

[34] Quoted in Richard Preston (1998). "The Bioweaponeers." *The New Yorker.* 9 March 1998, pp. 52-65.

[35] This story was covered in multiple oputletds. See: Kyle B. Olson (1999). "Aum Shinrikyo: Once and Future Threat?" *Emerging Infectious Diseases*. 5:4. http://wwwnc.cdc.gov/eid/article/5/4/99-0409_article. Last accessed 27 October 2014. Also: Monterey Institute of International Studies (2001). "Chronicle of Aum Shinrikyo's CBW Activities." http://cns.miis.edu/reports/pdfs/aum_chrn.pdf. Last accessed 27 October 2014.

[36] See: Terrorism Research & Analysis Consortium (2014). "Affia Siddiqui: Individual Profile" [online database]. http://www.trackingterrorism.org/group/aafia-siddiqui-individual-profile. Last accessed 27 October 2014. Shane Harris (2014). "Lady al Qaeda: The World's Most Wanted Woman." *Foreign Policy* [online edition, 26 August 2014]. http://www.foreignpolicy.com/articles/2014/08/26/lady_al_qaeda_the_worlds_most_wanted_woman. Last accessed 27 October 2014.