World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

Volume 5, Number 3, 2014, Pages 1–52
p-ISSN: 2094-7321 e-ISSN: 2094-7313

Western Pacific Surveillance and Response

Open access journal with continuous publication

Western Pacific Surveillance and Response (WPSAR) is an open access journal dedicated to the surveillance of and response to public health events. The goal of the journal is to create a platform for timely information sharing both within our region and globally to enhance surveillance and response activities. WPSAR is a continuous publication which means articles will be published online as soon as they have completed the review and editing process. Every three months articles will be batched for a print issue. It is a publication managed by the World Health Organization Regional Office for the Western Pacific.

To contact us:

Western Pacific Surveillance and Response
World Health Organization
Office for the Western Pacific Region
United Nations Avenue
1000 Manila, Philippines
wpsar@wpro.who.int
www.wpro.who.int/wpsar

p-ISSN: 2094-7321
e-ISSN: 2094-7313

An assessment of risk posed by a *Campylobacter*-positive puppy living in an Australian residential aged-care facility

Cameron Moffatt,[a] Ranil Appuhamy,[b] Will Andrew,[c] Sandy Wynn,[d] Jan Roberts[e] and Karina Kennedy[f]

Correspondence to Cameron Moffatt (e-mail: cameron.moffatt@act.gov.au).

Introduction: In April and June 2012, two outbreaks of *Campylobacter* gastroenteritis were investigated in an Australian aged-care facility (ACF); a *Campylobacter*-positive puppy was identified as a potential source of infection.

Methods: An expert panel was convened to assess transmission risk from the puppy to elderly residents and to guide further public health action. Criteria considered as part of the panel's assessment included the puppy's infectivity, the bacterium's transmissibility, puppy–resident contact, infection control and cleaning practices and animal management at the facility. A literature review was used to assist the panel, with a final risk being determined using a likelihood and consequence matrix.

Results: The panel determined that the setting and low infective dose made transmission likely despite varying degrees of contact between the puppy and cases. While infection control practices were generally appropriate, the facility's animal policy did not adequately address potential zoonotic risk.

Conclusion: In summary, puppies should not be considered as companion animals in ACFs due to high rates of *Campylobacter* carriage and the underlying susceptibility of the elderly. Infection control and animal policies in ACFs should reflect an awareness of zoonotic disease potential.

Campylobacter is the most commonly notified cause of gastroenteritis in Australia, but few outbreaks are identified relative to disease incidence.[1] As in other industrialized countries, the majority of Australian cases are attributed to foodborne transmission, with chicken consumption and raw poultry contact identified as significant risk factors for disease.[2,3] Human illness generally manifests as an acute self-limiting enteritis with symptoms of diarrhoea, fever and abdominal pain; extra-intestinal manifestations, notably bacteraemia and sequelae such as Guillain–Barré syndrome and reactive arthritis may also occur.[4]

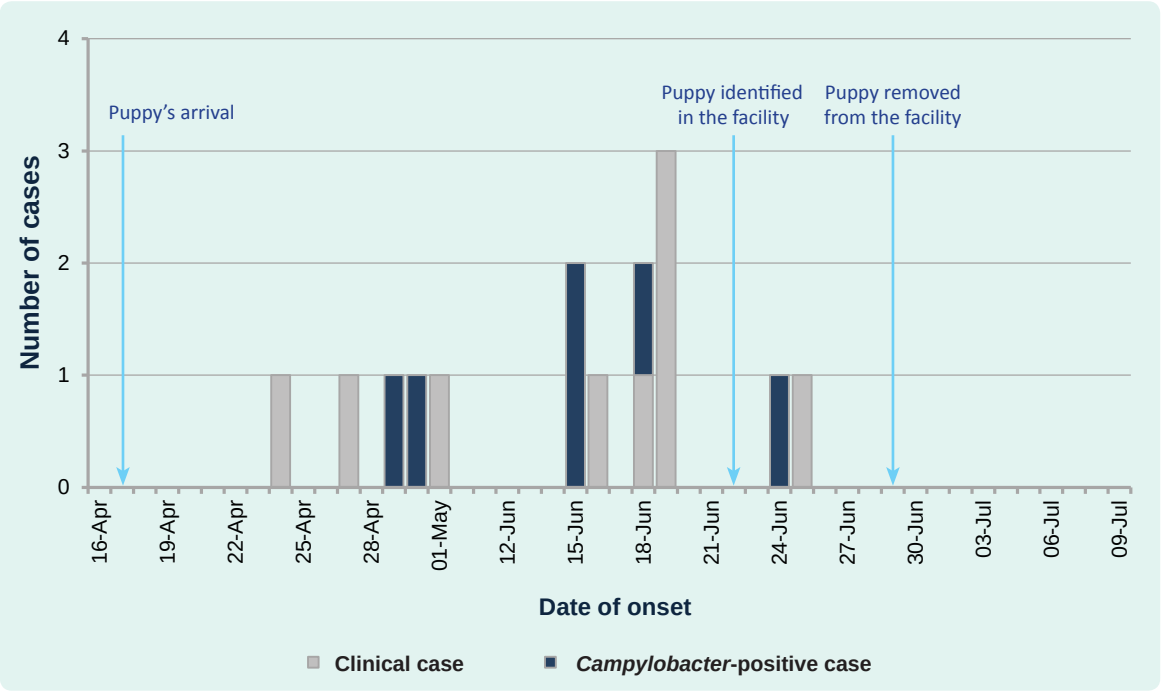
Event Background

Between 24 April and 25 June 2012, two outbreaks of *Campylobacter* gastroenteritis occurred at an Australian residential aged-care facility (ACF) (**Figure 1**). These outbreaks affected 13 residents and two staff including five residents and one staff member with laboratory-confirmed campylobacteriosis. Inspections by environmental health officers and infection control staff identified no issues with either food safety or infection control practices. Following the second outbreak, investigators learnt of a four-month-old puppy living in the facility; the dog's arrival predated the initial outbreak by one week.

Investigation of the puppy revealed it had access to communal areas, residents' rooms and the dining room. Anecdotally staff reported close contact between the puppy and residents and staff. The animal's health was reported as good with no history of diarrhoeal illness. It was encouraged to toilet outside but on occasion

[a] OzFoodNet, Communicable Disease Control Section, Health Protection Service, ACT Government Health Directorate, Canberra, Australia.
[b] Office of the Chief Health Officer, ACT Government Health Directorate, Canberra, Australia.
[c] Territory and Municipal Services Directorate, Canberra, Australia.
[d] Infection Control, Health Protection Service, ACT Government Health Directorate, Canberra, Australia.
[e] Infection Control, Community-based Services, ACT Health Directorate, Canberra, Australia.
[f] Department of Microbiology and Infectious Diseases, Canberra Hospital and Health Services, Canberra, Australia.
Submitted: 12 May 2014; Published: 11 August 2014
doi: 10.5365/wpsar.2014.5.2.009

Figure 1. **Suspected animal-to-human outbreaks of *Campylobacter* gastroenteritis in an Australian aged-care facility, 2012**



was reported to have defecated within the facility. Its diet consisted of commercial puppy biscuits and chews.

Pending further testing and assessment, public health advice was given to remove the puppy from the facility. In addition to laboratory-confirmed infections in people, a *Campylobacter*-positive faecal sample was recovered from the puppy. Both the human- and canine-derived campylobacters were tested for relatedness via speciation, antibiotic susceptibility testing and pulsed-field gel electrophoresis (PFGE). Only one human isolate could be re-grown by the reference laboratory and was confirmed as a *Campylobacter jejuni* subspecies *jejuni*, with sensitivity to ciprofloxacin, nalidixic acid, gentamicin and tetracycline. The canine isolate was also identified as *Campylobacter jejuni* subspecies *jejuni* with resistance to ciprofloxacin and nalidixic acid. PFGE results showed an obvious heterogeneity between the human and canine isolates. While these results could not demonstrate a causal link between the puppy and human cases, the recovery of a significant human pathogen from an animal residing among a vulnerable population raised concerns of risk to residents' health.

METHODS

An expert panel was organized to assess the risk of *Campylobacter* transmission from the puppy to residents (and staff) at the ACF and to determine if additional public health actions should be taken. The panel comprised disciplines including epidemiology, public health medicine, veterinary medicine, infection control and medical microbiology. Panel members were asked to consider both risk assessment and risk management, specifically if the puppy posed a risk to residents' health and also if the puppy should be allowed back into the facility (and under what conditions).

To assess the risk of transmission from the puppy to residents, the panel members were asked to consider the puppy's infectivity, the bacterium's transmissibility, the level of contact between the puppy and cases, the current infection control and cleaning processes and current management of animals within the facility. A literature review was performed to provide a background hazard assessment, an examination of *Campylobacter* transmissibility and the consequences of the infection. To assist with ongoing risk management, the panel

Figure 2. **Risk assessment matrix***

LIKELIHOOD	CONSEQUENCE →				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Extreme	Extreme
Likely	Medium	Medium	High	High	Extreme
Possible	Low	Medium	Medium	High	Extreme
Unlikely	Low	Medium	Medium	High	High
Rare	Low	Low	Medium	Medium	High

* Adopted from Australian Capital Territory Health Directorate Risk Management Guidelines.

members were also asked to consider the potential impact of antibiotic therapy for the puppy as well as to review the facility's infection control and animal policies. The panel used a likelihood and consequence matrix to derive a final assessment of risk (**Figure 2**).

RESULTS

Risk assessment

Likelihood of transmission of the bacterium from the puppy to residents and staff

With animal-assisted interventions (AAI) in health settings now common, the potential for zoonotic transmission should be considered.[5] Potential risk can be minimized by having clean, healthy, vaccinated, well-behaved and trained animals. Thus service animals, like guide dogs, could be regarded as posing little threat to human health in ACFs with no published reports of infectious diseases that affect humans originating in this category of animal.[5,6] However, the situation should be viewed differently with respect to puppies and young dogs in an ACF.

The panel assessed the following criteria to assist with determining the likelihood of *Campylobacter* transmission from the puppy:

(1) Infectivity of the puppy

Contact with puppies and young chickens have been identified as risk factors for campylobacteriosis in Australia,[2,7] with an estimated 8500 cases being attributed to these two exposures annually.[3] The biological plausibility of this is supported by evidence of shedding of *Campylobacter* spp. in both symptomatic and asymptomatic dogs with particular evidence of a correlation between younger dogs and the shedding of *Campylobacter jejuni*,[8,9] the major species that affects humans.

The deficiencies in understanding what constitutes normal and abnormal canine intestinal microflora means that the patho-physiology of *Campylobacter* enteritis in dogs is not well understood.[10] However, some *Campylobacter* species, in particular *Campylobacter jejuni*, are likely pathogenic in dogs but colonization occurs more commonly.[10] Limited information is available on the nature and duration of immunity after infection, but long-term infection and re-infection with different strains without symptoms indicates a lack of protective immunity in dogs.[11]

While not a commonly cited phenomenon, genetically proven transmission of *Campylobacter jejuni* from a puppy to a baby has been documented.[12] Given a lack of data showing transmission of *Campylobacter* from animals to vulnerable older population groups, this may be a useful analogy given that extremities of age are recognized periods of increased susceptibility to infection.[13]

(2) Transmissibility of the bacterium

Modelling in humans suggests a 5–50% probability of infection after a dose of 100 organisms and a 50–80% probability of infection with 10 000 organisms;[14] human challenge studies have shown the infectious dose to be as low as 500 organisms.[15] In humans, excretion

of bacteria in faeces may occur for several weeks after clinical recovery with long-term carriage observed in immune-deficient patients.[16]

(3) Contact with the puppy

When an individual dog carries *Campylobacter jejuni*, the risk of transmission may be high depending on factors such as the level of contact between the dog and people.[17] Investigators developed an ordinal scale to assess the frequency, intensity and duration of contact between cases and the puppy with the assessment performed by an ACF staff member familiar with the affected staff and residents. The results showed most contact instances were unplanned, involved occasional patting of the puppy and occurred no more than once or twice per week.

(4) Infection control and cleaning processes

Inspections conducted by public health staff did not identify any specific infection control issues. However, these inspections were carried out before the puppy was identified. No issues were found with access and availability of hand washing facilities, and residents had access to either a personal or a shared bathroom. Additional hand washing and sanitizer stations were located throughout the facility for staff, resident and visitor use. While strict enforcement of hand washing remains the most important hygiene measure following animal contact, there could be no certainty that residents had washed their hands (or used a hand sanitizer) after contact with the dog.

(5) Animal management

Animal entry to the facility was discretionary, with the facility only requiring an informal evaluation of an animal's medical, social and behavioural suitability. Notably, the facility's animal policy permitted animal entry to food service areas provided that the animal did not interfere with processes (e.g. begging for food).

Consequence of infection

Although generally self-limiting, adverse outcomes in the elderly as a result of *Campylobacter* infection do occur. Following these outbreaks, one resident case died, while another required hospitalization for management of ongoing gastroenteritis. Both had laboratory-confirmed campylobacteriosis. Although deaths in ACFs are not unexpected events, these findings are consistent with research showing the highest mortality for *Salmonella* and *Campylobacter* infections in the elderly occurs in the period shortly after illness.[18] Mortality data also shows the standardized mortality ratio (SMR) for *Campylobacter* cases ≥65 years of age to be 200% higher than the general population at one month post-infection (SMR 3.0, 95% CI: 2.0–4.3).[19]

Based on the overall risk assessment and using a likelihood consequence matrix (**Figure 2**),[20] the panel determined that the puppy posed a high risk to residents' health.

Risk management

The panel also considered several other activities that could be undertaken to assist with reducing risk to an acceptable level.

(1) Eliminating infection in the puppy using antibiotics

A review of bacterial enteritis in dogs and cats[10] identified that veterinary guidelines were lacking on the efficacy of antimicrobial therapy and suggested human guidelines be considered with treatment reserved for moderate to severe cases and early infections. Erythromycin, fluoroquinolones and second generation cephalosporins have been used for treatment of diarrhoeic dogs, but the efficacy is unclear.[10] Treatment of carriers has been considered in high-risk environments, such as pet stores or kennels, but the risk of re-exposure limits the chance of efficacy and increases the risk of antibiotic resistance.[10] Animals treated with antibiotics could also potentially serve as reservoirs for antibiotic-resistant microorganisms introduced to the facility while the animal is present.[5]

(2) Infection control and animal management considerations

International guidelines[21] recommend that only adult animals that are a part of a formal AAI programme should be permitted into a setting such as an ACF; dogs in particular need to be at least one year of age but ideally two years of age or older. An animal that is part of an AAI programme should be more temperamentally suited to the environment, providing greater assurance of behavioural

control. Criteria for assessing temperamental suitability might include how the animal reacts to strangers, loud or novel stimuli, threatening voices or gestures, crowding, excessive patting or restraint, the presence of other animals and the handler's commands.[21]

The presence of a handler or other supervision while a dog is interacting with residents is an important consideration. From an infection control perspective this can assist with restricting animal movements into sensitive areas such as kitchens, dining rooms, laundries, sterile supply and medication preparation areas.[5] The handler or supervisor can also take responsibility for ensuring that residents sanitize or wash their hands both before and after contact with the animal. If there is a toileting incident involving the animal, avoidance of direct contact with animal faeces should be stressed; the use of gloves and leak-resistant bags to discard absorbent material used in the cleaning process is recommended.[5]

Recommendations

After considering the panel's findings of a high risk to elderly residents and the options available for the management of that risk, public health authorities adopted the following recommendations as proposed by the panel:

1. that the puppy must not return to the facility until it is at least one year of age;
2. that the puppy must have its behaviour and temperament assessed as being appropriate for an aged-care environment; and
3. that the facility must revise its infection control and animal policies to ensure zoonotic disease risks are considered.

DISCUSSION

An aged-care outbreak of campylobacteriosis is an anomaly requiring thorough investigation to identify and eliminate ongoing risk. Under such circumstances investigators need to be cognizant of novel causes of transmission. While zoonotic transmission is less commonly reported, puppies have been identified as a recognized risk factor for campylobacteriosis,[3,7] and there is extensive evidence detailing shedding by asymptomatic dogs, particularly younger animals.[8,9]

In view of this known risk and the potential for adverse health outcomes among elderly persons following infection,[18,19] a precautionary approach was adopted and the puppy was excluded from the facility pending further investigation and expert consultation. The subsequent isolation of *Campylobacter jejuni* in the canine stool sample was not entirely unexpected; however, the fact it was a drug-resistant organism from an animal living amidst a vulnerable population was of concern.

The investigation did face challenges, in particular having only a limited number of viable specimens for comparative testing. Although direct zoonotic transmission was not demonstrated, there was no evidence to suggest either person-to-person or foodborne transmission routes were involved. It is plausible that the puppy, as the putative source of infection, may have been colonized with a variety of genetically distinct *Campylobacter* organisms that were being intermittently shed.[8] There was also a temporal link between the animal's arrival and removal and the commencement and cessation of cases.

CONCLUSION

This risk assessment and public health investigation both highlight the need for greater awareness of zoonotic transmission of *Campylobacter* and the potential for adverse outcomes among a vulnerable population, namely frail elderly persons living in aged-care. ACFs need to adopt and enforce policies that recognize zoonotic risk and restrict inappropriate animal access. Puppies and young dogs should not be considered or permitted as companion animals in ACFs due to their high rates of *Campylobacter* carriage, their social immaturity, the susceptibility of elderly residents to infection and poor outcomes.

Ethics statement

Ethics approval to conduct the investigation and risk assessment was not sought as the work was being conducted as part of a public health response.

Conflicts of interest

None declared.

Funding

OzFoodNet is funded by the Australian Government Department of Health.

Acknowledgements

The authors wish to acknowledge the following groups for their assistance with the investigation: staff at the Communicable Disease Control section at the ACT Health Protection Service; Environmental Health officers at the ACT Health Protection Service; staff at the ACT Government Analytical Laboratory; staff at ACT Pathology; staff at Capital Pathology; staff at the Microbiological Diagnostic Unit, University of Melbourne; and residents and staff at the affected aged-care facility.

References:

1. OzFoodnet Working Group. Monitoring the incidence and causes of diseases potentially transmitted by food in Australia: Annual Report of the OzFoodNet network, 2009. *Communicable Diseases Intelligence Quarterly Report*, 2010, 34:396–426. pmid:21413526
2. Stafford RJ et al.; OzFoodNet Working Group. A multi-centre prospective case-control study of campylobacter infection in persons aged 5 years and older in Australia. *Epidemiology and Infection*, 2007, 135:978–988. doi:10.1017/S0950268806007576 pmid:17134530
3. Stafford RJ et al.; OzFoodNet Working Group. Population-attributable risk estimates for risk factors associated with *Campylobacter* infection, Australia. *Emerging Infectious Diseases*, 2008, 14:895–901. doi:10.3201/eid1406.071008 pmid:18507899
4. Kirkpatrick BD, Tribble DR. Update on human *Campylobacter jejuni* infections. *Current Opinion in Gastroenterology*, 2011, 27:1–7. doi:10.1097/MOG.0b013e3283413763 pmid:21124212
5. Sehulster LM et al. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago, American Society for Healthcare Engineering/ American Hospital Association, 2004.
6. DiSalvo H et al. Who let the dogs out? Infection control did: utility of dogs in health care settings and infection control aspects. *American Journal of Infection Control*, 2006, 34:301–307. doi:10.1016/j.ajic.2005.06.005 pmid:16765210
7. Tenkate TD, Stafford RJ. Risk factors for campylobacter infection in infants and young children: a matched case-control study. *Epidemiology and Infection*, 2001, 127:399–404. doi:10.1017/S0950268801006306 pmid:11811871
8. Hald B et al. Longitudinal study of the excretion patterns of thermophilic *Campylobacter* spp. in young pet dogs in Denmark. *Journal of Clinical Microbiology*, 2004, 42:2003–2012. doi:10.1128/JCM.42.5.2003-2012.2004 pmid:15131162
9. Torre E, Tello M. Factors influencing fecal shedding of *Campylobacter jejuni* in dogs without diarrhea. *American Journal of Veterinary Research*, 1993, 54:260–262. pmid:8430936
10. Weese JS. Bacterial enteritis in dogs and cats: diagnosis, therapy, and zoonotic potential. *The Veterinary Clinics of North America. Small Animal Practice*, 2011, 41:287–309. doi:10.1016/j.cvsm.2010.12.005 pmid:21486637
11. Koene MGJ et al. Strain variation within *Campylobacter* species in fecal samples from dogs and cats. *Veterinary Microbiology*, 2009, 133:199–205. doi:10.1016/j.vetmic.2008.06.022 pmid:18678447
12. Wolfs TFW et al. Neonatal sepsis by *Campylobacter jejuni*: genetically proven transmission from a household puppy. *Clinical Infectious Diseases*, 2001, 32:E97–99. doi:10.1086/319224 pmid:11229867
13. Crossley KB, Peterson PK. Infections in the Elderly. In: *Principles and Practice of Infectious Diseases*, Mandell GL, Bennett JE, and Dolin R, Editors. Philadelpia, Churchill Livingstone Elsevier, 2010, 3857–3864.
14. Heymann DL, editor. *Control of Communicables Manual 19th edition*. Washington, DC, American Public Health Association, 2008, 94–98.
15. Kothary MH, Babu US. Infective Dose of Foodborne Pathogens in Volunteers: A Review. *Journal of Food Safety*, 2001, 21:49–68. doi:10.1111/j.1745-4565.2001.tb00307.x
16. Blaser MJ, Engberg J. Clinical aspects of *Campylobacter jejuni* and *Campylobacter coli* infections. In: *Campylobacter*, Nachamkin I, Szymanski CM, and Blaser MJ, Editors. Washington, DC, American Society for Microbiology, 2008, 99–121.
17. Parsons BN et al. Typing of *Campylobacter jejuni* isolates from dogs by use of multilocus sequence typing and pulsed-field gel electrophoresis. *Journal of Clinical Microbiology*, 2009, 47:3466–3471. doi:10.1128/JCM.01046-09 pmid:19794053
18. Gradel KO et al. Morbidity and mortality of elderly patients with zoonotic *Salmonella* and *Campylobacter*: a population-based study. *The Journal of Infection*, 2008, 57:214–222. doi:10.1016/j.jinf.2008.06.013 pmid:18656265
19. Ternhag A et al. Mortality following *Campylobacter* infection: a registry-based linkage study. *BMC Infectious Diseases*, 2005, 5:70. doi:10.1186/1471-2334-5-70 pmid:16162289
20. ACT Government Health Directorate. *Risk Management Guidelines, Internal Audit and Risk Management*. Canberra, Department of Health, 2012.
21. Lefebvre SL et al.; Writing Panel of Working Group. Guidelines for animal-assisted interventions in health care facilities. *American Journal of Infection Control*, 2008, 36:78–85. doi:10.1016/j.ajic.2007.09.005 pmid:18313508

Testing-adjusted chlamydia notification trends in New South Wales, Australia, 2000 to 2010

Michelle Cretikos,[a] Darren Mayne,[b] Roderick Reynolds,[c] Paula Spokes[d] and Daniel Madeddu[e]

Correspondence to Michelle Cretikos (e-mail: mcret@doh.health.nsw.gov.au).

Introduction: Between 2005 and 2010, Australian notification rates for chlamydia infection increased by 64% from 203 to 333 per 100 000 population. Interpreting this trend is difficult without examining rates and local patterns of testing. We examined the effect of adjusting for local testing rates on chlamydia notification trends in New South Wales (NSW), Australia from 2000 to 2010.

Methods: We used testing data for NSW residents for Medicare Benefits Schedule items for chlamydia from 1 July 1999 to 30 June 2005 and 1 July 2007 to 30 June 2010. This data set excluded testing by public sector laboratories. We also obtained laboratory-confirmed genital chlamydia notifications in NSW residents for 1 July 1999 to 30 June 2010 and excluded notifications from public laboratories. We used negative binomial regression to assess trends in chlamydia notification rates by age and sex after adjusting for local government area (LGA)-level Medicare-funded testing rates, socioeconomic disadvantage, remoteness and Medicare provider density.

Results: Testing-adjusted rates of chlamydia notifications declined by 5.2% per annum (rate ratio [RR] = 0.95, 95% confidence interval (CI) = 0.93–0.96) for women overall, and 2.3% (RR = 0.98, 95% CI = 0.96–1.00) and 5.0% per annum (RR = 0.95, 95% CI = 0.93–0.98) for men in LGAs with moderate and high densities of Medicare providers, respectively. Notification rates remained stable for men in low Medicare provider density LGAs (RR = 1.01, 95% CI = 0.96–1.07).

Discussion: It is likely that increased testing for chlamydia has driven increases in chlamydia notification in NSW over the last decade. Notification data provide no evidence for a general increase in the prevalence of chlamydia in the NSW community for this period. Notification-based chlamydia surveillance should be routinely adjusted for local testing rates.

Chlamydia is a sexually transmitted infection caused by the intracellular bacterium *Chlamydia trachomatis*. Typically, infections are asymptomatic,[1] resulting in a cycle of ongoing infection, transmission and reinfection.[2] Chlamydia is a significant public health problem as a proportion of women with untreated infection may develop pelvic inflammatory disease, tubal infertility and ectopic pregnancies.[3–5] Chlamydia infection also facilitates the transmission of HIV.[6]

Chlamydia is the most frequently notified condition in Australia with 74 305 cases of chlamydia notified in 2010 or 35.5% of all notifications nationally. Of these, 18 278 cases (24.6%) were notified from New South Wales (NSW). Between 2005 and 2010, Australian notification rates for chlamydia infection increased by 64% from 203 to 333 per 100 000 population. In 2010, notification rates were 1.4 times higher among females (384) relative to males (279) per 100 000 people overall. Chlamydia notifications are increasing most rapidly in people aged 15–19 years, with female and male notification rates in this age group growing by 75% and 114% between 2005 and 2010, respectively. Notifications in the 15–29 year age group accounted for approximately 80% of annual chlamydia notifications between 2005 and 2010.[7]

The rapid rise in chlamydia notifications has generated renewed public health focus on control strategies, including social marketing campaigns targeting young people and promoting safe sexual practices and screening for chlamydia by general practitioners and sexual health clinics.[8,9] The increase in large-scale social marketing campaigns and promotion of screening presents a problem for notification-based

[a] NSW Ministry of Health, Sydney, New South Wales, Australia.
[b] Public Health Unit, Illawarra Shoalhaven Local Health District, New South Wales, Australia.
[c] Public Health Unit, Murrumbidgee and Southern NSW Local Health Districts, New South Wales, Australia.
[d] Communicable Disease Branch, Health Protection New South Wales Ministry of Health, Sydney, New South Wales, Australia.
[e] HIV and STI Branch, Centre for Population Health, NSW Ministry of Health, Sydney, New South Wales, Australia.
Submitted: 07 February 2014; Published: 14 August 2014
doi: 10.5365/wpsar.2014.5.1.009

Table 1. **Medicare Benefits Scheme items for *Chlamydia trachomatis* testing, financial years 2000 to 2005 and 2008 to 2010**

Item	Description
69316	Detection of *Chlamydia trachomatis* by any method – one test
69317	Detection of *Chlamydia trachomatis* by any method plus one test described in item 69494
69319	Detection of *Chlamydia trachomatis* by any method plus two tests described in item 69494
69369	Detection of *Chlamydia trachomatis* by any method in specimens from one or more sites
69370	Detection of *Chlamydia trachomatis* by any method and *Neisseria gonorrhoea* by nucleic acid amplification techniques in specimens from one or more sites

chlamydia surveillance as variation in disease incidence cannot be distinguished from the underlying variation in rates of chlamydia testing.[2,10] It is known that rates of chlamydia notifications are strongly associated with testing rates, as is the case for many notified conditions.[11,12] When both testing and notification data are available, then notifications can be adjusted for area-level testing prevalence to assess trends in disease intensity and make comparisons to inform chlamydia epidemiology, surveillance and control.

The aim of the current study was to investigate the effect of chlamydia testing and area-level socio-demographic factors on trends in chlamydia notification over time among residents of NSW, Australia.

METHODS

An ecological design was used to assess trends in chlamydia notifications over time by age and sex after adjusting for population testing rates in NSW using 2006 Australian Standard Geographical Classification (ASGC) Local Government Area (LGA) as the analysis unit. The LGA is an administrative boundary that in 2006 represented a median of around 20 000 residents. The LGA boundary for 2006 was used because LGA boundaries change over time and 2006 was the mid-point of the study period. The effects of socioeconomic disadvantage, medical provider density and remoteness on long-term trends were also examined.

Study Population and Period

The study population consisted of all persons aged 15 years and over in NSW between 1 July 1999 and 30 June 2010.

Data sources

Chlamydia testing data were provided by the Commonwealth Department of Health and Ageing (DoHA) for Medicare Benefits Schedule (MBS) items 69316, 69317, 69319, 69369 and 69370 based on the patient's LGA of residence at time of pathology testing (**Table 1**). This data set included all tests by private sector laboratories rebated by Medicare, the Australian Government universal health-care insurance, from 1 July 1999 to 30 June 2005 and 1 July 2007 to 30 June 2010 but excluded testing by public sector laboratories funded by the state health system over the same period. Data were not available for 1 July 2005 to 30 June 2007 because a common MBS item was used for all sexual health testing during this period and it was not possible to identify chlamydia tests.

Laboratories have been required to report all diagnoses of *Chlamydia trachomatis* infection in NSW since August 1998.[13] Non-identifiable counts of laboratory-confirmed genital chlamydia notifications were provided by the NSW Ministry of Health for financial years 2000 to 2010 by financial year, sex, five-year age group, LGA of residence, test type and laboratory. To ensure consistency with the private sector laboratory testing data, the primary analysis was limited to notifications from private sector laboratories. A secondary analysis included all notifications to assess the sensitivity of observed trends and associations to the laboratory notification source (public or private).

Medical provider density was calculated for each LGA using counts of fulltime equivalent Medicare providers for financial years 2000 to 2010. An Australian financial year covers the period from 1 July to 30 June

of the following calendar year. For each LGA, the total number of fulltime equivalent Medicare providers was divided by the total population aged 15 years and over and expressed as the number of providers per 10 000 population. The density distribution was divided into five equal parts. The bottom quintile was classified as "low access", the top quintile as "high access" and quintiles two to four as "middling access".

Area-level socioeconomic disadvantage was classified using the Index of Relative Socioeconomic Disadvantage (IRSD) from the 2006 Australian Census of Population and Housing. This index is a general socioeconomic index that summarizes a range of information about the economic and social conditions of people and households within an area.[14] LGA IRSD scores were calculated as the population-weighted mean of their constituent Census Collection Districts scores and used to assign socioeconomic disadvantage across the entire study period. The IRSD distribution was divided into five equal parts. The bottom quintile was classified as "high disadvantage", the top quintile as "low disadvantage" and quintiles two to four as "middling disadvantage".

Remoteness was defined for LGAs using 2006 ASGC Remoteness Areas.[15] This classification defines the accessibility/remoteness of geographic areas based on their road network distance to goods, services and opportunities for social interactions.[16] Study LGAs were classified as either metropolitan, inner regional, or outer regional, remote and very remote.

Statistical analysis

Age-specific annual testing and notification rates per 100 000 population were calculated by financial year, sex, medical provider density, relative socioeconomic disadvantage and remoteness for ages 15–19, 20–24, 25–34, 35–44 and 45+ years using Australian Bureau of Statistics midpoint estimated resident populations. Summary rates were also calculated by the direct method and used the 2001 Australian population as the standard.

Associations between annual age-specific testing and notification rates were assessed using scatter plots and Spearman's rank-order correlation coefficients (ρ). Trends over time and group differences in chlamydia notifications were estimated as rate ratios using negative binomial models to account for extra Poisson variation observed in the data. The initial model included age, sex, trend over time and their interactions. Backward elimination was used to reduce this to a baseline model including significant interactions and main effect terms only. The logarithm of the age-specific testing rate per 100 000 population was then added to estimate testing-adjusted trends and group differences. Finally, medical provider density, relative socioeconomic disadvantage and remoteness were added to the testing-adjusted models to assess associations between these variables and notification rates after adjusting for chlamydia testing. The final model was fit separately for males and females due to interactions between sex and other variables. Data analysis was undertaken in SAS Version 9.2 using the GENMOD procedure. Statistical significance was evaluated using a Type I error rate of 0.05 for main effects and 0.01 for interactions.

Ethical approval

The Executive Committee of the NSW Population and Health Services Research Ethics Committee determined that ethical review was not required.

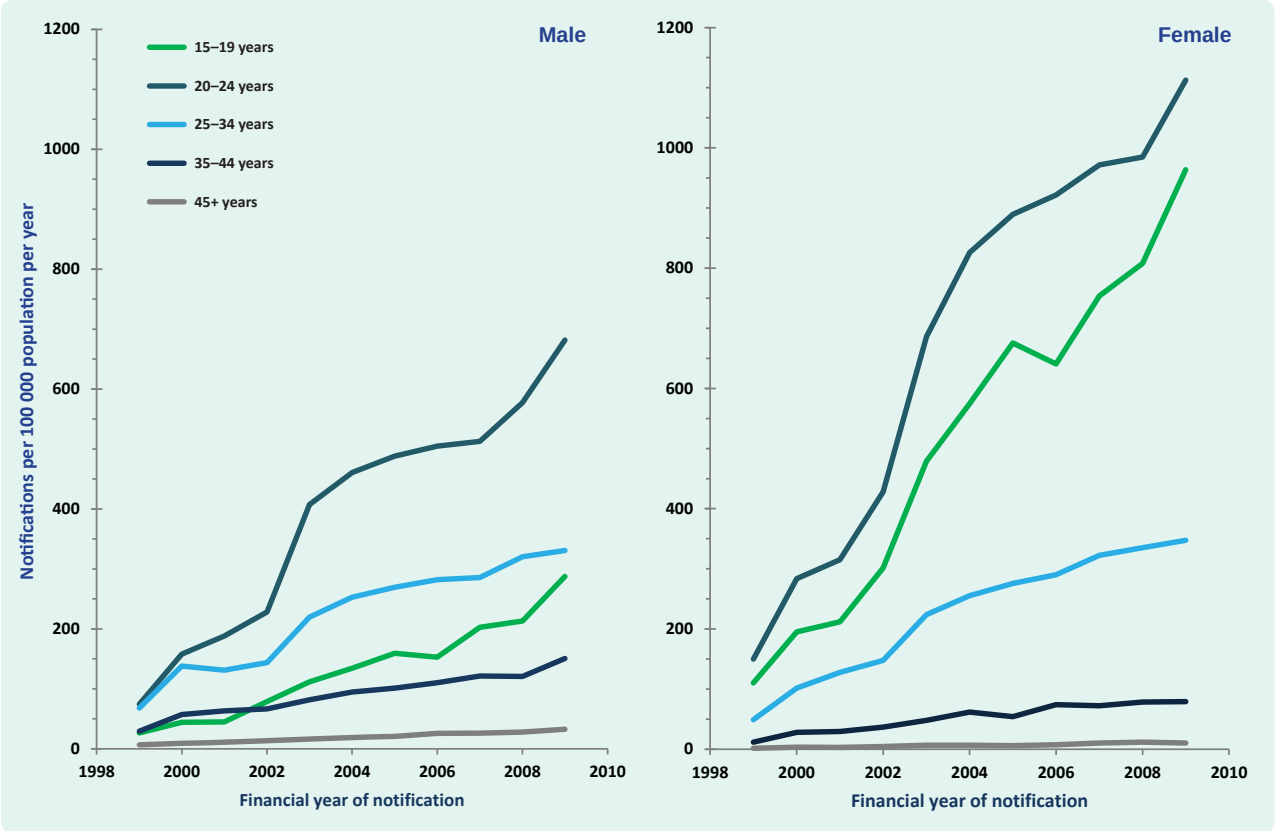
RESULTS

From 1 July 1999 to 30 June 2005 and 1 July 2007 to 30 June 2010, 1 007 540 Medicare-rebated chlamydia tests were performed for NSW residents. Over the same periods, 81 435 cases of *Chlamydia trachomatis* infection were notified to NSW public health units: 61 773 (75.9%) from private sector laboratories and 19 662 (24.1%) from public sector laboratories. The proportion of private/public laboratory notifications remained consistent at around 75% of all notifications from private laboratories over time. The proportion of notifications that were identified through nucleic acid amplification techniques such as polymerase chain reaction (PCR) rose dramatically from 58% in 1999–2000 to 99.7% in 2009–2010. The proportion of notifications resulting from a PCR test reached 97% by 2002–2003.

Trends over time

In unadjusted analyses over both study periods, notification rates increased on average by 13% (95% confidence interval [CI]: 10%–16% per annum; however, this trend varied by age and sex (**Figure 1**). Notification rates increased significantly in both males (11.3%)

Figure 1. **Notification rates by age and sex, New South Wales, Australia, 2000 to 2010**



and females (15.7%) with the greatest increases in the 20–24 year age group for both sexes. The same pattern was seen for annual testing rates in both sexes and age groups over time (**Table 2**). Although the relative increases in rates of testing were similar for males and females, absolute testing rates increased to 16 126 tests per 100 000 person years in females aged 20–24 years in 2009 compared to a maximal testing rate of 5408 per 100 000 person years among men aged 20–24 years. A strong log-linear relationship between age-specific testing and notification rates was observed for both males and females with 87% of variability in notification rates explained by annual testing rates for both groups ($\rho = 0.93$, $P < 0.001$, **Figure 2**).

After adjusting for chlamydia testing rates, socioeconomic status, remoteness and Medicare provider density, chlamydia notification rates decreased on average by 3.9% (CI: 0.09–6.9) for males and 5.5% (CI: 3.7–7.3) for females per annum over the study period. Significant effect modification of the trend over time by Medicare provider density was found in males but not females (**Table 3**). Notification rates reduced by 2.3% (CI: 0.2–4.4) and 5.0% (CI: 2.5–7.5) per annum for males in middling and high Medicare provider density areas, and there was a non-significant increase in chlamydia notifications of 1.1% (CI: –4.4 to 6.7) per annum for males in low Medicare provider density areas (**Figure 3**).

Demographic and LGA level effects

After adjusting for chlamydia testing rates, socioeconomic status, remoteness and Medicare provider density, increasing age was associated with decreasing notification rates in both males and females. Chlamydia notification increased at a similar rate with increasing urbanization for both males and females: notification rates were 45% and 38% higher for males and females living in metropolitan areas and 29% higher for both sexes living in inner regional areas compared to those living in outer regional, remote and very remote areas, respectively. For both males and females, chlamydia notifications were highest and of a similar magnitude for areas of middling socioeconomic disadvantage (**Table 3**).

Sensitivity analyses

The results of sensitivity analyses for trend over time by sex and age when all chlamydia notifications were

Table 2. **Age-specific chlamydia testing and notification rates by sex, New South Wales, Australia, 2000 to 2010**

Years	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tests per 100 000 population per year											
Males											
15–19	359.1	422.9	475.6	638.2	878.7	1110.9	N/A	N/A	1283.2	1828.2	2187.6
20–24	1074.6	1254.6	1528.2	2008.9	2719.5	3321.1	N/A	N/A	3210.3	4610.3	5408.0
25–34	1100.2	1180.5	1404.4	1794.4	2221.2	2884.0	N/A	N/A	2660.4	3786.9	4489.8
35–44	722.5	827.3	934.4	1202.7	1473.1	1797.3	N/A	N/A	1902.6	2459.8	2826.5
≥ 45	244.7	276.1	318.7	427.0	514.1	614.8	N/A	N/A	732.4	885.8	996.8
Females											
15–19	1726.3	1889.0	2077.5	2951.0	4234.0	5017.6	N/A	N/A	7306.5	8997.9	10 021.4
20–24	3214.9	3506.4	4033.0	5323.4	6949.2	8531.1	N/A	N/A	11 983.3	14 735.3	16 125.6
25–34	2304.3	2398.3	2632.3	3238.1	4374.9	5306.3	N/A	N/A	7561.1	9505.2	10 583.7
35–44	1132.3	1176.2	1243.1	1544.9	2002.8	2435.5	N/A	N/A	3926.8	4708.0	5224.3
≥ 45	202.4	219.6	264.7	293.0	372.3	435.3	N/A	N/A	728.3	863.1	931.9
Notifications per 100 000 population per year											
Males											
15–19	26.5	44.1	44.8	78.6	111.4	134.2	159.1	152.9	202.7	213.1	287.3
20–24	74.3	157.8	188.2	228.2	407.1	460.6	488.0	504.7	512.8	577.2	681.8
25–34	67.8	138.0	131.1	143.7	219.5	252.9	269.5	282.1	285.4	320.1	330.6
35–44	29.4	57.2	63.3	66.4	81.7	94.5	101.0	110.3	121.3	120.7	150.7
≥ 45	6.7	9.0	10.5	13.8	16.1	18.4	20.5	25.6	26.0	27.9	32.7
Females											
15–19	110.4	195.1	211.8	301.4	478.9	574.9	675.3	640.6	753.7	808.0	963.8
20–24	150.0	283.5	315.1	428.0	685.9	826.1	889.4	921.7	971.7	984.9	1112.8
25–34	49.1	101.5	127.9	147.5	224.0	255.2	275.8	290.2	322.3	335.2	347.6
35–44	11.8	28.1	29.5	36.7	47.9	61.8	54.2	74.1	72.2	78.4	79.3
≥ 45	1.5	3.3	3.1	4.3	6.8	6.6	5.9	7.5	10.5	11.9	10.2

Note: No unique Medicare Benefits Schedule item number was available for chlamydia testing in financial years 2006 and 2007.

included were consistent with the findings derived from private notifications only.

Socioeconomic disadvantage was very sensitive to source of notification data. The rate-ratios for males from areas with middling (RR = 1.32, CI: 1.24–1.41) and high (RR = 1.23, CI: 1.14–1.33) socioeconomic disadvantage increased and were both statistically significant when estimated from all notifications compared to private notifications only. By comparison, female rate-ratios increased differentially for areas of high (RR = 1.39, CI: 1.29–1.51) and middling (RR = 1.35, CI: 1.26–1.45) socioeconomic disadvantage, indicating increased notification risk with increasing socioeconomic disadvantage.

Remoteness was also sensitive to notification source and became non-significant for both males (LR = 3.75, DF = 2, P = 0.15) and females (LR = 0.23, DF = 2, P = 0.89) when rate ratios were derived using all notifications. This likely reflects a public testing bias as cross tabulations of notification source by remoteness indicated that the percentage of notifications from private providers decreased with increasing remoteness.

DISCUSSION

Main findings

We found that testing-adjusted chlamydia notifications have declined for all NSW women and for NSW men in areas of high and middling Medicare provider density over the last decade. Age gradients in chlamydia notification remain after adjusting for differences in testing rates. These findings are consistent regardless of the laboratory notification source. Further, we found

Figure 2. Associations between age-specific testing and notification rates by sex, New South Wales, Australia, 2000 to 2010

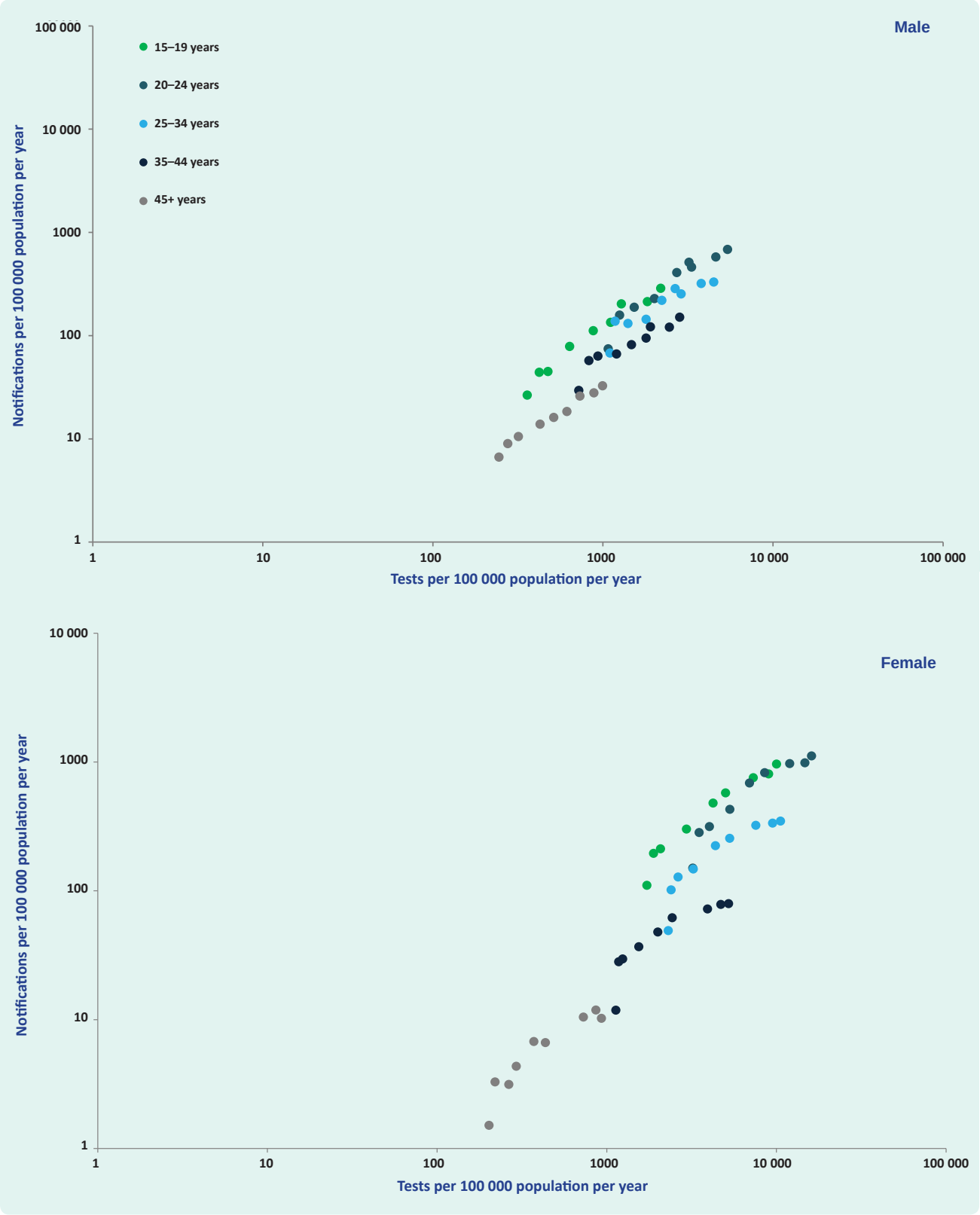


Table 3. Influences on test-adjusted chlamydia notification rates by sex, New South Wales, Australia, 2000 to 2010

	Males				Females			
	Rate ratio	95% CI	LR Test (DF)	*p*	Rate ratio	95% CI	LR Test (DF)	*p*
Year (trend)	0.96	0.94–0.99	6.68 (1)	0.0098	0.95	0.93–0.96	37.67 (1)	< 0.0001
Age group								
(REF: ≥ 45 years)			519.41 (4)	< 0.0001			536.62 (4)	< 0.0001
15–19 years	3.59	3.21–4.01			4.70	3.74–5.90		
20–24 years	2.76	2.35–3.25			3.26	2.50–4.27		
25–34 years	2.07	1.80–2.39			1.97	1.58–2.47		
35–44 years	1.32	1.17–1.50			1.05	0.88–1.27		
Remoteness areas								
(REF: Rural and remote)			62.42 (2)	< 0.0001			55.73 (2)	< 0.0001
Metropolitan	1.45	1.32–1.59			1.38	1.27–1.50		
Inner regional	1.29	1.17–1.41			1.29	1.18–1.41		
Socioeconomic disadvantage								
(REF: Low)			31.99 (2)	< 0.0001			32.33 (2)	< 0.0001
Middling	1.20	1.12–1.28			1.22	1.14–1.30		
High	1.06	0.98–1.16			1.15	1.06–1.24		
Medicare provider density								
(REF: Low)			35.30 (2)	< 0.0001	*Not included in female model*			
Middling	0.73	0.61–0.88						
High	1.02	0.84–1.23						
*Year * MPD*								
(REF: Low)			36.99 (2)	< 0.0001	*Not included in female model*			
Middling	1.03	1.00–1.06						
High	0.98	0.95–1.01						

Note: Year (trend) centred at 1999; adjusted model – adjusted using the logarithm of the directly age-standardized testing rate per 100 000 person years.
CI, confidence interval; LR, likelihood ratio; DF, degrees of freedom; *p*, probability value; and MPD, medicare provider density

that testing-adjusted notification rates increase with increasing urbanization but only for tests conducted by private laboratory providers. This indicates that public laboratories may provide an important testing function in non-metropolitan areas of NSW.

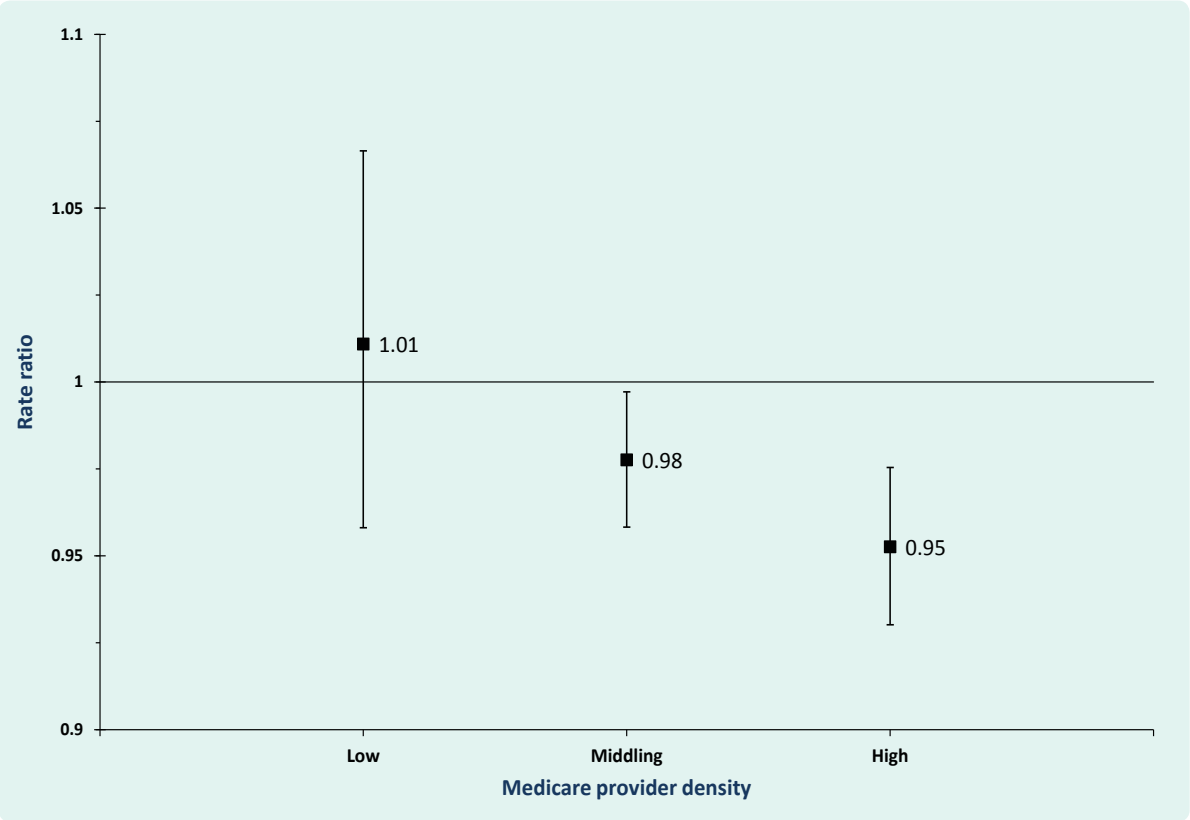
Our findings suggest that notification trends and between-area comparisons are likely confounded by underlying patterns of testing, which may vary markedly depending on the local availability of medical providers and local patterns of practice.[17–20] Given the prevalence of chlamydia, the rapid increase in testing seen over time (including the increased use of nucleic acid testing) and variations in patterns of testing by age and sex, it is essential to incorporate information on community testing rates to understand patterns of chlamydia-related disease in the community when using notification-based data.

Testing-adjusted rates may be used to assess trends in disease intensity and make comparisons that inform chlamydia epidemiology, surveillance and control. It has been previously recommended that spatiotemporal surveillance methods should be routinely used for surveillance of trends in bacterial sexually transmitted infections.[21] Our results suggest that such surveillance must adjust for underlying testing rates to ensure any differences detected between or across areas reflect changes in disease intensity rather than differences in testing patterns.

Policy and practice implications

There is strong evidence that chlamydia notification rates are highly correlated with rates of testing. This highlights the need to incorporate the proportion positive for chlamydia in routine surveillance reports as is done in

Figure 3. Testing-adjusted chlamydia notification trend rate ratios for males in low, middling and high Medicare provider density areas, New South Wales, Australia, 2000 to 2010



other countries such as the United States.[22,23] This level of correlation is to be expected given that chlamydia is estimated to be prevalent in approximately 4–5% of 15–24 year olds.[24–26]

We only identified one other Australian study that had examined the pattern of chlamydia notifications adjusted for changes in the level of testing for chlamydia in the community over time.[27] This study from Western Australia found that between 2009 and 2011, the chlamydia testing rate increased 6%, while the test positivity rate increased 20% and the notification rate increased 25%. From 2011 to 2012, the testing rate increased 5%, while the test positivity rate decreased 7% and the notification rate remained stable. This study did not adjust for the effects of Medicare provider density, socioeconomic status or remoteness.

A 2007 to 2010 collaborative Australian study examined chlamydia testing and positivity rates through sentinel health services that target at-risk populations.[28] This study found modest increases in chlamydia prevalence in young heterosexuals between 2006 and 2010, but the findings were limited as the study populations were at-risk groups attending services such as sexual health centres.[29]

Community levels of testing for chlamydia within general practice are still considered suboptimal, with less than 10% of the target group screened at least once a year in 2007–2008.[17] This indicates that chlamydia testing should still be promoted in this age group.[17,30] A recent mathematical model estimates that up to 40% of the population aged under 25 years would need to be screened (and treated if necessary) on an annual basis to reduce the community prevalence of chlamydia within the next 10 years.[31]

There are currently two large-scale studies under way in the Australian primary care context that are trialling a multifaceted testing intervention aimed at increasing chlamydia testing.[32] Implementation of such interventions is likely to result in a continued rise in the number of chlamydia notifications each year, given that we found no evidence of a threshold effect for chlamydia testing in NSW.[12] If the overall trend in incidence of

chlamydia in the community is to be monitored using notification-based data, it is important to routinely adjust for location-specific levels and patterns testing.

Strengths and limitations

This is the first Australian study to examine the association between the rates of chlamydia notification and rates of chlamydia testing, after adjusting for a range of demographic and local-level contextual effects, over the period of a decade. We used the best available information to conduct an analysis of testing and notification rates using comparable data; however, our study was limited by the use of private laboratory data only. A sensitivity analysis demonstrated that the main findings were unlikely to be biased by the source of laboratory notification. It is likely that people who experience socioeconomic disadvantage are more dependent on public sexual health clinics or public hospitals for testing for sexually transmitted infection.

Our study was a community-based study that was not able to examine for potential effects or trends over time within high-risk groups such as sex workers or men who have sex with men. Given the largely asymptomatic nature of chlamydia, particularly in women, and that 80% of notifications are from the age group targeted by screening programmes,[7] we assumed the majority of testing was performed as a routine screen, as recommended.[9,30] We could not determine whether the test had been performed in symptomatic or asymptomatic patients or whether the patient had known risk factors for chlamydia infection apart from age. It is known that general practitioners will preferentially test patients who report symptoms or risk factors such as a recent change in sexual partner.[20] Testing is also still conducted more frequently in women, likely due to increased opportunities for testing.[18,20]

We could not adjust for possible inconsistencies in the data related to the change in Medicare items for chlamydia tests and the interruption in the availability of data relating to chlamydia testing during 2006 and 2007. The break and then change in the Medicare items used for chlamydia may have taken some time to adopt; therefore, the information around the time of introduction of the new Medicare items in 2006 may be incomplete. Our data may also have been affected by a change in the type or sensitivity of the tests performed, especially given the rapid increase in the proportion of notifications resulting from PCR tests between 2000 and 2003.

Our findings do not rule out increases in the prevalence of chlamydia in at-risk population groups, increases in the prevalence of chlamydia over time in particular areas of NSW or within shorter time periods than the full decade that we examined. A final limitation is that Medicare captures data on the number of tests performed rather than the number of unique individuals tested. Repeat testing of some individuals may have affected the outcomes of the study.

Future studies

Additional research is needed to better understand the rates of infection and reinfection with chlamydia in both the community and in priority subgroups, as well as the effect of community-based interventions designed to interrupt transmission.

We have highlighted that there is substantial variation in rates of testing and rates of notification at the local level and in various age-groups, and this variation is affected by socioeconomic status and location remoteness. Future studies are needed to better understand the drivers for these variations in testing patterns and practice. We also need to better understand the rates of testing for symptomatic versus asymptomatic infection (i.e. true screening rates).

Future surveillance should routinely incorporate chlamydia testing data from both private (Medicare-funded) and public laboratory data to reduce possible bias in relation to socioeconomic status and location. Information derived from rates of notification of chlamydia should be more carefully interpreted to take account of the inherent limitations of these data, given that rates of notifications are biased by rates of presentation to medical professionals and rates of testing – including over time, by location and by patient (including by age and sex).

Finally, further work is required to better understand the relationship between test-adjusted notification rates and rates of admission to hospital for chlamydia-related complications such as pelvic inflammatory disease and ectopic pregnancy.

CONCLUSION

Increased testing is likely to be driving increasing chlamydia notification rates in young people in the general community in NSW over the longterm, given the relatively high prevalence of chlamydia infection in young people. Notification data to 2010 provide no evidence for increasing chlamydia prevalence in the general community in NSW after adjusting for increasing rates of testing. Differences between groups, especially local contextual variables such as socioeconomic status and remoteness, are sensitive to source of notification data, but trends over time by age and sex are consistent across notification types. Comprehensive data on testing rates over time and by location should inform routine chlamydia surveillance at all levels of government for the general community as well as priority population groups.

Conflicts of interest

None declared.

Funding

None.

Acknowledgements

We acknowledge the assistance of the Commonwealth Department of Health and Ageing as well as the New South Wales Ministry of Health, Local Health Districts and Public Health Laboratories.

References:

1. Nelson HD, Helfand M. Screening for chlamydial infection. *American Journal of Preventive Medicine*, 2001, 20 Suppl;95–107. doi:10.1016/S0749-3797(01)00253-7 pmid:11306238
2. Miller WC et al. Prevalence of chlamydial and gonococcal infections among young adults in the United States. *The Journal of the American Medical Association*, 2004, 291:2229–2236. doi:10.1001/jama.291.18.2229 pmid:15138245
3. Bender N et al. Chlamydia infection, pelvic inflammatory disease, ectopic pregnancy and infertility: cross-national study. *Sexually Transmitted Infections*, 2011, 87:601–608. doi:10.1136/sextrans-2011-050205 pmid:22028428
4. Haggerty CL et al. Risk of sequelae after *Chlamydia trachomatis* genital infection in women. *The Journal of Infectious Diseases*, 2010, 201 Suppl 2;S134–155. doi:10.1086/652395 pmid:20470050
5. Rekart ML et al. Chlamydia public health programs and the epidemiology of pelvic inflammatory disease and ectopic pregnancy. *The Journal of Infectious Diseases*, 2013, 207:30–38. doi:10.1093/infdis/jis644 pmid:23100568
6. Fleming DT, Wasserheit JN. From epidemiological synergy to public health policy and practice: the contribution of other sexually transmitted diseases to sexual transmission of HIV infection. *Sexually Transmitted Infections*, 1999, 75:3–17. doi:10.1136/sti.75.1.3 pmid:10448335
7. NNDSS Annual Report Writing Group. Australia's Notifiable Disease Status, 2010: Annual Report of the National Notifiable Diseases Surveillance System. *Communicable Diseases Intelligence Quarterly Report*, 2012, 36:1–69. pmid:23153082
8. NSW Department of Health. Sexually Transmissible Infections (STIs) and Blood Borne Viruses (BBVs) Related Campaigns and Resources: Safe Sex. No Regrets, 2012. New South Wales, Department of Health, 2012 (http://www0.health.nsw.gov.au/publichealth/sexualhealth/safesex.asp, accessed 19 March 2013).
9. NSW STI Programs Unit. Clinical Guidelines for the management of STIs among priority populations Sydney, NSW STIPU, 2012 (http://www.stipu.nsw.gov.au/icms_docs/147045_GP_STI_Testing_Tool_2012.pdf, accessed 19 March 2013).
10. Donovan B, Grulich AE. Where are we going with chlamydia? *Sexual Health*, 2006, 3:207–208. doi:10.1071/SH06053 pmid:17112428
11. Hocking J et al. The pattern of notification and testing for genital *Chlamydia trachomatis* infection in Victoria, 1998–2000: an ecological analysis. *Australian and New Zealand Journal of Public Health*, 2003, 27:405–408. doi:10.1111/j.1467-842X.2003.tb00417.x pmid:14705302
12. Chen MY, Fairley CK, Donovan B. Nowhere near the point of diminishing returns: correlations between chlamydia testing and notification rates in New South Wales. *Australian and New Zealand Journal of Public Health*, 2005, 29:249–253. doi:10.1111/j.1467-842X.2005.tb00763.x pmid:15991773
13. Communicable Diseases Branch. Year in review: communicable disease surveillance, NSW, 2009. *New South Wales Public Health Bulletin*, 2010, 21:157–166. doi:10.1071/NB10038 pmid:20964097
14. Australian Bureau of Statistics. *Socio-Economic Indexes for Areas (SEIFA) - technical paper*. Canberra, Commonwealth of Australia, 2008.
15. Australian Bureau of Statistics. *Statistical geography volume 1 - Australian Standard Geographic Classification (ASGC), July 2006*. Canberra, Commonwealth of Australia, 2006.
16. Commonwealth Department of Health and Aged Care. *Measuring remoteness: Accessibility/Remoteness Index of Australia (ARIA) - revised edition*. Canberra, Commonwealth of Australia, 2001.
17. Kong FYS et al. Australian general practitioner chlamydia testing rates among young people. *The Medical Journal of Australia*, 2011, 194:249–252. pmid:21381999
18. Sawleshwarkar S et al. Chlamydia testing in general practice in Australia. *Sexual Health*, 2010, 7:484–490. doi:10.1071/SH09110 pmid:21062591
19. Hocking JS et al. Chlamydia testing in general practice - a survey of Victorian general practitioners. *Sexual Health*, 2006, 3:241–244. doi:10.1071/SH06042 pmid:17112434
20. Khan A et al. Willingness to offer chlamydia testing in general practice in New South Wales. *Australian and New Zealand Journal of Public Health*, 2006, 30:226–230. doi:10.1111/j.1467-842X.2006.tb00862.x pmid:16800198
21. Schleihauf E, Watkins RE, Plant AJ. Heterogeneity in the spatial distribution of bacterial sexually transmitted infections. *Sexually Transmitted Infections*, 2009, 85:45–49. doi:10.1136/sti.2008.030197 pmid:18723583

22. Chen MY, Fairley CK, Donovan B. Nowhere near the point of diminishing returns: correlations between chlamydia testing and notification rates in New South Wales. *Australian and New Zealand Journal of Public Health*, 2005, 29:249–253. doi:10.1111/j.1467-842X.2005.tb00763.x pmid:15991773

23. Centers for Disease Control and Prevention. *2011 Sexually Transmitted Diseases Surveillance: Chlamydia Profiles*. Atlanta, Centers for Disease Control and Prevention, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention, Division of STD Prevention, 2013 (http://www.cdc.gov/std/chlamydia2011/default.htm, accessed 19 March 2013).

24. Lewis D et al. The prevalence of *Chlamydia trachomatis* infection in Australia: a systematic review and meta-analysis. *BMC Infectious Diseases*, 2012, 12:113. doi:10.1186/1471-2334-12-113 pmid:22583480

25. Vajdic CM et al. The prevalence of genital *Chlamydia trachomatis* in Australia 1997–2004: a systematic review. *Sexual Health*, 2005, 2:169–183. doi:10.1071/SH05018 pmid:16335545

26. Hocking JS et al. A chlamydia prevalence survey of young women living in Melbourne, Victoria. *Sexual Health*, 2006, 3:235–240. doi:10.1071/SH06033 pmid:17112433

27. *Report on testing data for notifiable sexually transmissible infections and blood-borne viruses in Western Australia 2012*. Western Australia, Department of Health, 2012 (http://www.public.health.wa.gov.au/cproot/4674/2/report_on_testing_data_for_notifiable_sti_and_bbv_in_wa.pdf, accessed 19 March 2013).

28. Guy RJ et al.; ACCESS Collaboration. A new national Chlamydia Sentinel Surveillance System in Australia: evaluation of the first stage of implementation. *Communicable Diseases Intelligence*, 2010, 34:319–328. pmid:21090187

29. Ali H et al.; ACCESS Collaboration. Understanding trends in genital *Chlamydia trachomatis* can benefit from enhanced surveillance: findings from Australia. *Sexually Transmitted Infections*, 2012, 88:552–557. doi:10.1136/sextrans-2011-050423 pmid:22645390

30. *Guidelines for preventive activities in general practice (8th Ed), 2012*. Melbourne, The Royal Australian College of General Practitioners, 2012 (http://www.racgp.org.au/download/Documents/Guidelines/Redbook8/redbook8.pdf, accessed 19 March 2013).

31. Regan DG, Wilson DP, Hocking JS. Coverage is the key for effective screening of *Chlamydia trachomatis* in Australia. *The Journal of Infectious Diseases*, 2008, 198:349–358. doi:10.1086/589883 pmid:18588484

32. Guy RJ et al. *Genital chlamydia infection in young people: a review of the evidence 2011*. New South Wales, NSW Health Department, 2011 (http://www.med.unsw.edu.au/nchecrweb.nsf/resources/SHPReport/$file/GenitalChlamydiaReview-Nov2011.pdf, accessed 19 March 2013).

A large outbreak of shigellosis commencing in an internally displaced population, Papua New Guinea, 2013

Edwin Benny,[a] Kelly Mesere,[a] Boris I Pavlin,[b] Logan Yakam,[c] Rebecca Ford,[d] Mition Yoannes,[d] Debbie Kisa,[d] Mohammad Y Abdad,[d] Lincoln Menda,[e] Andrew R Greenhill[df] and Paul F Horwood[d]

Correspondence to Paul F Horwood (e-mail: paul.horwood@hotmail.com).

Objective: The objective of this study was to investigate a large outbreak of shigellosis in Papua New Guinea that began in a camp for internally displaced persons before spreading throughout the general community.

Methods: Outbreak mitigation strategies were implemented in the affected area to curtail the spread of the disease. Data were collected from the surveillance system and analysed by time, place and person. Rectal swab samples were tested by standard culture methods and real-time polymerase chain reaction to determine the etiology of the outbreak.

Results: Laboratory analysis at two independent institutions established that the outbreak was caused by *Shigella* sp., with one strain further characterized as *Shigella flexneri* serotype 2. Approximately 1200 suspected cases of shigellosis were reported in a two-month period from two townships in Morobe Province, Papua New Guinea. The outbreak resulted in at least five deaths, all in young children.

Discussion: This outbreak of shigellosis highlights the threat of enteric diseases to vulnerable populations such as internally displaced persons in Papua New Guinea, as has been observed in other global settings.

Shigellosis (bacillary dysentery) is a major cause of morbidity and mortality, particularly in developing countries. The number of *Shigella* infections throughout the world annually has been estimated at more than 160 million cases, with more than 1 million deaths. The majority of these cases (> 60%) and deaths (> 70%) occur in children younger than five years.[1] The disease is endemic in most developing countries and caused by four species of *Shigella*, which are classified based on biochemical and serological differences: *Shigella dysenteriae*, *S. flexneri*, *S. boydii* and *S. sonnei*. Shigellosis is typically spread through the faecal–oral route by person-to-person contact or through contaminated food or water. It is a known risk among refugees and internally displaced persons (IDPs).[2] The infectious dose of *Shigella* can be as low as 10 organisms,[3] thus facilitating the rapid spread of the organism during outbreaks. The symptoms of shigellosis include fever, watery diarrhoea, abdominal cramps and bloody stools with mucus.

In this study we report on the epidemiological and laboratory findings of a large outbreak of shigellosis which commenced in a settlement camp for IDPs before spreading throughout the general community in Morobe Province, Papua New Guinea. An outbreak investigation was initiated following reports of numerous cases of gastrointestinal disease in a settlement camp in Morobe Province, Papua New Guinea in September 2013. The settlement camp was established following tribal fighting between two neighbouring groups, the Watut and Bupu Garaina people; the Bupu Garaina people were internally displaced following the conflict.

METHODS

The outbreak was first reported in late September 2013 from a health centre close to the settlement camp near the township of Bulolo, Morobe Province. Over the next two weeks, more than 300 cases of diarrhoea and

[a] Morobe Provincial Hospital, Lae, Papua New Guinea.
[b] World Health Organization, Port Moresby, Papua New Guinea.
[c] Bulolo District Health Services, Morobe Province, Papua New Guinea.
[d] Papua New Guinea Institute of Medical Research, Goroka, Papua New Guinea.
[e] Angua Hospital, Lae, Morobe Province, Papua New Guinea.
[f] School of Applied and Biomedical Services, Federation University, Churchill, Victoria, Australia.
Submitted: 4 April 2014; Published: 15 September 2014
doi: 10.5365/wpsar.2014.5.2.003

dysentery were recorded at the health centre in close proximity to the camp. Over the subsequent weeks, the outbreak spread to the township of Bulolo and then to the nearby township of Wau, which is located approximately 50 km away. The case definition for this outbreak was clinic attendees with acute watery and loose stools (with or without mucus and blood) and with or without fever. Detailed line lists were compiled from representative patients to include age, sex, onset date, presentation date, residence, clinical symptoms, outcome and laboratory results. Data were analysed in Microsoft Excel 2010.

Following the initial reports of the outbreak, local and provincial health teams were mobilized and outbreak mitigation strategies were implemented:

- A temporary ban was issued for all cooked-food and ice-block sales in Bulolo township.
- Treatment points were established at the health centre near the camp and other hotspot areas.
- Temporary toilets were built for the care centre.
- Stocks of necessary medications were filled for the affected health clinics.
- Appropriate treatment was advocated using standard treatment guidelines[2] including aggressive therapy with oral rehydration solution (ORS) for mild diarrhoeal cases.
- A health education and awareness campaign was conducted to promote healthy practices.
- An inspection of hygiene, water and sanitation was conducted in Bulolo township shops and markets to ensure businesses and the general public were complying with hygiene practices stated in the Public Health Act.

Rectal swabs were collected and stored in Cary-Blair medium and sent to the Angau Memorial Hospital (Lae, Morobe Province) and the Papua New Guinea Institute of Medical Research (Goroka, Eastern Highlands Province) for bacterial culture analysis using standard methods as outlined by the World Health Organization. Samples were also tested for *Shigella* spp. using a previously published real-time polymerase chain reaction (PCR) assay.[4]

The public health activities and laboratory testing outlined in this study were organized by the Ministry of Health and Morobe Provincial Health Authority as part of routine outbreak investigation procedures, and as such have a standing authorisation from the National Ethics Committee. All samples were anonymised for the purpose of this study.

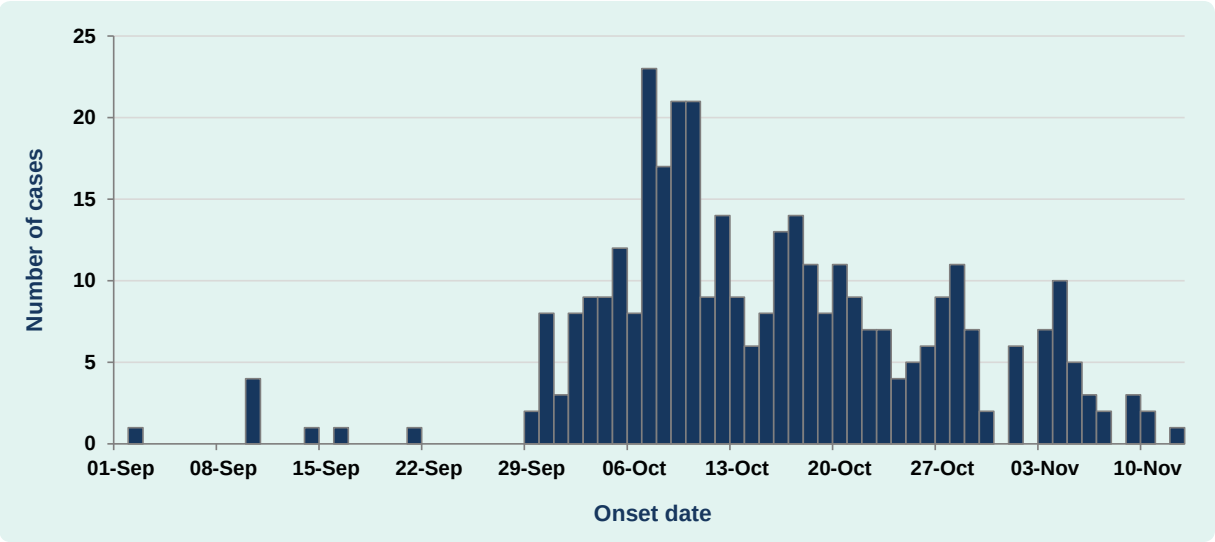
RESULTS

An increase in cases of dysentery and diarrhoea was first recorded at the Bulolo Health Centre in the last week of September 2013 (**Figure 1**). By the end of the first week of October, over 20 cases of dysentery/diarrhoea were being reported at the clinic per day. In the second week of October cases began presenting at the Wau Health Centre. Dysentery/diarrhoea cases continued to be reported from both Bulolo and Wau until the first week of November. Overall, approximately 1200 cases of diarrhoea and dysentery were reported from the Bulolo/Wau area. The majority of cases were recorded at the Bulolo Health Centre (approximately 900), with the remaining cases recorded at the Wau Health Centre (approximately 300). A detailed line list from randomly selected patients was compiled for 510 cases from the outbreak (Bulolo–368; Wau–142) and the remaining cases were reported as aggregated data.

The outbreak resulted in five deaths (three in Bulolo and two in Wau), with a case fatality proportion of approximately 0.4%. All of the deaths occurred in children under five years of age, and pre-existing morbidities and late presentation to health clinics were believed to be important factors in all of the deaths. There were unconfirmed reports of additional deaths that were not recorded due to the remoteness of the outbreak region.

Among the cases for whom age was recorded (n = 496), the majority were in children: over 70% of age-reported cases were in children less than 15 years of age with a large proportion less than five years of age. Children less than five years old accounted for 58.3% (n = 289) of cases; children five to 14 years: 13.1% (n = 65); people aged 15–50 years: 25.0% (n = 124); and older adults more than 50 years: 3.6% (n = 18). Males were more commonly recorded with dysentery/diarrhoea symptoms during the outbreak, constituting 54.3% of cases. However, there was no statistical difference in male–female cases.

Figure 1. **Epidemic curve from the shigellosis outbreak in Bululo, September to November 2013**



Note: The data are based on 358 patients for whom date of onset was recorded.

Shigella sp. was isolated from four out of six stool samples analysed at the Angau Memorial Hospital laboratory. *Shigella* sp. was also isolated from one out of 11 stool samples analysed at the Papua New Guinea Institute of Medical Research. This isolate was subsequently serotyped as *S. flexneri* serotype 2 using Shigella antisera (Denka Seiken Co. Ltd, Tokyo, Japan). In addition, three of the 11 samples tested positive for *Shigella* sp. using real-time PCR. The sample from which the *S. flexneri* strain was isolated was one of the positive samples. The *S. flexneri* isolate was archived and will be used for genomic analysis to further characterize the outbreak strain.

With the assistance of the police and town council, the communities heeded the ban on sales of ice blocks and cooked food. The ORS treatment points were maintained until no more cases were reported. Toilets were built for the care centres, and several IDPs were voluntarily repatriated to their home villages. An awareness task force led by the officer-in-charge of the Bulolo Health Centre covered all of the hamlets and sections of the towns with prevention messages on the Five Fs (Food, Fingers, Fluid, Faeces, Flies). Shops and fast food outlets not conforming to the standards and instructions issued by environmental health officers were given notice and followed up until they complied.

DISCUSSION

In this paper we report on a large outbreak of shigellosis that commenced in a settlement camp for IDPs before spreading to the surrounding community and another township in the same area. The outbreak resulted in approximately 1200 cases of suspected shigellosis, which is one of the largest outbreaks reported in the literature.

This outbreak highlights the threat of shigellosis to vulnerable populations. At particular risk are displaced persons, refugees and people in institutional settings. However, as the spread of this outbreak to the broader community illustrates, much of the population-at-large is at risk of shigellosis. Papua New Guinea has one of the lowest rates of access to safe water and sanitation in the Western Pacific Region.[5,6] In this instance, the outbreak originated in a settlement camp for displaced persons; however, the rapid spread of the disease throughout the general community is an indication that improvements are needed in the delivery of basic services. The recent country-wide outbreak of cholera is further evidence of the impact that enteric diseases can have on regions where there is inadequate access to safe water and sanitation.[7] Improvements in safe water and sanitation, though often challenging to implement and maintain in remote, resource-poor settings, need to be prioritized.[8]

Shigella has been established as an important cause of disease in Papua New Guinea. In a recent study in the highlands of the country, *Shigella* was isolated from 22% of patients (adults and children) presenting to an urban clinic or hospital outpatients with diarrhoea/dysentery; with *S. flexneri* the most common species detected.[9] Similarly, a molecular-based study detected *Shigella* as

the most common pathogen in children (less than five years old) hospitalized with acute watery diarrhoea in the same setting.[10] An outbreak of shigellosis, attributed to *S. flexneri* serotype 3, was reported in a remote region of Papua New Guinea in 2009, complicated by a concurrent outbreak of H3N2 influenza.[11] These findings are of great importance given the lack of a vaccine to prevent infection with *Shigella* and the increasing antibiotic resistance of *Shigella* globally, including Papua New Guinea.[9,12]

In this study, the low isolation and detection rates of *Shigella* from outbreak samples were probably due to the extended time between sample collection and laboratory testing (more than a week). The logistical issues of transporting clinical material in Papua New Guinea have been noted previously during recent outbreaks of cholera,[13] shigellosis[11] and chikungunya.[14] Incomplete road networks and the paucity of diagnostic laboratories commonly hamper disease outbreak investigations. However, the isolation of *Shigella* from independent sampling and testing from two laboratories confirm that *Shigella* sp. was the etiological agent of the outbreak. During the shigellosis outbreak, fragile health care systems and poorly equipped clinics were further stretched by the increase in cases. Although this resulted in suboptimal completion of line lists and may affect the representativeness of the data, we are confident that the results presented in this paper are an accurate description of the shigellosis outbreak in this region. Further studies to fully understand the epidemiology of shigellosis are required in Papua New Guinea with the hope that control strategies can be developed.

Conflicts of interests

None declared.

Funding

None.

Acknowledgements

The authors thank the staff from the Bulolo and Wau Health Centres and the general community from the two townships for their assistance with our investigations. Field investigations and outbreak mitigation measures were conducted with support from the Government of Papua New Guinea, the Morobe Provincial Health Authority and the World Health Organization. Laboratory investigations at the Papua New Guinea Institute of Medical Research were supported by the Internal Competitive Research Award Scheme from the Government of Papua New Guinea.

References

1. Kotloff KL et al. Global burden of *Shigella* infections: implications for vaccine development and implementation of control strategies. *Bulletin of the World Health Organization*, 1999, 77:651–666. pmid:10516787
2. *Guidelines for the control of shigellosis, including epidemics due to Shigella dysenteriae type 1*. Geneva, World Health Organization, 2005 (http://whqlibdoc.who.int/publications/2005/9241592330.pdf, accessed 29 January 2014).
3. DuPont HL et al. Inoculum size in shigellosis and implications for expected mode of transmission. *Journal of Infectious Diseases*, 1989, 159:1126–1128. doi:10.1093/infdis/159.6.1126 pmid:2656880
4. Lin WS, Cheng CM, Van KT. A quantitative PCR assay for rapid detection of *Shigella* species in fresh produce. *Journal of Food Protection*, 2010, 73:221–233. pmid:20132666
5. *National Health Plan 2001–2010: Health Vision 2010. Policy Directions and Priorities. Vol. 1*. Port Moresby, Papua New Guinea Ministry of Health, 2000.
6. World Health Organization, United Nations Children's Fund Joint Monitoring Programme for Water Supply and Sanitation. *Estimates for the use of improved sanitation facilities, Papua New Guinea*. New York, United Nations Children's Fund, 2010 (http://www.unicef.org/infobycountrypapuang_statistics.html, accessed 14 November 2011).
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. Horwood PF, Greenhill AR. Cholera in Papua New Guinea and the importance of safe water sources and sanitation. *Western Pacific Surveillance and Response Journal*, 2012, 3:3–5. doi:10.5365/wpsar.2011.2.4.014 pmid:23908900
9. Greenhill AR et al. Antibiotic resistant Shigella is a major cause of diarrhoea in the Highlands of Papua New Guinea. *Journal of Infection in Developing Countries*. In press.
10. Soli KW et al. Detection of enteric viral and bacterial pathogens associated with paediatric diarrhoea in Goroka, Papua New Guinea. *International Journal of Infectious Diseases*, 2014: pii: S1201-9712(14)01463-5. In press. doi:10.1016/j.ijid.2014.02.023 pmid:25193391
11. Rosewell A et al. Concurrent influenza and shigellosis outbreaks, Papua New Guinea, 2009. *Emerging Infectious Diseases*, 2011, 17:756–758. doi:10.3201/eid1706.101021 pmid:21470485
12. Rosewell A et al. *Shigella* spp. antimicrobial drug resistance, Papua New Guinea, 2000–2009. *Emerging Infectious Diseases*, 2010, 16:1797–1799. doi:10.3201/eid1611.101025 pmid:21029550
13. Greenhill AR 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 pmid:23908909
14. Horwood PF et al. Outbreak of chikungunya virus infection, Vanimo, Papua New Guinea. *Emerging Infectious Diseases*, 2013, 19:1535–1538. doi:10.3201/eid1909.130130 pmid:23965757

Newborn care practices and home-based postnatal newborn care programme – Mewat, Haryana, India, 2013

Latika Nath Sinha,[a] Prabhdeep Kaur,[a] Rakesh Gupta,[b] Suresh Dalpath,[c] Vinod Goyal[c] and Manoj Murhekar[a]

Correspondence to Latika Nath (e-mail: drlatika@gmail.com).

Background: In India, the Home Based Postnatal Newborn Care programme by Accredited Social Health Activists (ASHAs) under the National Rural Health Mission was initiated in 2011 to reduce neonatal mortality rates (NMRs). ASHAs get cash incentives for six postnatal home visits for newborn care. We studied newborn care practices among mothers in Mewat, Haryana, having a high NMR and determined risk factors for unsafe practices and described the knowledge and skills of ASHAs during home visits.

Methods: A cross-sectional survey was conducted among mothers who had delivered a child during the previous seven months using cluster sampling. We interviewed mothers and ASHAs in the selected subcentres using semi–structured questionnaires on the six safe newborn care practices, namely safe breastfeeding, keeping cord and eyes clean, wrapping baby, kangaroo care, delayed bathing and hand washing.

Results: We interviewed 320 mothers, 61 ASHAs and observed 19 home visits. Overall, 60% of mothers adopted less than three safe practices. Wrapping newborns (96%) and delayed bathing (64%) were better adopted than cord care (49%), safe breastfeeding (48%), hand washing (30%), kangaroo care (20%) and eye care (9%). Cultural beliefs and traditional birth attendants influenced the mother's practices. The lack of supervision by auxiliary nurse midwives (ANM), delayed referral and transportation were the other challenges.

Conclusion: Knowledge–practice gaps existed among mothers counselled by ASHAs. Poor utilization of reproductive and child health services decreased opportunities for ASHA–mother dialogue on safe practices. Recommendations included training ANMs, training TBAs as ASHAs, innovative communication strategies for ASHAs and improved referral system.

Globally, over 130 million babies are born every year, and almost 4 million die in the first four weeks of life.[1] Presently, the infant mortality rate (IMR) for India is 47 per 1000 live births, and the neonatal mortality rate (NMR) is 32 per 1000 live births.[2] India aims for a two-thirds reduction in IMR, from the 1990 level of 84/1000 live births to 28/1000 live births by 2015.[3] The NMR contributes to 68% of the IMR, and any further reduction in IMR can only come from a decline in NMR.[4] The effective interventions to reduce the NMR component of the IMR in settings with high mortality and weak health systems include outreach, family-community care, health education to improve home-care practices and a simultaneous expansion of clinical care.[5] Several trials incorporating community-level interventions in South Asia (Pakistan, Bangladesh, Nepal) and sub-Saharan Africa (Nigeria, Malawi, Ethiopia) have shown reductions in neonatal mortality rates.[6] Community-based trials from Maharashtra and Uttar Pradesh in India showed 62% and 54% reductions in neonatal mortality, respectively, through multiple prenatal and postnatal home visits by trained community level health workers.[7,8] Based on evidence from these trials, and WHO and UNICEF recommendations, the Government of India introduced home-based newborn care involving community-based workers, Accredited Social Health Activists (ASHAs), under the National Rural Health Mission in June 2011.[4]

Mewat district in Haryana has the highest IMR of 91/1000 live births and NMR of 47/1000 live births in the state.[9,10] The Home Based Post Natal Newborn Care (HBPNC) programme was implemented with technical assistance from the United Nations Office for Project Services-Norway India Partnership Initiative in addition to health system strengthening in Mewat.[11,12] An ASHA

[a] National Institute of Epidemiology, Chennai, India.
[b] National Rural Health Mission, Haryana, India.
[c] Child Health and Immunization, Directorate of Health Services, Haryana, India.
Submitted: 31 January 2014; Published: 29 September 2014
doi: 10.5365/wpsar.2014.5.1.006

is paid a monetary incentive for making one prenatal visit (in eighth month of pregnancy) and six postnatal (on days 1, 3, 7, 14, 28 and 42) home visits.[4]

State programme managers assessed the level of implementation of various interventions targeted to improve newborn care at the community level; mothers were usually dependant on traditional birth attendants (TBAs) who conducted home deliveries and subsequently advised them on newborn care. Therefore, we estimated the knowledge, attitude and practices among mothers regarding newborn care and determined the factors associated with unsafe neonatal care practices by mothers. We also estimated key indicators of the HBPNC programme for training, knowledge, timeliness, quality and documentation of ASHAs' home visits.

METHODS

Study area

Mewat district in the south of Haryana has a population of 1 089 406.[13] It has six rural blocks with 431 villages. Muslims comprise 82% of the population, and the majority of the people in the rural part of the district are farmers. The female literacy rate in the district is 36.6%.[14] In an otherwise well-performing state this district is a high focus area due to its poor heath indicators and infrastructure.[15,16] Of the 715 ASHAs in the district providing newborn care, 438 had received two rounds of training on providing home-based care.

Study population and study design

We surveyed mothers who had delivered a live child within the reference period (1 July 2012 to 31 January 2013) and who resided in the same cluster health subcentre (health unit catering to a population of 5000 with an auxiliary nurse midwife [ANM] in charge) during delivery and during the data-collection period. The corresponding ASHAs in the subcentre areas were also included in the study. It was a cross-sectional study.

Sampling procedure and sample size

We used cluster sampling techniques with subcentres as Primary Sampling Units. The estimated number of pregnancies in one year is 35 000 (birth rate is 35/1000 live births); per the District Level Household and Facility Survey 3, 29% of mothers practised safe breastfeeding practices in Mewat.[17] A relative precision of 20% (equivalent to an absolute precision of 5.8% on either side) was used and was rounded off to 6% to calculate sample size. Assuming the same 29% of mothers knew other safe newborn care practices, a 95% confidence interval, an absolute precision of ± 6% and design effect of 1.38, a sample size of 320 mothers was needed. We interviewed 20 mothers in each of the 16 clusters. We selected the clusters using probability-proportionate-to-size linear systematic sampling method. Mothers within the selected cluster were selected using the line list of deliveries within the reference period in the subcentre. A 5% non-response rate was seen among the mothers. The first respondent was selected randomly from the list, while the subsequent mothers were selected from the chronological order of deliveries, giving priority to more recent deliveries. All the ASHAs serving the subcentre areas were also interviewed.

Data collection

We used a questionnaire to collect data from mothers regarding socio-demographic characteristics; knowledge, attitude and practices of newborn care and their interaction with ASHAs during the course of their last pregnancy up to 42 days after delivery. ASHAs were interviewed regarding their knowledge; practices; important skills such as taking weight, temperature and recognizing danger signs; motivating factors and hindrances in providing home-based newborn care. ASHAs' activities during home visits were observed using a checklist. Data were collected by trained field investigators and the principal investigator between January and March 2013. Operational definitions are shown in **Box 1**.

Data analysis

Data were entered and analysed using Epi Info (version 3.5.3) and MS Excel software. We estimated the proportion for awareness, practice of safe newborn care and reasons for not adopting safe practices among mothers. We also estimated the proportion of ASHAs giving correct advice on safe practices, training, timeliness, quality and documentation of home visits.

Human subject protection

The study was approved by the Institutional Ethics Committee of the National Institute of Epidemiology,

Box 1. **Operations definitions**

Mother: Mothers of babies delivered within the period 1 July 2012 to 31 January 2013.
Neonate/Newborn: Childhood period from zero to 28 days.
Early breastfeeding: A mother putting her newborn child to breast within one to six hours of delivery.
Colostrum feeding: A mother feeding her newborn the first milk (colostrum) secreted from her breast after delivery.
Exclusive breastfeeding: A mother who fed her newborn only breast milk for the entire neonatal period.
Safe breastfeeding: A mother who adopted all three of the breastfeeding practices.
Keeping cord stump and eyes clean: Not applying anything to the umbilical cord of the neonate in the entire neonatal period except on medical advice by a qualified doctor.
Not applying anything to the eyes except on medical advice.
Wrapping baby: Wrapping the neonate in multiple layers of clothing.
Kangaroo care (skin-to-skin care): Holding the neonate with his/her bare skin in contact with the bare skin of mother/caregiver.
Delaying bath: Not giving a bath to the newborn until at least 48 hours after delivery.
Hand washing: Washing hands by mother/caregiver with soap and water each time before handling the child.
Safe newborn care practice: A mother adopting the following six practices – safe breastfeeding, keeping cord clean and eye care, wrapping baby, kangaroo care, delaying bath and hand washing.
ASHA: A woman of a village (married/widowed/divorced) 25–45 years of age recruited as a link worker between community and health delivery systems under the National Rural Health Mission on a population of 1000.
"102 ambulance referral service" (Haryana Swasthya 102 Vaahan Sewa): Ambulance service provided by the government in response to a call on a toll-free number ("102") in medical emergencies.

Chennai. We briefed the participants about the study, gave them an information sheet and took written informed consent from them. Special care was taken to explain the study to illiterate mothers before their consent was taken in the presence of witnesses.

RESULTS

Socio demographic characteristics

We interviewed 320 mothers, 61 ASHAs and directly observed home visits of 19 ASHAs. Most mothers were housewives (211, 66%), illiterate (243, 76%) and Muslims (226, 71%). Also, 118 (37%) did not have any antenatal check-up during their pregnancy, and 124 (39%) had no antenatal check-up in the first trimester. Home deliveries by traditional birth attendants (TBAs) were reported by 165 (52%) mothers, and 63 (36%) mothers had not been counselled on newborn care. Among the 155 hospital deliveries, 94% had a hospital stay of less than 48 hours post-delivery. One hundred and sixty-two (51%) mothers had three or more children, and the majority (275, 86%) had less than two years spacing between children.

Safe practices

Overall, 237 (74%) mothers started breastfeeding within the first hour, 279 (87%) fed colostrum, and 188 (58%) mothers exclusively breastfed their newborn. The baby was wrapped in multilayers by 308 (96%) mothers, and 64 (20%) of them practised the kangaroo care method. Delayed bath after 48 hours was given to babies by 205 (64%) mothers. Half of the mothers (158, 49%) did not apply anything on the cord stump, and 28 (9%) mothers kept the eyes clean. The proportion of mothers aware of, yet not practising, was highest for hand washing with soap and water before handling a newborn (45%), cord care (42%) and exclusive breastfeeding (32%) (**Figure 1**).

The common reasons stated by mothers for non-adoption of safe practices were that they prefer to follow tradition, advice/influence of local TBAs (midwives), family pressure and personal choice besides medical reasons. TBAs bathed the newborns immediately, used unsterile thread to tie the cord and advised mothers to coat the newborns' cord stumps with multiple applications. Among the mothers who were aware of, yet not following safe practices, the TBA influence was reported as the leading cause by 37% of the mothers for the practice of delayed breastfeeding, 26% for not keeping the cord clean and by 17% for bathing immediately after birth. For hand washing with soap and water, 59% of mothers stated they "did not consider it necessary," and 15% respondents said they had "no time" for this practice (**Figure 2**).

Risk factors for unsafe practices

ASHAs' knowledge and service delivery

Among the ASHAs, 51 (83.6%) knew how to use the weighing scale, and 43 (70%) could correctly take a temperature using a digital thermometer. Although 90% of the ASHAs interviewed knew the importance of most of the safe practices, the lesser known and advocated safe practices were delayed bathing by 52 (85.2%)

Figure 1. **Awareness and adoption of newborn care practices among mothers in Mewat, Haryana, India, 2013 (*n* = 320)**

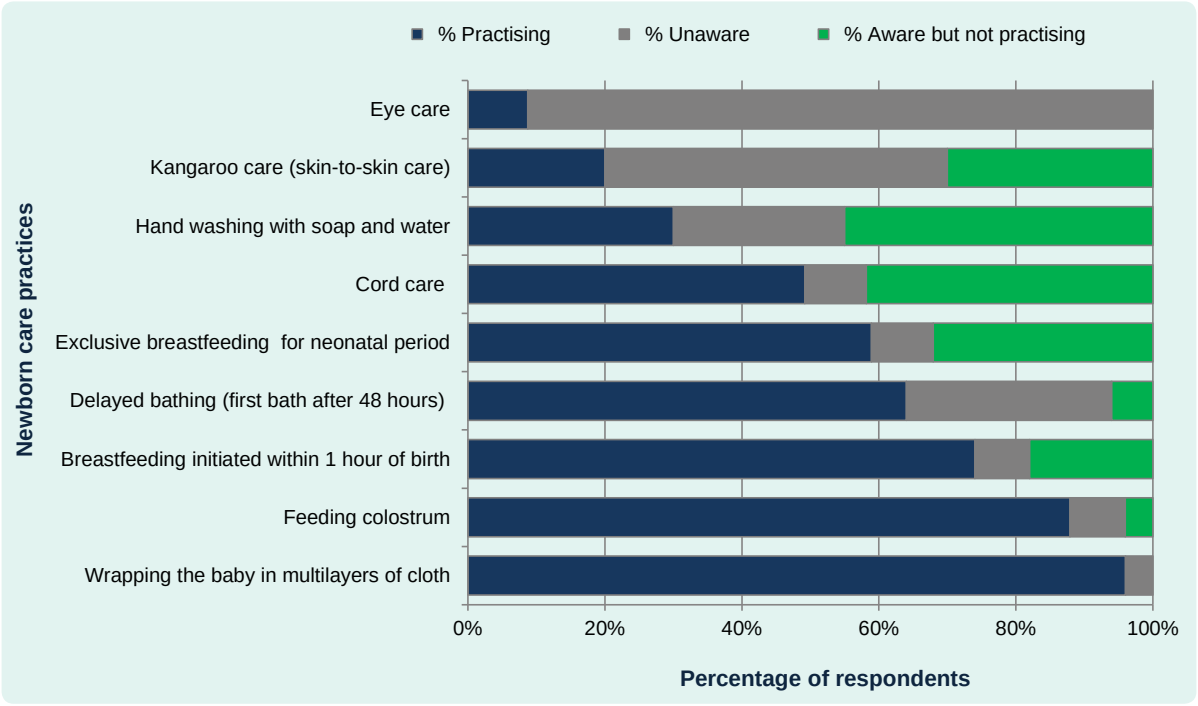
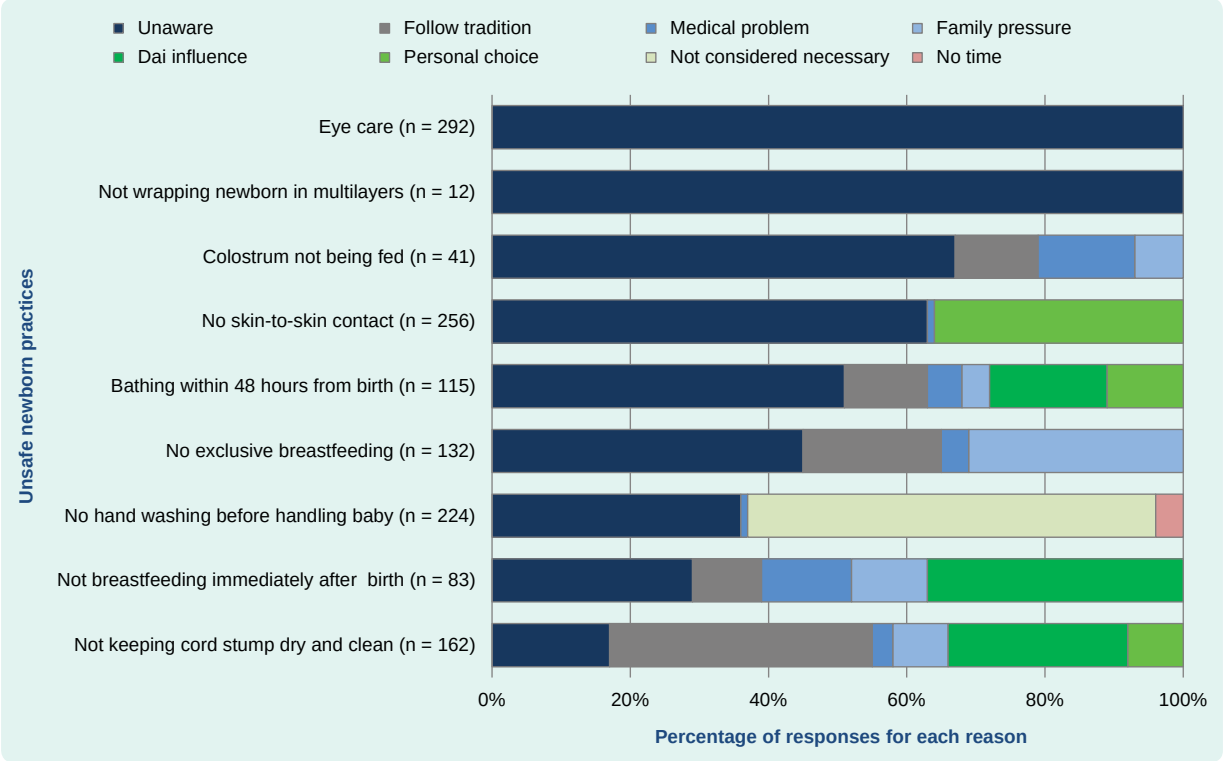


Figure 2. **Reasons given by mothers for not practising safe newborn care by each practice, Mewat, Haryana, India, 2013**



ASHAs, kangaroo care method by 44 (72%), hand washing with soap and water before handling newborn by 41 (67%) and safe eye care by 24 (39%) of the ASHAs. Only 30% of the mothers reported ASHAs' visits on day one of the birth (among home deliveries), and 15% of the mothers recalled all seven visits by an ASHA. On direct observation of 19 ASHAs, only 32% washed their hands before handling the baby, 40% gave

Table 1. **Key activities of Home Based Newborn Care by trained ASHAs in Mewat, Haryana, India, 2013**

Key activities	*n*	%	Total
Timeliness of home visits			
Mothers who reported ASHAs' visit on first day (within 24 hours of home delivery)	55	33	165
Mothers who reported all seven postnatal home visits by ASHAs for newborn care	47	15	320
Quality of visit (by direct observation of 19 home visits)			
Carrying weighing scale	14	74	19
Carrying thermometer	11	58	19
Took weight of newborn correctly after adjusting for zero error	10	71	14
Took temperature of newborn correctly	8	73	11
Gave information on immunization (BCG, polio, hepatitis B)	18	95	19
Gave information on birth registration to mother	17	90	19
Advised on cord care	16	84	19
Physically examined newborn for jaundice/rash	14	74	19
Advised on kangaroo care	8	42	19
Gave information about 102 ambulance service for sick newborn	7	37	19
Advised on recognition of danger signs	7	37	19
Washed hands before handling newborn	6	32	19
Advised on hand washing before handling newborn	4	21	19
Advised on eye care	3	16	19
Used the pictorial flip chart to explain safe practices to mothers	0	0	19
Documentation			
ASHAs filling out the postnatal care cards	11	58	19
ASHAs found with erroneously filled out postnatal care cards	38	62	61
ASHAs visits crosschecked/verified by ANMs	4	7	61
Status of referrals made:			
Number of ASHAs who referred sick newborns in last seven months	34	56	61
Availability of 102 ambulance for these referrals	8	24	34
Number of ASHAs who reported delays/refusals in 102 service	26	43	61

information about 102 ambulance referral service (**Box 1**) and 37% mentioned danger signs. None of the ASHAs used the pictorial flip chart given to them in their trainings to increase the mothers' understanding. There was no monitoring or supervision of the ASHAs' home visits by the ANMs. Among the ASHAs, 58% were simultaneously filling out the postnatal cards. Delay in 102 service was reported by 43% of the ASHAs (**Table 1**).

We analysed the dose response relationship to determine the relationship of each of the unsafe practices with the decrease in the number of post-delivery home visits by ASHAs. There was a significant increasing trend of unsafe newborn care practices with regards to early bathing and cord care with fewer visits ($P < 0.01$) but not in early breastfeeding and kangaroo care (**Table 2**).

DISCUSSION

Our study showed adoption of select newborn care practices among mothers; however, there were gaps in the adoption of a few practices either due to lack of awareness or influence of other stakeholders. ASHAs played an important role in influencing the mother's behaviour; however, lack of utilization of various Reproductive and Child Health (RCH) programme services limited the opportunities for contact with the health system.

Improvement in adoption of breastfeeding practices, except exclusive breastfeeding, can possibly be attributed to the consistent efforts made by the ASHAs to educate mothers during home visits. A similar change was seen in a study in Sri Lanka on involvement

Table 2. **Unsafe newborn care practices versus number of ASHA visits among mothers in Mewat, Haryana, India, 2013 (n = 320)**

Unsafe practices		Number of home visits > 7 visits	5–6 visits	3–4 visits	0–2 visits	χ^2 for trend	p-value
Bathing baby before 48 hours	%	12	24.0	25.0	38.0		
	OR	1	2.4	2.2	3.8	12.1	< 0.01
Unclean cord	%	18	23.0	32.0	28.0		
	OR	1	1.4	2.3	2.4	8.9	< 0.01
No exclusive breastfeeding	%	18	26.0	25.0	31.0		
	OR	1	1.6	1.3	2.5	5.9	< 0.05
Not feeding colostrum	%	10	24.0	32.0	34.0		
	OR	1	2.6	3.2	4.2	5.7	< 0.05
No hand washing	%	23	23.0	26.0	29.0		
	OR	1	0.9	1.0	2.7	5.4	< 0.05
No early breastfeeding	%	20	21.0	29.0	30.0		
	OR	1	0.9	1.3	1.7	2.8	NS
No kangaroo care	%	60	75.0	66.0	55.0		
	OR	1	1.8	2.5	1.5	1.5	NS
All practices	%	21	25.0	26.0	29.0		
	OR	1	1.3	1.4	2.5	5.8	< 0.05

OR, odds ratio; NS, not significant

of health workers in postnatal home visits.[18] The odds of practising safe breastfeeding among mothers was found to be higher (odds ratio: 7.6; 95% confidence interval: 6.03–9.71) among those who received one-on-one counselling and hands-on support in an intervention trial where community-based trained workers made home visits within the first three days of birth in Bangladesh.[19] Therefore, more intensive counselling by ASHAs in the first three postnatal visits might further improve adoption of this practice.

Cord care and hand washing were the two practices that were not adopted despite awareness. Hand washing was primarily influenced by low risk perception by mother and cord care was influenced by TBAs who conducted the home delivery. Similar low coverage of clean cord care was seen in Southern Nepal among home deliveries, increasing the risk of umbilical infections by 29% (due to topical applications) and 62% (due to other unclean practices).[17] A randomized controlled trial in Pakistan showed that training TBAs and their integration into the health system to propagate newer safe practices, such as cord care, were effective in reducing neonatal mortality by 30%.[20] We need to consider strategies to better engage the TBAs to increase the adoption of these practices.

Low awareness regarding kangaroo care and eye care led to low adoption of these practices. ASHAs were not emphasizing the multiple benefits of kangaroo care such as prevention of hypothermia and the role of skin-to-skin contact to promote longer duration of breastfeeding, increased bonding, reduced pain responses and crying in newborns.[21,22] Adoption of these newer practices requires engaging not only the mothers but also the community at large using innovative communication strategies like messages, songs, flip charts and sharing of personal experiences as done in the Shivgarh intervention trial.[23]

There was low utilization of RCH services in Mewat for family planning, antenatal care and delivery. This reduced the number of contacts of the mother with ASHA/ANM for counselling on birth preparedness, benefits of institutional deliveries and postnatal newborn care.[6] The lack of acceptance of family planning may lead to poor birth spacing in this population that increases the risk of pre-term and low birth weight babies who are more susceptible to infections and hence mortality.[24,25] An ASHA visit on the first day after home delivery might influence the mother, but less than half of the newborns were visited on day one in our study. The importance of a first day home visit in reducing mortality by 67% was highlighted in a meta-analysis.[3] Visits on subsequent

days by ASHAs are important for early recognition of feeding problems and treatable infections followed by prompt referrals to reduce morbidity and mortality in newborns.[3] One of the key issues emerging from our study was poor supervision of ASHAs' home visits by ANM. Observation revealed that inadequate documentation and inability to use instruments was noticeable among illiterate ASHAs who were formerly TBAs. In addition, lack of ANM training on HBPNC guidelines might be preventing effective supervision of ASHA visits and their documentation.

We have not included mothers who went to their maternal/native place outside the subcentre areas for their delivery in this study. One of our other limitations was a problem in recall by mothers of ASHA visits even though the reference period was seven months.

Our sample was representative of the district, and the results can be extrapolated to the entire district. This study has shown good implementation and outcomes in an underdeveloped district; therefore, the benefits of this programme might be similar in other districts with even better health systems.

In conclusion, mothers adopted a few safe practices; however, there were gaps in the adoption of several safe practices despite being informed of them. ASHAs seem to have played a key role in facilitating the adoption of safe practices; however, the quality of services can be further improved. There was a need for innovative training strategies to improve the ASHAs' skills and a need for engaging communities including elder family members and TBAs in counselling sessions to increase community acceptance of safe practices. Practices such as kangaroo care and hand washing need more emphasis in the training. Strengthening delivery of RCH services would increase opportunities for ASHA–mother dialogue on safe practices. Training of TBAs and recruiting them as ASHAs would further strengthen the programme. Training of all ANMs in HBPNC guidelines to enable supportive supervision in the field was recommended. The responsiveness of the 102 ambulance services to newborn emergencies also needed improvement.

The local health authorities implemented some of our study recommendations immediately. Approximately 75 TBAs were inducted into the ASHA system, and a cadre of ASHA facilitators were trained for better supervision of home visits. There was re-training of ASHAs to enhance communication skills. A grievance unit was established to address delays in referral transport. We need follow-up studies to determine the effectiveness of the actions taken by the health authorities.

Conflicts of interest

None declared.

Funding

The funding was done by the National Rural Health Mission, Haryana, India.

Note:

This paper was accepted for publication as a result of a call for articles to all presenters at the 2013 TEPHINET conference.

References:

1. Lawn JE, Cousens S, Zupan J; Lancet Neonatal Survival Steering Team. 4 million neonatal deaths: When? Where? Why? *Lancet*, 2005, 365:891–900. doi:10.1016/S0140-6736(05)71048-5 pmid:15752534
2. *World Bank report on Neonatal Mortality Rates*. Washington, DC, World Bank, 2012.
3. Gogia S Sr et al. Community based newborn care: a systematic review and metaanalysis of evidence: UNICEF-PHFI series on newborn and child health, India. *Indian Pediatrics*, 2011, 48:537–546. doi:10.1007/s13312-011-0096-8 pmid:21813923
4. *Home Based Newborn Care–Operational Guildelines*. New Delhi, Ministry of Health and Family Welfare, 2011, 8–10 (http://www.nihfw.org/Doc/NCHRC-Publications/Operational Guidelines on Home Based Newborn Care (HBNC).pdf, accessed 25 August 2014).
5. Darmstadt GL et al.; Lancet Neonatal Survival Steering Team. Evidence-based, cost-effective interventions: how many newborn babies can we save? *Lancet*, 2005, 365:977–988. doi:10.1016/S0140-6736(05)71088-6 pmid:15767001
6. Nair N et al. Improving newborn survival in low-income countries: community-based approaches and lessons from South Asia. *PLoS Medicine*, 2010, 7:e1000246. doi:10.1371/journal.pmed.1000246 pmid:20386728
7. Kumar V et al.; Saksham Study Group. Effect of community-based behaviour change management on neonatal mortality in Shivgarh, Uttar Pradesh, India: a cluster-randomised controlled trial. *Lancet*, 2008, 372:1151–1162. doi:10.1016/S0140-6736(08)61483-X pmid:18926277
8. Bang AT et al. Neonatal and infant mortality in the ten years (1993 to 2003) of the Gadchiroli field trial: effect of home-based neonatal care. *Journal of Perinatology*, 2005, 25 Suppl 1;S92–107. doi:10.1038/sj.jp.7211277 pmid:15791283
9. National Health System Resource Centre. *5th Common Review Mission Report 2011. Haryana.* New Delhi, Ministry of Health and Family Welfare, 2012 (http://mohfw.nic.in/WriteReadData/

I892s/3174333004Main%20Report_5th_CRM%20.pdf, accessed 25 August 2014).

10. Lahariya C et al.; INCLEN Program Evaluation Network International (IPEN). Interdistrict variations in child health status and health services utilization: lessons for health sector priority setting and planning from a cross-sectional survey in rural India. *The National Medical Journal of India*, 2012, 25:137–141. pmid:22963289
11. *12th Norway India Partnership Initiative Programme management group-minutes of meetings*. New Delhi, Norway India Partnership Initiative, 2011.
12. *Annual Report 2011: Norway India Partnership Initiative*. New Delhi, Norway India Partnership Initiative, 2011.
13. *Census India 2011*. New Delhi, Ministry of Home Affairs, 2011.
14. Ministry of Minority Affairs and Indian Council of Social Science Research. *A baseline survey of minority concentration districts of India Mewat (Haryana).* New Delhi, Institute for Human Development, 2008 (http://www.icssr.org/Mewat[1].pdf, accessed 25 August 2014).
15. National Rural Health Mission. *Strategy Initiative to catch up with MDG Goals 4 and 5 - Accelerating Strategy for mother and child survival in high focus states and high focus districts in non high focus states*. New Delhi, Ministry of Health and Family Welfare, 2009.
16. *National Rural Health Mission for the Twelfth Five-Year Plan*. New Delhi, Ministry of Health and Family Welfare, 2012.
17. Mullany LC et al. Risk factors for umbilical cord infection among newborns of southern Nepal. *The American Journal of Epidemiology*, 2007, 165:203–211. doi:10.1093/aje/kwj356 pmid:17065275
18. Senarath U, Fernando DN, Rodrigo I. Newborn care practices at home: effect of a hospital-based intervention in Sri Lanka. *Journal of Tropical Pediatrics*, 2007, 53:113–118. doi:10.1093/tropej/fml080 pmid:17169975
19. Mannan I Sr et al.; Bangladesh Projahnmo Study Group. Can early postpartum home visits by trained community health workers improve breastfeeding of newborns? *Journal of Perinatology*, 2008, 28:632–640. doi:10.1038/jp.2008.64 pmid:18596714
20. Khadduri R et al. Household knowledge and practices of newborn and maternal health in Haripur district, Pakistan. *Journal of Perinatology*, 2008, 28:182–187. doi:10.1038/sj.jp.7211903 pmid:18059464
21. Johnston CC et al. Kangaroo care is effective in diminishing pain response in preterm neonates. *Archives of Pediatrics & Adolescent Medicine*, 2003, 157:1084–1088. doi:10.1001/archpedi.157.11.1084 pmid:14609899
22. Conde-Agudelo A, Belizán JM, Diaz-Rossello J. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *The Cochrane Database of Systematic Reviews*, 2011, (3):CD002771. pmid:21412879
23. USAID-ACCESS. *Demystifying community mobilization: an effective strategy to improve maternal and newborn health*. Washington, DC, United States Agency for International Development, 2007 (http://pdf.usaid.gov/pdf_docs/PNADI338.pdf, accessed 8 September 2014).
24. Joshi HS et al. Risk Factors Associated with Low Birth Weight in Newborns. *Indian Journal of Community Medicine*, 2005, 30:142–143.
25. Haaga JG. Mechanisms for the association of maternal age, parity, birth spacing with infant health. California, RAND Labor and Population, 1991 (http://www.rand.org/pubs/notes/N2991.html, accessed 25 August 2014).

A marked decline in the incidence of malaria in a remote region of Malaita, Solomon Islands, 2008 to 2013

Hellen Oloifana-Polosovai,[a] John Gwala,[a] Humpress Harrington,[a] Peter D Massey,[b] Elmer Ribeyro,[a] Angelica Flores,[a] Christopher Speare,[c] Edwin McBride,[d] David MacLaren[d] and Rick Speare[e]

Correspondence to Rick Speare (e-mail: rickspeare@gmail.com).

Setting: Atoifi Adventist Hospital (AAH), Solomon Islands, the only hospital in the East Kwaio region.

Objective: To use routine surveillance data to assess the trends in malaria from 2008 to 2013.

Design: Descriptive study of records from (1) AAH laboratory malaria records; (2) admissions to AAH for malaria; and (3) malaria treatments from outpatient records.

Results: AAH examined 35 608 blood films and diagnosed malaria in 4443 samples comprised of 2667 *Plasmodium falciparum* (Pf) and 1776 *Plasmodium vivax* (Pv). Between 2008 and 2013 the total number of malaria cases detected annually decreased by 86.5%, Pf by 96.7% and Pv by 65.3%. The ratio of Pf to Pv reversed in 2010 from 2.06 in 2008 to 0.19 in 2013. For 2013, Pf showed a seasonal pattern with no cases diagnosed in four months. From 2008 to 2013 admissions in AAH for malaria declined by 90.8%, and malaria mortality fell from 54 per 100 000 to zero. The annual parasite index (API) for 2008 and 2013 was 195 and 24, respectively. Village API has identified a group of villages with higher malaria incidence rates.

Conclusion: The decline in malaria cases in the AAH catchment area has been spectacular, particularly for Pf. This was supported by three sources of hospital surveillance data (laboratory, admissions and treatment records). The decline was associated with the use of artemisinin-based combined therapy and improved vertical social capital between the AAH and the local communities. Calculating village-specific API has highlighted which villages need to be targeted by the AAH malaria control team.

In the 22 Pacific island countries and areas, malaria is endemic in Papua New Guinea, Solomon Islands and Vanuatu.[1] Malaria is close to elimination in Vanuatu only in Tafea Province and in Solomon Islands only in Isabel Province. Solomon Islands has been successful in reducing malaria incidence and mortality. The annual parasite index (API), was reduced from 82 in 2008 to 45 in 2012.[2] Mortality was 15.7, 7 and 3 per 100 000 in 2003, 2007 and 2012, respectively.[2,3] In Malaita Province, the API was 137, 83 and 33.5 in 1996, 2009 and 2011, respectively.[4–6] Apart from reducing malaria cases and deaths, the Ministry of Health has the goal of eliminating malaria from two of nine provinces: Isabel and Temotu. The recent and ongoing outbreak of dengue in Solomon Islands has highlighted the challenges of vector control and health education relevant for malaria.[7]

A national policy for all patients to receive a diagnostic malaria test if suspected was implemented in 1968.[8] In the mid-1970s, the API was 30 with malaria largely controlled by residual dichlorodiphenyltrichloroethane (DDT) sprayed inside houses.[9] With the cessation of DDT use in 1993 the API rose to 400.[10] Insecticide treated nets (ITNs) were trialled in the early 1990s, and national distribution began in 1996.[8,10] In 2008 artemisinin-based combination therapy (ACT) was made free for all ages.[8] The reported malaria cases (confirmed) in Solomon Islands fell more than 50% between 2000 and 2009 from 368 913 (68 107) to 84 078 (33 002) cases.[11,12] In the Atoifi Adventist Hospital (AAH) catchment area, the setting for this study, ITNs were made available in the 1990s but not distributed to all residents. New ITNs were distributed in November 2010 but to five villages

[a] Atoifi Adventist Hospital, Atoifi, Malaita, Solomon Islands.
[b] Health Protection, Hunter New England Population Health, Tamworth, Australia.
[c] Tropical Health Solutions Pty Ltd, Townsville, Australia.
[d] College of Medicine and Dentistry, James Cook University, Cairns, Australia.
[e] College of Public Health, Medical and Veterinary Sciences, James Cook University, Townsville, Australia.
Submitted: 22 July 2014; Published: 30 September 2014
doi: 10.5365/wpsar.2014.5.3.002

only. In July 2009, ACT became the only malaria treatment available in the AAH outpatients department (OPD).

A laboratory scientist at the AAH laboratory noted a decline in the number of malaria cases and the proportion of cases due to *Plasmoduim falciparum* (Pf) between 2008 and 2013. However, the laboratory data had not been analysed. The aims of this study were to use the data from malaria tests performed at AAH from 2008 to 2013 to (1) describe the trend in confirmed malaria and the proportion of Pf to *Plasmodium vivax* (Pv); (2) confirm any trends in the laboratory data by assessment of malaria treatment and admission data; and (3) determine the API for the AAH catchment area and for major villages in this area for 2008 and 2013. The Regional Action Plan for the Control and Elimination of Malaria in the Western Pacific (RAP) calls for strengthening national routine surveillance systems to monitor malaria trends and programme impact (Objective 6).[1] Hence, this project aligned well with the RAP.

METHODS

Study design

Descriptive study involving review of (1) laboratory records of malaria tests; (2) admissions for malaria; and (3) prescription of malaria treatments.

Study setting and population

Lying between latitudes 6° and 12° South, Solomon Islands is a tropical country with a total population of 515 870 (2009 census) and is ranked 143 out of 187 on the Human Development Index.[13,14] AAH is in Malaita Province, located on the remote east coast of the island of Malaita (population 137 597) at Uru Harbour and services the people of the East Kwaio region. There is no road access to Atoifi. People travel by light aircraft, boat, canoe or foot. AAH is in a unique situation of being the only hospital and centre for malaria microscopy in East Kwaio, and it is also the only malaria treatment centrea in the Uru Harbour area. AAH provides primary health care services and inpatient services for patients referred from distant clinics.

Testing criteria: any patient presenting or referred to OPD with a fever has a blood sample taken for a malaria film before administration of any treatment. This is standard practice consistent with the national policy.[8] A malaria microscopist is always available and examines the film soon after collection or within 48 hours.

Malaria data

The following details are recorded for every malaria test: date of test, patient name, age, sex, village and result. For this study, all specimens were thick blood films stained with Romanovsky stain (Chem-Supply Pty., Ltd, Australia). Specimens were microscopically examined under oil immersion; and results recorded as malaria species: Pf, Pv or mixed (Pf and Pv). For calculations, mixed infections were counted as Pf. All results were written in a malaria laboratory book. Examinations were done mainly by the same two scientists; when they were away, another three laboratory technicians provided results. Rapid diagnostic tests are available at AAH, but so rarely are they done that no data was available.

For this study each laboratory record from 2008 to 2013 was entered into Microsoft Excel (2010) and analysed.

For a 10-week period in 2009, from 23 July 2009 to 30 September 2009, records were missing from laboratory books and could not be found. An estimate was generated for total tests and positive cases by averaging data for the missing period using matching values for 2007, 2008 and 2010.

Hospital admissions

Admissions to the hospital for malaria were obtained from the AAH admission register. The case definition was based on the Solomon Islands Health Information System, whereby that a patient with clinical malaria had symptoms of malaria (confirmed), was hospitalized and was treated with antimalarial drugs. Details collected included age, sex, outcome and length of stay.

Treatments for malaria

The use of antimalarial drugs over the same period was accessed from the records of AAH OPD. Since malaria

treatment for inpatients is always initiated in OPD, these records also capture inpatient treatments.

Demography

People who access services at AAH are primarily from two administrative districts, Gulalofou (Ward 17) and Waneagu/Taelanasina (Ward 18). From the 2009 census, the populations of these districts were 6031 and 3478, respectively, totalling 9509.[13] This figure was used as the denominator for calculating API, annual blood examination rate (ABER), malaria admission rate and malaria mortality rate for the AAH catchment area. API is the number of confirmed malaria cases per 1000 population per year, and ABER is the number of tests done for malaria per year, expressed as a percentage of the catchment population. Solomon Islands has an annual 2.3% population growth.[13] For Malaita Province the annual population growth rate was 2.51%. Using 2009 as the starting point, the population was estimated for the other years using the more conservative 2.3% annual increase.

Over 150 villages are in the AAH catchment area with the largest having approximately 300 residents. To provide a denominator to calculate API and ABER at the village level, Family Heath Cards were used. To obtain data to complete these cards, AAH conducts a regular village demographic survey for the Ministry of Health. Data were available for 2008 but not for 2013. Using a conservative approach, the 2008 population numbers were used as the denominator in 2013. API and ABER for villages were calculated by dividing the number of malaria cases and blood films examined by the population and multiplying by 1000.

Rates

Rates of malaria were calculated for the two-year period 2008–2009, prior to and during the introduction of the medication CoArtem® (Novartis, USA) and compared to the most recent two-year period 2012–2013. Two-year periods were used to increase the strength of the comparison. The rate ratio between periods was calculated with a 95% confidence interval (CI).

Assessment with the RAP

Results for malaria control in the AAH catchment area were then reviewed in line with the criteria in the RAP.[1]

Ethics approval was given by the Atoifi Human Research Ethics Committee.

RESULTS

From 2008 to 2013 (missing 10 weeks of data in 2009), the AAH examined 35 608 blood films for malaria (**Table 1**); the number of cases tested decreased 45.2% over this period.

Males accounted for 44% (15 816/35 571) of the tests and children under five years for 33% (11 617/34 916) (**Table 1**). The proportion of tests by sex and age group remained similar over the period.

The number of cases of malaria and percent positive were highest in 2008 (1817 and 23.6%) and lowest in 2013 (246 and 5.8%) (**Figure 1** and **Table 2**). Between 2008 and 2013 the total number of positive cases of malaria decreased by 86.5%, Pf by 96.7% and Pv by 65.3%. The ratio of Pf to Pv reversed in 2010 from 2.059 in 2008 to 0.194 in 2013 (**Table 2**). The change in ratio was greatest between 2012 and 2013.

Fourteen mixed infections of Pf and Pv were diagnosed and counted as Pf. In 2012, cases of malaria, Pf and Pv rose, but this was reversed for Pf in 2013 with a 78.8% decrease in cases, while Pv had a decrease of 4.6%.

For the period 2008–2009, the annual malaria incidence rate was 13 906 per 100 000 population; for the period 2012–2013, the rate was 3161 per 100 000. The rate ratio was 0.23 (95% CI: 0.21–0.25), showing a significant reduction.

Malaria was diagnosed in all months for Pv from 2008 to 2013 and for Pf from 2008 to 2012. In 2013, Pf was not diagnosed in four months; the pattern of Pf changed from a year-long transmission to a suggestion of

Table 1. **Number of all malaria tests by year, sex and age group, AAH, Solomon Islands, 2008–2013**

Year and sex	0–4 years	5–9 years	10–14 years	15+ years	Unknown	Total
2008	***2364 (31%)***	***1028 (13%)***	***427 (6%)***	***3768 (49%)***	***114 (1%)***	***7701***
Male	1337	589	210	1479	45	3660
Female	1024	438	217	2285	60	4024
Unknown	3	1		4	9	17
2009*	***1811 (31%)***	***732 (12%)***	***390 (7%)***	***2814 (48%)***	***94 (2%)***	***5841***
Male	992	405	180	1082	35	2694
Female	818	327	210	1732	59	3146
Unknown	1					1
2010	***2192 (34%)***	***781 (12%)***	***339 (5%)***	***3094 (48%)***	***60 (1%)***	***6466***
Male	1106	412	150	1070	30	2768
Female	1085	369	189	2022	29	3694
Unknown	1			2	1	4
2011	***2232 (38%)***	***653 (11%)***	***294 (5%)***	***2624 (44%)***	***123 (2%)***	***5926***
Male	1197	339	130	904	58	2628
Female	1033	314	164	1715	64	3290
Unknown	2			5	1	8
2012	***1684 (31%)***	***682 (13%)***	***331 (6%)***	***2525 (46%)***	***230 (4%)***	***5452***
Male	835	348	176	865	101	2325
Female	847	332	155	1658	129	3121
Unknown	2	2		2		6
2013	***1334 (32%)***	***411 (10%)***	***272 (6%)***	***2134 (50%)***	***71 (2%)***	***4222***
Male	645	219	125	719	33	1741
Female	689	192	147	1414	38	2480
Unknown				1		1
Total	**11 617**	**4287**	**2053**	**16 959**	**692**	**35 608**

* The data for 2009 are incomplete as 10 weeks of laboratory records were unavailable.

Figure 1. **Number of malaria cases by month and year, AAH, Solomon Islands, 2008–2013**

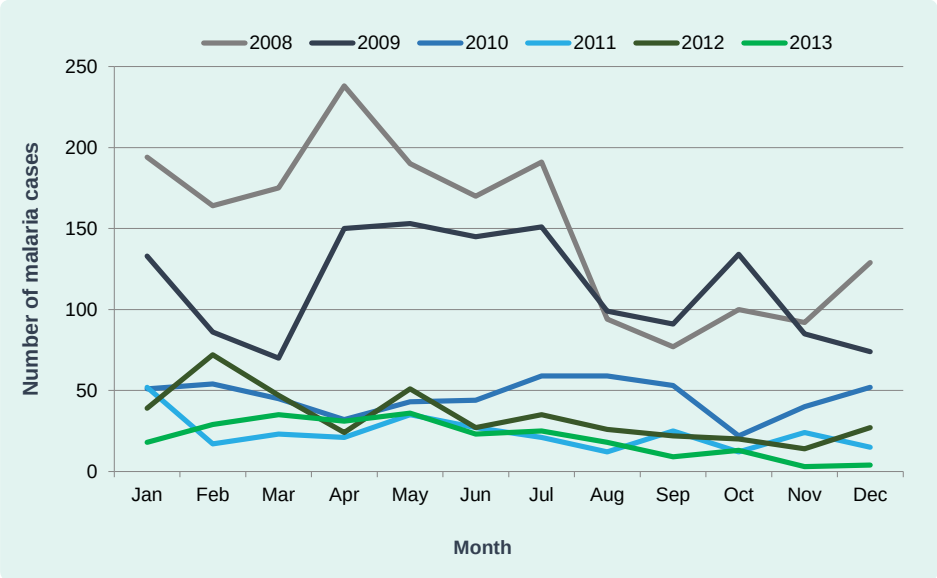


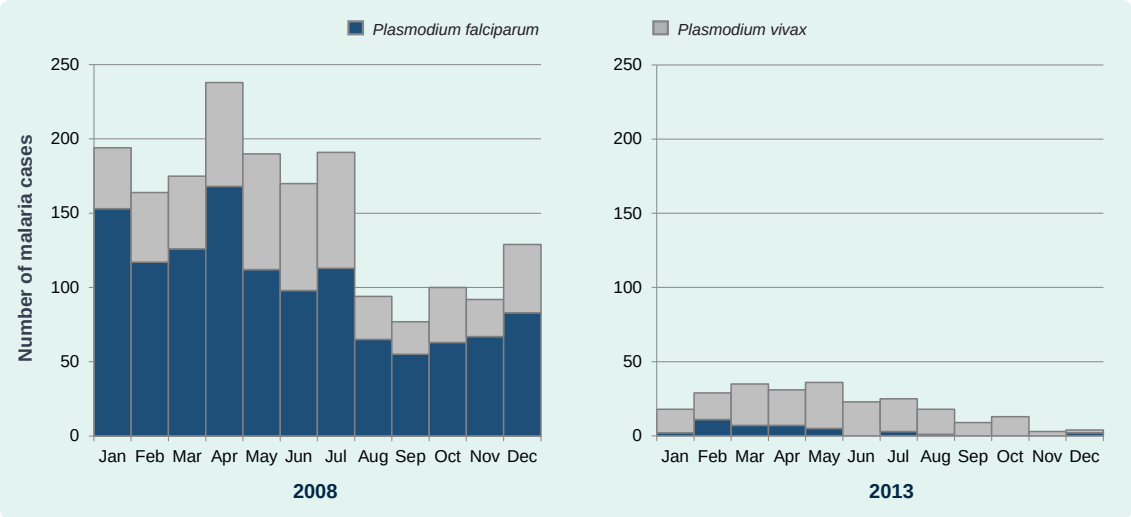
Table 2. **Malaria cases by species and year diagnosed at AAH, Solomon Islands, 2008–2013**

Year	Total slides	Malaria	(%)	Pf	(%)	Pv	(%)	Pf/Pv ratio
2008	7701	1817	(23.6)	1223	(15.9)	594	(7.7)	2.059
2009*	5841	1132	(19.4)	798	(13.7)	334	(5.7)	2.389
2010	6466	558	(8.6)	271	(4.2)	287	(4.4)	0.944
2011	5926	285	(4.8)	146	(2.5)	139	(2.3)	1.050
2012	5452	405	(7.4)	189	(3.5)	216	(4.0)	0.875
2013	4222	246	(5.8)	40	(0.9)	206	(4.9)	0.194
Total	**35 608**	**4443**		**2667**		**1776**		

Pf, *Plasmodium falciparum*; Pv, *Plasmodium vivax*

*The data for 2009 were incomplete as 10 weeks of laboratory records were unavailable.

Figure 2. **Number of malaria cases by species and month for 2008 and 2013, demonstrating marked decline in both species and development of a seasonal pattern for *Plasmodium falciparum* in 2013, AAH, Solomon Islands**



a seasonal pattern with transmission mainly in the first five months of the year (**Figure 2**).

The mean age of malaria cases was lower for both males and females than negative cases (**Table 3**). The mean age of Pv cases was less than that of Pf cases for both sexes for most years. The difference in mean age was greatest in 2013 (**Table 3**).

Malaria admissions

Hospital admission records for malaria were available for all six years except for the first three months of 2008 (**Table 4**). Males and children under five years made up 50.3% and 43.3% of total admissions, respectively. The number of admissions declined 90.8% from 2008 to 2013, and the number of deaths fell to zero from 54 per 100 000 in 2008 (**Table 4**). Length of stay did not change. Hospital policy from 2009 was to keep all malaria inpatients until the course of ACT was complete.

Malaria treatments

Over the six-year period, data were missing for 10 of the 72 months (**Table 5**). The number of malaria treatments fell 91% from 2008 to 2013 (**Table 5**). Chloroquine, Fansidar and quinine were not used after 2009. The category of "no specific details" contains records that stated malaria treatment was given, but no drug details were recorded in OPD records. After July 2009, this category could include only ACT as all other malaria treatments were removed from the AAH OPD.

Table 3. **Mean age of patients with positive malaria films, by sex and year, AAH, Solomon Islands, 2008–2013**

Year	Male			Female		
	Pf	Pv	Negative	Pf	Pv	Negative
2008	14.59	12.14	17.67	18.13	17.07	22.54
2009	13.53	14.16	16.89	17.21	14.66	21.43
2010	13.94	10.57	16.51	16.38	14.36	21.31
2011	9.09	10.83	15.51	21.98	13.43	20.05
2012	17.60	14.99	16.87	20.51	20.95	20.73
2013	10.38	8.41	17.80	21.18	8.77	22.25
2008–2013	13.19	11.85	16.88	19.39	14.87	21.39

Pf, *Plasmodium falciparum*; Pv, *Plasmodium vivax*

Table 4. **Admissions and outcomes for patients admitted with malaria by year, AAH, Solomon Islands, 2008–2013**

	2008*	2009	2010	2011	2012	2013	Total
Admissions	153	188	84	50	38	14	527
Deaths	5	2	2	1	0	0	10
Case fatality ratio of admitted cases (%)	3.3%	1.1%	2.4%	2.0%	0.0%	0.0%	1.9%
Median length of stay (days)	4	4	4	4	6	4	4
Less than 5 years of age (number,% of total malaria admission per year)	67, 43.8%	69, 36.7%	35, 41.7%	31, 62.0%	17, 44.7%	8, 57.1%	228, 43.3%
Admissions per 100 000 population	1646	1977	863	502	373	154	
Deaths per 100 000 population	54	21	21	10	0	0	

* Missing admission records for January to March for 2008.

Table 5. **Number of people prescribed malaria drugs by year, AAH OPD, Solomon Islands, 2008–2013**

Drug	2008*	2009†	2010‡	2011	2012	2013§	Total
Chloroquine	801	805	0	0	0	0	1606
Fansidar	43	60	0	0	0	0	103
Primaquine	10	6	3	3	10	8	40
Quinine	7	3	0	0	0	0	10
ACT	0	165	495	338	287	52	1337
No specific details	978	772	559	307	270	98	2984
Total	**1839**	**1811**	**1057**	**648**	**567**	**158**	**6080**

ACT, artemisinin-based combination therapy.

* Missing data for January to February 2008.

† Missing data for October to December 2009.

‡ Missing data for January to February 2010.

§ Missing data for April to June 2013.

Table 6. **ABER and API for the AAH catchment population, 2008–2013**

Year	Population	Examined	ABER	Malaria	API
2008	9295	7701	83%	1817	195
2009*	9509	7318	77%	1375	145
2010	9728	6466	66%	558	57
2011	9951	5926	59%	285	29
2012	10 180	5452	54%	405	40
2013	10 414	4222	40%	246	24

ABER, annual blood examination rate; API, annual parasite index.

* 2009 has estimates for missing data.

ABER and API

The API for the Atoifi catchment area declined from 195 in 2008 to 24 in 2013, while ABER halved from 83% to 40% for 2008 to 2013, respectively (**Table 6**).

For villages with a reliable 2008 population estimate, the highest API of 732 was for Gounasuu (**Table 7**). Gounasuu also had the highest API in 2013 although it had declined by 50% to 366.

This study reports confirmed malaria cases over six years (2008 to 2013) from a major hospital in a remote region of Solomon Islands. Since every febrile case or suspected malaria case has a blood test, positive cases of malaria were always laboratory-confirmed cases. This contrasts with presumptive clinical reporting of malaria cases which overestimates malaria incidence.[15] In our study, a presumptive clinical diagnosis of malaria would have overestimated incidence by approximately four times in 2008 and 17 times in 2013. The other unique aspect is that AAH is the only source for malaria treatment in the Uru Harbour area. AAH therefore captures a high proportion of symptomatic malaria cases in the Uru Harbour region. The AAH data provide a reliable estimate of the incidence of malaria in the AAH catchment area.

A large and significant reduction in the rates of diagnosed malaria occurred during the period 2008 to 2013. The data show a remarkable fall in the number of blood films positive for malaria, particularly for Pf. The fall in the number of Pf cases was so great that in 2013, no cases were diagnosed in four months and a pattern consistent with seasonal transmission appeared for the first time. The seasonal pattern has been maintained in 2014 with no Pf cases for two (April, May) of the first six months (personal observation of two AAH staff). Variation in climate is unlikely to account for this. Although there are no weather records for East Kwaio, the weather has not varied significantly over these years, being generally hot (> 26 °C) with at least 200 mm of rain per month.

Table 7. **ABER and API for selected villages for 2008 and 2013**

Villages	2008					2013					Reduction	
	Population	Number of slides examined	Number tested positive	ABER (%)	API	Population	Number of slides examined	Number tested positive	ABER (%)	API	ABER (%)	API (%)
Alasi	307	275	63	89.6	205	307	194	6	63.2	19	29.5	90.7
Abitona	145	345	66	237.9	455	145	204	13	140.7	90	40.9	80.2
Ambulo	46	93	19	202.1	413	46	74	1	160.9	22	20.4	94.7
Atoifi	220	585	80	265.9	364	220	390	6	177.3	27	33.3	92.5
Bunibuniana	93	206	42	221.5	452	93	106	2	113.9	22	48.5	95.1
Canaan	194	223	47	114.9	242	194	133	13	68.5	67	40.3	72.3
Galilee	92	101	25	109.8	239	92	56	5	60.9	54	44.6	80.1
Gethsamane	72	77	20	106.9	278	72	21	0	29.1	0	72.7	100.0
Gounasuu	41	109	30	265.8	732	41	87	15	212.2	366	20.2	50.0
Loama	265	296	70	111.7	264	265	168	6	63.4	23	43.2	91.3
Na'au	304	521	117	171.4	385	304	324	17	106.5	56	37.8	85.5
Sifilo	207	481	84	232.4	406	207	193	1	93.2	5	59.9	98.8
Wyfolonga	123	297	64	241.5	520	123	164	23	133.3	187	44.8	64.0

ABER, annual blood examination rate; API, annual parasite index.

Pv progressively became the dominant species over this time since its incidence fell less than Pf. Since primaquine is rarely used at AAH for vivax malaria, some of these cases could be relapses from hypnozoites. As malaria elimination progresses globally, Pv is becoming the predominant malaria species.[16] The number of severe cases of malaria, as indicated by admissions, showed a similar spectacular decline, falling 91%. This was a conservative value since for the commencing year, 2008, three months of admissions data were missing, making the true reduction higher. Since the national malaria admission rate was 750 per 100 000 in 2008 and 1000 in 2012, the AAH rate of 1646 per 100 000 in 2008 was more than double, and the 2012 rate of 373 per 100 000 was a third of the national rate.[8] Solomon Islands malaria-related mortality in 2007 and 2012 was 7 and 3 per 100 000, respectively.[2] The AAH catchment area, with its malaria mortality rate of 54 per 100 000 was almost eight times the national rate in 2008 and much lower (zero) by 2012.

These results demonstrate that control of malaria in the Atoifi catchment area has exceeded the national performance. The API for Malaita Province in 2011 was 33.0, placing it sixth among the provinces.[6] Atoifi achieved a lower API by 2013.

Prior to July 2009, malaria was treated with Fansidar with or without chloroquine. The AAH OPD records showed quinine being prescribed to initiate therapy on admission in 2008 and 2009 but not subsequently.

Causation cannot be attributed from such a study. However, the fall in malaria coincided with two significant events at AAH: (1) introduction of ACT as the only treatment available at OPD in July 2009; and (2) introduction of a long-term research capacity-strengthening project in 2009 that is still ongoing.[17] ACT was introduced nationally in 2009 with variable results and not such a large decline in malaria incidence as reported in our study.[8,18] The approach taken for the research capacity-strengthening activities at Atoifi is very inclusive, involving community members as well as health professionals and researchers.[19] It includes community-based research of diseases of importance to the people of the area.[20,21] This has made the AAH more accessible to the surrounding communities.[17] Social capital is important in malaria control in Solomon Islands.[22] The improved vertical social capital between the AAH and the local communities, which commenced in 2009, may have also contributed to the marked decline in malaria incidence. Indoor spraying is not conducted in this area and ITN use has not been assessed.

The initial API for the study area was much higher than that reported for Solomon Islands nationally and for Malaita Province. In 2009, the API for Solomon Islands was 77.0 while the API for Malaita Province in the same year was the highest for the Solomon Islands at 82.9.[23] The initial incidence of malaria in the Atoifi area was double the national API but similar to rates in the capital, Honiara.[24] The villages with the highest APIs (Gounasuu, Wyfolonga and Abitona) are clustered within two kilometres of each other in a mangrove swamp, and vector-biting rates are probably high. However, there have been no entomological studies in this area. These villages can now be targeted for special attention by the malaria control programme at Atoifi. The API at Atoifi, the community which includes the AAH, was as high in 2008 as the APIs of the surrounding less well developed villages. This may have been due to Anopheles in the AAH being infected by patients attending the hospital and transmitting malaria locally. As a result of this finding, in late 2013 the hospital installed mosquito screens on the windows of all hospital wards. These examples highlight the value of calculating a village API.

Limitations

Malaria was diagnosed by thick film only. This is the standard practice used in routine medical diagnostic laboratories in most developing countries. The accuracy of identifying *Plasmodium* species by thick film is less than by thin film.[25] Since the same microscopists performed the majority of examinations; were trained in malaria microscopy; used a standard staining technique; had good quality, well-maintained microscopes; and results were provided to clinicians promptly, the trend data will be reliable.[25,26] Atoifi also meets the standards of the Solomon Islands laboratory quality assurance programme and both microscopists are certified. Calculations for API and ABER were based on hospital data (numerator) and the total population of the administrative districts of Gulalofou and Waneagu/Taelanasina (denominator). Some people from very remote parts of these districts only travel to AAH for life-threatening illness or may bypass AAH to travel to health clinics in other districts.[27] In addition, since the southern part of Ward 18 includes

Table 8. **Trends in malaria at AAH compared with the malaria elimination progress criteria in the RAP (p. 31)[1]**

Criteria	2008	2013	Comment
Deaths due to malaria (number and rate) will decrease by at least 50% by 2015 compared with the 2007 baseline	5, 3 per 1000 cases	0, 0	Achieved by 2009
Confirmed malaria cases (number and rate) will be reduced by at least 50% by 2015 compared with the 2007 baseline	1817 API 195	246 API 24	Achieved by 2010
Percentage of cases due to *Plasmodium falciparum* will be decreased compared with the 2007 baseline	67.1%	15.4%	Achieved: Pf/Pv ratio reversed by 2012
Admitted malaria cases (number and rate) will drop by at least 50% by 2015 compared with the 2007 baseline	153 1646 per 100 000 population	14 134 per 100 000 population	Achieved by 2011
Malaria test positivity rate (for microscopy and rapid diagnostic tests) will be reduced to less than 5%	23.6%	5.8%	Close to meeting 5% positivity rate in 2013

populations adjacent to Singalagu Harbour, residents may attend the Singalagu clinic instead of AAH, underestimating malaria incidence. However, we believe these factors have not changed over the period of the study and the trend data is reliable.

Although 10 weeks of data for 2009 were missing from the laboratory data, the available data had a high standard of accuracy with a low percentage of data missing. The admissions register was missing three months of data for the baseline year (2008) and for the treatment records in OPD. Additional problems with administrative data were illustrated by the lack of details in malaria treatment records. AAH has now requested OPD to record specific details of treatment given.

This study illustrates the value of analysing routinely collected administrative data to provide trends in disease. Laboratory results, hospital admissions and malarial treatments provided the indicators relevant to incidence and severity of malaria.

The RAP states that successful implementation of malaria programme activities is expected to result in six achievements by 2015.[1] It is interesting to compare progress at Atoifi against five of these, bearing in mind that the RAP uses 2007 as a baseline and 2015 as the endpoint (**Table 8**).

CONCLUSION

The decline in the incidence and severity of malaria in the AAH catchment area has been spectacular, particularly for Pf. This was supported by three sources of hospital administrative data (laboratory, admissions and treatment records). The marked decline appears to be associated with the use of ACT and improved vertical social capital between AAH and the surrounding communities. Calculating village-specific API has highlighted which villages need to be targeted by the AAH malaria control team. The study illustrates the value of using routinely collected hospital administrative data in monitoring disease trends in a tropical resource-poor setting.

Conflicts of interest

None declared.

Funding

This study received financial support from TDR, the Special Programme for Research and Training in Tropical Diseases, cosponsored by United Nations Children's Fund, United Nations Development Programme, the World Bank and WHO (grant 1–811001688).

References

1. *Regional Action Plan for Malaria Control and Elimination in the Western Pacific (2010–2015).* Manila, World Health Organization Regional Office for the Western Pacific, 2012:63 (http://www.wpro.who.int/mvp/documents/Malaria_Regional_Action_Plan_FINAL.pdf, accessed 11 September 2014).
2. *Solomon Islands–Australia Partnership for Development. Independent Performance Assessment Panel – Assessment for 2012: Final Report*. Honiara, Government of Solomon Islands, 2013 (http://aid.dfat.gov.au/countries/pacific/solomon-islands/Documents/solomon-islands-p4d-independent-assessment-2012.pdf, accessed 11 September 2014).
3. *Monitoring and Evaluation Plan: 1 May 2011–31 December 2014. Multi-country Western Pacific Rolling Continuation Channel Malaria Grant 15 June 2011*. Honiara, Solomon Islands National Malaria Control Programme,

2014 (https://www.spc.int/frp/index2.php?option=com_docman&task=doc_view&gid=476&Itemid=33, accessed 11 September 2014).

4. Over M et al. Impregnated nets or DDT residual spraying? Field effectiveness of malaria prevention techniques in Solomon Islands, 1993–1999. *The American Journal of Tropical Medicine and Hygiene*, 2004, 71 Suppl;214–223. pmid:15331840
5. O'Sullivan M et al. Malaria elimination in Isabel Province, Solomon Islands: establishing a surveillance-response system to prevent introduction and reintroduction of malaria. *Malaria Journal*, 2011, 10:235. doi:10.1186/1475-2875-10-235 pmid:21834995
6. *Progress in malaria control and moving towards elimination in Solomon Islands and Vanuatu*. Manila, World Health Organization Regional Office for the Western Pacific, 2012 (http://www.wpro.who.int/world_health_day/2014/progressinmalariacontrolSOLVAN.pdf, accessed 11 September 2014).
7. Nogareda F et al. Ongoing outbreak of dengue serotype-3 in Solomon Islands, January to May 2013. *Western Pacific Surveillance and Response Journal*, 2013, 4:28–33. doi:10.5365/wpsar.2013.4.2.013 pmid:24319611
8. *World Malaria Report 2013*. Geneva, World Health Organization, 2013:238 (http://www.who.int/malaria/publications/world_malaria_report_2013/en/, accessed 11 September 2014).
9. Avery JG. A review of the malaria eradication programme in the British Solomon Islands Protectorate. *Papua New Guinea Medical Journal*, 1974, 17:61–67.
10. Kere NK et al. Permethrin-impregnated bednets are more effective than DDT house-spraying to control malaria in Solomon Islands. *Medical and Veterinary Entomology*, 1996, 10:145–148. doi:10.1111/j.1365-2915.1996.tb00720.x pmid:8744706
11. *World Malaria Report 2010*. Geneva, World Health Organization, 2011:286 (http://www.who.int/malaria/world_malaria_report_2010/en/, accessed 11 September 2014).
12. *Country Profile – Solomon Islands*. Manila, World Health Organization Regional Office for the Western Pacific, 2010 (http://www.who.int/malaria/publications/country-profiles/2010/mal2010_slb.pdf?ua=1, accessed 19 September 2014).
13. *Report on 2009 Population and Housing Census. Statistical Bulletin 06/2011*. Honiara, Government of Solomon Islands, 2011:51.
14. United Nations Development Programme. Human Development Report 2013. *The rise of the South: Human progress in a diverse world*. New York, United Nations Development Programme, 2013:216 (http://hdr.undp.org/en/2013-report, accessed 11 September 2014).
15. Roucher C et al. Changing malaria epidemiology and diagnostic criteria for *Plasmodium falciparum* clinical malaria. *PLoS ONE*, 2012, 7:e46188. doi:10.1371/journal.pone.0046188 pmid:23029433
16. Koepfli C et al. A large *Plasmodium vivax* reservoir and little population structure in the South Pacific. *PLoS ONE*, 2013, 8:e66041. doi:10.1371/journal.pone.0066041 pmid:23823758
17. Redman-MacLaren M et al. Mutual research capacity strengthening: a qualitative study of two-way partnerships in public health research. *International Journal for Equity in Health*, 2012, 11:79. doi:10.1186/1475-9276-11-79 pmid:23249439
18. Wijesinghe RS et al. Exploring provider and community responses to the new malaria diagnostic and treatment regime in Solomon Islands. *Malaria Journal*, 2011, 10:3. doi:10.1186/1475-2875-10-3 pmid:21219614
19. Redman-Maclaren ML et al. Research workshop to research work: initial steps in establishing health research systems on Malaita, Solomon Islands. *Health Research Policy and Systems*, 2010, 8:33. doi:10.1186/1478-4505-8-33 pmid:21034512
20. Massey PD et al. Progress towards TB control in East Kwaio, Solomon Islands. *Rural and Remote Health*, 2013, 13:2555. pmid:23731167
21. Massey PD et al. TB questions, East Kwaio answers: community-based participatory research in a remote area of Solomon Islands. *Rur and Remote Health*, 2012, 12:2139. pmid:23094978
22. Uchiyama H, Kawabata M. Social capital and health in malaria-prevalent areas of the Solomon Islands. *The Kobe Journal of Medical Sciences*, 2011, 57:E49–62. pmid:22926073
23. Atkinson JA et al. Operational research to inform a sub-national surveillance intervention for malaria elimination in Solomon Islands. *Malaria Journal*, 2012, 11:101. doi:10.1186/1475-2875-11-101 pmid:22462770
24. Kunimitsu A. The accuracy of clinical malaria case reporting at primary health care facilities in Honiara, Solomon Islands. *Malaria Journal*, 2009, 8:80. doi:10.1186/1475-2875-8-80 pmid:19389239
25. Payne D. Use and limitations of light microscopy for diagnosing malaria at the primary health care level. *Bulletin of the World Health Organization*, 1988, 66:621–626. pmid:2463112
26. Durrhelm DN et al. Diagnostic disagreement–the lessons learnt from malaria diagnosis in Mpumalanga. *South African Medical Journal*, 1997, 87:609–611. pmid:9254820
27. MacLaren D, Kekeubata E. Reorienting health services through community health promotion in Kwaio, Solomon Islands. *Promotion & Education*, 2007, 14:78–79. doi:10.1177/10253823070140021701 pmid:17665704

Preparedness for molecular testing of Middle East respiratory syndrome coronavirus among laboratories in the Western Pacific Region

Raynal C Squires[a] and Frank Konings[a]

Correspondence to Frank Konings (e-mail: koningsf@wpro.who.int).

Since the notification of the first cases of Middle East respiratory syndrome coronavirus (MERS-CoV) in September 2012, a total of 837 laboratory-confirmed cases and 291 deaths have been reported globally as of 23 July 2014,[1] primarily in the Arabian Peninsula. However, the possibility of importation of MERS-CoV in the World Health Organization (WHO) Western Pacific Region exists given the large number of individuals who travel annually to the Middle East for religious purposes, employment or other reasons. Malaysia[2] and the Philippines[3] have recently reported cases in people travelling from the Middle East. As such, it is essential that laboratory capacity be in place for the detection of MERS-CoV.

Several laboratories worldwide established molecular detection of MERS-CoV by reverse transcriptase polymerase chain reaction (RT–PCR) early in the outbreak. WHO encouraged these laboratories to provide technical support and reference testing service to countries without such capacity while expanding MERS-CoV testing at the national level by building primarily on the existing molecular testing capacity of the Global Influenza Surveillance and Response System (GISRS). Serological assays for MERS-CoV have also been developed, but they are not widely available and have not been fully validated; case confirmation has relied predominantly on molecular detection methods.

We present the findings of a voluntary, rapid survey targeting national-level public health laboratories in the Western Pacific Region. The survey was administered after nearly two years of activities aimed at building laboratory capacity for MERS-CoV detection and sought to determine preparedness of countries for MERS-CoV testing. Questions addressed three main areas: availability of protocols, guidance and reagents; immediate testing capacity; and referral mechanisms.

The survey was web-based, consisted of 21 multiple-choice questions and was conducted between 18 June and 14 July 2014. Participating laboratories were assured of confidentiality and the reproduction of aggregated data alone in publications. A total of 21 survey invitations were distributed to 18 countries and areas (areas[4] are non-sovereign jurisdictions within a WHO region, such as the French overseas collectivities of New Caledonia and French Polynesia; countries and areas are together referred to as "countries" in this article). Invitations principally targeted one responsible laboratory in each country; for three countries, two laboratories were included as they were both tasked with MERS-CoV testing. Survey responses were not verified for accuracy.

Results are illustrated in **Table 1**. The survey was completed by 19 laboratories in 16 countries of the Western Pacific Region. The majority of participating laboratories (15/19) were National Influenza Centres (NICs) or located within an institution housing an NIC, highlighting the role of the pre-existing GISRS network in MERS-CoV testing.

Sixteen (84.2%) laboratories in 13 countries indicated that they had capacity in place for molecular detection of MERS-CoV, while three laboratories used referral mechanisms instead. All 16 laboratories with MERS-CoV testing capacity responded that they had a standard operating procedure for molecular detection of MERS-CoV in place, with 12 choosing to incorporate

[a] Emerging Disease Surveillance and Response Unit, Division of Health Security and Emergencies, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.

Submitted: 21 July 2014; Published: 14 August 2014
doi: 10.5365/wpsar.2014.5.3.001

Table 1. **Responses to a web-based survey determining preparedness for molecular testing for MERS-CoV among 19 national-level public health laboratories in the WHO Western Pacific Region,* conducted 18 June to 14 July 2014**

Category	Proportion	%
In-country molecular testing in place	**16/19**	**84.2**
Standard operating procedure for MERS-CoV testing in place	16/16	100.0
MERS-CoV included in in-house respiratory pathogen algorithm	12/16	75.0
Incorporating detection method of Corman et al[5]	12/16	75.0
MERS-CoV testing reagents and positive controls on hand	16/16	100.0
Sample sequencing available on- or off-site	11/16	68.8
Immediate testing capacity		
1–50 samples	8/16	50.0
50–250 samples	5/16	31.2
> 250 samples	3/16	18.8
Laboratories having tested suspected samples	10/16	62.5
Participated in an external quality assessment for MERS-CoV	10/16	62.5
In-country testing not available but via referral	**3/19**	**15.8**

* Laboratories participating in the survey were located in: Australia, Cambodia (two laboratories), Fiji, French Polynesia, Hong Kong (China), Japan, the Lao People's Democratic Republic, Malaysia (two laboratories), Mongolia, New Caledonia, New Zealand, Papua New Guinea, the Philippines, the Republic of Korea, Singapore and Viet Nam (two laboratories).

MERS-CoV into their standard algorithm for respiratory pathogens. All 16 reported having the appropriate positive control material, primers and probes for MERS-CoV RT–PCR on hand. Most laboratories (12/16) used or adapted the recommended RT–PCR protocol for screening and confirmation designed by Corman et al.[5] Sequencing, as a means of confirming discordant results and providing insight into the origin, spread and possible mutation of the virus, was equally available in on- or off-site facilities in 11 laboratories. Ten laboratories (in 10 countries) reported having participated in an external quality assessment (EQA) for MERS-CoV testing; most (8/10) used the EQA organized by the Robert Koch Institute in Germany. All 16 laboratories followed, or incorporated as part of their own design, the WHO interim recommendations for MERS-CoV testing[6] and interim guidelines for laboratory biorisk management.[7]

At the time of the survey, 10 laboratories in nine Western Pacific Region countries had already tested suspected samples of MERS-CoV, indicating the importance of testing capacity in the Region even though the virus thus far primarily affects countries outside the Region. To determine each laboratory's emergency outbreak capacity, participants were also asked to estimate the volume of suspected MERS-CoV samples that could be processed in 48 hours. Of the 16 laboratories with MERS-CoV testing capacity, three (18.8%) indicated they could test over 250 samples, five (31.2%) could test 50–250 samples and eight (50%) could test 1–50 samples. Two-thirds (11) of these laboratories maintained that they could report to public health authorities within one day of obtaining results; the remainder could report in 2–5 days.

Referral is an important mechanism for pathogen identification and confirmation. Of the 19 laboratories participating in the survey, five (two in low-income and three in high-income countries)[8] had no mechanism for international referral of MERS-CoV samples. The absence of referral in the three high-income countries may indicate strong confidence in domestic expertise to confirm and identify pathogens. Most laboratories (17/19) reported having one or more staff certified by the International Air Transport Association (IATA) to ship infectious material abroad; the majority (73.7%) reported having more than one such staff.

The findings of this survey revealed good regional laboratory coverage in the Western Pacific Region for molecular detection of MERS-CoV, primarily through the GISRS laboratory network, nearly two years after the first reported MERS-CoV case in the Middle East. All countries indicated that they had national-level laboratories with the necessary materials for MERS-CoV testing on-site or employed international referral. It is important to continue strengthening the apparatus for MERS-CoV detection in the Region, in particular ensuring testing proficiency by EQA participation, and enhancing referral mechanisms and IATA certification where needed. National-level capacity is a key asset provided that it is well connected with the public health system at the subnational level. In-country referral capacity must therefore also be in place. WHO and its partners will continue to provide technical support to countries to address these issues. In conclusion, while there proved to be sufficient time to build laboratory capacity for the detection of MERS-CoV before its entry into the Western Pacific Region, we may not be so fortunate for future emerging infectious diseases. Thus, maintaining and further strengthening the public health laboratory system is a critical undertaking.

Funding

None.

Conflicts of interest

None declared.

Acknowledgements

The authors are grateful to the participating laboratories and countries that shared their information and took the time to complete the survey. We would also like to thank Sarah Hamid for critical reading of the manuscript.

References

1. *WHO Disease Outbreak News*. Geneva, World Health Organization, 2014 (http://www.who.int/csr/don/en/, accessed 12 August 2014).
2. Premila Devi J et al. Laboratory-confirmed case of Middle East respiratory syndrome coronavirus (MERS-CoV) infection in Malaysia: preparedness and response, April 2014. *Euro surveillance: European Communicable Disease Bulletin*, 2014, 19:20797–20802. pmid:24832116
3. *MERS-CoV update-16 April 2014*. Manila, Department of Health, 2014 (http://www.doh.gov.ph/content/merscov-update-16-april-2014.html, accessed 12 August 2014).
4. *WHO Western Pacific Region Countries and Areas*. Manila, World Health Organization Regional Office for the Western Pacific, 2014 (http://www.wpro.who.int/countries/en/, accessed 12 August 2014).
5. Corman VM et al. Detection of a novel human coronavirus by real-time reverse-transcription polymerase chain reaction. *Euro surveillance: European Communicable Disease Bulletin*, 2012, 17:20285–20290. pmid:23041020
6. *Laboratory Testing for Middle East Respiratory Syndrome Coronavirus: Interim recommendations September 2013*. Geneva, World Health Organization, 2014 (http://www.who.int/entity/csr/disease/coronavirus_infections/MERS_Lab_recos_16_Sept_2013.pdf, accessed 12 August 2014).
7. *Novel coronavirus: interim recommendations for laboratory biorisk management 19 February 2013*. Geneva, World Health Organization, 2014 (http://www.who.int/entity/csr/disease/coronavirus_infections/Biosafety_InterimRecommendations_NovelCoronavirus_19Feb13.pdf, accessed 12 August 2014).
8. *World Bank Country Data*. Washington, DC, World Bank, 2014 (http://data.worldbank.org/country, accessed 12 August 2014).

Estimating the size of key populations at higher risk of HIV infection: a summary of experiences and lessons presented during a technical meeting on size estimation among key populations in Asian countries

Dongbao Yu,[a] Jesus Maria Garcia Calleja,[b] Jinkou Zhao,[c] Amala Reddy[d] and Nicole Seguy[e] on behalf of the participants of the Technical Consultation on Lessons Learnt from Size Estimation among Key Populations in Asian Countries

Correspondence to Dongbao Yu (yud@wpro.who.int).

Problem: Size estimates of key populations at higher risk of HIV exposure are recognized as critical for understanding the trajectory of the HIV epidemic and planning and monitoring an effective response, especially for countries with concentrated and low epidemics such as those in Asia.

Context: To help countries estimate population sizes of key populations, global guidelines were updated in 2011 to reflect new technical developments and recent field experiences in applying these methods.

Action: In September 2013, a meeting of programme managers and experts experienced with population size estimates (PSE) for key populations was held for 13 Asian countries. This article summarizes the key results presented, shares practical lessons learnt and reviews the methodological approaches from implementing PSE in 13 countries.

Lessons learnt: It is important to build capacity to collect, analyse and use PSE data; establish a technical review group; and implement a transparent, well-documented process. Countries should adapt global PSE guidelines and maintain operational definitions that are more relevant and useable for country programmes. Development of methods for non-venue-based key populations requires more investment and collaborative efforts between countries and among partners.

Population size estimates (PSE) for key populations at higher risk of HIV exposure, such as female sex workers (FSW), men who have sex with men (MSM) and people who inject drugs (PWID), are a crucial component of national HIV strategic planning, programme design and monitoring and evaluation (M&E). PSE are key information for advocacy, setting targets for prevention, service delivery and estimating resource needs at national and subnational levels.[1] To help countries measure key population sizes, global guidelines were updated in 2011 to reflect new technical developments and recent field experiences in applying these methods.[2] National-level PSE are essential for epidemic models used to project the magnitude and trends of HIV epidemics and are key to building indicators required for programme M&E. It is a priority of international technical agencies and development partners, including United Nations Programme on HIV/AIDS (UNAIDS),[3] World Health Organization (WHO), the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund)[4] and the United States President's Emergency Fund for AIDS Relief to encourage and support national AIDS programmes to collect and use these data.

PSE exercises for many countries comprise two phases: (1) local size estimation of key populations in a geographically specified area, and (2) extrapolation

[a] HIV, Hepatitis and STI, World Health Organization Regional Office for the Western Pacific, Manila, Philippines.
[b] HIV Department, World Health Organization, Geneva, Switzerland.
[c] The Global Fund to fight AIDS, Tuberculosis and Malaria, Geneva, Switzerland.
[d] Joint United Nations Programme on HIV/AIDS, Regional Support Team for Asia and the Pacific, Bangkok, Thailand.
[e] World Health Organization Representative Office in China, Beijing, China.
Submitted: 5 May 2014; Published: 30 September 2014
doi: 10.5365/wpsar.2014.5.2.008

Table 1. **Population size estimation methods used and year conducted, reported by countries participating in the meeting**

Country	Key populations	Mapping/census/ enumeration	Survey multiplier	Capture/ recapture	Network scale-up	Other methods
Bangladesh	FSW, MSM, PWID	2009	2004	2004	–	2010
Cambodia	PWID	2012	2012	2012	–	2012
China	FSW, MSM, PWID	2012	–	–	2012 (MSM)	2012
India	FSW, PWID	Annually since 2007	–	–	–	–
Indonesia	FSW, MSM, PWID	2012	–	–	–	–
Lao People's Democratic Republic	FSW, MSM, PWID	2010	–	–	–	–
Malaysia	FSW, PWID	2009	2009	–	–	2009
Mongolia	FSW	2006	–	–	–	–
Myanmar	FSW	2010	–	–	–	–
Nepal	FSW, MSM, PWID	2011	–	–	–	–
Philippines	FSW, MSM, PWID	2011	–	–	–	2011
Thailand	FSW, MSM, PWID	2010	2010	–	2010 (PWID)	2011
Viet Nam	FSW, MSM, PWID	2011	2011	2011	–	2011

Note: the years in the table denote the latest round.

FSW, female sex workers; MSM, men who have sex with men; PWID, people who inject drugs.

from areas with local size estimates to a regional or national level. The methodologies for local PSE range from direct observation and counting (i.e. census of entire populations or enumeration/mapping of selected subgroups or locations) to surveys or samples of key populations (i.e. service or unique object multiplier methods, capture/recapture with overlapping surveys of the same population) to surveys of the general population (i.e. network scale-up method or directly asking a behaviour among the general population).[5]

CONTEXT

Calculating the PSE for key populations most at risk of HIV remains challenging. Many people in these groups are highly mobile and may remain hidden due to fear of stigma, harassment and even prosecution. In addition, new technologies such as mobile phones and the Internet facilitate seeking clients and sex partners. To help countries address these challenges, global guidelines for estimating the size of key populations were updated in 2011 to reflect new technical developments and recent field experience in applying new methods.[2] Due to the concentrated and low-level epidemics in Asia, estimating the size of key populations has been particularly important to measure the burden of HIV, track the epidemic and assess service coverage.

ACTION

From 24 to 25 September 2013, a meeting on PSE for key populations was held for 13 Asian countries. The meeting was organized by WHO with support from the UNAIDS Regional Support Team for Asia and the Pacific, the United States Centers for Disease Control and Prevention and the Global Fund. Programme managers and experts working in HIV surveillance, monitoring and evaluation with experience in implementing PSE were nominated by the ministries of health from Member States. Experts from partner agencies were invited to participate and facilitate discussions. Each participant was invited to present the PSE work conducted in each respective country. Presentations focused on methodology, results, lessons learnt and use of data. A panel discussion summarized the major findings, methodological issues, data use, challenges and next steps for implementation of PSE in the region (**Table 1**).

Coordination

In most of the countries, data collection was coordinated centrally by national AIDS programmes and their partners. These partners included civil society organizations implementing targeted interventions; national research

Table 2. **Duplication-adjustment methods**

Country	Key population group	Method of duplication calculation
Bangladesh	MSM	During census/enumeration MSM were asked leaving and entering hotspots where they were going to and/or coming from.
India	FSW, MSM, PWID	Patterns of mobility were asked of key informants during mapping.
Nepal	FSW, MSM, PWID	Key informants were asked about number of hotspots typically visited by key population during mapping, averaged and adjusted at national level.
Thailand	FSW	Service providers estimated the overlap in coverage in Bangkok. Estimated 20% overlap in large district; 10% overlap in small district.
Viet Nam	FSW, MSM, PWID	Respondents were asked whether they had visited multiple sites during key population surveys.

FSW, female sex workers; MSM, men who have sex with men; PWID, people who inject drugs.

Table 3. **Inflation factors to account for hidden or non-venue-based subgroups**

Country	Key population group	Basis of inflation factor	Inflation factor used
Indonesia	MSM	% of MSM survey respondents who were not exposed to intervention	5, 5.9, 11.8X (depending on type of district)
Malaysia	FSW	Not given	2X
Myanmar	FSW	Not given	1.4X
Nepal	PWID	Not given	PWID: 1.4X
Thailand	FSW, MSW	Expert opinion	FSW: 1.82X MSW: 2.18X
Viet Nam	PWID	Police estimate of % of drug users that they track	1.4X

FSW, female sex workers; MSM, men who have sex with men; PWID, people who inject drugs.

institutes; and local offices for narcotics control, social hygiene and/or police.

Methods commonly used

All 13 countries mapped venues and/or locations that key populations frequented with subsequent sampling/enumeration to obtain sizes of FSW and MSM (**Table 1**).[1] Five countries applied the survey-based multiplier either using exposure to prevention services or distributing unique objects.[1] Three countries reported their work on capture/recapture, and two countries shared results from network scale-up studies.[6] Many countries commented on the inadequacy of the methods available for capturing important non-venue-based subgroups, such as home-based sex workers, MSM and sex workers who meet partners/clients via the Internet or mobile phones.[7]

Methodological innovations

Countries reported on the following methodological innovations developed to customize global PSE:

Validation of census enumeration results

India assigned a proportion of hotspots which were mapped by two independent field teams. Results were compared and when found to be inconsistent, remapping of a broader area was undertaken. In Nepal, two independent mapping teams compared and validated the number of hotspots in a sample of districts.

Duplication adjustment methods

The mobile nature of most key populations often results in double counting individuals in different venues. Methods for duplication adjustment are described in **Table 2**.

Adjustments for hidden or non-venue-based key population subgroups

Inflation factors were developed to adjust the data from venue-based methods (e.g. census/enumeration, capture/recapture, or survey-based multipliers using time-location sampling) to include the non-venue-based

Table 4. **Examples of extrapolation methods by countries participating in the meeting**

Country (KP)	Extrapolation approaches	Number of categories*
India (PWID)	Urban and rural areas	2
Indonesia	Using regression models to predict size at district level	450+
Malaysia (PWID)	States grouped by addiction severity	3
Myanmar (FSW)	Townships grouped by epidemiological characteristics	4
Nepal	Matching districts by epidemiological zone	6
Philippines (FSW)	Capital and area outside of capital	2
Thailand (MSM)	Extrapolation by regions and capital	5

* Category is defined according to the HIV epidemics at the subnational level, as determined by the social-economic, demographic and epidemiological factors of geographic areas.

FSW, female sex workers; KP, key population; MSM, men who have sex with men; PWID, people who inject drugs.

group (**Table 3**). Inflation factors in Indonesia were based on survey samples obtained from respondent-driven sampling (RDS)[8] surveys that were believed to be more representative of the non-venue-based key population.[9] The proportion of respondents who reported not frequenting venues formed the basis of the inflation factors.

Other countries (e.g. Viet Nam and Nepal) used key population survey data on the proportion of respondents who were not reached by interventions as the inflation factor. This adjustment assumes that the key population surveys, from which intervention coverage data are derived, are representative of those who prefer not to be hidden, either because of incentives to participate in the survey or because recruitment was done by trusted peers as in the case of RDS.

Other adjustments

Two other adjustments were developed in Nepal and also appeared in the Viet Nam national size estimation protocol to improve the accuracy of the PSE.[10,11] The first was an adjustment for frequency of visiting venues,[12] taking into account that those who visited less frequently (e.g. once or twice a month) might be underestimated. An additional adjustment was made to account for turnover in a population, defined as the rate at which members of the key population leave the local area or stop the population-defining risk behaviour (e.g. women who stop selling sex).

Extrapolation strategies

All countries, except those using national network scale-up in surveys, extrapolated data from areas with local PSE to the national level. This is generally the proportion of the key population compared to the entire adult male or female population in areas with local data and forms the basis of the proportion applied to national or subnational adult populations. Due to the diversity of key population-driven epidemics at the subnational level, countries have attempted to refine this extrapolation method by applying different proportions to different geographic areas (**Table 4**). Indonesia presented regression models to predict district-level key PSE based on several socio-cultural-economic variables available from a national survey conducted every three years.[13] This best-fit regression model used size estimates, generated through census/enumeration from approximately half of the country's districts, as the outcome variable.

Developing ranges for size estimates

Due to the inherent imprecision associated with size estimation, most countries present a range of values for national- and subnational-level PSE and vary in their approaches for setting these boundaries (**Table 5**). In many countries, multiple sources of size estimates data are triangulated to obtain a final consensus range agreed upon by national stakeholders, technical experts and key population groups. In other countries, a single data source is selected as the most valid estimate, believed to be the

Table 5. **Approaches to developing upper and lower bounds on national size estimates**

Country	Group(s)	Method for determining range	Range of national estimate
Bangladesh	MSM	Lower value based on mapping counts; higher value based on expert consultation	32 000–143 000
Cambodia	PWID	Lowest and highest results of different survey-based multipliers	10 000–28 000
India	PWID	Median absolute deviation between mapped result and key population intervention targets	68 000–132 000
Indonesia	FSW, MSM, PWID	Confidence interval calculated on the basis of district-level estimates produced by regression model	FSW: 180 000–260 000 MSM: 0.9–1.2 million PWID: 60 000–80 000
Malaysia	PWID	Low and high values based on multiplier data collected from drug users versus other key informants.	80 000–156 000
Nepal	FSW	Low and high values based on key informant estimates from mapping	24 000–28 000
Philippines	MSM	Low and high values based on range of different survey results	390 000–689 000
Myanmar	FSW	Range based on key informant estimates during mapping	35 000–73 000
Thailand	PWID	Low and high value based on network scale-up result and summation result from national general population survey	40 000–93 000

FSW, female sex workers; MSM, men who have sex with men; PWID, people who inject drugs.

correct estimate relative to others, with upper and lower boundaries based on a statistical calculation relevant to the method used.[1] Technical advisers involved in the PSE process often use regional or global benchmarks to ensure the range is a plausible proportion of the general population. Most countries presenting their results at the meeting presented a large range, with upper bounds more than double the minimum estimates. Moreover, the methods used for estimating ranges are not standardized among countries.

KEY LESSONS LEARNT

Developing country-specific protocols and local capacity

Country representatives emphasized the importance of adapting global PSE guidelines for local contexts. Operational definitions used for different key populations varied considerably by country. Maintaining country-specific operational definitions that resulted in data that were more relevant and useable for country programme planning was felt to outweigh the challenges such differences pose to making intercountry comparisons.

Several countries described the importance of conducting multiple rounds of size estimation for refining methods and obtaining more precise results. This has assisted in expanding local capacity for collecting data, standardizing approaches and using multiple methods to triangulate data. Several countries such as China and India described a significant investment of resources to update local size estimates on a regular basis, which is particularly important for large countries with diverse epidemics. It is important that before initiating surveys, key populations have been provided with services and recorded at service delivery facilities to collect information on unique visits.[6]

Using PSE data and engaging stakeholders

Optimizing the use of PSE for programme planning and resource allocation requires different stakeholders to have consensus about the final estimate. Many countries reported the importance of engaging stakeholders in a transparent process for data collection, application of adjustments and extrapolation of results which was achieved through documentation, technical expert review and community engagement in all stages of the process. Representatives also recognized the need for multiple estimates. Thailand reported using a broad definition of MSM in their size estimates exercises but determined about 30% of the total MSM community were high risk and focused on the size of this subgroup to allocate resources for HIV prevention services for MSM.

Ongoing challenges for estimates of key subgroups and non-venue-based populations

Participants advocated for separate estimates for the transgender population and male sex worker subgroups as critical for developing more effective local prevention programmes. Countries continue to struggle to estimate the size of populations who prefer to be hidden due to stigma, discrimination and punitive laws or who are changing their behaviour patterns. This issue has been a long-standing challenge for MSM and PWID groups but may be increasingly relevant for subgroups such as home-based FSW.

DISCUSSION AND RECOMMENDATIONS

This paper reviews recent PSE activities for key populations in 13 Asian countries. The authors recognize that not all Asian countries were represented at the meeting, and it was not feasible for country representatives to present a comprehensive overview of all PSE activities to date. Instead, this report focuses primarily on information presented at the meeting, supported with published literature.

Many countries in the region have accumulated valuable experience in adapting PSE methods to meet challenging contexts. However, some countries participating in the meeting continue to rely on expert opinions or regional benchmarks rather than data collected via recommended methods. Countries that have applied multiple methods for the same key population in the same geographic areas often face the challenge of resolving large discrepancies. The quality of size estimation is of concern for some countries. Greater resources with good technical assistance should be spent on triangulating these data and distinguishing between expected differences due to methodological limitations, poor implementation and large fluctuations in size of particular key populations. Due to the complexity of interpreting PSE for key populations, establishing a consistent technical review group of experts to analyse, document and disseminate PSE results is critical for using key PSE to strengthen a country's AIDS response. Finally, considering the high cost involved in a stand-alone PSE exercise, countries are encouraged to integrate it with other ongoing activities and surveys.

Participating countries strongly support efforts to develop local solutions to refine the available methods and have requested that development partners facilitate opportunities to share good practices. One promising proposal is the successive sampling size method[14] recently introduced at a UNAIDS meeting of PSE techniques for hard-to-reach populations in October 2013. Recommendations made during the meeting included the mobilization of resources from governments, technical partners and funding agencies which could include the consideration of PSE in the development of the concept note for the Global Fund's new funding mode.[15] Efforts should also be made to consolidate and disseminate information from different countries related to their experiences in adjustments for hidden subgroups and extrapolation from local to national levels. Most importantly, PSE should be planned, implemented and directly linked with programming.

Participants of the meeting

The following participants attended and contributed to the meeting:

Dr Md Anisur Rahman, Dr Ly Penh Sun, Dr Hong Hu, Dr Houlin Tang, Professor Kuntoro, Ms Viny Sutriani, Dr Keophouvanh Douangpachanh, Dr Fazidah Binti Yuswan, Dr Mohd Nasir Abudul Aziz, Dr Zayasaikhan Setsen, Dr Ko Ko Naing, Dr Kyaw Soe, Mr Noel S Palaypayon, Dr Panithee Thammawijaya, Professsor Apinun Aramrattana, Mr Nguyen Long Duc, Dr Tran Quang Dai, Dr Abu S Abdul-Quader, Dr Bui Hoang Duc, Dr Yi Chen, Dr Jonathan Neil V Erasmo, Dr Wolfgang Hladik, Dr DCS Reddy, Dr SK Singh, Dr Heng Sopheab, Dr Guohui Wu, Professor Joseph Irvin Harwell, Assistant Professor Huso Yi, Professor Mo Kit Han Phoenix, Dr Zixin Wang, Dr Kin Ho Philip Wong, Mr Daniel Low-Beer, Dr Jinkou Zhao, Dr Dongbao Yu, Dr Nicole Seguy, and Dr Jesus Maria Garcia Calleja.

We also would like to acknowledge the assistance and contribution of Virginia Loo, Ying-Ru Lo, Amaya Maw Naing and Laximi Achaya.

Funding

None.

Conflict of interest

None declared.

References

1. *Consolidated guidelines on HIV prevention, diagnosis, treatment and care for key population.* Geneva, World Health Organization, 2014 (http://apps.who.int/iris/bitstream/10665/128048/1/9789241507431_eng.pdf?ua=1&ua=1, accessed 29 September 2014).
2. UNAIDS, WHO Working Group on Global HIV/AIDS and STI Surveillance. *Guidelines on Estimating the Size of Populations Most at Risk to HIV*. Geneva, World Health Organization and UNAIDS, 2010 (http://www.unaids.org/en/media/unaids/contentassets/documents/epidemiology/2011/2011_estimating_populations_en.pdf, accessed 29 September 2014).
3. *2010–2011 UNAIDS UBW Broad Activity Achievement Report.* Geneva, The Joint United Nations Programme on HIV/AIDS, 2012 (http://www.unaids.org/en/media/unaids/contentassets/documents/document/2012/ubw2010-2011/Secretariat_2010-2011BAReport.pdf, accessed 29 September 2014).
4. *Global Fund HIV Proposal Development for Key Population Proposals and for the Targeted Pool in Round 11: Toolkit.* Geneva, The Joint United Nations Programme on HIV/AIDS, 2011.
5. Abdul-Quader AS, Baughman AL, Hladik W. Estimating the size of key populations: current status and future possibilities. *Current Opinion in HIV and AIDS*, 2014, 9:107–114. doi:10.1097/COH.0000000000000041 pmid:24393694
6. Johnston LG et al. Incorporating the service multiplier method in respondent-driven sampling surveys to estimate the size of hidden and hard-to-reach populations: case studies from around the world. *Sexually Transmitted Diseases*, 2013, 40:304–310. doi:10.1097/OLQ.0b013e31827fd650 pmid:23486495
7. Li Q et al. Online sex-seeking behaviors among men who have sex with men: implications for investigation and intervention. *AIDS and Behavior*, 2012, 16:1690–1698. doi:10.1007/s10461-011-0005-0 pmid:21785872
8. Hechathorn D. Respondent-driven sampling: A new approach to the study of hidden populations. *Social Problems*, 1997, 44:174–198. doi:10.1525/sp.1997.44.2.03x0221m
9. Kendall C et al. An Empirical Comparison of Respondent-driven Sampling, Time Location Sampling, and Snowball Sampling for Behavioral Surveillance in Men Who Have Sex with Men, Fortaleza, Brazil. *AIDS and Behaviour*, 2008, 12(1): Suppl 97–104. doi:10.1007/s10461-008-9390-4
10. HIV/AIDS and STI Control Board & National Centre for AIDS and STD Control. *Mapping & Size Estimation of Most-at-risk-population in Nepal, 2011*. Katmandu, National Centre for AIDS and STD, 2011, Volumes 1–4.
11. *Size Estimation of Injecting Drug Users, Commercial Sex Workers, and Men Who Have Sex with Men in Vietnam*. Vientiane, National Institute of Hygiene and Epidemiology, 2010.
12. Karon JM, Wejnert C. Statistical methods for the analysis of time-location sampling data. *Journal of Urban Health*, 2012, 89:565–586. doi:10.1007/s11524-012-9676-8 pmid:22421885
13. *2012 Size Estimation of Key Affected Populations*. Jakarta, Ministry of Health Indonesia, 2013.
14. Handcock MS, Gile KJ, Mar CM. *Estimating Hidden Population Size using Respondent-Driven Sampling Data. arXiv: 1209.6241 [stat.ME].* (http://arxiv.org/pdf/1209.6241v1.pdf, accessed 29 September 2014).
15. *Roll out of the new funding model and Technical Assistance Special Initiative*. Global Fund Regional Meeting, 8–9 April 2014,Kingston, Jamaica. Geneva, The Global Fund to Fight AIDS, Tuberculosis and Malaria, 2014 (http://www.theglobalfund.org/documents/regional_meetings/2014-04-08-Jamaica/Events_2014-04-08-R-M-LAC-TechnicalAssistanceSpecialInitiative_Presentation_en/, accessed 29 September 2014).

Western Pacific Surveillance and Response Instructions to Authors

ABOUT WPSAR

The aims of WPSAR are:

1. to provide an open access journal to publish articles on the surveillance of and response to public health events and emergencies in the WHO Western Pacific Region and in areas with relevance to the Western Pacific Region; and
2. to build capacity in communicating epidemiological and operational research within the WHO Western Pacific Region.

Our objectives are:

1. to provide a platform for people working in surveillance and response in the Western Pacific Region to share their scientific and operational findings;
2. to publish a broad range of articles not limited to conventional research articles:
   - to disseminate short reports on outbreak investigations;
   - to publish analyses of surveillance data on communicable diseases;
   - to encourage the publication of evaluations of new and existing surveillance systems;
   - to promote the use of risk assessment for public health by facilitating risk assessment articles;
   - to support preparedness and response to public health events and emergencies through the dissemination of lessons learnt from such events; and
3. to build capacity in communicating epidemiological and operational findings in the Western Pacific Region through pre-submission assistance.

Scope

WPSAR covers all activities related to the surveillance of and response to public health events and emergencies, with a focus on topics that are relevant to the Western Pacific Region. Public health events may be acute or ongoing and can fall under any of the following areas: communicable diseases, natural disasters, food safety, bioterrorism, and chemical and radiological events. Other events and topics may also be considered. Response activities include those for acute events, e.g. responding to natural disasters, or for response to cases or epidemics of disease.

Why publish in WPSAR?

WPSAR is not limited to conventional research. It publishes a broad range of articles, including short outbreak investigation reports, lessons from the field, analyses of surveillance data, evaluations of surveillance systems and risk assessments for public health events. There are limited opportunities to publish these types of articles in other journals. We also accept the more traditional original research, perspectives and case reports/case series articles.

WPSAR is an open access journal, meaning it is free of charge for both readers and authors. It is also a continuous publication, which means articles are published as soon as they have completed the review and editing process.

WPSAR accepts all articles that fit the scope of the journal and that meet the minimum publication standards. We are especially interested in field epidemiology and operational research.

WPSAR also aims to build capacity in scientific writing and encourages submissions from authors with little or no experience in publishing in peer-reviewed journals. The Coordinating Editor often works with new authors on their submissions to ensure that articles fit the scope of WPSAR and meet the minimum standards for publication.

INSTRUCTIONS TO AUTHORS FOR ARTICLE WRITING AND SUBMISSION

WPSAR follows the guidelines of the *Uniform Requirements for Articles Submitted to Biomedical Journals by the International Committee for Medical Journal Editors* (ICMJE).

Formatting guidelines

Please submit your article in a Microsoft® Office Word file or a compatible file in English. Double-spaced, 12-point Arial font should be used to format your article. Please remove all automatic formatting including automatic numbering and referencing before submitting.

The format of the article will depend on the article type. Please see below for specific instructions per article type.

Outbreak Investigation Report

A short article describing a field or outbreak investigation including how it was detected, investigated and controlled. Rapid risk assessments undertaken during these investigations are also encouraged. These articles may be considered for rapid publication.

- Structured article with an abstract of ≤ 250 words and sections for introduction, methods, results and discussion
- Structured abstract with sections for objective, methods, results and discussion
- Word limit: ≤ 1500 words
- ≤ 15 references
- ≤ 2 figures/graphs/pictures

More comprehensive investigations can be submitted as Original Research.

Surveillance Report

A summary and interpretation of surveillance data over a given period of time. A description of the surveillance system and the limitations of the data collected must be included.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 10 figures/graphs/pictures

Surveillance System Implementation/Evaluation

An article describing the implementation of a new surveillance system or an evaluation of an existing surveillance system used to detect public health events.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Risk Assessments

An article detailing a risk assessment of a public health threat or event.

- Structured article with an abstract ≤ 250 words and sections for introduction (including risk question/s), risk assessment methodology, results, discussion and recommendations
- Structured abstract with objectives, method, results and discussion
- The results should include an assessment and/or characterization of the hazard, exposure and context, as well as the level of risk or risk characterization. The limitations must also be included. Risk management may be included in the discussion.
- Word limit: ≤ 3000 words
- ≤ 30 references
- ≤ 3 figures/graphs/pictures

Original Research

Original research articles may include epidemiological studies including outbreak investigations.

- Structured article with an abstract of ≤ 250 words and sections for introduction, methods, results and discussion
- Structured abstract with objective, methods, results and discussion
- Word limit: ≤ 3000 words
- ≤ 40 references
- ≤ 5 figures/graphs/pictures

Lessons from the Field

An article describing a problem faced in field epidemiology or during a public health event and the experience in trying to overcome the problem.

- Structured article with an abstract ≤ 250 words and sections for problem, context, action, lesson(s) learnt or outcome and discussion
- Structured abstract with the headings of problem, context, action, lesson(s) learnt and discussion
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Perspectives

An unstructured article discussing an issue regarding the surveillance of and response to public health events. The scope of the discussion must be clearly defined.

- Word limit: ≤ 1000 words
- ≤ 10 references
- ≤ 1 illustration

Case Report or Case Series

An unstructured article describing an unusual case or series of cases of public health significance. Subheadings may be used to increase the readability of the article.

- Unstructured abstract of ≤ 250 words
- Word limit: ≤ 2000 words
- ≤ 15 references
- ≤ 3 figures/graphs/pictures

Regional Analysis

An article providing an analysis of a topic for the Western Pacific Region, typically authored by WHO staff as part of their routine work on behalf of Member States. Regional Analyses do not undergo peer review.

Letter to the Editor

A letter commenting on a previously published article OR a letter commenting on the theme of the issue. Letters do not undergo peer review.

- Word limit: ≤ 500 words
- ≤ 5 references
- ≤ 1 illustration

News, Meeting and Conference Reports

News items and meeting and conference reports do not undergo peer review. Please contact the Coordinating Editor at WPSAR@wpro.who.int if you intend on submitting such an article.

Illustrations

Refer to the article type for the limit on illustrations (figures/graphs/pictures). Please insert all illustrations at the end of the article with titles. Each illustration must be referred to in the text and must be understood on its own. Use Microsoft® Office Excel for graphs and Microsoft® Office Word for tables and diagrams. Additionally, please provide a Microsoft® Office Excel spreadsheet of the data used to create a graph. Footnotes should be placed under the illustration and should use the following symbols in superscript format: *, †, ‡, §, ‖, **, ††, etc.

References

Reference the most recent and relevant publications. Please use the Vancouver referencing style with in-text citations and a bibliography at the end of the text. Sample references can be viewed on the National Institutes of Health website.

Place the bibliography at the end of the article text and not as footnotes. Write journal names in full. Use superscript sequential numbering for citing references in the text. Place the number after any punctuation. For example:

> These results are consistent with the original study.[11]

Reference personal communication in the text only and include the person's full name and institution.

Caution should be used in referencing websites; it should be done only when their content has been substantially described in the article.

Peer review process

Every article is initially screened by the Editorial Team to ensure it fits the scope of the journal. All articles, with the exception of regional analyses, letters to the editor, news items and meeting and conference reports, then undergo external peer review by two reviewers. This blind peer review process ensures that the reviewer does not know the identity of the author(s) and the author(s) do not know the identity of the reviewer. Significant effort is made to make this process timely, but since it relies on the availability and cooperation of persons external to the journal, it can take considerable time.

Upon receipt of the reviews, the Coordinating Editor assesses the comments and recommendations made by the reviewers, and then decides on the outcome of the peer review process. One of four options will be chosen: accept submission, accept with revisions, submit for review, or decline submission. The corresponding author will be advised of this outcome.

If the article has been accepted or accepted with revisions are required, you will be invited to revise your article according to the reviewer comments. A separate MS Word document outlining how you addressed each of the reviewer comments is also required. You must indicate the page and paragraph numbers where the changes were made and should provide reasons for not making a suggested change. Both the changes and reasons will be assessed

against the reviewer comments by the Coordinating Editor and may require further clarification from the authors. Once all comments have been adequately addressed, the article will commence the publication process.

If the outcome of the review process is "submit for review", then the same process is followed. However, the resubmitted article and responses to the reviewer comments are sent back to the original reviewers for another round of peer review. You will be asked to respond to a second round of reviewer comments, which will again be assessed by the Coordinating Editor. Once both sets of reviewer comments have been adequately addressed, the article will commence the publication process.

The publication process comprises rigorous editing for content and style by an external technical editor, followed by layout and proofreading. Authors may be asked to provide further information or clarifications during these stages. An article is not formally accepted for publication until these stages have been completed and approval has been granted by the Editorial Team. The authors will also have an opportunity to approve the final proof prior to publication on the WPSAR website. The article will be batched with others in the next quarterly issue.

Authorship

As per the International Committee of Medical Journal Editors (ICMJE), all authors should have contributed significantly to the article through one or more of the following in each category A, B and C:

A

- Study design
- Data collection
- Data analysis
- Data interpretation

B

- Drafting the article
- Critically revising the article

C

- Final approval of the article for submission

Any other contributors may be listed in the Acknowledgements section.

Acknowledgements

Contributors who do not fulfil the authorship requirements may be acknowledged. Permission from all contributors in the acknowledgement section should be sought. We assume that permission has been granted and will not follow up with the authors to confirm.

Ethics and permissions

It is the responsibility of authors to gain appropriate ethics approval for their work. A statement of ethics approval obtained or an explanation of why ethics approval was not required should be included for all articles during the submission process.

License for publication

Prior to publication, all authors are asked to sign a licence to publish that grants exclusive copyright license to the World Health Organization.

Conflicts of interest

A conflict of interest is defined by ICMJE as "when an author or author's institution, reviewer, or editor has financial or personal relationships that inappropriately influence (bias) his or her actions". Conflicts of interest may be financial, institutional, research or personal. A relationship does not always represent a conflict of interest and does not necessarily preclude publication in WPSAR. All authors and reviewers will be required to state any potential conflicts of interest, which will be assessed by the Editorial Team.

Funding

Authors will be required to state the sources of funding for their work.

Photographs for cover

If authors have taken photographs that are relevant to their article, they may be submitted for consideration for publication on the cover of the issue. Submission of a photograph does not guarantee its publication.

Language

Articles should be written in English. Authors who require assistance with preparing their articles in English should contact WPSAR at WPSAR@wpro.who.int. Once published, all abstracts and most articles are translated into Chinese.

Article submission process

Submit articles to the Coordinating Editor through the online journal management system on the WPSAR website. When submitting the article, you will be requested to provide the following:

- a cover letter describing the article and why it should be published;
- a title page with:
  - the article title,
  - a short title,
  - a brief description of the article of ≤ 50 words,
  - ≤ 7 keywords,
  - full names of all authors and institutions,
  - full contact details of the corresponding author,
  - data in an MS Excel spreadsheet for any graphs
  - names and e-mail addresses of two suggested reviewers (optional but recommended);
- acknowledgements, conflicts of interest, ethics statement and funding information (attached as a separate file to ensure a blind review);
- an MS Word file or equivalent of the article; and
- a scanned copy of the WPSAR licence for publication signed by all authors.

With the online journal management system, you will be able to track the progress of your article through the editorial process. If you encounter any difficulties with this system, please refer to our *WPSAR online journal system – User guide for authors*.

Corrections

If authors of a published article become aware of any errors with the article, they should contact the Coordinating Editor at WPSAR@wpro.who.int. Corrections will be published online.

World Health Organization
Western Pacific Region

WPSAR
Western Pacific Surveillance and Response Journal

wpsar@wpro.who.int | www.wpro.who.int/wpsar