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REVIEW

Overview of the CSIRO Australian Animal Health Laboratory

John Lowenthal*

Emerging Infectious Diseases Program, CSIRO Health and Biosecurity, Australia

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Summary Emerging infectious diseases arising from livestock and wildlife pose serious threats to global human health, as shown by a series of continuous outbreaks involving highly pathogenic influenza, SARS, Ebola and MERS. The risk of pandemics and bioterrorism threats is ever present and growing, but our ability to combat them is limited by the lack of available vaccines, therapeutics and rapid diagnostics. The use of high bio-containment facilities, such as the CSIRO Australian Animal Health Laboratory, plays a key role studying these dangerous pathogens and facilitates the development of countermeasures. To combat diseases like MERS, we must take a holistic approach that involves the development of early biomarkers of infection, a suite of treatment options (vaccines, anti-viral drugs and antibody therapeutics) and appropriate animal models to test the safety and efficacy of candidate treatments.

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* Correspondence to: Emerging Infectious Diseases Program, CSIRO Health and Biosecurity Flagship, Australian Animal Health Laboratory, Australia. Tel.: +61 3 5227 5759; fax: +61 3 5227 5531.
E-mail address: john.lowenthal@csiro.au

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Introduction

Over the past three decades, there has been an increase in the incidence of emerging infectious diseases (EIDs) in humans, with approximately 70 percent of them arising from animals. A number of factors, including the geographic expansion of human populations, intensification of agriculture and habitat disruption due to climate change and deforestation, have led to a greater risk of EIDs being transmitted from wild and domesticated animals to humans [1]. Furthermore, increased global travel and trade has increased the likelihood that EIDs will rapidly spread. EID outbreaks are unpredictable and often difficult to contain due to the absence of effective control measures such as vaccines and antiviral therapeutics. The World Health Organization has warned that the next human pandemic is likely to be zoonotic and that wildlife is a prime culprit.

While the current list of known EIDs is a major concern, it is the existing unknown threats with the potential for efficient human-to-human transmission that pose the largest concern. Over the past decade, there have been a number of epidemics, raising the concern that they are precursors to a pandemic. Examples include the highly pathogenic H5N1 avian influenza virus that has decimated poultry production in Asia and claimed over 350 lives since 2003 with continuing regular outbreaks, the Hendra virus in Australia, the Nipah virus in Malaysia and Bangladesh and hemorrhagic fever viruses (Ebola and Marburg), which have emerged from bats via intermediate hosts, such as horses and pigs, to infect and kill humans over the past two decades. The SARS epidemic in 2003—2004 claimed over 800 lives and cost more than $80b to the global economy. The virus was shown to be transmitted from bats to civet cats to humans. In 2012, a novel coronavirus emerged in the Middle East (MERS-CoV), with a 37% mortality rate for the more than 1600 currently confirmed cases in 26 counties.

High-security biological containment research facilities

BSL3 and 4 facilities must conform to strict infrastructure requirements, policies and procedures to ensure the safety of researchers who are working with a range of dangerous pathogens. There are several international bodies that develop and maintain biosafety guidelines. In the United States, it is the Centers for Disease Control and Prevention (CDC) in partnership with the U.S. National Institutes of Health Biosafety (http://www.cdc.gov/biosafety/publications/bmbl5/BMBL.pdf). The European guidelines are set by a legislative act of the European Union. In Australia, the Department of Agriculture and the Office of the Gene Technology Regulator have this responsibility. While regulations surrounding BSL3 and 4 facilities may differ from country to country, the basic principles of biocontainment are uniformly observed. For example, all work involving potentially infectious material must be conducted within primary containment, such as a biological safety cabinet. In the case of BSL4 facilities, primary containment is provided by a Class III biological safety cabinet located within a BSL4 cabinet laboratory or by the wearing of positive pressure protective suits with an independent breathing air supply (BSL4 suit laboratory or animal facility). Examples of BSL-4 laboratories around the world include the National Microbiology Laboratory (Winnipeg, Canada, http://www.nml-lnm.gc.ca/index-eng.htm), the Pirbright Institute (Pirbright, UK, http://www.pirbright.ac.uk/), the Uniformed Services University of the Health Sciences (Bethesda, USA, http://www.usuhs.mil/) and the CSIRO Australian Animal Health Laboratory (Geelong, Australia, http://www.csiro.au/places/AAHL).

The CSIRO Australian Animal Health Laboratory (AAHL)

The AAHL is one of the world's premier high-biocontainment facilities, allowing researchers to work with BSL4 pathogens that are highly lethal to humans and for which there is no vaccine or effective treatment. The AAHL is unique in the world in its capacity to undertake studies on a wide range of large numbers of domestic animals and wildlife [2]. At the AAHL, exotic disease agents are used in the laboratory for researching emergency disease diagnoses and studying the relationships between the pathogens and different animal and human hosts. The AAHL facility is unique in that its BSL3 and BSL4 animal facilities are sufficiently large to allow researchers to study a range of security sensitive biological agents (SSBAs) in diverse species, including ferrets, bats, poultry, pigs, dogs, alpacas and horses, as well as small laboratory mammals. As one of only six high-containment animal research centers in the world, we work with national and international human and animal health organizations as part of a global One Health network.

AAHL's mission is to be prepared to quickly and effectively respond to any new emerging infectious