



Questions from the Lab – is Australia and the near region ready for the next attack of ‘flu?

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The author

Group Captain Lisa Jackson Pulver is a proud Koori woman, bred and born in inner Sydney. She became a registered nurse in 1981 and gained entry to the Medical School at Sydney University in 1992. She completed a Master of Public Health degree in 1995 and PhD (Medicine) in 2001. Dr Jackson Pulver joined the RAAF Specialist Reserve in 2004, and became the first recruited public health epidemiologist in the Specialist Reserve. She has since served with Joint Health Command, and provides advice and support for the work of the Chief of Air Force around Indigenous Affairs.

Group Captain Jackson Pulver's most recent posting was to the Directorate General Personnel-Air Force, in a small team integral to standing up a dedicated Air Force strategy for Aboriginal and Torres Strait Islander Affairs—'Our Place Our Skies'—which has seen a doubling of personnel identifying as Aboriginal and Torres Strait Islanders, implementation of recruitment and retention programs including the RAAF Indigenous Youth Program, RAAF mentoring programs, study tours and influencers tours, and the publication of an Air Force-specific supplement to the *Defence Handbook on Indigenous Affairs*.

Dr Jackson Pulver's civil work in public health has included becoming a well-regarded epidemiologist and public health professional within the NSW public health system. She moved into academic life at the

University of NSW (UNSW) in 2003, where she holds the Inaugural Chair of Aboriginal Health, is a Professor of Public Health, and Director of the School of Public Health and Community Medicine's Muru Marri unit within UNSW Medicine. She is currently attending the Defence and Strategic Studies Course at the Centre for Defence and Strategic Studies at the Australian Defence College.

Abstract

This paper addresses the question of whether Australia and the near region are ready for the next attack of influenza. It notes that new pathogens are constantly emerging and also rapidly changing, developing better-tuned defences that resist human efforts to contain and control them. The paper asserts that rapidly-transmitted strains of influenza that occur either naturally or as a result of human manipulation constitute a real and strategic-level security challenge for Australia over the coming decade.

The paper provides a brief overview of the virus, its history and recent outbreak status. It contends that Australia's current disease control capacity is already challenged and that its capacity to respond to such threats is an issue requiring urgent consideration. The paper concludes that the seemingly 'common flu' is an example of a non-traditional threat for which Australia and its near neighbours are particularly under-prepared.

Questions from the Lab – is Australia and the near region ready for the next attack of ‘flu?

Introduction

Over the next ten years, Australia and its neighbours will be facing a threat that is invisible, elusive, evolving, deadly and one from which it will potentially cost billions, if not more, to recover. This threat is tiny and has caused harm and death since the earliest days of life on earth. The threat is a pathogen, that is, ‘a microorganism, such as a bacterium, that parasitizes an animal (or plant) or a human and produces a disease’.¹

Pathogens are infectious agents that are adaptable, can grow into new forms, and thrive in any evolving human environment to flourish, spread and mutate.² They can be spread horizontally (between members of the same species), vertically (between parent and child) and, in some cases, from animals to humans.³ New pathogens are also constantly emerging.⁴ They are also rapidly changing, developing better-tuned defences that resist human efforts to contain and control them.⁵ Mark Woolhouse and Eleanor Gaunt contend there are some 1400 species of human pathogen, with 16 per cent first reported in recent decades. Importantly:

The new species are disproportionately viruses, have a global distribution, and are mostly associated with animal reservoirs. Their emergence is often driven by ecological changes, especially with how human populations interact with animal reservoirs.⁶

Pathogens are of growing concern to public health, security and government officials around the world.⁷ Such non-traditional threats to Australia’s security were acknowledged in the 2008 National Security Statement, as well as the 2013 Defence White Paper.⁸ The US, in its latest National Security Strategy, has similarly recognised that outbreaks of infectious diseases, continuing challenges with drug-resistant microbes, the deliberate release of disease-causing pathogens and the concomitant ‘dangers of a raging virus’ all contribute to the continuing concerns posed by our increasingly-globalised lifestyle.⁹

The Ebola virus, which keeps evolving, is arguably the most prominent and deadly disease in recent years. However, more familiar and considerably more dangerous to Australians are outbreaks of influenza.¹⁰ This paper will provide a brief analysis of why influenza is a strategic-level security issue for Australia and provide a brief overview of the virus, its history and recent outbreak status, before concluding that the seemingly ‘common flu’ is an example of a non-traditional threat for which Australia and its near neighbours are particularly under-prepared.

What is influenza?

Influenza is an acute infection caused by one of three influenza viruses, type A, B or C, with additional subtypes classified according to unique and seasonal combinations of surface proteins.¹¹ Influenza viruses mutate according to their environment and exposure to other genetic material contained in the nuclei of other pathogens.¹² They include the common seasonal flu, and are highly adaptable, with variant strains endemic across multiple species, including swine, avian and human populations.

Some localised outbreaks resolve without becoming epidemic, while others move out of the epidemic phase to become a pandemic, that is, ‘an epidemic so widely spread that vast numbers of people in different countries are affected’.¹³ Pandemics occur as a confluence of a virus capable of causing sustained human-to-human transmission in a population that has little immunity against the current variant strain of the virus. Annual influenza outbreaks worldwide result in roughly three to five million cases of severe illness, and about 250,000 to 500,000 deaths.¹⁴

Influenza is spread by infected droplets, which are either ingested or carried through the air via talking, coughing or sneezing, and by personal contact. The time from infection to the onset of symptoms is usually about two days, although this can vary from one to eight days. The virus is infectious from the day before symptoms appear and continues for up to ten days. The symptoms include dry cough, sudden

fever, sore throat, runny nose, headaches, generalised pain and malaise. Influenza can cause severe illness or death, particularly in the frail, those suffering from chronic illness, the elderly and the very young.

Advice from public health officials regarding local actions to reduce the spread of infection can reduce the severity of outbreaks and associated morbidity.¹⁵ Those infected or feeling unwell should avoid crowds, offices and public transport. Those needing to leave their homes should wear facemasks. Antiviral medication and appropriate pharmacotherapy for those with secondary symptoms is the usual course of treatment.¹⁶

The history of influenza

The epidemiological history of influenza for the last 300 years is well documented. The most serious outbreak was the 1918 pandemic of the so-called 'Spanish Flu', which infected an estimated 50 per cent of the world's population, with 25 per cent suffering clinical illness, resulting in an estimated 40 to 50 million deaths.¹⁷ By comparison, the 'Asian Flu' outbreak of 1957 killed two million people, and the 'Hong Kong Flu' of 1967 killed one million people.¹⁸ According to Christopher Potter:

Annual epidemics are due to antigenic drift; and pandemics, occurring at 10 to 50 year intervals, are due to new virus subtypes resulting from virus re-assortment. Nothing has been introduced during the past 100 years to affect the recurrent pattern of epidemics and pandemics; and our future in the new century is clearly indicated by our past.¹⁹

There are contemporary strains of influenza with the potential to cause mass casualties—on an unprecedented scale—once again. Avian influenza, often called 'Bird Flu', has been spreading within Asia for more than a decade.²⁰ In 2005, avian influenza broke out in Europe, reached the Middle East in 2006 and then northern Africa in 2007. During 2011 and 2012, China, Vietnam and Cambodia all reported human deaths due to avian influenza. In 2014, it was found in Canadian chicken flocks and farmed bird populations, and deaths have been reported in the human population.²¹

'Swine Flu' (H1N1), like avian influenza, is transmitted by infected droplets. The 2009 'Swine Flu' pandemic infected between 43 million and 89 million people, killed around 12,500 people and spread to over 120 countries within eight weeks.²² More recently, a sub-type (H3N2v) has been detected in India which, as at February 2015, had killed some 875 people.²³

The threat

Influenza viruses circulate widely in bird populations. Until recently, however, the transmission of avian influenza has been restricted to those in contact with bird flocks and farmed birds. In 2011, laboratory tests using genetic manipulation showed that it was possible to modify the virus to allow direct transmission between mammals, which is particularly worrying because humans rarely have immunity to these viruses, which can cause severe disease and death.²⁴

These experiments showed that avian influenza is transmittable without first undergoing the usual recombination process in an avian host, and that it potentially can mutate into a form that may persist in human populations and be 'capable of sustained human-to-human transmission'.²⁵ Moreover, it is clear that this type of genetic manipulation of reference material from influenza, and possibly other viral samples, is well underway around the world.²⁶ Mark Walters, for example, has contended that:

Every time we sneeze, there seems to be a new form of flu: bird flu, swine flu, Spanish flu, Hong Kong flu, H5N1, and most recently, H5N7. While these diseases appear to emerge from thin air, in fact, human activity is driving them. And the problem is not just flu, but a series of rapidly evolving and dangerous modern plagues.... We are contributing to—if not overtly causing—some of the scariest epidemics of our time.²⁷

Fortunately, Australia has not been an epicentre of outbreaks of avian influenza, unlike its near neighbours, in part because Australia does not have the same population and agricultural pressures. However, according to a 2006 study, a global pandemic would kill between 1.4 million and 142 million people, with a cost to the world's economies between \$US330 billion and \$US4.4 trillion.²⁸ In Australia, the battle to control a pandemic outbreak with high infectivity would likely result in illness to a significant

proportion of the population, and a high number of deaths; it would also likely overwhelm a health system that has little capacity to cope with a surge of people requiring both diagnostic services and care.²⁹

Australia has been proud of its support to neighbours in time of human need and disaster management. But when it comes to communicable disease control, Australia's standing as a notable 'first world nation' in the Asia-Pacific region is hindered by the fact that Australia is the only OECD country that does not have a separate national authority responsible for communicable disease control.³⁰ A further complication is that Australia has limited local surge capacity in vaccine making. The National Medical Stockpile could be expected to cope for an initial period, however, vaccination makers would require time and physical resources to create targeted vaccines.³¹

A further, more sinister consideration is the potential role of 'bioterrorists' who may seek to use biological material to kill and debilitate people for political or ideological purposes.³² Although it takes considerable resources to create genetically-modifiable viral material, and the process is difficult, the potential exists for viruses and other pathogens to be modified and purposely released to cause terror in a target population and consequent disease and mortality. Following a review of the comparative epidemiology of avian and human influenza, Chuong Bui and colleagues noted in early 2015 that:

Analyses of certain H7N9 strains demonstrate similarities with engineered transmissible H5N1 viruses which make it more adaptable to the human respiratory tract. These differences in the human and bird epidemiology of H5N1 and H7N9 raise unanswered questions as to how H7N9 has spread, which should be investigated further.³³

Exemplars of this adaptation include some outbreaks in human populations which appear unusual. In one outbreak of the so-called 'Middle East Respiratory Syndrome' coronavirus during the 2014 Hajj, it was observed that the identification of multiple strains and the pattern of infection in humans were not typical.³⁴ In a review of another outbreak, the genetic characteristics of one influenza sub-type, present in both birds and humans, presented disturbing results about the unique development and spread of these pathogens.³⁵ The incidence of outbreaks such as these, that do not follow the known epidemiology for naturally-occurring outbreaks, is clearly concerning.³⁶

Conclusion

Rapidly-transmitted strains of influenza that occur either naturally or as a result of human manipulation constitute a real and strategic-level security challenge for Australia over the coming decade, not least because:

The continual antigenic evolution of the virus is soon followed by specific and reciprocal changes in the immune status of infected human populations so that the pattern of influenza each year or decade reflects the experience of the community during the preceding one.³⁷

Pandemics are a risk to our near neighbours, with the potential for high morbidity, high mortality and antigenic shift into more deadly and infectious forms with resultant consequences worldwide.³⁸ Moreover, any chance of predicting the next pandemic of influenza is now a thing of the past. The occurrence of novel viral strains with known means of creation, transmission and spread is already before us.

Fortunately, the public health response to naturally-occurring outbreaks, and that of any biological attack, is largely the same. However, with increasing global travel, as well as international trade and movement of livestock, localised outbreaks can quickly escalate into pandemics, with subsequent mortality and morbidity exacerbated by drug-resistant secondary bacterial infection and the potential intervention of opportunistic adversaries intent on harming the Australian people. Given that Australia's current disease control capacity is already challenged, its capacity to respond to such threats is an issue requiring urgent consideration.

Notes

- 1 These organisms can be bacterium, virus or other microorganisms: Elizabeth A. Martin (ed.), *Oxford Concise Colour Medical Dictionary*, Fifth Edition, Oxford University Press: Oxford, 2009, p. 546.
- 2 John M. Last (ed.) *A Dictionary of Public Health*, Oxford University Press: Oxford, 2007, p. 338.
- 3 Edwin D. Kilbourne, 'History of Influenza', *Influenza*, 1987, p. 15. Also Martin, *Oxford Concise Colour Medical Dictionary*, p. 798. Infections transmitted between animals and humans are by direct contact or droplet, or by the insect parasites of animals, such as fleas, ticks and worms.
- 4 Mark Woolhouse and Eleanor Gaunt, 'Ecological origins of novel human pathogens', *Critical Reviews in Microbiology*, Vol. 33, No. 4, 2007, p. 231.
- 5 Kilbourne, 'History of Influenza', p. 15.
- 6 Woolhouse and Gaunt, 'Ecological origins of novel human pathogens', p. 231.
- 7 Kevin Rudd, 'The First National Security Statement to the Parliament', Address by the Prime Minister of Australia', *Department of the Prime Minister and Cabinet* [website], 4 December 2008, available at <<http://pmtranscripts.dpmc.gov.au/browse.php?did=16289>> accessed 10 August 2015. See also Harvey Rubin, 'Future Global Shocks: pandemics', OECD/IFP Project on 'Future Global Shocks', *OECD* [website], 14 January 2011, p. 4, available at <<http://www.oecd.org/gov/risk/46889985.pdf>> accessed 10 August 2015; and Ali S. Khan and Nicole Lurie, 'Health Security in 2014: building on preparedness knowledge for emerging health threats', *Lancet*, Vol. 384, 2014, p. 96.
- 8 Rudd, 'The First National Security Statement to the Parliament'; Commonwealth of Australia, *Defence White Paper 2013*, Department of Defence: Canberra, 2013, pp. 19, 27 and 112.
- 9 Barak Obama, 'National Security Strategy', *Office of the President of the United States* [website], 20 February 2015, p. 13, available at <https://www.whitehouse.gov/sites/default/files/docs/2015_national_security_strategy.pdf> accessed 10 August 2015; Khan and Lurie, 'Health Security in 2014', p. 93.
- 10 Sara E. Davies and Jeremy Youde, 'Surveillance, Response and Responsibilities in the 2005 International Health Regulations', in Sara E. Davies and Jeremy Youde (eds.), *The Politics of Surveillance and Response to Disease Outbreaks: the new frontier for states and non-state actors*, Ashgate: Farnham, 2015, p. 157. Flu is a commonly-known infectious disease that requires an annual vaccination to keep up with the changes the virus undergoes. See World Health Organisation (WHO), 'Influenza (Seasonal)', Fact Sheet No 211 (March 2014), *WHO* [website], available at <<http://www.who.int/mediacentre/factsheets/fs211/en/>> accessed 10 August 2015; also NSW Government, 'Communicable Diseases Factsheet Influenza', (updated July 2012), *NSW Health* [website], available at <<http://www.health.nsw.gov.au/Infectious/factsheets/Factsheets/influenza.PDF>> accessed 20 June 2015.
- 11 Christopher W. Potter, 'A history of influenza', *Journal of Applied Microbiology*, Vol. 91, No. 4, 2001, p. 574; and WHO, 'Influenza (Seasonal)', and NSW Government, 'Communicable Diseases Factsheet Influenza'.
- 12 WHO, 'Influenza (Seasonal)'; and Colin R. Howard and Nicola F. Fletcher, 'Emerging Virus Diseases: can we ever expect the unexpected?', *Emerging Microbes and Infections*, 26 December 2012, p. 6 available at <<http://www.nature.com/emi/journal/v1/n12/full/emi201247a.html>> accessed 10 August 2015.
- 13 Martin, *Oxford Concise Colour Medical Dictionary*, p. 538. 'Strains are classified according to the presence of different subtypes of two glycoproteins (antigens) on the viral surface: haemagglutinin (H) and neuraminidase (N). Small changes in the structure of these antigens, which occur frequently in influenza A and B viruses, require the continual development of new vaccines to protect against annual outbreaks of the disease. Major changes in antigenic structure occur much more rarely, when there is genetic recombination between strains that can infect more than one species (most strains of the virus are highly species-specific). However, when it does occur, it could result in the development of hybrid strains causing new forms of influenza that are difficult to contain; the pandemic of 1918-19 is thought to have arisen in this way': Martin, *Oxford Concise Colour Medical Dictionary*, p. 377.
- 14 WHO, 'Influenza (Seasonal)'.
- 15 David L. Heymann (ed.), *Control of Communicable Diseases Manual*, 20th Edition, American Public Health Association Press: Washington DC, 2015, pp. 306-13.
- 16 C. Raina MacIntyre, Dominic Dwyer, Holly Seale *et al*, 'The First Randomized, Controlled Clinical Trial of Mask Use in Households to Prevent Respiratory Virus Transmission', *International Journal of Infectious Diseases*, Vol. 12, 2008, p. 208; and WHO, 'Influenza (Seasonal)'; and NSW Government, 'Communicable Diseases Factsheet Influenza'.

- 17 Potter, 'A history of influenza', p. 576, and Christian Enemark, 'Health Security Challenges: biological weapons and pandemic influenza', *Security Challenges*, Vol. 3, No. 3, 2007, p. 137.
- 18 Enemark, 'Health Security Challenges'.
- 19 Potter, 'A history of influenza', p. 572.
- 20 Kathleen M. Vogel, 'Expert Knowledge in Intelligence Assessments: bird flu and bioterrorism', *International Security*, Vol. 38, No. 3, Winter 2013/14, p. 39.
- 21 See, for example, 'Update on Avian Influenza Situation in British Columbia', *Canadian Food Inspection Agency* [website], 6 December 2014, available at <<http://www.inspection.gc.ca/animals/terrestrial-animals/diseases/reportable/ai/2014-2015-ai-investigation-in-bc/statement-2014-12-06/eng/1417908993045/1417908995514>> accessed 10 August 2015.
- 22 Centers for Disease Control and Prevention (CDC), 'Updated CDC estimates of 2009 H1N1 influenza cases, hospitalizations, and deaths in the United States, April 2009–April 10, 2010', *CDC* [website], available at <http://www.cdc.gov/h1n1flu/estimates_2009_h1n1.htm> accessed 15 January 2015.
- 23 The 'v' indicates that a variant that normally infects pigs has shifted to infect humans; see also 'Swine flu in India claims 875 lives', *The South Asia Daily*, 23 February 2015.
- 24 Sander Herfst, Eefje J.A. Schrauwen, Martin Linster *et al*, 'Airborne transmission of influenza A/H5N1 virus between ferrets', *Science*, Vol. 336, No. 6088, 2012, pp. 1534-41; and Masaki Imai, Tokiko Watanabe, Masato Hatta *et al*, 'Experimental adaptation of an influenza H5 HA confers respiratory droplet transmission to a reassortant H5 HA/H1N1 virus in ferrets', *Nature*, Vol. 486, No. 7403, 2012, pp. 420-8.
- Reference material provenance: M. Peiris, University of Hong Kong, provided A/Indonesia/5/2005 with permission from I. Kandun of the Indonesian Government; cited in Herfst *et al*, 'Airborne transmission of influenza A/H5N1 virus between ferrets'. Also National Institute of Hygiene and Epidemiology, Hanoi, Vietnam for the A/Vietnam/1203/2004 (H5N1) virus, obtained from the CDC: cited in Imai *et al*, 'Experimental adaptation of an influenza H5 H1 confers respiratory droplet transmission to a reassortant H5 Ha/H1n1 virus in ferrets'.
- Gain-of-Function (GoF) experiments result in a type of mutation where the altered gene product possesses a new molecular function or a new pattern of gene expression. GoF mutations are almost always dominant or semi-dominant. These GoF are now considered 'dual-use research of concern', that is, research that can be used for good or for harm.
- 25 Enemark, 'Health Security Challenges', p. 137;
- 26 Debolina Banerjee, 'Gain-of-Function Influenza Research: a new paradigm or an engineered pandemic? A Comprehensive Assessment of the Merits and Risks of Gain-of-Function Experiments and a Proposed Framework Going Forward', unpublished thesis, Department of Molecular Biology, Princeton University: Princeton, 2014, available at <<http://arks.princeton.edu/ark:/88435/dsp01b8515n57k>> accessed 9 March 2015; and Vogel, 'Expert Knowledge in Intelligence Assessments', pp. 39-71.
- 27 Quoted from publisher's synopsis of Mark Jerome Walters, *Seven Modern Plagues*, Island Press: Washington DC, March 2014, available at <<http://www.publish.csiro.au/pid/7279.htm>> accessed 20 May 2015.
- 28 WHO, 'Summary of States Parties 2013: report on IHR capacity implementation: regional profiles', *WHO* [website], 2014, available at <http://www.who.int/ihr/publications/WHO_HSE_GCR_2014.10/en/> accessed 10 August 2015; and Warwick J. McKibbin and Alexandra Sidorenko, *Global Macroeconomic Consequences of Pandemic Influenza*, Lowy Institute for International Policy: Sydney, 2006.
- 29 Australasian Faculty Public Health Medicine, 'Does Australia Need a National Centre for Disease Control?', paper presented at Public Health Association of Australia Communicable Disease Control Conference, Canberra, 2011.
- 30 WHO, 'Summary of States Parties 2013'.
- 31 Enemark, 'Health Security Challenges', pp. 142-3; and Australasian Faculty Public Health Medicine, 'Does Australia need a National Centre for Disease Control?'.
- 32 Vogel, 'Expert Knowledge in Intelligence Assessments', p. 40.
- 33 Chuong Bui, Anna Bethmont, Abrar Ahmad Chughtai *et al*, 'A Systematic Review of the Comparative Epidemiology of Avian and Human Influenza A H5N1 and H7N9 – Lessons and Unanswered Questions', *Transboundary and Emerging Diseases*, 29 January 2015, p. 1, available at <<http://www.ncbi.nlm.nih.gov/pubmed/25644240>> accessed 10 August 2015.

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- ³⁴ C. Raina MacIntyre, 'The discrepant epidemiology of Middle East respiratory syndrome coronavirus (MERS-CoV)', *Environment Systems and Decisions*, Vol. 34, No. 3, 2014, p. 383.
- ³⁵ Bui *et al*, 'A Systematic Review of the Comparative Epidemiology of Avian and Human Influenza A H5N1 and H7N9 – Lessons and Unanswered Questions', p. 4.
- ³⁶ Macintyre, 'The discrepant epidemiology of Middle East respiratory syndrome coronavirus (MERS-CoV)'; and Lauren M. Gardner, David Rey, Anita E. Heywood *et al*, 'A Scenario-Based Evaluation of the Middle East Respiratory Syndrome Coronavirus and the Hajj', *Risk Analysis*, Vol. 34, No. 8, 2014, p. 1391; Bui *et al*, 'A Systematic Review of the Comparative Epidemiology of Avian and Human Influenza A H5N1 and H7N9 – Lessons and Unanswered Questions', p. 4.
- ³⁷ Kilbourne. 'History of Influenza', p. 3.
- ³⁸ The International Health Regulations (IHR) have been in existence since 1969 and are designed to support the 194 signatories across the globe to help prevent and respond to public health risks that threaten the health of our citizens. Its mandate is across all public health emergencies, including pandemic influenza, to 'prevent, protect against, control and provide a public health response to the international spread of disease and which avoid unnecessary interference with international traffic and trade'. The IHR requires signatory countries to report certain disease outbreaks and public health events to the WHO. There is also a regular review of national capacity monitoring, including that for public health. The latest of these was 2013. See WHO, 'International Health Regulations', *WHO* [website], available at <http://www.who.int/topics/international_health_regulations/en/> accessed 10 August 2015.



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