Influenza and pertussis vaccination coverage in pregnant women in the Northern Territory in 2015—new recommendations to be assessed  
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Abstract

Background: Pregnant and post-partum women are at increased risk for more severe illness and complications from influenza. Vaccination during pregnancy has been shown to protect mothers as well as infants from influenza. With pertussis, infants do not begin their own pertussis-containing vaccine series until 6–8 weeks of age and are not fully immunised until 6 months of age leaving a window of significant vulnerability for this disease in newborns. Immunisation against influenza and pertussis during pregnancy provides protection for both mother and neonate against influenza and pertussis. Influenza vaccination has been recommended at any time throughout pregnancy since 2010 and the administration of diphtheria, tetanus, pertussis vaccine (DTPa) for each pregnancy from week 28 onwards was introduced onto the Northern Territory (NT) Immunisation Program in 2015. This study was undertaken to document the compliance with these recommendations and to explore possible barriers to vaccination.

Methods: Perinatal data for all women who delivered in 2015 in NT public hospitals were obtained from the perinatal data registry. These data were then linked with the NT Immunisation Register which includes adult vaccination data, allowing coverage rates by age, region and Indigenous status to be calculated.

Results: Overall maternal vaccination coverage was 39.3% for influenza and 22.3% for pertussis.
Conclusion: Despite being on the vaccination schedule, coverage rates for influenza and pertussis during pregnancy are suboptimal. Indigenous status was the most important factor in influencing whether a pregnant woman was vaccinated for influenza. Rates of maternal vaccination for pertussis between 28 and 38 weeks gestation improved during the course of the year but further promotion and education aimed at both healthcare providers and pregnant women is required to increase coverage rates.

Keywords: influenza; pertussis; pregnancy; vaccination coverage; immunisation.

Introduction

Pregnant and postpartum women are at higher risk for severe illness and complications from influenza than women who are not pregnant because of changes in the immune, cardiovascular and respiratory systems during pregnancy. Vaccination during pregnancy has not only been shown to protect mothers but also infants from influenza, including infants aged <6 months, for whom no influenza vaccines are currently licensed. Australian and international guidelines recommend influenza vaccination for all pregnant women, regardless of week of gestation or season, as well as for women planning pregnancy. The Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG), the Australian Government Department of Health via the Australian Immunisation Handbook, and the Women’s Business Manual all actively promote influenza vaccination for pregnant women. The Immunise Australia Program offers free influenza vaccine for all pregnant women in Australia. Influenza vaccination can be administered at any time during pregnancy, before and during the influenza season. The Australian and Northern Territory (NT) guidelines also recommend annual influenza immunisation for all Indigenous people over the age of 15 years. Due to the very high rates of influenza in Indigenous children, vaccination of this group (from 6 months to under 5 years of age) was introduced in 2015.

The overwhelming majority of morbidity and mortality attributable to pertussis infection occurs in infants under 6 months of age. Infants do not begin their own vaccine series against pertussis with the diphtheria, tetanus and acellular pertussis vaccine (dTPa) until 6–8 weeks of age and are not fully immunised until 6 months of age. This situation leaves a window of significant vulnerability for newborns, many of whom appear to contract serious pertussis infections from family members and caregivers, including their mother. From 2008, the NT offered dTPa vaccine to postnatal women and all other close contact household members who had not previously received the vaccine in order to provide a protective ‘cocoon of immunity’ around the newborn. This approach was changed in 2015 when the National Immunisation Guidelines recommended dTPa vaccine from 28 to 38 weeks gestation to all pregnant women for each pregnancy.

The aim of vaccination with dTPa during pregnancy is to stimulate maternal antibodies which will then cross the placenta and protect newborns during the first 6 months after birth.

Inactivated influenza vaccines and combined dTPa vaccines are considered to be safe when given in pregnancy. Studies have shown vaccination has been effective at reducing influenza in pregnant women and neonates, and pertussis in neonates. Data on vaccination coverage rates for influenza and pertussis in pregnant women is limited. The NT is unique with its use of an active adult vaccination registry allowing us to determine fairly accurately the immunisation coverage of pregnant women. This article aims to document the vaccination rate for both influenza and pertussis in pregnant women for each pregnancy.

Methods

Population and study period

All women who gave birth at a public hospital in the NT in 2015 were included in this study. The study retrospectively reviewed their immunisation rates.

Definition for valid immunisation

Valid immunisation for influenza was defined as 1 dose of inactivated vaccine anytime during the
pregnancy. Valid immunisation for pertussis was defined as receiving a dose of dTpa anytime between 28 and 38 weeks gestation. As maternal vaccination is a newly introduced recommendation in the NT the number of women compliant with previous cocooning recommendations (i.e. received a dTpa vaccine within 1 week of delivery, or in the preceding 5 years) was also recorded.

Ethical approval

The study design and access to registry data was approved by our institute’s Ethics Committee and registered with the Human Research Ethics Committee of the NT Department of Health and Menzies School of Health Research (HREC) reference number 2015/2485. The proposal was also reviewed and approved by the Central Australian Human Research Ethics Committee reference number HREC-16-436.

Data Collection

Birth data was accessed from the Midwives’ Collection (Perinatal Register) which records all births within the NT public health system. The perinatal records for births in 2015 were reviewed. The mother’s name, age, hospital record number (HRN), Indigenous status, suburb of residency, date of delivery, place of delivery and gestation of the baby at delivery was obtained from the perinatal registrar. These data were linked to the NT Immunisation Register using a unique identifier (HRN). This allowed us to determine the vaccination status and timing of administration in relation to pregnancy for each woman. Residential location obtained from the perinatal registry was coded into the 4 regions of Darwin, Katherine, East Arnhem and Alice Springs. Indigenous status was coded as Indigenous or non-Indigenous. Maternal age was grouped as either <25, 25–34 or ≥ 35 years old.

Statistical analyses

Data were entered into STATA v13.1 and Microsoft Excel, and both were used to perform the statistical analysis. Socio-demographic factors explored as possible determinants of vaccination coverage rates were tested for each vaccine independent of Indigenous status by Yates chi square. Analysis was stratified by Indigenous status due to concerns of possible confounding. Mothers who gave birth in unknown locations were excluded from the location analysis. A p value of ≤0.05 was considered statistically significant.

Results

In 2015 there were 3,338 births in NT public hospitals. Baseline characteristics of the mothers who gave birth in 2015 are shown in Table 1. Of these 3,338 women, 1,311 (39.3%;95%CI 37.6-41.0) received a valid vaccination for influenza. Only 746 (22.3%;95%CI 20.9–23.8) received a dTpa vaccine between 28 and 38 weeks gestation, while a further 1,976 (59.2%;95%CI 57.5–60.9) women received a dTpa vaccine in accordance with previous guidelines (i.e. within 1 week after or the 5 years prior to giving birth).

Potential socio-demographic factors that may influence influenza vaccination coverage rates are presented in Table 2. Influenza coverage rates were significantly higher in Indigenous women (64.4%) compared to non-Indigenous (23.2%) p<0.0001. There was no difference in age-specific vaccination rates when comparing within each Indigenous status category.

| Table 1: Characteristics of women who gave birth in 2015 |
|---------------------------------|----------------|----------------|
| Characteristics                | Indigenous n (%) | Non-Indigenous n (%) |
| Indigenous status              | 1304 (39.1)      | 2034 (60.9)      |
| Age                            |                 |                 |
| < 25                           | 624 (47.8)       | 348 (17.1)       |
| 25–34                          | 538 (41.3)       | 1265 (62.2)      |
| ≥ 35                           | 142 (10.9)       | 421 (20.7)       |
| Total                          | 1304 (100)       | 2034 (100)       |
| Region                         |                 |                 |
| Alice Springs                  | 435 (33.4)       | 366 (18.0)       |
| Darwin                         | 637 (48.8)       | 1520 (74.7)      |
| East Arnhem                    | 104 (8.0)        | 40 (2.0)         |
| Katherine                      | 124 (9.5)        | 98 (4.8)         |
| Unknown¹                       | 4 (0.3)          | 10 (0.5)         |
| Total                          | 1304 (100)       | 2034 (100)       |

¹ Omitted from the χ² test
However rates for influenza vaccination still varied overall geographically (\(p=0.009\) Indigenous and \(p=0.05\) non-Indigenous), even when taking Indigenous status into consideration, with higher rates in Alice Springs compared to other regions. The majority of pregnant women vaccinated for influenza received their vaccine during March to June (see Figure 1). This lead to an increase in the percentage of babies born to influenza vaccinated mothers in the later parts of the year October to December (see Figure 2).

Pertussis coverage rates did not significantly differ based on Indigenous status or maternal age (Table 3) but did overall geographically, with consistently higher rates in Alice Springs. Coverage rates for Katherine and East Arnhem varied by Indigenous status but were similar overall in both regions. The percentage of babies whose mothers received a dTpa vaccine during the third trimester increased as the year progressed (see Figure 3).

### Table 2: Influenza coverage rates according to demographic characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Indigenous</th>
<th>Non-Indigenous</th>
<th>P value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. vaccinated (rate)</td>
<td>P value</td>
<td>No. vaccinated (rate)</td>
<td>P value</td>
</tr>
<tr>
<td>Indigenous status</td>
<td>840 (64.4)</td>
<td>471 (23.2)</td>
<td>&lt;0.0001</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>840 (64.4)</td>
<td>0.91(^*) NS</td>
<td>471 (23.2)</td>
<td>0.83(^*) NS</td>
</tr>
<tr>
<td>&lt; 25</td>
<td>405 (64.9)</td>
<td>0.91(^*) NS</td>
<td>81 (23.3)</td>
<td></td>
</tr>
<tr>
<td>25–34</td>
<td>343 (63.8)</td>
<td>288 (22.8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 35</td>
<td>92 (64.8)</td>
<td>102 (24.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td>840 (64.4)</td>
<td>0.009(^*)</td>
<td>471 (23.2)</td>
<td>0.05(^*)</td>
</tr>
<tr>
<td>Alice Springs</td>
<td>308 (70.8)</td>
<td>104 (28.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darwin</td>
<td>391 (61.4)</td>
<td>339 (22.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Arnhem</td>
<td>63 (60.6)</td>
<td>10 (25.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katherine</td>
<td>76 (61.3)</td>
<td>18 (18.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown/Other</td>
<td>2 (50.0)</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^*\) \(\chi^2\) test for difference between all groups.  
\(^+\) Omitted from the \(\chi^2\) test

Figure 1: Number of pregnant women receiving an influenza vaccination per month in 2015
Figure 2: Percentage of babies born to influenza vaccinated mothers each month in 2015

Table 3: dTpa coverage rates according to demographic characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Indigenous</th>
<th>Non-Indigenous</th>
<th>P value</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. vaccinated (rate)</td>
<td>P value</td>
<td>No. vaccinated (rate)</td>
<td>P value</td>
</tr>
<tr>
<td>Indigenous status</td>
<td>307 (23.5)</td>
<td>439 (21.6)</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>0.14* NS</td>
<td>0.33* NS</td>
</tr>
<tr>
<td>&lt; 25</td>
<td>158 (25.3)</td>
<td>75 (21.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25 – 34</td>
<td>124 (23.0)</td>
<td>284 (22.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 35</td>
<td>25 (17.6)</td>
<td>80 (19.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Region</td>
<td></td>
<td></td>
<td>0.01*</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Alice Springs</td>
<td>118 (27.1)</td>
<td>110 (30.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darwin</td>
<td>131 (20.6)</td>
<td>303 (19.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East Arnhem</td>
<td>20 (19.2)</td>
<td>12 (30.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Katherine</td>
<td>38 (30.6)</td>
<td>14 (14.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown/Other†</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*χ² test for difference between all groups.
†Omitted from the χ² test

Figure 3: Percentage of babies born to dTpa vaccinated mothers
Discussion

This study is one of only a few studies looking at the vaccination coverage rates of influenza and pertussis during pregnancy. Other studies have not been to this scale or have relied on patient recall surveys due to a lack of adult immunisation registries in many jurisdictions. The documented coverage rates for women giving birth in public hospitals in the NT in 2015 were 39.3% for influenza and 22.3% for pertussis. Even though these rates are comparable to published data,21-25 there is much room for improvement as targets of >70% vaccination coverage are the goal to ensure population immunity is sufficient to reduce transmission.

The rate of influenza vaccination during pregnancy however continues to increase each year. Review of NT data from 2013 and 2014 showed that 30.2% and 33.6% of pregnant women respectively received an influenza vaccination.26 With 39.3% of women receiving an influenza vaccination in 2015 this is the highest rate yet. This is hopefully a result of increased education targeting midwives and other antenatal care providers in the NT about the benefits to mother and neonate of influenza vaccination at any time during pregnancy.

Significantly more Indigenous mothers received an influenza vaccination compared to non-Indigenous (64.4% vs 23.2%). Indigenous Australians are at increased risk of influenza and adverse influenza infection outcomes.27 Given the increased risk, annual influenza vaccination is recommended in Australia, and the vaccine is free, for all Aboriginal and/or Torres Strait Island people aged 15 years and older.8 The longstanding campaigns every flu season recommending influenza vaccination for all Indigenous people in the NT are probably the cause of the higher vaccination rates in Indigenous mothers rather than pregnancy being recognised as an indication for influenza vaccination. No difference was detected in vaccination rates for dTpa based on Indigenous status so it is more likely that the difference seen with the influenza vaccination is related to the influenza vaccine program in Indigenous adults.

The majority of pregnant women vaccinated for influenza received their vaccine during March and April, with a slow decline across the course of the year. This corresponds well with the vaccine release and targeted information campaigns for all high risk patients to be vaccinated. To greater improve the rate of vaccination increased education should focus on time periods after the traditional influenza season September–February.

The coverage rate for pertussis is much lower when compared to influenza in the NT. This is likely because of recent changes in the recommendations for when dTpa should be given in relation to pregnancy. From 2009 onwards the NT recommended dTpa vaccination postnatally to pregnant women and all other family members or caregivers as part of a ‘cocooning strategy.’ This approach was changed in 2015 in accordance with national guidelines to recommending dTpa vaccination from 28 weeks gestation to all pregnant women each pregnancy. While only 22.3% of women received a dTpa vaccination between 28 and 38 weeks gestation, a further 59.2% women fulfilled the cocooning recommendations. This means overall 81.5% of women received a dTpa vaccination.

Rates of dTpa vaccination during the third trimester improved across the course of the year (see Figure 3), reflecting perhaps the time needed to make changes in recommendations, as the program was launched quickly in response to adverse outcomes in infants and new evidence of the effectiveness of the pertussis vaccine in pregnancy from the United Kingdom.12 Active promotion of maternal pertussis vaccination through education of antenatal care providers in the NT did not commence until March/April which is a likely cause for the markedly lower rates in the first 3–4 months of the year. Even though rates were improving towards the end of the year further education of antenatal care providers and mothers about the new recommendations is required. Aiming to increase the proportion of women receiving their vaccine during the third trimester, will increase the number of neonates protected through passive immunisation from maternal antibodies.10 It is important to review figures in 2016 to ensure ongoing improvement and that reluctance to administer vaccines during pregnancy is not contributing to the low coverage rates.
After correcting for Indigenous status, influenza and dTpa vaccination coverage rates varied by location of birth for both Indigenous and non-Indigenous women. Consistently higher rates were seen in Alice Springs with overall 51.4% receiving an influenza vaccination and 28.5% receiving a dTpa vaccination during the third trimester. Factors leading to higher coverage in Alice Springs, such as the use of clinical champions and targeted education, should be reviewed; these may then inform other areas with lower coverage such as Darwin. It is important to note that the place the baby was born was used as a surrogate for location therefore more specific regional differences were not able to be detected.

Age was not identified as a determining factor for whether women received an influenza or dTpa vaccination.

Our study has limitations. Firstly, this study only looked at birth data from the NT public hospital system and did not include patients utilising the private health care system. In 2011, 19% of total NT births were in the Darwin Private Hospital. Of the women who gave birth in the private system 98% were non-Indigenous so, given non-Indigenous women elsewhere had lower coverage rates, this exclusion may have led to an overestimation of overall vaccination coverage rates, particular for influenza which differed significantly based on Indigenous status.

Another limitation is that this study only captured vaccination data from the NTIR. The NTIR relies on the person administering the vaccination to then report it to the registry. Therefore vaccination data may be missed if the woman was vaccinated interstate before moving to the NT. Also some work places offer influenza vaccination, including to staff in the Defence Forces and at many other government workplaces and these vaccinations are not always reported to the NTIR. It has been noted that some GP clinics that may not have easy access to reporting mechanisms, also do not report their vaccinations. This would lead to under-reporting of vaccinations and therefore a potential underestimation of vaccination coverage rates.

**Conclusion**

The documented vaccination coverage in pregnant women is 39.3% for influenza and 22.3% for pertussis. These estimates should be considered as a minimum as only documented vaccination to the NTIR is taken into account. This study highlights that vaccination education campaigns at the Centre for Disease Control this year will need to focus on raising awareness for pertussis vaccination from 28 to 38 weeks gestation. These campaigns will target pregnant women, midwives, general practitioners, obstetricians and other antenatal care providers. Improvement in documentation of all immunisations given in the NT to the NTIR will assist coverage analysis and help target future vaccination education campaigns.

**Conflicts of interest**

No conflicts of interest to report.

**References**

9. Standard Treatment Manual for Women’s


11. Centre for Disease Control, Department of Health Northern Territory. NT Immunisation schedule. 2015


26. Parke H. Uptake of influenza vaccination by pregnant women in the Northern Territory. The NT Dis Control Bull 22(4) 2015


Mumps outbreak in the Northern Territory 2015–2016

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1Centre for Disease Control Alice Springs, 2Darwin, 3Katherine

Abstract

The Northern Territory experienced an outbreak of mumps commencing in July 2015. Despite high vaccination coverage, the outbreak spread, primarily in the Indigenous population, through remote communities in the Katherine and Barkly regions and in urban Alice Springs. At the time of writing there were also a few cases notified from Top End communities.

Public health responses were implemented including isolation, immunisation catch-up and awareness raising. A community-based response was implemented if transmission was confirmed in a community. To the end of November 2016 there were 129 cases notified, with 91% being Indigenous and 83% between the ages of 10 and 35 years. Vaccination information was available in a large proportion (81.4%) of cases and in those a significant proportion (48.6%) were fully vaccinated.

There were 6 communities that identified ongoing transmission and implemented responses based on ensuring all community members born after 1965 had had 2 valid doses of mumps-containing vaccine.

It is likely that waning immunity together with poor housing infrastructure and overcrowding contributed to the spread of mumps in the Indigenous population.

Key words: mumps; disease outbreaks; measles-mumps-rubella vaccine.

Background

The earliest written description of mumps in existence dates back to the fifth century BC with a description of a mumps epidemic in the island of Thasos given by Hippocrates in his Corpus Hippocraticum.1 Mumps is usually a mild disease characterised by non-specific viral symptoms, fever and parotitis and in unvaccinated populations is shown to cause subclinical infection in one third of patients. Mumps does however the potential for more serious disease with orchitis, meningitis, hearing loss, encephalitis and pancreatitis all being recognised complications. Mumps has become a relatively rare disease in Australia since the introduction of the first mumps containing vaccine into the National Immunisation Program in 1983 and the addition of a second dose in 1994.

Since 2000, the notified sporadic cases of mumps in the Northern Territory (NT) vary between 1 and 14 per year. There was an outbreak from early 2007 to early 2009 which comprised over 100 notified cases and affected mainly Indigenous teenagers and young adults in the Darwin rural and Alice Springs regions (Figure 1).

Currently, the vaccination coverage rate for Measles-Mumps-Rubella (MMR) vaccine at 5 years is 94.2% Australia wide and 94.5% in the NT.2 Despite these high vaccination rates, a recent resurgence of mumps has been observed in Western Australia3 and likewise in other industrialised countries around the world.4-5

The public health response to a case of mumps involves isolation and raising awareness in contacts to restrict further spread by early isolation of any secondary cases. Post-exposure prophylaxis of contacts is ineffective,6 but household and other contacts are usually brought up-to-date with their MMR vaccinations, to ensure they will not acquire infection from potential secondary household cases and that they are immune to measles and rubella.

In the outbreak setting, the use of a third dose of MMR vaccine at the community level to ‘ring fence’ the outbreak has been tried but effectiveness has not been established.7,8

In March 2015, an outbreak of mumps was detected in the Kimberley region of Western Australia9 (WA) which extended across the rest of northern WA through 2015–2016. By July 2015, the first cases of mumps linked to this outbreak were notified in the NT. This article describes the epidemiology of the recent outbreak of mumps in the NT and the public health response undertaken by the Centre for Disease Control (CDC).
Methods

Data collection

Mumps is a nationally notifiable disease and has a national case definition which relies on either confirmatory laboratory evidence or a combination of suggestive laboratory, clinical and epidemiological evidence (Box). In practice almost all cases are diagnosed by polymerase chain reaction (PCR) testing on a buccal or throat swab or urine sample. Mumps cases may be notified to the CDC by the laboratory or clinicians. Following notification, additional data are collected by CDC staff and entered into the NT Notifiable Diseases System (NTNDS). Other data sets such as the NT immunisation register and electronic patient information systems are interrogated to determine vaccination status of cases. Data concerning all cases of mumps notified in the

<table>
<thead>
<tr>
<th>Confirmed case</th>
<th>Laboratory suggestive evidence</th>
<th>Clinical evidence</th>
<th>Epidemiological evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A confirmed case requires either:</td>
<td>Detection of mumps-specific IgM antibody (in the absence of recent mumps vaccination).</td>
<td>A clinically compatible illness characterised by swelling of the parotid or other salivary glands lasting 2 days or more without other apparent cause.</td>
<td>An epidemiological link is established when there is:</td>
</tr>
<tr>
<td>1. Laboratory definitive evidence</td>
<td></td>
<td></td>
<td>1. Contact between 2 people involving a plausible mode of transmission at a time when:</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
<td>A. one of them is likely to be infectious (6-7 days before onset of overt parotitis to 9 days after); AND</td>
</tr>
<tr>
<td>2. Laboratory suggestive evidence AND clinical evidence</td>
<td></td>
<td></td>
<td>B. the other has an illness that starts within approximately 12 to 25 days after this contact; AND</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
<td>2. At least 1 case in the chain of epidemiologically linked cases (which may involve many cases) is laboratory confirmed.</td>
</tr>
<tr>
<td>Laboratory definitive evidence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Isolation of mumps virus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Detection of mumps virus by nucleic acid testing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. IgG seroconversion or a significant increase in antibody level or a fourfold or greater rise in titre to mumps virus EXCEPT when there has been recent mumps-containing immunisation.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NT between July 2015 and end November 2016 were extracted from the NTNDS and analysed using STATA v13.1.

All cases of confirmed mumps likely to have been acquired in the NT from the beginning of July 2015 were included in the outbreak. Those known to have been acquired outside the NT were excluded. We defined fully vaccinated as having had 2 MMR vaccines after 11.5 months of age at least 4 weeks apart and partially vaccinated as having had at least 1 MMR vaccine but not fulfilling requirements for being fully vaccinated.

Public health response

The public health response to the mumps outbreak in the NT consisted of a combination of measures which included individual follow up of each individual case, awareness raising activities and community-based measures directed at affected communities.

Individual follow up

A public health response was initiated for each case which consisted of the following:

- Isolation of cases for 9 days from onset of parotitis or until swelling subsided, whichever was the sooner
- Catch-up vaccination offered to close contacts of cases born after 1966, who were not fully vaccinated against mumps
- Data collection, education and advice to patients and practitioners.

Awareness raising activities

- Distribution of health alerts and fact sheets to health care providers in the primary healthcare setting and the Emergency Departments of hospitals, including advice on clinical features and diagnostic testing
- Public awareness-raising through poster distribution, letters to schools, radio interviews and contribution to articles in local newspapers and discussions with community leaders.

Community level response

When there was more than a single case detected in a community and it was likely that localised transmission was occurring, a community level response was initiated. This included:

- Discussion by teleconference with clinic staff and other stakeholders regarding the outbreak, including the clinical aspects, epidemiology, awareness raising and immunisation
- A communications plan to increase awareness-raising in the community and health care workers
- Consideration of options for a specific vaccination program. Options 1 to 4 included:
  1. Opportunistic checking that all clinic attendees born after 1965 were fully vaccinated for mumps and immunisation of those found not to be fully vaccinated
  2. Systematically checking that all community members born after 1965 were fully vaccinated for mumps and immunisation of those found not to be fully vaccinated
  3. Opportunistic offering all clinic attendees between the ages of 8 and 35 years a third or extra MMR vaccine, regardless of the number of previous doses received
  4. Systematically offering a third or extra MMR vaccine to all community members between 8 and 35 years regardless of the number of previous doses received.

Results

By the end of November 2016, there had been a total of 129 outbreak cases of mumps in the NT, with 91% of these occurring in the Indigenous population in communities in the Katherine, Barkly and Alice Springs region. There was little difference in the gender distribution with 48% of cases occurring in males. There was no reported hospitalisation of cases and no reports of serious complications. The epicurve is illustrated in Figure 2.

The age range of cases was 4 to 70 years (mean age 25.5 years) with 83% of cases occurring in the 10–34 year age group. Analysis of the vaccination status for those whom vaccination status was recorded (n=105), showed 48.6% were fully vaccinated, 38.1% were partially vaccinated and 13.3% were unvaccinated. There were 10 cases (9.6%) who had received 2 MMR vaccines but their first vaccine was given before 11.5 months of age and so were deemed partially vaccinated. The age distribution and vaccination status is illustrated in Figure 3.
The first case of mumps in this outbreak was diagnosed on 15 July 2015 in an 18 year old woman from a small Indigenous community in the Katherine region of the NT that has cultural and familial ties with the communities in WA affected by the recent mumps outbreak. By November 2015, there were 12 cases in total in the NT, 7 coming from the same community in the Katherine region. The CDC unit in Katherine, in partnership with the health service, initiated a public health response that consisted of the usual isolation of cases and catch-up immunisation for non-immune contacts and a public awareness campaign with distribution of posters, discussions with community leaders and alerts to the schools. The immunisation records of the residents of the community affected by the 7 cases were reviewed and a
community-wide systematic catch-up immunisation program for 8 to 35 year olds initiated (Option 2). Over a 3 day period 95 MMR vaccinations were administered. There were no further cases of mumps in this community following the intervention, although the outbreak continued in other communities in the region and in Katherine township. Option 2 was also implemented in 2 other communities with evidence of local transmission.

By February 2016, the first reports of cases of mumps with an epidemiological link to the outbreak in WA started appearing in the Barkly region. Cases steadily grew from this time, although most cases were unable to be linked. By November 2016 a total of 60 cases had been reported in the Barkly region, focusing mainly on Tennant Creek and 4 surrounding Indigenous communities. Throughout the outbreak, the CDC Barkly unit continued to recommend the public health control measures to clinicians and worked with the local health service providers to raise awareness. In September 2016, the CDC supported specific vaccination catch-up campaigns in the communities with the greatest number of cases, where opportunistic and systematic vaccination catch-up programs were recommended, depending on the size of the community and the resources available. There were 3 remote communities in the Barkly region that were considered to have active transmission and these communities implemented a systematic review of vaccination status for all residents with catch-up vaccination offered to those with incomplete immunisation (Option 2). Cases continued to appear throughout the spring but were fewer than the peak in August (Figure 2).

A smaller cluster of cases was seen in the Alice Springs region, with 16 cases notified between July and November 2016. No obvious epidemiological links were found to the other regions of the NT or WA. Of particular concern was the appearance of cases in the Alice Springs Correctional Centre (ASCC). On 6 September 2016, the first case of mumps was notified in a non-Indigenous inmate of the ASCC, again with no established epidemiological link. Cases were isolated and the prison health clinic undertook a targeted catch-up vaccination for all contacts of cases who had resided in the same dormitory as the case. An opportunistic catch-up vaccination program was initiated for all new entrants into the prison, along with a systematic catch-up program for all current inmates. A total of 221 MMR vaccinations were given in the ASCC between September and November 2016. A further 9 cases were suspected with only 1 meeting the criteria for notification into the NTNDS.

Small clusters were also observed in Darwin and East Arnhem regions (6 and 7 cases respectively).

**Discussion**

As with previously described outbreaks, this outbreak also occurred in a highly vaccinated population. Several theories have been proposed to explain the resurgence of mumps in highly vaccinated populations, including possible primary vaccine failure (failure for vaccination to give an adequate immune response), secondary vaccine failure (where immune response wanes with time from last vaccination), suboptimal effectiveness of the vaccine (due to possible appearance of new adapted genotypes of mumps virus) and reduced immune boosting from circulating wild type mumps virus. It is likely that most of these factors have played a role in this outbreak.

Transmission of any disease is influenced by the proportion of non-immune people in the population and the probability that a non-immune person will be exposed to an infectious case. This probability is determined by the frequency of contact between people and the length of time a case is infectious. In situations of overcrowding, there will be greater frequency of contact between people, and thus greater transmission of disease. In remote Indigenous communities where there are high average household numbers and increased frequency of travel between communities, disease transmission is more likely and offers an explanation as to why Indigenous people were disproportionately represented in this outbreak.

Another contributing factor may have been the variation of the vaccination schedule for Indigenous children in the NT from 1984 to 1994, where the first dose of MMR was given at 9 months of age. It is now considered that those who have received their first dose of MMR
vaccine before 11.5 months of age should receive a third dose. Thus, any Indigenous person in the cohort currently aged between 22 and 32 years will have received their first MMR dose at 9 months of age and hence should have received a third dose. Interestingly, there were 10 such cases deemed only partly immune by virtue of not receiving a required third dose.

Boosting immunity with a third MMR vaccination has been utilised as an outbreak response measure. This was studied in a large outbreak of mumps in a school in the US in 2009-2010, where a third MMR vaccination was offered to the general school population during the outbreak.\textsuperscript{12} A total of 1755 vaccinations were given out of 2265 eligible students and a reduction in cases was seen in all age groups offered the vaccination, with the attack rate overall dropping from 4.93% in the pre-vaccination period to 0.13% in the post-vaccination period. The authors however, were not able to confidently attribute the decline to this strategy as the number of new mumps cases had started to decline before their intervention.\textsuperscript{11}

Another study in the US measured the antibody response to a third vaccine given to those who had a documented history of having received 2 doses of MMR, but with no evidence of mumps antibody.\textsuperscript{7} Of the 440 participants studied, 94% were found to already have immunity and were not given a third vaccination. The majority of those vaccinated with the third MMR became seropositive at 2 to 3 months post vaccination.\textsuperscript{7} Whether this correlates with an adequate immune response in an outbreak setting was not established.

While studies point towards the effectiveness of this strategy, more research is needed to fully answer this question.

**Conclusion**

The cause of the mumps outbreaks in the NT in 2015 and 2016 is not clear, although overcrowding in the context of waning immunity would seem likely contributing factors. The effectiveness of offering a third MMR vaccination as an outbreak control response measure has not yet been established. The over-representation of Indigenous people in the outbreak adds to the growing body of evidence that overcrowding is a significant contributing factor to the high rates of infectious diseases seen in the Indigenous population.

**Acknowledgements**

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**References**

A series of exotic mosquito detections at Darwin International Airport, Northern Territory between February 2015 and January 2016
William Pettit and Nina Kurucz, Centre for Disease Control, Darwin

Abstract

Between February 2015 and January 2016 there were 4 separate detections of the dengue mosquito, Aedes aegypti, in surveillance traps at Darwin International Airport (DIA). The Northern Territory is currently free of establishments of exotic Aedes species however its proven receptiveness for Ae. aegypti establishment has been well documented. The detections at DIA were all associated with aircraft arriving from South East Asian ports with genetic analyses indicating differences between the Ae. aegypti captured at DIA and endemic Ae. aegypti from Queensland (unpublished data).

In February and March 2014 exotic vector surveillance at international airports in Perth, Melbourne and Adelaide detected Ae. aegypti. Since these initial detections there have been numerous detections of Ae. aegypti at Australian international airports that also included Sydney, Brisbane and Darwin (unpublished data). This report describes the detections at DIA and the response measures.

Key words: Aedes aegypti; Darwin International Airport; exotic mosquito; surveillance.

Introduction

Since the late 1950’s, the Northern Territory (NT) has been free of endemic populations of the dengue mosquito Aedes aegypti despite regular importations of this species into NT sea ports and occasional localised establishments in NT towns.1,2 Three establishments of Ae. aegypti in Tennant Creek and on Groote Eylandt were all successfully eliminated during 2 year programs.3,4,5 Genetic analyses of samples from these locations showed that the Ae. aegypti from Tennant Creek were indistinguishable from Ae. aegypti from Queensland, while those from Groote Eylandt were different and therefore of overseas origin (unpublished data).

Between February 2014 and March 2016 Ae. aegypti was frequently detected at Australian international airports including Perth, Melbourne, Adelaide, Brisbane, Sydney and Darwin (unpublished data). In February 2015, the first detection of Ae. aegypti at DIA occurred with another 3 occurring in October 2015, December 2015 and January 2016. Although there is a record of Ae. aegypti and the Asian Tiger mosquito, Ae. albopictus, being collected from passenger aircraft in Darwin,6 these more recent detections are the first to occur in surveillance traps at Darwin airport terminals. The detections occurred in routine surveillance traps serviced by the Australian Department of Agriculture and Water Resources (DAWR) on a weekly basis. These included a CO₂ baited Biogents® BG sentinel trap (BG trap), a standard ovitrap and 2 sentinel tyre traps. DAWR has responsibility for exotic vector surveillance within a 400m zone of Australia’s first ports of entry. The Medical Entomology (ME) unit of the NT Department of Health (NT DoH) collaborates with DAWR in the NT by providing a taxonomic identification service for mosquitoes as well as assisting with enhanced surveillance activities and insecticide treatments following exotic mosquito detections.

Methods

All 4 Ae. aegypti detections at DIA occurred in close proximity to the terminal (Figure 1) and within 280m of the arrival gate used by international passenger planes arriving in Darwin.

Detection January 2015

The first Ae. aegypti detection at DIA occurred in a sentinel tyre trap (Figure 2) in the garden at the north eastern corner of the terminal building. A sentinel tyre trap contains approximately 3L of water that is enriched with a small amount of plant material to attract mosquitoes to lay eggs in the tyre. The tyre trap is serviced by DAWR on a weekly basis to check for the presence of mosquito larvae. When the tyre was sampled on 28 January 2015 it was found to contain Ae. aegypti larvae (1 x 3rd instar and 11 x 2nd instars). Routine sampling of the trap water 1
week prior on 21 January 2015 was likely to have disturbed some \textit{Ae. aegypti} eggs on the inside walls of the tyre causing them to drop into the water and hatch. Given the regular weekly sampling regime for all DIA surveillance traps it is likely that an \textit{Ae. aegypti} adult female visited the trap and deposited eggs sometime between 14 January 2015 and 21 January 2015 (routine tyre trap sampling dates).

On 3 February 2015 a 4\textsuperscript{th} instar \textit{Ae. aegypti} larva was sampled from the same tyre trap. It is strongly suspected that this larva hatched from the same batch of eggs that gave rise to the larvae detected 6 days earlier. The sentinel tyre was not treated with chlorine (bleach) to kill any remaining unhatched eggs after the detection on 3 February 2015. The samples collected by DAWR on 28 January 2015 and 3 February 2015 were provided to ME for formal identification on 11 February 2015 and 16 February 2015 respectively.

**Detection October 2015**

This detection occurred in a sentinel tyre in the domestic baggage handling area located about 60m east of the international arrival gate. A single 4\textsuperscript{th} instar \textit{Ae. aegypti} larva was detected when the tyre was sampled on 5 October 2015, and 1 2\textsuperscript{nd} instar larva was detected when it was sampled again on 7 October 2015. The tyre was not treated with bleach to kill any dormant eggs following the first detection, but was treated after the second detection on 7 October 2015. Disturbance of the trap water during routine sampling on 28 September 2015 is likely to have caused \textit{Ae. aegypti} eggs to drop into the water and hatch. The eggs were probably laid in the tyre sometime between 21 September 2015 and 28 September 2015 (dates of sampling).
samples collected by DAWR on 5 October 2015 and 7 October 2015 were provided to ME for formal identification on the day of collection.

**Detection November 2015**

In November, *Ae. aegypti* were reared from the wooden paddle of a standard ovitrap (Figure 3) that was positioned behind a drink bubbler approximately 190m east of the international arrival gate. The trap’s water and paddle were collected by DAWR on 15 November 2015. The water from the trap was checked for mosquito larvae before being discarded and the paddle was dried for 24hrs before being immersed in water to hatch any possible mosquito eggs. Larvae that hatched from eggs on the paddle were reared to late instars (17 x 3rd instars and 31 x 4th instars) before being identified to species level on 2 December 2015. All larvae were identified as *Ae. aegypti*. Since the ovitraps at DIA are serviced on a weekly basis the eggs would have been laid on the paddle sometime between 8 November 2015 and 15 November 2015 (dates of sampling). All larvae were provided to ME for formal identification on 2 December 2015.

**Detection January 2016:**

A sample collected on 17 January 2016 from a BG trap (Figure 4) within the baggage handling area was found to contain 1 adult female *Ae. aegypti*. This trap is located against the western wall and about 15m away from the airside entrance. The specimen was in very good condition which suggested that it had been captured within the previous 24hrs. The BG traps deployed by DAWR run continuously, are supplied with CO₂ (mosquito attractant) from a cylinder at a rate of 250mL/min, and are collected and reset on a weekly basis. The specimen from the BG trap was provided to ME for formal identification on Monday 18 January 2015.

**Exotic mosquito detection responses**

Each of the responses to *Ae. aegypti* detections at DIA by DAWR and ME followed the same established procedures for detections of exotic *Aedes* species at a first port of entry.
Larval mosquito control and enhanced surveillance

Following each *Ae. aegypti* airport detection DAWR and ME officers conducted larval surveys of airsides and landside areas in the vicinity of the DIA terminal and on the grounds of all businesses within the airport precinct. The surveys commenced on the day of the detection and were usually concluded within 2 days. Any mosquito larvae found during the surveys were collected and identified, with actual and potential mosquito breeding sites treated with insecticide or made to be free draining.

Four weeks of enhanced surveillance trapping immediately followed each *Ae. aegypti* detection. Two additional adult BG traps were installed in the garden on the north side of the terminal. Following the February 2015 detection, a BG trap was also set in a shaded location, approximately 400m north east of the terminal. All BG traps were baited with CO₂ gas and operated continuously. Samples were collected from the traps on a daily basis for 1 week, and then once a week for 3 weeks. All samples were delivered to ME on the day of collection for taxonomic identification. In addition, 4 standard ovitraps were deployed within 250m of the terminal within 2 days of detection and were collected and reset at fortnightly intervals. All enhanced surveillance traps were discontinued and removed from DIA at the end of each 4 week period since no exotic mosquitoes were detected.

During the response to the February 2015 detection flame traps (deep water holding sumps) on the aircraft arrival apron were treated to control larvae using Prolink® pellets (s-methoprene) and Aquatain® AMF liquid mosquito film (polydimethylsiloxane). Since September 2015 DIA has carried out a proactive routine insecticide treatment program to control mosquito breeding in flame traps and has applied Aquatain® AMF liquid mosquito film on a fortnightly basis and Prolink® briquettes (s-methoprene) on a monthly basis.

Adult mosquito control

No adult mosquito control was conducted following the first detection of *Ae. aegypti* larvae in the tyre trap in the landside garden at DIA in February 2015. There were no pupae or pupal skins in the trap to indicate that any emergence had occurred and the adult female that had laid the eggs was likely to have left the area and died of old age by the time the larvae had been identified. Following all other *Ae. aegypti* detections at DIA, a residual pyrethroid insecticide treatment (Bestox® PC50 - 50g/L alpha-cypermethrin) was applied to vertical surfaces and mosquito harbourage areas in the domestic baggage handling area as well as to the wall behind the international arrivals carousel at the west end of the terminal. It was applied as a course droplet spray to walls (to a height of 2m) and potential mosquito harbourage areas using a hand-held pressure sprayer. The treatments were conducted at times when the domestic baggage handling area was able to be vacated for a short period.

Following the detection of an adult *Ae. aegypti* female in the BG trap in the domestic baggage handling area on 18 January 2016, an ultra-low volume (ULV) insecticide fog was applied in the domestic baggage handling area on 19 January 2016 to knock down and kill any adult *Ae. aegypti* that might have been harbouring in the area. The insecticide used was Twilight® ULV mosquito adulticide concentrate (89g/L d-phenothrin and 89 g/L piperonyl butoxide), applied using a Leco P1 handheld fogger. This was the only instance in which insecticide fogging has been carried out at DIA the terminal for exotic *Aedes* control.

In response to multiple detections of *Ae. aegypti* at international terminals around Australia in late 2015 DAWR conducted on-arrival insecticide treatments of cargo holds using canisters containing d-phenothrin and permethrin for aircraft arriving from SE Asia at Perth, Darwin and Melbourne starting on 9 December 2015. This program was expanded to include Brisbane from 23 December 2015 and Adelaide from 15 January 2016. These treatments were ceased on 30 April 2016 (unpublished data) as dry season conditions returned to South East Asia.

Results

No *Ae. aegypti* larvae or adults were detected during larval surveys and enhanced trapping.
activities in the 4 weeks following each detection, with the exception of secondary detections in sentinel tyres that had registered the initial detections.

Discussion

The NT international air and sea ports have a proven receptiveness and thus a high risk for *Ae. aegypti* establishment, as outlined in the recent vector monitoring risk assessment of Australia’s first ports of entry report.7 The *Ae. aegypti* detection in January 2015 was the first to be recorded in surveillance traps at DIA. All 4 detections likely occurred as a result of a combination of insufficient port sanitation at the aircrafts’ ports of origin, insufficient or ineffective cargo hold insecticide treatments, and harbourage areas within cargo holds where *Ae. aegypti* may not be exposed to cargo hold treatments. It should be noted that the January 2016 detection of an adult *Ae. aegypti* at DIA occurred despite the active DAWR program of on-arrival cargo hold insecticide treatment at that time.

The high number of exotic *Aedes* detections at Australian international airports since 2014 show the importance of exotic mosquito surveillance, timely responses and proactive mosquito breeding site reduction measures at international sea and airports. Without the ability and resources to detect exotic mosquito arrivals in a timely manner, there is a high risk that exotic mosquitoes like *Ae. aegypti* and *Ae. albopictus* could readily establish populations in Darwin or other first ports of entry in Australia.8 A widespread reestablishment of *Ae. aegypti* in the NT would bring with it a high risk of local transmission of exotic diseases such as dengue, Zika and chikungunya.8

Conclusion

The early detections and lack of establishments of *Ae. aegypti* at NT first ports of entry show that current exotic vector surveillance and elimination procedures in the NT are effective. The global spread of exotic mosquitoes through international transport and cargo movements along with increasing insecticide resistance capabilities of exotic mosquitoes presents a real challenge for controlling the introduction of exotic vectors. This challenge will have to be addressed if the NT is going to remain dengue mosquito free and therefore free of local transmission of dengue, chikungunya and Zika viruses.

Acknowledgements

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References

Development of the Centre for Disease Control public health response for crusted scabies

Christian James, Centre for Disease Control, Darwin

Abstract

Scabies is endemic in many remote Aboriginal communities in the Northern Territory (NT). Crusted scabies is due to the same scabies mite, but occurs when the patient's immune system fails to control the initial scabies infestation. The management of crusted scabies remains challenging because it involves a clinical, public and environmental health approach.

The primary objective of this project was to develop a crusted scabies public health response which complimented the Healthy Skin Program: Guidelines for Community Control of Scabies, Skin Sores, Tinea and Crusted Scabies in the Northern Territory (Healthy Skin Guidelines). The secondary objective was to widen and improve distribution of the Healthy Skin Guidelines.

The new tools will aid in the acute phase management and public health response of crusted scabies across the NT.

Keywords: crusted scabies; public health response; Healthy Skin Guidelines.

Introduction

Scabies is endemic in many remote Aboriginal communities in the Northern Territory (NT), with data suggesting that in some communities up to 50% of children and 25% of adults have scabies. Crusted scabies is due to the same scabies mite, but occurs when the patient’s immune system fails to control the initial scabies infestation. Traditionally clinicians have used a combination of clinical experience, the Healthy Skin Guidelines and the CARPA Manual to clinically diagnose crusted scabies patients. In August 2015 the Healthy Skin Guidelines were revised and formalised the requirements for hospital and community diagnosis and the management of crusted scabies. It also highlighted the steps required to manage a household and house after a confirmed case of crusted scabies.

Crusted scabies was made notifiable in the NT from 1 January 2016. Prior to 2016, only limited information has been available regarding the number of people with crusted scabies in the NT and the geographic and demographic distribution of these cases. Since becoming notifiable in January 2016, 27 people have been notified with crusted scabies across the NT. Of these patients 17 were from remote/rural areas and 10 from urban areas (Figure 1) with a mean age of 45 years and 26 of those patients identified as Indigenous and 1 as non-Indigenous.

Figure 1. Confirmed crusted scabies cases by location in 2016

With the addition of crusted scabies to the list of Notifiable Diseases, the NT Centre for Disease Control (CDC) prioritised the development of a standardised public health response to crusted scabies. The Healthy Skin Guidelines comprehensively outline the response required to treat patients, household contacts and the household in a confirmed case of crusted scabies.
The primary objective of this project was to develop a crusted scabies public health response to compliment the Healthy Skin Guidelines. The second objective was to improve distribution of the Healthy Skin Guidelines among clinicians in the NT.

**Public heath response**

The public health response for crusted scabies is well described in the Healthy Skin Guidelines. The identified concerns from a CDC perspective are not what to do, but more so who is to do it. The public health response to a confirmed case of crusted scabies requires household contact tracing for residents who have stayed in the household 7 days preceding diagnosis. Once this list is generated the household is visited where a team provides education to the household on cleaning and removal of any item that the index case has had prolonged contact with (if less than 5 days since the index was admitted to hospital). All household contacts are reviewed and provided with Lyclear (Premethrin) and observed using the treatment. All household contacts that are identified as having scabies upon the visit will be followed up and given a second dose of Lyclear (Premethrin) in 7 days’ time. The Healthy Skin Guidelines and CARPA recommends cleaning of the household to remove any potential fomites. These documents refer to Environmental Health as a technical resource point for information and education on household cleansing and using pesticide bombs.

**Understanding crusted scabies disease and management in the NT**

A mixed method disease analysis approach was used to monitor the management of the disease and the performance of health services. A traffic light system was used to assess the disease knowledge/service performance, acute and chronic management and public health response to crusted scabies (Figure 2).

There was no formalised measure attached to the traffic light system, classifications were made through observation and consultation with key internal and external stakeholders.

The in-hospital management of crusted scabies was considered to be functional, with well-defined and actioned referral processes and a clear diagnosis and management pathway involving specialist infectious disease or dermatology physicians.

Health workforce knowledge, diagnosis and treatment of crusted scabies in rural/remote and public health response were identified as partially completed due to availability of formalised crusted scabies education, existing protocols such as the Healthy Skin Guidelines and CARPA, however there are inconsistencies with knowledge and a lack of awareness around guidelines and protocols. These areas need refinement to be standardised and effective across the NT.

**Figure 2. Mixed method disease progression and performance analysis**
Community awareness and knowledge around crusted scabies, long-term follow up of patients in urban and rural settings, crusted scabies notification and public health response were all identified below average and these areas require considerable work was needed to address the short comings. This simple analysis provided a road map for discussion among all stakeholders.

**Stakeholder consultation**

The consultation process was used to discuss what internal and external agencies perceived as their role in education, diagnosis and treatment of crusted scabies. Additionally this consultation process identified what stakeholder resources are available to manage the public health response to a confirmed case of crusted scabies in urban and rural / remote locations across the NT.

Environmental Health outlined that greater communication is required to educate health service providers regarding their role in a crusted scabies public health response. Environmental Health has personnel available in major urban centres and can provide technical advice to health services in urban and rural/ remote locations and staffing dependent can provide specialist technical support during a public health response in urban areas if the public health response occurs less than 5 days after the patient left their dwelling. Environmental Health have agreed to work with CDC to prepare a multilingual video presentation that outlines a brief introduction to scabies and how the parasite can infect members of a household, and demonstrate what actions are required to clean a household to minimise the risk of household contacts being infected by scabies. This video will be used by Health and Environmental Health staff during a public health response to a confirmed crusted scabies case in either urban or remote settings. Strategies were also discussed around raising community awareness and knowledge around scabies through Environmental Health media campaigns.

*One Disease* is a non-governmental organisation whose focus is to work with health services and community members to develop the capacity of stakeholders to diagnose, manage and ultimately prevent crusted scabies. Currently *One Disease* has staff based in Darwin, with several staff members assigned to travel to regional and remote areas. *One Disease* has future plans to expand personnel to Katherine and Alice Springs. During consultation *One Disease* identified their major priorities as developing the capacity of health staff to diagnose and manage crusted scabies, and to work with community members to develop an understanding of the disease and a chronic care model to prevent reoccurrences of crusted scabies in a urban and remote patients (Figure 2). It was noted that *One Disease* staff require a referral from the treating clinical teams in hospital or the primary health team before they can work with the patient to provide education and advice. *One Disease* has demonstrated a willingness to participate in urban and remote public health responses if resources are available.

Aboriginal controlled community health organisations (ACCHO) and general practitioners are also identified as an integral part of the public health response. Often patients are referred to regional and major hospitals by community health services. These patients and their families have an established relationship with the community controlled sector. The referring service or health provider will be contacted upon notification of crusted scabies and asked to contribute or partake in the public health response.

Prior to crusted scabies becoming notifiable in 2016, clinicians working in rural and remote areas following the *Healthy Skin Guidelines* and *CARPA* would facilitate a limited response to households where a crusted scabies patient was living. Despite having less access to resources and staff, an effective public health response can be planned in these locations because health centre staff generally have an established relationship with the community.

It was noted that a significant proportion of confirmed crusted scabies cases were now being identified in urban areas. While clinicians working in urban areas have greater access to resources, they may have less of a defined relationship with the patients and household. Additionally there seemed to be a lack of clarity over who was responsible for completing the public health response. These *Guidelines*
propose a structured multidisciplinary approach for a public health response in urban areas. CDC’s primary focus was to notify the referring community medical teams and then coordinate the public health response in urban areas including involving specialist stakeholders, where available, such as Environmental Health and One Disease (Figure 3) in conjunction with the individuals and households.

**Communication and innovation**

Secondary to the development of a NT-wide public health response, this project identified the need to review the dissemination process of the Healthy Skin Guidelines. This document was reviewed in 2015 and provides NT clinicians with the current management guide for skin diseases in the NT. The Guidelines will be resent to all health services across the NT. To enhance the distribution of the Healthy Skin Guidelines this project identified an innovative solution to disseminate the Guidelines. Preliminary design work has started on designing a smart phone app which highlights key areas of the Healthy Skin Guidelines and introduces a diagnostic tool for scabies and crusted scabies.

**Conclusion**

The disease management and public health response analysis was used to identify where the gaps in knowledge and resources lie with regards to crusted scabies and hence was pivotal in the development of this crusted scabies public health response. All stakeholders agreed that the community awareness and knowledge of crusted scabies was poor, even among patients with previous episodes of crusted scabies. Health worker knowledge was considered to be average, despite access to numerous free education packages and several clinical treatment guides including the 3rd edition of the

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**Figure 3. Proposed flowchart for CDC public health response: Treatment of household contacts and house**

- **Identify patient’s primary place of residence and compile a list of household contacts for the preceding 7 days.**

  - **Primary residence**
    - Rural / Remote

  - **Discuss case with regional Environmental Health Officer (EHO) (< 5 days since patient was admitted to hospital) and One Disease (if regionally available).**

  - **Use Appendix 4 from the Healthy Skin Program to assist in planning visit.**

  - **CDC on call officer**

- **Complete Crusted Scabies Public Health Response Form and fax to treating Doctor and / or PHC / AMS practice manager for in community follow-up.**

- **Treatment of house for Crusted Scabies**

  - The EHO will provide information and assistance to the family of the primary residence to provide education so the family can take responsibility for the cleaning of the household.

- **Household contact treatment**

  - Treat all household contacts and close contacts with a single application of permethrin 5% cream (head to toe) or crotamiton 10% cream if under 2 months of age.

  - All contacts who themselves have clinical scabies should complete a full treatment course as described in section 3.2.1 of the Healthy Skin program.
Healthy Skin Guidelines and CARPA. Consensus among stakeholders was that the knowledge surrounding diagnosis and management in community varied among practitioners depending on experience and orientation. The long term follow up and management of crusted scabies patients was identified as an area of concern for all stakeholders.

A public health response to crusted scabies is complicated and dependant on factors including health worker and community knowledge, fast and accurate diagnosis, efficient hospital management, appropriate referral to One Disease, Environmental Health and primary health facilities, appropriate resources and most importantly a willingness to develop a strong relationship with the patient and family. The proposed public health response aims to develop clinicians and community information to improve stakeholder knowledge, provide a series of innovative tools to assist fast and accurate diagnosis and provide stakeholders with a easy to follow guide to help minimise both household contacts contracting crusted scabies and preparing the index case to safely return home to the community.

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References

Invasive Group A Streptococcus (iGAS) infection
Someone close to you has an iGAS infection

If you show signs of the following in the next 30 days

- Skin sores (school sores)
- Sore throat
- Fever (sweats)

SEE YOUR DOCTOR
Visit the health clinic and say you are an iGAS contact

The infection can be easily spread through contact

- Kissing
- Touching skin
- Coughs and sneezes
- Sharing clothes and towels
- Sharing bedding

What can I do to STOP iGAS infections?

- Wash hands with soap before eating
- AND after coughing or sneezing
- Treat all scabies (itchy skin) and skin sores
- Treat everyone in the house if anyone has scabies
- Wash bedding and clothing
- Visit your doctor or health clinic if you or your family have skin sores, a sore throat, scabies (itchy skin) or fever

www.nt.gov.au/health
Get prepped on PrEP
Jacqueline Murdoch and Manoji Gunathilake, Centre for Disease Control, Darwin

Abstract

Pre-exposure prophylaxis for HIV, or ‘PrEP’ is the daily use of antiretroviral medication to prevent HIV acquisition in those at high risk. Clinical trials have shown that consistent use of PrEP can prevent up to 86% of new HIV infections. Although combination tenofovir disoproxil fumarate and emtricitabine was licensed for use as PrEP in Australia by the Therapeutic Goods Administration in May 2016, it is not currently subsidised by the Pharmaceutical Benefits Scheme. Access options for Australians include importation for personal use and participation in demonstration trials. Risks of PrEP include renal damage, loss of bone mineral density and development of drug resistance. Condom use and safe injecting practices continue to be promoted to PrEP users to provide additional protection against HIV acquisition and importantly to protect against other sexually transmitted infections and blood borne viruses. Clients in the Northern Territory can receive information, assessment, scripts and follow up for PrEP at Clinic 34.

Key words: HIV; Emtricitabine, Tenofovir Disoproxil Fumarate Drug Combination; pre-exposure prophylaxis.

The newest tool in the fight against HIV

PrEP, or pre-exposure prophylaxis for HIV, is one of the newest tools in the fight against HIV. PrEP is the use of anti-retroviral drugs taken to prevent infection of HIV by people who are not infected with HIV but are at high risk. PrEP acts like malaria prophylaxis, or the oral contraceptive, in that it is taken before exposure to block a new infection occurring when a person is exposed to infection. It is a powerful means of biomedical prevention and provides an important adjunct to other prevention methods including correct and consistent condom use, safe injecting practices, early antiretroviral therapy in people with HIV infection to reduce infectiousness and post-exposure prophylaxis (PEP).

The Therapeutic Goods Administration (TGA) approved the use of tenofovir disoproxil fumarate and emtricitabine (TDF/FTC, brand name Truvada) as PrEP in May 2016, a move that was welcomed by HIV researchers and activists.

Once daily dosing with combination TDF/FTC is the current recommended regimen. Other drug combinations, other dosing schedules and long acting drugs which could be administered monthly or quarterly are currently being studied for use as PrEP.

Up to 86% effective in preventing HIV infections

The efficacy of PrEP was established by a number of randomised placebo-controlled clinical trials in men who have sex with men (MSM), heterosexual adults and injecting drug users. These clinical trials observed substantial variation in the efficacy of PrEP (44% to 75%), mostly due to variations in adherence. When adjusted for adherence, efficacy rose to 92% in MSM and 84% in heterosexuals. The observed gap between average and adherence-adjusted levels of protection varied across studies, countries and research sites. None of these trials reported any significant increase in behaviour disinhibition with PrEP, and all trials promoted condom use and safer sex practices.

The most impressive effectiveness for HIV prevention with PrEP has been seen in 2 recent studies in Western Europe, 1 of which only required intermittent rather than ongoing PrEP dosing. Both the PROUD and IPERGAY studies were performed in ‘real world’ settings and achieved high adherence. The PROUD study in the United Kingdom reported an efficacy of 86%; for every 20 infections that might have occurred in participants, 17 were stopped by PrEP. The study was conducted among 544 high risk MSM attending sexual health clinics in England. Participants were randomised to commence daily PrEP immediately, or to defer PrEP for 1 year. There were 3 HIV infections among 276 participants randomised to the immediate arm (incidence 1.3 per 100 patient-years), and 19 in 269 participants in the deferred arm (8.9 per 100 patient-years).

The IPERGAY study in France reported exactly the same level of effectiveness as PROUD (relative risk reduction of 86%), although it studied only intermittent or ‘on demand’ PrEP
There were 400 high-risk MSM asked to take 2 TDF/FTC pills (or placebo) from 1 day to 2 hours before they anticipated having sex. If they actually did have sex, then they were to take a third pill 24 hours after sex and a fourth pill 48 hours after sex. There were 2 HIV infections among the 200 participants randomised to the TDF/FTC arm (incidence 6.75 per 100 patient-years) and 16 in the 200 randomised to the placebo arm (0.94 per 100 patient-years).

Both studies were designed as small pilot studies with the intention of moving to larger efficacy studies. However in late 2014, as a result of high and statistically significant effectiveness in the treatment arms, both studies stopped their placebo arms and all participants were offered PrEP.

**Side effects and safety**

The safety profile of daily TDF/FTC use for HIV negative individuals is known from clinical trials with follow up of participants from 1 to 4 years. Across 10 randomised controlled trials, rates of adverse events did not differ between PrEP and placebo. Common adverse reactions that were reported by more than 2% of TDF/FTC subjects were headache, abdominal pain and weight loss.

Renal impairment, including cases of acute renal failure and Fanconi syndrome and decreased bone mineral density are the major side effects of TDF/FTC use in individuals with HIV. PrEP studies have found a 1% decline in bone mineral density in TDF/FTC users, but no increase in minimal trauma fractures compared to placebo, although participants were only followed for 1 to 2 years. In these studies, the decline in bone mineral density was observed during the first few months on PrEP, and it either stabilised or returned to normal thereafter.

Risk of drug resistance while using PrEP is low, occurring in approximately 1 per 1000 PrEP users in clinical trials of daily dosing. These low rates have also been seen in trials of intermittent dosing performed to date.

Toxicity risks from longer term use in HIV negative individuals remain unknown. The most likely negative sequelae of long-term PrEP use are the development of resistance and, in a small number of people, the development of renal toxicity and loss of bone mineral density.

**Offering PrEP**

PrEP is now widely recommended around the world. In 2014, the World Health Organization (WHO) recommended offering PrEP to MSM. As of November 2015, WHO has expanded that recommendation to include all population groups at substantial risk of HIV infection, stating that “offering PrEP should be a priority for populations with an HIV incidence of about 3 per 100 person-years or higher.”

TDF/FTC has been licensed for PrEP in the US since 2012 and the US CDC recommends it as 1 prevention option for sexually active MSM at substantial risk of HIV acquisition, heterosexually active men and women at substantial risk of HIV acquisition and people who inject drugs who are at substantial risk of HIV acquisition. It also recommends discussing PrEP with HIV-discordant heterosexual couples who are planning conception and pregnancy.

The Australasian Society for HIV Medicine (ASHM) in Australia supports the use of PrEP in HIV negative individuals who are at high risk of becoming HIV infected: men who have condom-less sex with multiple partners; people who share injecting equipment; and patients in a relationship with a person with HIV who is not on treatment or who does not have an undetectable viral load. ASHM’s Australian Commentary on the US CDC guidelines provides a detailed matrix to guide behavioural risk assessment and PrEP eligibility in the Australian context. Given the low prevalence of HIV in the community and the low but real risk of toxicity, ASHM notes that daily PrEP should not be recommended for people at low risk.

**Clinical use and monitoring**

It is essential that HIV sero-negativity and baseline kidney function are established before starting PrEP. Hepatitis B and C and other STI screening are also recommended, as studies have shown high baseline rates of STIs in patients commencing PrEP.

If a person with HIV fails to be diagnosed when they commence TDF/FTC for PrEP (for example, if they are in the window period when an HIV test may not yet show positive or if they delay commencing their PrEP for some reason), it will not only give the false impression that PrEP has failed, there is a high likelihood that they will develop resistance to this medication, limiting their
future treatment options for HIV. Patients should be counselled to continue using condoms and safe injecting practices. This will provide additional protection from the transmission of HIV but importantly prevent the acquisition of non-HIV sexually transmissible and blood-borne infections.

ASHM strongly advises regular monitoring of any patient initiated on PrEP. US CDC and Australian guidelines recommend testing for HIV at least every 3 months to ensure that those with incident HIV infection do not continue to take PrEP. This will also provide an opportunity to discuss the continued need for PrEP, assess adherence and discuss any side effects. Monitoring of renal function every 3 to 6 months is necessary and guidelines recommend regular screening for other STIs and blood borne viruses.

Access to PrEP in Australia

While TDF/FTC (as Truvada) has been licensed by the TGA for PrEP, it is not currently subsidised by the Pharmaceutical Benefits Scheme (PBS) for preventative use. Consumers in Australia can currently purchase the drug without subsidy, however the cost is prohibitive at approximately $850 per bottle of 30 pills.

One option for consumers in Australia is to import Truvada or generic versions into Australia for private use under the TGA’s Personal Importation Scheme. This involves arranging from Australia for a medicine to be sent to the consumer from an overseas supplier or family/friend. The medicines are only to be used by the patient and must not be supplied to any other person. It is important to note that generic medicines have not been approved for supply in Australia by the TGA; and the TGA warns there is no guarantee about their safety or quality. Subject to satisfying various conditions, consumers may import a maximum of 3 month supply of medications at a time.

Generic TDF/FTC costs between $150 and $400 for a 3 month supply. HIV consumer groups have detailed information on how to import TDF/FTC for personal use. They recommend discussing PrEP with a doctor, having an HIV and other STI tests, obtaining a valid Australian prescription and managing ongoing PrEP use with a doctor. They also offer tips on how to find legitimate overseas suppliers.

Another option for consumers in Australia is to seek enrolment in observational research studies (demonstration projects). There are several PrEP demonstration projects being undertaken in Australia: VicPrEP in Melbourne (now full), EPIC NSW (currently over recruited) and QPrEPd (currently enrolling participants in Queensland). In late November a new PrEP access trial was announced for South Australian residents. There are no PrEP studies currently enrolling participants in the Northern Territory, however the options for trials are currently being explored.

Clients in the Northern Territory can receive information, assessment, scripts for PrEP and follow up at Clinic 34.

Cost-effective?

Despite PrEP’s high effectiveness, the cost of FTC/TDC makes it an expensive prevention strategy and funding for the scaling up of PrEP remains controversial. A systematic review of the impact and cost-effectiveness of scaling up PrEP found that it was a cost effective addition to HIV prevention programs in specific settings, depending on epidemic context, individual adherence levels, coverage and prioritisation strategy. France is the only country that currently subsidises PrEP for high risk populations, although Botswana will do so from April 2017.

In August this year the Pharmaceutical Benefits Advisory Committee (PBAC) in Australia rejected an application to list FTC/TDC for HIV PrEP on the PBS, citing a lack of cost effectiveness. It noted that the cost of treating someone at high risk of HIV infection with FTC/TDC would be between $105,000 and $200,000 per year. PBAC also noted that “in order to make Truvada available for PrEP to the whole at-risk population a substantial reduction in price would be needed to achieve cost-effectiveness.” Advocates have called on Truvada’s manufacturer Gilead to reduce the price of Truvada to allow the Federal Government to subsidise the drug as PrEP, citing modelling that shows access to PrEP across Australia for those at high risk would halve new HIV infections over the next year.
References


19. Interim Policy on Pre Exposure Prophylaxis to Prevent HIV SHBBV, Sexual Health and Blood Borne Virus Unit, CDC, NT.


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Abstracts from peer reviewed published articles related to the Northern Territory

High chlamydia and gonorrhoea repeat positivity in remote Aboriginal communities 2009–2011: longitudinal analysis of testing for re-infection at 3 months suggests the need for more frequent screening


Extremely high rates of diagnosis of *Chlamydia trachomatis* (CT) and *Neisseria gonorrhoeae* (NG) have been recorded in remote communities across northern and central Australia. A key strategy recommended for reducing rates of CT and NG is testing for reinfection at 3 months post treatment (re-testing). Using longitudinal laboratory testing data from 65 remote communities, we assess patterns in re-testing and levels of repeat CT and NG positivity in this priority setting.

Collecting and analysing testing data to improve the surveillance of sexually transmitted infections in the Northern Territory

Su J-Y


The literature has shown that surveillance data for common sexually transmitted infections (STIs) does not adequately measure disease occurrence or effectiveness of control measures because the number of notifications is strongly influenced by the amount of testing. This thesis explores how laboratory testing data could be used to improve the surveillance of STIs in the Northern Territory (NT), which has very high levels of STIs, particularly in the Aboriginal population.

Over the past 15 years, innovations using testing data to improve STI surveillance systems have occurred in several countries, and more recently in 2 Australian states, with differing but promising success, but most of them lacked sustainability. I therefore examined the theoretical and practical aspects of enhancing an STI surveillance system using laboratory testing data, and conducted 3 projects to test the feasibility and effectiveness of this approach in the NT.

The first project used testing data to investigate the sharp decrease in gonococcal cultures performed in the NT, illustrating the data’s utility in monitoring testing activities at the jurisdiction level. The second project used testing data to calculate testing rates and test positivity rates to assist in the interpretation of time trends in the gonorrhoea notification rate at the district level. The third project used testing and notification data to evaluate the effectiveness of a sexual health program (that included population screening for STIs) in a group of remote communities.

The benefits of using laboratory testing data to enhance STI surveillance have been demonstrated in several countries and 2 Australian states. The thesis has demonstrated the feasibility of accessing and analysing such data in the NT and the benefits for STI control in a high-prevalence population. I therefore conclude by proposing a best practice model for how such an enhanced surveillance system could, and should, be implemented in the NT.

Multidrug-resistant tuberculosis in the Northern Territory: A 10-year retrospective case series

Judge D, Krause V


**Background and objective:** To describe the clinical characteristics, risk factors, diagnostic modalities, treatments, subsequent outcomes and complications of Multidrug-resistant tuberculosis (MDR-TB) cases residing in the Northern Territory (NT).
Methods: A retrospective case series was conducted of all patients treated for MDR-TB in the NT between 1 January 2004 and 31 December 2013. This is the first study to analyse data relating to the subset of MDR-TB cases treated in the NT. Cases were identified by the NT Centre for Disease Control (NT CDC): the public health unit responsible for the management of tuberculosis in the NT. Outcome measures included patient demographics, diagnostics, HIV status, treatment methods, outcomes, and complications.

Results and conclusions: Six MDR-TB cases were treated in the NT; 5 of these were notified by the NT CDC during the study period (1.5% of all NT TB notifications). The median age of all 6 patients was 31 years (range 21 to 50 years), sex distribution was equal and all were born overseas. Country of birth in a World Health Organization (WHO) high burden MDR-TB country and previous treatment were most highly correlated with a current diagnosis of MDR-TB. Access to rapid drug susceptibility testing reduced the time to effective therapy from 45 to 27 days. Five patients met criteria for the WHO outcome term ‘treatment success.’ The median length of treatment for the 5 patients treated in Australia was 623 days (537 to 730 days). Side effects to therapy were common and serious. The incidence of MDR-TB in the NT is similar to other Australian states. Rapid drug susceptibility testing reduces the time to effective therapy. Treatment regimens are complex, toxic and have serious resource implications for health care providers. Successful treatment outcomes are possible with coordinated TB control programs.

Influenza vaccination coverage among pregnant Indigenous women in the Northern Territory of Australia

Moherley S, Lawrence J, Johnston V, Andrews R


Pregnant Aboriginal and Torres Strait Islander women are at particular risk of severe illness and high attack rates of influenza infection. In Australia, routine seasonal influenza vaccination is currently strongly recommended for all pregnant women and women planning pregnancy, and is provided free of charge for all pregnant women. We sought to determine vaccination coverage, describe the trends and characteristics associated with influenza vaccine uptake and determine the validity of self-reported influenza vaccination in a population of Indigenous pregnant women who were participants of a vaccine trial, prior to and during the 2009 H1N1 influenza pandemic. Vaccine coverage over the study period was 16% (35/214), increasing from 2.2% (3/136) in the period preceding the pandemic (2006–2009) to 41% (32/78) in the intra-pandemic period (2009 –2010). Self-report was not a reliable estimate of verified vaccination status in the pre-pandemic period (κ=0.38) but was reliable in the intra-pandemic period (κ=0.91). None of the socio-demographic characteristics that we examined were associated with vaccine uptake. Whilst the increase in maternal influenza coverage rates are encouraging and indicate a willingness of pregnant Indigenous women to be vaccinated, the majority of women remained unvaccinated. Activities to improve influenza vaccination coverage for Indigenous pregnant women and monitor vaccine uptake remain a priority.

Long-term impact of a “3+0” schedule for 7 and 13 valent pneumococcal conjugate vaccines on invasive pneumococcal disease in Australia, 2002–2014

Jayasinghe S, Menzies R, Chiu C, Toms C, Blyth C, Krause V, McIntyre P

Clin Infect Dis 2016;doi: 10.1093/cid/ciw720

Background Australia introduced universal PCV7 from 2005, replaced by PCV13 in 2011; uniquely among high-income countries giving doses at 2, 4 and 6 months (3+0 schedule). Data on impact of a timely 3+0 PCV schedule with high coverage are sparse, with none for PCV13.

Methods We used national surveillance of invasive pneumococcal disease (IPD) from 2002 for baseline and appropriate later comparison periods to calculate incidence rate ratios (IRRs) by serotype and age using a Poisson model. PCV coverage was assessed from the Australian Childhood Immunisation Register.
**Results** After 9 years of timely 3 dose PCV coverage of >92%, all-age IPD in Australia almost halved (IRR 0.53; 95%CI 0.50–0.57), but differed by PCV era. Reductions in IPD due to vaccine serotypes from PCV7 (IRR 0.20; 0.17–0.22) were about 2-fold greater than for IPD due to extra serotypes in PCV13 (13v-non7v) in a similar period (IRR 0.58; 0.51–0.66). Post-PCV13 declines in serotype 19A IPD in persons aged <2 years (IRR 0.23; 0.13–0.35) and ≥2 years (IRR 0.35; 0.28–0.44) differed from other 13v-non7v IPD (<2 years IRR 0.73; 0.35–1.48 and ≥2 years IRR 0.96; 0.81–1.15). Meningitis due to vaccine serotypes nearly disappeared in children eligible for 3 PCV13 doses. IPD due to non-PCV13 serotypes increased by 30% compared to 76% for non-PCV7 serotypes in equivalent period of vaccine use.

**Conclusions** Reductions in vaccine type IPD post-PCV13 were inferior to Australian experience with PCV7 and reports from high-income countries giving a PCV booster dose. Applicability of findings to other settings would depend on age of IPD onset, serotype profile and timeliness of vaccination.

**Determining Culex annulirostris larval densities and control efforts across a coastal wetland, Northern Territory, Australia**

**Kurucz N, Jacups S, Carter J**


The Darwin coastal wetlands provide suitable breeding conditions for *Culex annulirostris*, which is abundant between December and August each year. This species is the principal vector for arboviruses, including Ross River virus and Murray Valley encephalitis, and is an appreciable pest species. Aerial control is conducted when routine larval surveys for this species predict high numbers of emergent adults. We sought to determine the most productive vegetation categories and seasonal aspects associated with *Cx. annulirostris* breeding and control operations in these wetlands. By applying a generalized linear model to compare larval densities and aerial control efforts for each vegetation category, we found that *Schoenoplectus* reeds were the most productive vegetation type in May and June and were associated with the greatest amount of control required. Other vegetation categories associated with tidal mangroves and lower topographic elevation were also productive during these months for extended periods, while rain-affected reticulate areas and grassland floodplains were most productive in January and April. In addition, areas associated with nutrient rich organic matter appeared to initiate *Cx. annulirostris* breeding and were highly productive seasonally. This study has highlighted the vegetation categories most significantly associated with *Cx. annulirostris* breeding in a Darwin wetland. This knowledge can be applied to current control efforts to improve aerial control efficiency for this species and could be applicable in other areas of northern Australia.

**Hospitalised childhood injuries in the Northern Territory 2001–2011**

**Skov S, O’Kearney E, Dempsey K**


**Summary**

During the 11 year study period from 1 January 2001 to 31 December 2011 there were 10,428 hospitalisations in children age 0–14 years in NT public hospitals with annual counts varying between 835 (2005) and 1,039 (2011). Boys outnumbered girls throughout the study period with 62% of admissions overall: this proportion was virtually the same for both Aboriginal and non-Aboriginal children. Australia wide, boys comprised 63% of admissions during a similar but not identical time period (1999–2007). Aboriginal children accounted for 52% of all admissions in the NT. In NT non-Aboriginal children the proportions in each age group were 0–4 year olds 34%, 5–9 years 33% and 10–14 years 33% which was very similar to the national proportions. Proportions in NT Aboriginal children were a few percent higher among 0–4 and 5–9 year olds and 8% less in 10-14 year olds.
Rates for all injuries combined were higher in the NT than seen Australia wide. Between 1999–2007 Australia wide the yearly age standardised rate for all injuries in all children declined very slightly and was around 1,500 per 100,000 population. In the NT, the age-standardised rate over the period 2001–2011 was 1,717 per 100,000 population with a significantly increasing trend over the study period. The NT annual rate varied between 1,520 and 1,922 and was in excess of 1,600 per 100,000 population in eight of the 11 study years.

Age-standardised rates were higher in the NT than nationally for boys and girls. Rates for NT Aboriginal children were significantly higher than both NT non-Aboriginal children and all Australian children. NT non-Aboriginal rates were broadly similar to the all of Australia rates. A significant increase over the study period was seen in rates for NT Aboriginal children, both boys and girls, but not for either sex among non-Aboriginal children.

Rates in the Central Australian region in both Aboriginal and non-Aboriginal children were significantly higher than those in the Top End region and increased over the study period whereas Top End region rates showed no significant change.

For all injury types combined, the Barkly district had the highest age-standardised rate over the whole study period followed by Katherine and the Alice Springs Rural district. The Darwin Urban district had the lowest rate.

The leading 5 injury causes in the NT were, Falls (39%), Other unintentional injury (32%), Transport (12%), Exposure to smoke, fire, heat and hot substances (8%), and Assault (4%). Aboriginal children had the same top 5 but with Other unintentional injury in first place and Falls in second place. The top 5 causes for NT non-Aboriginal children and for the whole of Australia were, in order, Falls, Other unintentional injury, Transport, Exposure to smoke, fire, heat and hot substances and Poisoning, pharmaceuticals. The proportions accounted for by each of the top 3 causes were fairly similar in the NT and nationally. In total, Falls, Other unintentional injury and Transport were responsible for about 88% of all admissions nationally and in NT non-Aboriginal children and about 83% in NT Aboriginal children.

Falls

During the study period there were 4,045 hospitalisations for fall injuries with a low of 318 in 2005 up to 425 in 2010. Fall injuries accounted for a relatively greater proportion of non-Aboriginal admissions (43%) than Aboriginal ones (35%). The age-standardised rate in non-Aboriginal children (637 per 100,000) was similar to the national rate (around 650 per 100,000) and lower than that for Aboriginal children (723 per 100,000). Over the study period the NT rates for the whole population, all boys and Aboriginal children showed an increasing trend but did not change for non-Aboriginal children of either sex. Rates were highest in the 5–9 year old age group for both Aboriginal and non-Aboriginal children.

The age-standardised rate was also higher in Central Australia with an increasing trend than the Top End where there was no significant trend over time. The Katherine district had the highest rate over the study period followed by the Barkly with the lowest rate in the Darwin Urban district.

The top 10 most common types of falls accounted for 90% of all falls hospitalisations in the NT and 88% Australia wide. Nine of the top 10 causes were the same in the NT as nationally. The most common type of fall for NT non-Aboriginal and Aboriginal children and nationally was Fall involving playground equipment. Fall from tree was in third place in the NT but in tenth place nationally whereas Fall from out of or through building was in seventh place in the NT but not in the top 10 nationally. Both of these fall types were more important causes for Aboriginal than non-Aboriginal children in the NT.

Other unintentional injury

This injury category is comprised of a wide range of diverse injury types. There were 3,380 hospitalisations over the entire study period for Other unintentional injury with a low of 256 in 2003 and a high of 372 in 2010. Aboriginal children accounted for 57% of this category of
injuries and they were the most common type of injury responsible for admissions among Aboriginal children. The age-standardised rate for Aboriginal children was substantially higher than for non-Aboriginal children (731 and 421 per 100,000 population respectively). The overall NT rate of 554 per 100,000 was higher than the national rate of around 475 and showed an increasing trend, whereas the national rate did not change. Within the NT, rates for all boys, all girls and Aboriginal children increased over time.

The rates in Central Australia were significantly higher than the Top End for both Aboriginal and non-Aboriginal children. An increasing trend was apparent in Central Australia but not in the Top End. The Barkly district had the highest rate overall followed by East Arnhem with the lowest rate seen in the Darwin Urban district.

The top 10 causes accounted for 76% of Other unintentional injuries in the NT; virtually the same proportion as nationally. Of the top 10 causes 8 were the same in the NT as nationally but in somewhat different orders and proportions. A major difference in the NT was injuries due to contact with animals. Bitten or crushed by other reptiles and Contact with venomous animals were much more common in the NT as was Bitten or struck by dog to a lesser extent. Contact with venomous animals was much more common in Aboriginal children.

**Transport**

There were 1,296 hospitalisations related to transport injuries of which all but seven were land transport-related. The numbers ranged from 88 in 2011 to 145 in 2008. Transport injuries caused a greater proportion of non-Aboriginal admissions (16% compared with 9% in Aboriginal children), and non-Aboriginal children accounted for 61% of transport injury admissions. The age-standardised rate during the study period was significantly higher among non-Aboriginal children for the whole NT and in the Top End. The overall rate in the NT (218 per 100,000) was very similar to the national rate. The Central Australian rate was higher than the Top End. There was no significant increasing or decreasing trend over time in any population sub-group or region in the NT. The Alice Springs Urban district had the highest overall rate followed by Katherine with the lowest rate in the Darwin Rural district.

In contrast to the age group distribution for all injury types, 10–14 year olds accounted for the greatest proportion of transport injuries in both Aboriginal and non-Aboriginal children with the 0–4 year age group the smallest proportion. This is the same profile as seen Australia wide.

The most common modes of transport relating to hospitalisations in the NT were Pedal cycle (44%), Car (20%), Motor cycle (12%), Pedestrian (9%) and Animal or animal drawn vehicle (5%). This is the same as Australia wide and with similar proportions with the exception that Car and Motor cycle are in the reverse order. Injuries relating to Special all terrain or off road vehicles were notably more common in the NT.

Pedal cycle injuries were the most common type for both Aboriginal and non-Aboriginal NT children although relatively more important for non-Aboriginal children. Car-related injuries and pedestrian injuries were relatively more common in Aboriginal admissions.

The top 10 single causes made up 83% of all transport injury hospitalisations both in the NT and Australia wide with 8 of the top 10 causes being the same. The most common single cause of transport injury hospitalisations both in the NT and nationally was a pedal cyclist injured in non-collision transport accident. Occupant of special all-terrain or other motor vehicle designed primarily for off road use injured in transport accident was in seventh place in the NT but was not in the top ten nationally.

**Exposure to smoke, fire, heat and hot substances**

There were 777 hospitalisations due to this cause during the study period with a low of 47 in 2002 and a high of 102 in 2011. This cause was relatively more important in Aboriginal children accounting for 9% of their admissions compared with 6% for non-Aboriginal children, with 65% of these admissions being in Aboriginal children. The age-standardised rate was substantially higher in Aboriginal than non-Aboriginal children (183 and 73 per 100,000 population respectively). The national
rate was around 55 per 100,000 population. Australia wide there was no significant change in age-standardised rates between 1999 and 2007 but in the NT rates did increase significantly for all children, all boys, all girls, both Aboriginal and non-Aboriginal children and both regions. The overall age-standardised rate was higher in Central Australia than the Top End. The Alice Springs Rural district had the highest rate overall followed by Darwin Rural with the lowest rate in the Darwin Urban district.

The youngest children accounted for a much greater proportion of these injuries with 69% of them being in the 0–4 year age group in the NT and 70% Australia wide.

The top 10 types of injury were responsible for 94% of NT hospitalisations due to exposure to smoke, fire, heat or hot substances, and 93% Australia wide. Of the top 10 causes, nine were the same in the NT as nationally. The major difference being in the NT that *Exposure to controlled fire not in building or structure*—which are mostly campfire burns—was the most common cause for both Aboriginal (27%) and non-Aboriginal children (24%) whereas nationally it was only responsible for 4% of admissions and in ninth place. The other most common causes in both the NT and nationally were *Contact with hot drinks, food, fats and cooking oils, Contact with other hot fluids and Contact with hot water.*

**Assault**

There were 398 admissions arising from assaults ranging from 30 in 2001 to 42 in 2002. Assault admissions accounted for 3.8% of all injury admissions in the NT and were in fifth place overall compared to 1.3% of all admissions Australia wide and seventh place. Assault was a much more important cause of admissions amongst Aboriginal children who accounted for 82% of all such admissions and for whom they represented 8% of all admissions compared with 1% for non-Aboriginal children. Boys and girls accounted for equal proportions of assault-related admissions, whereas for all injuries boys represented 62%. Among admissions for Aboriginal children, girls outnumbered boys. Age standardised rates were much higher in Aboriginal children and in central Australia. The highest rate was seen in the Barkly district followed by Alice Springs Rural with the lowest in the Darwin Urban district.

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**NT malaria notifications July—September 2016**

Elizabeth Stephenson, CDC, Darwin

There were 6 cases of malaria notified in the 3rd quarter of 2016. The following Table provides details about where the infection was thought to be acquired, the reason exposed, the infecting agent, whether chemoprophylaxis was used and where the patient lived.

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<th>Reason Exposed</th>
<th>Agent</th>
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<td>Darwin</td>
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## NT NOTIFICATIONS OF DISEASES BY ONSET DATE & DISTRICTS

1 July—30 September 2016 and 2015

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Ratio of the number of notifications in the 3rd quarter (Q3) of 2016 to the mean Q3 2010–2015: selected diseases

Ratio of the number of notifications in the 3rd quarter (Q3) of 2016 to the mean Q3 20010–15): sexually transmitted diseases
Comments on notifications

Enteric Diseases
A large proportion of the increased notifications for the common enteric diseases (campylobacteriosis, shigellosis, cryptosporidiosis and to a lesser extent salmonellosis) can be attributed to the introduction of PCR testing which is much more sensitive. In the 3rd quarter of 2016, there were 132 cases of campylobacteriosis notified which is roughly twice the 5 year mean of 63 cases. There were also twice as many shigellosis cases notified (35 cases vs 5 year mean of 18 cases). There were 25 cryptosporidiosis notifications compared to the 5 year mean of 13, which again is a 2-fold increase. Salmonellosis notifications were up by 30% (119 cases vs 5 year mean of 92 cases).

Mumps
The mumps outbreak which commenced in 2015 continued through the 3rd quarter of 2016 when 68 cases were notified, the usual number being 0 –2 cases per quarter. The outbreak originated in 2014 in Western Australia where there have been over 900 cases. In the Northern Territory cases have been mainly in the Barkly and Katherine regions with only a handful of cases in East Arnhem and the Darwin regions. Community-based responses in the form of enhanced vaccination programs have been implemented in some communities.

Invasive Group A streptococcal disease
There were 28 cases of invasive Group A Streptococcal disease in the 3rd quarter, continuing the trend of higher than expected cases this year. This is 1.3 times higher than expected, comparative to the 5 year mean of 21 cases for the same period.

Zoster
The increase in herpes zoster notifications is likely related to the increased awareness about herpes zoster infection and diagnostic testing with PCR.

**********

Herpes zoster vaccine now available for FREE for people aged 70–79 years.
See your GP for more information.
### Immunisation coverage for children aged 12--<15 months at 30 September 2016

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<th>%Polio</th>
<th>%HIB</th>
<th>%Hep</th>
<th>%Pneumo</th>
<th>%Fully vaccinated</th>
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### Immunisation coverage for children aged 24--<27 months at 30 September 2016

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<th>%Polio</th>
<th>%HIB</th>
<th>%Hep</th>
<th>%MMR</th>
<th>%MenC</th>
<th>%Varicella</th>
<th>%Fully vaccinated</th>
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<tr>
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<td>96.9%</td>
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### Immunisation coverage for children aged 60--<63 months at 30 September 2016

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<tr>
<th>Region</th>
<th>Number</th>
<th>%DTP</th>
<th>%Polio</th>
<th>%MMR</th>
<th>% Fully vaccinated</th>
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<td>Darwin</td>
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<td>93.4%</td>
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<tr>
<td>Winnellie PO Bag</td>
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<td>95.2%</td>
<td>94.0%</td>
</tr>
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<td>Palm/Rural</td>
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</tr>
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</tr>
</tbody>
</table>
Immunisation coverage at 30 September 2016
Charles Strebor and Holly Carmichael, CDC, Darwin

Background information to interpret coverage

Children were assigned to regions based on the postcode taken from their Medicare address listed in the Australian Childhood Immunisation Register (ACIR). Children with a PO Box address listed are counted among that PO Box postcode. Winnellie PO Bag is postcode 0822, which includes most Darwin Rural District communities, some East Arnhem District communities and some residents of the Darwin ‘rural area’ who collect mail from the Virginia store or Bees Creek. Alice Springs PO Bag is postcode 0872, which includes Alice Springs District, Nganampa and Ngaanyatjarra communities.

The cohort of children assessed at 12 to <15 months of age on 30 September 2016 were born between 1 April 2015 and 30 June 2015 inclusive. To be considered fully vaccinated, these children must have received 3 valid doses of vaccines containing diphtheria, tetanus, pertussis, and poliomyelitis antigens, either 2 or 3 doses of PRP-OMP Hib or 3 doses of another Hib vaccine, 3 doses of hepatitis B vaccine and 3 doses of conjugate pneumococcal vaccine. All vaccinations must have been administered by 12 months of age.

The cohort of children assessed at 24 to <27 months of age on 30 September 2016 were born between 1 April 2014 and 30 June 2014 inclusive. To be considered fully vaccinated, these children must have received the vaccines outlined above plus meningococcal C vaccination (given at the 12 month schedule point), 2 valid doses of a measles, mumps, rubella (MMR) containing vaccine and the first dose of the varicella vaccination (given in combination as MMRV at the 18 months schedule point). All vaccinations must have been administered by 24 months of age.

The cohort of children assessed at 60 to <63 months of age on 30 September 2016 were born between 1 April 2011 and 30 June 2011 inclusive. To be considered fully vaccinated, these children must have received 4 or 5 valid doses of vaccines containing diphtheria, tetanus, pertussis antigens, 4 doses of poliomyelitis vaccine and 2 valid doses of poliomyelitis vaccine. All vaccinations must have been administered by 60 months (5 years) of age.

Interpretation and comment

Immunisation coverage rates for Northern Territory (NT) children by regions as estimated by the ACIR are shown on page 39.

Children in the NT were less likely to be fully immunised in the 12 <15 months cohort (NT 93.7%, National 93.9%) and the 24 to <27 months cohort (NT 88.6%, National 91.9 %) though more likely to be fully immunised in the 60 to <63 months cohort (NT 93.7%, National 93.4%).

Indigenous children were less likely to be fully immunised than non-Indigenous children in the 12 <15 month cohort (Indigenous 93.9%, non-Indigenous 93.2%) and in the 24 to <27 month cohort (Indigenous 88.0%, non-Indigenous 88.9%) but more likely to be fully immunised in the 60 to <63 month cohort (Indigenous 94.9%, non-Indigenous 93.7%).

The Centre for Disease Control (CDC) is currently reviewing the reasons for the lower coverage in both Indigenous and non-Indigenous children at age 2 years. CDC is working with the Australian Immunisation Register to review data quality and processing of vaccine recording in this age group. Further targeted strategies to improve this coverage are planned.

Further information about the ACIR coverage may be found at: http://www.ncirs.edu.au/surveillance/immunisation-coverage/
## Adult and Special Groups Vaccination Schedule

**November 2016**

<table>
<thead>
<tr>
<th>Eligible groups</th>
<th>Diseases covered</th>
<th>Vaccine</th>
<th>Administration</th>
<th>Additional information</th>
</tr>
</thead>
</table>
| **All people**
  All people born after '966 who have not received 2 MMR vaccines or who are not immune | Measles, mumps, rubella (MMR)     | M-M-R® II or Priorix®          | 0.5 ml SC      | Give two MMR vaccines at least 28 days apart                                             |
| **All people at 65 years of age**                                               | Diphtheria, tetanus, pertussis    | Boostrix® or Adacel®           | 0.5 ml IMI     | If not given in the last 10 years self funded                                             |
| **All people at 70 years of age**                                               | Herpes Zoster (shingles)          | Zostavax®                      | 0.65 ml SC     | 71-79 year olds can receive the Zostavax vaccine as part of a catch up program. Give one dose only |
| **Indigenous people**
  Indigenous people 15 years of age and over                                      | Pneumococcal                      | Pneumovax25®                   | 0.5 ml IMI     | See NT pneumococcal vaccination and revaccination guideline                               |
| **Indigenous people 20 years to 50 years**
  if not previously vaccinated or who do not have immunity through natural infection | Influenza                         | Fluarix® Tetra                 | 0.5 ml IMI     | Annually                                                                               |
| **Hepatitis B**                                                                 | Hepatitis B                       | Engerix® B adult or H-B-Vax® II | 1 ml IMI       | 0, 1 and 6 month schedule                                                               |
| **Non-Indigenous**
  Non-Indigenous people 65 years of age and over                                   | Pneumococcal                      | Pneumovax25®                   | 0.5 ml IMI     | See NT pneumococcal vaccination and revaccination guideline                               |
| **Influenza**                                                                    |                                   | Fluarix® Tetra                 | 0.5 ml IMI     | Annually                                                                               |
| **Pregnancy related**
  Pregnant women (every pregnancy)                                                | Influenza                         | Fluarix® Tetra                 | 0.5 ml IMI     | Any stage of pregnancy                                                                  |
| **Diphtheria, tetanus, pertussis (dTPa)**                                        |                                   | Boostrix®                      | 0.5 ml IMI     | From the 28th week of pregnancy                                                         |
| **Fathers and carers in the same household of infants under 7 months**           | Diphtheria, tetanus, pertussis (dTPa) | Boostrix®                      | 0.5 ml IMI     | From the 28th week of the mother’s pregnancy, if no dTPa vaccine in the last 10 years  |
| **People with chronic medical conditions**                                       | Pneumococcal                      | Pneumovax 25® (Prevenar® - high risk) | 0.5 ml IMI | See NT pneumococcal vaccination and revaccination guideline                              |
| **Influenza**                                                                    |                                   | Flu Quadri® Junior (<3 years)  | 0.25 ml IMI     | May require 2 doses if first year of receiving influenza vaccine                          |
| **Influenza**                                                                    |                                   | Fluarix® Tetra                 | 0.5 ml IMI     | Annually                                                                               |
| **Household and sexual contacts of people with Hepatitis B**                     | Hepatitis B                       | Engerix® B adult or H-B-Vax® II | 1 ml IMI       | 0, 1 and 6 month schedule                                                               |

**More Information:**
- NT Immunisation Register - Top End 8022 8315 - Central Australia 8951 6928
- Australian Immunisation Handbook (AIH)
## Childhood Vaccination Schedule November 2016

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<tr>
<th>Age</th>
<th>Hepatitis B</th>
<th>Rotavirus</th>
<th>Diphtheria</th>
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<th>Hepatitis B</th>
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<th>Conjugate Haemophilus influenzae type b</th>
<th>Measles</th>
<th>Mumps</th>
<th>Rubella</th>
<th>Varicella</th>
<th>Diphtheria</th>
<th>Tetanus</th>
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<th>Measles</th>
<th>Mumps</th>
<th>Rubella</th>
<th>Varicella</th>
<th>Human Papillomavirus</th>
<th>Polysaccharide Pneumococcal</th>
<th>Adult Diphtheria</th>
<th>Tetanus</th>
<th>Pertussis (dTap)</th>
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<td>Engerix-B 0.5ml IM</td>
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</tr>
</tbody>
</table>

### Vaccine notes:
- ✓ All children.
- ✗ ORAL VACCINE: First dose must be given by 14 weeks and 6 days of age; Second dose must be given by 24 weeks and 6 days of age.
- ✗ Indigenous people only.
- ⚫ Requires 3 doses given at 0, 2 and 6 months.
- ✗ Indigenous children only aged 6 months to less than 5 years. All children with a chronic medical condition 6 months of age and over. Give 2 doses, 28 days apart to children under 9 years of age who are receiving influenza vaccine for the first time in their life.
- ✗ NEVER to be given as the 1st dose of MMR containing vaccine.
- ✗ All children receive a dTPa at either 12 or 13 years in 2017.
- ✗ BCG vaccine - for eligible groups and vaccine eligibility please refer to the CDC Immunisation Website: [www.health.nt.gov.au/centre_for_disease_control/immunisation](http://www.health.nt.gov.au/centre_for_disease_control/immunisation)

### Information:
- NT Immunisation Register:
  - Top End: 8922 8315
  - Central Australia: 8961 6928

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The Northern Territory Disease Control Bulletin Vol 23, No. 4, December 2016
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<thead>
<tr>
<th>Category</th>
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<tbody>
<tr>
<td>Category A or B condition</td>
<td>NT Pneumococcal Vaccination and Pneumovax 23</td>
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<tr>
<td>No category A or B condition</td>
<td>NT Pneumococcal Vaccination and Pneumovax 23</td>
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Vaccine Notes

3

Children 2 years of age 35 years of age 15 years of age 15 years of age

2

Children 2 years of age 35 years of age 15 years of age 15 years of age

1

Children 2 years of age 35 years of age 15 years of age 15 years of age

Does your client have a condition in Category A or B?

www.nt.gov.au/health

Revised Immunisation Guideline Vol 23, No. 4, December 2016
**Disease Control staff updates September—December 2016**

**Top End**

Farewell to **Charles Strebor**, Northern Territory Immunisation Register (NTIR) Coordinator. Charles began working with the NTIR in October 2005, at a time when the Register had 2.5 staff. Under Charles’ leadership, the register was able to integrate information from a myriad of datasets into 1 place—what is now called the NTIR. Charles was involved with overseeing the transformation from a small team within the Centre for Disease Control (CDC) to what has become, by necessity, 1 of the larger CDC teams. Charles leaves knowing that the register is in good hands with capable staff ready for the changes that will come as a result of the creation of a national Australian Immunisation Register (AIR). **Holly Carmichael** will fill the coordinator role until recruitment is completed. **Kelly Lomas** has joined CDC as an Immunisation Data Entry Officer and comes to us from Casuarina Community Care Clinic.

Farewell to **Katherine Moriarty**, Senior Policy Advisor Sexual Health and Blood Borne Virus, who has worked for CDC for 5 years. Katherine has accepted a position of Harm Reduction Coordinator with the Government of British Columbia in Canada and is looking forward to new experiences and challenges.

After a career spanning 30 years we said goodbye to Dr **Steven Skov**, who made an outstanding contribution to the Department of Health and the NT. Steven started working for the Department of Health as a medical officer at Alice Springs Hospital in 1986. Two years later he became a District Medical Officer and over the next decade worked in almost every community in Central Australia, including longer stints at Papunya, Mt Liebig and Haasts Bluff.

After moving to Darwin in 1998 he went on to work with CDC in 2004 and worked largely with CDC for the remainder of his career with the Department. His efforts saw him become a highly valued team member and highly regarded specialist public health physician. While attached to CDC Steven also spent several periods as Acting Chief Health Officer.

During his time in the Territory Steven proved himself a strong advocate for improvements in public health, in particular in the areas of sexual health, alcohol and other drugs and safety and injury policy.

Steven’s efforts over 3 decades have been exceptional. His hard work and dedication to improving the health of Territorians have been evident throughout his career. We wish him well in his next endeavours.

**Central Australia**

Farewell to **Christina Beatson** who has been the Clinical Nurse Consultant for CDC at Tennant Creek for the past 4 years. Christina provided an exceptional service in Tennant Creek and will be missed. Christina has taken up a public health nurse position in Townsville.

**Abby Wagner**, receptionist in Alice Springs CDC, moved to Darwin in November and has taken up an administration position with NAAJA. **Brianna Sanderson** has commenced in the Rheumatic Heart Disease Register Coordinator position while **Nina Missen** and **Chelsea Lodge** are on maternity leave. Brianna and had been working as a Ward Clerk at the Alice Springs Hospital and has a background in nutrition and dietetics.