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Implementing the International Health Regulations (2005) in the World Health Organization Western Pacific Region

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DEVELOPING THE INTERNATIONAL HEALTH REGULATIONS (2005)

It has been 10 years since severe acute respiratory syndrome (SARS) – the first emerging infectious disease of global significance in the 21st century – occurred in the Western Pacific Region in 2003. At that time, the revision process of the International Health Regulations (IHR) was underway.[1] However, as considered by MacKenzie and Merianos in this issue of WPSAR "perhaps the most important legacy from SARS was the additional urgency and focus given to the revision of IHR by the World Health Assembly."[2] The substantially revised IHR (2005) entered into force in June 2007 and represented a major development from IHR (1969) in the use of an international legal instrument to protect public health. Recently, IHR (2005) has been used as a global tool to collectively respond to the emergence of Middle East Respiratory Syndrome coronavirus (MERS-CoV) from 2012 and the avian influenza A(H7N9) virus in 2013.

One of the major changes of IHR (2005) was an introduction of event-based reporting, from mandating the reporting of three diseases (yellow fever, plague and cholera) under IHR (1969) to the reporting of any event that may constitute a public health emergency of international concern (PHEIC) under IHR (2005). Other significant changes included: (1) the legal requirement of Member States to develop national IHR core capacities; (2) the establishment of National IHR Focal Points (NFPs) to facilitate official communications; (3) the notification of any event that may constitute a PHEIC from NFPs to the World Health Organization (WHO) IHR Contact Points; and (4) agreed upon procedures for determining and responding to a PHEIC.[3] As one observer has commented, "establishing effective global public health surveillance is at the heart of IHR (2005)."[4]

IHR (2005) IN THE WHO WESTERN PACIFIC REGION

IHR (2005) has played a vital role in the development and strengthening of national and regional capacities required for detecting, assessing, reporting and responding to acute public health events and emergencies in the WHO Western Pacific Region. The Western Pacific Region has been a hotspot for emerging infectious diseases and remains vulnerable to future health security threats due to multiple factors such as increased international travel and trade, migration and urbanization, intensive production of livestock and illegal wildlife trade.[5] The Asia Pacific Strategy for Emerging Diseases (APSED) is a regional tool to assist countries with IHR (2005) implementation and progress has been made in establishing capacities within the APSED focus areas.[6] Although measuring capacity improvement and related health impact as a direct result of IHR (2005) remains a challenge,[7] there are certainly success stories in this Region.

As a result of developing IHR core capacities in the Region, more than 90% of Member States have now established event-based surveillance systems – one such system is described by Dagina et al. in this issue of WPSAR.[8] Most (25 of 26) Member States that responded to the 2013 IHR Monitoring questionnaire have established their coordination mechanisms between human and animal health sectors on zoonoses.[6] Modified field epidemiology training programs are now operating in Cambodia, the Lao People's Democratic Republic, Mongolia and Papua New Guinea. The majority (85%) of

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the Member States have validated their health emergency communications plans, policies and guidelines through an actual emergency or simulation exercise.[6]

As reported by Fearnley and Li in this issue of WPSAR,[9] since IHR (2005) has been in force, more than 150 diseases and public health events have been reported from National IHR Focal Points to the regional WHO IHR Contact Point under the IHR (2005) communication mechanism. Most events reported were infectious disease outbreaks, notified for early alert, information sharing, joint risk assessment and rapid response. None of the reported IHR events originating from the Region led to formal determination of PHEIC as per IHR procedures.[3]

Recent outbreak responses in the Region highlight both achievements and challenges in IHR (2005) implementation. The 2012 Cambodia outbreak of hand, food and mouth disease tested the value of IHR mechanisms and the need for continuing core capacity strengthening.[4] The recent avian influenza A(H7N9) event reported from China under IHR (2005) demonstrated improved capacities at both national and international levels for response, and it highlighted the value of past investment in IHR core capacity development.

While national and regional surveillance and response systems for emerging diseases have been strengthened, the Region is still not fully prepared for responding to future severe health security threats. A significant number of Member States in the Region were unable to meet the IHR (2005) obligations by the required June 2012 deadline. Fourteen of 27 Member States requested a two-year extension to meet the IHR core capacity requirements.[6] This June 2014 extension deadline is fast approaching, and it is expected that some Member States will ask for another two-year extension.

One challenge in meeting IHR (2005) core capacities is reported by Rosewell et al. in this issue of WPSAR.[10] The recent large cholera outbreak in Papua New Guinea highlighted a lack of trained health care workers to respond to this event, and the article describes lessons learned that may assist in meeting this IHR (2005) core capacity.[10] Similarly, another challenge identified in the Pacific Region in IHR (2005) implementation was difficulties in assessing whether the core capacities had been met using the WHO annual IHR monitoring questionnaire.[7] To assist Pacific island countries and territories in completing the questionnaire, in this issue of WPSAR Craig et al. describes how this was adapted to meet the needs in the Pacific.[11]

MOVING FORWARD

Once reached, sustaining IHR (2005) core capacities is also a key issue as "in an era of limited resources, competing priorities and political challenges, achievement of the IHR goals, even with an extension, will be a challenge."[12] Many resource-limited countries in the Region still rely heavily on external support, and the current global financial situation poses significant risks to sustaining what has already been gained. Building and maintaining the surveillance systems envisioned in IHR (2005) will require on-going substantial financial and technical resources.[13] Therefore, although the ideal is to invest in all capacity areas equally, reality calls for prioritization, or a more focused approach, to meet IHR (2005) obligations. Given limited resources, focusing on those common capacities will provide a foundation for an all-hazards approach for addressing public health emergencies regardless of causes.[12] One example of this focused approach is the strengthening and monitoring of basic surveillance and response systems that can enable early detection, timely assessment and swift response to all emerging disease outbreaks and public health emergencies.

Implementing IHR (2005) has been a collective learning process for Member States, WHO and partners and will continue to be so. The Region is still in the middle of its journey towards achieving the common regional health security goals under IHR (2005). IHR (2005) has made a positive contribution to strengthening national capacities and has fostered more timely and transparent sharing of information on health security threats in this Region.

References:

1. World Health Assembly. *Revision and updating of the International Health Regulations, WHA48.7, May 8, 1995*. Geneva, World Health Organization, 1995.
2. Mackenzie J and Merianos A. The legacies of SARS- international preparedness and readiness to respond to future threats in the Western Pacific Region. *Western Pacific Surveillance and Response Journal*, 2013, 4(3). doi:10.5365/wpsar.2013.4.2.009
3. *International Health Regulations (2005) 2nd ed*. Geneva, World Health Organization, 2008 (http://www.who.int/ihr/ September finalversion9Nov07.pdf, accessed 17 September 2013).

4. The Lancet Infectious Diseases. Cambodian outbreak tests International Health Regulations. *Lancet Infectious Diseases*, 2012, 12:577. doi:10.1016/S1473-3099(12)70178-0 pmid:22795834

5. Horby PW, Pfeiffer D, Oshitani H. Prospects for emerging infections in East and southeast Asia 10 years after severe acute respiratory syndrome. *Emerging Infectious Diseases*, 2013, 19:853–860. doi:10.3201/eid1906.121783 pmid:23738977

6. *The Asia Pacific Strategy for Emerging Disease - Progress Report 2013*. Manila, World Health Organization Regional Office for the Western Pacific, 2013.

7. Hardiman MC; World Health Organization Department of Global Capacities, Alert and Response. World Health Organization perspective on implementation of International Health Regulations. *Emerging Infectious Diseases*, 2012, 18:1041–1046. doi:10.3201/eid1807.120395 pmid:22709544

8. Dagina R et al. Event-based surveillance in Papua New Guinea: strengthening an International Health Regulations (2005) core capacity. *Western Pacific Surveillance and Response Journal*, 2013, 4(3). doi:10.5365/wpsar.2013.4.2.001

9. Fearnley E and Li A. International Health Regulations (2005): public health event communications in the Western Pacific Region. *Western Pacific Surveillance and Response Journal*, 4(3). doi:10.5365/wpsar.2013.4.3.003

10. Rosewell, A et al. Human resources for health: lessons from the cholera outbreak in Papua New Guinea. *Western Pacific Surveillance and Response Journal*, 2013, 4(3). doi:10.5365/wpsar.2013.4.2.006

11. Craig A et al. The Pacific experience: supporting small island countries and territories to meet their 2012 International Health Regulations (2005) commitments. *Western Pacific Surveillance and Response Journal*, 2013, 4(3). doi:10.5365/wpsar.2012.3.4.007

12. Ijaz K et al. International Health Regulations–what gets measured gets done. *Emerging Infectious Diseases*, 2012, 18:1054–1057. doi:10.3201/eid1807.120487 pmid:22709593

13. Baker MG, Fidler DP. Global public health surveillance under new international health regulations. *Emerging Infectious Diseases*, 2006, 12:1058–1065. doi:10.3201/eid1207.051497 pmid:16836821

The legacies of SARS – international preparedness and readiness to respond to future threats in the Western Pacific Region

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THE SEVERE ACUTE RESPIRATORY SYNDROME (SARS) OUTBREAK

It is now 10 years since the world was faced with the first severe and readily transmissible new disease of the 21st century – severe acute respiratory syndrome (SARS). Unknown and unrecognized, it emerged in late 2002 as the probable cause of an outbreak of atypical pneumonia in Guangdong Province, southern China. It then spread to Hong Kong (China) via an infected traveller who arrived at his hotel on 21 February 2003 where he infected 15 other guests. They, in turn, travelled to other countries carrying the new disease and initiating outbreaks in Viet Nam, Singapore and Canada. Three weeks later, with increasing numbers of cases among hospital staff in Hong Kong (China) and Viet Nam, the World Health Organization (WHO) issued a global alert on 12 March 2003 about this new acute respiratory syndrome of unknown etiology. However, the disease was spreading rapidly along major air routes, prompting WHO to issue an emergency travel advisory on 15 March, as well as naming the new disease "severe acute respiratory syndrome" and providing the first surveillance case definition.[1] The disease continued to spread, reaching 26 countries on five continents and causing at least 8096 cases and 774 deaths worldwide before it was finally contained.[2] The SARS epidemic had a dramatic effect on the global economy leading to serious economic losses, collapse of regional tourism and travel industries and substantial declines in the gross national product of affected countries.[3] While actual figures for the cost of the outbreak vary and depend on different interpretations, the approximate cost was believed to approach US$ 40 billion.

The global response to SARS was unprecedented and provided a new way of working internationally, using real-time electronic communication.[4] The response was coordinated by WHO from its headquarters in Geneva and its Western Pacific Regional Office in Manila with assistance from its country offices and from the many partners in the Global Outbreak Alert and Response Network (GOARN).[5,6] WHO established real-time information sharing among networks of virologists, clinicians and epidemiologists who communicated through daily teleconferences and video conferences, virtual grand rounds and via secure web sites. Their goal was to: (1) expedite the identification of the etiological agent and development of diagnostic reagents;[7–9] (2) share clinical information, including presenting features, disease progression, treatment and prognostic indicators; and (3) describe the key epidemiological features of this novel disease, including the evolution of the epidemic, transmission dynamics and risk factors for the disease;[10] and later, the effectiveness of control measures.

Under WHO's leadership, the work of these networks supported the global implementation of effective prevention and control strategies even before the agent of SARS was identified. The SARS epidemic was contained by applying basic public health principles of disease control: enhanced surveillance; early case detection and triage; patient isolation; the tracing, monitoring and home isolation of their contacts; enhanced hospital infection control; and raising public awareness about the disease and its prevention. These efforts were assisted by the natural history of infection with SARS coronavirus (CoV), which differed from other respiratory viruses, as

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its transmission was greatest when illness was most severe and asymptomatic transmission was rare. Thus evidence-based control measures were reinforced while other measures, such as the quarantine of well contacts, were relaxed.[11]

On 5 July 2003, WHO was able to declare the end of the epidemic, although some additional cases were later described from laboratory accidents in Singapore, Taipei and Beijing, and four sporadic cases of SARS were reported from Guangdong between December 2003 and January 2004. Although the origin of the novel SARS-CoV remains an enigma, it is probable that the source of infection was small mammals in the live animal markets in Guangdong Province, China, where a wide variety of wildlife species, including Himalayan palm civets, Chinese ferret-badgers and raccoon-dogs, were kept in overcrowded conditions with poor biosecurity.[12] Seroprevalence studies in live animal traders in Guangzhou demonstrated significantly higher exposure to SARS-CoV compared to controls, especially in those who traded primarily in masked palm civets. The SARS-CoV strain responsible for the global epidemic was similar to virus isolates obtained from small mammals sampled in live animal markets, especially civets, but differed significantly from them by having a 29 base-pair deletion in ORF8 that created a novel sublineage.[12] In response to these findings, China issued a ban on the hunting and sale of civets (lifted in August 2003) and improved biosecurity in civet farms and within live animal markets. More recently, increasing evidence has indicated insectivorous bats as the natural reservoir for SARS-CoV.[13,14]

WHO declared that the last outbreak of SARS was contained on 18 May 2004 and there has been no evidence of SARS-CoV infection in humans since that time.

LESSONS LEARNT FROM THE SARS OUTBREAK

Several important lessons were learnt from the SARS outbreak. It provided a clear demonstration that a previously unknown pathogen could emerge at any time and in any place and, without warning, threaten the health, well-being and economies of all societies. SARS also demonstrated: (1) that countries must have the capability and capacity to maintain an effective alert and response system to detect and quickly react to outbreaks of international concern and to share information about such outbreaks rapidly and transparently; (2) that responding to pandemic threats requires global cooperation and global participation; and (3) that a global alert and response network is needed to provide technical assistance when national disease control systems are stressed beyond their capacity.[15] SARS also warned that wildlife may be the reservoirs of novel pathogens and that animal surveillance activities must be coordinated with human surveillance as a One Health response.

The response to SARS clearly showed the relevance and importance of the GOARN to WHO's outbreak response capability. GOARN had been created by WHO in 2000 as a partnership with technical institutions and networks to improve the coordination of international outbreak responses and to provide an operational framework to focus the delivery of support to countries. Previously all deployments had been to single country outbreaks, but in responding to SARS, deployments were made to several countries, significantly helping with outbreak assistance and surge capacity.

REVISION OF THE INTERNATIONAL HEALTH REGULATIONS

Perhaps the most important legacy from the SARS epidemic was the additional urgency and focus given to the revision of the International Health Regulations (IHR) by the World Health Assembly.[16,17] The revised IHR (2005), adopted by the World Health Assembly in May 2005,[18] came into force on 15 June 2007, providing the legal framework for the collective responsibility of countries, WHO and other intergovernmental organizations for global health security. Signatories are obligated to develop core public health capacities for alert, risk assessment and outbreak response and to inform WHO, through national IHR focal points, of any event with the potential to spread or extend beyond their borders. Countries were given a five-year period in which to implement the new Regulations; although if they had not achieved compliance in all core capacities by 2012, they were able to request a two-year extension. Many countries failed to meet the 2012 deadline, and have requested a two-year extension.

Since the adoption of IHR (2005), the world has witnessed several emergent zoonoses including the geographical expansion of highly pathogenic

avian influenza A(H5N1),[19] the emergence of a novel coronavirus in the Arabian peninsula in 2012–2013,[20,21] and a low pathogenic avian influenza A(H7N9) in China in 2013[22,23] – three viruses causing severe, often fatal, human respiratory disease. The world also experienced the H1N1 pandemic in 2009; an estimated 284 400 influenza-related deaths, with 9.7 million years of life lost, occurred during the 16 months of this pandemic of moderate severity (April 2009–August 2010).[24]

These examples clearly demonstrate the need to link human disease surveillance and response activities with those for animal diseases if we are to detect potential outbreaks of zoonotic diseases early and in time to limit spread. Building on their individual tracking, verification and alert mechanisms, the World Organization for Animal Health (OIE), the Food and Agricultural Organization of the United Nations (FAO) and WHO launched the Global Early Warning System in 2006 for predicting and responding to zoonoses. An exciting new global early warning system is also being developed to detect novel zoonotic emerging diseases that move from wildlife to humans. The PREDICT program is run by the United States Agency for International Development Emerging Pandemic Threats Program and is coordinated through the University of California and Columbia University with partners in the Americas, Africa and south-eastern Asia, including China, Laos, Cambodia, Viet Nam, Malaysia, Thailand and Indonesia. Using a new 'SMART' surveillance method (Strategic, Measurable, Adaptive, Responsive, Targeted) designed to detect novel diseases with pandemic potential early, it is hoped that PREDICT will give health professionals an opportunity to prevent the further spread of a new zoonotic disease.[25]

ASIA PACIFIC STRATEGY FOR EMERGING DISEASES

To assist Member States in the Western Pacific and South-East Asia regions to meet the core capacities requirements of IHR (2005), a joint plan known as the Asia Pacific Strategy for Emerging Diseases (APSED) was developed.[26] APSED had five principal objectives: (1) to reduce the risk of emerging diseases; (2) to strengthen the early detection of outbreaks of emerging diseases; (3) to strengthen the early response to emerging diseases; (4) to strengthen preparedness for emerging diseases; and (5) to develop sustainable technical collaboration in the Asia Pacific region. Not surprisingly at the time, the threat posed by H5N1 highly pathogenic avian influenza was the major focus that drove the activities and planning in APSED and that laid the foundations for building up the core capacities required by IHR (2005). It also demonstrated the importance of the intersectoral collaboration in partnership with OIE and FAO. While surveillance, early detection and rapid response are the keys to reducing the threats from emerging diseases, an understanding of the mechanisms of emergence are also essential in planning and preparedness.[27]

The first APSED (2005) was so successful in meeting its objectives, with event-based surveillance systems and trained rapid response teams able to quickly conduct field investigations established in most countries, that a second, updated strategy, APSED (2010),[28] has been initiated to consolidate gains made in the first five years. While APSED (2010) continues to focus on emerging diseases, it has expanded its scope to eight focus areas and also to include other public health threats. At the same time, given the demographic, socioeconomic and political diversity of the 48 countries and areas of the Asia Pacific Region, there is a greater realization that implementation of APSED must be responsive to the individual situation and context in each country.

CHALLENGES FOR THE FUTURE

There have been major achievements in health security during the past decade since the world faced the potential SARS pandemic. Implementation of IHR (2005) has been a crucial step in this progress and stimulated new ways of working across sectors, within and between countries, and in partnership with WHO, and with other inter-governmental organizations and nongovernmental organizations. This has led to the rapid and transparent sharing of information on diseases of international public health concern; supported by an increased knowledge of the mechanisms and origins of disease emergence, transmission and modes of spread it has provided us with a much more effective and rapid ability to detect and respond to future threats.

Nevertheless, there remains a long way to go. Not only are nearly half of the countries in the Asia Pacific region still developing their IHR (2005) core capacities, with some possibly requiring additional time, but the region has been the epicentre for many emerging infectious diseases. More than half of the world's population live in the Asia Pacific region, providing many

challenges in building, strengthening and sustaining functional national systems and capacities for managing emerging diseases. The world is still facing the ongoing threat from avian influenza A(H5N1) and from new diseases such as the novel coronavirus in the Middle East and A(H7N9) avian influenza in China. Doubtless, new threats will emerge in the near future. The importance of IHR (2005) in detecting and responding to these threats in a transparent, collaborative and coordinated way cannot be overestimated; it is the single most important development in public health in this new millennium.

Conflicts of interest

None declared.

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References:

1. World Health Organization. Severe acute respiratory syndrome (SARS). *Weekly Epidemiological Record*, 2003, 78:81–83. PMID:12701272
2. Global Alert and Response (GAR). *Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003 (based on data as of the 31 December 2003)*. Geneva, World Health Organization, 2003 (http://www.who.int/csr/sars/country/table2004_04_21/en/, accessed 9 May 2013).
3. Wong YCR, Siu A. Counting the economic cost of SARS. In: Peiris M, Anderson LJ, Osterhaus ADME, Stohr K, Yuen KY, eds. *Severe Acute Respiratory Syndrome*. Oxford, Blackwell Publishing, 2005, 213–230.
4. Heymann DL. The international response to the outbreak of SARS in 2003. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 2004, 359:1127–1129.
5. *SARS: how a global epidemic was stopped*. Geneva, World Health Organization, 2006 (http://whqlibdoc.who.int/wpro/2006/9290612134_eng.pdf, accessed 9 May 2013).
6. Mackenzie JS et al. The WHO response to SARS, and preparations for the future. In: Knobler S, Mahmoud A, Lemon S, Mack A, Sivitz L, Oberholtzer K, eds. *Learning from SARS: preparing for the next disease outbreak*. Washington, DC, Institute of Medicine, National Academies Press, 2004, 42–50.
7. Peiris JSM et al.; SARS study group. Coronavirus as a possible cause of severe acute respiratory syndrome. *Lancet*, 2003, 361:1319–1325. doi:10.1016/S0140-6736(03)13077-2 pmid:12711465
8. Ksiazek TG et al.; SARS Working Group. A novel coronavirus associated with severe acute respiratory syndrome. *The New England Journal of Medicine*, 2003, 348:1953–1966. doi:10.1056/NEJMoa030781 pmid:12690092
9. Drosten C et al. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. *The New England Journal of Medicine*, 2003, 348:1967–1976. doi:10.1056/NEJMoa030747 pmid:12690091
10. Department of Communicable Disease Surveillance and Response. *Consensus document on the epidemiology of severe acute respiratory syndrome (SARS)*. Geneva, World Health Organization, 2003 (http://www.who.int/csr/sars/en/WHOconsensus.pdf, accessed 9 May 2013).
11. Merianos A. Severe acute respiratory syndrome. In: Heymann D, ed. *Control of Communicable Diseases Manual*, 19th Edition. Washington, DC, American Public Health Association, 2008.
12. Guan Y et al. Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. *Science*, 2003, 302:276–278. doi:10.1126/science.1087139 pmid:12958366
13. Lau SK et al. Severe acute respiratory syndrome coronavirus-like virus in Chinese horseshoe bats. *Proceedings of the National Academy of Sciences of the United States of America*, 2005, 102:14040–14045. doi:10.1073/pnas.0506735102 pmid:16169905
14. Li W et al. Bats are natural reservoirs of SARS-like coronaviruses. *Science*, 2005, 310:676–679. doi:10.1126/science.1118391 pmid:16195424
15. Heymann DL, Mackenzie JS, Peiris M. SARS legacy: outbreak reporting is expected and respected. *Lancet*, 2013, 381:779–781. doi:10.1016/S0140-6736(13)60185-3 pmid:23668493
16. World Health Assembly. *Revision of the International Health Regulations. Resolution WHA56.28*. Geneva, World Health Organization, 2003 (http://apps.who.int/gb/archive/pdf_files/WHA56/ea56r28.pdf, accessed 3 May 2013).
17. World Health Assembly. *Severe acute respiratory syndrome. Resolution WHA56.29.* Geneva, World Health Organization, 2003 (http://apps.who.int/gb/archive/pdf_files/WHA56/ea56r29.pdf, accessed 3 May 2013).
18. *International Health Regulations (2005).* Geneva, World Health Organization, 2005 (http://whqlibdoc.who.int/publications/2008/9789241580410_eng.pdf, accessed 3 May 2013).
19. Capua I, Marangon S. Control and prevention of avian influenza in an evolving scenario. *Vaccine*, 2007, 25:5645–5652. doi:10.1016/j.vaccine.2006.10.053 pmid:17169466
20. *Novel coronavirus summary and literature update – as of 25 April 2013*. Geneva, World Health Organization, 2013 (http://www.who.int/csr/disease/coronavirus_infections/update-20130425/en/index/html, accessed 9 May 2013).
21. The Health Protection Agency (HPA) UK Novel Coronavirus Investigation Team. Evidence of person-to-person transmission within a family cluster of novel coronavirus infections, United Kingdom, February 2013. *Euro Surveillance: European Communicable Disease Bulletin*, 2013, 18(11):pii:20427 (http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20427, accessed 9 May 2013).
22. Gao R et al. Human infection with a novel avian-origin influenza A (H7N9) virus. *The New England Journal of Medicine*, 2013, 368:1888–1897. doi:10.1056/NEJMoa1304459 pmid:23577628
23. Chen Y et al. Human infections with the emerging avian influenza A H7N9 virus from wet market poultry: clinical analysis and characterisation of viral genome. [Epub ahead of print]. *Lancet*, 2013, 381:1916–1925. doi:10.1016/S0140-6736(13)60903-4 pmid:23623390
24. Dawood FS et al. Estimated global mortality associated with the first 12 months of 2009 pandemic influenza A H1N1 virus circulation: a modelling study. *The Lancet Infectious Diseases*, 2012, 12:687–695. doi:10.1016/S1473-3099(12)70121-4 pmid:22738893

25. Morse SS et al. Prediction and prevention of the next pandemic zoonosis. *Lancet*, 2012, 380(9857): 1956-1965. doi:10.1016/S0140-6736(12)61684-5 pmid:23200504

26. *Asia Pacific Strategy for Emerging Diseases (2005)*. Manila, World Health Organization Regional Office for the Western Pacific, 2005 (http://www.wpro.who.int/emerging_diseases/documents/APSED_final_endorsed_and_edited_by_EDT-map_removed_FORMAT-20/en/index.html, accessed 9 May 2013).

27. Mackenzie JS. Responding to emerging diseases: reducing the risks through understanding the mechanisms of emergence. *Western Pacific Surveillance and Response*, 2011, 2:1–5. doi:10.5365/wpsar.2011.2.1.006

28. *Asia Pacific Strategy for Emerging Diseases (2010).* Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/emerging_diseases/APSED2010/en/, accessed 3 May 2013).

Human resources for health: lessons from the cholera outbreak in Papua New Guinea

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Issue: Papua New Guinea is striving to achieve the minimum core requirements under the International Health Regulations in surveillance and outbreak response, and has experienced challenges in the availability and distribution of health professionals.

Context: Since mid-2009, a large cholera outbreak spread across lowland regions of the country and has been associated with more than 15 500 notifications at a case fatality ratio of 3.2%. The outbreak placed significant pressure on clinical and public health services.

Action: We describe some of the challenges to cholera preparedness and response in this human resource-limited setting, the strategies used to ensure effective cholera management and lessons learnt.

Outcome: Cholera task forces were useful to establish a clear system of leadership and accountability for cholera outbreak response and ensure efficiencies in each technical area. Cholera outbreak preparedness and response was strongest when human resource and health systems functioned well before the outbreak. Communication relied on coordination of existing networks and methods for empowering local leaders and villagers to modify behaviours of the population.

Discussion: In line with the national health emergencies plan, the successes of human resource strategies during the cholera outbreak should be built upon through emergency exercises, especially in non-affected provinces. Population needs for all public health professionals involved in health emergency preparedness and response should be mapped, and planning should be implemented to increase the numbers in relevant areas. Human resource planning should be integrated with health emergency planning. It is essential to maintain and strengthen the human resource capacities and experiences gained during the cholera outbreak to ensure a more effective response to the next health emergency.

ISSUE

Papua New Guinea is strengthening its capacity to identify, assess and respond to health emergencies in line with requirements of the International Health Regulations (IHR).[1] To support the implementation of IHR (2005), the country has adopted components of the *Asia Pacific Strategy for Emerging Diseases (2010)*,[2] which outlines areas of achievement relating to health emergencies. Key to this strategy is the development of a national health emergencies plan that has been recently drafted by health authorities. To achieve the objectives of the national health emergencies plan, capable public health professionals are needed for the timely, effective response to public health emergencies at national and subnational levels.

CONTEXT

Papua New Guinea has the highest gross domestic product of the Pacific island countries, yet it invests only a small percentage (3.6%) in health.[3] As a consequence, the number of health care workers falls well short of internationally recommended staff-to-population ratios. The health workforce is not distributed according to the needs of the population; most (87%) of the population live in rural areas, yet over half (52%) of the health workers are in urban areas.[4] Further human resource issues include weak standards of patient care, unhealthy workplace practices, run-down and inadequate infrastructure and equipment, and education and training that may not always meet the needs of the health care system.[5] The tertiary education

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system is currently unable to produce enough quality health workers.[4]

When a health crisis such as a cholera outbreak occurs, strategies for health workforce preparedness are crucial and must be in place to limit outbreak-associated morbidity and mortality. Human resource strategies should address the distribution of workers to rural areas, supervision, teamwork, remuneration and conditions for rural health workers. When cholera emerged in July 2009,[6] it caused widespread morbidity and mortality due in part to a lack of health system access and preparedness. In excess of 15 500 cases were reported with a case fatality ratio of 3.2%. No strategy was in place to address the supply of clinical or allied health workers. The subsequent spread of the disease to neighbouring provinces not only provided significant challenges to health authorities,[7] but it also provided an opportunity to implement and evaluate novel human resource strategies. The purpose of this report is to outline the lessons learnt to improve management of human resources in future health emergencies.

ACTION

A qualitative approach was used to review human resource strategies during the cholera outbreak. Data-gathering methods included document review of situation reports; key informant interviews with provincial cholera coordinators and members of cholera task forces at all levels, including governmental and nongovernmental stakeholders; and field observation. Specifically, key informant discussions were held with one provincial cholera coordinator, one Head of Mission and one Medical Coordinator for Médecins Sans Frontières (MSF Holland), three cholera experts from the World Health Organization and one adviser to a Provincial Health Adviser from a Provincial Health Office. This strategy was developed by the Human Resources for Health Knowledge Hub team based on their field research experience.

OUTCOME

(1) Task forces are effective for outbreak management

Working together, the National Cholera Task Force and Provincial Cholera Task Forces established a clear system of leadership and accountability for cholera outbreak response in each sector, enabled the National Department of Health to demonstrate its overall leadership and provided a framework for effective partnerships among international and national humanitarian actors in each sector at all levels of government. In provinces where there was a good working relationship between the Provincial Health Office and provincial hospitals before the outbreak, coordination generally functioned much better than in provinces where the relationship was poor. In provinces where the Provincial Health Office and provincial hospitals did not work cohesively before the outbreak, collaboration became exacerbated during the crisis, especially in the absence of good leadership. Through task forces, policy issues were identified and then moved forward through existing systems within health authorities.

(2) Prioritizing interventions is crucial following risk assessment

The process of conducting risk assessments and the subsequent prioritization of public health measures are crucial for effectively managing health emergencies, especially in the context of concurrent emergencies. Greater capacity to respond to health emergencies would be enabled by increasing staffing levels in relevant areas of health emergencies. The current staff numbers at all levels of government are vastly inadequate for running systems that generate information for risk assessment of health emergencies in Papua New Guinea.[4] For example, without additional staff who can support provincial disease control officers with data management, ongoing surveillance, outbreak detection and verification processes between or during health emergencies risk assessment will remain challenged and prioritization of interventions may be based on scant information.

(3) External staff can effectively coordinate outbreak response

Two main models of subnational cholera task force coordination were adopted: (1) the cholera task force coordinator was the Provincial Health Adviser, and (2) the coordinator was a respected, effective leader from outside the government system. This flexibility in the subnational coordination modality was useful, as both models of coordination worked effectively. In the more challenging settings, recruiting coordinators from outside the provincial government system was successful. The Provincial Disaster Coordinator is not always the most appropriate coordinator of a health emergency.

Task forces with active multisectoral participation were most effective.

(4) Designated emergency response funds are essential at all levels

Provinces that maintained a designated emergency response fund that could be immediately accessed were able to quickly implement control measures such as mobilizing rapid response teams. The emergency response budget must be able to cover the travel costs of relocated staff and their allowances. The financial accounts of Provincial Health Offices must be acquitted to ensure that task forces have control of the funding allocated for health emergencies and can use it for interventions that they have prioritized.

(5) Local leaders are important for behaviour change

It was noted on several occasions that the behaviour changes required of a community during cholera outbreaks are difficult to achieve, even if only required for a few months while the outbreak is occurring in a given setting. Communities are more likely to adopt recommended behaviours following repeated visits and messaging from respected persons such as village leaders, ward councillors, health workers or those organized by such leaders. Anecdotally, one-off visits by people with public address systems instructing the population what they should do did not appear to change behaviours during the period of the outbreak. When health authorities try to achieve behaviour change results without involving the community, the human resource burden is beyond the scope of their capacity. Behaviour change messages and materials required standardization, which was best achieved from the central level. The development of these tools could have been timelier and a pre-existing repository of communication tools would have been useful.

(6) Timely recruitment of laboratory management is key to functionality

National cholera surveillance worked effectively with only one functioning laboratory in Papua New Guinea. However, the vacant Director position at Central Public Health Laboratories could impact significantly the overall laboratory function and the capacity to take on new work (e.g. cholera surveillance) during crises. Re-establishing diagnostic capacity during outbreaks worked well at the provincial level; however, further support will be necessary to ensure sustainability of the training.

(7) Effective surveillance systems rely on adequate numbers of trained staff

Timely surveillance of outbreaks is a realistic goal in Papua New Guinea, but it is reliant on adequate staffing. During the cholera outbreak, the command and control centres facilitated the information management component of the health emergency. Given the limited staff and data management capacity at the subnational level, the national surveillance staff were frequently required to perform provincial data entry.

(8) Surveillance requires data management support but temporary workers are not sustainable

Supportive visits to the provinces, where data entry may have occurred for the first time, were sometimes the only way to stimulate the flow of data to the national level. Data managers who were recruited to work temporarily under the disease control officer during the cholera outbreak were crucial at the time of the emergency. However, because the situation continued for several months, when the temporary workers returned to their original positions, it took some time to replace them. Consideration should be given to having a permanent data manager position at the provincial level. If data managers were available between outbreaks, they could support a weekly reporting system for syndromes of public health importance. In provinces where there were challenges with the flow of cholera surveillance data, sometimes large amounts of data were never forwarded to the national level.

(9) Formalizing the rapid response team was simple and effective

Once the Senior Executive Management of the National Department of Health decided to formalize the national rapid response team, action was swiftly taken. Within weeks, the national rapid response team had completed its first investigation, confirming cholera and micronutrient deficiencies associated with high mortality among internally displaced persons. In addition to the technical support provided in field epidemiology, assistance was provided to provincial authorities in

outbreak communication and water, sanitation and hygiene.

(10) Leadership and training enable effective staff rotation policies

In the context of inflexible systems for recruiting clinical staff for outbreak surge capacity, the rotation of district staff appeared to be a successful strategy for ensuring adequate case management, training staff and preparing staff from unaffected districts. However, managing the available human resources to staff cholera treatment centres, mobiliszing response teams to affected rural areas and maintaining routine services in rural facilities was complicated and difficult.

Stakeholders felt the success of the strategy was due to the strong provincial leadership and the initial training of a core group of clinical staff largely by MSF once the outbreak had spread to the capital of the first affected province. The initial treatment centre established by MSF enabled clinical management training of many health care workers who had never been exposed to cholera and provided a platform for operational research.[8] The training ensured the nurse unit managers and other clinical staff were competent not only in effectively managing cholera cases but also in running a treatment centre. Operating the centre involved activities such as rostering, clinical audits, ongoing training, cleaning, provision of water and sanitation, procurement, infection control and mortuary services. The strategy was less effective in locations where existing leadership was weak. In such locations, stakeholder technical assistance was rejected, financial resource allocation did not correspond to interventions prioritized by the provincial task force, and the rotated district staff did not always perform the activities they were recruited to perform.

During the later stages of the outbreak, experienced cholera treatment centre teams from the first-affected provinces were recruited to work in cholera treatment centres in other provinces with high mortality. This was effective for improving the management of cases and the treatment centre during the period the team was on the ground. However, it did little to improve the situation in the longer term as opportunities to share the expertise of clinical staff from previously affected provinces were not seized and not much was done to improve systems. Staff rotation also enabled clinical staff to witness their colleagues treating cases of this "new disease" and not getting sick or dying. In this way, experienced staff were able to reassure colleagues who had fled their health facilities for fear of the disease. Cholera outbreaks, like the one in Papua New Guinea, can be expensive if they continue for months in settings with limited infrastructure. The cholera treatment centres were initially staffed with clinicians, infection control officers and security guards at an overall cost of approximately US$13 500 per month (largely for salaries).

(11) Rosters and volunteers are essential for staff rotation in remote settings

In settings where health care workers were present, unpaid volunteers often provided safe water to the makeshift treatment centres, monitored intravenous flask needs of patients in their homes before moving to makeshift treatment facilities and prepared rehydration solutions for patients as well as chlorine solutions for infection control. Such activities enabled health care workers to catch up on much-needed sleep during intense periods of transmission in remote areas. To complement the important contributions of volunteers, district health authorities developed rosters of staff from nearby facilities to ensure that clinicians shared shifts with community health workers during periods of intense transmission. In settings where strong local leadership was absent, a functional roster system was a challenge and staff were frequently overburdened, placing patient lives at risk.

DISCUSSION

Clinicians are the backbone of primary health care in Papua New Guinea and include mostly community health workers and health extension officers with far fewer nurses and doctors. They are essential in the implementation of mortality-reduction interventions during outbreaks and for ensuring the ongoing function of essential health services. For these reasons, mapping and projecting population health needs for clinical staff has been prioritized in Papua New Guinea. However, a variety of public health professionals are required for health emergency planning, preparedness and response. They include officers trained in environmental health, health promotion, logistics, communications, laboratory diagnosis and surveillance, data management, field epidemiology as well as monitoring and evaluation. The creation of a cadre of trained field epidemiologists to monitor disease trends, provide intelligence to those

conducting risk assessments, inform decision-makers about potential disease threats and guide the response during a public health emergency is essential. Objectives of the national health emergencies plan are best achieved if the required human resources are clearly identified and articulated in the national human resources plan.

The Papua New Guinea response to cholera demonstrates system inadequacies, including the systems that identify, develop and make projections on human resource requirements for health. Generally, locations that functioned well before the epidemic responded better to it, especially in provinces where emergency funding arrangements had been put in place before the outbreak. Pre-service training, opportunities for ongoing training, increased supervisory visits, production, utilization of all public health professionals, supervision and support, financial support and incentives, housing and training in supervision and outreach have all been previously identified as areas for strengthening.[9] Developing human resource targets is important for achieving desired health system outcomes. The target of at least one trained field epidemiologist per 200 000 population is an example of a benchmark that should be established for Papua New Guinea.[10] However, there are several other cadres of public health professionals that are required for emergency response, all of which are currently in limited supply and would also benefit from such targets. These cadres should also feature in the mapping and projections of public health professional needs in any fully adopted national workforce plan and may be a consideration for targets relating to their ratio to the population.

CONCLUSION

The human resources for health in Papua New Guinea made emergency response a challenge during the cholera outbreak. While the outbreak response was generally well managed, improvement to human resource systems before the next emergency will enable a more effective response as is essential for the achievement of the IHR core capacity requirements. Public health professionals needed for health emergency preparedness and response should be mapped, and planning should be implemented to increase the numbers in relevant areas. Human resource planning should be integrated with health emergency planning. It is essential to maintain and strengthen the human resource capacities and experiences gained during the cholera outbreak to ensure a more effective response to the next health emergency.

Conflicts of interest

None declared.

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References:

1. *International Health Regulations (2005), Second Edition*. Geneva, World Health Organization, 2008 (http://whqlibdoc.who.int/publications/2008/9789241580410_eng.pdf, accessed 15 April 2013).
2. *Asia Pacific Strategy for Emerging Diseases (2010).* Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/emerging_diseases/APSED2010/en/index.html, accessed 15 April 2013).
3. *Countries – Papua New Guinea*. Geneva, World Health Organization, 2013 (http://www.who.int/countries/png/en/, accessed 15 April 2013).
4. *Papua New Guinea health workforce crisis: a call to action.* Washington, DC, The World Bank, 2011 (http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2013/01/24/000333037_20130124103924/Rendered/PDF/NonAsciiFileName0.pdf, accessed 15 April 2013).
5. Dawson H, Gray K. *Human resources for health in maternal, neonatal and reproductive health at community level: A profile of Papua New Guinea*. Sydney, University of New South Wales, 2011 (http://www.hrhhub.unsw.edu.au/HRHweb.nsf/resources/MNRH_PNG-Web.pdf/$file/MNRH_PNG-Web.pdf, accessed 15 April 2013).
6. Rosewell A et al. Vibrio cholerae O1 in 2 coastal villages, Papua New Guinea. *Emerging Infectious Diseases*, 2011, 17:154–156. doi:10.3201/eid1701.100993 pmid:21192890
7. Horwood PF et al. Clonal origins of Vibrio cholerae O1 El Tor strains, Papua New Guinea, 2009–2011. *Emerging Infectious Diseases*, 2011, 17:2063–2065. doi:10.3201/eid1711.110782 pmid:22099099
8. Rosewell A et al. Cholera risk factors, Papua New Guinea, 2010. *BMC Infectious Diseases*, 2012, 12:287. doi:10.1186/1471-2334-12-287 pmid:23126504
9. Foster M et al. *Working Paper 1: Papua New Guinea Country Report.* Canberra: Australian Agency for International Development, 2009 (http://www.ode.ausaid.gov.au/publications/documents/working-paper-health-service-delivery-png.pdf, accessed 15 April 2013).
10. Ijaz K et al. International Health Regulations–what gets measured gets done. *Emerging Infectious Diseases*, 2012, 18:1054–1057. doi:10.3201/eid1807.120487 pmid:2270959

The Pacific experience: supporting small island countries and territories to meet their 2012 International Health Regulations (2005) commitments

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Issue: By 15 June 2012, States Parties to the International Health Regulations (2005), or IHR (2005), were required to have established the core capacities required to implement Annex 1 of IHR (2005).

Context: The Pacific is home to 10 million people spread over 21 Pacific island countries and territories. Seven of those have populations of less than 25 000 people; 14 of the 21 Pacific island countries and territories are States Parties to the IHR (2005).

Action: The World Health Organization Division of the South Pacific embarked on an initiative to support Pacific Island States Parties meet their 15 June 2012 IHR obligations. We adapted the 2012 IHR Monitoring Questionnaire (IHRMQ) to assist Pacific island countries and territories determine if they had met the capacities required to implement Annex 1 of the IHR (2005). If a Pacific island country or territory determined that it had not yet met the requirements, it could use the assessment outcome to develop a plan to address identified gaps.

Outcome: Direct support was provided to 19 of 21 (91%) Pacific island countries and territories including 13 of 14 (93%) States Parties. Twelve of 14 (86%) fulfilled their requirements by 15 June 2012; those that had not yet met the requirements requested extensions and submitted plans describing how the IHR core capacities would be met.

Discussion: Adapting the 2012 IHRMQ for this purpose provided an efficient tool for assessing national capacity to implement Annex 1 of IHR (2005) and provided clear indication of what capacities required strengthening.

ISSUE

On 15 June 2012, five years after the International Health Regulations (2005), or IHR (2005), entered into force, the States Parties to IHR (2005)[1] were required to have in place the core public health capacities required to implement Annex 1 of the IHR (2005), and, if it was found that the capacities needed were not yet in place, to request a two-year extension to allow more time to meet the requirements.[2]

As coordinating body for IHR (2005), the World Health Organization (WHO) monitors States Parties' progress towards fulfilment of the core capacity requirements. Central to this monitoring is the annual IHR Monitoring Questionnaire (IHRMQ).[3] The 2012 edition of IHRMQ was made available to States Parties in March 2012 to be completed and returned to WHO by 1 August 2012.

This paper describes how the WHO Division of the South Pacific used the 2012 IHRMQ to produce a tailored tool with which Pacific island countries and territories could determine fulfilment of their capacity to implement Annex 1 of IHR (2005) to meet their 15 June 2012 obligations. We discuss how we supported Pacific island countries and territories to apply the adapted tool and reflect on lessons learnt in the process. We hope that our experience in the Pacific will be informative for other similar contexts.

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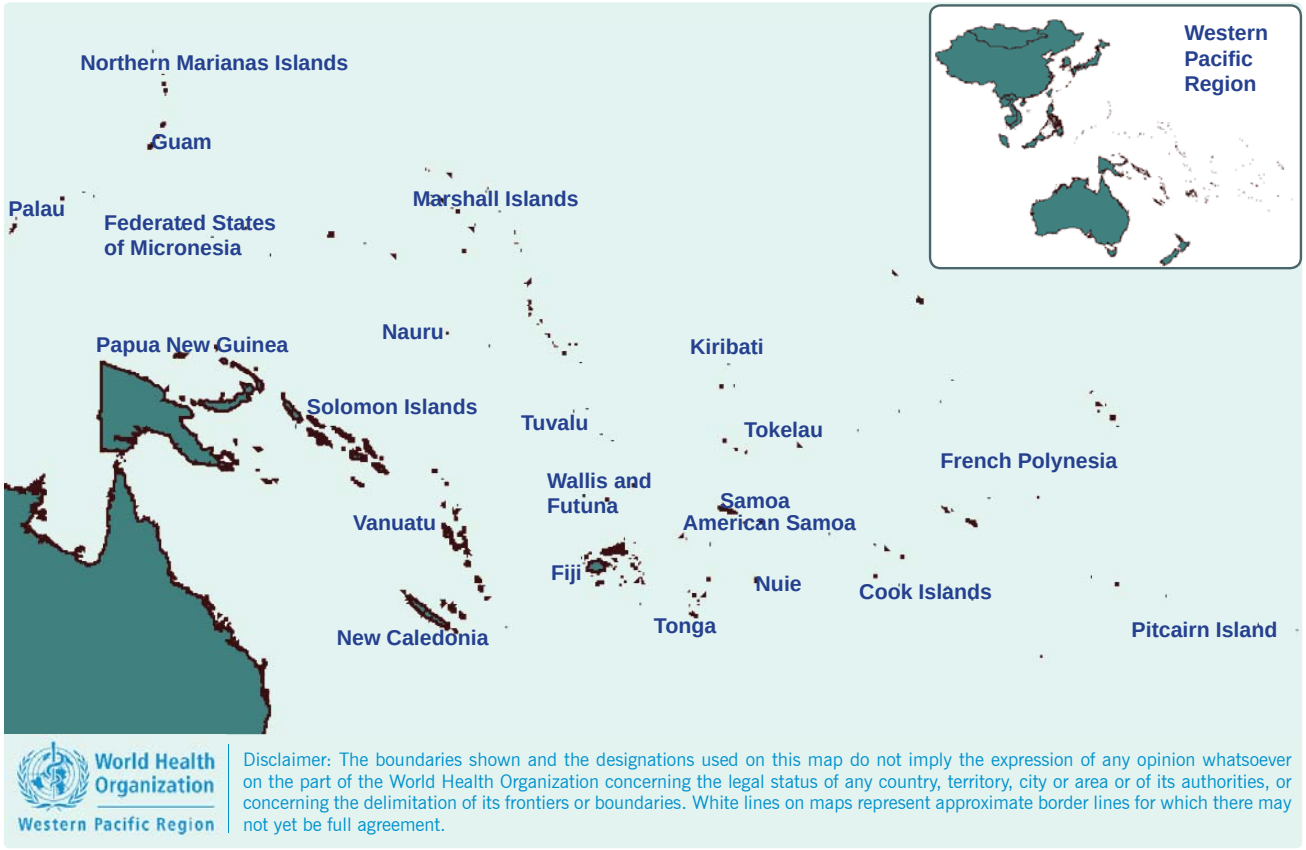
Figure 1. **Map of the Pacific island countries and territories in the Western Pacific Region**



CONTEXT

The Pacific covers almost one third of the earth and is home to approximately 10 million people (excluding Australia and New Zealand which are developed countries that do not require technical assistance).[4] Of these, 6.5 million reside in Papua New Guinea. The other 3.5 million Pacific Islanders are dispersed over many hundreds of islands and atolls that make up the other 20 Pacific island countries and territories (**Figure 1**). Seven Pacific island countries and territories have populations of less than 25 000, and three have populations less than 10 000; Tokelau has a population of just 1200 people. Fourteen Pacific island countries and territories are States Parties to IHR (2005), and seven are territories or administrative areas for which IHR (2005) responsibilities are delegated to their metropolitan country. The majority of the Pacific island countries and territories are considered to be of lower-middle income.[5]

Small population size, geographic isolation and limited human and financial resources make independent achievement of many of the IHR (2005) core capacities extremely challenging for these island territories. Some of these challenges have been addressed by drawing on regionally based public health resources such as the Pacific Public Health Surveillance Network's (PPHSN) Laboratory Network[6] and the WHO-led Pacific Syndromic Surveillance System,[7,8] in addition to bilateral agreements with Pacific Rim countries such as New Zealand, Australia or the United States.

ACTION

Assisting Pacific island countries and territories to meet their IHR (2005) capacity obligations

In response to Pacific island countries and territories' requests for assistance, the WHO Division of Pacific Support (based in Suva, Fiji) embarked on a project to support States Parties meet their IHR (2005) notification obligations by 15 June 2012. WHO had committed this assistance through the Asia Pacific Strategy for Emerging Diseases (2010).[9] Even though islands that are territories of other nations are not States Parties to IHR (2005), and therefore not required independently

to report their progress directly to WHO (rather through their metropolitan country), we encouraged them to participate in the project for self-assessment purposes. Six of seven territories were enthusiastic to participate.

Adapting the 2012 IHRMQ for use as a tool to assess Pacific island countries and territories ability to implement Annex 1 of IHR (2005)

The IHRMQ is an annual questionnaire developed for global use and sent to all IHR (2005) States Parties. It is an important source of information for countries to determine whether they have met the IHR (2005) core capacity requirements. It can be helpful to adapt this global tool for application to best meet the context of each region, country or territory. For this purpose, we analysed the questions in the 2012 IHRMQ to identify those that were most directly related and fundamental to the content of Annex 1 of IHR (2005) and were most pertinent to determining whether the core capacities had been established.[1] To ensure consistency with the full 2012 IHRMQ we did not modify the wording of any of the questions; however, to make it more user-friendly and Pacific-oriented, we added explanatory/interpretive notes beside relevant questions. Finally, we expanded the response options by adding: "Yes, drawing on international resources"; "Yes, drawing on national resources"; "No"; and "Not relevant". This allowed Pacific island countries and territories to more accurately reflect the situation in their jurisdictions, including where a Pacific island country or territory drew on regionally based networks or had bilateral agreements in place to achieve certain core capacities.

This tool was distributed to Pacific island countries and territories' National IHR Focal Points or public health focal points (for those that are areas/territories) in the week of 14 May 2012, approximately one month before the 15 June 2012 date for extension requests.

Supporting Pacific island countries and territories assess their capacity achievement

After we distributed the tool, Pacific island countries and territories were contacted and offered one-on-one telephone or e-mail assistance to explain and apply the tool. The form of assistance depended on the country or territory's needs, national decision-making processes and logistical factors such as stability of telephone lines or availability of relevant personnel. Usually, assistance was delivered as a series of telephone conferences focusing on specific aspects of IHRMQ that were of particular concern to a Pacific island country or territory.

On 31 May 2012, senior public health staff from 12 of 14 (86%) States Parties and five of seven territories (71%) met with WHO and Secretariat of the Pacific Community (SPC) staff as part of a Pacific region meeting. Important objectives of this meeting were to ensure the IHR (2005) assessment and reporting process was clear, to review the Pacific-wide public health networks and their roles in core capacity development and to provide additional one-on-one assistance to any Pacific island country or territory requesting further support.

OUTCOME

Direct support was provided to 19 of the 21 Pacific island countries and territories (91%), including 13 of the 14 States Parties and six of the seven territories. Every effort was made to engage the two other Pacific island countries and territories.

Twelve of 14 States Parties completed their national assessments and determined their ability to implement Annex 1 of IHR (2005) by 15 June 2012 and reported the conclusion of their national assessment to WHO by the notification date. Six of the 14 determined that they had in place the capacities required to implement Annex 1 of IHR (2005) and did not request an extension. The other eight determined that they had not yet met the requirements and requested a two-year extension. As required, all States Parties requesting an extension submitted an implementation plan for how they would meet the IHR (2005) core capacity requirements within the extension period.

DISCUSSION

In the last two decades, WHO, SPC and the Pacific island countries and territories have worked closely to establish and sustain PPHSN (a voluntary network of Pacific island countries and territories' public health authorities, WHO, SPC and other regional public health entities) and Pacific-wide networks and services that provide important capacity support such as early warning for outbreaks,[7,8] laboratory testing or outbreak response. Through the support of PPHSN, many of

IHR (2005) core capacities are available to Pacific island countries and territories, some of which could never be achieved by smaller individual Pacific island countries and territories. For example, for most Pacific island countries and territories the catchment populations are too small to supply the necessary number of samples to warrant the investment in national confirmatory testing capacity, and therefore it is necessary to rely on the PPHSN-coordinated laboratory network to facilitate overseas testing.

Feedback from Pacific island countries and territories indicated that they appreciated the tailored tool and the one-to-one assistance provided to apply the tool. Pacific island countries and territories expressed their desire for future IHR (and other) assessment tools to be shorter and simpler, noting that they would be better received, more useful to individual nations and more likely to be completed in time. The IHR (2005) assessment tools could be simplefied by excluding questions not directly related to the core capacities of the IHR (2005) or stratifying questions into core and supporting questions so countries can prioritize the essential (and legally binding) IHR (2005) core capacity requirements.

Although mentioned in the IHR (2005) documentation, several Pacific island countries and territories' officers responsible for completing IHRMQ did not realize that they could report successful national fulfilment of core capacities if their nation drew on sources/services from neighbouring countries or from international preparedness, surveillance or response capacities for national purposes. To address this misunderstanding, and to address the issue of the IHRMQ's length and complexity, modification could be made to the response options or accompanying instruction documentation.

A key finding from our evaluation of the assistance provided was that contextualization of global tools was well received. The importance of WHO's regional and country offices for country liaison and provision of support to apply WHO-developed tools is of paramount importance.

Harmony between IHR (2005) and other global, regional, subregional and national health emergency capacity development frameworks is also critical. Where possible, objectives of various frameworks should be closely aligned and complementary. Similarly, where possible, assessment processes should be standardised to lessen the resource drain on already over-burdened ministries.

CONCLUSION

The IHR (2005) and the 2012 IHRMQ provide a valuable framework within which nations can assess current capacity and develop plans to address gaps. However, when considering very small population countries, the need for flexibility and adaptability should be considered. In our experience, WHO's (or other development agencies') assistance to interpret global monitoring tools is appreciated, aids understanding, and will likely facilitate higher quality, timely and complete reporting. There are calls from small nations to streamline planning and assessment processes to reduce the burden placed on limited national public health staff. This can, in part, be achieved by ensuring planning and assessment tools are clear, focused and succinct.

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References:

1. *The International Health Regulations (2005)*. Geneva, World Health Organization, 2007 (http://www.who.int/ihr/finalversion9Nov07.pdf, accessed 20 September 2012).
2. *Information to States Parties regarding determination of fulfilment of IHR Core Capacity requirements for 2012 and potential extensions*. Geneva, World Health Organization, 2012 (http://apps.who.int/iris/bitstream/10665/70820/1/WHO_HSE_GCR_2012.1_eng.pdf, accessed 25 September 2012).

3. *International Health Regulations Monitoring Questionnaire, 2012 edition*. Geneva, World Health Organization, 2012.
4. Pacific Islands' Population tops 10 million. Fiji, *Island Business Magazine*, 2011.
5. *Data – Pacific island small states*. Washington, DC, World Bank, 2012 (http://data.worldbank.org/region/pss, accessed 28 June 2012).
6. *Pacific Public Health Surveillance* Network. New Caledonia, Secretariat of the Pacific Communities, 2012 (http://www.spc.int/phs/pphsn/, accessed 28 June 2012).
7. Kool JL et al. Pacific-wide simplified syndromic surveillance for early warning of outbreaks. *Global Public Health*, 2012, 7:670–681. doi:10.1080/17441692.2012.699536 pmid:22823595
8. Paterson BJ et al. Sustaining surveillance: evaluating syndromic surveillance in the Pacific. *Global Public Health*, 2012, 7:682–694. doi:10.1080/17441692.2012.699713 pmid:22817479
9. *Asia Pacific Strategy for Emerging Diseases (2010)*. Manila, World Health Organization Regional Offices for the Western Pacific, 2011 (http://www.wpro.who.int/emerging_diseases/documents/ASPED_2010/en/index.html, accessed 28 June 2012).

Event-based surveillance in Papua New Guinea: strengthening an International Health Regulations (2005) core capacity

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Under the International Health Regulations (2005), Member States are required to develop capacity in event-based surveillance (EBS). The Papua New Guinea National Department of Health established an EBS system during the influenza pandemic in August 2009. We review its performance from August 2009 to November 2012, sharing lessons that may be useful to other low-resource public health practitioners working in surveillance.

We examined the EBS system's event reporting, event verification and response. Characteristics examined included type of event, source of information, timeliness, nature of response and outcome.

Sixty-one records were identified. The median delay between onset of the event and date of reporting was 10 days. The largest proportion of reports (39%) came from Provincial Health Offices, followed by direct reports from clinical staff (25%) and reports in the media (11%). Most (84%) of the events were substantiated to be true public health events, and 56% were investigated by the Provincial Health Office alone. A confirmed or probable etiology could not be determined in 69% of true events.

EBS is a simple strategy that forms a cornerstone of public health surveillance and response particularly in low-resource settings such as Papua New Guinea. There is a need to reinforce reporting pathways, improve timeliness of reporting, expand sources of information, improve feedback and improve diagnostic support capacity. For it to be successful, EBS should be closely tied to response.

Event-based surveillance (EBS) is defined as "the organized and rapid capture of information about events that are a potential risk to public health."[1] Rumours or other ad hoc reports are transmitted through formal and informal channels such as media, health workers, community leaders and nongovernmental organizations, and assessments on the risk these events pose to public health enable a timely, effective and measured response.

Under the Asia Pacific Strategy for Emerging Diseases,[2] and to meet requirements of the International Health Regulations or IHR (2005),[3] the Papua New Guinea National Department of Health (NDOH) established an EBS system in August 2009 during the influenza A(H1N1) pandemic. One surveillance and one administrative officer received reports about potential public health events from community members, health workers, embassies and daily media. The EBS system was established to complement the existing indicator-based surveillance systems operating in provincial hospitals, which, due to poor timeliness, were inappropriate for the early detection of public health events. This paper reviews the performance of the EBS system from 2009 to 2012, sharing lessons that may be useful to other low-resource public countries in initiating or improving their surveillance systems.

STRUCTURE OF THE EBS SYSTEM

Basic structure

A simple Microsoft Excel database captures the nature of events (e.g. chemical, infectious, food safety); location; dates of events, reports and follow-ups; sources of reporting; verification status; and responses. The database is maintained by an EBS Coordinator within the Command Centre of the Communicable Diseases Surveillance and Emergency Response (CDS&ER) Unit of NDOH.

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Reporting mechanisms

The system receives ad hoc reports from any source, including health workers, nongovernmental organizations, embassies, media and the general public. Reports are received at CDS&ER or the World Health Organization (WHO) and are channelled to the EBS Coordinator. Active surveillance through review of the two major national newspapers is also conducted. However, by routing data directly from the ground level to the national level, the system bypasses established reporting channels, i.e. from local/district to provincial to national levels.

Verification and assessment

Using a structured questionnaire (**Figure 1**), the EBS Coordinator verifies events reported from non-health sources by contacting the nearest health authorities or provincial health offices (PHOs) who are responsible for disease surveillance and control. Information about the presenting syndrome, place and date of occurrence and

Figure 1. **Papua New Guinea outbreak/event report and assessment form**

Outbreak/Event Report and Assessment Form

Information about source of report		
What is your **name**?	What is your **phone number**?	
What is your **position**?		
If report is second-hand information, what is the original source of **information**? (Name, contact information)		
Location of event		
What is the **name of the village** (specific location where the event took place)?		
What is the **district**?		
What is the **province**?		
Description of the event		
What do you want to report (what happened/who is affected/what are the symptoms)?		
Number of cases among **children**:	Number of deaths among **children**:	
Number of cases among **adults**:	Number of deaths among **adults**:	
When did the problem **begin**?		
Is the problem **ongoing**? YES/NO		
What do you think is the cause of this event?		
What are the **control measures** being implemented?		
What **support** do you need from us?		
Is there any **other information** you wish to share?		
Thank you.		
For office use only:		
ASSESSMENT – If **any** of this conditions are met, a response is **required**		
Is the disease unusual/unexpected in this community?		YES / NO
Could the disease have an impact on international travel or trade?		YES / NO
Could the suspected disease cause outbreaks with high potential for spread (e.g. cholera, measles)?		YES / NO
Is there a higher than expected mortality or morbidity from the suspected disease?		YES / NO
Is there a cluster of cases or deaths with similar symptoms (e.g. bloody diarrhoea, haemorrhagic signs and symptoms)?		YES / NO
Could the disease be caused by a contaminated, commercially available product (e.g. food item)?		YES / NO
Is there a suspected transmission within a health care setting (i.e. nosocomial transmission)?		YES / NO
If the event is a **non-human event** (e.g. animal disease or chemical spill), does the event have **known** or **potential** consequence for human health?		YES / NO

Name of person filling out this form:

Date:

number of cases and deaths due to the syndrome are collected. The EBS Coordinator also provides guidance to provincial health authorities about investigation and response measures. A log of all verification, assessment and follow-up activities is maintained in the EBS database.

Response

The legal mandate for outbreak investigation and response lies primarily with PHO. In specific circumstances (e.g. events associated with a particular health facility or mining enterprise), investigations may be initiated directly by affected parties. Support from higher levels (e.g. NDOH, WHO and/or other partners) occurs only upon request from local authorities. The EBS Coordinator follows up periodically with the relevant PHO to obtain reports about the local response.

All events investigated through the EBS system are reported back to stakeholders (e.g. provincial health authorities, hospital management) through a weekly National Surveillance Bulletin.

METHODS

We conducted a descriptive analysis of the line-list of events captured by EBS from August 2009 to November 2012; calculated the proportion of events that were verified, responded to and laboratory confirmed; and assessed the timeliness of the system by calculating the interval between occurrence and reporting to the system and between reporting and verification of events.

RESULTS

There were 61 unique records in the EBS system. From August to December 2009, 10 events were recorded; 22 events were recorded in 2010; five in 2011; and 17 in 2012 (**Table 1**). Additionally, there were seven events recorded for which no dates were available. There was no clear pattern to the time of event reporting (data not shown).

The most common reports (n = 16) were of acute watery diarrhoea, followed by bloody diarrhoea (n = 9), influenza-like illness (n = 8), acute gastrointestinal syndromes (n = 7) and acute fever and rash (n = 6). Other events included neurological syndrome (n = 5), unspecified acute febrile illness (n = 3), acute respiratory illness not classified as influenza-like illness (n = 3), a haemorrhagic syndrome, an animal die-off and an unknown cause of death.

Among 36 events for which both data were available, the median delay between event onset and date of reporting was 10 days (range= 0–109 days). Ten events (28%) took more than 30 days to report. Fourteen of the 23 reports not coming from health care workers or public health authorities had both dates listed; of these, all but one were verified with the relevant local health authorities on the same day they were received.

The largest number of reports (n = 24) came from PHOs followed by direct reports from clinical health care workers (n = 15), media (n = 7), other sources (n = 6), nongovernmental organizations (n = 4) and the community (n = 4). The reports were widely geographically distributed (data not shown).

Most events (n = 34) were investigated directly by the PHO. A minority involved either onsite or remote assistance from NDOH, with or without support from WHO in Papua New Guinea and/or the regional office in Manila, Philippines or other development partners. A few events involved investigations conducted solely by a third party (e.g. the reporting hospital or a mining company).

Most events (n = 51) were substantiated to be true public health events. Only three events were discarded as false reports; an additional six could not be verified, and one record did not report final outcome.

Among the true events, confirmed or probable etiologies were identified in 16, and in the remaining 35, the etiology could not be determined.

DISCUSSION

EBS is a simple-to-use strategy that forms a cornerstone of public health surveillance and response, particularly in low-resource settings such as Papua New Guinea. It is adaptable to a wide variety of public health events and settings, especially rare events and those occurring in populations that do not access the formal health care system (e.g large segments of the 87% rural population in Papua New Guinea).[4] For it to be successful, EBS should be closely tied to response; formalization of EBS through the use of assessment tools and response

Table 1. **Summary of health events captured in the Papua New Guinea event-based surveillance system, 2009 to 2012**

A. 2009 (*n* = 10)

Event	Source of information	Investigation/response involvement*	Outcome
Acute watery diarrhoea (5)	PHO	NDOH then WHO then other partners	Etiology not determined
	PHO	PHO then NDOH + WHO	Laboratory-confirmed cholera
	Community	PHO then NDOH + WHO	Unverifiable
	Media	NDOH then WHO then other partners	Laboratory-confirmed cholera
	PHO	NDOH then WHO then other partners	Laboratory-confirmed cholera
Bloody diarrhoea (3)	PHO	PHO then NDOH + WHO	Etiology not determined
	HCW	Unknown then NDOH then WHO	Etiology not determined
	PHO	PHO then NDOH	No outbreak (false rumour)
Influenza-like illness (2)	PHO	NDOH + WHO then other partners	Etiology not determined
	PHO	PHO	Unverifiable

B. 2010 (*n* = 22)

Event	Source of information	Investigation/response involvement*	Outcome
Acute fever and rash (4)	Other	Unknown	Etiology not determined
	PHO	PHO	Etiology not determined
	PHO	PHO	Etiology not determined
	HCW	PHO then NDOH + WHO	Etiology not determined (severe allergic reactions in four health workers)
Acute gastrointestinal syndrome (2)	HCW	Unknown	Etiology not determined
	Media	PHO	Etiology not determined (food poisoning)
Acute neurological syndrome (1)	PHO	Unknown	Etiology not determined
Acute respiratory illness (2)	Other	Unknown then NDOH	Etiology not determined
	PHO	NDOH	Clinically suspected pertussis; no samples collected
Acute watery diarrhoea (10)	PHO	Unknown then NDOH	No outbreak (false rumour)
	NGO	PHO then NDOH	No outbreak (false rumour)
	PHO	PHO then NDOH	Positive for cholera by rapid diagnostic tests
	Other	NDOH then WHO	Laboratory-confirmed cholera
	PHO	PHO then NDOH + WHO	Etiology not determined
	Community	PHO then NDOH then other partners	Laboratory-confirmed cholera
	Community	PHO then NDOH then other partners	Laboratory-confirmed cholera
	HCW	PHO then NDOH then other partners	Laboratory-confirmed cholera
	HCW	PHO then NDOH	Etiology not determined
	Media	NDOH then WHO then other partners	Etiology not determined
Bloody diarrhoea (3)	PHO	PHO then NDOH	Etiology not determined
	PHO	PHO then NDOH	Etiology not determined
	Media	PHO	Etiology not determined (PHO investigation report unavailable)

C. 2011 (*n* = 5)

Event	Source of information	Investigation/response involvement*	Outcome
Acute fever and rash (1)	Other	NDOH then WHO	Clinically suspected chickenpox; no samples collected
Acute neurological syndrome (1)	HCW	PHO then NDOH + WHO	Laboratory-confirmed meningococcal meningitis
Animal health (1)	Community	Unknown	Unverifiable (animal health authority's investigation report unavailable)
Bloody diarrhoea (1)	HCW	Unknown	Unverifiable
Unknown cause of morbidity or mortality (1)	Media	NDOH then WHO	Unverifiable

D. 2012 (*n* = 17)

Event	Source of information	Investigation/response involvement*	Outcome
Acute febrile illness (1)	HCW	Vanimo General Hospital then NDOH + WHO	Laboratory-confirmed chikungunya
Acute fever and rash (1)	HCW	PHO then WHO	Etiology not determined
Acute gastrointestinal syndrome (3)	NGO	PHO then NDOH	Etiology not determined
	PHO	PHO then NDOH	Etiology not determined
	NGO	Unknown	Etiology not determined
Acute neurological syndrome (1)	HCW	NDOH then WHO	Etiology not determined
Acute watery diarrhoea (1)	HCW	PHO then NDOH	Etiology not determined
Bloody diarrhoea (2)	Media	PHO then NDOH	Etiology not determined
	PHO	PHO then NDOH + WHO	Etiology not determined
Haemorrhagic syndrome (1)	Media	OK Tedi Development Foundation then PHO then NDOH + WHO	Etiology not determined
Influenza-like illness (6)	HCW	NDOH	Etiology not determined
	Other	PHO then NDOH	Etiology not determined
	PHO	PHO then NDOH + WHO	Etiology not determined
	HCW	PHO then NDOH + WHO	Laboratory-confirmed influenza H3N2
	PHO	PHO	Etiology not determined
	PHO	Unknown	Etiology not determined
Neurological (1)	HCW	Kiunga District Hospital then NDOH then IMR	Etiology not determined

E. Undetermined year (*n* = 7)

Event	Source of information	Investigation/response involvement*	Outcome
Acute febrile illness (2)	NGO	PHO then NDOH + WHO	Etiology not determined
	Other	Unknown	Unverifiable
Acute gastrointestinal syndrome (2)	HCW	PHO then NDOH + WHO	Etiology not determined (cholera ruled out by laboratory)
	PHO	Unknown	District investigated no reports from PHO to National Level
Acute neurologic syndrome (1)	PHO	Unknown	Clinical neonatal tetanus
Acute respiratory illness (1)	PHO	PHO then NDOH + WHO	Etiology not determined
Acute watery diarrhoea (1)	NGO	PHO	Unverifiable

HCW – Health care worker; IMR – Papua New Guinea Institute of Medical Research; NDOH – National Department of Health; NGO – Nongovernmental organization; PHO – Provincial Health Office; WHO – World Health Organization.

* Investigation and response includes both remote verification/advice and onsite field investigation.

tracking, as described in WHO's Guide to Establishing Event-based Surveillance,[1] facilitates this response.

The single largest source of reports to the EBS system was the PHO, which is expected given the requirement for PHOs to report serious public health events to the national government. However, that the majority of reports were received through other sources, such as health care workers and the media, points to a need to reinforce to partners that their first point of contact should be the PHO, in line with their authority to implement public health measures.

Positive system attributes

The EBS system is fully flexible for any type of public health event; the system successfully identified a chemical event and a nutritional emergency. The incorporation of new reporting sources is relatively easily accomplished, although feedback to distant sites may be a challenge.

The cost of the system, although not formally evaluated, appears exceptionally low, requiring two part-time staff members, and incurring little more cost than that of the phone calls and electricity involved. The great cost, of course, comes later in the need to respond to the many true outbreaks that are detected by the system. One logistical barrier is the frequent lack of phone credit on the part of informants (even Provincial Disease Control Officers who are directly responsible for outbreak investigations), which could be remedied by employing a toll-free reporting number; this would likely improve sensitivity and acceptability, as it would obviate the need for reporters to incur individual costs by reporting, although it would increase the cost of the system at the national level.

Formalizing the system beyond simply receiving rumour reports (i.e. by using standardized forms and logging all reports) has several benefits. These include improved accountability, since, once a report is logged, it must be pursued until it is investigated or dismissed; a more consistent approach to assessing reports; the ability to evaluate the relative contribution of disparate reporting sources; and others. In our opinion, these benefits far outweigh the additional burden of collecting EBS data systematically.

It is equally crucial to regularly disseminate EBS performance characteristics and findings back to reporters and other stakeholders. This is currently done through a weekly National Surveillance Bulletin, although its reach is currently limited to those stakeholders who can receive e-mail. Increasing the reach of the bulletins, including through broadcasting findings over the well-established radio network for health posts, is being explored.

Challenges and opportunities for improvement

Reporting pathway

One of the challenges of the current system is the bypassing of provincial authorities of reports made directly from nongovernmental organizations or the public to the national government. This has required awareness-raising/training of provincial authorities on the benefits of an additional source of surveillance information.

Delay in notification

The objective of EBS is to identify events early to enable rapid verification and response if the event poses a risk to public health. In Papua New Guinea, there is certainly room for improvement as public health events were identified after a median delay of 10 days. Nevertheless, given that indicator-based data are often subject to a delay of three months or more, EBS is timelier. Far more concerning is the fact that 28% of EBS events took more than 30 days to be investigated. After such a delay the opportunity for control is largely lost, and limited resources are wasted on mounting largely fruitless responses.

Reach of the system

Another challenge of the system is in reaching the majority rural population, who, by virtue of their remoteness, may not be aware of benefits and mechanisms of reporting events or who simply cannot do so. For this reason it may be useful to consider strengthening EBS in high-risk settings first. This may include raising awareness of EBS among large employers in remote settings with a high degree of international mobility, such as those in the extractive industries or logging workers who are

at the interface of potential sylvatic zoonotic disease transmission events.

The EBS system in Papua New Guinea could further be improved by systematically collecting information from media sources, both traditional and social; by being more responsive to the media, for example by publishing articles in response to media stories; and proactively reaching out to health reporters to improve story accuracy. While EBS is more sensitive than the routine indicator-based surveillance system, given the high specificity of the EBS reports (only 5% of reports are discarded as non-events), there is room to improve the sensitivity of the system by casting a wider net.

Lack of resources for response

It is reassuring that most responses were initiated by the PHO in the respective province, especially as most PHOs are quite limited in the extent to which they can conduct field investigations. For example, most Provincial Disease Control Officers do not have reliable access to a computer or a vehicle, and most have never formally been trained in epidemiologic principles. There is an urgent need to train these individuals for them to fulfil their mandates. Therefore, NDOH and WHO are now incorporating EBS training into all surveillance training and resource materials such as the Papua New Guinea Field Epidemiology Training Programme and the recently updated Papua New Guinea Outbreak Manual.

Lack of diagnostic capacity

As evidenced by the huge proportion of events for which an etiology could not be determined, improvements in diagnostic capacity are urgently needed. This is primarily an issue of sample collection and transport, rather than an issue of actual analysis, as described for the 2010 national cholera outbreak.[5]

CONCLUSION

EBS is a critical asset for Papua New Guinea's public health surveillance. Through this system, Papua New Guinea has successfully met virtually all of the IHR requirements related to EBS; the only area requiring further work is direct outreach to communities to increase reporting. The EBS system has effectively identified a large number of urgent public health events and instigated prompt responses to those events. Elements of the system such as feedback and the link to laboratory confirmation need to be strengthened for the system to function to its full potential.

Conflicts of interest

None declared.

Funding

None.

References:

1. *A Guide to establishing event-based surveillance*. Manila, World Health Organization Regional Office for the Western Pacific, 2008 (http://www.wpro.who.int/emerging_diseases/documents/eventbasedsurv/en, accessed 25 April 2013).
2. *Asia Pacific Strategy for Emerging Diseases (2010).* Manila, World Health Organization Regional Office for the Western Pacific, 2011 (http://www.wpro.who.int/entity/emerging_diseases/documents/docs/ASPED_2010.pdf, accessed 25 April 2013).
3. *International Health Regulations (2005), 2nd edition*. Manila, World Health Organization Regional Office for the Western Pacific, 2008 (http://whqlibdoc.who.int/publications/2008/9789241580410_eng.pdf, accessed 25 April 2013).
4. *National Health Plan 2011–2020: Volume 1 Policies and Strategies*. Government of Papua New Guinea, 2010 (http://www.wpro.who.int/health_services/papua_new_guinea_nationalhealthplan.pdf, accessed 25 April 2013).
5. Greenhill A et al. Improved laboratory capacity is required to respond better to future cholera outbreaks in Papua New Guinea. *Western Pacific Surveillance and Response Journal*, 2012, 3:30–32. doi:10.5365/wpsar.2011.2.4.016

International Health Regulations (2005): public health event communications in the Western Pacific Region

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The revised International Health Regulations, known as IHR (2005), went into effect on 15 June 2007, requiring World Health Organization (WHO) Member States to notify all events that may constitute a public health emergency of international concern (PHEIC).[1] All cases of smallpox, wild-type poliovirus, novel subtypes of human influenza virus infection and severe acute respiratory syndrome must be notified; events that meet two of the four following criteria also must be notified: (1) the event has a serious public health impact; (2) the event is unusual or unexpected; (3) there is a significant risk of international spread; and (4) there is a significant risk of international travel or trade restrictions.[2] A decision-making tool to assist countries in determining whether to notify is provided in Annex 2 of IHR (2005). Member countries report to WHO via a designated National IHR Focal Point (NFP); NFPs communicate to WHO through the designated WHO IHR Contact Point at regional offices.[3]

This report provides feedback to the Western Pacific Region on the types of communications and events notified under IHR by disease and country. Significant public health events in the region communicated via IHR from 2007 to 2009 were summarized from internal reports, and an assessment was conducted of information in the dedicated IHR e-mail inbox of the WHO Regional Office of the Western Pacific from January 2010 to June 2013. Other methods of IHR communications which may contribute additional information on IHR mechanisms in the Region were not included.

Between June 2007 and December 2009, more than 100 public health events in the Western Pacific Region were communicated to WHO. These included the first Zika virus outbreak in Micronesia (Federated States of), an imported case of polio in Australia, a large outbreak of cholera in Papua New Guinea, an Ebola Reston virus outbreak in the Philippines, human infections of avian influenza A(H5N1) from several countries, cases of multidrug-resistant tuberculosis, and food contamination. During the influenza A(H1N1) pandemic in 2009, the first PHEIC declared by the WHO Director-General under IHR (2005), IHR communications, including correspondence among NFPs, WHO country and regional offies, as well as WHO Headquarters, increased considerably.

Since 2010, the WHO regional office has received between 1100 and 2000 IHR e-mails per year. Increased volume in 2010 was due to continued weekly updates from Member States on pandemic influenza A(H1N1), and in 2011 was due to the Japan earthquake and tsunami event. Between January and May 2013, over 750 e-mails were received; most were related to the avian influenza A(H7N9) event in China. Of the approximately 50 public health events notified since 2010, 10 required no further action under IHR. Three mandated diseases were notified: wild-type poliovirus in China, 2011; human infections of avian influenza A(H5N1) in China, Cambodia and Viet Nam; and a novel subtype of avian influenza A(H7N9) in China, 2013. The latter resulted in more than 30 official IHR notifications with multiple notifications on some days.

Since 2010, most communications under IHR were of infectious disease outbreaks: measles in the Philippines and New Zealand; the first outbreak of chikungunya virus in Papua New Guinea; plague in China; hand, foot and mouth disease in Cambodia with a high case fatality rate in children (initially reported as an unknown illness which met the criteria for notification); and unexpected tularaemia cases in Australia. Other diseases notified included typhoid, cholera, dengue, legionellosis and norovirus. There were 24 separate avian

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influenza A(H5N1) IHR notifications from four countries and areas (Cambodia, China, Hong Kong [China] and Viet Nam); three countries and areas (Australia, Singapore and Hong Kong [China]) reported oseltamivir-resistant cases of influenza A(H1N1). The few non-infectious disease events included a food safety event associated with seaweed products in Australia, and the radionuclear event after the Japan earthquake in 2011.

Fourteen different countries and areas within the Region have made notifications via IHR e-mail since 2010 – Australia, Cambodia, China, Fiji, Hong Kong (China), Japan, the Republic of Korea, the Lao People's Democratic Republic, New Caledonia, New Zealand, Papua New Guinea, the Philippines, Singapore and Viet Nam – with Australia and China reporting the most. Cambodia and Viet Nam also frequently reported new cases of avian influenza A(H5N1) between 2010 and May 2013.

WHO regional IHR e-mail also facilitates notifications and contact tracing of infectious cases between NFPs. From 2010, 27 such contact-tracing requests were made; including five for tuberculosis, three for measles related to international flights and one for measles at a resort with international guests. A further 30 communications were sent to advise the WHO Regional Office that successful contact had been made between countries where at least one country was in the Region. IHR communications also included 22 food safety issues and/or recalls from the International Food Safety Authorities Network and approximately 50 requests for information from Member States about significant public health issues occurring elsewhere in the Region.

To test IHR procedures, especially for those countries and areas that have not notified to date, WHO conducts an annual regional exercise, "IHR Exercise Crystal."[4] In December 2012, 21 of 27 NFPs in the Region participated, with over 86% using Annex 2 of IHR (2005) to determine that the exercise scenario required IHR notification; 15 completed the notification within the allocated five-hour time period. The exercise also identified e-mail as the most reliable communication method.[4] Sites unable to participate cited unexpected conflicts, real public health emergencies or other reasons for non-participation.[4] (See report for full details and recommendations.) This exercise demonstrated the ability of participants to communicate via IHR and notify appropriately. A global assessment of the implementation of IHR revealed that 88% of the 69% of Member States that responded to a survey reported excellent or good knowledge of Annex 2, and 77% reported always or usually using Annex 2 to assess public health events.[5] The regional exercise and global survey both suggest that IHR mechanisms are acceptable to Member States.

The majority of events communicated through IHR in the Western Pacific Region were infectious disease outbreaks, with significant increases in volume due to human infection with three novel influenza viruses – pandemic influenza A(H1N1), avian influenza A(H5N1) and avian influenza A(H7N9) – as well as a radionuclear event in Japan. Member States not reporting may not have had an event meeting the criteria for notification or may lack capacity in surveillance and detection of events.

Conflicts of interest

None declared.

Funding

None.

References

1. *International Health Regulations (2005), 2nd edition*. Geneva, World Health Organization, 2008 (http://www.who.int/ihr/9789241596664/en/index.html, accessed 15 June 2013).
2. *WHO guidance for the use of Annex 2 of the International Health Regulations (2005). Decision instrument for the assessment and notification of events that may constitute a public health emergency of international concern.* Geneva, World Health Organization, 2008 (http://www.who.int/ihr/revised_annex2_guidance.pdf, accessed 14 June 2013).
3. *National IHR focal point guide. Designation/establishment of national IHR focal points*. Geneva, World Health Organization, 2006 (http://www.who.int/ihr/English2.pdf, accessed 15 June 2013).
4. *IHR event communication exercise in the WHO Western Pacific Region 2012*. Manila, World Health Organization Regional Office for the Western Pacific, 2013 (http://www.wpro.who.int/emerging_diseases/meetings/docs/IHRCrystal2012.pdf, accessed 15 June 2013).
5. *Report of the Review Committee on the Functioning of the International Health Regulations (2005) and on Pandemic Influenza A(H1N1) 2009*. Geneva, World Health Organization, 2011 (http://www.who.int/preview_report_review_committee_mar2011_en, accessed 15 June 2013).

Ongoing outbreak of dengue serotype-3 in Solomon Islands, January to May 2013

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Introduction: In January 2013, clinicians in Honiara, Solomon Islands noted several patients presenting with dengue-like illness. Serum from three cases tested positive for dengue by rapid diagnostic test. Subsequent increases in cases were reported, and the outbreak was confirmed as being dengue serotype-3 by further laboratory tests. This report describes the ongoing outbreak investigation, findings and response.

Methods: Enhanced dengue surveillance was implemented in the capital, Honiara, and in the provinces. This included training health staff on dengue case definitions, data collection and reporting. Vector surveillance was also conducted.

Results: From 3 January to 15 May 2013, 5254 cases of suspected dengue were reported (101.8 per 10 000 population), including 401 hospitalizations and six deaths. The median age of cases was 20 years (range zero to 90), and 86% were reported from Honiara. Both *Aedes aegyti* and *Aedes albopictus* were identified in Honiara. Outbreak response measures included clinical training seminars, vector control activities, implementation of diagnostic and case management protocols and a public communication campaign.

Discussion: This was the first large dengue outbreak documented in Solomon Islands. Factors that may have contributed to this outbreak include a largely susceptible population, the presence of a highly efficient dengue vector in Honiara, a high-density human population with numerous breeding sites and favourable weather conditions for mosquito proliferation. Although the number of cases has plateaued since 1 April, continued enhanced nationwide surveillance and response activities are necessary.

Solomon Islands is an archipelago located in the South Pacific comprising a double chain of 992 islands with a population of 515 870 in 2009. It is divided into nine provinces, and 80% of the population live in rural areas (**Figure 1**). The National Referral Hospital (NRH) is located in the capital city, Honiara. Syndromic surveillance is conducted at seven sentinel sites, four sites in Honiara and three in the provinces.

During the first week of January 2013, clinicians at NRH noted several patients presenting with dengue-like illness. Serum from three cases was positive for dengue virus (DENV) by rapid diagnostic test (RDT). Over subsequent weeks, increasing numbers of suspected and RDT-positive dengue cases were identified. On 6 March, dengue serotype-3 (DENV-3) was isolated from four patients. By 15 May, more than 5200 suspected cases had been identified. This report describes the ongoing outbreak investigation, findings and response.

METHODS

During the last week of January 2013, enhanced dengue surveillance was implemented in Honiara and Guadalcanal Province health facilities and was progressively implemented in the remaining provincial hospitals over the subsequent six weeks. This comprised the training of clinical staff in case detection and notification, distribution of RDT to hospitals and the development and implementation of a database and protocol for collating and analysing the surveillance data. The dengue surveillance data were submitted

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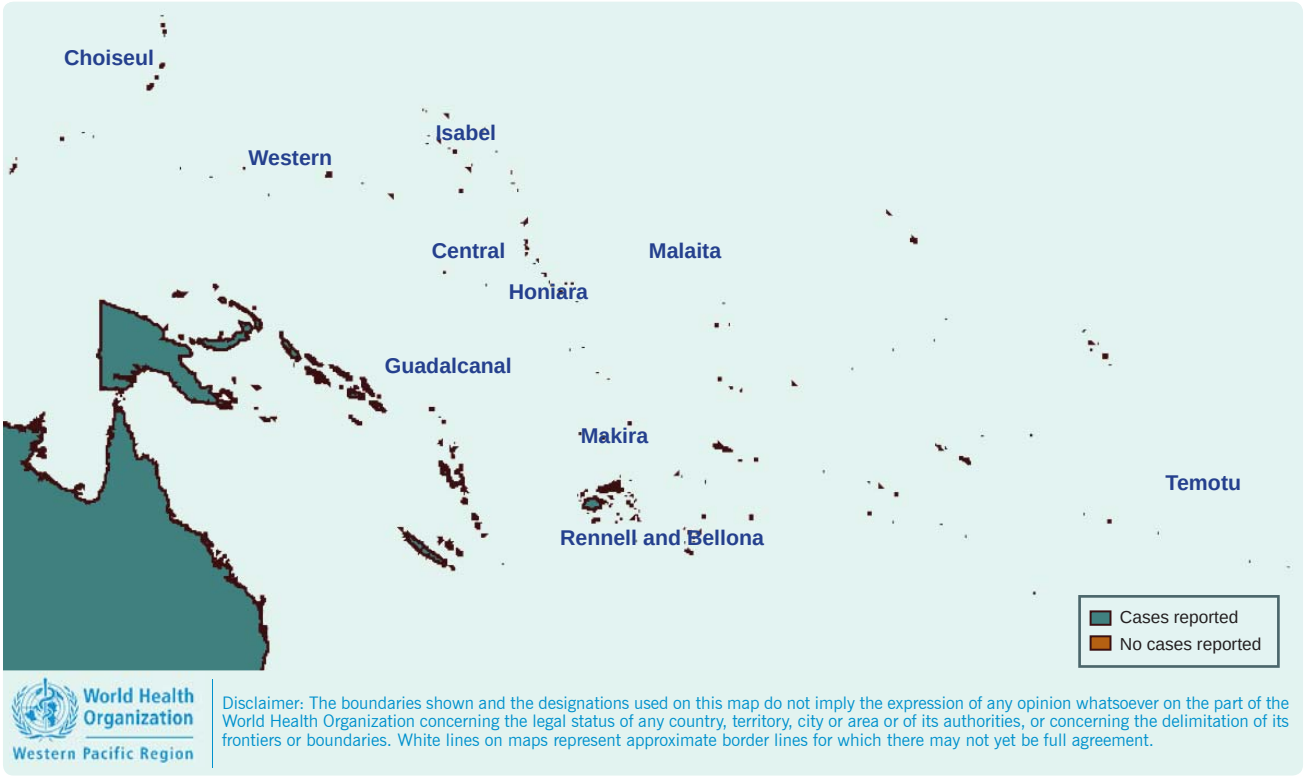
Figure 1. **Location of dengue serotype-3 outbreak, Solomon Islands, January to May 2013**



weekly by health facilities to the National Surveillance and Response Unit of the Ministry of Health for analysis and dissemination.

A suspected case of dengue was defined as a patient with fever by clinical history or examination (≥ 38 °C); a negative malaria test (malaria RDT or microscopy parasite smear) plus two or more of the following symptoms: anorexia and nausea, rash, aches and pains (headache, eye pain, muscle ache or joint pain); a positive tourniquet test; leukopenia (< 4000/ml); or a dengue warning sign (abdominal pain or tenderness, persistent vomiting, mucosal bleeding, liver enlargement > 2 cm, clinical fluid accumulation, lethargy, restlessness, increase in haematocrit concurrent with rapid decrease of platelet count). Rates were calculated using the 2009 census data, which were aggregated by age (< 15, 15–24, 25–59 and 60+).

Serum was collected for RDT testing (Dengue Duo, Standard Diagnostics Inc., Kyonggi-do, Republic of Korea) from suspected cases that had warning signs or cases from areas with unknown, new or poorly characterized dengue transmission. The RDT was considered positive for dengue if it tested positive for non-structural protein 1 (NS1) and/or anti-DENV immunoglobulin M (IgM).[1] Further testing by enzyme-linked immunosorbent assay (PanBIo Dengue IgM capture ELISA, Queensland, Australia) and cell culture was conducted by the World Health Organization (WHO) Collaborating Centre for Arbovirus Reference and Research in Brisbane, Australia and by reverse transcriptase polymerase chain reaction (RT–PCR) by the Institut Louis Malardé, French Polynesia.

The National Vectoborne Disease Control Programme conducted vector surveillance activities, including larval surveillance and aspiration of adult mosquitoes from February to late April across several Honiara suburbs. Adult vectors were collected using ad hoc indoor and outdoor human landing catches at peak biting times. The vector surveillance was implemented to establish the presence and distribution of dengue vectors in Honiara and other provincial capitals where dengue cases were being recorded, including Auki in Malaita Province and Gizo in Western Province.

RESULTS

Epidemiological and laboratory investigation

From 3 January to 15 May 2013, there were 5254 cases of suspected dengue reported (101.8 per 10 000 population). Approximately 9% of cases

Table 1. **Number of suspected and RDT-positive dengue cases and attack rates by gender, age and province, Solomon Islands, January to May 2013**

	Population	Total cases	Rate (per 10 000 population)	RDT-positive cases	Rate (per 10 000 population)
Gender					
Male	264 455	2478	93.7	619	23.4
Female	251 415	2769	110.1	601	23.9
Unknown		7			
Age Group					
< 15	209 463	1886	90.0	221	10.6
15–24	96 542	1211	125.4	242	25.1
25–59	182 816	2042	111.7	495	27.1
60+	27 049	112	41.4	20	7.4
Unknown		3		242	
Province					
Honiara	64 609	4539	702.5	1107	171.3
Guadalcanal	93 613	259	27.7	34	3.6
Malaita	137 596	101	7.3	18	1.3
Western	76 649	263	34.3	49	6.4
Temotu	21 362	54	25.3	6	2.8
Isabel	26 158	7	2.7	0	0.0
Choiseul	26 372	11	4.2	2	0.8
Central	26 051	19	7.3	4	1.5
Makira	40 419	1	0.2	0	–
Rennell and Bellona	3 041	0	–	0	–
Total	**515 780**	**5254**	**101.8**	**1220**	**23.6**

RDT – rapid diagnostic test

(*n* = 401) reported in Honiara were admitted to NRH. No data was available for hospitalization rates outside the capital. Six patients died (case fatality: 0.1%).

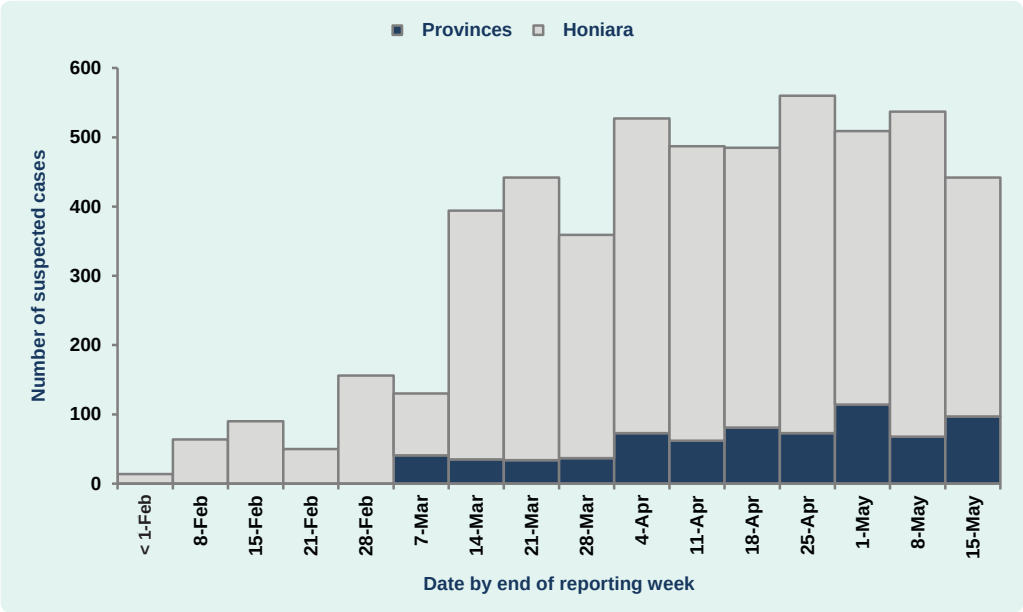
Males comprised 47% of suspected cases and the median age was 20 years (range zero to 90). Adults aged 15 to 24 and 25 to 59 years were most affected with 125 and 112 cases per 10 000 population (age-adjusted), respectively. The least affected age group was adults aged > 60 years with 41 cases per 10 000 population. Most cases (86%) were reported from Honiara (703 cases per 10 000 population), followed by Western Province and Guadalcanal Province (excluding Honiara) with 34 and 28 cases per 10 000 population, respectively (**Table 1**). The number of new cases reported from Honiara has been stable since 1 April 2013, while the number of suspected cases in the provinces has been increasing since the beginning of March (**Figure 2**).

Sera from 3141 suspected cases were tested by RDT, and 1220 (39%) were positive. On 13 February, anti-dengue IgM was detected in four of 12 samples by ELISA testing. On 6 March 2013, cell culture from four RDT NS1-positive and IgM-negative samples isolated DENV-3. An additional 10 RDT NS1-positive samples were RT–PCR positive for DENV-3.

Entomology investigation

Targeted sampling of mosquito breeding sites in Honiara identified two receptacles positive for *Aedes aegypti* and

Figure 2. **Number of suspected dengue cases by week, Solomon Islands, January to May 2013 (n = 5254)**



152 receptacles positive for *Aedes albopictus*. Dengue vector surveillance outside Honiara (rural Guadalcanal, Malaita and Gizo) identified only *Aedes albopictus*.

Control measures

Control measures implemented by the Ministry of Health and Medical Services with WHO support included: clinical training seminars, based on WHO clinical management guidelines,[2] for doctors and nurses to ensure high-quality patient care; implementation of diagnostic and case management protocols for health care professionals; vector control activities including: blanket space-spraying of Honiara and focal treatments of case house clusters with interior residual sprays, exterior residual sprays, residual treatment of breeding sites and targeted ultra-low volume fogging; and public communication campaigns including press statements, radio messages and house-to-house delivery of dengue information pamphlets, educating the public on the prevention of mosquito bites, the signs and symptoms of dengue, and promoting early health-seeking behaviour. Government of Solomon Islands declared a national clean-up day on 20 March 2013, further encouraging the public to remove, cover or destroy potential mosquito breeding sites such as old tyres, rubbish and other water–filled containers.

DISCUSSION

At the time of reporting, the DENV-3 outbreak in Solomon Islands continues. The capital city, Honiara, is the epicentre of the outbreak with almost 90% of suspected cases and where, from January to May, more than 7% of the population have met the criteria for suspected dengue and presented to a health facility. Despite a relatively low hospitalization rate of 8.6%, the strain on the health system has, and continues to be, substantial.

As dengue is a serotype-specific immunizing infection, the broad and even age distribution up to 49 years of age suggests an absence of prior DENV-3 infection – and thus susceptibility – in the majority of the population. Despite the large susceptible population, the number of new dengue cases has plateaued since April 2013. This may be due, at least in part, to the implementation of effective control measures. The normal seasonal decrease in rainfall from April to June, with the corresponding decrease in mosquito population, is also a likely contributing factor.[3–5] At this time, the provinces have not experienced substantial dengue activity when compared to Honiara, which may be due to an absence of *Aedes aegypti* combined with lower population density in a predominantly rural versus urban environment. *Aedes albopictus*, which is the

only dengue vector identified outside Honiara, has been implicated as an epidemic vector of dengue but usually in smouldering outbreaks characterized by limited rather than explosive transmission. Conversely, *Aedes aegypti* is a more efficient and effective dengue vector and is frequently implicated as the primary epidemic vector in explosive dengue outbreaks.[6]

The outbreak response was initiated in January after the detection of the first locally acquired cases. Subsequent response measures focused on limiting dengue transmission and minimizing progression to severe or complicated dengue. Due to the limited capacity and the lack of knowledge on dengue fever by health care professionals and the population, effective response actions were delayed, especially at the provincial level, because training was required to inform clinicians about dengue symptoms, treatment and preventive and control measures. Due to limited resources, vector and larval surveillance were aimed at determining vector presence/absence and approximating spatial distribution rather than densities.

This DENV-3 outbreak is continuing in Solomon Islands. Continued nationwide enhanced surveillance and response activities are recommended with particular attention needed at the provincial level, which is experiencing an increasing number of cases and where medical and other response capacity is limited.

Conflict of interest

None declared.

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References:

1. World Health Organization and the Special Programme for Research and Training in Tropical Diseases. *Dengue: Guidelines for Diagnosis, Treatment, Prevention and Control*. Geneva, World Health Organization (WHO) and the Special Programme for Research and Training in Tropical Diseases (TDR), 2009 (http://www.who.int/tdr/publications/documents/dengue-diagnosis.pdf, accessed 10 June 2013).
2. World Health Organization and the Special Programme for Research and Training in Tropical Diseases. *Handbook for Clinical Management of Dengue*. Geneva, World Health Organization and the Special Programme for Research and Training in Tropical Diseases (TDR), 2012 (http://apps.who.int/iris/bitstream/10665/76887/1/9789241504713_eng.pdf, accessed 10 June 2013).
3. Chan YC, Ho BC, Chan KL. *Aedes aegypti* and *Aedes albopictus* in Singapore City. *Bulletin of the World Health Organization*, 1971, 44:651–657. pmid:5316749
4. Li CF et al. Rainfall, abundance of *Aedes aegypti* and dengue infection in Selangor, Malaysia. *The Southeast Asian Journal of Tropical Medicine and Public Health*, 1985, 16:560–568. pmid:3835698
5. Rozilawati H, Zairi J, Adanan CR. Seasonal abundance of *Aedes albopictus* in selected urban and suburban areas in Penang, Malaysia. *Tropical Biomedicine*, 2007, 24:83–94. pmid:17568381
6. Lambrechts L, Scott TW, Gubler DJ. Consequences of the expanding global distribution of *Aedes albopictus* for dengue virus transmission. *PLoS Neglected Tropical Diseases*, 2010, 4:e646. doi:10.1371/journal.pntd.0000646 pmid:20520794

A family cluster of nitrite poisoning, Suzhou City, Jiangsu Province, China, 2013

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Background: In April 2013, a hospital in Suzhou City notified authorities of a patient with nitrite poisoning with two other family members who had similar toxic symptoms five days prior. We investigated the event to identify the cause, source and possible route of contamination.

Methods: A case was defined as any person living in the Yang Shan Hua Yuan community who had been diagnosed with cyanoderma and food poisoning symptoms from 15 to 25 April 2013. Active case finding was conducted by interviewing community residents and reviewing medical records from local clinics; information was then retrospectively collected on the patient's food history, cooking procedures and food sources.

Results: We identified three nitrite poisoning cases, one male and two females, from the same family. The time between dinner and onset of illness was less than an a hour. A retrospective survey showed that a substance presumed to be sugar mixed with asparagus on 17 April and with stir-fried asparagus on 21 April wasthe suspected contaminant. The presumed sugar came from a clean-up of a neighbouring rental house. Nitrite was detected in a vomitus sample, the sugar substance and two leftover food samples.

Conclusion: This family cluster of nitrite poisoning resulted from the mistaken use of nitrite as sugar to cook dishes. We recommend that sodium nitrite be dyed a bright colour to prevent such a mistake and that health departments strengthen food hygiene education to alert people about the danger of eating unidentified food from an unknown source.

Nitrite is the general term of a category of inorganic compounds, mainly sodium nitrite. This white to slight yellowish crystalline powder is very soluble in water, hygroscopic and has been widely used in industry and construction.[1] Since the early 1900s, sodium nitrite has been used to inhibit growth of disease-causing microorganisms, give taste and colour to meat and inhibit lipid oxidation that leads to rancidity.[2]

Sodium nitrite can be toxic in high amounts for humans;[3] acute nitrite intoxication can occur after ingestion of 200mg to 500mg with an incubation period commonly within one hour, ranging from 20 minutes to three hours. Symptoms include dizziness; fatigue; tight-chest; nausea; vomiting; cyanosis in the lips, fingernails and skin; tachycardia; unconsciousness; coma; and even death.[4,5] Nitrite can cause methemoglobinemia, which makes red blood cells lose their oxygen-carrying ability, reducing the amount of oxygen that is released from haemoglobin. In China, acute nitrite poisoning is commonly caused by mistaking nitrite for salt or from eating large amounts of vegetables or meat with a high nitrite content.[6–9]

In April 2013, a hospital in Suzhou City notified Suzhou Center for Disease Control and Prevention of a patient in a coma from nitrite poisoning with two family members who had similar toxic symptoms five days prior. We conducted an investigation to identify the cause of the nitrite poisoning, to identify he source of the potential toxin and possible contamination routes and to recommend control measures to prevent similar events in the future.

METHODS

A case was defined as any person residing in the Yang Shan Hua Yuan (YSHY) community with cyanoderma (lip, tongue tip, fingertip, conjunctiva, face or the whole body) and with at least one of the following symptoms: dizziness, headache, fatigue, tachycardia, drowsiness, nausea, vomiting, abdominal pain or diarrhoea from

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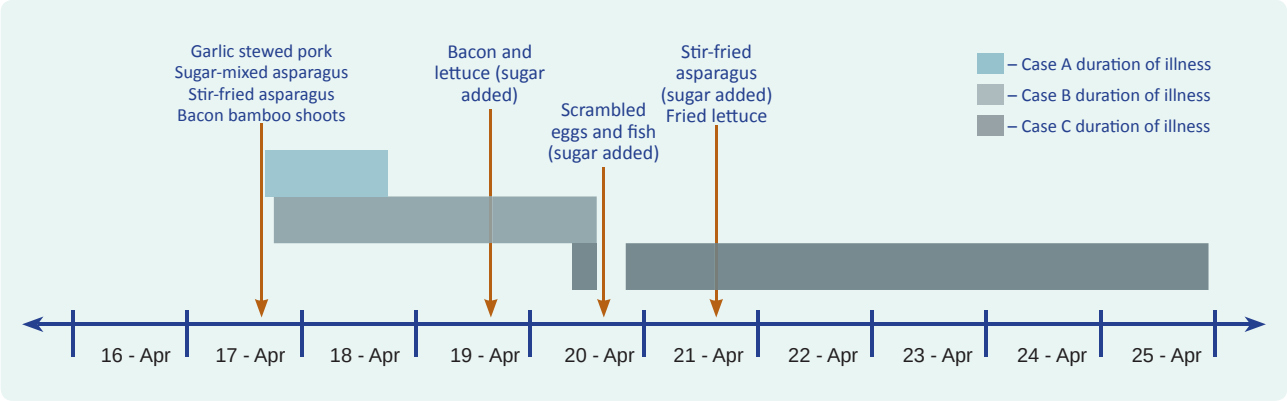
Figure 1. **Timeline of dinner and duration of illness for a family cluster of nitrate poisoning, Suzhou District, Jiangsu, China, 2013**



15 to 25 April 2013. Active case finding was conducted by interviewing residents in the YSHY community and reviewing the medical records from all local clinics.

We conducted in-depth interviews with the patients and their families using a structured questionnaire regarding food and water consumption and other environmental factors. The question focused on meals eaten 12 hours before patients' clinical onset, specific cooking procedures of suspected foods and sources of food and condiments. The Ethics Committee of the Suzhou Center for Disease Control and Prevention approved this investigation.

One venous blood sample and one vomitus sample were collected from the patients; we also collected 10g salt, 20g chicken powder, 15g of sugar substance, 20g monosodium glutamate, 100g uncooked asparagus, 50g bacon, 150g leftover stir-fried asparagus and 100g leftover fried lettuce from a dinner before illness onset. Samples were tested for nitrite content or density using the Griess-Saltzman method according to the Chinese national standard (GB/T5009.33–2010).[10]

RESULTS

Three cases were identified: one male and two females from the same family. Clinical features included lip cyanosis (3/3), dizziness (3/3), tachycardia (3/3), nausea (3/3), vomiting (1/3), unconsciousness (1/3) and coma (1/3).

Case A and Case B ate dinner together on 17 April. Case A, a 43-year-old male, experienced symptoms about 50 minutes after dinner, including lip cyanosis, dizziness, cardiopalmus and nausea. He went to a local hospital for treatment and was transferred to the emergency department of a Suzhou city hospital where he was intravenously injected with methylene blue (MB). He recovered and was discharged the next day. Case B, the 21-year-old daughter of Case A, became ill about an hour after dinner; she felt dizzy, nauseated and had an accelerated heartbeat. She went to the same local hospital for treatment, was transferred to the emergency department of a Suzhou city hospital and received MB treatment by intravenous injection. She was hospitalized for three days (**Figure 1**).

Case C, a 68-year-old female, is the mother of Case A. On 20 April, she was visiting her granddaughter (Case B) and was asked to see a doctor due to her lip cyanosis. She was given a vitamin C intravenous drip treatment, felt better and returned home. On 21 April, she ate dinner with her family and about 40 minutes later felt dizzy, nauseated and became unconscious. She was sent to the local hospital for treatment, fell into a coma, and was admitted to a Suzhou city hospital intensive care unit for four days (**Figure 1**).

As nitrite poisoning was diagnosed, case interviews focused on the meals eaten and activities of the three cases and their family members for 17 April and 21 April (**Figure 1**). On 17 April, the family dinner was composed of four dishes (garlic stewed pork, sugar mixed asparagus, stir-fried asparagus and bacon bamboo shoots). Cases A and B ate all four dishes; Case C and a non-ill family member ate three dishes but not the sugar mixed asparagus. Thus the sugar mixed asparagus was considered the probable contaminated food since Case A and B were ill after this meal.

Table 1. **Nitrite density of samples collected in a family cluster of nitrite poisoning, Suzhou City, Jiangsu, China, 2013**

Sample	Density(mg/kg)
Patient	
Vomitus	173
Venous blood	0.30
Food	
Sugar substance	714 286
Stir-fried asparagus (leftover)	9071
Chicken powder	474
Uncooked asparagus	187
Fried lettuce (leftover)	14
Bacon	6.7
Salt	2.2
Monosodium glutamate	1.9

On 21 April, Case A, Case C and the same non-ill family member had dinner together, eating stir-fried asparagus and fried lettuce. All three family members ate both dishes, but Case A and the non-ill family member mainly ate the fried lettuce while Case C mainly ate the stir-fried asparagus. She became ill later that night, making the stir-fried asparagus another probable contaminated food.

Interviews revealed that the non-ill family member assisted a neighbour in cleaning a rental house on 15 April; he found an unmarked plastic bag of what was presumed to be sugar and took it home as a condiment. Case C used this to cook the sugar mixed asparagus on 17 April and the stir-fried asparagus on 21 April but not for the other dishes. Case A reported that he also added a little of the presumed sugar when he cooked lettuce on 19 April and fish on 20 April.

Laboratory testing showed that the sugar substance was high-density nitrite (714 286mg/kg). The nitrite content of the leftover stir-fried asparagus from the 21 April dinner was 9071mg/kg and the vomitus sample was 173mg/kg. The nitrite content of the leftover fried lettuce from the 21 April dinner was lower at 14mg/kg (**Table 1**).

DISCUSSION

In this investigation, strong laboratory and epidemiological evidence led to the conclusion that the mistaken use of nitrite as sugar in food preparation was the source of this family cluster of nitrite poisoning. The presumed sugar was identified as high-density nitrite by laboratory testing, and the nitrite contents in the suspected food of stir-fried asparagus as well as patient vomitus were also high. It is unlikely that other food items were the cause of the nitrite poisoning as the three cases had no other common food exposures before onset.

It appears that Case C suffered minor nitrate poisoning before her hospitalization after the shared second meal on 21 April. Case A reported adding a little presumed sugar when he cooked lettuce on 19 April; Case C ate the leftover lettuce on 20 April, possibly explaining why she had lip cyanosis on 20 April.

The epidemiological evidence in this investigation was clear for the first incident because on 17 April Case A and Case B both ate the nitrite-contaminated sugar mixed asparagus; the other two family members present were not poisoned as neither ate the contaminated food. Similarly, for the second incident on 21 April, Case C mainly ate the nitrite-contaminated stir-fried asparagus and then became ill. However, the other two family members present at this meal were not poisoned even though they ate some contaminated food. A possible explanation for Case A is that he mainly ate the fried lettuce at this meal, which was not contaminated by nitrite, plus he had received MB treatment four days previously which may have left some residue in his body making him asymptomatic. The non-ill family member mainly ate the fried lettuce and also consumed some nitrite-contaminated food on 21 April. However, he was 71 years old with moderate Alzheimer's disease, perhaps making it less likely for him to report mild symptoms to his family.

The nitrite content in the chicken powder sample exceeded the national standard for condiments. The environmental investigation determined that the family shared one spoon for the sugar and the chicken powder, making it plausible that some nitrite may have gotten into the chicken powder. The nitrite content in the uncooked asparagus sample was also high because it was pre-treated with the presumed sugar on 21 April.

In recent years, nitrite intoxication has happened frequently in China despite risk communication efforts. This is probably because of the similar characteristics

and appearance of sodium nitrite to salt and sugar; it tastes salty and is widely used as a food additive. In China, sodium nitrite can be easily purchased, and many residents are unaware of the potential harm of sodium nitrite. From this investigation we found weaknesses in the regulations, surveillance and supervision work. We recommend that sodium nitrite be dyed a bright colour, such as red, blue or yellow, to avoid mistaking it for plain salt or sugar. Health departments should carry out health education on food hygiene and food safety, especially in rural areas, to improve residents' knowledge and awareness. The Food and Drug Administration should strengthen the supervision of sodium nitrite sales, strictly manage and control sodium nitrite use for industry and as a food additive, and require the nitrite industries to add obvious warning labels on packages of nitrite.

Conflicts of interest

None declared.

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References:

1. Laue W et al. *Nitrates and nitrites*. Ullmann's Encyclopedia of Industrial Chemistry, 2002, 265–280.
2. Sindelar JJ, Milkowski AL. Human safety controversies surrounding nitrate and nitrite in the diet. *Nitric Oxide*, 2012, 26:259–266. doi:10.1016/j.niox.2012.03.011 pmid:22487433
3. Locey BJ. Nitrites. *Encyclopedia of toxicology (second edition)*, 2005, 231–235.
4. Sun G. Prevention Medicine [In Chinese]. *Beijing, People's Health Press*, 2005, 164.
5. Jin P, Gangqiang D, Zhenhua G. *Emergency response and prevention of food borne diseases* [In Chinese]. Shanghai, Fudan University Press, 2006, 136–138.
6. Keqin Z et al. Investigation of an intoxication related to nitrite with unidentified label [In Chinese]. *China Tropical Medicine*, 2011, 11:1426–1427.
7. Fang Y, Liu Q, Zhang B. Investigation of food poison caused by cool food contaminated with sodium nitrite [In Chinese]. *Chinese Journal of Public Health Management*, 2012, 28:218.
8. Rongxian R, Haixiu AZ. Characteristic analysis of nitrite intoxication during 1994–2007 in Edan city, Hebei province, China [In Chinese]. *Chinese Journal of Health Education*, 2009, 25:718–719.
9. YuHet al. Investigation on acute nitrite poisoning in Yangjiang city, Guangdong province, China [In Chinese]. *Zhonghua Liu Xing Bing Xue Za Zhi*, 2002, 23:419–421. pmid:12667350
10. *Determination of nitrite and nitrate in foods-national food safety standard. (GB/T5009.33–2010) - National Standards of People's Republic of China* [in Chinese]. Beijing, China Standards Press, 2010.

Ongoing rubella outbreak among adults in Tokyo, Japan, June 2012 to April 2013

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Introduction: A large rubella outbreak has been occurring in Tokyo, Japan since June 2012. Rubella vaccination, introduced in Japan in 1976, has targeted different age groups, resulting in a large proportion of the current population being unvaccinated.

Methods: Rubella cases reported in Tokyo from 2 January 2012 to 21 April 2013 were analysed. A clinical case had generalized maculopapular rash, fever and lymphadenopathy; a laboratory-confirmed case was a clinical case with a positive serology or polymerase chain reaction test for rubella. A descriptive analysis of cases by age, sex, vaccination history and other epidemiological information was conducted.

Results: A total of 2382 cases were reported from all areas of Tokyo. Three-quarters were male (n = 1823; 76.5%); the highest number of cases occurred among males aged 35–39 years and females aged 20–24 years. About a third of males (27%) and females (32%) reported never receiving rubella vaccination, with 68% and 56%, respectively, having an unknown vaccination status.

Discussion: This outbreak reflects the changing, yet incomplete, immunization policies for rubella in Japan that may increase the risk of congenital rubella syndrome (CRS). To suppress the outbreak of rubella and prevent CRS cases, we recommend vaccination for the entire susceptible population.

Rubella is usually a mild, rash-producing, febrile illness in children; however, infection in pregnant women, especially during the first trimester, can result in still births, fetal death or congenital defects known as congenital rubella syndrome (CRS). Rubella vaccination was added to the Japanese national immunization schedule in 1976 and up until 1994 was limited to girls in grades seven to nine (ages 12–15). In 1995 vaccination of all children (12–90 months old) was introduced. According to the nationwide sentinel surveillance system, before 1998 there were an estimated 170 000 or more rubella cases every year;[1] since 1999 cases have decreased by one-quarter to one-twentieth.[2] A second dose of the measles-rubella (MR) vaccine was introduced in 2006 on entry to grade one (five to six years old). In 2011, administrative MR vaccine coverage was 95.3% at age one year and 92.8% at age five to six years.[3] After a large measles outbreak in 2007 and establishing a goal of measles elimination by 2012, a catch-up programme using the bivalent vaccine was offered for grades seven and 12 (ages 12–13 and 17–18) from April 2008 through March 2013.

As a consequence of these vaccination policies, different age cohorts have different levels of protection against rubella. In the 2012 annual national sero-epidemiologic survey, 73%–86% of males and 97%–98% of females aged 30–50 years were seropositive for rubella antibody, while 90% or more of children aged over one year and adolescents of both sexes were seropositive.[4]

Case-based surveillance for CRS started in 1999 in Japan; all physicians were required to report all CRS cases. During the period 1999–2011 there were 19 CRS cases reported in Japan, including three in Tokyo. In 2008, rubella surveillance in Japan changed from being part of the sentinel surveillance system, where a proportion of physicians reported cases, to being a disease notifiable by all health care providers. From 2008 to 2011, fewer than 50 rubella cases were reported per year in Tokyo.

Since June 2012, after seven years of low incidence, a large increase in rubella notifications was

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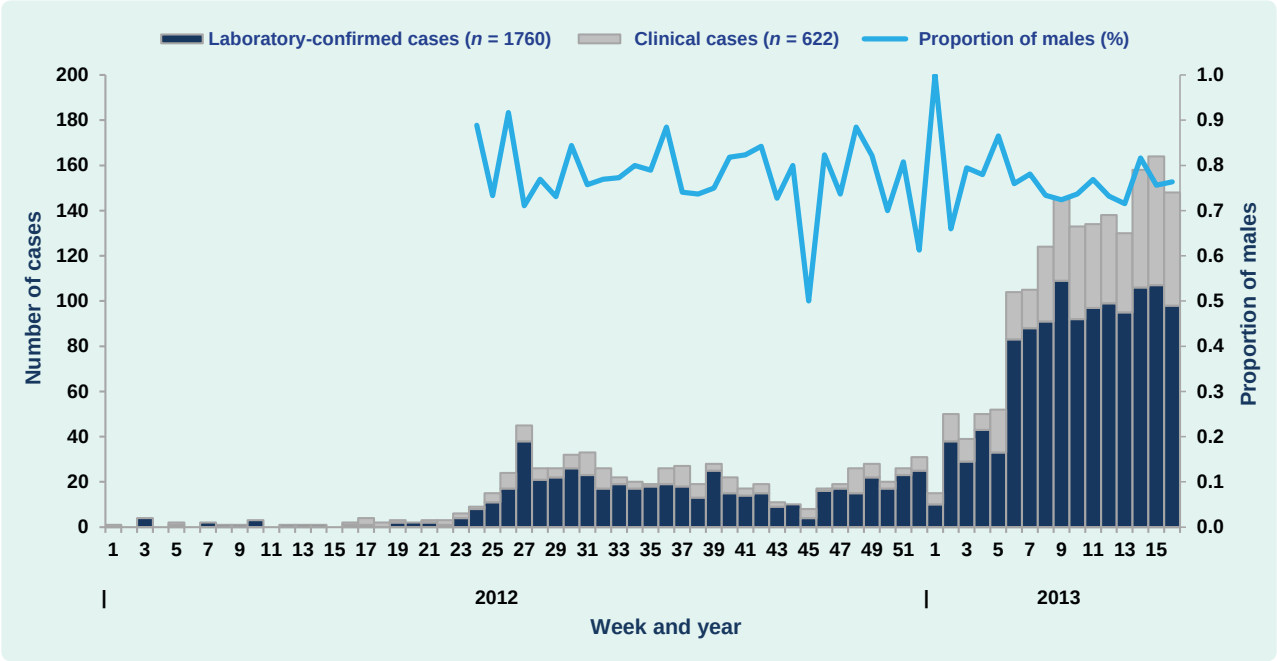
Figure 1. **Number of reported rubella cases and proportion of males by epidemiological week of diagnosis, Tokyo, Japan, Week 1, 2012–Week 16, 2013**



observed in Tokyo. Here we describe the epidemiology of rubella cases notified in Tokyo from January 2012 to April 2013.

METHODS

Rubella cases with a diagnosis date between 2 January 2012 and 21 April 2013 in Tokyo were extracted from the National Epidemiological Surveillance of Infectious Diseases (NESID) system on 1 May 2013. NESID is the nationwide case-based surveillance system; rubella was added in January 2008. All physicians are required to report all clinically diagnosed and laboratory-confirmed rubella cases to local health officials through a designated form. Case details, which can be accessed at the national level, are then entered into the centralized notification system by local health officials. Case details include diagnosis method (clinical or laboratory), age, sex, diagnosis date, suspected route and location of transmission, vaccination history, complications and location of medical facility. For Tokyo, this surveillance system covers approximately 13 million people, 31 public health centres and approximately 12 000 medical facilities.

A clinical rubella case was defined as a person with generalized maculopapular rash, fever and lymphadenopathy. A laboratory-confirmed case was a clinical case with detection of rubella through polymerase chain reaction (PCR), rubella-specific IgM antibody or seroconversion tests. As the weekly number of reported rubella cases in Tokyo was between zero and four during 2008 and 2011, a rubella outbreak was defined as the continual occurrence of more than four rubella cases in a week.

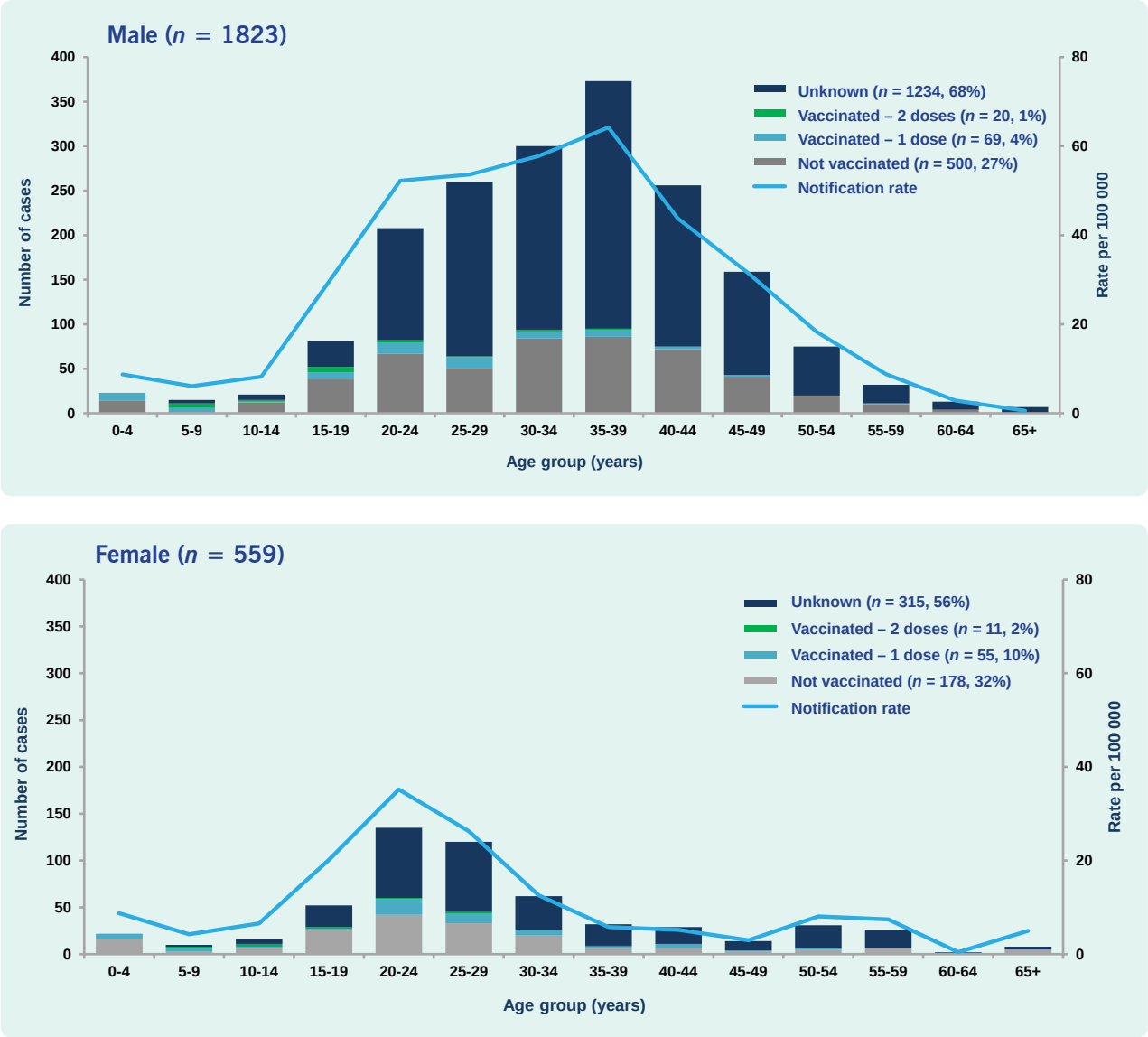
History of vaccination was based on either maternity health records or patient recall. Gender- and age-specific notification rates per 1 million inhabitants were calculated using the October 2012 census estimates for Tokyo as denominator.

RESULTS

A total of 2382 rubella cases (18 per 100 000 population) were reported between 2 January 2012 (week 1) and 21 April 2013 (week 16) from 917 hospitals and clinics throughout Tokyo. From week six in February 2013, more than 100 cases were notified per week. As of 1 May 2013 (week 18), total cases for 2013 were 1689–89 times to higher than the same period of 2012 (**Figure 1**).

Most cases (n = 1760; 73.9%) were laboratory confirmed; 242 by PCR. There were 1823 (76.5%) male cases and 18 pregnant women cases. The overall

Figure 2. **Number and rate of reported rubella cases by sex, age group and vaccination status, Tokyo, Japan, Week 1, 2012–Week 16, 2013**



male-to-female ratio was 3.3:1; in 2012 it was 3.6:1, whereas in 2013 it was 3.1:1. The median age of notified cases was 35 years for males and 26 years for females (**Figure 2**). Males aged 30–39 years were the most commonly notified age group, although in December 2012, there was an increase in notifications for females aged 20–29 who had not been vaccinated. In 2013, notifications for children aged less than 15 years and adults aged more than 50 years emerged. Almost a third of males (27%) and females (32%) reported never receiving a rubella vaccination with 68% and 56%, respectively, having an unknown vaccination status. Complications included thrombocytopenic purpura ($n = 9$), hepatic dysfunction ($n = 7$), encephalitis ($n = 5$) and meningitis ($n = 1$).

Japan was the reported place of exposure for 2366 cases, 1635 of which were in Tokyo. Nine cases reported being exposed outside Japan; exposure location for seven cases was unknown. Further exposure information was reported for 501 (21%) cases and included the workplace ($n = 200$), family or housemates ($n = 113$), crowded places ($n = 92$); friends ($n = 36$), welfare facilities ($n = 28$), schools ($n = 25$) and nurseries ($n = 7$).

Outbreaks in companies, schools or institutions were also reported ($n = 17$) with the index cases all being adults. There was also secondary and tertiary transmission of rubella among unvaccinated people in most of these places.

DISCUSSION

The current rubella outbreak in Tokyo is part of an ongoing larger outbreak of rubella across Japan, with more than 60% of cases reported nationally being from Tokyo and surrounding areas.[3] Most cases were reported in males aged 20–44 years, similar to the resurgence of rubella in Greece in 1993[5] and the current outbreak in Poland.[6] Potential reasons for this outbreak may include vaccine failure, high population density, lack of awareness in the population, insufficient isolation after disease onset and transmission from asymptomatic cases. We believe that this outbreak was strongly influenced by the history of selective immunization policies in Japan that left a large susceptible population. Poland also reported a similar history of selective immunization.[6] In contrast, although Finland first provided rubella vaccination for school-age girls only, they have since achieved high coverage rates and rubella elimination.[7]

The current Japanese immunization schedule does not always provide free access to rubella vaccine or catch-up vaccination for adults and therefore comes with a financial burden. In March 2013 as an outbreak response, the Tokyo metropolitan government provided financial support to the 62 local governments for adult MR vaccination. All started offering free or reduced cost vaccine programmes; however, instead of vaccinating the susceptible population identified by this outbreak, i.e. adult males, most local governments targeted females of childbearing age and their partners. While the intent is to curtail the incidence of CRS, this effort may not be sufficient to suppress the current outbreak.[8,9]

Several countries have alerted the public, especially travellers, about the outbreak in Japan.[10–13] We strongly recommend that travellers confirm their vaccination history before visiting Tokyo and that women in the early phases of pregnancy avoid visiting Tokyo or at least avoid crowds. The latter is an official recommendation by Ministry of Health, Labour and Welfare.

Not all cases in this outbreak were laboratory confirmed, with a quarter based on clinical symptoms only. These cases could have been many other diseases misclassified as rubella. Since more than half of vaccination histories were unknown, there may have been recall bias about vaccination histories. We were also unable to conduct further tests to determine the genotype of this outbreak. However, the current dominant genotypes in Japan were genotypes 1E and 2B.[4] Kanagawa prefecture, located south of Tokyo, also reported that the circulating rubella virus was type 2B.[14]

In Tokyo, the incidence of rubella in 2012 was 52 cases per million population and in 2013 is 128 cases per million. To control rubella and prevent CRS, the WHO Regional Office for the Western Pacific set a target for rubella of less than 10 cases per million population by 2015.[15] An increase of cases in pregnant women and three cases of CRS were notified in Tokyo during this outbreak, suggesting that Japan still has a way to go to reach this goal.

Conflict of interest

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References:

1. National Institute of Infectious Diseases and Tuberculosis and Infectious Diseases Control Division, Ministry of Health, Labour and Welfare, Japan. Rubella, Japan, 1995–1999. *Infectious Agents Surveillance Report*, 2000, 21(1) (http://idsc.nih.go.jp/iasr/21/239/tpc239.html, accessed 17 May 2013).
2. National Institute of Infectious Diseases and Tuberculosis and Infectious Diseases Control Division, Ministry of Health, Labour and Welfare, Japan. Measles and rubella in Japan, as of March 2006. *Infectious Agents Surveillance Report*, 2006, 27(4):85–86 (http://idsc.nih.go.jp/iasr/27/314/tpc314.html, accessed 17 May 2013).
3. Tanaka-Taya K et al.; Centers for Disease Control and Prevention (CDC). Nationwide rubella epidemic - Japan, 2013. *Morbidity and Mortality Weekly Report*, 2013, 62:457–462. pmid:23760185
4. National Institute of Infectious Diseases and Tuberculosis and Infectious Diseases Control Division, Ministry of Health, Labour and Welfare, Japan. Rubella and congenital rubella syndrome in Japan, as of March 2013. *Infectious Agents Surveillance Report*, 2013, 34(4):87–89 (http://www.nih.go.jp/niid/en/iasr-e/865-iasr/3469-tpc398.html, accessed 17 May 2013).

5. Panagiotopoulos T et al. Increase in congenital rubella occurrence after immunisation in Greece: retrospective survey and systematic review. *BMJ (Clinical Research Ed.)*, 1999, 319:1462–1467. doi:10.1136/bmj.319.7223.1462 pmid:10582926

6. Paradowska-Stankiewicz I et al. Ongoing outbreak of rubella among young male adults in Poland: increased risk of congenital rubella infections. *Euro Surveillance: European Communicable Disease Bulletin*, 2013, 18(21): pii: 20485 (http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20485, accessed 27 June 2013).

7. Davidkin I, Peltola H, Leinikki P. Epidemiology of rubella in Finland. *Euro Surveillance: Communicable Disease Bulletin*, 2004, 9(4):pii=459 (http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=459, accessed 27 June 2013).

8. World Health Organization. Rubella vaccines: WHO position paper. *Weekly Epidemiological Record*, 2011, 86(29):301–316 (http://www.who.int/wer/2011/wer8629.pdf, accessed 17 May 2013).

9. Centers for Disease Control and Prevention (CDC). Elimination of rubella and congenital rubella syndrome–United States, 1969–2004. *Morbidity and Mortality Weekly Report*, 2005, 54:279–282. pmid:15788995

10. *Taiwan CDC stresses importance of timely childhood vaccination and advises infants below one year of age and pregnant women having little or no immunity to rubella to avoid visiting endemic areas as this year's first imported rubella case confirmed*. Taiwan, Centers for Disease Control, 2013 (http://www.cdc.gov.tw/english/info.aspx?treeid=EE0A2987CFBA3222&nowtreeid=D3C5BBCF8E60CF3D&tid=FCD7B3F0F553A70F, accessed 17 May 2013).

11. Department of Public Health. *Rubella Outbreak in Japan*. Guam, Department of Public Health and Social Services, 2013 (http://www.dphss.guam.gov/article/2013/04/11/rubella-outbreak-japan, accessed 17 May 2013).

12. Centers for Diseases Control and Prevention (CDC). *Rubella (German measles) in Japan*. Atlanta, Centers for Disease Control and Prevention, 2013 (http://wwwnc.cdc.gov/travel/notices/alert/rubella-japan, accessed 27 June 2013

13. Public Health Agency of Canada. *Rubella (German measles) in Japan and Poland*. Ontario, Public Health Agency of Canada, 2013 (http://www.phac-aspc.gc.ca/tmp-pmv/notices-avis/notices-avis-eng.php?id=115, accessed 27 June 2013).

14. National Institute of Infectious Diseases and Tuberculosis and Infectious Diseases Control Division. *Flash Report of rubella virus in Japan*. Tokyo, Ministry of Health, Labour and Welfare, 2013 (http://www.nih.go.jp/niid/en/iasr-rubella-e.html, accessed 27 June 2013).

15. *Fact sheet on rubella and congenital rubella syndrome (CRS)*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/mediacentre/factsheets/fs_20120228/en/index.html, accessed 27 June 2013).

Epidemiology of the 2012 influenza season in Victoria, Australia

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Objective: To assess the magnitude and severity of the 2012 influenza season in Victoria, Australia using surveillance data from five sources.

Methods: Data from influenza notifications, sentinel general practices, a sentinel hospital network, a sentinel locum service and strain typing databases for 2012 were descriptively analysed.

Results: Influenza and influenza-like illness activity was moderate compared to previous years, although a considerable increase in notified laboratory-confirmed influenza was observed. Type A influenza comprised between 83% and 87% of cases from the general practitioners, hospitals and notifiable surveillance data. Influenza A/H3 was dominant in July and August, and most tested isolates were antigenically similar to the A/Perth/16/2009 virus used in the vaccine. There was a smaller peak of influenza type B in September. No tested viruses were resistant to any neuraminidase inhibitor antivirals. Higher proportions of type A/H3, hospitalized cases and those with a comorbid condition indicated for influenza vaccination were aged 65 years or older. Influenza vaccination coverage among influenza-like illness patients was 24% in sentinel general practices and 50% in hospitals.

Discussion: The 2012 influenza season in Victoria was average compared to previous years, with an increased dominance of A/H3 accompanied by increases in older and hospitalized cases. Differences in magnitude and the epidemiological profile of cases detected by the different data sources demonstrate the importance of using a range of surveillance data to assess the relative severity of influenza seasons.

Victoria is Australia's southernmost mainland state with a population of approximately 5.5 million and a median age of 37.3 years.[1] It has a temperate climate and an influenza season that usually occurs between May and October. The Victorian influenza surveillance system consists of several surveillance data sources used to monitor seasonal influenza and influenza-like illness (ILI) activity in Victoria: notified laboratory-confirmed influenza, sentinel general practices and hospitals, a sentinel metropolitan locum service and reference laboratory typing.

Medical practitioners and laboratory personnel are required by state law to notify the Department of Health of all laboratory-confirmed cases of influenza within five days of diagnosis. Identification, demographic and diagnostic data must also accompany the notification.

The Victorian General Practice Sentinel Surveillance (GPSS) programme provides reports on ILI by sentinel general practitioners (GPs) from May to October each year. A subset of these ILI cases is swabbed for laboratory testing for influenza.[2] The Influenza Complications Alert Network (FluCAN) is a real-time sentinel hospital surveillance system for acute respiratory disease and collects surveillance data on hospitalised adults with laboratory-confirmed influenza.

The Melbourne Medical Deputising Service (MMDS) is the largest medical locum service in Australia and provides 24-hour medical services to patients at their residence in the Melbourne metropolitan area and Geelong. MMDS provides the proportion of ILI diagnoses made from all consultations.

Influenza-positive samples submitted to the World Health Organization (WHO) Collaborating Centre for Reference and Research on Influenza for strain characterization and antiviral drug sensitivity testing comprise the fifth surveillance data source.

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The objectives of the Victorian influenza surveillance system are to: monitor the epidemiology of laboratory-confirmed influenza in Victoria; identify the onset, duration and relative severity of annual influenza seasons in Victoria; provide samples for the characterization of circulating influenza strains in the community to assist in the evaluation of the current seasonal vaccine and formulation of the following season's vaccine; provide potential for early recognition of new influenza viruses and new or emerging respiratory diseases; and estimate influenza vaccine effectiveness each year.

Here we describe the epidemiology of the 2012 influenza season from the Victorian influenza surveillance system.

METHODS

Notifiable diseases surveillance (notified cases)

Records of all laboratory-confirmed influenza cases (defined as detection of influenza virus by nucleic acid testing or culture from an appropriate respiratory tract specimen) with a 2012 notification date were extracted from the Department of Health Public Health Event Surveillance System on 19 March 2013. For consistency and comparability only cases classified as "routinely notified" were used in the descriptive analyses; this excluded cases identified from outbreak investigations and GPSS but included FluCAN cases, which were unable to be separated from the data set. As this report focuses on case-based surveillance, notified institutional outbreaks were excluded.

General Practice Sentinel Surveillance programme

In 2012, 104 GPs (74 from 29 metropolitan practices and 30 from 12 rural practices) participated in GPSS, which operated from 30 April to 28 October (weeks 18 to 43) inclusive. The number of ILIs, defined as a case with fever, cough and fatigue/malaise,[3] and total consultations per week were submitted weekly by fax, e-mail or online submission. ILI rates were calculated as the number of ILI patients per 1000 consultations.

GPs collected either a nose or throat swab from a subset of patients presenting within four days of symptom onset, chosen at the discretion of the GP. Data collected on swabbed patients included: age, sex, symptoms (fever, cough, fatigue, myalgia, other), seasonal influenza vaccination status (for 2012 and the previous 2011 vaccines), date of vaccination/s and any co-morbidity for which influenza vaccination is recommended.[4]

Testing of these clinical specimens comprised extraction of ribonucleic acid and in-house validated real-time multiplex polymerase chain reaction (PCR) assays to detect type A influenza viruses (matrix gene), type B influenza viruses (nucleoprotein gene) and type C influenza viruses (matrix gene). Influenza A virus-positive samples were further subtyped using individual real-time PCR assays incorporating primers and probes specific for the haemagglutinin gene of A(H1N1)pdm09 and A(H3) strains.

Influenza Complications Alert Network

FluCAN is a hospital-based programme that collects surveillance data on hospitalized patients with laboratory-confirmed influenza in near real-time.[5] The network also aims to estimate vaccine coverage and vaccine effectiveness by comparing vaccination status in PCR-confirmed cases with a sample of test-negative controls. In Victoria, four hospitals are involved, two of which have paediatric units that collect data on hospitalized children.[6] Subtyping of influenza A virus infections is not routinely conducted in FluCAN.

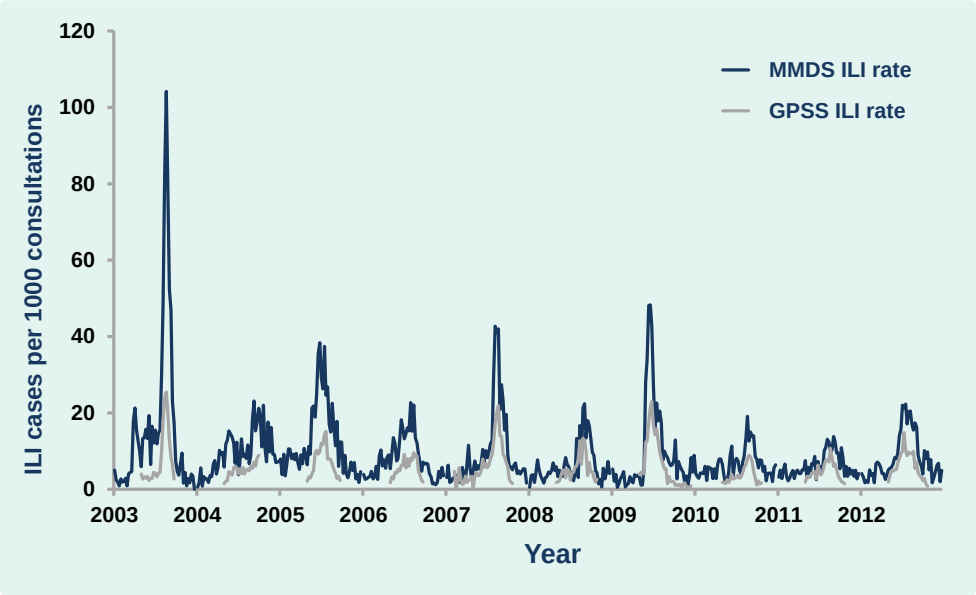
Melbourne Medical Deputising Service

Weekly rates of influenza-related diagnoses by MMDS clinicians per 1000 consultations were calculated from records returned from the MMDS clinical database using the search terms "influenza" and "flu." To avoid inclusion of those immunized prophylactically, records that contained the terms "Fluvax," "at risk" and "immunization" were excluded.

Strain characterization and antiviral resistance testing

In 2012, all influenza-positive GPSS samples tested by the Victorian Infectious Diseases Reference Laboratory (VIDRL) as well as a selection of virus specimens and isolates tested by other Victorian laboratories were forwarded to the WHO Collaborating Centre for Reference and Research on Influenza for strain characterization and antiviral drug sensitivity testing. Samples were

Figure 1. **General Practice Sentinel Surveillance (GPSS) and Melbourne Medical Deputising Service (MMDS) influenza-like illness (ILI) consultation rates, Victoria, Australia, 2003 to 2012**



first inoculated into Madin-Darby Canine Kidney cells to obtain virus isolates. Those successfully isolated were then analysed by haemagglutination inhibition assay to determine antigenic similarity to the current vaccine strains. Isolates were also tested in a neuraminidase inhibition assay to determine susceptibility to the antiviral drugs oseltamivir, zanamivir, peramivir and laninamivir.

Data analyses

Descriptive analyses of the surveillance data were conducted in Microsoft Excel. Distributions of influenza and vaccination status by type/subtype, age group and presence of a comorbid condition were compared using the chi-squared test in Stata (version 10.0; StataCorp LP, College Station, TX, USA) with $P < 0.05$ considered significant.

RESULTS

Influenza-like illness

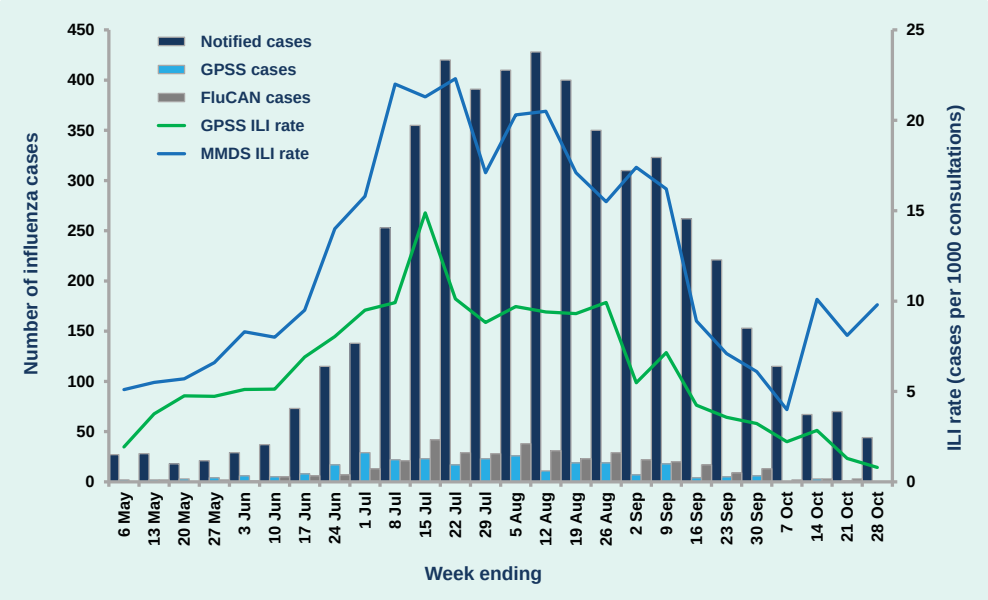
In 2012 GPPS conducted 186 375 consultations during the 26-week surveillance period, of which 1176 (six per 1000 consultations) were for patients with ILI. Consultations for ILI were significantly higher for metropolitan GPs compared to rural GPs (seven and five per 1000 consultations, respectively; $P < 0.001$). During the same period, 948 cases of ILI were diagnosed from 76 267 MMDS consultations (12 per 1000 consultations). ILI cases peaked at 14.9 and 22.3 per 1000 consultations for the GPSS and MMDS systems during the week ending 15 July and one week later, respectively; both were slightly higher than those observed in 2010 and 2011 (**Figure 1**). Elevated ILI activity was sustained in MMDS for approximately two months beginning in early July (**Figure 2**).

Laboratory-confirmed influenza

Laboratory-confirmed influenza cases were reported from three sources – notified cases ($n = 5058$), GPSS ($n = 280$) and FluCAN ($n = 389$) (**Table 1**). There was no clearly defined peak for notified cases in 2012, although 72% were notified in the two months between mid-July and mid-September (Figure 2). There were also no well-defined peaks for laboratory-confirmed cases of influenza from GPSS and FluCAN, although for FluCAN hospitals the highest number of cases admitted was in mid-to-late July (**Figure 2**).

Most notified cases ($n = 4278$; 85%) were influenza type A with subtyping reported for 223 (5%); of these, 67 (30%) were H1 and 156 (70%) were H3. H3 cases were detected throughout the peak period while H1 cases were mainly reported in July. There were also 745 cases (15%) of influenza type B notified, predominantly in the latter half of the surveillance period (**Figure 3**); 29 cases of type A and type B coinfection; and six cases of type C infections.

Figure 2. **Number of laboratory-confirmed influenza cases and influenza-like illness consultation rates by surveillance source, Victoria, Australia, 30 April to 28 October 2012**



Notified cases – cases notified to Department of Health; GPSS – General Practice Sentinel Surveillance; FluCAN – Influenza Complications Alert Network; ILI – influenza-like illness; MMDS – Melbourne Medical Deputising Service

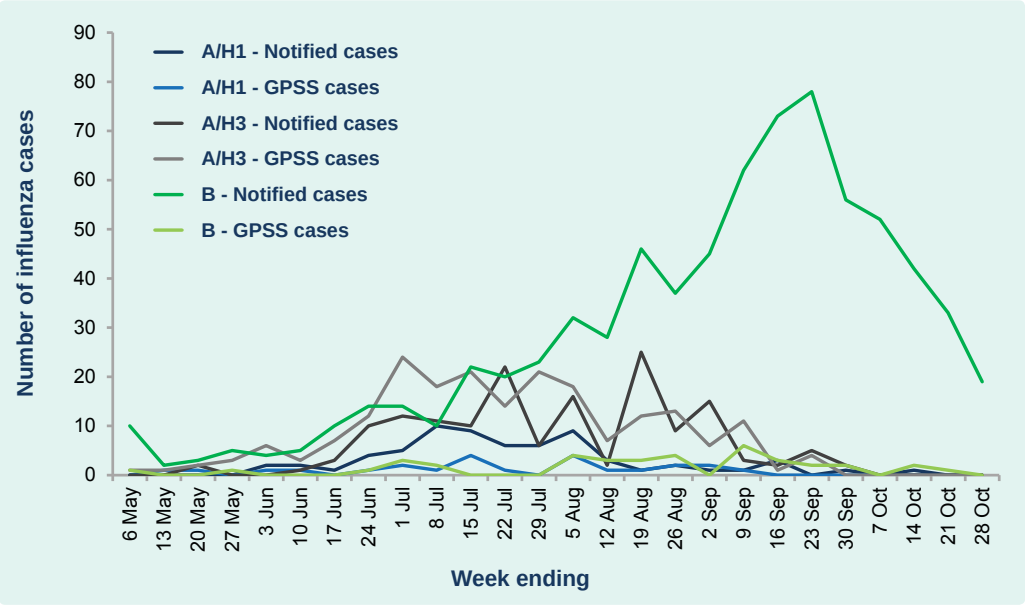
Table 1. **Laboratory-confirmed influenza cases* by surveillance source, age group and type/subtype, Victoria, Australia, 2012**

Source	Age group (years)	A/H1		A/H3		A (not subtyped)		B	
		n	%	*n*	%	*n*	%	*n*	%
Notified cases	0–4	18	27	13	8	471	12	48	6
	5–14	7	10	11	7	400	10	182	25
	15–29	14	21	21	13	543	13	149	20
	30–49	11	16	35	22	1117	28	194	26
	50–64	10	15	25	16	580	14	74	10
	≥ 65	7	10	51	33	940	23	94	13
	Not reported	–	–	–	–	4	–	4	–
	Total	**67**	**100**	**156**	**100**	**4055**	**100**	**745**	**100**
GPSS	0–4	3	13	23	11	2	22	2	5
	5–14	2	8	32	16	1	11	9	24
	15–29	5	21	28	14	3	33	11	29
	30–49	9	38	69	34	3	33	13	34
	50–64	5	21	35	17	0	0	2	5
	≥ 65	0	0	18	9	0	0	1	3
	Total	**24**	**100**	**205**	**100**	**9**	**100**	**38**	**100**
FluCAN	0–4	–	–	–	–	22	6	5	10
	5–14	–	–	–	–	7	2	4	8
	15–29	–	–	–	–	28	8	9	18
	30–49	–	–	–	–	59	17	13	26
	50–64	–	–	–	–	54	16	4	8
	≥ 65	–	–	–	–	169	50	15	30
	Total	–	–	–	–	**339**	**100**	**50**	**100**

Notified cases – cases notified to Department of Health; GPSS – General Practice Sentinel Surveillance; FluCAN – Influenza Complications Alert Network.

* Excluding 29 notified cases of type A and B coinfection and 10 cases of type C (six notified cases and four from GPSS).

Figure 3. **Number of laboratory-confirmed influenza cases by type/subtype* and surveillance source, Victoria, Australia, 30 April to 28 October 2012**



Notified cases – cases notified to Department of Health; GPSS – General Practice Sentinel Surveillance

* 4055 cases of influenza A that were not further subtyped were excluded.

Of the 1176 ILI cases identified from GPSS, 709 (60%) were swabbed and 280 (39%) were positive for influenza. The proportion of swabbed ILI cases positive for influenza ranged from 15%–25% until mid-June then quickly rose to 40%–60% until late September, and from 35% in 50–64 year-olds to 54% among those aged 5–14 years ($P = 0.06$). Of the 280 laboratory-confirmed influenza cases from GPSS, 205 (73%) were A/H3 infections, 24 (9%) were A/H1, 38 (14%) were type B and four were type C; specimens from the remaining nine influenza A cases contained insufficient virus for subtyping. Most (71%) of the type B cases were detected in August and September (**Figure 3**). The majority of the 389 FluCAN cases ($n = 339$; 87%) were type A but were not subtyped.

Sixteen notified cases were reported to have died due to influenza: one due to type B infection and the remainder type A, of which three were subtyped as H3. Twelve cases were aged 65 years or older, one was aged zero to four years, with the remaining three cases aged between five and 64 years.

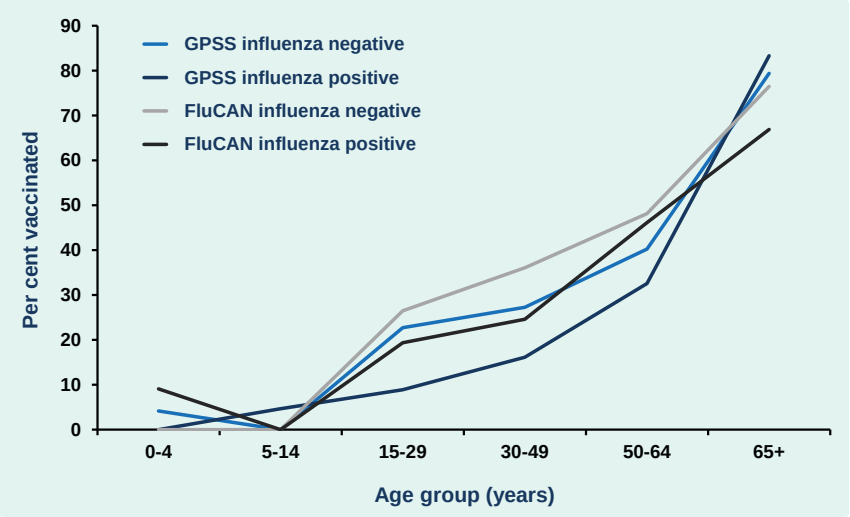
The age group with the highest proportion of laboratory-confirmed cases was those aged 30–49 years for both notified cases (27%) and GPSS (34%). There were also relatively high proportions of cases aged 65 years or older from FluCAN and notified cases (47% and 22%, respectively) but not GPSS (7%). However, the rate of notified cases was highest for those aged zero to four years and 65 years or older, with 154 and 137 notified cases per 100 000 population, respectively, compared to 61–90 per 100 000 for the other age groups.

There was a significant difference in the age distribution of notified cases by influenza type B and A subtypes (excluding influenza A cases that were not subtyped, $P < 0.001$). A higher proportion of influenza A/H1 cases were aged zero to four years, whereas for influenza A/H3 cases, a higher proportion were aged 65 years or older. There was no difference observed in GPSS ($P = 0.12$) (**Table 1**). In FluCAN, cases of influenza type A were significantly older than those with type B ($P = 0.003$).

Vaccination status

Vaccination status was recorded for 688 (97%) of 709 swabbed GPSS patients of whom 168 (24%) reported being vaccinated. FluCAN collected vaccination status from cases and influenza-negative controls and recorded vaccination status for 772 of 935 (83%) patients who had been swabbed, half of whom were

Figure 4. **Proportion of General Practice Sentinel Surveillance (GPSS) and Influenza Complications Alert Network (FluCAN) patients vaccinated* by influenza status, age group and surveillance source, Victoria, Australia, 2012**



* Includes only those patients who were swabbed and tested for influenza.

vaccinated (n = 385; 50%). There was no statistically significant difference between the proportion of influenza-positive and -negative patients with known vaccination status in either GPSS (P = 0.89) or FluCAN (P = 0.23). For both surveillance data sets the proportion of patients vaccinated increased with age (**Figure 4**). With the exception of those aged 65 years or older in GPSS, the proportion of influenza-positive patients who were vaccinated in adult age groups was lower than the proportion of influenza-negative patients who were vaccinated in each system.

Comorbidities

Data on comorbidities for which influenza vaccination is indicated were reported for 632 (89%) of the 709 swabbed patients from GPSS. The presence of a comorbid condition was reported for 111 (18%) of swabbed patients; there was no difference between influenza-positive and influenza-negative patients (17% compared with 18%; P = 0.60). However, the proportion with a reported comorbidity rose steadily with increasing age group from 3% in those aged zero to four years to 58% in the 65 years or older age group (P < 0.001). In FluCAN patients, the proportion with a reported comorbidity rose steadily with increasing age group from 31% in those aged zero to four years to 87% in the 50–64 year age group and 90% in the 65 years or older age group.

Strain characterization and antiviral resistance testing

A total of 1293 patient specimens were submitted to the WHO Collaborating Centre in 2012. Culture was attempted for 1095 of these samples, with 563 (51%) yielding an influenza virus isolate: 470 (83%) type A viruses, 92 (16%) type B viruses and one type C virus. Most of the viruses isolated were A/H3 viruses (n = 437, 93%) with most of these (82%) being antigenically similar to the A/Perth/16/2009 virus used in the seasonal influenza vaccine. A/H1 viruses comprised just 7% (n = 33), with 29 being antigenically similar to the A/California/7/2009 strain used in the vaccine; the remaining four were low reactors (haemagglutination inhibition titre ≥ 8 fold lower). Among the 92 type B viruses isolated, 54 (59%) were antigenically similar to the B/Brisbane/60/2008 (Victoria lineage) strain used in the vaccine. The remainder included 16 Victoria and 21 Yamagata lineage viruses.

Neuraminidase inhibition assays indicated that none of the 473 viruses tested was resistant to any of the antiviral drugs tested.

DISCUSSION

The magnitude of ILI activity in the 2012 influenza season in Victoria, as shown by GPSS and MMDS, was slightly higher than 2010 and 2011 but broadly average compared to the previous 10 years. Although the proportion of ILI patients identified by MMDS was higher than GPSS, both were consistent with trends observed in previous years. The number of laboratory-confirmed influenza cases from GPSS was also comparable to 2010 and 2011.[7,8] The number of patients reported through FluCAN in 2012 was considerably higher than the 146 cases reported in 2011 (the first year that all four hospitals participated in FluCAN).[9] Notified cases of laboratory-confirmed influenza increased by 68% in 2012 compared to 2011 and was also much higher than the 1914 notified cases in 2010.[7,8] This increase was disproportionate compared with that of the other data sources in the Victorian surveillance system; therefore we believe the increase in notified cases reflects an increase in testing rather than a dramatic increase in disease.[10]

Type A influenza peaked during July and August, with a much smaller peak of type B in September. Subtyping of viruses from GPSS and a subset of notified cases indicated the 2012 season was dominated by influenza A/H3, continuing the trend of seasonal dominance of A/H3 away from the emergence and almost exclusive predominance of influenza A(H1N1) pdm09 in 2009.[11] A season in which H3 is the dominant subtype followed by a smaller type B increase is a well-established pattern of influenza epidemics during the winter months of temperate zones,[12] as in Victoria in 2007,[13] New Zealand in 2012,[14] the United States of America[15] and Canada[16] during the 2012/13 northern hemisphere influenza season.

Although the type A influenza reported through FluCAN were not further characterized, it is likely that a substantial proportion were A/H3 infections, given that a high proportion of FluCAN cases were aged 65 years or older and that many cases in this age group among notified cases were A/H3. A higher median age of A/H3 cases compared to seasonal A/H1 and type B cases has recently been observed in Victoria.[17] However, the increase of H3 in older cases only partially explains the increase in all notified cases; similar proportional increases were observed across all age groups, possibly arising from increased presentation of more severe cases caused by A/H3 virus infections across all ages as well as increased testing.

The proportion of ILI patients who were swabbed in GPSS declined to 60% in 2012 from 71% in both 2010 and 2011.[7,8] As the aim of this component of GPSS is to determine what strains are circulating each season, demographic and other data are not collected on these patients. Therefore further comparison cannot be made, neither over the years nor between those that were swabbed or not. While providing flexibility to the doctors, discretionary swabbing is also a limitation of GPSS as factors that may influence a GP to differentially swab one patient over another (such as age or vaccination status) are unknown.

Vaccination coverage among patients in both GPSS and FluCAN systems increased between 2011 and 2012, possibly due to a shift in age distribution to older patients in 2012.[6,18] Higher vaccination coverage in FluCAN patients compared to GPSS in both years may be due to the older age distribution and higher prevalence of comorbid conditions indicated for influenza vaccination (groups for which influenza vaccine is provided free through the National Immunization Programme[4]) of those attending hospitals compared to general practice.

Two observations from the surveillance system suggest that the 2012 seasonal trivalent influenza vaccine (comprised of A/California/7/2009 (H1N1) pdm09-like virus, an A/Perth/16/2009 (H3N2)-like virus and a B/Brisbane/60/2008-like virus)[19] may have been moderately effective. First, the results of strain typing suggested a good antigenic match of vaccine strains – particularly the A/H1 and A/H3 subtypes – to a high proportion of Victorian isolates for which strain characterization testing was undertaken. Second, a higher proportion of swabbed patients in nearly all adult age groups of GPSS and FluCAN who were negative for influenza were vaccinated compared to those who tested positive. However, these findings should be interpreted with caution. We have previously demonstrated with Victorian data that an apparent good match of vaccine to circulating strains does not necessarily correlate with greater vaccine effectiveness.[20] It has been suggested that antibody immunity measured by haemagglutination inhibition assay may not be an optimal correlate of protection against clinical infection because it may not always detect drift in the haemagglutinin antigen.[21,22] Also, the relatively few participating institutions and

limited number of specimens forwarded for strain characterization may not necessarily be representative of all virus/es circulating in the community. The calculation of influenza vaccine effectiveness from surveillance data requires application of a more systematic methodology,[18,23] which will be reported separately.

The inclusion of hospitalized cases from FluCAN augmented the Victorian influenza surveillance system in 2012 by including cases at the severe end of the clinical spectrum. However, while FluCAN cases were reported independently, they were also included in the notified cases data set. While community surveillance suggested a relatively benign influenza season, hospital data indicated an increase in severe disease among older people, presumably associated with A/H3. This demonstrates the importance of using a range of surveillance data sources. Efforts are continuing to improve the quality and breadth of integrated influenza surveillance in Victoria by subtyping a higher proportion of type A influenza infections (especially those identified through FluCAN) and examining the feasibility of establishing ILI and influenza surveillance in hospital emergency departments.

Conflicts of interest

None declared.

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References:

1. Australian Bureau of Statistics. *Population by Age and Sex, Regions of Australia, 2011 – Victoria*. Canberra, Australian Bureau of Statistics, 2013 (http://www.abs.gov.au/ausstats/abs@.nsf/Products/3235.0~2011~Main+Features~Victoria?OpenDocument, accessed 21 June 2013).
2. Kelly H et al. Laboratory-supported influenza surveillance in Victorian sentinel general practices. *Communicable Diseases Intelligence*, 2000, 24:379–383. pmid:11225381
3. Thursky K et al. Working towards a simple case definition for influenza surveillance. *Journal of Clinical Virology*, 2003, 27:170–179. doi:10.1016/S1386-6532(02)00172-5 pmid:12829039
4. Australian Government Department of Health and Ageing. *Influenza (Flu).* Canberra, Australian Government Department of Health and Ageing, 2013 (http://health.gov.au/internet/immunise/publishing.nsf/Content/immunise-influenza, accessed 19 April 2013).
5. Kelly PM et al. FluCAN 2009: initial results from sentinel surveillance for adult influenza and pneumonia in eight Australian hospitals. *The Medical Journal of Australia*, 2011, 194:169–174. pmid:21401456
6. Cheng AC; FluCAN Investigators. Hospitalisation with confirmed influenza in a sentinel surveillance system in 2010 and 2011. *The Medical Journal of Australia*, 2012, 197:217. doi:10.5694/mja12.10060 pmid:22900868
7. Grant KA et al. Higher proportion of older influenza A(H1N1) pdm09 cases in Victoria, 2011. *Victorian Infectious Disease Bulletin*, 2012, 15:49–55.
8. Grant KA et al. Continued dominance of pandemic A(H1N1) 2009 influenza in Victoria, Australia in 2010. *Western Pacific Surveillance and Response Journal*, 2011, 2:10–18. doi:10.5365/wpsar.2011.2.2.009
9. Cheng AC et al. Hospitalisation with confirmed influenza in Victoria in the 2011 Season. *Victorian Infectious Disease Bulletin*, 2012, 15:56–58.
10. Kelly HA et al. The significance of increased influenza notifications during spring and summer of 2010–11 in Australia. *Influenza Other Respiratory Viruses*, 2012.
11. Fielding JE et al. Pandemic H1N1 influenza surveillance in Victoria, Australia, April–September, 2009. *Euro Surveillance: European Communicable Disease Bulletin*, 2009, 14:pii=19368. pmid:19883545
12. Finkelman BS et al. Global patterns in seasonal activity of influenza A/H3N2, A/H1N1, and B from 1997 to 2005: viral coexistence and latitudinal gradients. *PLoS ONE*, 2007, 2:e1296. doi:10.1371/journal.pone.0001296 pmid:18074020
13. Miller ER et al. Higher than expected seasonal influenza activity in Victoria, 2007. *Communicable Diseases Intelligence*, 2008, 32:63–70. pmid:18522306

14. Lopez L, Huang QS. *Influenza Surveillance in New Zealand 2012*. Wellington, Institute of Environmental Science and Research Ltd, 2013 (http://www.surv.esr.cri.nz/PDF_surveillance/Virology/FluAnnRpt/InfluenzaAnn2012.pdf, accessed 19 April 2013).

15. Centers for Disease Control and Prevention (CDC). Fluview: 2012–2013 influenza season week 14 ending April 13, 2013. Atlanta, Centers for Disease Control and Prevention, 2013 (http://www.cdc.gov/flu/weekly/weeklyarchives2012-2013/weekly15.htm, accessed 19 April 2013).

16. Public Health Agency of Canada. Fluwatch April 7 to April 13, 2013 (Week 15, 2013). Ottawa, Public Health Agency of Canada, 2013 (http://www.phac-aspc.gc.ca/fluwatch/12-13/w15_13/index-eng.php, accessed 19 April 2013).

17. Kelly HA et al. Epidemiological characteristics of pandemic influenza H1N1 2009 and seasonal influenza infection. *The Medical Journal of Australia*, 2009, 191:146–149. pmid:19645642

18. Fielding JE et al. Moderate influenza vaccine effectiveness in Victoria, Australia, 2011. *Euro Surveillance: European Communicable Disease Bulletin*, 2012, 17:pii=20115. pmid:22449867

19. World Health Organization. Recommended composition of influenza vaccines for use in the 2012 southern hemisphere influenza season. *Weekly Epidemiological Record*, 2011, 86:457–468. pmid:22046594

20. Kelly HA et al. Moderate influenza vaccine effectiveness with variable effectiveness by match between circulating and vaccine strains in Australian adults aged 20–64 years, 2007–2011. *Influenza and Other Respiratory Viruses*, 2012. doi:10.1111/irv.12018 pmid:23078073

21. Kelly H, Steffens I. Complexities in assessing the effectiveness of inactivatedinfluenza vaccines. *Euro Surveillance: European Communicable Disease Bulletin*, 2013, 18:pii=20403 (http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=20403, accessed 19 April 2013).

22. Skowronski DM et al. Interim estimates of influenza vaccine effectiveness in 2012/13 from Canada's Sentinel Surveillance Network, January 2013. *Euro Surveillance: European Communicable Disease Bulletin: European Communicable Disease Bulletin*, 2013, 18:pii=20394. pmid: 23399422

23. Cheng AC et al. Effectiveness of H1N1/09 monovalent and trivalent influenza vaccines against hospitalization with laboratory-confirmed H1N1/09 influenza in Australia: a test-negative case control study. *Vaccine*, 2011, 29:7320–7325. doi:10.1016/j.vaccine.2011.07.087 pmid:21810450

Seasonal influenza vaccine policies, recommendations and use in the World Health Organization's Western Pacific Region

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Objective: Vaccination is the most effective way to prevent seasonal influenza and its severe outcomes. The objective of our study was to synthesize information on seasonal influenza vaccination policies, recommendations and practices in place in 2011 for all countries and areas in the Western Pacific Region of the World Health Organization (WHO).

Methods: Data were collected via a questionnaire on seasonal influenza vaccination policies, recommendations and practices in place in 2011.

Results: Thirty-six of the 37 countries and areas (97%) responded to the survey. Eighteen (50%) reported having established seasonal influenza vaccination policies, an additional seven (19%) reported having recommendations for risk groups for seasonal influenza vaccination only and 11 (30%) reported having no policies or recommendations in place. Of the 25 countries and areas with policies or recommendations, health-care workers and the elderly were most frequently recommended for vaccination; 24 (96%) countries and areas recommended vaccinating these groups, followed by pregnant women (19 [76%]), people with chronic illness (18 [72%]) and children (15 [60%]). Twenty-six (72%) countries and areas reported having seasonal influenza vaccines available through public funding, private market purchase or both. Most of these countries and areas purchased only enough vaccine to cover 25% or less of their populations.

Discussion: In light of the new WHO position paper on influenza vaccines published in 2012 and the increasing availability of country-specific data, countries and areas should consider reviewing or developing their seasonal influenza vaccination policies to reduce morbidity and mortality associated with annual epidemics and as part of ongoing efforts for pandemic preparedness.

Influenza is an acute viral infection transmitted person to person predominately through droplet spread. Worldwide, annual influenza epidemics result in about 3 to 5 million cases of severe illness and about 250 000 to 500 000 deaths.[1] All age groups can be seriously affected, with the greatest risk of complications occurring among children aged under two years, adults 65 years or older, pregnant women and people of any age with certain chronic medical conditions or weakened immune systems.[2] The most effective way to prevent seasonal influenza and its severe outcomes is through vaccination, and safe and effective vaccines have been used for more than 60 years.[3] A recent systematic review of the scientific literature reported a pooled efficacy of 83% (95% confidence interval: 69%–91%) for trivalent live attenuated influenza vaccine in children six months to seven years of age.[4] The same review reported that trivalent inactivated influenza vaccines had an efficacy of 59% (95% confidence interval: 51%–67%) in healthy adults 18–65 years of age and provided significant protection against medically attended influenza. There is also evidence demonstrating the socioeconomic benefits of vaccinating people against influenza.[5–7]

In the Western Pacific Region of the World Health Organization (WHO), awareness of the public health importance of influenza and the need for pandemic preparedness has increased in recent years motivated by the re-emergence of highly pathogenic avian influenza A(H5N1) in 2003–2004 and subsequently by the occurrence of the influenza A(H1N1) pandemic in 2009. The Region currently has three WHO Collaborating Centres for Reference and Research on Influenza and 21 National Influenza Centres in 15 countries that monitor the impact and evolution of influenza viruses and provide isolates for global vaccine strain selection and formulation.[8,9] Despite the Western Pacific Region contributing more than 76% of the total virus isolates

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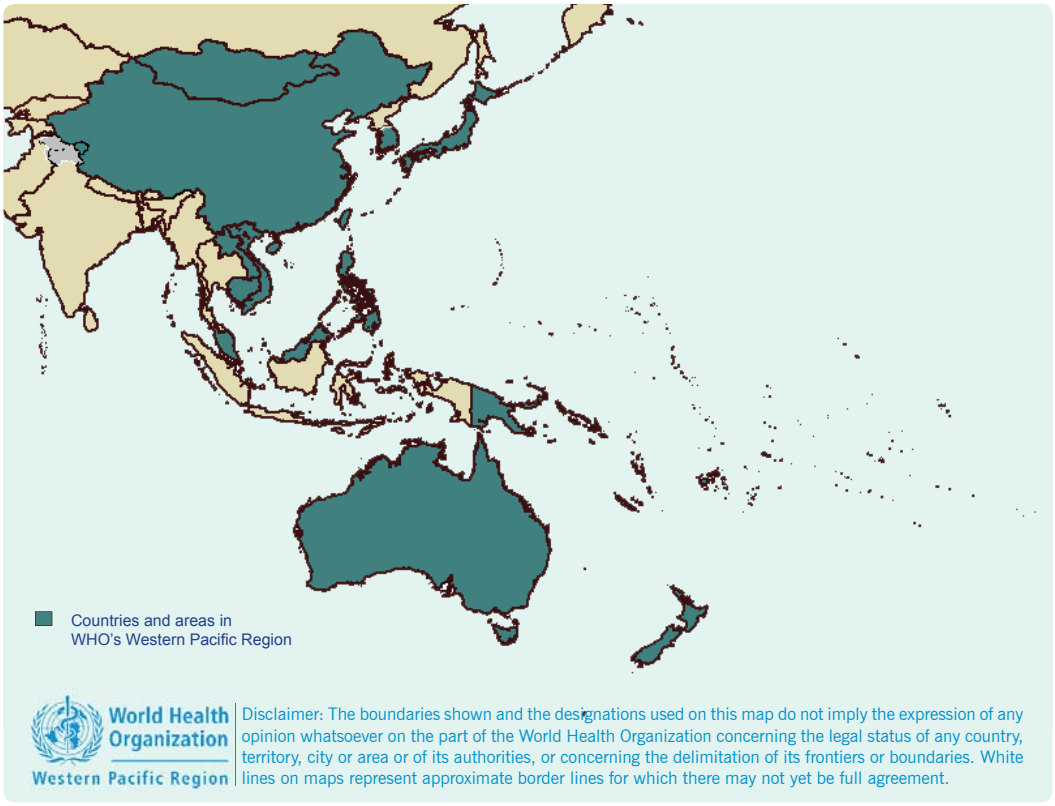
Figure 1. **Countries and areas in WHO's Western Pacific Region***



* American Samoa; Australia; Brunei Darussalam; Cambodia; China; Cook Islands; Fiji; French Polynesia; Guam; Hong Kong (China); Japan; Kiribati; the Lao People's Democratic Republic; Macao (China); Malaysia; the Marshall Islands; Micronesia, the Federated States of; Mongolia; Nauru; New Caledonia; Northern Mariana Islands, the Commonwealth of the; New Zealand; Niue; Palau; Papua New Guinea; the Philippines; the Pitcairn Islands; the Republic of Korea; Samoa; Singapore; Solomon Islands; Tokelau; Tonga; Tuvalu; Vanuatu; Viet Nam; and Wallis and Futuna.

submitted to the WHO Global Influenza Surveillance Response and System (GISRS) between 1998 and 2010 for vaccine strain selection,[10] influenza vaccination programmes have not been established consistently throughout the Region. These programmes facilitate governments' health policies for influenza vaccination and provide the mechanisms for ensuring the target groups for vaccination actually receive vaccines.

To describe seasonal influenza vaccination policies, recommendations and use in the Western Pacific Region, WHO conducted a survey in 2012. This report summarizes the results from the survey in the context of the new WHO position paper on vaccines against influenza that recommended pregnant women be given the highest priority for vaccination; it also recommended seasonal influenza vaccination for, in no order of priority, health-care workers, children aged six to 59 months, the elderly and persons with chronic medical conditions.[11]

METHOD

Data were collected via a survey conducted by WHO from July to October 2012. The questionnaire was sent electronically to all 37 countries and areas of WHO's Western Pacific Region (**Figure 1**).[12] Data collection was supported by regional members of GISRS,[13] staff of the Expanded Programme on Immunization and WHO country or liaison offices. The questionnaire requested data and information on seasonal influenza vaccination policies, recommendations and practices in place in 2011, including: existence of a national vaccination policy; funding mechanisms for vaccines (public funding, private market purchase or both); recommendations for risk groups to target for vaccination; types of influenza vaccines available; number of vaccine doses purchased and distributed in 2011; the time period (months) when influenza vaccines were available for the 2011 southern hemisphere and the 2011–2012 northern hemisphere

seasons; and the peak month(s) of influenza activity. Incomplete surveys were followed up until all information was provided. For one area that did not respond to the survey, data were extracted from the WHO 2010 Survey for the Global Mapping of Seasonal Influenza Vaccine (unpublished data). The proportion of the total population potentially covered with influenza vaccine was calculated using country and area population data from the WHO web site.[12] Ethics review was not required for this study as it was a survey of policy and national-level practices, not a study involving individual human participants.

RESULTS

Data were available from 36 (97%) of the 37 countries and areas of the Western Pacific Region; 35 countries and areas responded to the questionnaire and one had responded to the WHO 2010 Survey for the Global Mapping of Seasonal Influenza Vaccine. Data were not available from the Commonwealth of the Northern Mariana Islands.

Seasonal influenza vaccination policies

Eighteen (50%) countries and areas, comprising 93% of the total population of the Western Pacific Region, reported having established seasonal influenza vaccination policies; an additional seven (19%) reported providing influenza vaccination recommendations only for risk groups (but not as part of a vaccination policy). Eleven countries and areas (30%) reported having no policy or recommendations in place. Of the 25 countries and areas with policy or recommendations, health-care workers and the elderly were most frequently recommended for vaccination; 24 (96%) countries and areas recommended vaccinating these groups, followed by pregnant women (19 [76%]), people with chronic illness (18 [72%]) and children (15 [60%]). Other groups included in policies or recommendations were children only or the elderly with chronic illnesses, laboratory workers and first responders, caregivers of high-risk persons and Hajj pilgrims (**Table 1**).

Seasonal influenza vaccine use

Of the 36 participating countries and areas in the Region, 26 (72%) reported that seasonal influenza vaccine was available through public funding, private market purchase or both (**Table 2**). Cambodia, Cook Islands, Singapore and Viet Nam reported that seasonal influenza vaccine was available through private market purchase only. The remaining 22 countries and areas reported that influenza vaccine was purchased by the government (seven countries and areas) or was available through both government and private market purchase (15 countries and areas). Ten (28%) countries and areas reported that seasonal influenza vaccine was not available.

Of the 26 countries and areas with influenza vaccine available, seven (27%) reported using only inactivated, non-adjuvanted, southern hemisphere formulation vaccine for the 2011 season. Five countries and areas (19%) reported using both southern and northern hemisphere formulation vaccines, of which three used inactivated, non-adjuvanted vaccine and two used both non-adjuvanted and adjuvanted inactivated vaccines. The remaining 14 countries and areas (54%) reported using northern hemisphere formulation vaccines, 12 of which used inactivated, non-adjuvanted vaccines. Palau reported using both inactivated, adjuvanted vaccine and live attenuated vaccine. Wallis and Futuna reported using inactivated, adjuvanted vaccine (**Table 2**).

For the 21 countries and areas that reported the number of doses of vaccine purchased, the estimated proportion of the total population that could be covered by the purchased amount ranged from 0.3% in Cook Islands to 99.7% in Tokelau. Most countries and areas purchased enough to cover less than 25% of their total populations. For the 17 countries and areas that reported the amount of vaccine distributed, the estimated proportion of the total population that could be covered again ranged from 0.3% in Cook Islands to 99.7% in Tokelau, with most estimates being less than 20% (**Table 2**).

The majority of countries obtained their vaccine supply from international manufacturers. Australia, China and the Republic of Korea reported both domestic production and importation of influenza vaccines. Japan reported using only domestically produced vaccines (**Table 2**).

Peak influenza seasons and vaccination timing

Reported periods of peak influenza activity tended to coincide with the winter and spring months in temperate countries and areas and throughout the year in tropical countries and areas. For those countries and areas using

Table 1. **Recommendations for vaccine recipients by country and area, WHO Western Pacific Region, 2011**

Country/area	Policy	Recommended recipients					Other risk groups and comments
		HCW	Elderly (years)	Chronic illness	Pregnant women	Children (age)	
American Samoa*	N	Y	Y (> 40)	Y	Y	Y (6m–18y)	
Australia	Y	Y	Y (> 65)	N	Y	N	Aboriginal and Torres Strait Islanders older than 15 years, children older than six months with pre-disposing conditions, residents of nursing homes and other long-term care facilities, homeless people and their caregivers, people who may transmit to those with high risk of influenza complications, people in the poultry industry during avian influenza activity, people providing essential services, workers in other industries, travellers
Brunei Darussalam	Y	Y	Y (> 60)	N	Y	Y (6–23y)	Hajj pilgrims
Cambodia	N	–	–	–	–	–	
China	Y	Y	Y (> 60)	N	Y	Y (6–60y)	Close contacts of persons at high risk (staff of kindergartens and nursery schools, household contacts and caregivers)
Cook Islands*	N	Y	Y (> 60)	N	Y	N	
Fiji	N	Y	Y	Y	Y	N	
French Polynesia (France)	Y	Y	Y (> 60)	Y	Y	N	Persons with obesity (body mass index > 30)
Guam	Y	Y	Y (≥ 50)	Y	Y	Y (6m–18y)	Adults aged 19–49 years with high-risk medical conditions (e.g. asthma, heart conditions, lung conditions) Note: Follow CDC recommendation for universal influenza vaccine for any persons
Hong Kong (China)	Y	Y	Y (≥ 50)	Y	Y	Y (6 ≤ 71y)	Residents of nursing homes and long-term residents of homes for the disabled; poultry workers, pig farmers and pig-slaughtering industry personnel
Japan	Y	N	Y (> 65)	N	N	N	
Kiribati	N	–	–	–	–	–	
Lao People's Democratic Republic	N	Y	Y (> 50)	Y	Y	Y	
Macau (China)	Y	Y	Y (> 60)	Y	Y	Y (6m–18y)	
Malaysia	Y	Y	N	Y	N	N	Hajj pilgrims, elderly with one or more chronic illness
Marshall Islands*	N	Y	Y	-	Y	Y	
Micronesia,* Federated States of	N	Y	Y (< 50)	Y	Y	Y (6m–18y)	All adults over the age of 18
Mongolia	Y	Y	Y (> 60)	N	N	N	
Nauru	N	–	–	–	–	–	
New Caledonia	Y	Y	Y (> 65)	Y	N	N	Air and cruise crews
New Zealand	Y	Y	Y (> 65)	Y	Y	N	Persons of all ages with chronic conditions including children older than six months with defined pre-disposing conditions
Niue	Y	Y	Y (> 65)	Y	N	N	Children younger than six years with chronic illness
Northern Mariana Islands, Commonwealth of the	N	–	–	–	–	–	
Palau†	Y	Y	Y (> 50)	Y	Y	Y (≥ 6y)	All first responders
Papua New Guinea	N	–	–	–	–	–	
Philippines	Y	Y	Y (> 60)	Y	Y	Y (6m–18y)	Healthy persons providing essential and emergency community services, students and others in institutional settings Public health policy is in place only for the targeting of indigent elderly citizens. All other groups are public health recommendations.
Pitcairn Islands	N	–	–	–	–	–	
Republic of Korea	Y	Y	Y (> 50)	Y	Y	Y (6–60y)	Residents of nursing homes and other long-term care facilities, caregivers of children younger than six months, infection control personnel and workers in poultry-related industries.
Samoa	N	–	–	–	–	–	
Singapore	Y	Y	Y (> 65)	Y	Y	Y (6–60y)	Children six months to 18 years on long-term aspirin therapy, caregivers of children younger than 6 months, persons at high risk of complications of influenza
Solomon Islands	N	–	–	–	–	–	
Tokelau	N	–	–	–	–	–	
Tonga	N	–	–	–	–	–	
Tuvalu	N	–	–	–	–	–	
Vanuatu	N	–	–	–	–	–	
Viet Nam	N	Y	Y (> 65)	Y	N	Y (6–96y)	
Wallis and Futuna	Y	Y	Y (> 65)	Y	Y	Y (6–60y)	

CDC – Centers for Disease Control and Prevention; HCW – health-care workers; m – months; N – no; y – years; Y – Yes.

* These countries and areas reported not having established policy but having recommendations for seasonal influenza vaccination.

† Data from the WHO 2010 Global Influenza Vaccine Survey.

Table 2. **Vaccination information from countries and areas reporting having seasonal influenza vaccines available in 2011, WHO Western Pacific Region**

Country/area	Year vaccine introduced	Formulation	Type of vaccine	Public sector or private market purchase	No. doses purchased (% of population)		No. doses distributed (% of population)		Source (domestic or international)
American Samoa	2003	NH	TIV	Both	8900	(12.1)	6502	(11.5)	International
Australia	1997	SH	TIV	Both	3 776 512	(16.9)	–	–	Both
Brunei Darussalam	2003	Both	TIV	Both	28 000	(6.9)	26 800	(6.6)	International
Cambodia	–	Both	TIV	Private	–	–	–	–	International
China	1998	NH	TIV	Both	–	–	–	–	Both
Cook Islands	2010	Both	TIV	Private	60	(0.3)	60	(0.3)	International
French Polynesia	2002	NH	TIV	Both	16 000	(6.0)	–	–	International
Guam	1997	NH	TIV	Public	7300	(4.0)	–	–	International
Hong Kong (China)	1998	NH	TIV	Both	480 000	(6.8)‡	408 000	(5.8)‡	International
Japan	1951	NH	TIV	Both	50 000 000	(39.2)	50 000 000	(39.2)	Domestic
Macau (China)	2000	SH	TIV	Both	110 000	(19.9)	85 000	(15.4)	International
Malaysia	1988	Both	TIV & ATIV	Both†	–	–	–	–	International
Marshall Islands	2002	NH	TIV	Public	10 000	(18.4)	10 000	(18.4)	International
Micronesia, Federated States of	2000	NH	TIV	Public	17 000	(16.6)	10 000	(9.3)	International
Mongolia	1979	NH	TIV	Both	17 000	(0.6)	17 000	(0.6)	International
New Caledonia	1994	NH	TIV	Both	18 460	(7.5)	18 460	(7.5)	International
New Zealand	1997	SH	TIV	Both	988 000	(22.6)	988 000	(22.6)	International
Niue	2000	SH	TIV	Public	200	(13.4)	200	(13.4)	International
Palau*	1996	NH	TIV & LAIV	Public	5000	(24.3)	–	–	–
Philippines	–	SH	TIV	Both	–	–	–	–	International
Pitcairn Islands	1997	SH	TIV	Both	30	(57.7)	22	(42.3)	International
Republic of Korea	1997	NH	TIV	Both	3 986 900	(8.2)§	3 986 900	(8.2)§	Both
Singapore	1988	Both	TIV & ATIV	Private	–	–	–	–	International
Tokelau	2009	SH	TIV	Public	1466	(99.7)	1466	(99.7)	International
Viet Nam	2008	NH	TIV	Private	–	–	–	–	International
Wallis and Futuna	2004	NH	ATIV	Public	1600	(12.1)	1530	(11.5)	International

ATIV – adjuvanted trivalent inactivated influenza vaccine; LAIV – live attenuated influenza vaccine; NH – northern hemisphere formulation; SH – southern hemisphere formulation; and TIV – trivalent inactivated influenza vaccine.

* Data from the WHO 2010 Global Influenza Vaccine Survey.

† Public funding limited to frontline health-care workers.

‡ Estimation based on vaccine purchased by the government and claims made by private doctors to the government's Vaccine Subsidy Schemes.

§ Public sector purchase figure, i.e. does not include the 9–10 million doses available through private market purchase.

southern hemisphere formulation vaccine, peak months of activity occurred from June to November, except for Macau (China) that reported having peak activity during February and March. Most countries and areas using the northern hemisphere formulation vaccine reported peak influenza months from December to April, although peaks before this period were reported by seven countries and areas, five in the Pacific. Those countries and areas that reported using both the southern and northern hemisphere formulation vaccines tended to report influenza activity throughout the year. Most countries and areas conducted their vaccination programmes in the months before or during periods of peak influenza activity (**Table 3**).

DISCUSSION

Of the 36 countries and areas included in this study, 18 (50%) reported having an established policy regarding seasonal influenza vaccination, which is a larger proportion than 40% of the 157 countries that reported having a policy in a global survey.[14] Seven (19%) additional countries and areas in the Western Pacific Region reported providing recommendations

Table 3. **Reported peak influenza month(s) and months of influenza vaccine availability, WHO Western Pacific Region, 2011**

Country	Formulation	2011												2012			
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
American Samoa*	NH								v								
Australia	SH		v	v	v	v	v	v	v	v							
Brunei Darussalam	Both	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Cambodia	Both	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
China	NH							v	v	v	v	v	v	v	v		
Cook Islands	Both				v	v											
Fiji	–																
French Polynesia	NH									v	v	v	v				
Guam	NH	v	v	v	v	v			v	v	v	v	v	v	v	v	v
Hong Kong (China)	NH	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Japan	NH									v	v	v	v	v	v	v	
Kiribati	–																
Lao People's Democratic Republic	–																
Macau (China)	SH	v	v	v	v	v				v	v	v					
Malaysia	Both	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Marshall Islands	NH									v							
Micronesia, Federated States of	NH								v	v	v	v	v	v	v	v	v
Mongolia	NH									v	v	v	v				
Nauru	–																
New Caledonia	NH										v	v	v	v	v	v	
New Zealand	SH		v	v	v	v	v										
Niue	SH		v	v	v	v	v	v	v						v	v	v
Palau†	NH																
Papua New Guinea	–																
Philippines	SH				v												
Pitcairn Islands	SH					v											
Republic of Korea‡	NH							v	v	v	v	v	v	v	v		
Samoa	–																
Singapore	Both	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
Solomon Islands	–																
Tokelau*	SH																
Tonga	–																
Tuvalu	–																
Vanuatu	–																
Viet Nam	NH																
Wallis and Futuna	NH												v				

Key: Shaded months are the reported peak months for influenza illness; v – vaccine available.

NH – northern hemisphere formulation; SH – southern hemisphere formulation; "–" – influenza vaccine currently not available.

* American Samoa and Tokelau reported unknown vaccination month(s).

† Data from the WHO 2010 Global Influenza Vaccine Survey – seasonality and vaccine availability not reported.

‡ Public sector-purchased vaccine available October–December.

for risk groups for seasonal influenza vaccination, but these were not part of an established policy. However, unlike the rapid increase from 2004 in the number of countries in the Americas using seasonal influenza vaccine,[15] only three (8%) countries and areas in the Western Pacific Region reported introducing influenza vaccine after 2004. In 2011, influenza vaccine was not available in 10 (28%) countries and areas, and influenza

vaccine policy or recommendations were not available in 11 (30%) countries and areas. Therefore, the increase in influenza surveillance and response capacity and pandemic preparedness in the Western Pacific Region in recent years[16] has not been consistent across the Region in the use of vaccines as an effective control measure. This is particularly true in Pacific island nations.

The 2012 WHO position paper on vaccines against influenza recommended that pregnant women be given the highest priority for vaccination in countries initiating or expanding seasonal influenza vaccination programmes. This recommendation was based on the risk of severe disease in this group, the evidence of the safety of trivalent inactivated influenza vaccines throughout pregnancy and the effectiveness of vaccines in preventing illness for the women and their infants.[11] The vaccination of pregnant women has also been shown to be cost-effective in the United Kingdom and Northern Ireland.[17] Although the proportion of countries and areas in the Western Pacific Region that have recommended pregnant women as a risk group for vaccination (76%) is higher than the proportion reported from Europe (37%),[18] more work is needed to promote the inclusion of this risk group in existing and new policies and recommendations in the Region.

The new WHO position paper also recommended seasonal influenza vaccination for, in no order of priority, health-care workers, children aged six to 59 months, the elderly and persons with chronic medical conditions. All 18 countries and areas in the Region with public policies for seasonal influenza vaccination recommended vaccination for health-care workers and the elderly, which is consistent with reports from European countries[18] and the global vaccination survey.[14] Children were included in 15 (60%) country and area vaccination policies or recommendations in the Region, a much larger proportion than that reported by six (22%) of 27 European countries.[18] A global study comparing 10 countries in 2006 showed that the highest vaccination coverage rates for children were from the three Asian countries in the study, suggesting that paediatric vaccination is important in the Asia.[19] Persons at high risk of complications from influenza and/or those with chronic medical conditions were recommended for influenza vaccination in the policies of 18 (72%) countries and areas in the Region, higher than the proportions reported from European countries.[18]

Since 2006, there has been a global push to increase both the production and use of seasonal influenza vaccines through activities contained in the WHO Global Action Plan for Influenza Vaccines.[20] As a result, the number of countries that produce seasonal influenza vaccine has increased both globally and in the Western Pacific Region.[14,21,22] In 2008, WHO awarded grants to manufacturers in three countries in the Region, namely China, the Republic of Korea and Viet Nam. The manufacturer in the Republic of Korea has since licensed both pandemic and trivalent seasonal vaccines; the other two manufacturers are at different stages of development.[22] Despite the increase in vaccine production, this study shows the lack of concomitant vaccine use as most countries and areas that reported influenza vaccine use reported purchasing and/or using only enough vaccine to cover less than 25% of their total populations. Global seasonal influenza manufacturers reported that, despite growth in production capacity at the global, regional and national levels, more than two-thirds of countries distributed vaccine to cover only 10% of their populations.[14] Unfortunately, as risk-group population data were not collected by this study, it was not determined whether the reported number of doses of vaccine purchased by countries and areas were sufficient to cover the high-risk groups identified in vaccination policies or recommendations.

The second WHO Global Action Plan for Influenza Vaccines will place more focus on increasing seasonal vaccine use.[20] Reimbursement, communication, and, to a lesser extent, a country's development status have been previously correlated with vaccine use.[14] In China, the experiences in Beijing and Shaanxi suggest that effective promotional campaigns with reimbursement policies increase uptake in both high- and low-income areas.[23] Similarly, in a survey of 10 countries, higher rates of vaccination were generally observed in countries with existing recommendations or vaccination programmes.[19]

One component of a successful vaccination programme is a surveillance system that monitors the impact of vaccination on disease burden. The results from this study show that most countries and areas schedule their vaccination campaign before or during their peak influenza season, but they also show that several countries and areas reported peak seasons inconsistent with their current vaccination schedule. Given the progress made in influenza surveillance capacity development in the

Western Pacific Region in recent years, countries and areas are better able to understand the epidemiology of influenza in their populations, including seasonal patterns, and can now better match vaccination programmes with influenza seasonality.[24] In addition, to support policy and vaccination recommendations, GISRS members in the Region have developed a workplan to improve surveillance systems and to promote the implementation of special studies for additional data required.[25]

This study shows that more than two-thirds of the countries and areas in WHO's Western Pacific Region have either seasonal influenza vaccination policies or recommendations for vaccinating high-risk groups. In light of the new WHO position paper on vaccines against influenza published in 2012 and the increasing availability of country-specific data, countries and areas should consider reviewing or developing their seasonal influenza vaccination policies or recommendations to reduce morbidity and mortality associated with annual epidemics and as part of ongoing efforts for pandemic preparedness.

Conflicts of interest

As the Coordinating Editor of WPSAR was an author, another member of the Editorial team managed this publication.

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None.

Authors

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References:

1. *Influenza (Seasonal). Fact sheet No. 211*. Geneva, World Health Organization, 2012 (http://www.who.int/mediacentre/factsheets/fs211/en/index.html, accessed 11 December 2012).
2. Wiselka M. Influenza: diagnosis, management, and prophylaxis. *BMJ (Clinical Research Edition)*, 1994, 308:1341–1345. doi:10.1136/bmj.308.6940.1341 pmid:8019225
3. Hampson AW. Vaccines for pandemic influenza. The history of our current vaccines, their limitations and the requirements to deal with a pandemic threat. *Annals of the Academy of Medicine, Singapore*, 2008, 37:510–517. pmid:18618064
4. Osterholm MT et al. Efficacy and effectiveness of influenza vaccines: a systematic review and meta-analysis. *The Lancet Infectious Diseases*, 2012, 12:36–44. doi:10.1016/S1473-3099(11)70295-X pmid:22032844

5. Baguelin M et al. Health and economic impact of the seasonal influenza vaccination programme in England. *Vaccine*, 2012, 30:3459–3462. doi:10.1016/j.vaccine.2012.03.019 pmid:22446636
6. Postma MJ et al. Further evidence for favorable cost-effectiveness of elderly influenza vaccination. *Expert Review of Pharmacoeconomics & Outcomes Research*, 2006, 6:215–227. doi:10.1586/14737167.6.2.215 pmid:20528557
7. Prosser LA et al. Health benefits, risks, and cost-effectiveness of influenza vaccination of children. *Emerging Infectious Diseases*, 2006, 12:1548–1558. doi:10.3201/eid1210.051015 pmid:17176570
8. *List of WHO Collaborating Centres for Reference and Research on Influenza*. Geneva, World Health Organization, 2012 (http://www.who.int/influenza/gisrs_laboratory/collaborating_centres/list/en/index.html, accessed 11 December 2012).
9. *List of National Influenza Centres of the Western Pacific Region*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/topics/influenza/NIC.pdf, accessed 11 December 2012).
10. Oshitani H. Influenza surveillance and control in the Western Pacific Region. *Western Pacific Surveillance and Response Journal*, 2010, 1:3–4. doi:10.5365/wpsar.2010.1.1.005 pmid:23908873
11. World Health Organization. Vaccines against influenza WHO position paper – November 2012. *Weekly Epidemiological Record*, 2012, 87:461–476. pmid:23210147
12. *Countries and areas*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/countries/en/, accessed 13 August 2012).
13. *Sixth Meeting of National Influenza Centres and Influenza Surveillance in the Western Pacific and South-East Asia Regions*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/emerging_diseases/meetings/docs/6th.NIC.Meeting.Report.pdf, accessed 11 December 2012).
14. Palache A. Seasonal influenza vaccine provision in 157 countries (2004–2009) and the potential influence of national public health policies. *Vaccine*, 2011, 29:9459–9466. doi:10.1016/j.vaccine.2011.10.030 pmid:22024174
15. Ropero-Alvarez AM et al. Expansion of seasonal influenza vaccination in the Americas. *BMC Public Health*, 2009, 9:361. doi:10.1186/1471-2458-9-361 pmid:19778430
16. World Health Organization. Fifth meeting of National Influenza Centres – WHO Western Pacific and South-East Asia Regions. *Weekly Epidemiological Record*, 2012, 87:61–64. pmid:22355834
17. Jit M et al. The cost-effectiveness of vaccinating pregnant women against seasonal influenza in England and Wales. *Vaccine*, 2010, 29:115–122. doi:10.1016/j.vaccine.2010.08.078 pmid:21055501
18. Mereckiene J et al. Differences in national influenza vaccination policies across the European Union, Norway and Iceland 2008–2009. *Euro Surveillance: European Communicable Disease Bulletin*, 2010, 15(44):pii=19700.
19. de Lataillade C, Auvergne S, Delannoy I. 2005 and 2006 seasonal influenza vaccination coverage rates in 10 countries in Africa, Asia Pacific, Europe, Latin America and the Middle East. *Journal of Public Health Policy*, 2009, 30:83–101. doi:10.1057/jphp.2008.40 pmid:19367303
20. *Report of the second WHO Consultation on the Global Action Plan for Influenza Vaccines (GAP).* Geneva, World Health Organization, 2011.
21. Partridge J, Kieny MP, World Health Organization H1N1 influenza vaccine Task Force. Global production of seasonal and pandemic (H1N1) influenza vaccines in 2009–2010 and comparison with previous estimates and global action plan targets. *Vaccine*, 2010, 28:4709–4712. doi:10.1016/j.vaccine.2010.04.083 pmid:20488262
22. Partridge J, Kieny MP. Global production capacity of seasonal influenza vaccine in 2011. *Vaccine*, 2013, 31:728–731. doi:10.1016/j.vaccine.2012.10.111 pmid:23149268
23. Feng L et al. Seasonal influenza vaccine supply and target vaccinated population in China, 2004–2009. *Vaccine*, 2010, 28:6778–6782. doi:10.1016/j.vaccine.2010.07.064 pmid:20688038
24. Western Pacific Region Global Influenza Surveillance and Response System. Epidemiological and virological characteristics of influenza in the Western Pacific Region of the World Health Organization, 2006–2010. *PLoS ONE*, 2012, 7:e37568. doi:10.1371/journal.pone.0037568 pmid:22675427
25. Biregional Plan for Further Strengthening National Influenza Surveillance. *Guiding the way towards Influenza Control Policy and Regional Surveillance*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/topics/influenza/InfluenzaSurveillanceFiveYearWorkplan_website.pdf., accessed 11 December 2012).

Vibrio cholerae antimicrobial drug resistance, Papua New Guinea, 2009–2011

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Cholera is an acute infectious disease caused by *Vibrio cholerae*. The disease occurs in a variety of forms ranging from sporadic cases to outbreaks that may transition to endemic disease. While cholera case management focuses on early, rapid rehydration, antimicrobial therapy can reduce the volume of diarrhoea, duration of carriage and symptoms and is frequently recommended for patients with severe dehydration.[1–4] For this reason, antibiotics are often indicated for the management of moderate and severe cholera case patients. The current World Health Organization and Médecins Sans Frontières guidelines for cholera treatment recommend antibiotics for only severe cases, whereas the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) recommends antibiotics for both severe and moderate cases.[5,6]

The emergence of antimicrobial drug resistance following the introduction of antibiotics is a commonly reported global phenomenon. *Vibrio cholerae* remained susceptible to many antibiotics for a sustained period, with only 3% of the isolates demonstrating resistance in the worldwide survey conducted in 1976.[7] However, during the past two decades, reports from several cholera-endemic countries of strains resistant to antibiotics including tetracycline, ampicillin, kanamycin, streptomycin, sulphonamides, trimethoprim and gentamicin have appeared.[4] Indiscriminate use of antimicrobials is one of the commonest reasons for emergence of resistance.[4] For this reason, recommendations for antibiotic use for cholera case management should promote their selective use and be based on the antibiotic susceptibility pattern of *Vibrio cholerae* in the area.

The first outbreak of *Vibrio cholerae* O1 biotype El Tor, serotype Ogawa was reported in Morobe province of Papua New Guinea in July 2009.[8] Following this outbreak, cholera spread to other provinces and by April 2011, outbreaks were reported in almost half the provinces in the country, causing more than 15 000 reported cases and 493 deaths.[9] Occurrence of faecal culture-confirmed cholera diarrhoea in a population for at least three of the past five years is considered as a criteria for defining cholera endemicity in an area.[10] As transmission of cholera in Papua New Guinea continues into the third year (2012), the disease would be classified as endemic. During the outbreak, health authorities recommended doxycycline for adults and erythromycin or azithromycin for children and pregnant women for the treatment of cases with moderate and severe dehydration.

In previously cholera-free districts, health authorities collected stool samples or two rectal swabs from initial cases during outbreaks of acute watery diarrhoea to confirm the etiology. They also collected stool samples sporadically from districts where the outbreaks were ongoing. The stool specimens were sent to the National Reference Laboratory for culture following standard procedures for the isolation and identification of *Vibrio cholerae*. The stool samples were inoculated on Thiosulphate citrate bile salt sucrose and MacConkey's agar and incubated at 37 °C for 18–24 hours. The isolated *Vibrio cholerae* strains were serotyped using polyvalent and monovalent antisera (Denka Seiken Co, Ltd, Tokyo, Japan). Susceptibility to different antibiotics was tested by disk diffusion technique[11] following the Clinical and Laboratory Standards Institute (CLSI) guidelines[12] using a commercially available disk (Oxoid Ltd, England) of eight antimicrobial agents: amoxycillin (10 μg/disc), chloramphenicol (30 μg/disc), ciprofloxacin (5 μg/disc), erythromycin (15 μg/disc), nalidixic acid (30 μg/disc), norfloxacin (10 μg/disc), co-trimoxazole (25 μg/disc) and

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Table 1. **Details of the drugs, reference zone of inhibition and quality control strains based on Clinical and Laboratory Standards Institute (CLSI) guidelines**

Drug	Disk potency (µg)	Diameter of zone of inhibition (mm)			Quality control strains (mm)	
		Susceptible	Intermediate	Resistant	*E. coli* 25 922	*S. aureus* 25 923
Amoxycillin	10	≥ 17	14–16	≤ 13	16–22	27–35
Chloramphenicol	30	≥ 18	13–17	≤ 12	21–27	19–26
Ciprofloxacin	5	≥ 21	16–20	≤ 15	30–40	22–30
Erythromycin	15	≥ 23	14–22	≤ 13	–	22–30
Nalidixic acid	30	≥ 19	14–18	≤ 13	22–28	–
Norfloxacin	10	≥ 17	13–16	≤ 12	28–35	17–28
Co-trimoxazole	25	≥ 16	11–15	≤ 10	23–29	24–32
Tetracycline	30	≥ 19	15–18	≤ 14	18–25	24–30

tetracycline (30 µg/disc). Standard strains of *Escherichia coli* ATCC 25 922 and *Staphylococcus aureus* ATCC 25 923 were used as control strains. Interpretation of zone size was done in accordance with the CLSI guidelines classifying the antimicrobial resistance.[12,13] Since there is no *Vibrio cholerae*-specific CLSI interpretive criteria for several of the drugs for which resistance is described, we considered a zone of inhibition of 21mm for ciprofloxacin, 23mm for erythromycin, 19mm for nalidixic acid and 17mm for norfloxacin as the cut-off values to determine susceptibility (**Table 1**). We analysed the antimicrobial drug resistance data since the beginning of the cholera outbreak in the country.

During the period August 2009 to April 2011, *Vibrio cholerae* was isolated from 321 samples, of which 305 (95%) were tested for antibiotic susceptibility. Cholera isolates were of El Tor biotype and Ogawa serotype. Of the 299 isolates tested against tetracycline (proxy for doxycycline), 29 (9.7%) were resistant and 94 (31.4%) showed intermediate resistance. Of the 254 isolates tested against erythromycin, 97 (38.2%) were resistant while 139 (54.7%) demonstrated intermediate resistance. Most isolates (75.8%) were resistant to amoxycillin while the resistance to norfloxacin (0%), nalidixic acid (0.3%), ciprofloxacin (1%) and co-trimoxazole (3.2%) were low (**Table 2**). A total of 251 isolates were tested for both erythromycin and tetracycline. Of these, 14 (6%) and 60 (24%) showed complete and intermediate resistance to the antibiotics, respectively.

The proportion of isolates showing either complete or intermediate resistance to tetracycline rose from 27.8% (10/36) in 2009 to 50.5% (107/212) in 2010 before decreasing to 11.8% (6/51) in 2011. Isolates were not tested for erythromycin resistance in 2009, but in 2010 and 2011, 92.1% (187/203) and 96.1% (49/51) of the isolates showed intermediate or complete resistance, respectively.

Not all the isolates could be tested for all eight antimicrobials. This was a limitation of the data. We report high levels of resistance to erythromycin among the Papua New Guinea *Vibrio cholerae* isolates with fluctuating resistance to tetracycline. Health care in Papua New Guinea is delivered through provincial hospitals at provincial level and health centres, rural hospitals and aid posts in the rural areas. The standard treatment guidelines prepared by the National Department of Health are followed in the country for treatment of common ailments in adults and children. Health authorities may consider these susceptibility data when reviewing the national treatment guidelines, as well as the availability, cost, usage and clinical outcomes. While doxycycline may still be considered for the treatment of severely dehydrated cases among adults, an alternative antimicrobial therapy to erythromycin should be considered for pregnant women or children. Monitoring of antimicrobial resistance of *Vibrio cholerae* should remain a priority for the public health laboratory surveillance system.

Conflicts of interest

None declared.

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Table 2. **Antimicrobial susceptibility pattern of *Vibrio cholerae* isolates, Papua New Guinea, 2009 to 2011**

Year	Amoxycillin			Chloramphenicol			Ciprofloxacin			Erythromycin		
	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant
2009	37	73.0	13.5	0	–	–	37	0.0	0.0	0	–	–
2010	215	70.7	21.9	204	3.9	2.0	217	1.4	0.9	203	34.5	57.6
2011	50	100	0.0	51	0.0	0.0	51	0.0	0.0	51	52.9	43.1
Total	**302**	**75.8**	**17.2**	**255**	**3.1**	**1.6**	**305**	**1.0**	**0.7**	**254**	**38.2**	**54.7**

Year	Nalidixic acid			Norfloxacin			Co-trimoxazole			Tetracycline		
	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant	# tested	% resistant	% intermediate resistant
2009	34	0.0	0.0	37	0	2.7	26	3.8	0.0	36	2.8	25.0
2010	215	0.5	0.9	208	0	0.5	205	3.9	2.0	212	13.2	37.3
2011	51	0.0	0.0	51	0	0.0	51	0.0	0.0	51	0.0	11.8
Total	**300**	**0.3**	**0.7**	**296**	**0**	**0.7**	**282**	**3.2**	**1.4**	**299**	**9.7**	**31.4**

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References:

1. Lindenbaum J, Greenough WB, Islam MR. Antibiotic therapy of cholera. *Bulletin of the World Health Organization*, 1967, 36:871–883. pmid:4865453
2. Rahaman MM et al. Effects of doxycycline in actively purging cholera patients: a double-blind clinical trial. *Antimicrobial Agents and Chemotherapy*, 1976, 10:610–612. doi:10.1128/AAC.10.4.610 pmid:791107
3. Saha D et al. Single-dose azithromycin for the treatment of cholera in adults. *The New England Journal of Medicine*, 2006, 354:2452–2462. doi:10.1056/NEJMoa054493 pmid:16760445
4. Sack DA et al. Cholera. *Lancet*, 2004, 363:223–233. doi:10.1016/S0140-6736(03)15328-7 pmid:14738797
5. Nelson EJ et al. Antibiotics for both moderate and severe cholera. *The New England Journal of Medicine*, 2011, 364:5–7. doi:10.1056/NEJMp1013771 pmid:21142691
6. Bigot A et al. Cholera guidelines, 4th edition. *Médecins Sans Frontières*, 2004.
7. O'Grady F, Lewis MJ, Pearson NJ. Global surveillance of antibiotic sensitivity of *Vibrio cholerae*. *Bulletin of the World Health Organization*, 1976, 54:181–185. pmid:1088100
8. Rosewell A et al. *Vibrio cholerae* O1 in 2 coastal villages, Papua New Guinea. *Emerging Infectious Diseases*, 2011, 17:154–156. doi:10.3201/eid1701.100993 pmid:21192890
9. Horwood PF et al. Clonal origins of *Vibrio cholerae* O1 El Tor strains, Papua New Guinea, 2009–2011. *Emerging Infectious Diseases*, 2011, 17:2063–2065. doi:10.3201/eid1711.110782 pmid:22099099
10. Meeting of the Strategic Advisory Group of Experts on Immunization, October 2009 - conclusions and recommendations. *Weekly Epidemiological Record,* 2009, 84:517–532.
11. Bauer AW et al. Antibiotic susceptibility testing by a standardized single disk method. *American Journal of Clinical Pathology*, 1966, 45:493–496. pmid:5325707
12. Centers for Disease Control and Prevention. *Manual for the laboratory detection of antimicrobial resistance among acquired bacterial pathogens of public health concern in the developing world (draft).* Atlanta, Georgia, Centers for Disease Control and Prevention, 2001, 55–64 (CDC/WHO/USAID) (http://www.who.int/csr/resources/publications/drugresist/en/IAMRmanual.pdf, accessed 1 March 2013).
13. Clinical and Laboratory Standards Institute. *Performance standards for antimicrobial susceptibility testing, Twenty Second Informational Supplement M100–S22*. Wayne, Pennsylvania, Clinical and Laboratory Standards Institute, 2012, 31(1).

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