Acute flaccid paralysis incidence and Zika virus surveillance, Pacific Islands
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Introduction
In February 2016, in response to outbreaks in several Pacific and South American countries, 1 Zika virus was declared a Public Health Emergency of International Health Concern by the World Health Organization (WHO). 2 This was based on increasing evidence that Zika virus infection may be associated with congenital malformations and autoimmune neurological diseases, including microcephaly, cranial nerve dysfunction and Guillain–Barré syndrome. 1,2

The emergence of the Zika virus has challenged basic outbreak surveillance systems in many at-risk, low-resource countries. Zika virus surveillance strategies need to be convenient, timely and cost-effective, ideally using routinely collected information. Data on the incidence of acute flaccid paralysis (AFP) in children younger than 15 years are routinely collected for polio surveillance by 177 of the 194 WHO Member States as part of the Global Polio Eradication Initiative. The most common cause of AFP is Guillain–Barré syndrome. 3,4 As the syndrome has been associated with Zika virus infection, increases in the incidence of AFP − routinely reported to the Global Polio Eradication Initiative − might provide a useful early warning for Zika virus outbreaks in resource-constrained settings. We analysed data from the Pacific Islands to test this hypothesis.

Local setting
The Pacific Islands, which fall within WHO’s Western Pacific Region, are home to several of the world’s smallest, least developed and most isolated populations. The collective population of these islands (excluding New Zealand) is approximately 11.4 million people, of whom 8.2 million reside in Papua New Guinea and the rest are dispersed over the thousands of islands and atolls that make up the other 20 Pacific Island countries and territories. Most islands’ health authorities rely on simple syndromic surveillance and ad hoc event reporting by clinicians for disease outbreak detection. Their ability to enhance early warning surveillance in response to acute public health threats such as Zika virus is hampered by poor health infrastructure, insufficient human resources and geographical isolation.

Relevant changes
Only one example was found (Solomon Islands in 2015) of a significant increase in reported AFP cases correlating with Zika virus emergence.

Lessons learnt
We found no conclusive evidence that routinely reported AFP incidence data in children were useful for detecting emergence of Zika virus in this setting. More evidence may be needed from adult populations, who are more likely to be affected by Guillain–Barré syndrome. Reporting of AFP may be deficient in regions certified as polio-free.

Problem
The emergence of Zika virus has challenged outbreak surveillance systems in many at-risk, low-resource countries. As the virus has been linked with Guillain–Barré syndrome, routine data on the incidence of acute flaccid paralysis (AFP) may provide a useful early warning system for the emergence of Zika virus.

Approach
We documented all Zika virus outbreaks and cases in 21 Pacific Islands and territories for the years 2007 to 2015. We extracted data from the Global Polio Eradication Initiative database on the reported and expected annual incidence of AFP in children younger than 15 years. Using a Poisson probability test, we tested the significance of unexpected increases in AFP in years correlating with Zika virus emergence. Data were analysed separately for each Pacific Island country and territory.

Abstracts in العربية, 中文, Français, Русский and Español at the end of each article.
We obtained data on Zika virus outbreaks in the 21 Pacific Island countries and territories from published and unpublished information. For published information, we performed a literature search using the search terms “Zika” and “Zika virus” in the PubMed database; the identified papers were reviewed for relevance to the Pacific Islands. Unpublished event-relevant information was extracted from WHO’s weekly Pacific Surveillance Syndromic Reports and from PacNet listserv posts. PacNet is the email-based outbreak notification and discussion forum of the Pacific Public Health Surveillance Network. Data extracted included the start and end dates of events, and the reported number of suspected and confirmed cases. To verify information extracted from unpublished sources we consulted staff at WHO’s Division of Pacific Technical Support in Fiji. We also collected information on Zika outbreaks and cases from January to November 2016 to provide a complete and up-to-date picture of Zika activity in the study area.

AFP surveillance for polio eradication purposes requires health workers to promptly report and investigate identified cases of AFP, including the results of testing for wild polio virus. We extracted data on the expected and reported annual incidence of AFP in children younger than 15 years for Pacific Island countries and territories from the Global Polio Eradication Initiative’s surveillance database. Then we compared these data with documented Zika virus outbreaks to identify space–time correlations.

We used the following Poisson probability formula to test the significance (at \( P ≤ 0.05 \)) of unexpected increases in the incidence of AFP in children in the years when Zika virus emerged in each Pacific Island country or territory:

\[
P(X = x) = \frac{e^{-\lambda} \lambda^x}{x!}
\]

Where \( P \) is the probability; \( X \) is the number of events in a specified time period; \( e \) is the mathematical constant (Euler’s number, approximately 2.72); and \( \lambda \) is the expected number of events in the specified time period.

### Zika virus cases

The first human outbreak of Zika virus was documented in the Pacific Islands in Yap State, Federated States of Micronesia in April 2007. The investigators identified 185 suspected cases, of which 49 were confirmed. No further Zika cases were detected in the Pacific Islands until October 2013, when an outbreak of 383 confirmed cases occurred in French Polynesia. Given travel pathways and close geographical and cultural ties, the outbreak in French Polynesia was suspected to have been the source of subsequent outbreaks on Easter Island (January–May 2014; 51 confirmed cases), New Caledonia (January–August 2014, more than 1400 confirmed cases and January–May 2015, 82 confirmed cases) and Cook Islands (February–May 2014; 54 confirmed cases). In 2015 two other countries reported emergence and autochthonous transmission of Zika virus: Solomon Islands (February–May 2015; 5 confirmed cases) and Samoa (September 2015 to May 2016; 24 confirmed cases). In 2015, sporadic (non-autochthonous) Zika cases were reported from Vanuatu (one case confirmed, April 2015) and Fiji (at least 15 cases, between August 2015 and June 2016).

### 2016 update

In 2016 (outside the analysis window) three other Pacific Island countries and territories and Kosrae State, in the Federated States of Micronesia (on which Zika had previously not been detected) reported autochthonous transmission: Tonga (January–April 2016; two confirmed cases), American Samoa (February 2016 and ongoing; 52 confirmed cases as at 3 November 2016), Marshall Islands (February–April 2016; two confirmed cases) and Kosrae State (February 2016 and ongoing; 23 confirmed cases as at 2 November 2016). In November 2016, Palau reported a single confirmed Zika case.

In addition, in March 2016 Papua New Guinea reported that six cases of Zika virus infection had been confirmed through retrospective testing of samples collected in May 2015 (one case), December 2015 (two cases) and February 2016 (three cases), indicating low levels of Zika virus transmission within the country.

### AFP cases

Based on Global Polio Eradication Initiative predictions, the total expected annual number of AFP cases for the year 2015 was 36 (26 for Papua New Guinea and 10 for the other 20 Pacific Island countries and territories). The aggregated number of AFP cases among children reported in each year were 38 (2007), 35 (2008), 30 (2009), 37 (2010), 26 (2011), 14 (2012), 18 (2013), 27 (2014) and 41 (2015; Table 1).

Analysis of individual Pacific Island countries and territories found only one example – the Solomon Islands in 2015 – where a statistically significant increase in reported AFP cases correlated with the emergence of Zika virus (\( P ≤ 0.001 \)). From February to May 2015, there were five confirmed cases of Zika virus infection out of 324 suspected cases in a population of about 651 700 people. In that year, nine cases of AFP were reported compared with the expected number of two. None of the seven other countries and territories reporting Zika virus cases from 2007 to 2015 (Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, New Caledonia, Samoa and Vanuatu) showed significant rises in reported cases of AFP associated with emergence of Zika virus.

The significant increase in AFP cases in the Solomon Islands may be an indication of the usefulness of AFP detection for signalling the appearance of a Zika virus outbreak. Alternatively, it may reflect an increased vigilance of public health surveillance following the major tropical cyclone Raquel, which affected the Solomon Islands in July 2015, or it may just be an anomaly.

### Lessons learnt

Recommendations to enhance surveillance for Zika virus in at-risk countries have included improving surveillance for Guillain–Barré syndrome via the existing surveillance systems for AFP used by polio eradication programmes. Our analysis, however, did not provide sufficient evidence that analysis of AFP incidence data collected for children provide a useful surveillance strategy.
Table 1. Reported Zika virus outbreaks in the Pacific Islands and acute flaccid paralysis cases in children aged < 15 years reported to the Global Polio Eradication Initiative, by country or territory and year, 2007–2015

| Pacific Island countries and territories | Population in 2016 2016a | Annual no. of AFP cases expectedb | No. of reported cases of AFP (Zika virus outbreaks: dates; no. of confirmed casesc) |
|----------------------------------------|---------------------------|---------------------------------|---------------------------------------------------------------------------------|
| American Samoa                         | 56 400                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (3) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Cook Islands                           | 15 200                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Fiji                                   | 880 400                   | 3                               | 2007: 7 (3) 4 (0) 5 (0) 6 (0) 4 (0) 7 (3) 8 (0) 4 (Aug; 2) |
| French Polynesia                       | 273 800                   | < 1                             | 2007: 1 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Guam                                    | 169 500                   | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Kiribati                                | 113 000                   | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Marshall Islands                        | 55 000                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Micronesia (Federated States of)       | 104 600                   | < 1                             | 2007: 0 (Apr–Jun; 49) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Nauru                                   | 10 800                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| New Caledonia                          | 277 000                   | < 1                             | 2007: 1 (0) 1 (0) 3 (0) 1 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (Jan–Aug; > 1 400d) 0 (Jan–May; 82) |
| Niue                                    | 1 600                     | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Northern Marianas Islands (Commonwealth of) | 55 700                   | < 1                             | 2007: 0 (0) 1 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Palau                                   | 17 800                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Papua New Guinea                       | 8 151 300                 | 26                              | 2007: 25 (0) 12 (0) 24 (0) 17 (0) 10 (0) 10 (0) 18 (0) 12 (0) 27 (May & Dec; 3e) |
| Samoa                                  | 194 000                   | < 1                             | 2007: 1 (0) 0 (0) 1 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Solomon Islands’                       | 651 700                   | 2                               | 2007: 3 (0) 3 (0) 3 (0) 7 (0) 3 (0) 0 (0) 1 (3) 6 (0) 9 (Feb–May; 5) |
| Tokelau                                 | 1 400                     | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Tonga                                   | 100 600                   | < 1                             | 2007: 0 (0) 0 (0) 1 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |
| Tuvalu                                  | 10 100                    | < 1                             | 2007: 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) 0 (0) |

continues ...
to detect Zika virus emergence in this setting (Box 1).

Populations in Pacific Island countries are small and it is likely that the capacity to conduct and ensure compliance with AFP reporting requirements varies. This may be influenced by a lack of awareness of polio surveillance and associated AFP reporting, given that the last indigenous case of polio virus in the Western Pacific Region was reported in Cambodia in 1997, and the Region has been certified as polio free since 2000. Small population sizes also means that the expected incidences of AFP in individual countries and territories are very low (often < 1 case) and therefore statistical power may be lacking. More evidence is needed to determine whether the case detection of AFP is compromised in remote areas and in regions certified as polio free.

It should be noted that the Global Polio Eradication Initiative’s AFP surveillance targets paediatric populations, who are less likely than adults to be affected by Guillain–Barré syndrome. Data that include adult age groups (which is not currently routine practice) may provide better evidence to determine whether AFP surveillance offers a suitable strategy for Zika virus early warning in low-resource settings, such as the Pacific Islands.

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المطلب

رصد الإصابة بالشلل الرخو الحاد وفirus Zika في جزر المحيط الهادئ

المتغيرات ذات الصلة لم يتم العثور عليها إلا في واحد (جزر سليمان) من الزيادات الواضحة في حالات الإصابة بالشلل الرخو الحاد المرتبطة بالاستلام المتعلق بالإصابة بالشلل الرخو الحاد (AFP) في السنوات المرتبطة بالتفشي فيروس زيكا. لم نعثر على دليل قاطع يشير إلى أن البيانات الروتينية من الزيادة الواضحة في حالات الإصابة بالشلل الرخو الحاد (AFP) لم تتماشى مع تفشي فيروس زيكا.

Leçons tirées

Nous n'avons trouvé aucune preuve concluante que les données systématiquement signalées sur les augmentations imprévues des cas de paralysis flasque pourraient être utilisées pour établir un système d'alerte anticipée pour le résurgence du virus Zika.

Problème

L'émergence du virus Zika pose un problème pour les systèmes de surveillance des épidémies dans de nombreux pays à faibles ressources et à risque. Étant donné qu'un lien a été établi entre ce virus et le syndrome de Guillain-Barré, les données systématiquement collectées sur l'incidence de la paralysis flasque aiguë (PFA) pourraient être utilisées pour établir un système d'alerte anticipée pour l'émergence du virus Zika.

Approche

Nous avons documenté toutes les flambées de virus Zika et tous les cas d'infestation à virus Zika dans 21 Îles et territoires du Pacifique, sur la période 2007 à 2015. À partir de la base de données de l'Initiative mondiale pour l'éradication de la poliomyélite, nous avons extrait des données sur l'incidence annuelle signalée et l'incidence annuelle prévue de la PFA dans les enfants de moins de 15 ans. En utilisant un test de probabilité de Poisson, nous avons testé la significativité de la corrélation entre les augmentations annuelles imprévues des cas de PFA et l'émergence du virus Zika. Les données ont été analysées séparément pour chaque territoire et chaque île du Pacifique.
Заболеваемость остро развивающимся периферическим параличом и эпидемиологический надзор за вирусом Зика, Океания

Проблема. Появление вируса Зика — важный предмет систем эпидемиологического надзора во многих бедных странах риска. Так как вирус был ассоциирован с синдромом Гийена — Барре, регулярно собираемые данные по заболеваемости остро развивающимися периферическим параличом (ОРПП) могут служить для полезной системы раннего предупреждения по вирусу Зика.

Подход. Нами задокументированы все вспышки и случаи заражения вирусом Зика на 21 острове и территории Океании в период с 2007 по 2015 год. Сведения были получены из баз данных глобальной инициативы по ликвидации полиомиелита и касались сообщаемой и прогнозируемой ежегодной заболеваемости ОРПП у несовершеннолетних моложе 15 лет. С помощью критерия Пуассона нами была проверена статистическая значимость неожиданных повышений частоты ОРПП по годам, коррелирующих с заболеваемостью вирусом Зика. Данные были проанализированы отдельно для каждого острова и территории Океании.

Местные условия. В большинстве стран Океании ранний предупреждающий надзор по таким важным угрозам для здоровья, как вирус Зика, был осложнён плохой инфраструктурой здравоохранения, недостаточным количеством персонала и географической изоляцией.

Однако описанные перемены. Был только один пример (Соломоновы острова, 2015) статистически значимого увеличения зарегистрированных случаев ОРПП, коррелирующих с заболеваемостью вирусом Зика.

Выводы. Нами не было найдено доказательств, позволяющих заключить, что регулярно сообщаемые данные об ОРПП у несовершеннолетних могут быть полезны для определения появления вируса Зика в этих условиях. Возможно, требуется больше данных из взрослых групп населения, которые затрагиваются синдромом Гийена — Барре с большей вероятностью. Сообщений об ОРПП может быть также недостаточно в регионах, для которых подтверждено отсутствие полиомиелита.

Резюме

Инфекция паралич, остров в Пацифик

Ситуация. Лапиновский вирус Зика за инфекционным заболеваемостью остро развивающимся периферическим параличом (ОРПП) могут служить для полезной системы раннего предупреждения по вирусу Зика. Данные были проанализированы отдельно для каждого острова и территории Океании.

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Resumen

Incidencia de la parálisis flácida aguda y seguimiento del virus de Zika, Islas del Pacífico

Situación. La aparición del virus de Zika ha puesto en peligro los sistemas de control del brote en muchos países en riesgo con escasos recursos. Dado que el virus se ha relacionado con el síndrome de Guillain-Barré, los datos rutinarios sobre la incidencia de parálisis flácida aguda (PFA) pueden proporcionar un sistema de advertencia temprana útil para la aparición del virus de Zika.

Enfoque. Se documentaron todos los brotes y casos del virus de Zika en 21 islas y territorios del Pacífico entre los años 2007 y 2015. Se recopiló información de la base de datos de la iniciativa de Erradicación Mundial de la Poliomielitis sobre la incidencia anual de PFA informada y prevista en niños menores de 15 años. Utilizando una prueba de probabilidad de Poisson, se demostró la importancia de los aumentos inesperados de PFA en los años correlacionados con la aparición del virus de Zika. Se analizaron los datos por separado para cada país y territorio de las Islas del Pacífico.

Marco regional. En la mayoría de los países de las Islas del Pacífico, el control de aviso temprano para amenazas sanitarias públicas agudas como el virus de Zika se ve obstaculizado por una infraestructura sanitaria pobre, escasos recursos humanos y aislamiento geográfico.

Cambios importantes. Únicamente se encontró un ejemplo (Islas Salomón en 2015) de un gran aumento en los casos de PFA informada que se correlacionaron con la aparición del virus de Zika.

Lecciones aprendidas. No se encontraron pruebas concluyentes de que los datos de incidencia de PFA informada de forma rutinaria en niños fueran útiles para detectar la aparición del virus de Zika en esta región. Es posible que se necesiten más pruebas de la población adulta, ya que esta tiene más probabilidades de ser afectada por el síndrome de Guillain-Barré. La notificación de casos de PFA puede ser deficiente en algunas regiones sin incidencias de poliomielitis.

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