Dengue in north Queensland, 2002

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Abstract

In 2002 three separate outbreaks of dengue were detected in north Queensland, including the first documented outbreak of dengue 4 in Australia. Molecular analyses identified Thailand and Indonesia as the likely origin of two of the outbreaks. Investigations during 2002 also included a suspected dengue outbreak in the Torres Strait which proved to be a false alarm, and a number of imported cases of dengue in north Queensland. *Commun Dis Intell* 2003;27:384–389.

Keywords: Aedes aegypti*, dengue, disease outbreak, north Queensland*

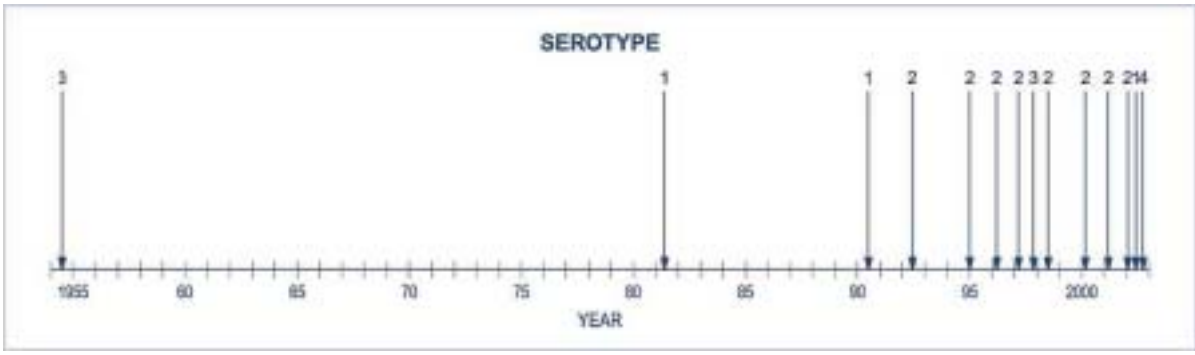
Introduction

Because the principal vector of dengue, the mosquito *Aedes aegypti*, occurs throughout much of north Queensland, the region is susceptible to outbreaks of the disease. Indeed, in keeping with global trends,[1] the frequency of outbreaks in north Queensland has increased markedly over the past decade (Figure 1). This report documents the dengue activity that occurred in the region in 2002, with brief descriptions of the responses that were undertaken.

Methods

The laboratory methods and control measures have been described elsewhere.[3,4] Briefly, an outbreak is defined by the recognition of a single confirmed locally-acquired case of dengue in north Queensland. A case was confirmed by either virus isolation, or polymerase chain reaction (PCR), or by haemagglutination inhibition assay (HAI). Any person with a compatible illness and a dengue IgM positive result by enzyme immunoassay (EIA) was also considered to be a confirmed case, provided there was an epidemiological link to another confirmed case.

Figure 1. Dengue outbreaks in north Queensland over the past 50 years



The serotype involved in each outbreak is shown above each arrow.

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Nucleotide sequencing and phylogenetic analyses were performed on sequence information of a 189 nucleotide region, and a 1,045 nucleotide region, of the envelope (E) genes of the dengue 2 and dengue 4 viruses respectively. Phylogenetic trees were constructed using modifications of EclustalW,[5] DnaDist[6] and the neighbour-joining method.[7] Trees were rooted using a dengue 1 virus sequence[8] and drawn using TreeView software[9] with bootstrap analyses of 1,000 replicates.

Premises within 200 m of each case's home or workplace were surveyed for breeding sites of *Ae. aegypti* and, where necessary, either elimination of breeding sites or larviciding was implemented. Particular attention was paid to locate cryptic breeding sites such as roof gutters.[10] Breteau Indices (the number of containers breeding *Ae. aegypti* per 100 premises) were calculated; an Index of 5 is considered the hypothetical lower limit, whereas an Index over 50 is considered high-risk for dengue transmission.[3]

Interior spraying with residual adulticides was undertaken, with consent, in premises within 100 m of each case.[11] Particular attention was paid to possible 'dissemination' premises: those that may act as sources for the rapid dispersal of dengue throughout a community.[3]

Results

Outbreaks

Kuranda dengue 2 outbreak

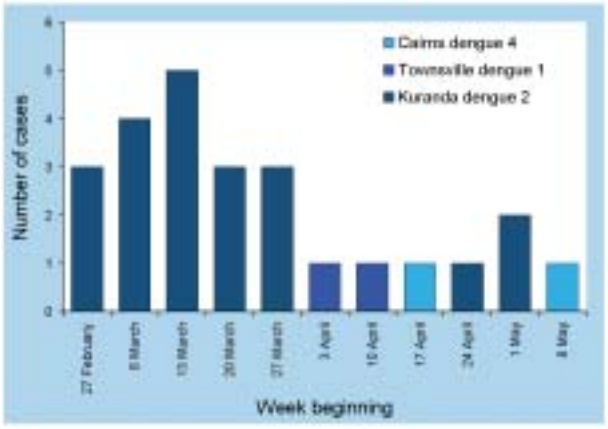
In early March 2002, the Tropical Public Health Unit (TPHU) was notified of an adult male resident of Kuranda, a rainforest village 20 km north-west of Cairns, with a dengue IgM and IgG positive EIA. The patient had not recently travelled away from Kuranda, and he did not have a typical dengue clinical illness. Because the TPHU had followed up several false-positive dengue IgM results around that time, it was decided to await confirmatory tests before implementing mosquito control measures. Although further tests did not confirm the diagnosis in the index case, an adult female resident of Kuranda also with a dengue IgM and IgG positive EIA was subsequently notified to the TPHU in mid-March. This patient also had not travelled, but she had a dengue-compatible illness, and worked in a local hotel where several other staff had a similar illness.

At this point it was considered that there was almost certainly an outbreak of dengue in Kuranda. This concern was heightened when mosquito surveys at the hotel revealed intense *Ae. aegypti* breeding, particularly in long pot plant boxes along the walls of the open-plan establishment. Larviciding (using s-methoprene pellets) and interior spraying (using the synthetic pyrethroid lambda-cyhalothrin) were undertaken at the hotel. Dengue was eventually confirmed in four other hotel staff, with dengue 2 being identified by PCR and/or isolation in two of the cases.

The mosquito surveillance and control measures were extended beyond the hotel. Local residents were informed by mail of the probable situation and of personal mosquito precautions and measures to reduce *Ae. aegypti* breeding in the home and at the place of work. These activities, together with media reporting of the outbreak, led to the recognition of other suspect cases in, and nearby, Kuranda.

Altogether there were 21 confirmed cases of dengue, with dengue 2 being identified in three, in the outbreak that lasted for 10 weeks (Figure 2). Eighteen of the cases occurred in the first five weeks; all of these were either staff or patrons of the hotel (8 cases), or people who either worked or lived close to the hotel (10 cases). There were no cases recognised over the next three weeks, but then the remaining three cases, all associated with the same residence in a street not far from the hotel, occurred in weeks nine and ten. A total of 172 premises were surveyed for mosquitoes in Kuranda, 14 (8%) of which had *Ae. aegypti* breeding in containers on site (Breteau Index = 11).

Figure 2. Epidemic curve of dengue outbreaks in north Queensland, 2002

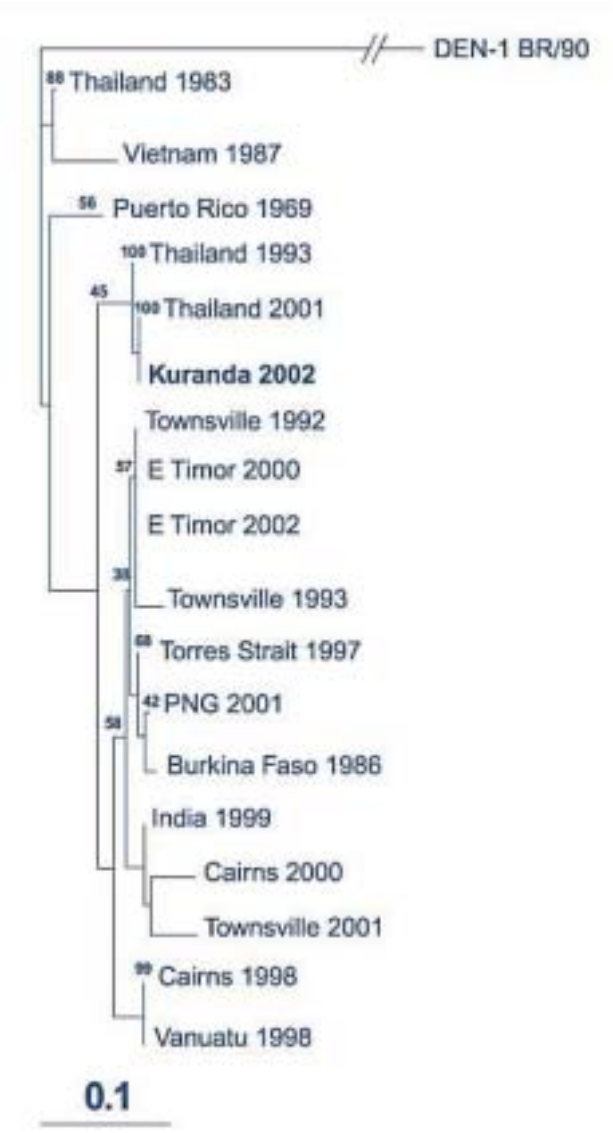


Because there had been a recent importation of dengue 2 from East Timor into north Queensland (Table), there was initial speculation that the Kuranda outbreak may have been initiated by a traveller recently arrived from that country. However, the molecular analysis of the dengue virus E gene indicated that this was very unlikely, and that it was much more probable that the dengue 2 virus had been imported from Thailand (Figure 3).

Townsville dengue 1 outbreak

In mid-April 2002, the TPHU was notified of an adult male, who lived on acreage approximately 40 km south of Townsville, with a dengue IgM and IgG positive EIA. He had had a typical, but mild, dengue-like illness, and had not recently travelled either overseas or to Kuranda. He had made a single afternoon trip to Townsville during his exposure period when he had visited a residential address in the suburb of Railway Estate. A week later dengue was confirmed by HAI, with dengue 1 being implicated as the infecting virus. Further enquiries revealed that an adult female who resided at the address in Railway Estate had had a mild febrile illness with rash in early April. Her illness was subsequently confirmed as dengue.

Figure 3. Phylogenetic relationships of the Kuranda 2002 dengue 2 virus isolate to other selected dengue 2 viruses, predicted from a 189 nucleotide region of the envelope (E) gene



The trees were rooted using a dengue 1 (DEN–1 BR/90) virus sequence (8) as an outgroup; the scale indicates the number of nucleotide substitutions per site and horizontal branch lengths are proportional genetic distance. The number above the branches indicates bootstrap confidence levels for 1,000 replicates.

Recognition of the outbreak was of particular concern as it was in Railway Estate that an outbreak of dengue 2 in Townsville commenced in 1992.[12] There were, therefore, many residents previously infected with dengue 2 virus who had a potentially increased risk of severe dengue should they acquire a second infection with a different serotype.[1] Case surveillance was enhanced through alerts to local general practitioners, notification of laboratories and media announcements; mosquito surveys and control measures were undertaken over a large area. One hundred and thirty-two premises, many of which were unscreened residences, were inspected in Railway Estate and *Ae. aegypti* breeding was found in 13 premises (Breteau Index = 10).

No further cases of dengue fever were identified, and the source of the outbreak remains unknown. No PCR-product or dengue virus was obtained, so molecular analysis was not possible. However, a large outbreak of dengue 1 was occurring in the South Pacific at the time,[13] suggesting that the virus may have been imported from an island nation in the region. Although there was an importation of dengue 1 into Townsville in April (Table), that case did not appear to have any connection with Railway Estate.

Cairns dengue 4 outbreak

In mid-May 2002, the TPHU was notified by Queensland Health Scientific Services (QHSS) that dengue 4 virus had been identified by both PCR and virus isolation in serum from an adult female resident of Smithfield, a northern suburb of Cairns. She had had a clinically compatible illness, but had not travelled away from Cairns in the recent past. Her partner had had a similar illness three weeks previously, about three weeks after returning from Indonesia. This travel history was thought not to be relevant, as the incubation period for dengue is usually less than 10 days.[1]

Since the male partner had consulted a general practitioner at the time of his illness and some blood tests had been done, residual serum was retrieved and forwarded to QHSS. Dengue 4 virus was detected by both PCR and virus isolation. A total of 52 premises were surveyed in Smithfield; 27 (52%) had *Ae. aegypti* breeding in containers on site (Breteau Index = 52). Despite the relatively high Breteau Index, no further cases were recognised in this outbreak.

Molecular analysis of the E gene of the dengue 4 viruses indicated that they were most closely related to other recent isolates acquired in Indonesia in 1998 and in East Timor in 2000 (Figure 4).

Figure 4. Phylogenetic relationships of the two Cairns 2002 dengue 4 virus isolates to other selected dengue 4 viruses, predicted from a 1045 nucleotide region of the E gene

The trees were rooted using a dengue 1 (DEN–1 BR/90) virus sequence (8) as an outgroup; the scale indicates the number of nucleotide substitutions per site and horizontal branch lengths are proportional genetic distance. The number above the branches indicates bootstrap confidence levels for 1,000 replicates.

A false alarm

In mid-June 2002, the TPHU was notified of a strongly reactive dengue IgM positive EIA result in the serum from a 16-year-old resident of Mer, an outer island in the Torres Strait. The youth had had a compatible illness and he had not recently travelled away from the island.

For several reasons it was decided to mount an immediate response to this EIA result before waiting for confirmation of the diagnosis. Mer was the epicentre of a large outbreak of dengue 2 in the Torres Strait in 1996–97,[2] and a mosquito survey earlier in 2002 had revealed intense *Ae. aegypti* breeding (Breteau Index = 205) on the island.[14] Furthermore, this island receives many visitors from Papua New Guinea, and a large number of visitors from other islands and the Australian mainland had visited the island for the Mabo Day celebration in early June (when the youth was acutely unwell).

The response required chartering an aircraft to fly vector-control personnel and equipment, to the island from Cairns. However, 13 days after the initial notification, QHSS reported that the serum sample from the youth was flavivirus IgM negative by EIA, and subsequently the HAI results were also reported as negative.

Importations of dengue into north Queensland

There were seven recognised importations of dengue into north Queensland in 2002 (Table). Six of these were in the first half of the year; they did not appear to be connected with the outbreaks in any way. Nevertheless, they all required the same public health follow-up, and mosquito surveys and control measures, as did each locally-acquired case. The average duration of viraemia in the imported cases, prior to the implementation of the public health responses,[15] was 6 days.

Discussion

This report describes dengue surveillance and control activities in north Queensland in 2002. This was the first year ever in which three separate outbreaks of dengue were recognised; indeed the occurrence of even two outbreaks in the same year is most unusual (Figure 2). The first documented outbreak of dengue 4 in Australia occurred in 2002. Although the outbreaks were small, they nevertheless required a huge investment in terms of persons, time and money to investigate and bring them under control.

The outbreaks demonstrated the limitations inherent in recognising dengue: the inadequacies in the commercially available dengue IgM diagnostic tests and the delays in notification of cases. The dengue IgM tests, although useful for screening purposes, not infrequently give incorrect results.[16] Therefore, any dengue IgM positive result reported by a

Table. Importations of dengue into north Queensland, 2002

Age, sex of patient	Imported from	Imported to, month	Notified by doctor at initial consultation	Delay between consultation & notification	Viraemic days in north Qld	Serotype
39 yrs, M	East Timor	Townsville, March	Yes	0 days	3	2
59 yrs, M	East Timor	Cairns, March	Yes	0 days	4	?
19 yrs, M	Papua New Guinea	Cairns, April	No	6 days	10	1
60 yrs, F	Vanuatu	Townsville, April	Yes	0 days	5	?
58 yrs, M	Vanuatu	Townsville, April	No	3 days	11	1
22 yrs, F	Thailand	Cairns & Pt Douglas, May	Yes	0 days	3	1
61 yrs, F	Philippines	Edmonton, November	No	1 day	7	3

laboratory in north Queensland must be confirmed by the QHSS reference laboratory before it can be accepted as being correct. False-positive results, as occurred with the 16-year-old resident of Mer, may arise from cross-reactivity with other flaviviruses, other infections (such as malaria and leptospirosis), and in chronic clinical disorders, especially if rheumatoid factor is present.[16]

All three index cases were notified by diagnostic laboratories rather than by the medical practitioners who undertook the initial consultations. This inevitably contributed to delays in implementing public health responses to the outbreaks. The Table, however, indicates that there is much more prompt notification of imported cases, indicating that practitioners are eliciting a travel history and are considering dengue in the differential diagnosis. Despite prompt notification, the seven imported cases were viraemic in north Queensland for a total of approximately six weeks.

The molecular analyses were extraordinarily useful in identifying the origin of the dengue viruses. The E gene sequence of the Kuranda dengue 2 virus was shown to be virtually identical to that of a dengue 2 virus acquired in Thailand in 2001. The dengue 4 virus was shown to have the greatest sequence similarity with a dengue 4 virus acquired in Indonesia in 1998, revealing the likely origin of the Smithfield outbreak.

The outbreaks have also demonstrated the importance of the strategic approach to dengue prevention and control that has evolved in north Queensland over the past decade. Fundamental to this approach is a dedicated team of vector control personnel, the Dengue Action Response Team, who use interior spraying of premises as an important control strategy. In all three outbreaks, no further local transmission occurred beyond the initial focus of transmission, and only three cases (12% of the total) were acquired after mosquito control measures were begun.[11] This strategic approach to dengue prevention and control has been described in the Dengue Fever Management Plan for north Queensland 2000–2005.[17]

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