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INTRODUCTION AND KEY FACTS

Dengue Fever (DF) is a mosquito-borne disease of public health concern in both tropical and subtropical countries, especially influenced by rainfall, temperature and unplanned rapid urbanization [1]. World Health Organization (WHO) member states have reported on average 2.4 million cases of DF annually over the past 5 years [1]. Even with these figures, other data suggests the number of dengue infections could be as high as 390 million annually, of which up to 96 million show clinical manifestation[1]. Global reporting has therefore not been good, and Papua New Guinea (PNG) is one of the countries that have not yet reported national DF surveillance data.

DF does not feature among the leading burden of diseases reported in PNG's National Health Plan 2011-2020, and it is not clear whether lack of reliable reporting was the reason. In 2015, DF was reported as being only rarely diagnosed and possibly having a low index of clinical suspicion in PNG. That same report further stated that dengue haemorrhagic fever (DHF) has not been reported in PNG for over a decade [2].

Three reports of the DF situation in the Western Pacific region from 2010 to 2012 state that there was no DF-specific surveillance in PNG [3-5]. However, DF's presence was verified from case importation to Queensland for which surveillance in Queensland is actively conducted [6].

DF surveillance in PNG is challenged by geographical isolation of its remote, mountainous, coastal, and island sparsely distributed and diverse rural communities [7]. This situation limits access, provision and coverage of health services. These challenges only add to those posed by DF itself, resulting in a paucity of information about its presence in PNG.

Transmission

There are four serotypes of the dengue virus: DEN-1, DEN-2, DEN-3, and DEN-4 [1], all of

which have been identified since the first isolation of the dengue virus (DENV) in 1943 [8]. Dengue is transmitted through bites by an infected female species of the *Aedes aegypti* mosquito that bites mainly in the early morning and in the evening before dusk. It is worth noting that this same mosquito also transmits chikungunya, yellow fever and the Zika virus infection [1]. Infected humans are the main carriers of the virus (4-12 days incubation period after the infected bite) and therefore the source of the virus for uninfected mosquitoes to complete the cycle of infection.

Symptoms

DF presents in both children and adults, characterized by high fever, and combination of the following symptoms: muscle and joint pains, pain behind the eyes, nausea, severe headache, vomiting, nausea, swollen glands or rash, and a drop in blood pressure. It can also be completely asymptomatic. The symptoms can last 2-7 days, even longer. It is usually more complicated or potentially deadly when blood plasma leaks, or there is fluid accumulation or severe dehydration, severe abdominal pain, bleeding either in vomit or gums, fatigue and restlessness [1].

Diagnosis, Treatment and Control

There is no specific treatment for DF other than just managing the symptoms such as through use of acetaminophen (paracetamol) for pain relief and replenishing the patient's body fluid volumes. Medical care by physicians and nurses, especially for DHF, also known as severe dengue, has been known to decrease mortality rates [1].

Recovery from infection by one serotype provides a lifelong immunity against that particular serotype. However, subsequent infections by other serotypes have been noted to increase the risk of developing DHF.

A recently developed vaccine, Dengvaxia (CYD-TDV), has been registered in several countries. The WHO will be following up with a Vaccine Position Paper recommendation on its use sometime in mid-2016 [1].

Several public health prevention measures should be taken to control the transmission of infection, including destroying the mosquito breeding sites, covering domestic water containers, using insecticides and wearing long-sleeved clothes. These should be accompanied by active monitoring and surveillance of vectors to determine effectiveness of control interventions.

Historical Perspective of DENV

The DENV was introduced into the Americas by the mosquito vector *Stegomyia aegypti* from Africa via slave ships and other commercial vessels which crossed the Atlantic Ocean during the 18th and 19th centuries, and five centuries prior to that [7]. The ancestor of the viruses has been postulated to have emerged

about 1000 years ago from sylvatic cycles involving non-human primates [7]. Two monkey species, the African green monkey (*Chlorocebus sabaeus*) and the Guinea baboon (Papiopapio), widely found across the African continent, have been the non-human primates reservoir of the virus in the sylvatic cycle. The virus jumped to humans due to low DENV virulence, thereby facilitating its sustenance and transmission. The DENV later exploited the mosquito vector *Aedes aegypti* to achieve transmission to humans [9].

DF was clinically diagnosed and reported to be widespread in North and South America, the Caribbean basin, Asia, and Australia during the 18th and 19th centuries [7]. The introduction of mosquito-eradication program between 1946 and 1970 in South America saw a decline in the incidence of DF. Unfortunately, an increase in the introduction and spread of mosquitoes by transportation for commercial and military purposes led to the re-emergence of DF as a major public health problem during the mid and later parts of the 20th century [7]. For example, during the Second World War, Southeast Asia experienced an increase in DF, with the vector continuing to intensify across affected geographic areas of the region. In addition, further spread occurred as a result of shipping and air traffic globally as well as ecological and demographic changes [7].

The successive epidemics of the 1980s and 1990s in Brazil involved three serotypes of the DENV. Low numbers of cases of DHF were reported, unlike in Asia, where reported epidemics occurred in large numbers of children. The reason for the differences was due to the presence of resistant genes in those with African ancestry. This was confirmed by high levels of antigenic antibodies against the American DENV-2 genotype and the cross-reactive DEN-1, both of which had been endemic in Latin America for many years [10].

Today, all the DENV serotypes circulate in Africa, South and Southeast Asia, the Caribbean basin and Central and South America and the Western Pacific regions [7]. The vector *Aedes* sub group *Stegomyia* is endemic in the Pacific region and may have been derived from a single original species unintentionally introduced by the first Austronesian navigators 1500 to 2000 years ago [11]. Due to strict isolation and ecological conditions in the islands, different species emerged. The introduction of *Aedes aegypti* into different islands over time may be linked to the Pacific history of human migration. This mosquito species introduction was first recorded in the Pacific in the late 19th and early 20th centuries [11]. The WHO reports that currently, over 70% of the world's dengue fever disease burden is borne by South-East Asia and Western Pacific countries [12].

Papua New Guinea's Current Situation

Several countries in the Pacific Region have no functioning surveillance centres, including PNG [5], where no surveillance was conducted before 2010. Reports from Australia's Northern Queensland and the Torres Strait Islands show evidence of imported cases from PNG [3]. However, the first DENV2 in PNG was reported earlier in 1944 [8]. Studies have shown over time that the disease is endemic in PNG [13]. The first epidemic of DF was reported in 1971 in Port Moresby and Rabaul [14]. One report noted a high prevalence of Arboviral antibodies in PNG, and that DF was endemic in PNG [13]. With no treatment yet available for DF, prevention is achieved through effective public health interventions such as vector control using treated mosquito nets, community action and participation, and public awareness [15].

Public health response at the national, provincial, district and community levels has been varied. Daru Hospital reported 170 cases (126 clinical presentations and 44 confirmed) in November 2015, and the National Capital District (NCD) reported 15 cases [16], while during the same period, no cases were reported from other provinces.

The National Department of Health (NDOH) continues to monitor the current 2016 outbreak with weekly updates [16]. Only 7 of the 170 cases in Daru developed severe disease needing hospitalization; however, all recovered and were discharged. Children below 5 years of age accounted for 12% (21/170) of the Daru cases.

Ongoing Routine Surveillance

The NDOH surveillance team reported that confirmed cases were reported in all three electorates of the NCD in February 2016 [15].There is clinic testing with rapid diagnostic test kits, with weekly samples being sent to either the Central Public Health Laboratory (CPHL) or the PNG-Institute of Medical Research (PNGIMR) for confirmatory testing. For example, between 25th April and May 6th, 2016, the CPHL tested 1855 blood samples with dengue Rapid Diagnostic Tests (RDT), of which 15% (335) of these samples were positive for DF. The CPHL and PNGIMR also tested the samples for other viruses, such as Chikungunya and Zika viruses. There have been no deaths reported in any of the major clinics in NCD such as Gerehu, Kilakila, 6-Mile and Kaugere clinics during the 2016 outbreak. Among a total of about 700 blood samples collected before 25th April, 2016, 40% tested positive for DF.

Public Health Response

Public health response in Port Moresby has been positive and improving with the National Capital District Commission (NCDC) as the lead implementing agency in carrying out the public health response in the city. Interventions envisioned include fogging, cleaning and

drainage as well as community awareness creation sessions. Additional interventions could include going from house to house and spraying the environment. Risk communication and awareness creation in communities is being conducted by the several agencies: NDOH, NCD, and the NCDC. Interventions proposed include focusing on cleaning and draining in each district and also targeting a day for the interventions. More DF awareness is likely also needed by the clinical staff as well as in communities, so that prompt notification, testing, tracing and examination of contacts and investigation of patient environments can be undertaken by the public health authorities to enable prompt care and necessary measures to be taken.

Coordination and Partnership

The NCDC, NCD Health, IMR, CPHL, WHO and NDOH are involved in the outbreak response and providing updates. While the current 2016 epidemic created an opportunity for collaborating with other sectors as part of the public health response, there are still many challenges. The NDOH report [15] highlighted challenges in implementing the program. These included:

- Lack of an effective, functioning surveillance system that would quantify the emergence, patterns of spread and magnitude of the problem;
- Lack of funding support for timely and progressive fogging in the city;
- Lack of community sustainability of the mosquito control activities;
- Inadequately coordinated communication and awareness creation and
- Lack of funding to enable dissemination of DF Information Education and Communication [IEC] materials (posters) that werealready designed.

Way Forward

There is room for other partners to be involved and actively participating in the response activities. The University of Papua New Guinea (UPNG) School of Medicine and Health Sciences (SMHS) Division of Public Health can facilitate support in terms of providing technical assistance support to developing and conducting operational research and data analysis and building community awareness and strengthened vigorous prevention strategies.

However, we cannot meet the DF challenge in PNG without first closing the surveillance gap described in this article. To achieve progress and mount an appropriate response, we need more and better data than we have now to count the not yet counted and make the now invisible visible. Without surveillance data we have no idea who is getting DF, where they

are, what their behaviours are, who is dying from it, or what the effects of any control measures might be. This information and more is needed to effectively target our response, and also to further learn from comparisons with DF surveillance data from other countries and areas in our region.

Then, building on the resulting surveillance information, more awareness in the community based on that evidence could more appropriately empower individuals, families, groups, clinicians, organizations, communities and the health services generally to play active roles in achieving, sustaining and protecting their own and the public's health and managing the various aspects of the DF threat and burden confronting us. Effective IEC strategies that are then appropriately tailored and targeted would help all stakeholders learn to make better decisions, modify their behaviours and change key areas of the social conditions necessary to overcome the DF challenge.

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