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Science & Society
Addressing the Gap in International Norms for Biosafety

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There is currently a lack of national-level norms for biosafety. Considering that a laboratory accident involving a contagious pathogen could have long-term consequences that extend beyond an individual incident into the practice of science more broadly, it is in the interests of scientists everywhere that international norms are developed.

For most research scientists, biosafety is a local concern. There are procedures to work safely in the laboratory that need to be followed, as well as taught to incoming students and post-docs. There are institutional biosafety committees, which review registrations for recombinant DNA work as well as infectious agents, animal protocols, and clinical trials. Many research institutions also have biosafety officers who provide advice on biological risks, and ensure compliance with the relevant regulations and guidelines. But, while most scientists deal with biosafety locally within their institution, how biosafety is practiced, regulated, and funded on an international level should be a concern of every scientist. As pathogens do not confine themselves to international borders, a laboratory accident involving a contagious pathogen could potentially have far-reaching effects around the world—not only as a direct impact of the breach of containment but on the overall practice of science.

Most accidents in biological science laboratories are limited to the researchers involved and possibly their close contacts. While these accidents are unfortunate events that may have severe consequences for those directly affected, they would not typically become matters of international concern. However, laboratory-acquired infections (LAIs) with particularly transmissible pathogens, including noncirculating human influenza strains, the severe acute respiratory syndrome (SARS) coronavirus, or other contagious pathogens, could have consequences that go well beyond the laboratory. In large part, it was these biosafety concerns that fueled the decision by the US government in early 2015 to pause funding for influenza gain-of-function (GOF) research while the risks and benefits of that research were analyzed (http://www.whitehouse.gov/blog/2014/10/17/doing-diligence-assess-risks-and-benefits-life-sciences-gain-function-research). Investigators first touched off the controversy in 2011–2012 with their development of a form of the H5N1 avian influenza virus that was transmissible between mammals [1,2]. While these researchers were widely acknowledged to be experienced in working with virulent strains and to have taken many biosafety precautions, fears were raised that such work could easily be replicated in laboratories with less robust safety systems, health monitoring, or experience, and could trigger a pandemic.

Unfortunately, these fears are merited: biosafety is uneven throughout the world, and almost always underfunded. The costs to staff, train, retrain, and implement good practices are often considered less important than other costs, such as funding the research itself. Furthermore, a system of detailing and reporting biosafety issues to a national or international body is often lacking. Biosafety breaches are embarrassing for the laboratory workers who made the mistakes, as well as for the research institution, and so even if biosafety lapses are detected, they may not be reported. The researcher may feel stigmatized, especially if the relationship with the supervisor and the institution is poor, and a culture of best biosafety practices has not been established. Therefore, how often accidents occur, or result in direct harm to the laboratory worker, is almost completely unknown.

In recognition of the fact that individual laboratory workers carry the most personal risk from LAIs, resources have been committed to boost biosafety at the local level. There is excellent guidance available for researchers, laboratories, and research institutions to adhere to high biosafety practices, and provide biosafety professional training pertaining to each individual discipline and type of work. There are also standards classifying pathogens at varying levels of biocontainment [Biosafety level-1 (BSL-1), BSL-2, BSL-3, and BSL-4] and what corresponding engineering controls should be in place to manage biorisks within a research institution, whether they pose risks to humans, livestock, or plants. The World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO), the World Organization for Animal Health (OIE), the Centers for Disease Control and Prevention (CDC), professional societies [including the American Biological Safety Association (ABSA), European Biological Safety Association (EBSA), and Asia Pacific Biosafety Association (A-PBA)] aim to bring technical information to practitioners, enhance laboratory safety practice, and promote biosafety standards.

However, while there is an abundance of information for individual researchers and institutions to work in biological systems safely, there is much less guidance at the international level. There are no international norms that would govern biosafety precautions with particularly dangerous pathogens, or detail how much nations should be spending on biosafety oversight as a proportion of research funding, or describe what components of biosafety systems are essential for oversight. Furthermore, there is a dearth of cross-disciplinary considerations, for example concerning those laboratory workers who deal with animal health as well as food safety. To come to this troubling conclusion, we performed an extensive analysis of key international treaties, agreements, instruments, guidelines, multilateral
engagement mechanisms, and information resources intended to guide each individual nation’s approach to biosafety in research, clinical, and industrial laboratories (http://www.upmchealthsecurity.org/our-work/publications/synopsis-of-biological-safety-and-security-arrangements). We identified the benefits and limitations of each in promoting biosafety, and how they contribute towards minimizing the global risk and consequences of laboratory accidents.

For example, among the international arrangements which directly concern biosafety and biosecurity is the 2005 World Health Assembly (WHA) Resolution 58.29 on Enhancement of Laboratory Biosafety. This resolution urges WHO Member States (which include all members of the United Nations except Liechtenstein) to adhere to principles that would increase biosafety. However, there is no assessment of whether the WHA guidance has been adopted by any Member State, or that sufficient funds have been committed to training, equipment, and other resources and infrastructure required in order to maintain safe and productive laboratories. There is no independent mechanism to monitor adherence to principles through reporting or external review, and countries do not need to report on their adherence to the resolution. More importantly, the document does not provide guidance for implementing a national biosafety system, such as how to develop training standards, designate governmental regulations, or enact a system for reporting and monitoring LAIs. The proportion of need for technical assistance by the Member States also exceeds the capacity of the WHO to provide.

Another example is the 2005 International Health Regulations (IHR) [3], which requires nations to detect and respond to disease threats; functioning laboratories are integral in that mission. The laboratories that are part of the IHR assessment are primarily medical and public health laboratories which would be used in the course of surveillance and diagnosis of disease. Research, industrial, and commercial laboratories are not explicitly covered under IHR obligations. Also, despite the requirement for WHO Member States to have established IHR core capacities by 2012, over 80% of countries have either requested an extension or have not reported on these critical capacities, so even the capacities of those laboratories that are included are currently unknown (http://apps.who.int/gb/ebwha/pdf_files/EB132/B132_15-en.pdf?ua=1).

In response to the poor implementation rates of the IHR 2005 standards, the United States, along with 30 countries and international organizations, put forth the Global Health Security Agenda in February of 2014, which focuses attention on implementing IHR standards in resource-constrained countries. However, the biosafety issues associated with potentially consequential research are not just in such resource-constrained countries but also in places that are at the leading edge of technological development, so the appropriate target may instead be research centers in well-resourced countries.

Considering the pace and progress of biotechnology, the lack of international norms for national biosafety programs is concerning. To develop them, it is up to biosafety experts, scientists, and their professional associations to determine what are the reasonable combinations of biosafety activities and oversight mechanisms that should be standard from one research-producing nation to another. Without national-level standards for biosafety, and interest in making sure that research institutions that perform potentially high-consequence research adhere to those standards, there will remain insufficient incentives to commit the resources required to achieve high levels of biosafety in individual laboratories and institutions. It is also in the interests of nations to encourage that these standards be developed and promulgated: taking steps to develop internationally agreed-upon standards for biosafety for work with contagious organisms has the potential to provide reassurance to other nations that scientific research is performed safely, and that an LAI may be caught, and stopped—before developing into a pandemic.

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Spotlight Programming Bacteriophages by Swapping Their Specificity Determinants

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Bacteriophages, bacteria’s natural enemies, may serve as potent antibacterial agents. Their specificity for certain bacterial sub-species limits their effectiveness, but allows selective targeting of bacteria. Lu and colleagues present a platform for such targeting through alteration of bacteriophages’ host specificity by swapping specificity domains in their host-recognition ligand.

Bacteriophages are viruses that propagate in bacteria and usually kill them. Ever