Peer-reviewed articles

An outbreak of *Plasmodium falciparum* malaria in the Torres Strait

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Abstract

This report describes the largest outbreak of *Plasmodium falciparum* malaria in the Torres Strait for more than 25 years. It details factors that may have contributed to the outbreak, the public health response and implications for the broader region. Eight cases of locally-acquired falciparum malaria occurred on Saibai and Dauan islands during March and April 2011. Including imports, there were 17 *P. falciparum* notifications between February and May 2011. Three cases of pure *P. vivax* malaria that might have been locally acquired have been omitted from this report. Malaria is endemic on the nearby coast of Papua New Guinea (PNG), and regularly imported to the Torres Strait where a competent vector exists in sufficient numbers to transmit the disease to the local population. The most common malaria vectors in northern Australia and Torres Strait are the *Anopheles farauti* complex. Factors contributing to the outbreak may include an increase in travel between the outer islands and PNG, inadequate local vector control and late or missed diagnoses of malaria. Outbreak management involved intensive case finding and treatment, vector control and health promotion. Reducing the risk of future outbreaks requires studies of vector behaviour, ecology and management, health promotion, improvements to protective infrastructure, and clinical guideline revision. Further malaria outbreaks are likely in the Torres Strait and elsewhere in northern Australia. It is important to maintain awareness and be prepared to respond rapidly. *Commun Dis Intell* 2012;36(2):E180–E185.

Keywords: *Plasmodium falciparum*, malaria, Australia, Torres Strait, *Anopheles farauti*

Introduction

The Torres Strait Islands are situated between the tip of Cape York on the Australian mainland, and Papua New Guinea (PNG). The northernmost islands Saibai, Boigu and Dauan lie within 5 kilometres of the PNG coast (Figure). The 1978 Torres Strait Treaty permits free movement for traditional activities of Torres Strait Islanders and people from 13 coastal PNG villages, in a designated cross-border zone. Traditional purposes do not include health, however it is acknowledged to be unwise for humanitarian and public health reasons to exclude PNG visitors from acute care services.[1]

Saibai Island comprises largely swampland. About 340 people live in the 1.7 km long township on the northwest coast, some of whom are PNG citizens.[2] Breeding sites of the malaria vector *Anopheles farauti* sensu lato (s.l.) include an abundance of mangrove swamps, coastal flats, and brackish pools.[3] Alternative feeding hosts on the island include feral deer and dogs.[4] Dauan is a small, rocky, volcanic island, 4.5 km south west of Saibai; the township lies along a narrow coastal strip backed by steep hills with swampland to the east, and salt marsh and mangroves to the north-west. There are far fewer suitable vector breeding sites than on Saibai.[3]

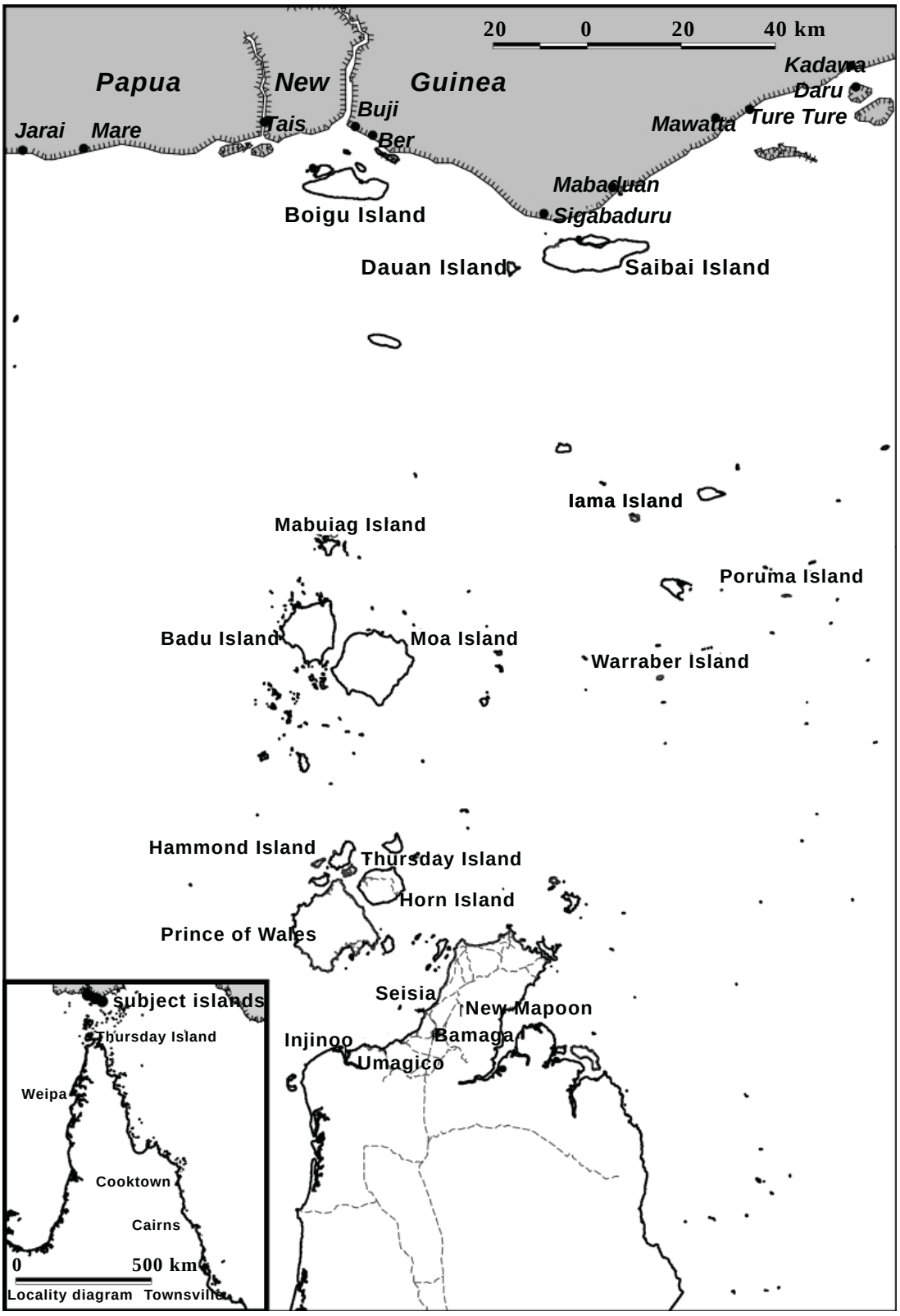
Malaria was previously endemic in the Torres Strait, but Australia was declared free of malaria in 1981.[5] *P. falciparum* and *vivax* infections are regularly diagnosed in the Torres Strait with most cases imported from PNG, and local transmission is rare. Saibai had small outbreaks of malaria in 1984, 1989, 1991, and 2004.[3,6–8] One case of locally-acquired falciparum malaria was diagnosed on Darnley Island in 2001.[9] There had been no locally transmitted malaria on Dauan in 25 years.

Malaria diagnosis was based on clinical presentation, rapid diagnostic tests (RDT, Binax Now® brand) and/or blood films. As falciparum malaria can cause serious morbidity and death, it was particularly important the chosen rapid test could detect this species. The definition of an outbreak included a single locally-acquired case of falciparum malaria. It is much more difficult to define local transmission of *P. vivax* malaria, due to relapses from hypnozoites, so 3 cases of pure vivax malaria in the study period are not described further in this paper.

The 'malaria receptive zone' of northern Australia (approximately north of the 19° parallel, corresponding to the distribution of *An. farauti* s.l.) was described over 60 years ago.[10] This report describes an outbreak in islands with frequent visitors from a country with endemic malaria.

Ethics approval was not sought for publication of this article because it is a public health report and individuals are not identified.

Figure: Map of Torres Strait



Papua New Guinea territory shaded grey

Description of outbreaks

Between 23 February and 26 May 2011, 17 cases of falciparum malaria were notified from the Torres Strait and Northern Peninsula Area Health Service District ('Torres District'). Of these, eight were definitely locally acquired, six were imported, and for three the site of acquisition was unclear (Table). Ten cases occurred in males and seven in females.

Table: Falciparum malaria cases, Torres Strait, 2011, by notification date and place of acquisition

Notification	Age	Nationality	Onset	Acquisition
23 March	3	TSI	17 March	Dauan
23 March	54	TSI	12 March	Saibai
24 March	21	TSI	17 March	Saibai
28 March	45	TSI	12 March	Saibai
31 March	24	TSI	28 March	Saibai
7 April	1	TSI	5 April	Saibai
7 April	33	PNG	5 April	Saibai
11 April	24	TSI	10 April	Saibai
20 March	28	PNG	unknown	PNG
25 March	31	PNG	unknown	PNG
1 April	25	PNG	29 March	PNG
6 April	24	PNG	4 April	PNG
3 May	35	PNG	2 May	PNG
9 May	29	PNG	2 May	PNG
23 February	22	PNG	18 February	PNG/Saibai?
6 April	13	PNG	1 April	PNG/Saibai?
26 May	29	TSI	23 May	PNG/Saibai?

PNG Papua New Guinean
TSI Torres Strait Islander

On 23 March 2011, an outbreak was declared following notification of two locally-acquired *P. falciparum* cases: a man living on Saibai, with symptom onset on 12 March, and a child on Dauan, with onset of illness on 17 March. Neither had travelled from their island in the preceding month.

On 24 March 2011 another case, living in the same house as the child, was notified with onset also 17 March. This person had left Dauan once in the preceding month to make a day trip to Saibai. Five further locally-acquired *P. falciparum* cases were reported on Saibai (one was mixed *P. falciparum* and *P. vivax* infection in a PNG national resident on Saibai for over a month). Three of these people were hospitalised; two were children, and one adult required admission to the intensive care unit because of hepatic and renal failure. One person refused transfer despite a recommendation from clinical staff.

Cases were considered imported if they had been in PNG 9 to 14 days before symptoms developed (corresponding to the incubation period).[11] One woman with imported malaria had an intrauterine foetal death in hospital attributed to malaria. One case with an uncertain site of acquisition was hospitalised for an acute abdomen, and coincidentally found to have malaria.

On Saibai, cases initially occurred at the east and west ends of the community, and later were found throughout the village. All the imported cases had acquired malaria in PNG; most came from the villages of Mabudauan and Sigabaduru. The majority of these were residing in the Saibai community west side when diagnosed (where PNG nationals live in completely unscreened houses).

Blood smears were positive for malaria in all but 1 locally-acquired case. The latter had a positive polymerase chain reaction (PCR) test, performed because of clinical suspicion. Gametocytes were not identified in blood smears of any of the locally-acquired cases, but were seen in 1 imported case notified on 6 April (symptom onset 2 days prior) and in a PNG national notified on 23 February (symptom onset 5 days prior) with uncertain place of acquisition.

Outbreak management

Measures to control the outbreak included passive and active case finding, supervised treatment with gametocytocidal therapy, vector control to reduce mosquito longevity and health promotion. During a funeral lasting several days on Saibai, local staff deemed it culturally inappropriate to commence community activities. This delayed response was a cause of concern. A formal 'Incident Management Team' convened on 8 April, was able to accelerate and coordinate these responses. The outbreak was declared over on 15 June 2011, 59 days after treatment of the last locally-acquired case.

Passive case finding and treatment

The outbreak prompted an urgent re-evaluation of clinical supervision, guidelines, recording, diagnosis and treatment at the Saibai and Dauan clinics. Nurses relatively inexperienced in the management of malaria were encouraged to ring doctors at Thursday Island Hospital and request air transfer if needed, and training was given in the rapid diagnostic test (RDT) use and its limitations. Treatment with effective, gametocytocidal artemether/lumefantrine continued, but the first doses were given under supervision. It was recognised that a problem with smear quality had arisen since on-site smear preparation had been abandoned in favour of sending venous blood specimens to the distant laboratory. This could not be addressed until after the outbreak.

Active case finding

Acute staffing and training issues resulted in a delay in active case finding until 4 April. Twice weekly checks of all 70 households were made, and then reduced to weekly. A nurse and health worker made home visits seeking persons with current fever or within the preceding 48 hours. Anyone identified through the use of this protocol attended the clinic for an RDT and a blood sample was sent for thick and thin films. Two cases were identified early by outreach. All 7 pregnant women were monitored daily for fever from 5 April.

Malaria and mosquito avoidance advice was provided and included: precautions during peak feeding times; long-sleeved, light coloured clothing; personal insect repellent; devices (plug-in or mosquito coils); impregnated bed nets; and surface spray to reduce adult mosquito numbers inside the house.

Vector control

The Cairns Public Health Unit and local district officers commenced vector control at Dauan on 25 March and Saibai 29 March. Vector surveillance methods (CO_2 baited light traps) confirmed large numbers of *An. farauti* s.l. on both islands. These were later identified by PCR as being the subspecies *An. farauti* 1. (Robert Cooper, Australian Army Malaria Institute, personal communication), capable of transmitting malaria.[12] Control strategies included residual insecticide spraying inside houses, thermal fogging in and around houses, and harbourage spraying (vegetation within a 50 m radius of houses). Fogging was timed to correspond to peak *An. farauti* flight activity. All methods utilised pyrethroid insecticides with the aim of killing the older, infected female mosquitoes.

Health promotion and public information

Malaria fact sheets were distributed, and the community was informed about vector control measures by the local public health team and a nurse. Announcements were made on local radio and published in the local Torres Strait newspaper.

Mosquito repellent was distributed and promoted from the health centre and on sale at the local shop. Pyrethrin-impregnated bed nets were supplied to households with pregnant women, children under the age of 5 years and confirmed cases. Due to logistical difficulties, nets only arrived towards the end of the outbreak. There was local support for restriction of cross border travel, but this was not a public health recommendation.

Discussion

Despite regular travel from endemic PNG, *P. falciparum* outbreaks in the Torres Strait are limited and sporadic. This could be because the human populations on outer islands are small and there is effective surveillance. Cases are generally diagnosed and treated early, leaving a limited time window for gametocytes to develop (i.e. for people to become infectious to mosquitoes). *P. falciparum* requires a longer period than *P. vivax* for gametocytes to appear.[13] Also, *An. farauti* may take a low proportion of blood meals from humans because both dogs and feral deer are alternative hosts.[4]

It remains unclear why an outbreak occurred at this time. Calls to exclude migrants from Australian clinics are frequent, and PNG nationals may be reluctant to attend if not very sick. It is likely that delayed diagnosis and treatment of early cases played a role. Whether there was an increased incidence on the PNG side, due to climatic or other factors, is unknown. Health service breakdowns in PNG were noted by Saibai nurses through radio contact. These may have temporarily increased health-seeking traffic to outer island clinics (Teresa O'Brien, Torres Strait and Northern Peninsula Area Health Service District, personal communication).

Infrequent malaria, and no deaths for many years, breeds complacency in both community and clinics. There was anecdotal evidence that mosquito avoidance behaviour (nets, spraying, cleaning yards) had declined since the old days of endemic malaria. There was clearly poor maintenance of mosquito screens, and no regular mosquito control activities by the council.

Although the standard of health care observed on Saibai was high, the outbreak prompted a search for

clinical problems. For example, some diagnostic and reporting criteria were felt to be poorly defined and requiring review.

Prior to the outbreak, two cases diagnosed in February and classified as 'possibly locally acquired' could have actually been an index local case:

- probable falciparum malaria in a Saibai resident with no history of travel, with onset on 5 February (not reported until 15 April);
- *P. falciparum* notified on 23 February (symptom onset on 18 February) in a PNG national who had been on Saibai for 3–4 four weeks beforehand.

The former tested positive on RDT, but negative on 1 smear. Treatment was commenced, but incorrectly interrupted when the microscopy result was obtained. Gametocytes were reported on smears in the second case, i.e. potentially infective to mosquitoes. It is doubtful whether these were the first local cases, with diagnostic uncertainty in the former, and a possible import in the latter (extended incubation is possible in persons from an endemic area).[14]

Data on malaria incidence in PNG are limited. Only 11% of suspected cases are tested, and 6% of reported cases are confirmed.[15] In recent limited surveys from the South Fly region where the treaty villages are situated, less than 10% prevalence of parasitaemia was reported.[16] It was not possible to check for an increased incidence in the South Fly region during or before the outbreak. Similarly, accurate head counts for travel between PNG and the outer islands are unavailable. Prior to the outbreak there appeared to be increased PNG attendances at the Saibai clinic.[1]

There were seven imported *P. falciparum* notifications in the Torres District in the first 4 months of 2011 (compared with 5 cases or less in the previous 5 years), suggesting a higher incidence. Active case finding may have identified more imports than otherwise, given that semi-immune PNG patients may not be very sick.

In the Torres Strait the main malaria vector is *An. farauti* 1.[17] The behaviour and ecology of this species varies enormously by locality. Research into these factors has not been conducted in the Torres Strait, but it would assist in managing future outbreaks by refining vector control approaches. In northern mainland Australia, *An. farauti* 1 typically feeds from 1900 hours to midnight, both outdoors and indoors.[4] Protective measures such as house screens and bed nets are of some value. Locals typically sit in cool open verandahs in the early evening, probably resulting in a greater risk of transmission. Of particular concern were the unscreened houses in west Saibai used by residents from PNG.

The excellent vector breeding conditions on Saibai make control of overall mosquito numbers impractical. Instead, vector control aims to reduce the longevity of adult females, so few would survive long enough to become infective and bite another person. Early case detection and effective gametocytocidal treatment are essential to prevent infection of local *An. farauti*.

To reduce the risk of further malaria outbreaks, the Incident Management Team has proposed: repair of mosquito screens; revised local malaria guidelines; commenced a study of the behaviour and ecology of *An. farauti* in the Torres Strait; developed local education resources; and reviewed regional vector control capacity and equipment.

Although malaria has been eliminated in northern Australia, this outbreak reminds us that cases are still a risk in the Torres Strait, and throughout the country's 'malaria receptive zone'. Travel from malaria endemic areas to this zone will always carry the potential for importation and local transmission. Mosquito elimination on the islands is not feasible because of their geography. Early diagnosis and treatment of cases, and vector control measures in their vicinity, are critical in preventing local outbreaks. Malaria does not currently pose a great public health threat in northern Australia, although there are occasional outbreaks, even on the mainland. It is however, a potentially lethal disease and timely diagnosis, treatment and public health responses are crucial.

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