Dengue in north Queensland, 2005–2008

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Abstract

The dengue vector, the mosquito *Aedes aegypti*, is present in urban settings in north Queensland, thereby putting the region at risk of outbreaks of dengue. This review describes some features of the 9 outbreaks of dengue that occurred in north Queensland over the 4 years, 2005–2008. *Commun Dis Intell* 2009;33:198–203.

Keywords: *Aedes aegypti*, dengue, north Queensland, mosquitoes

Introduction

Although dengue viruses are not endemic in north Queensland, the vector mosquito, *Aedes aegypti*, is present in urban settings in the region and on some Torres Strait islands. This means that north Queensland is prone to outbreaks of dengue, each one apparently initiated by a viraemic traveller from an endemic country.[1–4] Of concern, these outbreaks have become more frequent over the past 2 decades.[4] This review describes some features of the 9 outbreaks of dengue that occurred in north Queensland between 2005 and 2008.

Methods

The methods have been described elsewhere.[1–4] Briefly, following notification of laboratory-confirmed cases, details are ascertained about each case, including where the infection may have been acquired and where the case may have been infectious to the mosquito vector, *Ae. aegypti*. Mosquito control measures are then prioritised and implemented based upon this information. A dengue serotype-specific IgM enzyme-linked immunosorbent assay[5] has proven to be very useful in confirming cases and identifying the infecting serotype.[4] Phylogenetic analyses of dengue viruses isolated from cases have proven very useful in understanding possible links between outbreaks and the possible initial sources of the outbreak viruses.[2–4]

Results

2005

In late February, a case of locally-acquired dengue in a resident of Thursday Island in the Torres Strait was notified to the Tropical Population Health Services (TPHS). Further cases were identified, and the outbreak soon spread to 2 other islands. The infecting virus was identified as serotype 4; the 3 islands had all been affected by serotype 2 outbreaks in prior recent years.[1,4] This outbreak in the Torres Strait lasted for a total of 7 weeks, and there was a total of 56 confirmed cases (Figure 1). The first known case in the outbreak was, retrospectively, recognised as having an onset 10 days prior to the initial notification.

In early May, TPHS was notified of a case of locally-acquired dengue from the suburb of Currajong in Townsville. Although there was no sudden increase in numbers, 4 more cases occurred in that suburb over the next month (Figure 1). Indeed, this outbreak was characterised by a small number of cases – 18 in total – over a prolonged period, a total of 22 weeks, with considerable intervals between some of the cases. The first known case was retrospectively recognised as having an onset 24 days prior to the initial notification. The infecting virus was also identified as serotype 4.

Phylogenetic analyses indicated that the 2 outbreaks, although both caused by serotype 4 viruses, involved quite different genotypes. The Torres Strait virus was almost identical not only to an isolate from Indonesia, but also to a dengue 4 virus isolated in 2002 from a Cairns resident who had recently been to Indonesia.[3] The Townsville virus was almost identical to dengue serotype 4 viruses recently isolated in the Philippines (Figure 2).

2006

In mid-January, TPHS was notified of a case of locally-acquired dengue from the suburb of

Figure 1: Dengue serotype 4 outbreaks in the Torres Strait and Townsville, 2005

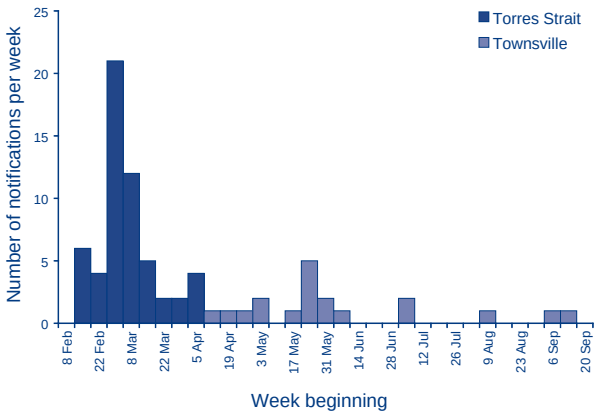
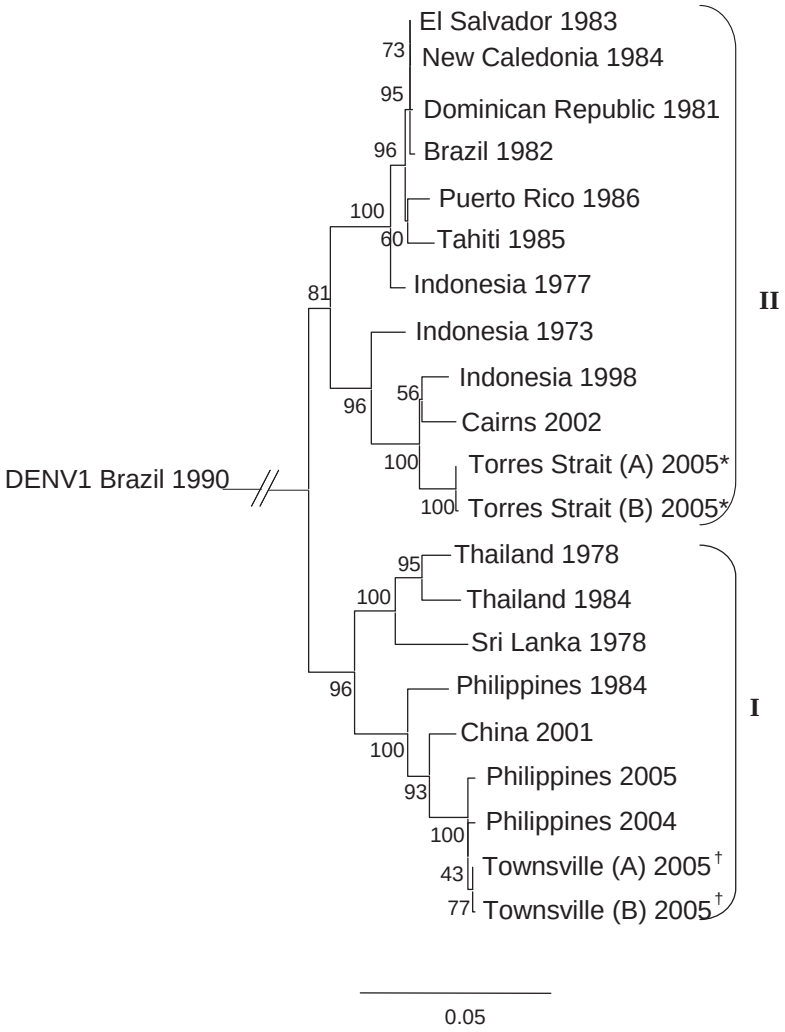


Figure 2: Phylogenetic relationships of the 2005 dengue serotype 4 viruses responsible for the Torres Strait* and Townsville† outbreaks of dengue



Cranbrook in Townsville. Although the outbreak affected residents of the older housing in this suburb, it lasted for only 6 weeks and there were only 8 confirmed cases. The earliest recognised case had an onset 23 days before the initial notification and the infecting virus was identified as serotype 3 (Figure 3).

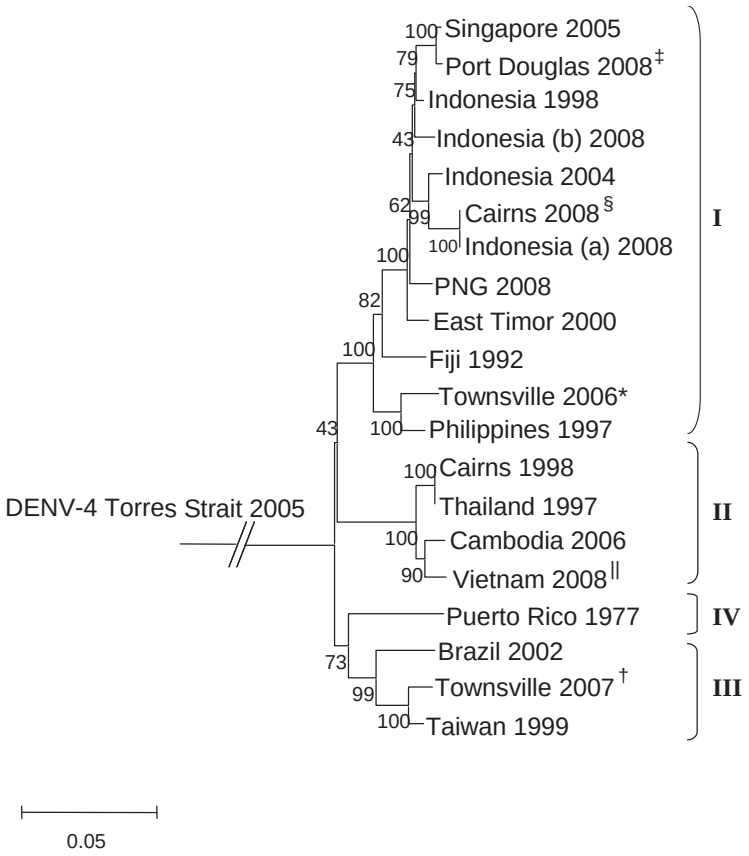
At the beginning of March, TPHS was notified of a case of locally-acquired dengue from Gordonvale, a township just south of Cairns. Two cases were recognised – one retrospectively – as occurring in the latter half of February but no more were recognised in the next 6 weeks. Severe tropical cyclone Larry occurred on 20 March, which not only demolished some general practices in the vicinity, but also resulted in vector control activities being diverted away from Gordonvale to areas more severely affected by the disaster. It was recognised in early April that the outbreak had not ceased, and that it had spread into several Cairns suburbs, Manunda in particular.

The outbreak had a total duration of 18 weeks, and included a total of 29 cases with 20 in Gordonvale residents. The earliest recognised case had an onset 17 days before the initial notification and the infecting virus was identified as serotype 2. A phylogenetic analysis indicated that the virus was virtually identical to isolates from a large outbreak that affected the Torres Strait in 2003 and Cairns in 2004. This prior outbreak was presumed to have been initiated by a traveller from Papua New Guinea.[4]

2007

In late March TPHS was notified of a case of locally-acquired dengue in a resident of the suburb of Cranbrook in Townsville. This location and the identification of the infecting virus as serotype 3 raised some concerns that the virus may have somehow 'overwintered' unrecognised in this suburb. However, the case had visited a residence in South Townsville, and several other people in that residence had recently been ill with an acute febrile

Figure 3: Phylogenetic relationships of the dengue serotype 3 viruses responsible for the outbreaks in Townsville in 2006* and 2007† and in Port Douglas‡ and Cairns§ in 2008

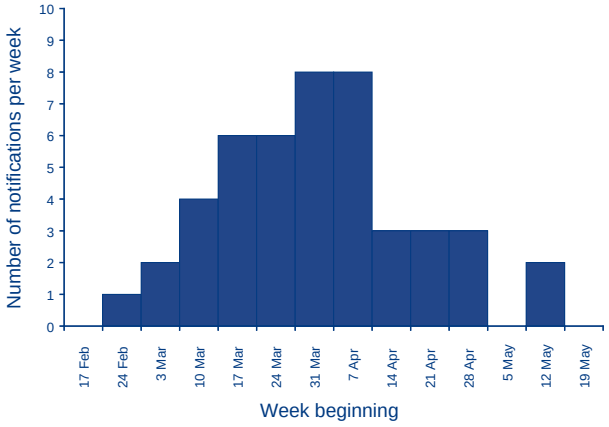


The case imported from Vietnam‖ into Port Douglas in early 2008 is also shown

illness. It was soon recognised that this outbreak was centred on South Townsville with no evidence of transmission in Cranbrook. South Townsville is an older, inner city suburb adjacent to Railway Estate, which was the centre for a large epidemic of serotype 2 dengue in the early 1990s.[6]

The first retrospectively recognised case had an onset 26 days before the initial notification, so the outbreak in South Townsville was well established before it was recognised on 21 March (Figure 4). The outbreak lasted for 12 weeks with a total of 46 confirmed cases, and although it moved into another suburb (West End) there was no evidence that Railway Estate was affected. A phylogenetic analysis demonstrated that the virus was quite different to the dengue serotype 3 virus isolated during the 2006 outbreak in Townsville; indeed the 2 viruses belonged to different genotypes (Figure 3).

Figure 4: Dengue serotype 3 outbreak in Townsville, 2007



2008

In late January TPHS was notified of an imported (from Vietnam) case of dengue in a resident of Port Douglas, a small beach resort situated about 60 km north of Cairns. Port Douglas was severely affected in 1998–1999 during an epidemic of dengue serotype 3.[2] The case was subsequently shown to have been infected by serotype 3 virus. Because the person was acutely ill, and therefore viraemic in Port Douglas, local medical practitioners were alerted to the possibility of subsequent local transmission and mosquito control activities were undertaken around the case's residence and place of work in Mossman, a nearby town.

About a week later TPHS was informed of a locally-acquired case of dengue in a Mossman resident who worked in Port Douglas. This first recognised locally-acquired case worked at a beachfront venue popular with both local residents and visitors. It soon became apparent that there was local transmission occurring in Port Douglas, with an initial focus around the venue. The outbreak eventually included 22 cases, and lasted for 10 weeks. Four of the cases were probably acquired in Mossman, the rest in Port Douglas.

Although the onsets of the illnesses of the imported case and the first recognised locally-acquired case were only 11 days apart, it was not possible to epidemiologically link the imported case to the venue. This apparent paradox was resolved when the phylogenetic analyses revealed that the imported serotype 3 and the outbreak serotype 3 viruses were quite different – indeed belonging to different genotypes – and were therefore not linked (Figure 3). The initial source of the outbreak was never recognised, but it was presumably a viraemic patron of the beachside venue.

In early November TPHS was notified of a locally-acquired case of dengue in a Cairns resident. The onset of his symptoms was 14 days before the notification. Mosquito surveys revealed a very low risk of transmission of dengue at his residence and at several locations around Cairns where he had worked as a tradesman, and no insights could be gained into where he may have acquired the infection. His dengue was caused by a serotype 2 virus and because he had been in Cairns for the duration of his viraemia, local medical practitioners were alerted to the possibility of further cases.

In late November TPHS was notified of a locally-acquired case of dengue in a resident of Cairns North, an older suburb not far from the city centre. Multiple cases were soon recognised in adjacent properties in that suburb, and dengue serotype 3 was identified as the infecting virus. Investigations revealed that the earliest case was an adult male who had become unwell 5 days after returning to Australia from Kalimantan (Indonesian Borneo); although he had been quite unwell for 4–5 days, he did not seek medical attention. He lived in an unscreened highset 'Queenslander' residence that provided ready access for *Ae. aegypti* mosquitoes, which were abundant in the vicinity. Subsequent serological tests indicated that he had recently had a dengue serotype 3 infection.

The hot and sultry weather, with some pre-monsoonal rains at that time, were ideal for *Ae. aegypti* proliferation and would have led to a relatively short extrinsic incubation period of the dengue virus. Indeed, the first recognised locally-acquired case had an onset 10 days after that of the case who apparently had imported the infection from Indonesia, and who was assumed to have initiated the outbreak. Not surprisingly the outbreak expanded rapidly and soon spread to 3 other suburbs: Clifton Beach (25 km north of central Cairns), Whitfield and Parramatta Park. The latter 2 suburbs have been involved in several previous outbreaks of dengue,[2,4] most recently an outbreak of serotype 2 dengue in 2003–04.[4] By the end of 2008, 5 quite separate Cairns suburbs were affected and 98 cases of dengue had been confirmed.

Cases of dengue serotype 3 that were acquired in Cairns were reported from numerous other sites, both within and outside Queensland, reflecting the continuous movement of people, particularly towards the end of the year. In late December, a locally-acquired case of dengue serotype 3 was confirmed from the suburb of Belgian Gardens in Townsville. Molecular analyses indicated that the dengue 3 viruses circulating in Cairns and Townsville were identical, providing strong evidence that an unknown traveller from Cairns had introduced the virus into Belgian Gardens. Both the Cairns and Townsville dengue serotype 3 outbreaks continued into 2009.

Just before the end of the year TPHS was notified of a case of locally-acquired dengue in a resident of the suburb of North Ward in Townsville; there was a 9 day interval between the onset of his symptoms and the notification. Dengue serotype 1 was identified as the infecting virus, and subsequent molecular analyses indicated that the virus was very closely related to recent dengue serotype 1 isolates from Singapore (data not shown). The importation that led to this outbreak was not identified. By the end of the year 4 more cases, all apparently acquired in North Ward, had been notified. This outbreak also continued into 2009.

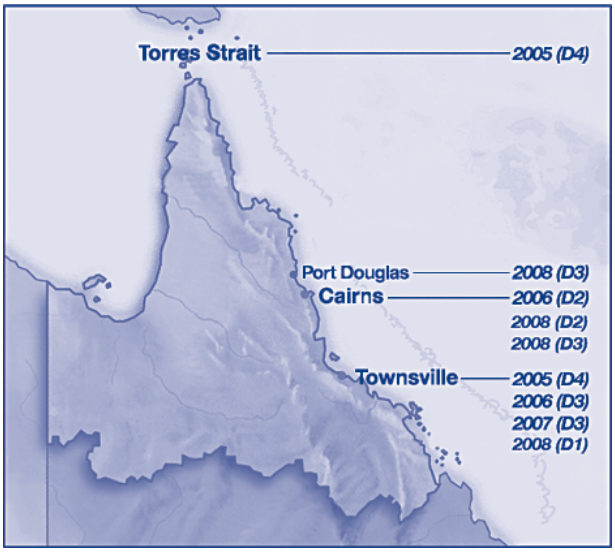
Discussion

The experiences over these 4 years indicate how vulnerable the region is to outbreaks of dengue. There were outbreaks in Townsville every year over the 4 years (Map).

Furthermore, all 4 serotypes of dengue viruses were involved in the outbreaks that occurred over the 4 years (Map). Since many hundreds, probably thousands, of people in the region have had a previous dengue infection, there is the not insignificant likelihood of severe complications such as dengue shock syndrome should secondary infections occur.

A common feature in most (7) of the outbreaks was a considerable delay (mean 18.9 [range 9–26] days) between the onset of the first known cases and the

Map: Outbreaks of dengue, north Queensland, 2005–2008



D1 = dengue serotype 1, D2 = dengue serotype 2, D3 = dengue serotype 3, D4 = dengue serotype 4.

recognition of the outbreaks. This delay, which obviously can delay the mosquito control measures, has understandably been described as the 'Achilles heel' of dengue control in north Queensland.[7] In an effort to reduce the delay, a new rapid diagnostic test was used for the first time during the dengue outbreaks that occurred in late 2008. This enzyme-linked immunosorbent assay can detect a protein (the NS1 protein) produced by replicating dengue viruses early during the course of the dengue illness.[8] The early experiences with this test, being used locally in north Queensland, appear promising with a rapid turnaround of the test results.

The molecular analyses have again proven to be extremely powerful and useful tools allowing clear understanding of the relationships between dengue viruses of the same serotype. They have enabled links between outbreaks to be clarified (Figures 2 and 3), and links between importations of dengue and subsequent outbreaks to be defined (Figure 3). The latter will continue to be important as there were 43 recognised viraemic importations of dengue into north Queensland over the 4 years (data not shown).

Mosquito control strategies have evolved, and will continue to do so, as experience is gained from each outbreak.[7] This evolution has led to a refinement of a comprehensive approach incorporating larval control, targeted interior spraying with synthetic insecticides and the use of lethal ovitraps.[7] A recent innovation has been the rapid deployment of biodegradable lethal ovitraps in and around the residences (and other relevant premises) of dengue cases.[9] The use of lethal ovitraps has improved response times and reduced insecticide use compared to earlier responses that utilised much wider use of interior spraying.[7,9] This has been enhanced by the new (Queensland) *Public Health Act 2005* that allows authorised public health officers to access yards and set lethal ovitraps when the residents are not present.

Following the large outbreak of dengue serotype 3, which led to 275 cases in the Port Douglas/Mossman area in 1998–1999,[2] the local government environmental health officer worked with the local communities on a program to reduce local *Ae. aegypti* populations. Although a considerable proportion of the local population would have been immune, it is encouraging that there were only 22 cases in the 2008 Port Douglas/Mossman outbreak. Similarly, following the large outbreak of dengue serotype 2, which led to 171 cases on Thursday Island in 2003–2004,[4] there was a massive clean-up of large items (that were potential *Ae. aegypti* breeding sites) on the island.[4] Again, it is encouraging that there were only 34 cases acquired in Thursday Island in the 2005 outbreak.

These 2 observations suggest that proactive programs designed to reduce *Ae. aegypti* breeding and therefore *Ae. aegypti* populations can reduce the size of dengue outbreaks in north Queensland, and therefore perhaps even prevent outbreaks from occurring. In 2005 it was stated that 'Clearly, more preventive *Ae. aegypti* control would have to be done in inter-epidemic periods to prevent explosive transmission'.[7] This message still stands; unless local authorities and local communities adopt innovative preventive measures – especially removal of *Ae. aegypti* breeding sites – outbreaks of dengue, some very large with considerable morbidity and occasional mortality, will continue to occur in north Queensland.

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