This case highlights the difficulty in developing countries in treating TB where resources for identifying MDR cases are limited and treatment regimens are unable to be implemented with susceptible second line drugs given through DOT for 18 to 24 months. It also shows that innovative solutions can potentially be worked out through discussion and communication.

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References


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Imported malaria cases at the Northern Immigration Detention Facility, Berrimah, Northern Territory - Risk assessment and recommendations

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Introduction

There have been no endemic cases of malaria recorded in the Northern Territory (NT) since 1962, and in 1981 the World Health Organisation declared the whole of Australia to be malaria free. Due to favourable environmental conditions and the presence of competent vectors of the disease, the area north of the 19° parallel in the NT is considered to be receptive to the re-introduction of malaria. Small outbreaks involving local transmission have been recorded in Queensland in 1986 and 2002. These illustrate the potential for malaria to be re-introduced into North Australia, and the importance of monitoring all imported malaria cases.

Cases of imported malaria are diagnosed in the NT every year and public health procedures are in place to manage these, including entomological investigations and control protocols. Entomological investigations are usually triggered if a malaria patient has infective stages (gametocytes) of the malaria parasite in the blood. A patient with gametocytes can potentially infect a vector mosquito which, in turn, could potentially transmit the parasite to another person. Entomological investigations involve analysing historical trapping data from any nearby routine adult trap sites, and setting adult traps at the case house and the nearest mosquito harbourage site. These determine the levels of potential malaria vectors present in the area. If high numbers of vectors are detected in
the traps, and the patient has been exposed to mosquito bites, a precautionary fogging operation may be recommended. The aim of the fogging operation is to knock down any adult malaria vectors that may be infective, thereby preventing the development of a local malaria transmission cycle.

**Illegal Foreign Fishers (IFFs) & imported malaria cases in North Australia**

In 2005 the Northern Immigration Detention Facility (NIDF) in Darwin was opened as a facility to accommodate all IFFs apprehended in north Australian waters. Eventually it is anticipated that the facility will house up to 600 people. The NIDF consists of a ‘General Population’ area and a ‘Medical Separation’ area. All IFFs are initially detained in the medical separation area until they have undergone a public health assessment. If they are certified to be ‘fit to travel’ they are transferred into the general population area. However, if they are unwell they are taken immediately to the nearest hospital, or have further medical tests conducted while they remain in the medical separation area of the NIDF.

There are also temporary processing centres in Nhulunbuy, Broome, Weipa and Thursday Island, in which IFFs are detained until they have been medically assessed. When they are passed as ‘fit to travel’ they are transferred, by aircraft, to the general population section of the NIDF in Darwin. If they do not pass health assessment they are treated for their illness at the temporary processing centre or local hospital before travelling to the NIDF.

Current ‘Health Assessment’ procedures for IFFs include answering a ‘TB and General Health Questionnaire’ with the aid of an interpreter followed by clinical screening by a medical officer. The assessment protocols were compiled by the NT Centre for Disease Control (Department of Health and Community Services - DHCS) and are designed to diagnose communicable diseases of public health significance as well as other medical or psychiatric conditions.

Malaria tests are conducted on IFFs who are:
- febrile;
- not febrile but have had recent fevers;
- found to have a history of treated or untreated malaria;
- found on examination to have an enlarged spleen; or are
- identified as a co-traveller of an index case of malaria.

**Figure 1. Malaria case in the NT, including refugee & IFF**

Malaria tests include thick and thin blood films and an antigen test. Until the results of the tests are available, IFFs who do not require hospitalisation must remain in the medical separation area. All IFFs diagnosed with *Plasmodium falciparum* are immediately admitted to hospital for treatment. Those diagnosed with the sexual stage (gametocytes present) of any of the other 3 forms of malaria (*P. vivax*, *P. ovale*, *P. malariae*) are also admitted to hospital. If gametocytes are not present, treatment is still required but the IFF is not hospitalised. These IFFs must remain indoors in screened or air-conditioned accommodation in the medical separation area between 6pm and 8am daily until their treatment is completed.

Since the opening of the NIDF in late 2005 there have been 8 cases of imported malaria detected in IFFs housed within the facility, with 5 of those positive for gametocytes. There has been an increase in the number of IFFs diagnosed and treated for malaria in the NT over the past few years (Figure 1). This is due to 2 main factors; the increasing numbers of illegal foreign fishing vessels (IFFVs) being apprehended in Australian waters, and the development of land-based processing and detention of IFFV crews. Once the NIDF is operating at full capacity the numbers of malaria cases involving IFF in the NT is likely to rise further.
A large proportion of the ‘Other’ malaria cases shown in Figure 1 comprise soldiers based in East Timor and tourists travelling to malarious areas.

**Malaria vectors in the Northern Territory**

There are 5 *Anopheline* species in the NT that have the potential to transmit malaria parasites. These species include *Anopheles farauti* s.l., *Anopheles annulipes*, *Anopheles amictus*, *Anopheles bancrofti* and *Anopheles hilli*. Within this group, *Anopheles farauti* s.s. is considered to be the most competent malaria vector. However, under favourable environmental and seasonal conditions the other species are also potential vectors.

*Anopheles farauti* s.s. is part of a species complex that includes at least 3 morphologically indistinguishable species within the NT. \(^2\) Within this complex, *An. farauti* s.s. (species No.1) can breed in brackish and fresh water, and is considered the most competent malaria vector of the *An. farauti* clade in the NT. \(^2,9,10\) *An. farauti* No. 3 is a freshwater breeder that is common in coastal and sub-coastal areas of the NT, while the less commonly encountered *An. farauti* No. 2 is a freshwater species that has been detected in a restricted range of coastal and inland areas in the NT. \(^5\) The competency of *An. farauti* species No. 2 and No. 3 as malaria vectors is not known.

Historically, *An. farauti* ss. (No. 1) was probably responsible for the malaria outbreaks in the coastal communities of the NT prior to 1962, including outbreaks in the Darwin area. \(^3,7\) Sites that are located near productive breeding sites of the *An. farauti* s.s. are considered to be especially receptive to the re-introduction of malaria.

**Malaria vector surveillance in the NIDF**

A routine adult mosquito monitoring trap was established at the NIDF in April 2006, principally to monitor malaria vector numbers in the area (Figure 2). If Medical Entomology Branch (MEB) is notified of a malaria case at the NIDF in which the patient is infectious and exposed to local mosquito bites, it is important to have a record of the recent abundance levels of malaria vector species in the area. It is also important to have historical trap result records so that the seasonal peak population trends of malaria vector species in the area can be mapped.

Since its inception in April 2006 the trap at the NIDF has detected moderate numbers of *An. farauti* s.l. and other potential vector species. There is another routine adult mosquito trap at the nearby Aviation Museum, 1.5 km to the west of the NIDF (Figure 2). Results from this trap will be useful in supplementing results from the trap at the NIDF. Historically the trap at the Aviation Museum has recorded high numbers of *An. farauti* s.l. during the peak abundance period for this species (March to June) and small to moderate numbers at other times of the year.

**Risk assessment**

**Changes to the apprehension protocols for IFFV crews**

Prior to September 2005, IFFs were detained aboard their vessels at a quarantine mooring point. The mooring points were located 1.5 nautical miles from shore, which effectively isolated the IFFV crews from *Anopheles* mosquito bites. IFFs suffering from fevers or other symptoms were reviewed by a doctor and, if necessary, relocated to Royal Darwin Hospital for treatment, usually during daylight hours. This meant that the chance of an IFF with infectious malaria transmitting the parasite to a local vector mosquito was very small.

After a death onboard an IFFV moored in Darwin harbour, recommendations were made to detain IFFs in land-based detention facilities. \(^8\) Detention of IFFV crews ashore, as compared to 1.5 nm offshore, increases the risk of an infectious IFF transmitting malaria to local mosquito vectors.

**Location of the NIDF**

The NIDF is located within an Australian Defence Force facility on the outskirts of the industrial area of Darwin. The facility is approximately 3km north of Darwin harbour, and 2km north of the tidally influenced Reichardt and Bleeser Creeks. The Mararra round swamp, which is a freshwater swamp at the top of Rapid Creek, is also located approximately 2km north of the facility.
Fig. 2. Potential *Anopheles* breeding sites near the Northern Immigration Detention Centre
Desktop and ground truthing surveys were conducted by MEB to locate potential brackish water and fresh water *Anopheles* breeding sites that are within dispersal distance of the facility. The major potential vector, *An. farauti s.s.*, can disperse up to 3 km and is usually found breeding in *Schoenoplectus* and *Eleocharis* reed swamps and the upper reaches of mangrove creeks that have a freshwater influence. These surveys did identify some potential breeding sites for the species within dispersal distance of the facility, at the top of Blesers Creek and Reichardt Creek (Figure 2). The sites were characterised by depressions within and adjacent to small creek lines draining into the mangroves, and cut-off pools at the interface of mangroves and reed swamps. Vegetation at these sites consisted of dry *Eleocharis* reeds, mangroves and paperbark trees. The depressions were dry at the end of the survey, but would become water filled and brackish during the wet season, and possibly produce large numbers of *An. farauti s.s.* at the end of the wet season.

Other potential breeding sites for freshwater *Anopheles*, such as *An. farauti* No. 3, *An. bancrofti*, *An. annulipes* and *An. amictus*, that were located include: a pandanus and paperbark swamp 1 km south-west of the NIDF; an extensive reed and paperbark swamp 1.5 – 3 km north of the NIDF; and a freshwater lagoon 2.5 km east of the NIDF (Figure 2).

**Malaria screening**

If an IFF has passed the health assessment, but becomes ill or feverish after arriving at the NIDF, he will either be hospitalised or admitted to the medical separation area. If malaria is suspected, blood slides and antigen tests are undertaken and sent to an interstate pathology unit for testing. The results of the blood slides take between 2 and 4 days to be returned, during which time the IFF will remain in the medical separation area. There is a danger that during this period the IFF may develop gametocytes and be exposed to malaria vector mosquitoes, especially after dark and during peak vector abundance periods. This is especially relevant to *P. vivax* malaria, which can develop gametocytes 3 days after symptoms appear.

Depending on the stage of the malaria parasite’s lifecycle, and the level of host natural immunity, an IFF may be infected with malaria, but pass the ‘Health Assessment’ procedures. This is particularly true for IFFs from malarious areas of Indonesia who are likely to have partial immunity to malaria. During the liver stage of the parasitic cycle (exoerythrocytic cycle), malaria can be difficult to diagnose and the patient is usually asymptomatic. In these instances, the parasite may enter the human blood stage (erythrocytic cycle) after an IFF has been transferred to the general population area of NIDF, with a subsequent rapid development of symptoms and gametocytes (48 hours for *P. falciparum* and *P. vivax*). This is especially relevant to some strains of *P. vivax*, which can have a very prolonged liver stage. IFFs in the general population area of the NIDF thus need to be very closely monitored for fevers and other malaria symptoms. If symptomatic persons in the general population area are not expediently identified and admitted to hospital or the medical separation area for tests and treatment, there is a risk that local malaria vector mosquitoes may become infective.

**Adequate personal protection from mosquitoes at the NIDF**

An inspection of the NIDF by MEB staff revealed that the residents at the facility could sometimes be exposed to high levels of biting insect activity. The central recreational area is an open-sided, undercover area with covered walkways radiating to the dining rooms and sleeping quarters. Sleeping quarters in the general population section consist of rows of demountables with 6 rooms in each demountable. The rooms have en suites and air-conditioning. Although they can be sealed against mosquito entry using the sliding glass door and a glass window in the en suite, there are no fly screens on the rooms. The dining room is a large air-conditioned building that is sealed against mosquito entry. The sleeping quarters in the medical separation area are also air conditioned and have en suites. There are no fly screens. Mosquito repellent is made available to the detainees for personal protection if they choose to use it.

Peak *Anopheles* biting periods are usually after sunset. There are a number of potential *Anopheles* breeding sites within dispersal distance of the NIDF, and during peak
abundance periods there are likely to be high levels of potential malaria vector species seeking blood meals in the area of the NIDF. During daylight and after sunset the residents of the facility apparently spend a lot of time in the undercover walkways of the sleeping quarters and in the recreational area. Times spent in the mosquito-proofed sleeping and dining quarters is limited to bed-time and meal times, and many of the residents choose not to sleep with the air-conditioning on, preferring to leave their doors open. Detainees at the NIDF are made vulnerable to mosquito bites by these patterns of activity. While there is some level of personal protection from mosquito bites with clothing, mosquito repellent and some sealed rooms, detainees are still likely to be exposed to mosquito bites after sunset.

**Recommendations**

- It is recommended that the process of testing IFFs for malaria at the NIDF be streamlined as much as possible. Delays in this process can mean that potentially infectious malaria patients may be exposed to malaria vectors, increasing the risk of local malaria transmission.

- The Health Assessment Procedures state that patients in the NIDF medial separation area who are suspected of malaria should be isolated from potential malaria vector mosquito bites between 6pm and 8am. There was no evidence of a screened or air-conditioned area for patients in this area to go outside for cigarettes or other activities at night. It is important that all IFFs detained in the medical separation area who are either suspected of malaria, or have tested positive for malaria but are not infectious, are protected from mosquito bites between 6pm and 8am in the *Anopheles* peak seasonal periods. It is recommended that modifications be made to existing buildings (such as fly screens), or another building erected, so that at-risk patients can be protected from mosquito bites, and still have access to sealed toilets and sleeping areas and a screened outdoor area if they choose to smoke after dark.

- Measures to protect IFFs from mosquito bites during peak periods of vector activity (March to June) should be increased. The provision of personal protection measures, such as mosquito repellents and long loose clothing, during this period is important. Insecticidal barrier treatments should also be considered during periods of malaria vector abundance. Residual barrier treatments can be applied to surrounding mosquito harbourage sites such as vegetation, fences and buildings, to reduce the numbers of adult mosquitoes entering the NIDF. There are a number of residual barrier sprays for controlling adult mosquitoes, and a licensed pest control operator can apply them professionally.

**References**

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