APPENDIX P

Draft Biting Insects Management Plan

PowerWater

Appendix P Draft Biting Insects Management Plan

P.1 Introduction

P.1.1 Background

The purpose of this Biting Insect Management Plan (BIMP) is to minimise the potential for increased biting insect populations both onsite and offsite as a result of construction and ongoing operational activities associated with the Proposed Development, i.e. development of a duplicated effluent rising main from the Ludmilla Waste WWTP to East Point Outfall.

Coastal areas, and especially mangroves, provide attractive habitats for many species of biting insects, such as mosquitoes and biting midges. Construction activities in, or adjacent to tidal areas, can potentially increase the number of biting insect breeding sites (Centre for Disease Control (CDC) 1988).

Mosquitoes are a serious potential public health issue in the Northern Territory (NT), both as pest insects and as vectors of a number of human diseases including the potentially fatal disease Murray Valley encephalitis virus (MVEV) and a number of other diseases, such as Ross River virus (RRV), Barmah Forest virus (BFV), and Kunjin virus (KUNV) (Warchot and Whelan, 2011).

Biting midges can also be a significant nuisance and can cause associated health problems depending on the individual being bitten (Warchot and Whelan, 2011).

It is noted that the East Point and Ludmilla areas are significant breeding sites for mosquitos and midges. The aim of this plan is also to rectify, wherever practical and possible, existing mosquito breeding sites created by previous development at the site. Rectification of existing mosquito breeding sites will be of benefit to workers, residents and visitors to East Point and Ludmilla, by reducing pest problems and the risk of mosquito borne disease transmission. Any proposed rectifications works will be undertaken in consultation with the Medical Entomology Branch of the NT Department of Health.

Mosquitoes

Ground depressions can breed mosquitoes during the wet season if water is allowed to pond and stagnate within them. Almost all of the mosquito breeding sites in the East Point area are manmade. These include:

- Depressions associated with landscaping (filling, revegetation and associated mulching), vehicle activity, and storage of mulch around East Point.
- Poor profiling of land surrounding Lake Alexander during landscaping of the lake surrounds.
- The old East Point golf course.

The Medical Entomology Branch of the Northern Territory Department of Health conducts a biting insect control program targeting high risk locations at East Point and Ludmilla because of the known potential for biting insect problems in the area. The routine biting insect control sites in the vicinity of the WWTP are shown in **Figure Appendix P-1**.

Biting Midges

Mangrove biting midges (*Culicoides ornatus*) are also known to be present at East Point. *Culicoides ornatus* is considered the most significant human pest biting midge species around coastal areas of the NT (Shivas, 1999; Shivas & Whelan, 2001), and is also the most common biting midge pest around coastal areas of the NT (Whelan, 2003).

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The mangrove biting midge breeds in mud adjacent to and under dense mangrove canopies. Their breeding sites are located in the region between the mean high water spring tide mark to below the level of occurrence of seaward mangroves (Shivas and Whelan, 2001). Key midge breeding sites include the upper tidal tributaries of mangrove creeks associated with pneumatophores of mangroves, with highest productivity during the mid to late dry season (Shivas, 1999). Other breeding sites include the front edge of the mangrove forest facing open water. These breeding sites are usually associated with mud substrates (Shivas, 1999).

P.2 Potential Human Health Impacts

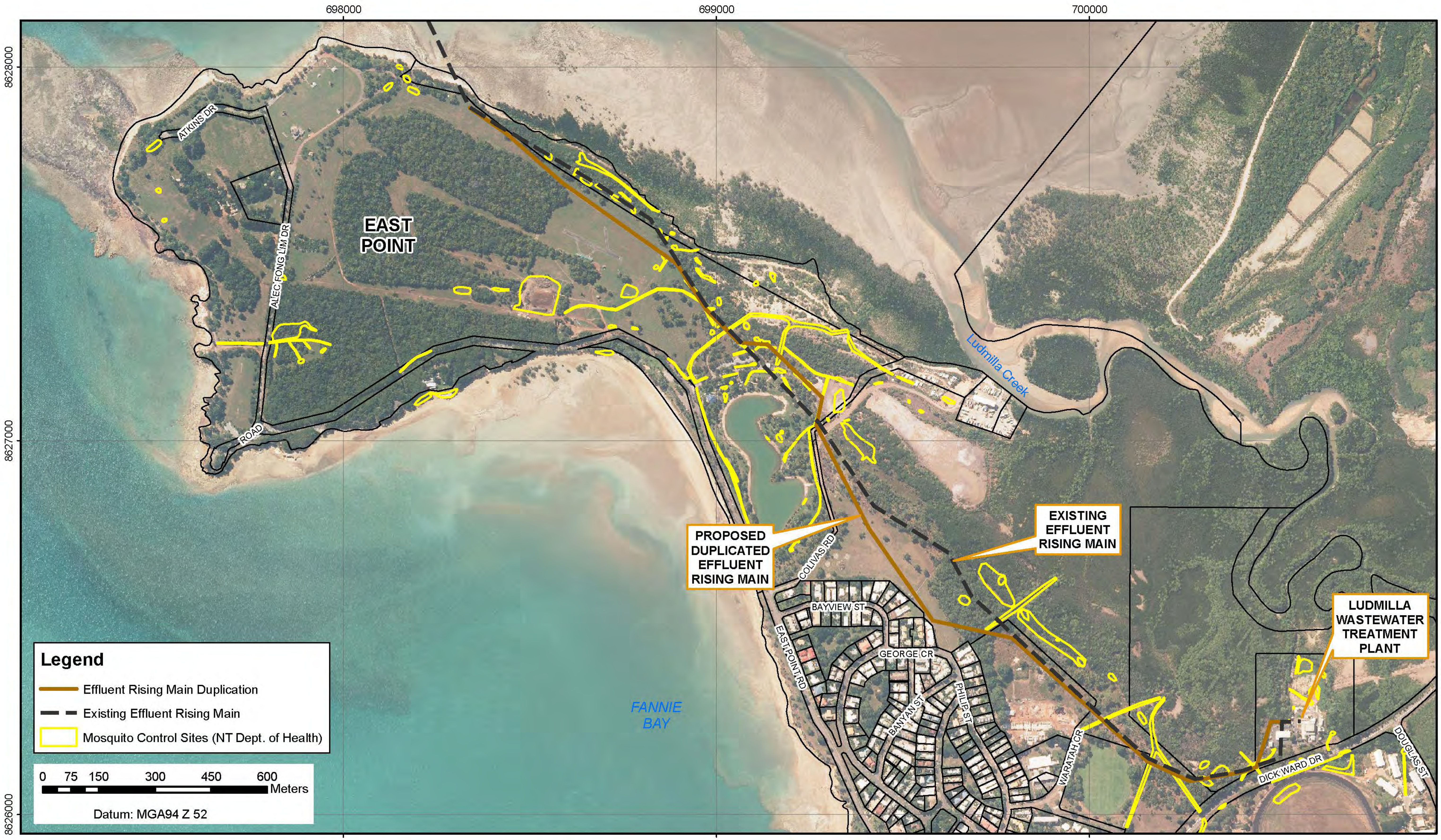
P.2.1 Mosquito Borne Disease

Biting insects have the potential to affect the health of workers and members of the public through the transmission of mosquito borne diseases or reactions to bites. The characteristics and risk of transmission of mosquito borne diseases identified in recent studies are summarised in **Table Appendix P-1** (DLP, 2011)**.**

P.2.2 Mangrove Midge Bites

Culicoides species bites can be a significant nuisance and can cause associated health problems. The bites are painful and large numbers of bites can cause a generalised reaction in non-immune people. Many people, particularly newly arrived or newly exposed people, suffer from bite reactions that can lead to intense itching, scratching, skin lesions, secondary infection and scarring (Warchot and Whelan, 2011).

The number of bites by *Culicoides* species that will constitute a human pest problem will largely depend on the individual being bitten. It has been suggested that over 60 bites per hour for workers regularly exposed to biting midge bites is unacceptable (Whelan et Al, 1997). For people unaccustomed to biting midge bites, one to five bites per hour may be unbearable (Warchot and Whelan, 2011). The amount of bites a person receives will be dependent on the amount of skin exposed and length of time spent outdoor in midge prone areas (Warchot and Whelan, 2011).



PowerWater

LOCATION OF
MOSQUITO CONTROL SITES

Figure Appendix P-1 Potential Biting Insect Breeding Areas

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Table Appendix P-1 Characteristics and risk of transmission of mosquito borne diseases (Source: DLP 2011)

Mosquito Borne Disease	Description and Risk of Transmission
Ross River virus (RRV) disease Symptoms can be debilitating and include joint pain, fever, lethargy, rash, headache and swollen glands, and can last for up to 12 months in some cases, although generally most people will have a severe illness from two weeks to three months (Whelan, 2003).	Most common arboviral disease in Australia and the NT (Russell and Kay, 2004; Whelan et al, 2008). The principal vectors *Aedes vigilax* and *Culex annulirostris* have been recorded in appreciable numbers at East Point / Ludmilla. Based on the likely abundance of the vector mosquitoes at East Point, *Ae. vigilax* will pose a very high risk of transmission in December and January. This species may also pose an appreciable risk in other months such as October and November depending on seasonal rainfall, or high tides. *Cx. annulirostris* will pose a moderate to very high risk during the wet season months of January to April.
Barmah Forest virus (BFV) Symptoms are similar to RRV, but are generally milder and BFV is not as common as RRV (CDC, 2009).	The principal potential vectors recorded at East Point / Ludmilla were *Ae. Vigilax* and *Cx. annulirostris*. Main risk months for BFV transmission are the months of October to July, with a peak in January to March, although transmission can occur during all months (Whelan, 1997b). The risk for BFV transmission will be similar to the RRV transmission risk.
Murray Valley encephalitis virus (MVEV) MVEV can cause a potentially fatal inflammation of the brain tissue. Symptoms include high fever, severe headache, seizures or fits (especially in young children), neck stiffness, drowsiness, confusion and progression to delirium and coma in severe cases (Whelan, 2004a).	The principal potential vector of MVEV was *Cx. annulirostris*. Main risk months for MVEV transmission are January to July with a peak in March to May (Whelan, 1997). Only 1 in around 1000 people bitten by an infected mosquito is likely to develop disease symptoms, therefore the risk of contracting this disease is much lower compared to RRV and BFV.
Kunjin virus (KUNV) KUNV can potentially cause a fatal inflammation of the brain, but is much rarer than with MVE disease. KUNV typically causes a milder syndrome of severe headaches and fever and has not been responsible for fatalities in the NT (Russell and Kay, 2004).	KUNV risk is considered to be similar to the MVEV risk. The principal potential vector of KUNV is the same as for MVEV, *Cx. annulirostris* (NSW Health, 2011).

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Mosquito Borne Disease	Description and Risk of Transmission
Malaria Endemic malaria is no longer present in the NT, but there is always a risk of limited local transmission from people returning from overseas countries with malaria. It is highly unlikely that local malaria transmission will occur in the proposed development area, as long as prevention measures remain in place and new Anopheles breeding sites are not created by development.	*Anopheles farauti ss*. is regarded as the principal potential vector in the Northern Territory (Whelan, 1995). *An. annulipes s.l*., *An. hilli, An. bancroftii* and *An. amictus* are also potential vectors. *An. farauti s.l.* and *An. hilli* can be seasonally present in relatively high numbers in the Darwin area, so these species probably pose the greatest risk in the Darwin area. Malaria transmission is more likely to occur if relatively high numbers of female Anopheles mosquitoes have bitten the malarious person, a high degree of personal exposure occurs, and there is a lack of effective vector control operations by health authorities. All of these factors are rarely present together in Darwin, and the likely low Anopheles mosquito abundance in most areas of East Arm indicates malaria transmission is potentially very unlikely. In Australia, malaria is a notifiable disease. Each imported case in the NT is assessed and treated by a health professional, and monitored by Medical Entomology for the potential to cause local malaria transmission.

(Adapted from: Warchot and Whelan, 2011)

P.3 Regulation

Legislation applicable to biting insect management at the Ludmilla WWTP includes:

- *Public Health Act 1952 (NT)*.
- *Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations 2007* (NT).
- *Workplace Health and Safety Act 2009* (NT).

Biting insect management at the Ludmilla WWTP will also be undertaken with regard to the *World Health Organisation* (WHO) *International Health Regulations 2005* (WHO, 2005).

The Medical Entomology division of the Department of Health has produced guidelines to manage and mitigate biting insect impacts during the planning and construction phases of developments in areas that are potentially productive mosquito breeding sites. These include:

- *Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the NT* (Medical Entomology 2009) (refer **Appendix P – Attachment A**).
- *Guidelines for preventing mosquito breeding* associated with *construction practice near tidal areas in the NT* (CDC 1988) (refer **Appendix P – Attachment B**).

Construction, development and maintenance of LWWTP will be undertaken in accordance with these guidelines.

All site staff, contractors and visitors must review the following documents, which provide guidance on personal protection from biting insect impacts, and act in accordance with aspects relevant to site activities:

- *Biting midges or sandflies in the Northern Territory* (Whelan, 2003) (refer **Appendix P – Attachment C**).
- *Personal protection from mosquitoes and biting midges in the Northern Territory* (Whelan, 2004b) (refer **Appendix P – Attachment D**).

P.4 Biting Insect Management Objectives

The biting insect management objectives for the Ludmilla WWTP are as follows:

- Prevent increases in the number of mosquito breeding sites.
- Prevent the transmission of mosquito-borne diseases arising from biting insect populations.
- Prevent increases in biting insect populations.
- To rectify (wherever possible and practical) existing mosquito breeding sites created by previous development at the site.

P.5 Management of Biting Insect Impacts

P.5.1 Potential Impact on Habitats

Mosquitos

Mosquitoes will breed in very high numbers in disturbed upper tidal areas, including areas where there is embankment of tidal water. Construction in tidal areas, or on sites with some saline soil, generally has the most potential to create productive mosquito breeding sites. Inappropriate site clearing and grading adjacent to tidal areas is therefore likely to create mosquito problems. All construction activities in tidal areas should be carefully considered in the planning stage, and any previous or resultant disturbed areas should be appropriately rehabilitated upon completion of development (Warchot and Whelan, 2011).

Proposed construction activities could potentially rectify existing mosquito breeding sites. Rectification of existing mosquito breeding sites will be of benefit to workers, residents and visitors to East Point / Ludmilla, by reducing pest problems and the risk of mosquito borne disease transmission. Wherever possible and practical rectification works will be incorporated into construction activities.

Midges

The only way to effectively reduce *C. ornatus* breeding would be to permanently flood or fill their breeding sites, from the mean high water spring tide mark to below the level of occurrence of seaward mangrove (Shivas and Whelan, 2001). As this is not possible, management of impacts associated with biting midges will focus on control and personal protection measures.

P.5.2 Management Measures

Mosquitoes

Mosquito impact management considerations are presented in **Table Appendix P-2.**

Biting Midges

As there is no specific midge larva control method that is considered to be appropriate for the site, management measures will focus on reducing midge bites through personal protection measures or treatment of areas with a suitable residual barrier insecticide such as bifenthrin and alpha-cypermethrin. It is noted that insecticide control options will only be considered in consultation with the Medical Entomology Branch of the NT Department of Health and with due consideration of their existing routine biting insect control programs (Warchot and Whelan, 2011).

Avoiding exposure to biting midges during peak monthly abundance around sunset and sunrise is the best form of personal protection. Other measures include the use of personal repellents and protective clothing such as long trousers, socks and shoes, and long sleeve shirts. Yellow or red lights can be used in outdoor areas to minimise attracting biting midges (Warchot and Whelan, 2011).

Extensive information on midge avoidance and personal protection can be found in '*Biting midges or sandflies in the Northern Territory*' (Whelan, 2003) (refer **Appendix P – Attachment C**) and 'Personal protection from mosquitoes and biting midges in the Northern Territory' (Whelan, 2004b) (refer **Appendix P – Attachment D**).

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Table Appendix P-2 Mosquito management considerations for construction and operation of the Ludmilla WWTP (Source: DLP, 2011)

Site Personnel
• Staff, contractors, and site visitors will be made aware of the potential risk of mosquito borne diseases and the high risk periods (late dry to wet season). • Staff, contractors, and site visitors will be advised to wear long sleeved shirts and trousers, avoid going outside at sunset, and to use insect repellent. Insect repellent will be provided at work sites. • Staff and Contractors will be educated about the early symptoms associated with exposure to mosquito–borne arbovirus and will be instructed on the need to report any symptoms to a Medical Officer.
Stormwater
• Stormwater drainage will be constructed in accordance with the '*Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the Northern Territory*' (Medical Entomology, 2009a) (Appendix A). • Any new major open stormwater drains should have concrete low flow inverts, while roadside drains, swales and other minor drains should have concrete low flow inverts when the fall of the drain would not be enough to prevent ponding. • All roadside drains and swales should discharge to a suitable stormwater drainage system, or directly to Ludmilla Creek or the sea. Major open drains should have concrete low flow inverts to the mangrove margin, and a free draining channel below the mangrove margin. • No stormwater sumps should be installed in any roadside or local area drainage within the development site. Gross Pollutant Traps, Side Entry Pits, Letterbox Pits and any other stormwater pit should be free draining to prevent the creation of potential breeding sites for mosquitoes. • All drains should be placed on an annual inspection and maintenance program.
Culverts
• Culverts for roads and associated drainage should always be installed flush with the upstream invert of the creekline / flowline, to prevent the upstream impoundment of water and subsequent mosquito breeding. If culverts are installed higher than the upstream surface level to allow for future reclaiming, then there should be appropriately sized drainage provisions provided to prevent upstream water ponding until the area is reclaimed. • Culverts should be installed with a slight 'V' invert to match the invert of any upstream and downstream drains, to prevent water ponding and minimise silt deposition in the culvert. Upstream and downstream open drains should also have V inverts.
Reclamation / Construction
• Any cut off tidal area created during construction should have appropriate temporary drainage provisions provided, to prevent upstream ponding until the upstream area is reclaimed. • All new reclaimed areas should have a suitable surface profile to prevent ponding on the filled surface. • Scrapes, and other disturbed areas should be rehabilitated to be free draining. • Site disturbance such as wheel ruts and compacted ground should be rectified upon completion of construction, to prevent these areas from becoming perennial mosquito breeding sites. • All earthworks will be scheduled during the dry season.
Ongoing Management
• Unwanted artificial receptacles and rubbish items will be removed annually. Building material and other material that could potentially pond water will be stored under cover, or in a manner that prevents ponding and receptacle mosquito breeding. Rainwater tanks and other storage tanks will be appropriately screened to prevent mosquito access. • Ongoing maintenance of stormwater drains and rectification of depressions on site will be undertaken by Power and Water Corporation (PWC).

(Adapted from: Warchot and Whelan, 2011)

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P.6 Administration

P.6.1 Key Performance Indicators

Key performance indicators for the management of biting insects at Ludmilla WWTP are:

- No increase in the area of mosquito breeding habitat.
- No complaints from workers and the general community in relation to biting insects.

P.6.2 Roles and Responsibilities

Implementation of this BIMP is the responsibility of the nominated Ludmilla WWTP Environment Management Representative (EMR). The EMR will ensure that all site staff, contractors and visitors are inducted into this BIMP prior to the commencement of site activities.

All construction, operations, and maintenance contractors must operate in accordance with this BIMP. All contractor environment management plans (EMPs) must be compliant with this BIMP.

Once inducted into this BIMP, personal biting insect protection is the responsibility of all site staff, contractors and visitors.

Appropriate personal protection equipment (PPE) will be made available in accordance with guidelines developed by the Medical Entomology Branch of the NT Department of Health. Provision of PPE is the responsibility of the nominated site occupational health and safety representative.

P.6.3 Monitoring and Reporting

The EMR will be responsible for:

- Identifying wet season ponding areas for rectification, and maintaining stormwater drains and sediment ponds to prevent mosquito breeding.
- Regular inspection of rainwater tanks and other locations for unwanted artificial receptacles that could act as breeding sites for exotic dengue carrying mosquitoes.

P.6.4 Observations, Complaints and Corrective Actions

Observations, non-conformances and complaints relating to biting insects will be recorded and actioned (as required) by the EMR. The following will require corrective action to comply with the BIMP:

- Creation of mosquito breeding sites during construction (expansion) and operation of the the LWWTP.
- Reporting of significant incidences of mosquito or biting midge bites.
- Confirmed infection of mosquito-borne diseases.

P.6.5 Records and Registers

The following records and registers that pertain to this BIMP will be maintained:

- Environmental incidents and complaints reports.
- Site inspections records.
- Stormwater drain inspection and maintenance records.
- BIMP inductions records.

Maintenance of records is the responsibility of the EMR.

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P.7 Administration

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Whelan, P.I. (2004b) *Personal protection from mosquitoes and biting midges in the Northern Territory.* Medical Entomology, Northern Territory Department of Health and Families.

Whelan, P. I., Hayes, G. and Montgomery, B. L. (1997) Biting midge surveillance in Darwin Harbour, *Culicoides ornatus* (Diptera:Ceratopogonidae) abundance and dispersal. In *Arbovirus Research in Australia*, vol. 7, Proceedings of the Seventh Arbovirus Research in Australia, and Second Mosquito Control Association of Australia Conference, pp. 326-336.

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WHO, (2005) *International Health Regulations - 2nd Edition*.

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Attachment A: Guidelines for preventing biting insect problems for urban residential developments or subdivisions in the Top End of the NT

Guidelines for Preventing Biting Insect Problems for Urban Residential Developments or Subdivisions in the Top End of the NT

Medical Entomology
Centre for Disease Control
Department of Health and Families
Northern Territory Government
Darwin NT

April 1997
Updated 2009

Guidelines for Preventing Mosquito Problems for Urban Residential Developments and Subdivisions in the Top End of the NT

Peter Whelan

Minimal Requirements

A contour map showing the Q100 line and/or seepage areas and maximum tidal limit is the minimal requirement for informed comment to planning applications. Contour intervals of 1m between maximum tide limit and 5m above maximum tide limit are required near tidal areas and at least 2m contours are required for other areas, and particularly around wetlands and seepage areas.

All of each block must be above the Q100, seepage line, or maximum tide limit.

Buffer Zones

There should be a buffer zone between urban residential development and significant sources of biting insects.

There should be no urban residential development within 1.6km of large uncontrolled areas of mosquito and biting midge breeding sites, unless specific medical entomology investigations are carried out. The major potential mosquito breeding areas are tidally influenced and seasonally inundated brackish reed swamps or flood plains, and relatively large areas of mangroves that are only flooded by the highest tides of the year. The major biting midge breeding sites are relatively large areas of dendritic mangroves.

Wherever practicable, a semi-rural or rural subdivision should be incorporated into a residential subdivision design to increase the effectiveness of a mosquito or biting midge buffer zone, Incorporating a rural residential or industrial buffer, between major sources of biting insects and the urban component of a subdivision, will generally allow the 1.6km buffer to be relaxed to 1km.

Lot sizes for those rural blocks located entirely within 500m of significant biting insect breeding sites must be 2ha or greater. Rural lots that will only have some portion of land located within 500m of significant biting insect breeding sites must be 1ha or greater, while rural lots located further than 500m from significant biting insect breeding sites must be 0.4ha or greater.

There should be no residential development within 1.6km of actual or planned soil, sand or gravel mining operations or mining leases unless such areas have been rehabilitated to the stage where they are not potential mosquito breeding sites.

There should be no urban development within 1.6km of sewage treatment plants and sites of effluent disposal, unless the facilities have been designed or with documented management plans such that they are not likely to be potential sources of mosquitoes.

Drains

A standard for drains is required for all urban residential development, which includes particular attention to the design and construction of the drains and the location of end points of such drains to prevent mosquito breeding.

Concrete sub soil drains, or open drains with concrete low flow capabilities are required for all urban residential drains and drains from urban facilities that are likely to have dry season low flows. These drains must be conveyed to a suitable end point that will not become a mosquito breeding site. Suitable end points are usually large rivers or daily flushed tidal areas. Guidelines on storm drains are attached as Appendix 1. Sub-soil drainage systems must be entirely free draining. i.e. the invert of all stormwater pits (eg side entry pits, grate pits, letterbox pits etc) must be level with the invert of the outlet pipe. Structures such as Gross Pollutant Traps must not pond water or lead to impeded flow in the sub-soil pipe system.

Stormwater drains may be required to cross adjacent properties to reach a satisfactory end point such as a daily flushed tidal area. Urban stormwater drains must not terminate at the development boundary. When stormwater drains are required to pass through neighbouring properties, the relevant landholder should be consulted and a drainage easement declared on the neighbouring property, to allow the owner of the stormwater drain to conduct annual maintenance.

Water features (dams, ponds, retention basins, detention basins etc)

Dams, ponds, retention basins or other constructed water features within or adjacent to a urban development should be constructed with steep sides (45° or greater) and be relatively deep (1.8m) to prevent the establishment of marginal semi-aquatic vegetation that promotes mosquito breeding. Management procedures for wetlands or water features should be in place to monitor and control mosquito breeding. This can include stocking ponds with native fish such as the delicate blue eye or black lined rainbow fish, and mechanical or weedicide methods to reduce marginal vegetation.

If water sensitive urban design principles are applied to urban development, they must be in accordance to the Medical Entomology guideline 'Constructed Wetlands for Water Sensitive Urban Design- Guidelines to Prevent Mosquito Breeding'.

Detention basins should be constructed as 'dry' basins, with the basin designed to completely drain within at least 5 days of initial water ponding. Detention basins are not recommended in or adjacent to tidal areas, as they will have the high potential to breed mosquitoes.

Access provisions should be provided for all water features within or adjacent to a residential development, to allow machinery access to conduct routine maintenance such as desilting. Overflow provisions will be required for all water features, with an appropriate end point chosen for overflow water and erosion prevention structures constructed at the overflow/discharge point. Water features will need to be placed on an annual maintenance program, to be conducted by the relevant authority.

Easements

Any open unlined stormwater drains in a residential area should have drainage easements to allow periodic maintenance of such drains and be included in a register for maintenance and possible future upgrading when required by the relevant authority.

Drainage reserves or easements should be declared over permanent and semi-permanent swamps, lagoons, creek lines, or other wet season inundated areas within or adjacent to the development.

Drainage easements should be declared between water features that will be connected during the wet season, to prevent the impedance of water along natural flow lines within or adjacent to the development.

Any subdivision bordering freshwater swamp lagoons and other wetlands, waterways and tidal or tidally affected areas should maintain a 40m easement between residential boundaries and the Q100 or highest tide levels so that access is possible for the management of such areas and to minimise disturbance that would create new mosquito sites.

Site Planning

The natural flow of surface water must not be impeded by site development (eg. construction of access roads). Access roads may need to be fitted with culverts of sufficient size to prevent upstream flooding for periods that will enable mosquito breeding.

Any existing artificial depressions within the proposed development, or within 1km of the development boundary, that are capable of holding water for a period greater than 5 days must be rectified by filling or rendered free draining.

Any areas of intensive irrigation (eg. horticulture, landscaped areas, playing field or open spaces) within subdivisions or adjacent to the subdivisions must not create areas where water can pool for a period greater than 5 days.

Erosion and Sediment control

Urban subdivisions will require sediment control during the construction phase, due to the clearing of vegetation increasing the suceptivity of the development area to erosion. Sediment control is required to prevent the siltation of natural drainage lines, flow paths, open drains (including end points) and underground stormwater systems, which can lead to impeded drainage and mosquito breeding.

Although most temporary sediment control structures are removed once development has been completed, they can be short term mosquito breeding sites. Where possible, all sediment control devices should be designed to drain completely within 5 days. Adjacent to tidal areas, water retention should not exceed 3 consecutive days. This is required to prevent mosquito larvae from completing their larval stages.

There may be instances when temporary sediment control structures (eg. silt traps) cannot be designed to drain freely within the specified time to prevent mosquito breeding. For development sites away from tidal areas, mosquito breeding can be prevented by constructing sediment control structures with steep sides (2:1 slope), with a sloping floor towards the downstream side of the sediment control structure, and appropriate erosion control structures constructed at the overflow/discharge point. Regular inspections should be conducted to ensure the sediment control structure remains free of vegetation that can encourage mosquito breeding. Water retention adjacent to tidal areas should be avoided, otherwise weekly surveys by the developer will be required to monitor and control mosquito breeding.

Erosion prevention structures should be constructed where appropriate (eg. on the down stream side of culverts, dam spill ways, along storm water drains and at drain end points) to prevent erosion and siltation of water features that will promote the creation of mosquito breeding sites. Erosion prevention structures should also be constructed at the headwalls of culverts, and bends and significant water entry points in storm water drains.

Septic Tanks, Sewage Treatment and Dispersal

Department of Health and Families (DHF) has certain requirements for the positioning, installation and maintenance of septic tanks, rainwater tanks and the reuse of sewage effluent.

Any septic tank and absorption trench should be sited on the area above the Q100 and not within 40m of the maximum tide limit. Septic tanks must be of an approved design and be completely screened to prevent mosquito entry. All septic tanks approved within urban areas should be entered on a registry for periodic inspection.

All rainwater tanks must be of an approved design and be completely screened to prevent mosquito entry. All approvals for rainwater tanks should be entered on a registry so that periodic inspection can be made.

Guidelines on the requirements for the treatment, storage and disposal of sewage effluent are attached as Appendix 2, with additional requirements available from the DHF Environmental Health Directorate, Health House Darwin (*Policy for the Design of Off Site Sewerage Ponds and the Disposal or Reuse of Sewerage Pond Effluent*).

General Information

Advice on the potential biting insect problems for residential development should be sought from the DHF at the initial subdivision application stage.

Detailed comments on areas for urban development should be sought at the detailed design stage and at least 12 months before the construction stage.

The DHF's Medical Entomology is available for advice on what may constitute a potentially significant biting insect breeding site. In some instances a desktop examination of the plans and topographic information by Medical Entomology may be sufficient to ascertain the necessary information for recommendations on a specific site, but in other instances brief site inspections or longer term studies may be necessary. In some instances where detailed entomological investigations are necessary, up to 12 months entomological monitoring may be required to gather sufficient information before the detailed planning stage, particularly in areas near potential biting insect sources or if reduction in the recommended buffer distance is sought. This service would be provided on a user pays basis.

For significant urban developments, it may be necessary for the developer to engage a consultant to document and advise on rectification of the biting insect problems, with the consultant liaising with Medical Entomology DHF.

Relevant documents on the various aspects regarding mosquito or biting midges are available from:-

Medical Entomology,

Department of Health and Families

PO Box 40596

Casuarina NT 0811

Phone: (08) 8922 8901

Appendix 1

Northern Territory Government

DEPARTMENT OF **HEALTH AND FAMILIES**

Guidelines on urban mosquito control drains

Medical Entomology

Centre for Disease Control

Department of Health and Families

Northern Territory Government

GUIDELINES ON URBAN MOSQUITO CONTROL DRAINS

1. Drains for mosquito control only need to be of dimensions that will drain an actual or potential flooded mosquito breeding site over a period of days, ie. the drain should be as small as possible to achieve the desired aim.

2. Drainage times for flooded areas that come under tidal influence at any time of the year should be three (3) days, while all freshwater areas should drain within five (5) days. If a drain overflows its banks during periods of high tides or heavy rainfall, the overflow water should drain back into the drain within the above times. When drains are constructed in low lying or level areas, any berm of spoil should have regular breaks to allow lateral drainage into the drain such that no pooling occurs outside the drain. In other situations the berm should be placed on the downhill side of the drain to prevent ponding uphill of the berm.

3. End points for drains that have a potential to breed mosquitoes should be such that the drains discharge directly into daily flushed tidal areas, to a formalised channel or creek that drains directly into a daily flushed tidal area, or a large body of water, without flowing through or into any low lying areas of restricted flow.

4. The ultimate standards for urban drains are impervious underground pipes or open lined channels with central low flow inserts. Central impervious low flow capabilities are essential where there is a likelihood of dry season low flows in a particular drain.

5. Earth sided drains that do not have dry season low flows should be formalised, straight, smooth, have broad U shaped inverts where practical and flow direct to suitable end points. Maintenance easements should be included alongside all open earth lined drains.

6. The end point for 100 year flood drains without dry season low flows that flow into tidal areas should be constructed to just below the maximum high tide level or to the fringe of the mangroves, whichever is lower.

7. There should be no vegetation, cut off pools or silt deposits in drains. Drain maintenance such as silt removal, weediciding or vegetation and debris removal for earth lined drains should be programmed on an annual basis. Drains that discharge into dams or lakes will require periodic silt removal at the discharge point into the water body to prevent the establishment of aquatic and semi aquatic vegetation.

8. The invert of the end point of drains that require concrete inverts or have dry season low flows should be below the average high tide level or to a natural well defined tidal creek. A channel could be dug back from a tidal creek to satisfy this requirement. As a guide for Darwin Harbour, the end points of the invert of low flows into tidal areas should be one metre below maximum high tide (at the 7.0 m ACD (3.0 m AHD) level).

9. Open earth lined drains should have erosion prevention drop structures of stone and mesh gabions installed wherever there is a likelihood of erosion within the drain.

10. Silt traps should be constructed in major drains from urban or industrial development areas before the drains enter freshwater or tidal creek lines. This is considered necessary before a new area is developed, particularly if the constructed drainage discharges into relatively wide level areas or to a creek or other water body. Any silt trap should have access for regular maintenance and silt removal.

11. Any land clearing operation should include the rectification of small depressions, particularly in low lying areas or near creek lines, such that no pooling will remain for more than five (5) days after flooding or rain.

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Appendix 2

Northern Territory Government

DEPARTMENT OF **HEALTH AND FAMILIES**

Mosquito breeding and sewage pond treatment in the Northern Territory

Medical Entomology
Centre for Disease Control
Department of Health and Families
Northern Territory Government
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MOSQUITO BREEDING
AND SEWAGE POND TREATMENT
IN THE NORTHERN TERRITORY

SUMMARY

The majority of effluent treatment in the NT occurs in sewage pond facilities. These sewage treatment facilities can be major sources of pest and vector mosquitoes near urban centres in the Northern Territory. Mosquito breeding is usually associated with inadequate design, operation, maintenance and final effluent disposal practices. This paper outlines the potential problems, gives some examples from previous or present treatment installations and suggests design and operational practices that can reduce mosquito breeding.

INTRODUCTION

Sewage and treated sewage effluent have been major artificial sources of mosquitoes near urban areas in the Northern Territory (Whelan, 1981, 1984, 1988). Nutrient rich sewage has the capacity to produce enormous numbers of mosquitoes, and as treatment facilities are relatively close to communities, they usually give rise to large and continuous problems from pest and vector mosquitoes.

Mosquito breeding is usually associated with inadequate design, operation and maintenance or faulty methods of effluent disposal or dispersal. Some of these practices can be relatively easily rectified, but there is a need for increased awareness of the nature of potential breeding places among planners, designers and operators of sewage treatment facilities.

The object of this paper is to emphasise the need for awareness of potential mosquito breeding in sewage facilities, and to outline some design considerations and operational practices that can reduce mosquito breeding.

MOSQUITO SPECIES

Culex gelidus**:** ‘The frosty mosquito’. This previously exotic mosquito species was first recorded in the NT sometime around 1996 (Whelan et al 2001), and has been in Australian since at least 1994 (Johnson et al 2006). It has been found breeding in high concentrations in primary, secondary and evaporation waste water ponds in the Top End of the NT, and in other high nutrient water bodies. This species also utilises many other habitats such as stormwater drains, artificial receptacles, septic tanks, and freshwater swamps with emergent vegetation (Johnson et al 2006).

Culex gelidus is a primary vector of Japanese encephalitis virus (JEV) in many parts of Asia (Williams et al 2005), and its introduction into Australia has been a concern. Recent testing of the vector competence of this species indicates it is highly susceptible to Murray Valley encephalitis virus, Kunjin virus and Ross River virus infection, indicating this species poses a potentially significant public health concern (Johnson et al 2006).

Culex quinquefasciatus: 'The brown house mosquito'. This species usually breeds in organically polluted water near human communities. It is frequently found breeding in high numbers in unsealed septic tanks and primary sewage ponds, although it will sometimes be found in organically overloaded secondary sewage ponds.

This is a very important pest species wherever favourable breeding sites exist. The females rarely travel more than two kilometres from their breeding sites. Due to the nature of the breeding sites, this species can be present throughout the year. *Culex quinquefasciatus* is a potential vector of arboviruses including West Nile virus, and is a possible vector of heartworm in dogs.

Culex annulirostris: 'The common banded mosquito', is the most common mosquito in the Northern Territory. It breeds in a variety of natural sites and is commonly found in open, shallow, vegetated freshwater swamps, streams and lagoons.

The most prolific artificial breeding places are in secondary sewage treatment and evaporation ponds and sewage pond effluent (Whelan, 1984, 1988). The larvae are most frequently found in still, sheltered areas where vegetation offers protection from disruptive wave action and aquatic predators.

This species can disperse up to 10 kilometres from the breeding area (Russell, 1986). It is abundant in the 'Top End' of the Northern Territory from January to August and in the southern region from October to April.

Culex annulirostris is the most numerous and common pest species in the Northern Territory, and is an important vector of a number of arboviruses (Russell, 2009). The most important disease carried by this species is the potentially fatal Murray Valley encephalitis. There have been confirmed cases of Murray Valley encephalitis in the Northern Territory, at an average of around one (1) case per year, and Murray Valley encephalitis virus (MVEV) is considered endemic to the Top End of the NT as far south as Tennant Creek (Kurucz et al 2005). *Culex annulirostris* also a vector of Kunjin virus (KUNV) disease, Ross River virus (RRV) disease and Barmah Forest virus (BFV) disease. Ross River virus disease is the most common and widespread mosquito borne disease in the Northern Territory. The most effective long term protection from these viruses lies in eliminating the breeding sites within flight range of urban areas.

***Anopheles annulipes s.l.**: 'The freshwater malaria mosquito' breeds in open, sunlit, temporary and permanent freshwater ground pools, streams or swamps. It is very rarely found in sewage ponds but it is frequently found in the lower organically loaded sewage effluent, particularly where the effluent flows into shallow, densely grassed areas.

The females can disperse up to two kilometres from their breeding places. The species is a potential vector of malaria where sufficient numbers occurs, and is a significant pest species in inland areas where suitable breeding sites exist.

DESIGN CONSIDERATIONS FOR EFFLUENT POND TREATMENT FACILITIES

Site Selection and Design

Disposal of Effluent

Appropriate planning for the final disposal is an important part of site selection. Disposal near the coast is relatively easy, but in inland areas can lead to major problems if appropriate disposal techniques are not used. These are discussed later.

Wind

Ideally ponds should be located in open windy areas since wind and the associated waves play an important part in preventing breeding by disrupting the larvae and pupae at the water surface. Also, wind action can restrict the growth of algae, aquatic floating ferns (*Azolla* sp.) and duck weed (*Lemna* sp.). These floating plants can shelter the larvae from both wave action and aquatic predators, unless they form a complete cover of a pond.

An example of bad siting was at Snake Bay, Melville Island, where small ponds with steep banks were protected from the wind by both a hill and a close, tall eucalypt forest. Colonisation of corner sections by duck weed (*Lemna* sp.) enabled *Cx. annulirostris* to breed in relatively large numbers.

Drainage

The choice of a site should consider the necessity to drain the ponds for maintenance without thereby creating swamps or pools of stagnant water. Effluent release from the final pond has usually been incorporated into design, but provision for emptying the intermediate ponds into suitable areas has often been overlooked.

Site design should ensure that there is no prevention of near site drainage pathways caused by any of the works. New diversionary drains should be constructed with erosion prevention principles to ensure there is no overland flow of surface water to the ponds or the disposal areas. Diversion drains should discharge to suitable endpoints that are free draining. Groundwater seepage from areas surrounding ponds or the ponds themselves should be intercepted by diversion drains to a free draining area. Long term ground water seepage will require drains with concrete inverts to promote flow and prevent vegetation growth.

With ponds constructed near tidal areas, particular consideration must be given to preserving existing tidal drainage patterns, or to ensure no dead tidal pockets are created. If upper mangrove drainage areas are blocked new breeding sites for salt water species of mosquitoes can be created. An example occurred at the Leanyer sewage ponds in Darwin, where considerable engineering work was required to drain non-draining tidal areas created by the location of the ponds and access embankments over tidal mud flats.

Access

Site design should allow for all weather access completely around the installation. Weed growth, tree growth, seepage, erosion and siltation must all be controlled, and fire prevention must be considered. There have been instances in Alice Springs of seepage from large pond systems causing swampy conditions and preventing vehicle access and hence control around the base of the ponds.

Pond Dimensions

Pond Size

Sewage pond size is primarily determined by engineering parameters related to design flowrates, pollution loadings, and the required effluent quality. Frequently there has been little consideration given the effect of pond size on mosquito breeding. Adoption of oversized ponds, either from inaccurate predictions of sewage volume or a desire to provide for future capacity, can lead to the ponds becoming shallow thickly vegetated swamps that are capable of breeding large numbers of mosquitoes.

This situation occurred at Batchelor and Tennant Creek, where the final evaporation ponds became swamplands breeding mosquitoes.

Consideration should be given to the staging of particularly evaporation pond construction, or the use of multiple smaller ponds rather than one large evaporation pond. In most cases, it is the margins of the ponds that provide the mosquito breeding conditions. Multiple small ponds can provide additional maintenance requirements so it is important to optimise the numbers and size of these ponds.

Attempts to reduce short-circuiting through a large pond by installing earthen peninsular barriers can markedly increase the mosquito breeding areas by providing additional margin length, and these are often inaccessible for mosquito control purposes.

Pond Depth

Selection of pond depth is usually dictated by the function of the pond, ie. primary, secondary, or evaporation. Adequate allowance must be made for solids deposition, particularly in primary ponds, otherwise excessive or longer term deposits will lead to siltation at the edges and corners, resulting in colonisation by vegetation and thus creating mosquito breeding locations.

Profiling the pond base, with the deepest side at the effluent entry point, can help alleviate the silt problem, particularly if there is a seasonal variation in input. For evaporation ponds, particularly those with earth sides or those which are operated on a continual basis, a minimum depth of two metres or more is recommended. This is to allow for the periodic drowning of any seasonal growth of grasses or semi aquatic vegetation such as *Eleocharis* sp. and *Typha* sp.

Construction Details

Concrete Margins

Vertical or sloping concrete margins have proven to be the most satisfactory engineering means of controlling mosquito breeding by promoting wave action, and maintaining margins free of vegetation and debris.

Vertical concrete walls have proven the most maintenance free and effective in reducing mosquito breeding. Sloping concrete margins have been tried in a number of locations. While better than unlined ponds, they have the drawback that wave action is damped by the slope. Debris and algae and organic matter can build up and enable emergent vegetation to establish. It is important that they have a concrete rim around the top to prevent landward inflow of water and silt, and sealed verges to prevent vegetation growth.

Concrete lining can be precast for remote locations or constructed in situ, and are cost effective. They should be deep enough to allow for wide variation in water level and should have a concrete lined horizontal bench just above the bottom level of the pond, to prevent establishment of vegetation along the margin in the initial stages of operation, and to prevent silt accumulation in the longer term. Sealed verges around the top of the banks are desirable to facilitate maintenance and to prevent entry of soil into the pond. Walled ponds may still have problems with floatables and wind blown debris in the corners and cut off pools near entry and exit points. Truncated corners and multiple or underwater entry and exit points can help to eliminate these latter problems.

Unlined earth banks

Sewage ponds with unlined earth banks have the greatest capacity for mosquito breeding, particularly those with gentle slopes where marginal vegetation can grow. They are accordingly not recommended, except as temporary or emergency measures. The banks should be constructed using low porosity materials such as compacted clay. If neglected, unlined earth banks can become either eroded, or overgrown with grass, shrubs and even trees such as *Acacia*, *Mimosa* and *Melaleuca* sp. Maintenance and corrective measures can be a major problem.

Other Linings

Various systems have been used to line earth banks as a temporary measure to reduce growth of vegetation, but they have not been entirely satisfactory.

Stone pitching of the margins is not satisfactory as it does not offer sufficient deterrent to vegetation growth, and mechanical maintenance of vegetation is subsequently difficult. Overlapping cement sheets have been used, but have problems with breakage and subsequent weed growth. Various types of bituminous or plastic sheeting have also been tried, and most have shown promise as short to medium term solutions. Problems encountered include inadequate anchoring, weed growth, ultraviolet deterioration, and human interference. The more modern ultra-violet resistant heavy duty plastics, anchored with earth mounds back from the rim of the ponds, have been more successful.

Maintenance

New pond systems

Before commissioning sewage pond systems, a general survey of the whole site should be conducted to ensure that mosquito breeding places have not been inadvertently created. Potential mosquito breeding sites include borrow pits formed during pond construction, pooling of water resulting from site drainage works, and pooling caused by road access blocking drainage paths. Any problems should be rectified before the ponds are commissioned.

Pond maintenance

Pond maintenance is a vital part of pond management. The highest levels of maintenance will be required for earth lined ponds with low and seasonally variable effluent flow rates. Some form of maintenance will be required, even for ponds with vertical concrete margins and sealed verges. Even those ponds in favourable locations, with ideal effluent characteristics, must have adequate provision for people and resources to carry out a regular and defined maintenance program.

Aspects of maintenance frequently overlooked include the regular control and removal of vegetation on the margins or the pond verges, the regular removal of floatables and other flotsam from accumulation points, and the repair of cracks and other failures that can allow pooling or increased soil moisture levels on the banks and subsequent vegetation growth.

For some ponds, a program of water level management may be adopted, which alternately floods and strands marginal vegetation or floatables. The form of maintenance will depend heavily on the pond design, effluent parameters, staff experience and staff availability.

Regrettably, it has been the NT experience that regular and adequate maintenance have been sometimes inadequate to prevent mosquito breeding. If there is any anticipation that regular and adequate maintenance can not be carried out, a maintenance-free design should be chosen.

EFFLUENT DISPOSAL OR DISPERSAL

Problems

Insufficient consideration was given to disposal of the effluent in many of the early sewage treatment facilities in the Territory. It was often assumed that 'adequate treatment' in the ponds was sufficient from an operational point, and therefore discharged treated effluent was frequently allowed to run down the nearest flow line. In practice this effluent often formed flooded, overgrown, stagnant pools that created prolific breeding grounds for *Culex* mosquitoes. Examples were the sewage treatment facilities at Coonawarra Naval Base and Nhulunbuy South in the 1970’s, where there was a lack of provisions for proper disposal.

In some instances, effluent from sewage treatment ponds was channelled or piped just beyond the perimeter fence or to the nearest available low lying area. In some situations, as at Nhulunbuy, the effluent was directed into sand dunes in the belief that infiltration would provide a satisfactory disposal method. This proved totally inadequate because the high organic loads of the effluent and algae invariably sealed against infiltration and resulted in pooling of effluent throughout the dunes.

Even after the final aerobic treatment in evaporation ponds, the resulting 'treated' effluent still retains a great capacity to breed mosquitoes. An example of this was the uncontrolled release of treated effluent into the Il Parpa Swamp area near Alice Springs during the period 1974-2002. The regular release of effluent created a large permanent vegetated swamp and very high numbers of *Cx. annulirostris* and *An. annulipes s.l*. This area has since been partially rectified by drainage measures in the swamp and a reorganisation of discharge practices (Kurucz et al 2002).

Large Evaporation Ponds

In the Northern Territory evaporation ponds, either designed or of 'ad hoc' design have commonly been used for effluent disposal in inland sites. Large evaporation ponds are rarely full to capacity for the entire year, and in many instances are just bunded areas containing effluent to prevent escape to other areas. Because of their large area, the often variable inflow and the variation in climate, large evaporation ponds often become shallow, flooded swamps with dense weed and reed vegetation for at least part of the year. These ponds can become considerable sources of *Culex annulirostris, Culex gelidus, Culex quinquefasciatus* or *Anopheles annulipes s.l.* Also, evaporation ponds that dry up and are then seasonally inundated during rainy periods can become breeding grounds for floodwater mosquitoes such as *Aedes normanensis*. The numerous aspects to be considered in designing large ponds to reduce the amount of mosquito breeding, include:

- initial and regular removal of all emergent vegetation within the evaporation area:
- levelling of the floor of the evaporation area:
- division of the evaporation area into a number of smaller areas;
- constructing a sloping floor to concentrate the water in a sink' area at the effluent entry point;
- concrete lining of the 'sink' area on the floor of the evaporation area and the lining of embankments.

Incorporating some of these aspects into the initial design can be expensive, but the alternatives are to have a regular maintenance program, which could be more expensive in the longer term. The alternative to well designed evaporation ponds is to consider a different effluent disposal method such as dispersal to land, sophisticated tertiary effluent plants, or effluent re-use schemes.

Small Evaporation Ponds

The use of small concrete lined evaporation ponds can be a very effective method of effluent disposal. The best designs incorporate a series of relatively small ponds that can progressively fill by gravity overflow. Such a system may be expensive to construct, particularly if the whole evaporation area required is relatively large. However, the method has the advantage of being relatively maintenance free and it can better prevent mosquito breeding when there are large seasonal variations in effluent volume.

Disposal to the Sea

Disposal direct to the sea or to a daily flushed tidal area is one of the most suitable methods for effluent disposal to prevent mosquito breeding. The critical aspect for tidal creeks is to ensure there is good drainage at low tides. However dispersal at the end of a relatively long, narrow or tortuous tidal creek can result in effluent build up in the creek which can also be pushed higher up the creek line by incoming tides into areas where mosquito breeding sites can develop.

Disposal onto large flat inadequately flushed tidal areas can create breeding sites for freshwater species of mosquitoes, as well as brackish water species such as *An. farauti s.l.* and *Verrallina funerea*, and salt water species such as *Cx. sitiens, An. hilli,* and *Ae. vigilax,* by creating a complex of fresh and brackish water habitats.

Disposal to Rivers

The suitability of discharge to rivers depends upon the volume of flow in the river, the seasonal variability of flow, and the downstream effects of the disposal. This method is unsuitable when the flow in the rivers or creeks is small or subject to wide seasonable variation, as eutrophication or ecological and vegetation changes will lead to mosquito breeding.

Disposal to Land

<u>Large Sprinkler dispersal</u>

This method has been relatively successful in areas where there have been particular problems with other disposal methods. It is most successful onto areas with well-developed stands of trees on well drained areas with soils of good permeability, but the success will depend on adequate resting of the disposal areas and the rate of volumes of effluent disposed to these areas.

Jabiru provided an example of an initially successful sprinkler dispersal scheme. The final effluent was automatically and periodically dispersed via a system of overhead sprinkler heads, onto a fenced area of open native eucalypt forest. Initial problems from fire damage of above ground plastic pipes and algal blocking of spray heads were rectified by the construction of an underground pipe system with tall metal risers and metal sprinkler heads. Over the longer term, this area became a major source of mosquitoes with dead trees, wet season ponding on-site and in downstream off-site flow lines, and tall, dense and uncontrollable grass-weeds in the dispersal site. It has become obvious that the initial site levelling and draining was not adequate, and off site wet season runoff into the disposal area has compounded the effluent ponding problems. The lack of regular slashing of grass led to intense fires that destroyed the trees, and hence reduced evapotranspiration.

Ideally, sites should be relatively level but with good drainage during rainy periods. Off site run-off should be directed away from the disposal site. There should be adequate sprinklers to have areas off-line for up to a week for drying and weed maintenance. Feeder lines to sprayheads should be laid out along contours, rather than at right angles to contours, so that water retained in the lines after the finish of spraying will remain in the lines rather than drain to the lowest sprinkler head. The sprinkler heads should be positioned on mounds of crushed rock to enable better infiltration and to reduce the probability of creating permanent pools of effluent near the sprinkler heads.

The area required will depend upon the volume of effluent to be disposed, and the long-term absorption capacity of the soil and the vegetation. In monsoonal areas, additional site selection and preparation is required to ensure that effluent contaminated runoff cannot pool in nearby flow lines or creeks.

Sprinkler dispersal of effluent can be used for tree and pasture growing or landscape watering, but the National Health and Medical Research Council Guidelines for the Reuse of Waste Water must be adhered to (NH & MRC, 1979). Tertiary chlorination has been used to provide a high quality effluent for drip irrigation and recreational area watering at Yulara. Sprinkler disposal using large spray heads has been successfully used on Blatherskite Park in Alice Springs, but potential problems exist in this area because of the high salinity of the water and rising water tables, which requires regular monitoring of the water table and suspension of irrigation when water tables are high.

<u>Small sprinkler dispersal</u>

When disposing of small volumes of effluent, the use of mini sprinklers fed by irrigation lines is a suitable alternative to drip irrigation. Small sprinklers tend to promote more evaporation compared to drippers by wetting larger areas and allowing greater soil infiltration. In addition it is easier to spot blockages with mini sprinklers compared to drippers. There is however a need to have regular maintenance of dispersal area to prevent grass and weeds from smothering the sprinklers.

<u>Drip Irrigation</u>

Disposal by dripper systems requires a high standard of effluent, usually with a tertiary chlorine treatment, to prevent dripper blockage by algae. Dripper systems can be used for both small or large scale disposal, but is usually only suitable for plantation situations where the vegetation growth at each dripper site can be practically and economically maintained. Drippers held off the ground can reduce root blockages of the drippers. Generally dripper systems are only suitable for the dispersal of small volumes of effluent per unit area or periodic release, and are generally expensive because of their high maintenance requirement.

There has been past issues with drip irrigation at Hermansburg, and Kings Canyon (Whelan 1994). The continuous volume of effluent released in both situations was too high for drip disposal, which created effluent ponding and mosquito breeding. Both systems did not receive adequate maintenance to prevent blockages of drippers, and treatment areas were not appropriately spelled. In both instances, a switch to sprinkler irrigation was required to adequately dispose of the required volumes of effluent over a wider area in the irrigation area.

This method is useful for relatively small volumes of effluent on sandy soil in low rainfall areas. A feeder channel is used to deliver effluent to a ploughed area of small furrows sloping gently away from the feeder channel. Disposal is by infiltration into the sandy soil. When infiltration becomes less efficient, the flow is directed to an adjacent ploughed area, and the original area is allowed to dry out and is reploughed.

This system requires a considerable amount of attention and maintenance, but was used successfully at Perth Airport, largely due to the sandy soils and relatively low effluent volumes per unit area.

<u>Channel Infiltration</u>

In this system, permanent infiltration channels are constructed and effluent flow is directed down a number of groups of channels which are alternatively spelled and maintained. The method can be used on less porous soils than is possible for furrow irrigation. If this method is to be used for the irrigation of tree or bush crops, intensive monitoring is required to ensure viability of the crop in the long term. Small scale use of this method has been tried at Batchelor and at the Katherine Abattoirs, but proved to be relatively labour intensive. A variation of the method has been used on a larger scale at Il Parpa in Alice Springs, for the growth of eucalypt trees. Problems on the larger scale have included high labour input, weed control in the channels, siltation in the feeder channels, rising salinity levels and rising water tables.

<u>Flood Bay Irrigation</u>

The degree of land preparation for flood bay irrigation is usually considerable, as a system of correctly graded flood bays is necessary to allow for efficient flooding and to prevent pooling at the end of the flood bays. The bays are periodically flooded and the effluent is allowed to evaporate or infiltrate in the bays over a period of four to five days. This method has been used successfully to grow eucalypts in Ilparpa in Alice Springs. Problems with flood bay irrigation arise during extended rainy periods, when extended flooding of the bays can occur and can result in mosquito breeding. A more sophisticated delivery system for a flood disposal method has been designed for Gapuwiyak. It incorporates an automatic siphon and a distribution drain designed to release effluent evenly over a very large flood bay.

<u>Vegetated Treatment Ponds</u>

Vegetated treatment or polishing ponds, using large aquatic plants such as Salvinia (water lettuce) or Eichornia (water hyacinth) have been used overseas, but many of these have faced major problems with the maintenance or removal of vegetation, and have become major mosquito breeding sites. This has resulted in expensive re-design or maintenance issues, or in some instances they have had to be decommissioned. There has been some success with prostrate water plants such as duckweed (*Lemna* sp) which can form total cover over ponds, thus denying suitable oviposition sites and preventing air access for larvae. However the pond sizes need to be relatively small so that the duckweed is not blown into corners by wind and wave action.

BIOLOGICAL CONTROL

Biological control, though not usually applicable to primary ponds, can be a very efficient means of controlling mosquito larvae in secondary and evaporation ponds.

The major biological control agents are fish, aquatic beetles and aquatic bugs. Fish can control mosquito larval numbers directly by eating the larvae, or indirectly by eating or disturbing algae or aquatic weeds which provide protection from other predators or wave action. Fish are usually only suitable for the higher oxygenated waters. Several species have shown promise in the Northern Territory, including the herbivorous bony herring (*Nematalosa erebi*), which was successful in reducing surface algae in the former Ludmilla sewage ponds in Darwin, and rainbow fish (*Melanotaenia* sp.), which was a very efficient larval predator in the final evaporation ponds for the Ranger sewage treatment. Other suitable fish species includes the blue eyes (*Pseudomugil* sp.) and gudgeons (*Mogurnda* sp, *Hypseleotris* sp.).

It is essential that marginal vegetation such as couch grass and reeds be eliminated or kept to a minimum, so that fish can have physical access to the mosquito larvae. Actively growing *Eleocharis* sp. and *Typha* sp., with upright stems, may not restrict access. However, when these weed species die or lodge over, they prevent physical access for the fish and enable mosquito breeding.

Aquatic beetle larvae (Family:*Carabidae*) and aquatic bugs (Family:*Belostomatidae*) are the most efficient mosquito larvae predators in secondary and evaporation ponds. The aquatic bugs are able to live in higher organic water than the aquatic beetle larvae, and can be present in very high numbers. Again, physical impedance by thick vegetation at the margins will reduce the effectiveness of these predators. These insect predators can achieve almost total control of mosquito larvae in sewage ponds of suitable water quality, and narrow or sparse vegetation margins.

CHEMICAL CONTROL

The aim of chemical control of mosquito larvae should be to apply the minimum amount of insecticide to prevent the production of adult mosquitoes. Chemical control should not be used as a long term strategy in sewage treatment areas, in order to avoid insecticide resistance and unwanted effects on non-target organisms. However, it may be necessary to apply insecticides during the initial operational period or when proper maintenance has not been carried out. The insecticides of choice to control mosquito larvae in sewage ponds and effluents are either temephos, methoprene, *Bacillus thuringiensis* var *israelensis* (*Bti*) or *Bacillus spaericus* (*Bs*), with *Bs* having advantages over Bti due to its persistence after application. Correct rates for temephos must be strictly adhered to, as over treatment can kill fish and other aquatic insects.

MOSQUITO SAMPLING

Regular inspections for mosquito larvae should be carried out in sewage ponds and their effluents to determine whether breeding is occurring and to determine the necessity for weed control or chemical control. Chemical control with temephos or *Bti* may be necessary at weekly or longer intervals. Methoprene may give longer control if applied as pellets or briquettes. In general briquettes will give the longer residual effect but need to be tethered in netting on sticks near the surface of the water, so that they do not sink into the silt or mud. Methoprene applications do not necessarily kill larvae or pupae, so an experienced operator is required to assess treated areas or take pupal samples and check emergence efficiency. The presence of late instar or pupae with the first two insecticides above indicates that control should have been carried out at shorter intervals. If only first and second instar larvae are present, then either biological control is quite efficient, or the mosquitoes have just started to breed in that area, and continued monitoring is necessary.

Mosquito larval or pupal samples can be collected by dipping into sheltered vegetated zones with a soup ladle. Generally care should be taken not to disturb the larvae by shadows or surface water agitation before dipping, and multiple dips should be performed to adequately assess population numbers. Any larvae collected should be stored in small vials with 70% alcohol or methylated spirits, together with information on collection locality, site, date and collector. Larval or pupal identifications should be checked by an entomologist.

Adult specimens collected by biting or harbourage collections can be sent for identification, packed loosely in tissue paper in a small box, together with all the details of collection.

Chironomid midge pupae or adults are often mistaken for mosquitoes and their presence has often resulted in control programs being instituted where none has been necessary.

SUMMARY

In the past, the design of sewage treatment ponds and their effluent disposal facilities in the NT has been largely dictated by engineering and microbiological principles. Little attention was paid to the possibility of breeding mosquito populations close to residential areas, with the resultant risk to public health. Appreciation of this potential risk followed by the application of design principles and adequate maintenance can reduce this problem. Biological control can then operate effectively. Chemical control can be used for start-up or emergency situations, although should not be relied on for ongoing mosquito control in ponds or effluent disposal areas.

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Appendix P Draft Biting Insects Management Plan

<u>Attachment B</u>: Construction practice near tidal areas in the NT – Guidelines to prevent mosquito breeding

Northern Territory Government

DEPARTMENT OF **HEALTH**

Guidelines for Preventing Mosquito Breeding Associated with Construction Practice near Tidal Areas in the NT

Medical Entomology

Centre for Disease Control

Northern Territory Department of Health

Darwin NT

June 1988

Updated February 2011

Contents

Guidelines for Preventing Mosquito Breeding Associated with Construction Practice near Tidal Areas in the NT

1.0 Introduction

There have been many instances of construction in or near tidal areas in the Top End of the Northern Territory that have resulted in ecological disturbance and subsequent mosquito breeding. Many of the deleterious disturbances have been the result of little or no recognition of the ecological consequences of construction practices, either during the construction period or on completion of the project. Much of the deleterious ecological disturbance can be avoided or minimized by consultation between engineers or construction authorities and people with ecological expertise.

One of the most significant impacts of construction in or adjacent to tidal areas is the creation of new sources of pest and potential disease causing mosquitoes. The creation of new mosquito breeding sites can have an enormous bearing of the quality of life, land values, costly rehabilitation measures, mosquito control programs and most importantly, the health and legal implications involved in an outbreak of mosquito-borne disease.

2.0 Aim of Guidelines

These guidelines are intended as a checklist for planners, engineers or any supervisory officers, responsible for the planning or implementation of any construction activity near tidal areas, in order to prevent the creation of mosquito breeding sites.

They are also intended to be used as a checklist in the preparation and evaluation of any Preliminary Environment Report or Environmental Impact Statement. In this way it is hoped that the 'potential for additional mosquito breeding areas will be recognized and avoided in the planning or implementation phases of any construction project, so that later costly or environmentally disruptive rectification works will not be necessary.

These guidelines should be used by the relevant construction or advisory authorities. Any doubts on the potential for creating mosquito breeding sites on any project can be referred to the Senior Medical Entomologist of the Northern Territory Department of Health.

3.0 Mosquitoes of Public Health Importance

Background information on mosquito biology, breeding sites, potential diseases and specific control measures can be found in "Mosquitoes of Public Health Importance in the Northern Territory and their Control" (1984), available from the Department of Health. Of the 100 species of mosquitoes in the Northern Territory, fifteen (15) species can breed in the intertidal zone, at least at certain sites and some times of the year. These include the principal vectors of malaria, Ross River virus, Murray Valley encephalitis, and a number of other arbovirus diseases, as well as some species regarded as the most important human pest species.

Salt Water Mosquitoes	**Common Name**	**Importance**
Anopheles hilli	Saltwater Anopheles	Potential malaria vector
Culex sitiens	Saltwater Culex	Localized pest species
Aedes alternans	Scotch Grey	Negligible pest
Aedes vigilax	Northern Saltmarsh mosquito	Major pest and disease vector
Brackish Water Mosquitoes	**Common Name**	**Importance**
Anopheles farauti s.l.	Australian malaria mosquito	Major malaria vector
Verrallina funerea	Brackish forest mosquito	Important mosquito local pest
Brackish to fresh water mosquitoes	**Common Name**	**Importance**
Culex annulirostris	Common banded mosquito	Major pest and disease vector
Anopheles bancroftii	Black malaria mosquito	Potential malaria vector and pest
Anopheles annulipes s.l.	Australian Anopheles mosquito	Potential malaria vector
Anopheles meraukensis	Freshwater reed Anopheles	Pest species
Coquillettidia xanthogaster	The golden mosquito	Important pest species
Mansonia uniformis	Aquatic plant mosquito	important pest species

3.1 Malaria

Malaria was only eradicated in the Northern Territory in 1962 and many communities in the Northern Territory remain vulnerable to malaria reintroduction, particularly those communities which are near large sources of *Anopheles* mosquitoes. Each year up to thirty malaria cases are imported into the Top End from overseas, and the Department of Health investigates and follows up each case. With increasing numbers of people living in remote areas with large mosquito populations, or adjacent to mosquito sources in expanding urban areas, the potential for malaria reintroduction is increasing. In particular circumstances, adult mosquito control measures near urban areas may be necessary, but problems due to lack of access, thick vegetation, or the proximity to urban areas, may prevent or reduce the effectiveness of these measures. We need to reduce these potential problems by reducing the mosquito breeding areas adjacent to urban areas.

3.2 Arbovirus Diseases

Each year there can be from 100 to 400 cases of Ross River virus disease reported in the Top End. These are laboratory confirmed cases only, and it is thought the number of clinical cases is very much higher. Many of these cases have likely sites of transmission in towns adjacent to particularly productive mosquito breeding areas. With a tropical lifestyle and an expanding population, it is becoming increasingly necessary to provide mosquito free urban areas.

4.0 Mosquito Breeding Sites in Coastal Areas

The breeding sites of the various mosquito species are illustrated in Fig. 1. The area of greatest potential for mosquito breeding lies within the upper high tide zone (from 7. 3m to 8.0m A. C. D. in the Darwin area). In addition, the region up to 1.0m above maximum high tide can be a significant mosquito breeding area, as this region is usually the recipient of seepage, rain water and silt inputs being transported to the tidal areas. These regions have the capacity for both natural and human disturbances that can lead to significant increase in mosquito breeding.

The intertidal areas of wide expanse, thick vegetation, very flat topography, and fresh water inflows are the largest sources of mosquitoes. These large tidally influenced marshes (e. g. Leanyer Swamp) have variable salinity water which is shallow and thickly vegetated and is the ideal breeding habitat for most of the important mosquito species. Natural tidal marshes such as these can be extended and made much more productive sources of mosquitoes with increased silt, nutrient and water inputs from urban and industrial developments.

Any construction practice that increases the flow of water, silt or nutrients, or interrupts or prolongs the drainage through these areas, has the capacity to increase the amount of mosquito breeding. This is particularly so in the upper high tide area, where the often naturally self draining margin of the mangroves can be easily disturbed and result in the pooling of tidal water. Such sites can be quite small, but extremely productive in the numbers of salt water mosquitoes such as *Aedes vigilax.*

At present the Northern Territory Government and the Darwin City Council have a continuing mosquito engineering control program around urban Darwin, to rectify past poor construction practices. The annual expenditure is in the region of $300 000.

This annual expenditure included funds for the construction of drains and a proportion to permanently upgrade those drains that repeatedly breed mosquitoes. The program will need to be relatively long term to rectify all the past poor construction practices and achieve a relatively mosquito free city, particularly when poor construction practices are still proceeding. In contrast, planners of the new satellite city of Palmerston considered the potential for mosquito breeding at an early stage. The siting of the urban areas, the rectification of existing mosquito breeding areas, the design and endpoints of the storm drains, and reclamation works in Palmerston have resulted in a relatively mosquito free urban environment. This consideration in the planning stage has been a very cost effective solution.

5.0 Construction practices that can result in mosquito breeding

Mosquito problems created by previous construction practices are detailed in Appendix I.

5.1 Sand Extraction

Deposits are usually found in low lying areas along swamps and creeks or close to the tidal areas. Any sand extraction activity has the capacity to produce wet season flooded depressions or waterfilled borrow pits that quickly become colonized with aquatic or semi aquatic vegetation and result in new mosquito breeding areas. These areas can be extremely productive, particularly if the borrow pits have some tidal influence, as this can eliminate may of the freshwater aquatic predators of mosquito larvae. Those sand extraction areas that are deep enough to penetrate the water table can become perennial mosquito sources.

5.2 Storm Water Drainage

Storm water drain construction can produce mosquito breeding sites by poor placement of berm material and the disruption of normal drainage patterns. If the disruption of drainage is in tidal areas it can create extreme mosquito problems.

Open unlined storm drains with relatively permanent dry season flows can be mosquito sources, particularly if the drain receives organic nutrients from urban run off or industrial processes.

If storm drains with considerable dry season flows are directed into low lying areas, particularly in the upper high tide zone, considerable ecological disturbance can result in dramatic increases in mosquito breeding.

5.3 Road embankments and Access Roads

Road embankments and access roads can result in impoundments or impedance of normal drainage patterns and frequently cause at least wet season pooling. Detailed topographic and vegetation surveys are usually necessary to avoid such disturbances.

5.4 Water Retention in Tidal Areas

The construction of water retention features can result in altered vegetation patterns that can give rise to mosquito breeding. Water retention in standing mangrove areas which results in the death of mangroves can create extremely productive sources of the salt marsh mosquito, the salt water *Anopheles* or the salt water *Culex* mosquito. Inundation of disturbed tidal areas by high tides, rain or waste water can result in emergence of large numbers of mosquitoes. Meticulous planning or water retention features is necessary to avoid creating mosquito breeding sites. Aspects that need particular attention include the final water level, the quality and salinity range of the impounded water, the maintenance drainage capability, the potential vegetation growth in or at the edges, and the inflow of silt.

5.5 Land Fill Operations

Land fill in tidal areas can disrupt previously self draining areas and result in pooling of water. This is particularly so if the land fill has silt laden run off and is sited in a complex drainage pattern. Pollution and vegetation growth at the edge of land fill operation in water can eliminate or restrict the normal activity of aquatic predators and give rise to mosquito problems.

5.6 Sewage Pond Construction

The siting of sewage ponds is one of the most important factors in reducing potential mosquito problems. Correct siting of ponds is vital near coastal areas, as disruption of mangrove drainage patterns cancreate new breeding sites, and access and service embankments can impound water to create additional mosquito breeding sites.

Maintenance needs, such as emptying certain ponds, can cause extreme mosquito problems unless the pond contents can be channelled or discharged directly to a daily flushed tidal area. These maintenance practices need to be considered in the planning stages and should be important factors in the choice of a site.

The type of ponds, particularly the depth, size and bank material can have a large bearing on whether the ponds are mosquito sources.

5.7 Urban Subdivisions

When urban subdivisions are poorly sited near pre-existing mosquito sources, or sites that have the potential to become sources, it is very likely that there will be public pressure at a later date to rectify the mosquito breeding. Sometimes the rectification works can be extremely expensive, or severely disrupt natural features such as swamplands. It is logical to avoid such costly rectification works or possible destruction of animal and fish habitats, by the correct siting of urban subdivisions.

The Department of Health has recommended avoiding large and uncontrolled tidally influenced mosquito breeding areas by having a 1.6km buffer between the breeding areas and the proposed urban development.

This buffer is very relevant for those large salt marsh swamps with fresh water input such as Leanyer Swamp and Howard Swamp, but it is of little relevance for very small areas that are not very productive, or that can be easily controlled or rectified.

If urban areas are built near these large and at present uncontrollable mosquito breeding areas, then attempts will be necessary to control the breeding. Examples of types of physical control methods recommended include:

1. Swamp drainage by a system of channels
2. Tidal bunds, tide gates and an internal drainage system
3. Steep sided relatively deep (greater than 2.0m) excavated fresh water lake
4. Salt water lake.

Insecticide control for extended periods should not be contemplated as a control measure around urban areas, as there can be no certainty that such methods will be effective in the longer term.

6.0 Guidelines for Construction Practice

Borrow Pits and Excavations

1. No borrow pits, extractive industry or excavation should be conducted within the tidal zone, unless provision is made to prevent ecological changes.

2. Borrow pits or extractive operations should not excavate to a base level below maximum high tide level.

3. Cover material and vegetation should not be pushed into the tidal zone. There should be no impedance of overland flow into the tidal zone.

4. All borrowing or extractive areas should be rehabilitated immediately upon completion of the operation such that all operational areas are completely self draining.

5. Vehicle disturbed areas such as wheel ruts and compacted soil areas should be rectified as soon as practical to prevent water ponding.

6.2 Storm Water Drainage

1. Drains should be constructed to discharge direct into regularly flushed tidal areas, such as tidal creeks or a formalized channel dug back from a tidal creek. In Darwin 100 year flood drains should be constructed to the 3.7 AHD level and low flow drains to the 3. 5 AHD (or below this level if silt accumulation is a potential problem).

2. Drains through tidal areas need to be of dimensions that will not result in silt accumulation in or near the drain. Low flow drains should be installed wherever there is the possibility of longer term dry season flows. Such drains can be either impervious above ground inverts or sub soil pipes.

3. Low flow drains should be installed wherever there is the possibility of longer term dry season flows. Such drains can be either impervious above ground inverts or sub soil pipes.

4. Access along all drains is necessary for regular maintenance.

5. Drains through tidal areas should follow the course of existing creeks or flow lines wherever possible.

6. Drains for mosquito control purposes should be only of dimensions that are necessary to drain over a period of 2 to 3 days for tidal areas, and 4 to 5 days for fresh water, unless there are other considerations requiring larger drains.

7. Silt traps should be installed in drains that are likely to carry considerale silt loads. This is particularly necessary in large urban drains during subdivision construction.

6.3 Embankments and Access Roads

1. No embankments should be constructed across tidal areas unless provision is made for sufficient tidal exchange to prevent any considerable ecological change. If upstream impoundments of tidal water are completely flushed at least once in 7 days, there is usually no significant mosquito breeding in the impounded tidal water.

2. Embankments should have provision for complete drainage of upland areas at least over a period of less than five days after flooding. This particularly applies to areas near the tidal limit, which would only be reached by tides once in 10 to 14 days.

3. Embankments for land reclamation purposes should have an internal drainage system with tide valves at the embankment. If upland flows are diverted around the reclamation area, the diverted flow should be discharged direct to the major tidal drainage line immediately seaward of the embankment.

4. Vehicle access along the upper high tide zone should be restricted as much as possible, to prevent the creation of vechile disturbed areas that could pond tide and rainwater.

6.4 Water Retention in Tidal Areas

1. An ecological and hydrological study should be undertaken before any water retention feature is constructed in a tidal area.

2. Those aspects that are considered critical to the success of an aquatic feature include:

    the levels and seasonal fluctuations in salinity; the possible aquatic and semi aquatic vegetation changes likely to occur; the effect on aquatic animal life; the number of days under tidal influence; the depth of the retained water; inputs of organic and other pollutants into the system; the' source., amounts. and quality of possible top up water; the provisions for periodic maintenance; possible ecological effects seaward of the retention.

3. If the tidal regime in the water feature is significantly reduced or eliminated, all existing mangroves in the retention area should be removed.

4. Silt traps should be constructed at all significant silt entry points.

5. Regular vegetation maintenance or control programs will be necessary. The provision of 1:1 side slope or impervious margins should be considered to reduce maintenance needs.

6. There should not be any small cut off areas at any height level of the water.

6.5 Land Fill in Tidal Areas

1. Land fill operations should not impede any established drainage patterns, either by the land fill operations, or possible erosion from the fill area.

2. There should be drainage provisions all around the base of sanitary land fill operations, and these drains should discharge direct to a daily flushed tidal system.

6.6 Sewage Pond Construction

1. Sewage ponds should be sited preferably on bare mud flat areas or land backed in preference to existing mangrove areas to minimize ecological disturbances.

2. The siting of ponds should not result in any impedance to pre-existing drainage lines,either landward or within the tidal area.

3. Pond drainage during maintenance should be direct to daily flushed tidal areas.

6.7 Urban Subdivision

1. A mosquito buffer zone for the exclusion of urban residential development is recommended within 1.6km of large and uncontrolled tidally influenced mosquito breeding areas, unless specific biting insect studies indicate this can be modified.

2. No urban residential developments are recommended within 1km of extensive areas of mangroves, unless biting midges are not likely to be a significant problem.

3. Any subdivisions bordering tidal areas should incorporate a buffer distance between the high tide level and property boundaries, so that access is possible for management purposes, and to prevent the creation of new mosquito breeding sites.

7.0 Consultation

Medical Entomology of the Northern Territory Department of Health is available for advice on what may constitute a potentially significant mosquito breeding site. In some instances where detailed entomological investigations are necessary, 12 months entomological monitoring may be required before the detailed planning stage. For significant entomological investigations, it may be necessary for the developer to engage an entomological consultant.

Consultation for any project within a tidally affected area may be required with the Northern Territory Department of Lands and Planning, or the Environmental Assessments section of the Northern Territory Department of Natural Resources, Environment, the Arts and Sports.

Peter Whelan Senior Medical Entomologist , NT Deartment of Heath 2011

Appendix 1

Northern Territory Government

DEPARTMENT OF **HEALTH**

Previous mosquito problems in the Top End of the NT created by Construction Practice

Medical Entomology

Centre for Disease Control

Department of Health and Families

Darwin NT

1987

Previous mosquito problems in the Top End of the NT created by Construction Practice

1.0 Sand Extraction

Bynoe Harbour

Sand extraction on a beach area in Bynoe Harbour resulted in an area of mangroves being bulldozed and pushed further into a tidal area to form a retarding barrier. Fresh water inflow into the retarding basin resulted in an area of impounded water varying from brackish to salt, depending on tidal movement. The large quantities of dead and dying mangroves contributed to high levels of organic matter and flotsam. The area proceeded to breed very large numbers of salt marsh mosquitoes and a range of other pest and potential disease carrying mosquitoes.

Casuarina Beach

Sand mining at Casuarina Beach was carried out behind the frontal dunes, to a depth below high tide level. Although initially the pits only collected freshwater, the weakened frontal dunes soon collapsed, allowing tidal entry into the pits.

The result was a range of fresh, brackish and tidal water pools, with mangroves and dense salt water couch grass, providing ideal habitats for a large range and huge numbers of mosquitoes. These mosquitoes seriously disrupted the recreational use of the nearby park, and affected nearby residential areas and the hospital area.

2.0 Storm Water Channelization Ludmilla Creek

During the installation of storm water drainage in the Ludmilla area, a large channel was constructed through the upper reaches of the Ludmilla mangroves to convey the increased storm water further downstream. The spoil from the channelization was thrown up on the sides of the channel to form a continuous embankment. This embankment disrupted the free drainage of the nearby mangrove and mud flat areas, resulting in cut off tidal depressions throughout the upper reaches of mangroves. These depressions created the breeding sites for hordes of salt marsh mosquitoes that plagued the general area for many years until rectified by the re-establishment of a drainage system under the combined mosquito engineering control group.

3.0 Storm Water Discharge, Sandy Creek, Tiwi

The construction of storm water drainage in the Tiwi area resulted in the discharge of storm water into the upper reaches of Sandy Creek along Rocklands Drive. With residential development, this extensive drainage system had considerable dry season flows from overwatering and wash down activities, which transformed the seasonal drainage line into a permanently flowing creek. Ecological changes occurred in the creek and for a considerable distance downstream into the mangrove areas of Sandy Creek. Fresh water and brackish water reeds began growing beneath mangroves and on former bare mud flat areas.

Silt accumulation caused drainage pattern changes and pooling of both fresh and tidal waters over considerable areas. Some areas of mangroves died while others colonized new areas. These ecological changes led to the creation of a range of mosquito breeding habitats and serious mosquito pest problem.

4.0 Road Embankments and Access Tracks

Tiger Brennan Drive

During the construction of the Tiger Brennan Drive extension, a large area of mangroves was cut off from regular tidal influence by an earth embankment. Some areas of the mangroves were flattened and left in situ, while other areas were bulldozed clear, leaving deep machinery tracks. Inadequate temporary drainage pipes were installed which were too small to allow sufficient drainage of impounded water, sited too high to allow complete drainage, and yet sufficient to allow tidal ingress and water level fluctuations. This situation led to a stagnant brackish water impoundment, with periodic tidal flooding of sheltered shallow water and artificial depressions. The resultant emergence of salt marsh and other species of mosquitoes required regular surveys and mosquito control operations in areas of inaccessible swamp. Notwithstanding that the affected area will soon be landfilled for future commercial development, even short-term impoundment of brackish water provides an unacceptable environment that promotes mosquito breeding.

Access Tracks

Access tracks, particularly those constructed by Electricity or Sewerage authorities, are frequently just above tidal reach, due to the positioning of many of their facilities. These tracks sometimes have inadequate drainage provisions which can interupt overland water flow into tidal areas or disrupt tidal drainage patterns. This can result in the retention of water in drainage lines and creeks, creating swampy areas, or cause pooling on the uphill sides of the track. In some instances, when drainage is constructed under the road, scouring on the downhill side of the drain can result in depressions that can fill after rain or high tides.

5.0 Water Retention Features in Tidal Areas

Examples of the range of problems created by water retention in tidal areas can be illustrated by the construction of the Frances Bay Mooring Basin, the old Fannie Bay Golf Club dam, the Gove alumina final retention pond and Palmerston Lake on the Darwin City Council Golf Course. All of these projects had water retained either permanently or temporarily during construction, and were periodically under water level fluctuations by tidal or storm water influence. Each impoundment exhibited a range of salinities and resulted in vegetation changes which included either death of mangroves, growth of fresh or brackish water reeds, death of fish or other aquatic mosquito predators or prolific algal growth.

Any of these factors can result in prolific breeding of mosquitoes. The ecological modifications caused by the construction has usually been considerable and the mosquito breeding can only be alleviated by expensive or critically timed water management procedures.

In the Frances Bay mooring basin, the mangrove death and coincident mosquito breeding was caused by the embankment of an area of mangroves upstream of the mooring basin, with inadequate provision for stormwater drainage from the impounded area.

The Old Fannie Bay Dam (now Lake Alexander) mosquito problems arose from the creation of a non draining tidal depression which was periodically flooded by high tides.

Extensive algal growth and colonization by dense reeds in the Palmerston Lake resulted from infrequent tidal entry, inadequate pumping capacity for top up sea water, inflow of organic rich storm water and the insufficient side slope and depth of the impoundment.

The Gove waste water retention pond was created by impounding a large area of mangroves behind an embankment. The low salinity and high PH of the impounded water caused the death of a large area of dense mangroves and destroyed all aquatic life except for periodic pulses of enormous numbers of mosquito larvae. The periodic plagues of salt marsh mosquitoes from this area precipitated industrial problems and ushered in a mosquito control program which was frequently inefficient. The large area of mosquito breeding and the inaccessibility of the breeding areas by a tangle of dead mangroves hindered larval control, and adult mosquito control by fogging was restricted by the lack of all around access to cope with varying wind directions.

6.0 Sanitary Land Fill, Leanyer Dump

Urban refuse fill into the edge of a salt marsh resulted in areas of polluted marsh becoming significant mosquito breeding sites as the normal aquatic predators such as fish beetles and bugs were eliminated. Other areas became breeding sites by poor placement of the fill creating cut off pools or silt runoff interrupting surface drainage patterns. Additional problems were created by depressions left by the operation of machinery on the salt marsh floor. In one instance, the stockpiling of a large number of tyres without a covering of soil led to appreciable numbers of artificial container breeding mosquitoes affecting nearby suburbs.

7.0 Sewer Line Construction

The installation of sewer lines, by the nature of gravity flow requirements, are invariably installed near the tidal zone. The creation of mosquito breeding has been caused by the construction of embankments to carry pipes across tidal areas, the subsidence of excavations, or the pushing of earth and debris into the mangroves. An embankment across a former tidal creek in Coconut Grove resulted in changing a free draining section of tidal creek into a dense swampy fresh water reed swamp. The ecological changes were not confined to upstream of the embankment. Continued seepage through the embankment caused mangrove species change in the tidal area below the embankment and the resultant root growth and silt accumulation created a series of brackish and saline cut off pools. A section of the control zone sewerage scheme bordering tidal areas of Fannie Bay created depressions by machinery disturbance and subsidence of earth cover. More recent installations for the Trade Development Zone created additional mosquito breeding sites by pushing earth and mangroves into the tidal zone.

8.0 Construction of Leanyer Sewage Ponds

The siting of the Leanyer Ponds and associated embankments led to severe disruption of mangrove drainage patterns. One embankment had provision for drainage but the culvert was not installed with any consideration for possible ecological consequences. This area retained fresh water in the wet season, but was still subject to very high tides. Mangroves within. the embankment died and the previous mud flat was transformed into a dense brackish water reed swamp. In addition, the maintenance of certain ponds could only be achieved by effluent release into the impounded area. In the tidal area, the drainage pattern disruptions led to very large areas of mangrove channels and flow lines without the capacity to drain freely at low tides. Subsequent mangrove vegetation growth further aggravated the disruption and resulted in large areas of tidal pooling. The consequences of these practices led to enormous populations of a range of mosquito species, severely affecting nearby residential areas.

Plate 1 This tidally flooded ex-sand mining pit is now the site of prolific breeding by *Aedes vigilax, Culex annulirostris* and *Anopheles farauti s.l.*.

Plate 2 An artificial drain constructed without an outlet to the tidal zone will simply pond and stagnate – and breed mosquitoes.

Plate 3 Inappropriate landfill here has blocked natural drainage on the salt marsh, leading to ponding and mosquito breeding.

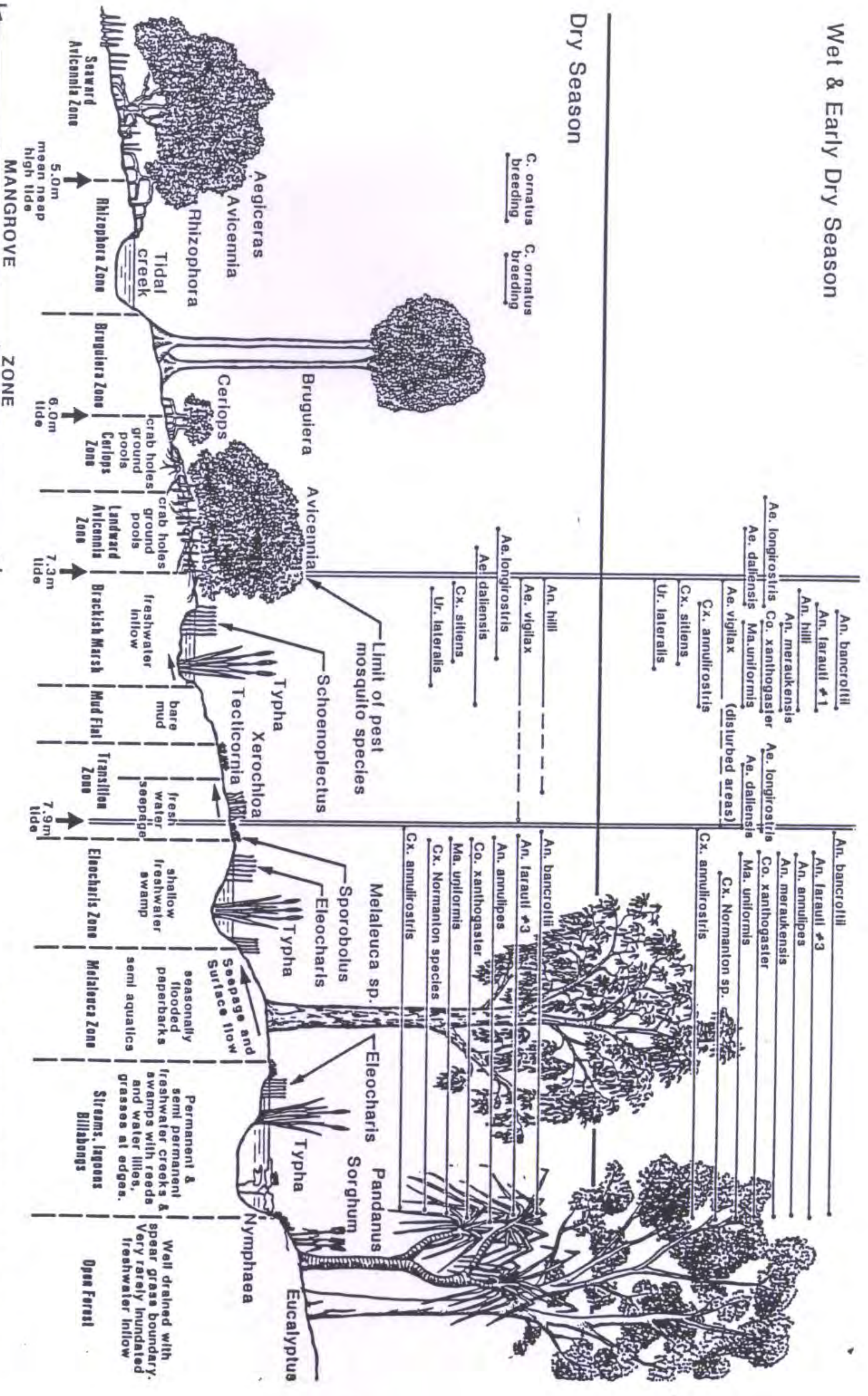
Plate 4 Interruption of drainage by nearby roadworks has led to tidally influenced ponding and killed the mangroves: large numbers of the saltmarsh mosquitos, absent before, were a problem here during the construction phase.

Plate 5 Pooling of stormwater through inadequate drainage creates mosquito breeding sites.

Plate 6 A sand dam placed through mangroves leads to upstream ponding; mangrove death and high numbers of mosquitoes.

Plate 7 Machinery distrubance of the tidal area can give rise to significant numbers of mosquitoes after high tides.

Plate 8 Damming of a mangrove creek for water storage, killed the mangroves and the resultant brackish water gave rise to very high numbers of mosquitoes.



P. WHELAN MEDICAL ENTOMOLOGY N.T. HEALTH 1982.

NOTE: 0m AHD = a 3.96 tide (or Mean Sea Level)

MOSQUITO AND BITING MIDGE BREEDING SITES – COASTAL DARWIN N.T.

Appendix P Draft Biting Insects Management Plan

Attachment C: Biting midges or sand-flies in the Northern Territory

CENTRE FOR DISEASE CONTROL
NORTHERN TERRITORY

THE NORTHERN TERRITORY DISEASE CONTROL BULLETIN

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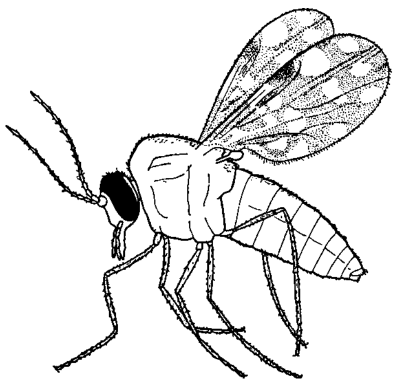
Biting Midges or 'Sandflies' in the Northern Territory

Peter Whelan, Senior Medical Entomologist, CDC Darwin

Introduction

Biting midges are small blood sucking flies in the family *Ceratopogonidae* (figure 1). They are commonly referred to as "sandflies" in northern Australia. The term "sand fly" is a misused term for a number of families of small biting flies. This includes the true sandflies, Family *Psychodidae,* (figure 2) which are not pests of humans in Australia, as well as black flies, Family *Simulidae*, (figure 3) which are serious pests in the inland areas of Qld and NSW following flooding, and the biting midges, Family *Ceratopogonidae* (figure 4).[1]

Figure 1. *Culicoides* – a female "Biting Midge"



Entomology for Students of Medicine.
Blackwell Scientific Ltd. 1962

Biting midges are the major midge pest problem in Northern Australia.[2] A number of members of this family bite people in the Northern Territory. They include two species in the genus *Lasiohelea*, which are found biting in small numbers in shaded areas in or near dense forests during the day. A species of *Styloconops* is found in small numbers biting and swarming around the head on open sandy beaches

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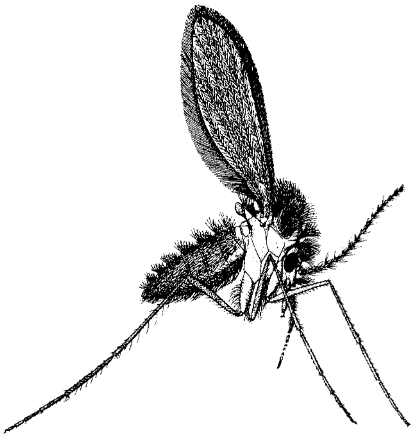
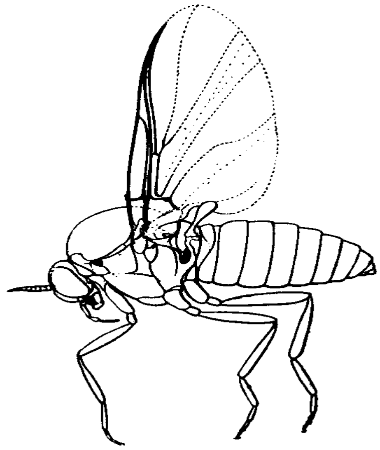
Northern Territory Government
Department of Health and Community Services

Figure 2. ***Phlebotomus*** **– a female "Sand Fly"**



Insects of Medical Importance
British Museum 1956

Figure 3. ***Simulium*** **– a female "Black Fly"**



Insects of Medical Importance.
British Museum 1956

during the day. The members of the *Culicoides* genus are more common, with many species and a wide range of breeding sites and biting habits.

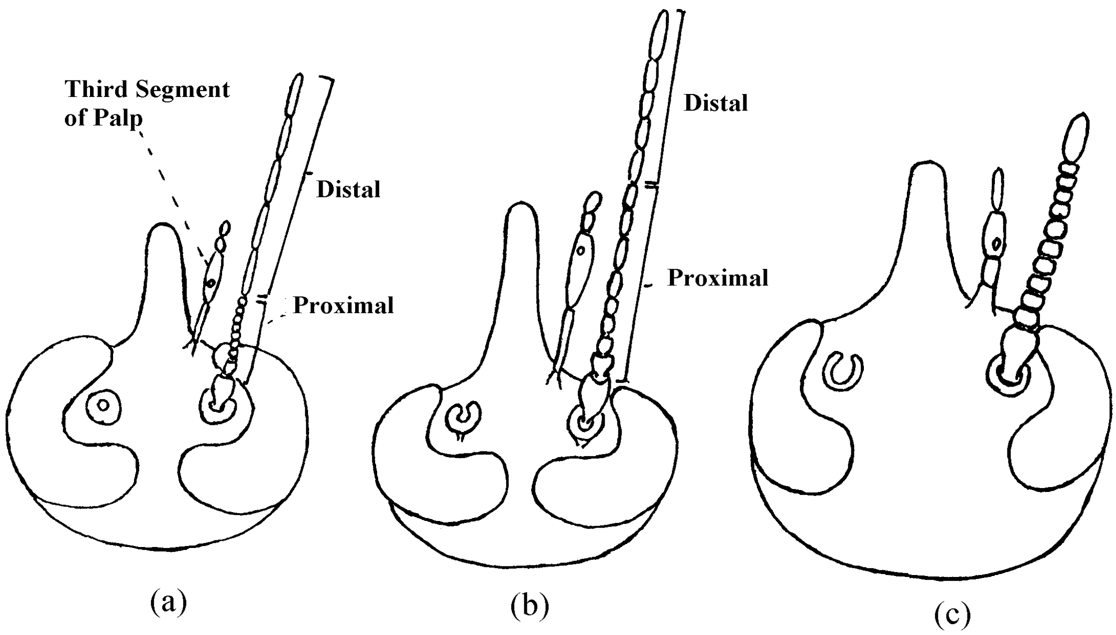
Thirty-three species of *Culicoides* have been recorded from the Darwin area.[3] The *Culicoides* species include some species that don't bite vertebrates, some which preferentially bite cattle and other domestic animals, and the few species that are serious pests of people. The breeding sites include fresh water margins and cattle dung. Most of the serious human pest species breed in tidal and estuarine sites.

Culicoides midges are small, robust flies, approximately 1 mm in length with two wings usually showing a pattern of clear patches on a grey background. They have a short, forward directing proboscis or mouthparts for piercing skin and sucking blood.

Two species, *Culicoides flumineus* and *Culicoides* species near *subimmaculatus* can be severe human pests in mangrove areas across the Top End of the NT, but are rarely found outside mangrove forests.[4]

One species, *Culicoides ornatus,* sometimes referred to as the "mangrove midge", is found in association with mangroves across northern Australia, and is usually responsible for severe biting midge pest problems near the coast. This

Figure 4. Heads of *Ceratopogonidae* (Biting Midges) (a) *Lasiohelea* (b) *Culicoides* (c) *Styloconops*



Atlas of Common Queensland Mosquitoes. Queensland Institute of Medical Research, 1982 species is a major pest because it occurs in very high numbers and has a habit of invading nearby residential or recreational areas.

Culicoides ornatus is becoming an increasing problem across northern Australia due to urban development encroaching nearer to their major breeding places.[5,6,7] They can impose serious restrictions on outdoor activities within flight range of their mangrove breeding sites due to the extremely annoying and painful bites, and to the discomforting after effects of the bites.

Bites of biting midges

It is only the female midges that bite. Biting midges do not transmit disease to humans in Australia. Their main human medical importance is as a biting pest.

Midges must take a blood meal for their eggs to mature. They do not, as is sometimes believed, urinate on people to cause discomfort. In the process of biting and sucking blood, they inject a salivary secretion that produces a skin reaction of varying intensity, depending on an individual's reaction. Bites usually produce a classic allergic response, with the first bite producing no noticeable effect, and the subsequent bites producing the reactions. If the exposure to midges is reasonably continuous, a process of desensitization may follow. People continuously exposed are usually tolerant to the bites, and generally have no reaction or show a mild reaction with a small red spot.[8]

The average reaction for newly exposed people is a red spot that develops a small dome shaped blister with a hole at the top. In people who are more sensitive to bites, the reaction may result in a red swelling over an area of a few centimetres. The bite area can be extremely itchy, and scratching is very difficult to avoid. Reactions may last 3 - 4 days with slowly decreasing irritation. Sometimes scratching breaks the skin and allows secondary bacterial infections that lead to unsightly sores and residual scarring.

Treatment of bites

Mild reactions from bites require little treatment other than the application of soothing lotions. Proprietary products such as Eurax, Stingose, Medicreme, Katers Lotion, Democaine and Paraderm cream can give relief from bites or prevent secondary infection. Useful non-proprietary products include tea tree oil, eucalyptus oil, aloe vera gel, or methylated spirits. Painful reactions to bites can be appreciably reduced by the intermittent application of ice packs to the bite site.

More severe reactions may need medical advice and systemic treatment using antihistamine products such as Phenergan, Telfast or Vallergan. Check with your doctor or pharmacist for available products and safety information.

Breeding sites of *Culicoides ornatus*

Culicoides ornatus is by far the most common biting midge pest around the coast of the Northern Territory.[3]

This midge breeds in the highest numbers in the dry season in the mangrove mud in the creek banks of upper tidal tributaries around the mean high water neap tide mark. This corresponds to an area reached by tides from 4.8 to 6.0 m in Darwin Harbor.[4,9] The prime breeding sites are in a narrow zone in the upper section of the creek bank associated with the occurrence of pneumatophores of the mangrove species *Avicennia marina* on narrow creek banks. The prime dry season breeding site has an upper limit where the *Avicennia* reduces in height and predominance, and a lower limit where the creek opens out from the overhanging *Avicennia* canopy.[4] Broad mangrove areas with many tidal tributaries will have a considerable area of breeding sites.

Other breeding sites of low to medium productivity occur at the front edge of the mangrove forest in the *Sonneratia* or woodland mangrove zone facing open water. These breeding sites are usually associated with mud substrates and not with sandy substrates. Narrow beach fringing mangrove areas are usually not appreciable sources of *Culicoides ornatus*, particularly in areas with sandy substrates.[4]

Another site exploited only in the wet season is in the *Ceriops* transition zone at the back of the creek bank forest. This is just below MHWS (Mean High Water Spring or average high tide mark) or 6.6m ACD (Admiralty Chart Datum) in Darwin harbor. This is where the mixed *Ceriops* starts in a transition from the taller creek bank mangroves to the smaller mangroves in drier, less frequently flooded areas only reached by tides from 6.5 to 6.8m.

The larvae are small active worm-like creatures that are confined to the surface mud. The larvae take in excess of 6 weeks to mature, when they change into a relatively inactive, air-breathing pupa. The pupa stage lasts only two to three days and the adults emerge around the time of neap tides.[9]

The flight activity of *Culicoides ornatus*

The numbers of adults emerging from pupa cases is related to the lunar cycle, with sudden rises in numbers inside their mangrove breeding sites of the order of 16 times the number occurring on the previous day. The peak in emergence occurs in the two days around the neap tide, although emergence of adults can continue for up to 4 days after the neap tide.[4]

The adults mate soon after emergence. The males are short lived while the females stay in the mangroves to develop and lay their first batch of eggs. The females then start to disperse from the mangroves in an active flight inland in search of blood meals. The dispersal starts about 2 days before the spring tide, and reaches a peak around the day of the spring tide. They show a marked abundance around spring tides with full moons, but are also numerous around spring tides of the new moon.[3]

The adults seek shelter in winds above 8 km/hour, so that there is little tendency for them to be borne long distances by strong winds. Light breezes from their breeding areas will however aid their dispersal flight. They are active fliers and despite their small size, are relatively hardy insects.

Mass movements of adults can occur to 0.5 to 1.5 km from the mangrove margin of their major breeding sites, although they will move greater distances up creeks and rivers with dense tree cover which form avenues of humidity for dispersal. The dispersal is a purposeful one, with the midges actively flying away from the mangroves. Often higher numbers can be found up to 1.0 km from the mangroves compared to numbers in the mangroves or at the mangrove margin. Elevated hills or escarpments within 1.5 km of prolific biting midge breeding sites often exhibit higher biting midge numbers compared with lower adjacent areas. Minor pest numbers can be detected up to 3 km from the nearest mangrove margin.

Most *C. ornatus* bite in the morning and evening. There is a peak in biting activity in the one hour either side of sunset, with a smaller peak in the one-hour after sunrise of about half the sunset peak. However there is a low level of activity throughout the night.

Seasonal abundance of *Culicoides ornatus*

The annual peak of *Culicoides ornatus* adults in the NT is in the August to October period in the late dry season, with lowest numbers in January and February during the wet season. Populations start to build up from the end of the wet season to the late dry season with a slight decrease in the coldest months of June and July. Populations start to decline rapidly after the first heavy rains occur. However pest numbers can still be present during the seasonal lows in the mid dry season and the mid wet season.

There are three different breeding sites in the mangroves, with varying seasonal productivity from the different breeding sites. Mangroves with small tidal tributaries that contain the prime creek bank breeding sites are dry season breeding sites. The greatest productivity from these creeks occurs in the August to October period. They are not significant sources of midges in the wet season.[4] The back of small mangrove creeks in the *Ceriops* transition zones has moderate productivity in the wet season.[4,9] Areas with extensive *Sonneratia* zones will have moderate productivity at least in the dry season[4] and probably all year around.

Highest numbers of *Culicoides ornatus* occur for the four days around the full moon, with high numbers to a lesser extent, four days around the new moon.

Protection from bites of *Culicoides ornatus*

Avoidance

Culicoides ornatus bite primarily in the early morning or evening around sunrise and sunset. Attacks can occur in the daytime in shaded areas adjacent to the mangroves near major mangrove breeding areas or in dense creek vegetation that is continuous with the mangrove breeding places. They will continue to bite throughout a still, humid day and warm humid night, particularly in sheltered areas outside the mangroves but close to their breeding areas. Often there is only a little biting activity in the mangroves during the day during and just after the spring tide, as all midges have usually dispersed landward.

Landward areas that are close to and within one kilometre of broad areas of mangroves with many tidal creek tributaries, especially near densely vegetated creeks that run into the mangroves, should be avoided. This particularly applies to the two days either side of the spring tides in the August to November period. Spring tides on full moons have roughly twice as many biting midges as spring tides on new moons.[3]

Minimum pest problems occur in the June-July period during the mid dry season or in January and February in the middle of the wet season. During any month the least pest problems occur in the two to three days either side of the neap tide, particularly neap tides following a new moon. A calendar marked with the 4 days around full moons and new moons, with highlights of seasonal peaks of abundance, can serve as a good midge avoidance reminder.

Biting midges are active under calm conditions and are generally inhibited by wind. Wind protected areas adjacent to and within 1.5km of large expanses of mangroves should be avoided around the spring tide period. People in open areas exposed to winds will experience less pest problems compared to other areas.

Elevated houses and high rise buildings have less pest problems than ground dwellings. Although midges probably fly over dense tree canopies and can fly in appreciable numbers at least 3 metres above the landscape surface, they are generally more numerous lower to the ground surface.[11]

The worst pest problems around Darwin include areas include landward areas adjacent to the mangroves and tidal areas of Sadgroves and Reichardt Creeks, Hudson Creek, Elizabeth River, and Buffalo Creek. The north shore of Frances Bay near Sadgroves Creek in the Charles Darwin National Park is a particularly troublesome area. This is due to the dendrite pattern of numerous narrow mangrove creeks and an extensive Sonneratia zone nearby. Urban areas of Stuart Park, the Narrows, and near Winnellie, which are closest to the Sadgroves creek mangroves, can experience seasonal moderate to minor pest problems. There are some minor pest problems near the lower reaches of Ludmilla creek and Alawa near Rapid Creek. Darwin city itself is relatively free from midges due to the relative lack of mangroves, the exposed cliffs, and the fact that the prevailing SE and NW winds do not blow from mangrove areas.

Clothing and netting

Full-length trousers, socks and shoes, and long sleeved shirts will usually provide considerable protection from midge attack. Pale clothing is generally less attractive than dark clothing. Any exposed part of the body will still be subject to midge bites, with most bites occurring on the legs. Protective clothing should be supplemented with the application of repellants on exposed skin.

Clothing impregnated with permethrin or bifenthrin insecticide offers considerable protection for people continually exposed to biting midges. Impregnation involves soaking the clothing in a prescribed volume and concentration of certain formulations of the insecticide. Protective clothing such as overalls and mosquito nets impregnated with permethrin or bifenthrin will remain effective through one or two washes at the most, and will need reapplication. The insecticides in these treatments can kill the insects after they land on them, but they can also have the effect of interfering with the normal biting behaviour. Impregnated clothes with the additional use of insect repellents can provide extremely good protection.

Normal insect nets and screens are usually not adequate to restrict entry to midges unless the mesh is very fine. Tents screens in particular should have mesh diameter approximately half that of normal mosquito netting. Clothing, screens, netting or tents can be impregnated with permethrin or sprayed with permethrin, bifenthrin or repellents containing Deet to increase their efficiency.

Houses should have outward opening doors and insect screens to prevent entry when opening doors during midge activity.

Repellents

Most repellents have limitations because of their short duration of effectiveness (about 2-4 hours) and their irritability to mucous membranes around the eyes and mouth. Care is needed with young children to avoid the spread of repellent to their eyes or mouth. Repellents are also removed by perspiration.

Repellents that contain Deet (diethyl toluamide) or Picaridin as the active constituent offer considerable protection. Mixtures of natural oils or oils with natural ingredients such as herbs or antiseptics are not as effective as repellents containing Deet or Picaridin. In general effective repellents require above 10% Deet and 9% Picaridin. Repellents in lotions are more effective than alcohol based spray-ons, while gels are the most effective formulations. Repellents can also be applied to mosquito netting or insect screens, although a sample application on a small piece of netting is wise as some repellents affect synthetics. Repellents containing relatively high amounts of Deet can melt some plastics, although those containing Picaridin don't have the same effect.

Other methods of repelling biting midges include the use of coils, repellent oil lamps, and electric vapor pads impregnated with insecticide. These work satisfactorily in closed situations such as rooms, or sheltered patio and veranda situations out of the wind, where a cloud of vapour or smoke can build up. However they cannot provide satisfactory protection in windy and exposed situations.

Smoke from a fire with green leaves will give some protection in emergency situations. Burning aromatic and oil producing foliage of plants such as *Hyptis* (horehound), *Calytrix* (turkey bush), *Melaleuca* species (paperbark) and *Eucalyptus* species (gum trees) can give appreciable protection. Rubbing the skin with the leaves of some of these plants can also provide some protection, but this is not as good as recommended repellents.

The so-called "electronic mosquito repellers" that emits a frequency that is supposed to repel biting midges by imitating the noise of males do not work and offer no protection against biting insect attack.

There is an urban myth that taking Vitamin B1 or thiamin can act as a repellent. There is no scientific evidence that Vitamin B1 acts as a repellent, or helps to reduce the reaction to insect bites by developing some immunity to the bites.[13] Other topical applications such as a Dettol™ and baby oil mixture do offer some physical barrier to biting midges, but are not as effective as Deet or Picaridin based repellents. The best protection from biting insects remains the avoidance of the problem areas at times of abundance and the use of protective clothing in combination with efficient repellents.

Use of lights

Biting midges can be attracted to lights. Houses in biting midge problem areas should have dull outside lighting, with little internal light visible from outside. Lightproof curtains that can be drawn at night offer a good alternative. Outside lights should be away from insect screens, as the midges attracted to the light can then penetrate the screens. Outside lights should be yellow (or red, which is even better) to reduce their attractiveness to biting insects. Attractive lights such as large incandescent bulbs or white or ultra violet fluorescent tubes positioned a distance away from a house or building can deflect biting midges to some extent. However rows of streetlights positioned between mangroves and residential areas are not effective barriers to midge dispersal inland.[11]

The reduction of vegetation

The reduction of vegetation around houses or recreation areas can reduce problems by removing shelter for the midges. A buffer of clear open space between the mangroves and residential areas can reduce biting midge numbers in a residential area, as long as the buffer is wide and subject to winds. However clear open buffers by themselves offer little protection unless they are at least 1 km wide. Mowing a wide margin around houses to eliminate dense grass can help reduce the available areas where midges can harbor.

The use of attractant traps

There are a number of insect attracting traps on the market. They generally use light or carbon dioxide as an attractant and either trap the insect in a container, electrocute, or drown the insects. Some are more useful than others but can not be relied to give considerable protection from bites for unprotected people in close proximity to the traps. In most cases they attract biting insects to the general vicinity and these are then diverted to people, who are more attractive targets. Some traps can help to reduce the overall population, as long as there are enough traps, the biting insect population is relatively small, and the area is isolated from re-invasion from other areas. However most trapping techniques can not cope with the huge populations of midges at one time, and those not trapped still result in a pest problem.

Evaluation of biting midge problems

The Medical Entomology Branch of the Department of Health and Community Services has conducted numerous investigations into biting midge problems in the Top End of the NT.[2,3,5] Potential problems have been investigated by trapping midges overnight using special carbon dioxide (CO2) baited traps. The number of midges collected can be counted or estimated by weight or volume and identified to species under a microscope in the laboratory.

The number of bites by biting midges that constitute a pest problem will largely depend on an individual. It has been suggested that over 60 bites per hour for most experienced biting midge workers are the thresholds of acceptability. For people unaccustomed to biting midge bites, even 1 to 5 bites per hour may be considered unbearable.

There is an approximate relationship between the number of midges collected in a CO2 trap and the number of bites that can be expected at the peak biting period. For an unprotected person, the number of bites in an hour at the peak biting time is approximately one quarter of the number collected in a CO2 trap over one night at the same position. Thus CO2 collections of over 240 per carbon dioxide trap per night are likely to represent a pest problem (equal to over 60 bites per hour) to unprotected people with prior experience of biting midges. Collections of over 1000 per trap per night represent over 250 bites in an hour and would constitute a major pest problem. Trap collections of over 5,000 per trap would constitute a severe pest problem.[3]

The numbers of *C. ornatus* collected by CO2 traps in different locations can indicate the magnitude of the human pest problem in each location. Trapping on a constant day in relation to the tide cycle over every month in a year can give an indication of the seasonal population fluctuations. Trapping at different distances from the mangroves and in different vegetation types can give an indication of the dispersal of midges into various areas.

Control of *Culicoides ornatus*

Insecticide fogging for adult midges

Insecticide fogging is the application of aerosol size particles directed against active flying insects. Insecticide fogging operations in residential areas by vehicle or hand held equipment are usually not very effective measures to eliminate pest problems, due to the rapid re-infestation of midges from nearby breeding and harborage areas. Sometimes re-infestation occurs very soon after the fog has cleared, although up to 12 hours protection can be achieved in some localized situations.

For effective midge control, the entire midge breeding and harboring area near residential development needs to be fogged each day over the 3-4 day period of peak emergence. This has to be timed to coincide with the time just after the midges have emerged and before they begin to disperse out of their breeding areas. This area would also have to be relatively isolated from other such areas to prevent re-invasion. Fogging also has to be carried out during the peak activity period in the evening and early morning.

For vehicle ground based operations, the fog has to be able to drift into the target area on favorable winds of the right velocity and in the right direction. This often reduces the opportunity for effective fogging. Fogs do not usually penetrate more than 50m into dense forested areas such as mangroves, monsoon forests and other thick vegetation.

One of the major problems is determining the level of control required. A reduction of *C. ornatus* numbers by 99% may be required to reduce a large pest problem to an appreciable level. This may be impossible to achieve for various operational purposes, and if there were still any remaining pest problem, the control would not be cost effective.

In the Darwin situation, the mangrove breeding and harboring areas are generally inaccessible, too wide, or too extensive for ground based application methods to effectively reduce midge numbers, although some temporary relief would be possible in some areas.

Aerial application of insecticides aimed at adult midges in breeding and harborage areas has given the best results in overseas investigations, but in some instances there has been immediate re-infestation. It is a difficult practice, as the breeding grounds have to be closely delineated and fogging must be based on an accurate forecast of adult emergence times. The fogging has to be with sufficient regularity to kill all the emerging dispersing females over the night and fog drift to nearby residential areas has to be avoided. Fogging is not carried out regularly for midge control in Australia and requires more local research. Fogging involves large continuing costs, which is often beyond the resources of many local authorities. Insecticide resistance and the killing of other insects pose additional potential problems.

Barrier spraying

The application of insecticides to create an artificial barrier or an insect killing zone around houses where biting insect harbor before biting offers some promise as a new control method. The application of residual insecticides to exterior walls, screens, patio plants, nearby hedging plants or lawns and other close vegetation may kill midges attracted to houses or people.[14] Insecticides that can be used include permethrin, deltamethrin and bifenthrin. Bifenthrin has the advantage over other similar insecticides, as it appears to have less of a repellent or agitation effect on insects, is less irritant to people, is ultra violet resistant, and binds very well to surfaces to give it a good residual effect.[14] As with all synthetic pyrethroids, it must only be applied as per the label and kept out of fish habitats.

Insecticide control of larval habitats

Breeding site treatment by applying insecticides to kill larvae before emergence of adults is a possible control method but there have been very few examples of successful larval treatment in mangrove areas. Larval habitat treatment involves considerable costs and organization, which is impractical in extensive breeding areas such as those surrounding Darwin. Insecticides would need to have good residual qualities and be able to penetrate dense mangrove tree cover and mud in a tidal situation. Most insecticides with these qualities would generally kill non-target insects. The problem of accurately delineating all the significant breeding sites and the seasonal fluctuation of breeding sites pose additional problems.

Elimination of breeding habitats

Reclamation of mangroves has been successful in eliminating biting midge breeding sites in various localized situations. This usually requires large amounts of fill material which is neither cheap or readily available. For *Culicoides ornatus*, the reclamation needs to extend from near the average high tide level to below the outer mangrove forest. This may involve significant engineering considerations posed by deep mud and erosion of the filled area.

Reclamation would not be practicable in most of the Darwin area because of the extensive areas involved. The destruction of large areas of mangroves would be environmentally undesirable and unacceptable to public opinion. This potential solution would only be practicable in localized areas if the breeding site was small, in close proximity to residential development, was regarded as an area of reduced environmental importance, and the filling could create a stable shore environment.

There should be conclusive evidence that the site to be reclaimed is a significant source of biting midges and that the midges are significant pests to nearby residential development. Mangroves can be an indicator of biting midge breeding sites, but the presence of mangroves does not confirm any site as the breeding place. Other specific factors such as substrate types are involved in productive breeding sites.

Buffer zones

There is some evidence that creating a buffer zone between urban residential development and mangrove areas can reduce the dispersal of biting midges into residential areas. Clearing of vegetation and mowing to allow wind disruption, or extensive streetlights or roads with active traffic in the buffer zone may enhance the buffer to some extent.[3] However extensive testing of a modified buffer with lights and different vegetation types in Darwin have shown that unmodified buffers and lights by themselves are not effective barriers to *C. ornatus* dispersal from mangroves to urban areas.[11] The effectiveness of buffers is generally related to the width of the buffer and the presence of blood sources or other attractions such as light in the buffer zone. However semi-urban residential or industrial development between mangroves and urban areas can reduce midge dispersal inland. In general, unmodified buffers need to be in the order of 1.5km, and modified buffers in the order of one kilometre to offer significant reduction in numbers.

Planning guidelines to prevent biting insect problems

The Medical Entomology Branch is involved in the planning process to reduce the effects of biting insects. Guidelines have been prepared for preventing biting insect problems in new urban and semi rural residential developments, industrial, and other developments.

In 1974 the planning for the new satellite town of Palmerston near Darwin included a buffer of at least 1-km from the mangrove boundary to urban residential development.[12] Palmerston is one of the few urban areas in Australia that has been specifically designed to minimize biting insect problems.

Good urban planning is required to;

- reduce the risk of biting insect pests
- recognize and avoid areas of biting insect breeding or harborage
- avoid costly and environmentally undesirable rectification methods
- avoid costly and ongoing biting insect control programs

The Medical Entomology Branch gives advice on what may constitute a potentially significant biting insect breeding site. In some instances detailed entomological investigations are necessary to gather sufficient information before the detailed planning stage. The avoidance of biting insect problems can be achieved in the initial planning process by consideration of development location, easements, buffer zones, and sub division design.

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Initial survey of underground mosquito breeding sites in Darwin, NT

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Introduction

Several studies on the dengue vector *Aedes aegypti* in northern Queensland have revealed a considerable percentage of the larval population to be living and surviving the unfavourable dry or winter season in underground breeding sites.[1,2] Service pits and manholes have been found to contain mosquito larvae.[1,3] The presence of natural predators of mosquito larvae such as *Mesocyclops* (Crustacea, Copepoda) species is known to considerably reduce mosquito breeding in service pits and manholes.[2, 3]

Darwin and the NT are free from the two main dengue vectors *Aedes aegypti* and *Aedes albopictus*.[4, 5] Darwin is considered a locality of high risk for the introduction of these exotic *Aedes* species.[5, 6] The Medical Entomology Branch (MEB) and the Australian Quarantine and Inspection Services (AQIS) carry out a comprehensive exotic mosquito surveillance program with the main goal to enable early detection of any exotic mosquito importation and institute elimination procedures.[7]

Since surveys began in 1974 all importations of exotic *Aedes* mosquitoes in Darwin have been successfully eliminated.[4, 8, 9] However, there is always the possibility of late detection, which could lead to the establishment of dengue vectors. The current paper is a preliminary investigation of the abundance of, and potential for, mosquito breeding in underground sites such as Telstra pits and manholes in Darwin. The purpose of the survey was to confirm the presence of water in pits and manholes, and sample these for mosquito larvae and aquatic predators such as *Mesocyclops*.

Methods

A Telstra officer and a MEB officer jointly carried out the initial survey on 27th March 2003. The Telstra officer opened the pits and manholes according to Telstra safety procedures and requirements. A manhole allows the entry of personnel to inspect and work inside the facility. The smaller pits are designed for inspection and maintenance purposes and do not allow physical entry by personnel. The manholes and pits sampled were selected for their likelihood of holding water near the end of the wet season.

The presence or absence of water was recorded. Water depth was measured using a ruler. Sampling for mosquito larvae and other aquatic invertebrates, including plankton, was carried out using a 100 ìm mesh plankton net of 20 cm length with an opening of 20 cm x 10 cm on an extendable handle.[10] The net was swept along the sides and corners of the manhole/pit on the surface and then in deeper water for 50-60 seconds. The net was emptied into a photographic tray and the sample transferred to sealable containers. The samples were taken to the MEB laboratory and placed into 70% ethanol. Mosquito larvae were identified using a stereo microscope. Plankton was sorted and *Mesocyclops* specimens were identified to genus level under a compound microscope.

Results

During the initial survey, ten service manholes and six pits were sampled (Table 1). Of these, more than half of the manholes were found to hold water, but only 1 pit held water (Table 1). The service pit holding water did not contain mosquito larvae or *Mesocyclops*. Of the 6 manholes holding water, 3 were breeding mosquitoes and 1 had *Mesocyclops* (Table 1). The copepods remain to be identified to species level to determine if they are potential mosquito larval predators. The mosquito larvae were all *Ochlerotatus (Mac) tremulus*.

Discussion

This survey of service manholes and pits at the end of the wet season in Darwin revealed the presence of water and mosquito larvae. The only mosquito species recorded was *Ochlerotatus tremulus*, an endemic species that is known to use both natural and artificial containers as breeding sites.[11] This species was also commonly found in the surveys of underground breeding sites in Queensland.[2, 3, 12] These studies often found a close association between the presence of *Ochlerotatus tremulus* and *Aedes aegypti*.[2, 12] The presence of *Ochlerotatus*

Table 1. Summary of survey of Telstra service pits and manholes in Darwin, 27 March 2003

Type	Number sampled	Number holding water	Number positive for mosquito larvae	Number positive for *Mesocyclops*
Manhole	10	6 (60%)	3 (30%)	1 (10%)
Pit	6	1 (16.7%)	0 (0%)	0 (0%)
Total	**16**	**7 (43.8%)**	**3 (18.8%)**	**1 (6.3%)**

tremulus in manholes in Darwin indicates their potential to serve as potential breeding sites for *Aedes aegypti*.

A larger survey is planned for the wet season 2003/04 to establish the amount of endemic mosquito breeding in manholes and pits, and the duration of breeding throughout and after the wet season. Part of the study will aim at establishing the relationship between a manhole or pit holding water with the recent rainfall, the soil type and topography. It is also planned to survey other underground breeding sites, such as PowerWater manholes and roadside side entry pits (SEP's) of underground stormwater drains. The results of these surveys will form the basis of a dengue management plan for Darwin and the Northern Territory.

Conclusions

Mosquito breeding does occur in underground manholes, indicating the possible use of underground breeding sites by exotic *Aedes* mosquitoes. These sites will require specific precautionary treatment in the quarantine area for all future risk importation of exotic *Aedes* mosquitoes. A larger survey in cooperation with Telstra will investigate mosquito breeding in the underground sites on a temporal and spatial scale.

Acknowledgments

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Firework related injuries during Territory Day Celebrations 2003

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Introduction

Active surveillance of firework injuries has been conducted annually by the Centre for Disease Control (CDC) in the Darwin region over the last 5 years. To gain a Territory-wide perspective of injuries, the information was collected over the entire Northern Territory (NT) in 2003.

Methods

Between the 28th of June and the 8th of July 2003 nursing staff in all NT hospitals collected data from people presenting to the Emergency Departments with injuries sustained from fireworks. Data was also collected over the same period at General Practices, the Australian Defence Force Health Services, Aboriginal Medical Services, Community Health Clinics, and Community Care Centres in the NT.

Survey forms were sent to the above health services and completed forms were faxed back at the end of the study period. A consent form allowed officers from Worksafe to conduct follow-up interviews to determine whether the injuries were due to faulty or illegal fireworks or unsafe use.

Results

In 2003 there were 32 people reported with injuries due to fireworks: 21 in Darwin/ Palmerston, 6 in Katherine, 3 in Alice Springs and 2 in Jabiru. The Top End of the NT reported 91% of the injuries. All injuries were sustained at private displays, predominantly by bystanders.

Of all persons injured by fireworks, 60 % occurred in males and 45% were in the 16-30 year age group (Figure 1).

Injuries to the hand (23%), lower extremities (23%) and eye and facial regions (31%) were the most common body regions affected (Figure 2). Of all persons injured, 62% were classified as moderate or severe (Figure 3). One injury required immediate admission and an eye injury required extensive review and day surgery at a later date.

Mechanisms of injury

Injuries in 2003 were caused in the following ways:

- 2 incidents where several sparklers were held together and burned rapidly resulting in severe hand burns;

Figure 1. Firework related injuries 2003 by age and sex

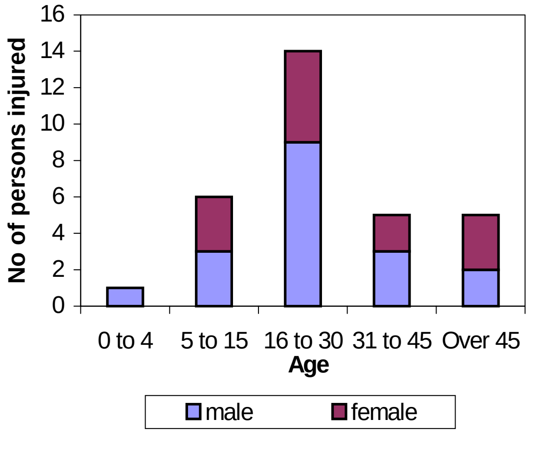


Figure 2. Body region affected by firework related injury

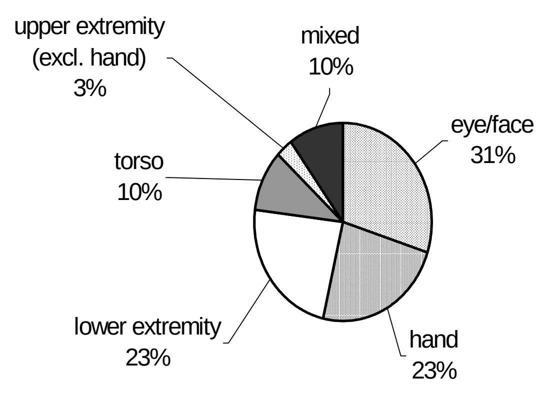
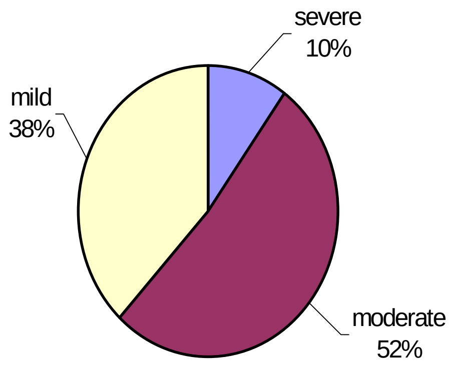


Figure 3. Severity of Firework related injury



Severe: admitted to hospital for IV antibiotics, analgesia, dressings, grafts
Moderate: requiring 2 or more reviews by a health practitioner
Mild: requiring only one visit to a health practitioner

- 3 incidents where fireworks exploded near faces creating eye injuries and facial burns (1 person continues to have treatment and requires day surgery for his eye);
- A 4 year old child was injured when his trousers were set alight by wayward fireworks;
- A wayward firework exploded under a plastic chair resulting in burns to the buttocks and thighs, and shrapnel injuries requiring a 3 day hospital admission.
- A firework hit a male in the genital and upper thigh area causing partial thickness burns; and
- Extinguishing a cigarette in an ash tray containing gunpowder residue from fireworks created a forceful explosion causing full thickness hand burns.

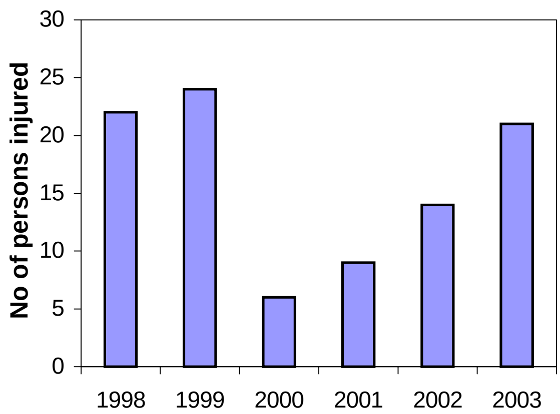
In the NT there have been 16 presentations to Emergency Departments, 28 appearances at the Burns Clinic, 1 immediate hospital admission, 2 surgical procedures, 12 Ophthalmology consultations, and 47 GP clinic visits from 28 June to 30 August 2003.

Trends

Comparison with previous years data from Darwin urban region allowed trends to be examined. Following an initial decline in the number of persons injured in 2000 there has been an increase between 2000 and 2003 (figure 4).

There were 7 more persons injured by fireworks reported this year compared to 2002 (Figure 4). Of these, 40% were sustained by 16-30 year olds (Figure 5) and 52% sustained by males. There were fewer severe injuries (2) reported this year compared to 2002 (5) with 57% of all firework injuries classified as moderate.
The estimated cost of health care to treat

Figure 4. Total number of persons injured by fireworks in Darwin 1998-2003

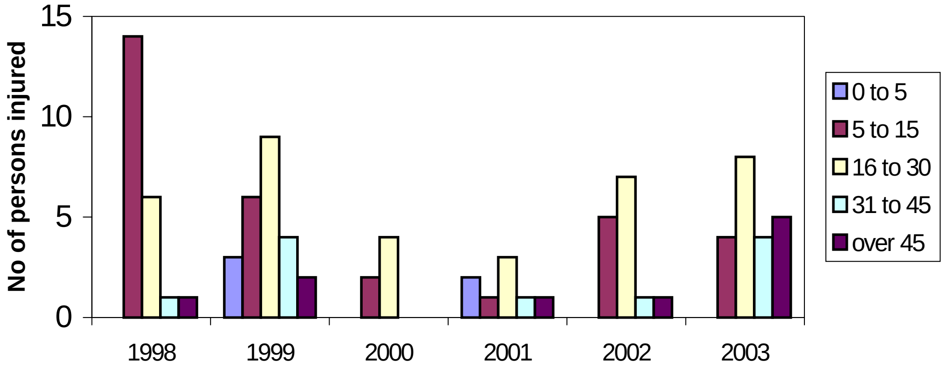


firework related injuries in the Darwin/ Palmerston region decreased this year compared to last year from $33,421 to $15,839. This may have been due to fewer severe injuries this year. These costs were calculated by the NT Department of Health and Community Services (DHCS) with assistance from the Hospital Services Program.

Other Community Reports

The Fire Department in the Darwin/Palmerston region reported 27 call outs this year compared to 66 in 2002. The Police also reported fewer call outs and the RSPCA reported fewer complaints compared to previous years.

Figure 5. Number of persons injured by fireworks by age group in Darwin 1998-2003



These reports stated that people were generally "well behaved". However there were several dangerous incidents on Territory Day. Many people took private fireworks to Mindil Beach in Darwin, the site of a public fireworks display. The combination of a high tide reducing the area for release of fireworks, and the vast number of people present (estimated at 14,000), created a hazardous environment.

Discussion

The number of persons injured by fireworks has steadily increased in the Darwin/Palmerston area in the last three years. In 2000 there was a decline in cases which coincided with the implementation of the Worksafe coordinated Fireworks Working Group. The Group consisted of representatives from Worksafe, Fire and Emergency Services, Department of Employment Education and Training, NT Police, and the DHCS. The aim of the group was to promote safer firework celebrations on Territory Day and provide ongoing implementation of safety campaigns.

In 2003 the strategies employed by the group included reducing the duration of sale of fireworks from 3 days to 2 days, conducting Burns Awareness Week in the week prior to Territory Day, and running a Safe Use of Fireworks campaign in schools. School age children were targeted for safety messages this year with 16,500 fliers placed in school newsletters across the NT. The 2003 safety campaigns obtained a higher profile than previous years. Interviews and paid newspaper advertisements promoted safe use of fireworks, exposed illegal wholesalers, and discussed the School Campaign. Despite these measures the injury rate has increased.

The data obtained from the 2003 survey across the NT will assist in allowing comparisons in future years and help direct safety campaigns. Of concern in 2003 was the relatively high number injured in Katherine compared with other areas.

Future safety campaigns need to be directed towards young adult males as a large proportion of injuries in 2003 were sustained in this population group. The public also needs to be educated on the safe use of sparklers as annually there are several injuries due to mishandling. Worksafe are currently investigating each person injured to determine whether the cause was incorrect use or faulty product.

As a result of the injury surveillance from 2003 the DHCS has come up with the following recommendations:

- Continue the DHCS Firework-related Injury Survey across the NT
- Ban private fireworks displays at Mindil Beach and other public displays
- Coordinate a media campaign to encourage the public not to take fireworks to public displays
- DHCS to continue to work with the Fireworks Safety Group to target young adult males in future safety campaigns
- Educate community on safe use of sparklers

Acknowledgments

Special thanks to Jackie Mein who first implemented the community surveillance of firework injuries in 1998.

TB control in the Darwin Correctional Centre and the crew of boats carrying asylum seekers

Nathan Zweck, Merv Fairley, Paul Kelly, Vicki Krause – TB unit, CDC Darwin

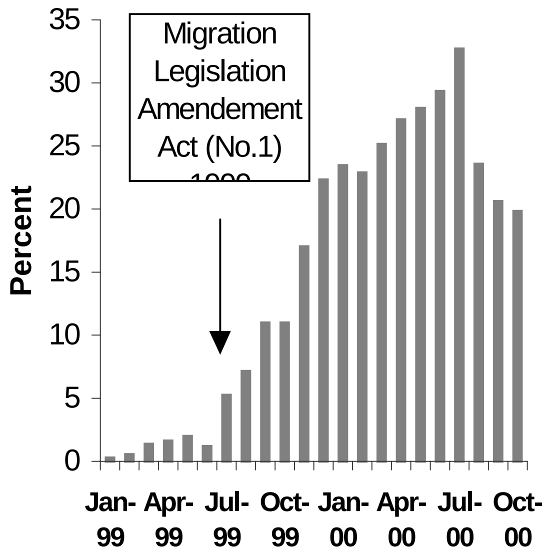
Introduction

Until 1999, screening of inmates for tuberculosis (TB) in the Darwin Correctional Centre (DCC) consisted of a Mantoux test on reception, which if positive (≥10mm induration) was followed by a chest x-ray days or weeks later. Each inmate also underwent a reception clinical examination by the prison's medical officer which included the symptoms and signs of TB.

However, a recent change in Commonwealth legislation necessitated an intensified approach. The *Migration Legislation Amendment Act (No. 1) 1999* was introduced in July 1999 in the Northern Territory (NT) and provided for harsher penalties for the Indonesian crew of boats carrying asylum seekers to Australia (up to 10 years in prison and a maximum fine of $110,000).[1] Prior to this, the maximum penalty was 2 years imprisonment[2], but crewmembers were usually deported soon after their cases were heard in the Darwin Magistrate's Court. Since September 1999 they have been tried and sentenced (usually for several years) in the Supreme Court of the NT. The previously negligible fraction of the prison population who were Indonesian nationals subsequently burgeoned to 33% (119/364) by July 2000 (S. LaBrooy, personal communication, November 2000, Figure 1). This influx was additional to small background numbers of Indonesian fishermen who have been incarcerated in DCC for days or weeks for offences under the *Fisheries Management Act 1991*.

The estimated annual TB incidence in Indonesia in 2001 was 271 per 100,000 population[3], around 10-fold that in the NT. Therefore, crew from Indonesia have a higher probability of entering DCC with active pulmonary TB (PTB) than Australian-born prisoners. The standard process for TB screening had the potential for unacceptable delays of days or weeks before disease detection. Therefore, since August 1999 Indonesian nationals have been screened with a chest x-ray as soon as possible after reception *regardless of Mantoux results*, and since March 2000, with the cooperation of the Department of Immigration, Multicultural and Indigenous Affairs (DIMIA), Australian Federal Police, Northern Territory Correctional Services, and the Royal Darwin Hospital, a chest x-ray has been performed at the Royal Darwin Hospital *prior* to reception at the DCC.

Figure 1. Indonesian nationals as a proportion of the Darwin prison population, January 1999 to October 2000



This report describes the prevalence of latent TB infection (LTBI) and active TB in a cohort of Indonesian inmates and judges whether intensified control activities for this group are justified.

Methods

Data collection and analysis

Data were collected in an Access database about DCC inmates (or those in custody and destined for DCC) who were clinically assessed at least once by staff of the NT Department of Health and Community Services TB Unit in the years 1999-2002. Data described by quarter or by year, refers to the date first assessed by the TB unit. Statistical analysis was performed using SPSS software (SPSS for MS Windows, release 6.1).

Table 1. Summary of screening procedures for TB in different groups of prisoners and detainees

Crew carrying asylum seekers	♦ CXR and report by TB Unit or Emergency Department medical officer prior to reception at DCC*
Unauthorised fishermen	♦ Symptom screen while detained on Darwin Harbour; ♦ assessment by medical officer (general practitioner) if symptom screening positive; ♦ CXR and TB Unit assessment prior to court appearance if medical
All prisoners	♦ Mantoux test, and assessment by prison medical officer at reception in DCC; ♦ CXR and review by TB Unit medical officer if Mantoux test positive (>=10mm) or symptoms suggestive of TB

*since March 2000; † since February 2001

Diagnosis of LTBI and TB

Screening of prisoners and those destined for prison varied according to a classification summarised in Table 1. At reception all prisoners underwent Mantoux testing with 10 international units of purified protein derivative intradermally (left forearm, flexor aspect) by staff of the private prison clinic contractor, unless they had a history of a positive Mantoux test or clinical TB. Inmates with ≥10mm induration had a chest x-ray and a clinical assessment by visiting staff of the TB Unit. If active TB was excluded, LTBI was diagnosed. Treatment of LTBI was offered if the sentence length allowed completion before discharge and there were no medical contraindications.

Screening crew of boats carrying asylum seekers

Since August 1999, all Indonesian crew were screened with a chest x-ray as soon as possible after reception regardless of Mantoux results. Since March 2000 those crew charged by the Australian Federal Police were screened for signs of active pulmonary TB with a chest x-ray at the Royal Darwin Hospital *prior* to reception at the DCC. If necessary, they were admitted to a respiratory isolation ward-room, investigated, and treatment was initiated there. When considered non-infectious (3 consecutive sputum specimens negative for acid-fast bacilli on microscopy) they were transferred to DCC where treatment was continued.

Screening of fishermen

Those charged with unauthorised fishing in Australian waters were detained in their vessels on Darwin Harbour awaiting arraignment to the Darwin Magistrate's Court, and a small proportion were ultimately incarcerated in DCC, usually for several weeks. Since February 2001, harbour detainees who were likely to be arraigned (captains and repeat offenders, around 100 per year) underwent screening for TB with a symptom questionnaire administered by staff of Barefoot Marine Pty Ltd with an Indonesian interpreter. If TB was suspected, they were reviewed by a designated Darwin general practitioner, and if required, chest x-ray screening was performed.

Definition of active TB

The diagnosis of active TB was according to the case definitions for TB in the NT[4]:

1. Isolation of *Mycobacterium tuberculosis* complex (*M tuberculosis*, *M bovis*, *M africans*) from a clinical specimen, or
2. Demonstration of AFB in a clinical specimen or in a histopathological specimen when a culture is not available in a patient with compatible symptoms or clinical or radiological signs, or
3. Compatible signs and symptoms and evidence of resolution following anti-TB treatment.

Definition of the completion of LTBI or TB treatment

Treatment for LTBI constituted 182 doses of isoniazid (6 months, daily administration) within 8 months or 60 doses of rifampicin and pyrazinamide or "2RZ" (2 months, daily administration) within 3 months. Treatment success was defined as ingestion of >=80% of

Table 2. Characteristics of 743 inmates clinically assessed in Darwin by the TB Unit, 1999-2002, by ethnicity

Factor	All n=743	Ethnicity			
		Aboriginal n=292	**NAAB*** N=85	**Indonesian** N=326	**Other OSB**[†] n=40
Age					
Median (Range)	29 (10-75)	31 (10-55)	36 (11-65)	25 (21-75)	39 (15-65)
Gender					
Male %	97.8	96.9	92.9	100	97.5

*NAAB = Non-Aboriginal Australian-born; [†]OSB = Overseas-born

the intended doses within the allowed time-frame. Treatment for TB constituted 182 doses of combined treatment (6 months, daily administration) within 8 months. Treatment success was defined as ingestion of >=80% of the intended doses (i.e. 146 doses) with 8 months, provided that 28 or more consecutive doses were not missed. If 28 or more consecutive doses were missed, a full course of treatment was recommenced.

Results

There was a total of 743 inmates clinically assessed on at least one occasion by the TB unit on, or prior to, arrival at the Darwin Correctional Centre in the 4-year period 1999 to 2002. The demographic details of the group are displayed by ethnic classification in Table 2. Of 743 inmates, 326 (44%) were Indonesian citizens and all Indonesians were male. Of the Indonesians, 284 (87%) were charged with transporting asylum seekers and 42 (13%) were charged with unauthorised fishing in Australian waters. The median age of the Indonesians was significantly lower than that of the other 3 ethnic groups combined (25 v 32 years; Wilcoxon Rank Sum test, $p < 0.0001$). Almost one-third (104/326) of the Indonesians were aged 12 to 19 years. None of the Indonesians were HIV-seropositive.

Latent TB

Of the total of 743 inmates assessed, 656 (88%) were diagnosed with LTBI, 17 (2%) had active TB, and 70 (9%) were not infected with TB (Table 3). The majority of those not infected (56/70) were Indonesians who were assessed by the TB unit whether their Mantoux result was positive or negative, in contrast to other ethnic classifications who were seen only if they recorded a positive Mantoux test or were symptomatic.

Of 326 Indonesians assessed, 323 (99%) underwent Mantoux testing and 268 (83%) of those tested had induration measuring ≥10mm (Figure 2). The 3 Indonesians not Mantoux tested included 2 fishermen who were deported prior to incarceration but after clinical and radiological assessments. After excluding 13 with active TB, 255 (95%) of the 268 with positive Mantoux tests were diagnosed with LTBI, 173 (68%) of whom accepted and commenced treatment. The completion rate was 96%.

Figure 2. Mantoux results and outcome of treatment of LTBI for Indonesian inmates

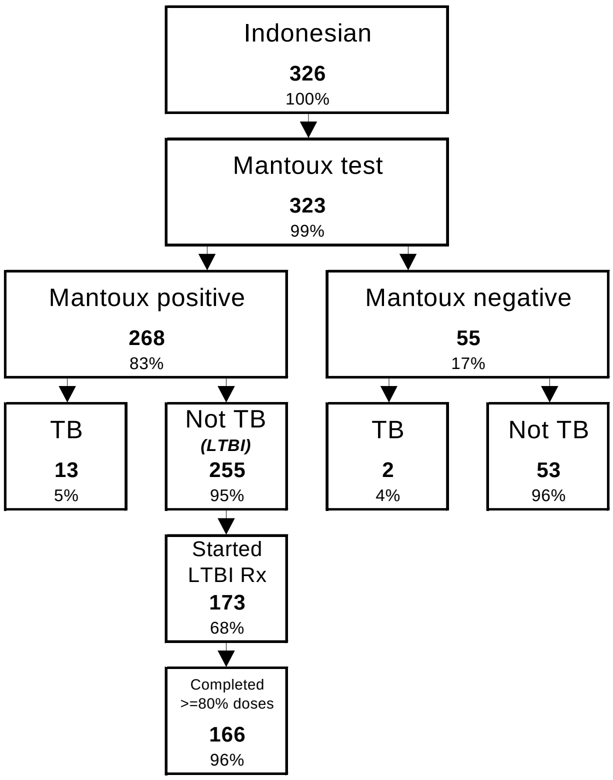


Table 3. Diagnoses, and outcomes of treatments, for all inmates assessed in Darwin by the TB unit, 1999-2002, by ethnicity

	All		Aboriginal		NAAB		Indonesian‡		Other OSB	
	n	%	n	%	n	%	n	%	N	%
Diagnosis										
LTBI	**656**	*88.3*	**285**	*97.6*	**80**	*94.1*	**255**	*78.2*	**36**	*90*
TB	**17**	*2.3*	**1**	*0.3*	**0**	*0*	**15**	*4.6*	**1**	*2.5*
Not infected	**70**	*9.4*	**6**	*2.1*	**5**	*5.9*	**56**	*17.2*	**3**	*7.5*
Total seen '99-2002	**743**	*100*	**292**	*100*	**85**	*100*	**326**	*100*	**40**	*100*
LTBI treatment										
INH completed pre-99	**17**	*2.6*	**11**	*3.9*	**5**	*6.3*	**0**	*0*	**1**	*2.8*
INH started 1999-2002	**222**	*33.8*	**35**	*12.3*	**9**	*11.3*	**173**	*67.8*	**5**	*13.9*
2RZ started 1999-2002	**8**	*1.2*	**5**	*1.8*	**3**	*3.8*	**0**	*0*	**0**	*0*
LTBI Rx not started	**409**	*62.3*	**234**	*82.1*	**63**	*78.8*	**82**	*32.2*	**30**	*83.3*
Total	**656**	*100*	**285**	*100*	**80**	*100*	**255**	*100*	**36**	*100*
Outcome of INH for LTBI 1999-2002										
Completed 100% doses	**191**	*86*	**23**	*65.7*	**3**	*33.3*	**161**	*93.1*	**4**	*80*
80-99% of doses	**8**	*3.6*	**3**	*8.6*	**0**	*0*	**5**	*2.9*	**0**	*0*
< 80% of doses	**12**	*5.4*	**4**	*11.4*	**2**	*22.2*	**5**	*2.9*	**1**	*20*
Stopped ADR	**4**	*1.8*	**1**	*2.9*	**1**	*11.1*	**2**	*1.2*	**0**	*0*
Still taking	**7**	*3.2*	**4**	*11.4*	**3**	*33.3*	**0**	*0*	**0**	*0*
Total	**222**	*100*	**35**	*100*	**9**	*100*	**173**	*100*	**5**	*100*
Outcome of 2RZ for LTBI 1999-2002										
Completed 100% doses	**6**	*75*	**3**	*60*	**3**	*100*	**0**	*0*	**0**	*0*
< 80% of doses	**1**	*12.5*	**1**	*20*	**0**	*0*	**0**	*0*	**0**	*0*
Stopped ADR	**1**	*12.5*	**1**	*20*	**0**	*0*	**0**	*0*	**0**	*0*
Total	**8**	*100*	**5**	*100*	**3**	*100*	**0**	*0*	**0**	*0*
Outcome of TB treatment 1999-2002										
Completed 100% doses	**14**	*82.4*	**1**	*100*	**0**	*0*	**13**	*86.7*	**0**	*0*
< 80% doses (deported)	**1**	*5.9*	**0**	*0*	**0**	*0*	**1**	*6.7*	**0**	*0*
Deported pre-diagnosis	**2**	*11.8*	**0**	*0*	**0**	*0*	**1**	*6.7*	**1**	*100*
Total	**17**	*100*	**1**	*100*	**0**	***0***	**15**	*100*	**1**	*100*

‡ All Indonesian inmates were assessed whether Mantoux positive or negative; other ethnic groups were assessed if Mantoux positive at reception or previously
NAAB, non-Aboriginal Australian-born; OSB, overseas-born; LTBI, latent TB infection; TB, active tuberculosis; INH, isoniazid; 2RZ, rifampicin and pyrazinamide for 2 months; ADR, adverse drug reaction

Excluding those who had completed LTBI treatment before 1999, 36% (230/639) of all inmates with LTBI accepted treatment with either 6 months of isoniazid (97%) or 2RZ (3%). The acceptance of treatment for LTBI by eligible Indonesians was high (68%) compared with eligible members of other groups, ie. 15% for Aboriginal, 16% for NAAB, and 14% for non-Indonesian overseas-born (Figure 3). The proportion of all inmates who did not complete LTBI treatment due to discharge from prison or an adverse drug reaction was 7% for isoniazid (16/222) and 25% for 2RZ (2/8). Only 4% (7/173) of the Indonesian cohort failed to complete LTBI treatment compared with 14% of Aboriginal, 33% of NAAB, and 20% of other OSB inmates (Figure 2).

Active TB

Pulmonary TB was diagnosed in 17 persons including 15 Indonesian nationals, 1 Aboriginal, and 1 Vietnamese national (Table 4). Diagnosis was by pre-reception or reception screening for 16 cases, while 1 case arose later during the period of incarceration after pre-reception assessment had excluded active TB (Box 1, Case B, p 23). Respiratory specimens were culture-positive for *Mycobacterium tuberculosis* (MTB) in 7 cases (41%) and 1 of these was sputum smear-positive for acid-fast bacilli. The remaining 10 cases (59%) were smear-negative and culture-negative for MTB and the diagnosis was made by excluding other aetiologies and taking into account clinical and radiological findings and their improvement with anti-TB treatment.

Of 326 Indonesians, 15 (4.6%) were diagnosed with active PTB during the study period including 14 cases diagnosed at the time of arrival in Australia (prevalent cases). The point prevalence of TB in this cohort on arrival was 14/326 or 4.3% (95%CI: 2.1-6.5%) and for culture-positive cases 6/326 or 1.8% (95%CI: 0.4-3.3%). Of the 312 Indonesians who did not have prevalent TB on arrival, 1 (0.32%) later developed incident disease.

All 7 culture-positive cases of TB (6 Indonesians, 1 Vietnamese) had isolates sensitive to the 4 standard anti-TB drugs used in the NT - rifampicin, isoniazid, pyrazinamide, and ethambutol.

Table 4. Details of 17 persons diagnosed with TB disease in custody or in prison in Darwin, 1999-2002.

Case no.	Quarter-Year first seen	Age	Ethnicity	Symptoms (a)	Offence (b)	Mantoux test(mm)	Sputum mycobacteriology results				CXR (e)	Case def.inition (f)
							Smear (c)	Culture	ID (d)	Sensitivity Profile		
1	3-1999	60	Indonesian	NS	Crew	30	-	+	MTB	RZHE (g)	F, C	1
2	3-1999	43	Indonesian	-	Crew	32	-	+	MAC		C	3
3	3-1999	53	Indonesian	C, F	Crew	0	-	-	-		F, C	3
4	3-1999	30	Indonesian	C	Crew	12	- (h)	+	MTB	RZHE	F, C	1
5	4-1999	30	Indonesian	W, NS	Crew	45	-	-	-		C	3
6	4-1999	49	Indonesian	-	Crew	22	-	+	MTB	RHZE	F, C	1
7	4-1999	30	Aboriginal	C, H	Other	16	-	-	-		F, C	3
8	4-1999	50	Indonesian	C, F	Crew	14	-	-	-		F, C	3
9	1-2000	36	Indonesian	H, W, P	Crew	25	-	-	-		C	3
10	2-2000	19	Indonesian	W	Crew	28	-	+	MAC		C	3
11	2-2000	58	Indonesian	C, H	Crew	10	-	-	-		F, C	3
12	4-2000	60	Indonesian	C, S, W, F, NS	Crew	15	-	-	-		F, C	3
13	4-2000	48	Indonesian	C, H	Crew	20	-	-	-		F, C	3
14	4-2000	35	Indonesian	C, W	Fisherman	0	-	+	MTB	RHZE	C	1
15	3-2001	42	Indonesian	S	Crew	30	-	+	MTB	RHZE	C	1
16	4-2002	41	Indonesian	NS	Fisherman	27	- (i)	+	MTB	RHZE	C	1
17	4-2002	43	Other OSB	W, H	Visa expiry	17	+	+	MTB	RHZE	F	1

Key: (a). Symptoms – C, Cough; S, Sputum production; W, Weight loss; H, Haemoptysis; F, Fever; NS, Night Sweats; P, Chest pain (b). Offence – Crew, crewmember of a boat carrying asylum seekers; Fisherman, unauthorised fishing in Australian waters (c). -, negative; +, positive (d). ID, Species identification; MTB, Mycobacterium tuberculosis; MAC, Mycobacterium avium complex (e). CXR, chest x-ray findings; F, fibrosis; C, consolidation (f). See methods section for 3 case definitions (g). R, rifampicin; Z, pyrazinamide; H, isoniazid; E, ethambutol (h). Bronchoalveolar lavage specimen (I). Induced sputum specimen

Table 5. Univariate analysis for selected variables and the prevalence of TB among Indonesian inmates at reception

	Sample N	TB	Not TB	Prevalence per 100,000	Odds Ratio	95% Confidence Interval	p-value
Mantoux result							
Median (mm)		21	18				0.29
>= 10mm	268	12	256	4478	1.24	0.38-4.0	1.0
< 10mm	55	2	53	3636			
>= 30mm	30	4	26	13333	4.35	1.28-14.8	0.03
< 30mm	293	10	283	3413			
Total	323	14	309				
Age							
Median (yrs)		45.5	24				< 0.0001
>= 40 yrs	54	10	44	18519	15.2	4.56-50.5	< 0.0001
< 40 yrs	272	4	268	1471			
Total	326	14	312				
Year assessed							
1999	77	7	70	9091	3.46	1.17-10.2	0.03
2000-02	249	7	242	2811			
Total	326	14	312				
Offence							
Crew	283	12	271	4240	0.89	0.10-7.57	0.7
Fishing	42	2	40	4762			
Total	325	14	311				

Predictors of active TB among the Indonesian cohort at reception

Table 5 shows the univariate analysis for possible predictors of all TB cases diagnosed in Indonesians at the time of prison reception. The median age at the time of first assessment of the 14 cases with active TB (45.5 years) was significantly higher than for the 312 who did not have active TB (24 years). The odds ratio for TB for those 40 years and over was 15.2 (95%CI: 4.6-50.5) compared with those under 40 years of age. A positive Mantoux result (>=10mm) is not significantly associated with TB. However, Mantoux results of 30mm and above are associated with a significantly higher prevalence of TB (13%) than results under 30mm. The prevalence of TB was not significantly different for Indonesians charged with transporting asylum seekers compared with those charged with unauthorised fishing. The proportion of Indonesians who had TB fell from 9.1% (7/77) in 1999 to 5.5% (6/109) in 2000 to 0.8% (1/131) in 2001. The proportion of arrivals aged 40 or more reduced from around 20% in 1999 and 2000 to 11.5% in 2001 (Figure 3).

Logistic regression using CXR category (normal/abnormal) in addition to the variables shown in Table 4 shows that age is the only independent significant predictor of TB ($p < 0.0001$), but the best model includes age (continuous), Mantoux category (30mm cutoff), and year of assessment (1999-2000 v. 2001-2002).

Utility of screening modalities

If we accept as a gold standard for the diagnosis of TB the combination of clinical, radiological, and bacteriological assessments, the sensitivity and specificity of a CXR alone (100% and 76%

Figure 3. Percentage of Indonesians in each age category by year of first assessment

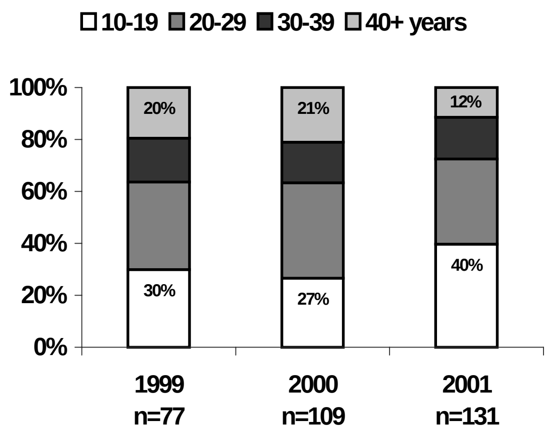


Table 6. Comparison of the Mantoux test (10mm cutoff) and chest x-rays for detection of active TB in 326 Indonesian prisoners in Darwin, 1999-2002.

	TB	Not TB	Total
Mantoux positive	13	255	268
Mantoux negative	2	53	55
Total	15	308	323*
Mantoux test: sensitivity = 87%, specificity = 17%, positive predictive value = 5%, negative predictive value = 96%			
Abnormal CXR	15	74	89
Normal CXR	0	236	236
Total	15	310	325†
CXR: sensitivity = 100%, specificity = 76%, positive predictive value = 17%, negative predictive value = 100%			

*3 did not have a Mantoux test; †1 did not have a CXR (not boat crew nor fisherman, inmate for only 2 days)

respectively) to detect active TB among the Indonesian cohort was superior to the Mantoux test with a 10mm cutoff (76% and 17% respectively, Table 6). The proportion of Indonesians with a positive Mantoux test who had TB (5%) was similar to the proportion with a negative Mantoux test who had TB (4%, Figure 2).

Discussion

This report describes a high prevalence of active TB at or prior to reception in the Indonesian cohort. Although the non-Indonesian, overseas-born cohort during 1999-2002 was small (40), the only smear-positive case among 743 prisoners was diagnosed in a citizen of Vietnam giving a comparable point prevalence (2.5%, 95%CI: -2.3-7.3%) to the Indonesian cohort. Countries in our region with estimated rates of TB over 100 per 100,000 population whose citizens have been incarcerated in Darwin include Vietnam (179), China (113), Philippines (297), Thailand (135) and Cambodia (585).[3] Chest x-ray screening regardless of Mantoux results is also appropriate for these citizens, but coordinating this to occur *prior* to incarceration will be more difficult than for Indonesian crew or fishermen whose arrival is less sporadic and more predictable.

Between 1989 and 1998 there were only 3 cases of TB notified in the NT among prisoners - 2 Indonesian fishermen in 1994 in Darwin, and 1 Aboriginal in Alice Springs Prison in 1996 – equating to a mean of 0.3 cases per year for the 10 year period (unpublished data). The current study period 1999-2002 has seen a total of 17 cases notified in 4 years, a mean of 4.25 cases per year representing an increase of 13 times compared with the earlier period.

The absence of smear-positive PTB among the Indonesian cases suggests that screening allowed disease detection at an early stage when mycobacteriology was either culture-positive alone, or culture-negative. This benefits the individual since earlier treatment improves their prognosis. Failing to detect these early cases at reception could allow silent deterioration to smear-positive disease increasing the risk of transmission within the prison. More advanced cases of smear-positive PTB may not have appeared in this Indonesian cohort since more severe illness (with malaise, weight loss, and debility) could preclude a case from embarking on the arduous journey by sea to Australia.

If only the culture-positive cases of PTB among Indonesians are considered, the point prevalence on arrival of 1.8% was high enough to demand that intensive screening for active TB should continue for this group. Although cases with smear-negative, culture-positive PTB have been shown to be only 22% as likely to transmit infection as those with smear-positive disease, transmission has still been shown to occur, and screening should therefore occur *prior* to prison reception.[5] A relatively high proportion (57%) of the Indonesian PTB cases were culture-negative compared to 28% of 377 cases of PTB diagnosed in the NT between 1989 and 2001 (unpublished data). High proportions of culture-negative cases have been documented in other settings where active screening rather than passive presentation with symptoms has been the method of case finding[6,7] (Table 7). This study documents a similar prevalence of TB of approximately 4000/100,000, and of culture-positive TB of approximately 2000/100,000, to 2 recent studies where refugees from South-East Asia were screened for TB.[6,8]

Table 7. Prevalence of TB and culture-negative proportion diagnosed by screening in selected cohorts

Authors	Sample	Prevalent TB cases	TB Prevalence/ 100,000			% Culture negative
			Overall	Culture positive	Culture negative	
MacIntyre & Plant, 1999	1101 refugees in camps in Laos, Cambodia, Vietnam	41	3724	2452	1272	34
Kelly et al, 2002	1863 East Timorese evacuees in Darwin	76	4079	2040	2040	50
van Burg et al, 2003	46424 European, Middle-Eastern, African asylum seekers in the Netherlands	103	222	86	136	61
This study	326 Indonesians in custody in Darwin	14	4294	1840	2454	57

There is no infirmary or respiratory isolation facility in the DCC. Thus, workup of inmates suspected of having PTB must be performed in the Royal Darwin Hospital, with each prisoner under 24 hour guard by 2 prison officers at an approximate cost to the DCC of $2000 per day. Furthermore, adequacy of staffing levels in the DCC is compromised by this exercise. There is therefore some urgency for TB to be rapidly ruled in or out if 3 sputum smears are negative and discharge to the DCC is imminent. Culture negativity will only be ascertained 8 weeks later so it is preferable to commence TB treatment and make a definitive decision about continuing treatment based on clinical, bacteriological and radiological parameters after 8 weeks.

The utility of using chest x-rays to screen all Indonesians regardless of Mantoux results or symptoms suggestive of TB is supported by the data concerning TB cases. Of the 15 Indonesian cases, 2 (12%) had a Mantoux result of 0mm, and a further 2 (12%) were asymptomatic (Table 4). Therefore, the presence of symptoms, or a positive Mantoux test alone should not be relied upon to correctly indicate a chest x-ray for disease detection. What is required in the crowded environment of a prison where the stakes are high if a missed diagnosis occurs is a test which is 100% sensitive, and the CXR fulfilled this for the Indonesian cohort (Table 6). The absence of HIV infection among the Indonesians is notable, since in other settings, 7 to 14% of HIV-seropositive persons with active TB have had a normal CXR.[9,10]

There was also a very high rate of LTBI in this Indonesian cohort. Unpublished NT data for the period 1989 to 2000 has previously shown that Indonesian inmates have higher rates of Mantoux positivity than the other 3 ethnic classifications (Indonesian 80%, Other OSB 49%, Aboriginal 39%, NAAB 29%). During 1999-2002, 83% of the Indonesian cohort were Mantoux positive, and 78% had LTBI.

The alteration in Commonwealth legislation relating to penalties for transportation of asylum seekers to Australia introduced the new prospect of incident cases among Indonesian inmates from reactivation of LTBI during sentences of several years duration. This risk has been reduced by the prompt treatment of LTBI in the majority of the cohort. A lifetime risk of active TB of up to 20% in persons born in high-prevalence countries who have a positive tuberculin skin test[11] translates to the prevention by this program of approximately 20 to 30 cases of active TB. Since the initial years after migration is the period of highest risk for immigrants to develop TB in a new country,[8,12] many of these "prevented cases" among Indonesians are likely to have arisen during incarceration in Australia.

The major reason for the higher uptake of LTBI treatment among Indonesians compared with other groups is the comparatively longer sentences being served by the 284 Indonesians convicted of transporting asylum seekers. The adults have been sentenced for at least 1 year, which allows a 6-month course of treatment to be completed. By contrast, 66% of the total prisoner population were sentenced for less than 6 months during 1998-1999.[13]

Heightened suspicion for active TB is required when screening older Indonesians in custody.

Age of 40 years or over is now included as a risk factor in a proposed clinical screening tool for use by DIMIA compliance officers to determine which deportees in their custody require chest x-ray screening prior to incarceration. It is also included along with symptoms suggestive of TB as an indication for referral of detained fishermen to a designated general practitioner for clinical TB screening, and chest x-ray if indicated.

One could debate the utility of prosecuting and incarcerating crew for several years as a deterrent to the arrival of asylum seekers. Long term solutions to forced mass population movements lie with addressing the root causes of civil conflict in countries of origin, increasing aid to countries of first transit and the United Nations High Commission for Refugees, and improving access to migration for persons from war-torn regions. However, while people from countries with high rates of TB continue to be imprisoned in the NT, heightened surveillance, and activities which prevent the progression, reactivation, and transmission of TB in the DCC must be maintained.

Acknowledgements

We are grateful to the following persons and agencies whose cooperation made the intensified screening possible: Chris Wake & Corrections

Box 1. Selected histories of cases with active TB

Case A. Prevalent case in a crewmember
A 60 year old Indonesian charged with people-smuggling in 1999 complained only of night-sweats and the Mantoux result was 30mm. His CXR showed bilateral upper lobe linear shadows and volume loss consistent with old TB, but with superimposed patchy consolidation consistent with reactivation. He was isolated in the Royal Darwin Hospital until 3 sputum specimens were shown to be smear-negative for acid-fast bacilli, empirical treatment for TB was commenced, and he was discharged to the prison. Later, the sputa cultured *Mycobacterium tuberculosis*, and following completion of a full course of anti-TB treatment his weight increased from 45 to 54kg. After serving 12 months of his sentence, he was returned to Indonesia.

Case B. Incident case in a crewmember
A case of PTB in a 36 year old Indonesian arose 6 months after reception. He had previously been detained in Australia for unauthorised fishing in 1997. His chest x-ray in 1997 showed bilateral apical fibrosis, but clinical and bacteriological assessments did not diagnose active PTB, and he was returned to Indonesia. When charged with people-smuggling in 2000, the chest x-ray changes were unchanged in comparison with 1997, sputum mycobacteriology was negative, and with a Mantoux reading of 25mm, he was treated for LTBI. After 5 months of LTBI treatment he developed chest pain, haemoptysis and weight loss, and a chest x-ray showed new nodular left apical infiltrates suggestive of TB reactivation. Despite negative sputum mycobacteriology, he commenced anti-TB treatment, clinically and radiologically improved, and completed a full course.

Case C. Prevalent case in a fisherman
A 35 year old Indonesian charged with unauthorised fishing in Australian waters in 2000 and destined for the DCC was instead isolated and investigated in the Royal Darwin Hospital since his pre-reception chest x-ray showed patchy consolidation in the right upper lobe. He had symptoms of an occasional dry cough and weight loss in the previous month and his Mantoux reading was 0mm. After 5 days under guard in the Royal Darwin Hospital, his sentence was served, 2 sputum specimens were smear negative for AFB, and he was returned to Indonesia. However, both sputa cultured *Mycobacterium tuberculosis* 2 months later. No follow up to recommend treatment was possible.

Case D. Prevalent case in a DIMIA deportee
A 43 year old citizen of Vietnam whose visitor's visa had expired was briefly incarcerated in DCC in 2002 prior to deportation under the Migration Act. Being neither in the custody of the Australian Federal Police, nor the Australian Fisheries Management Authority, he was not screened for TB prior to reception according to the established algorithms for crew transporting asylum seekers and unauthorised fishermen. His Mantoux result at reception was 17mm so a chest x-ray was performed. This was suggestive of old healed PTB with bilateral upper lobe fibrosis. There was a history of 6kg weight loss in the previous year and occasional haemoptysis. Three sputa were requested for mycobacteriology and the first 2 were smear negative. He was deported on the day the 3rd sputum was obtained, and this was subsequently reported as smear positive for acid-fast bacilli and cultured *Mycobacterium tuberculosis*. Negotiations are currently underway with DIMIA staff regarding clinical screening of deportees by compliance officers, and if indicated, chest x-ray screening at the Royal Darwin Hospital prior to incarceration in Darwin prisons or police holding cells.

Medical Services staff; Angela Brannelly and St Vincent's Correctional Health Service staff; Tony Tucker, Director Department of Immigration, Multicultural and Indigenous Affairs, Darwin; Roy McKay, Australian Fisheries Management Authority, Darwin; Jenny Scullion, Barefoot Marine Pty Ltd; Stewart LaBrooy, Northern Territory Correctional Services; Rod Williams, Steve Russell, and all prison officers who facilitated clinics, Darwin Correctional Centre; Ramzi Jabbour & Geoff Eyles, Australian Federal Police; Didier Palmer, Emergency Dept, Royal Darwin Hospital; Roger Weckert & Mark Palmer, Radiology Dept, Royal Darwin Hospital; and Dom Modoh and the many interpreters who assisted us.

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TB in Two Katherine Region Communities

Joy Pascall and Margaret Cooper, CDC Katherine

(Excerpts from a presentation at the September 2001 CDC Conference in Darwin)

Introduction

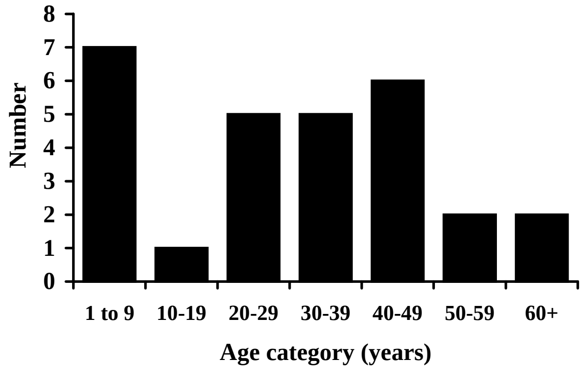
Communities A and B, which are located in the Katherine region, have historically had high rates of TB. Community A has a health clinic which provides primary health services to both communities and was staffed at the time by a Registered Nurse and an Aboriginal Health Worker (during the tourist season 2 Registered Nurses). Community B is in close proximity and the people inter-relate with community A to a high degree.

This article is a summary of a community based project to treat cases of latent tuberculosis infection (LTBI) in these communities.

TB epidemiology 1987-1999

TB has been a major health problem within these 2 communities. The first recorded case was in 1966, and from 1987-1999 28 cases of TB were notified (Figure 1). There was 1 TB-related death in 1989. Assuming population stability, this equates to a mean annual incidence of 560 per 100,000 for the 13-year period, compared with mean NT and national rates of approximately 25 and 5 per 100,000 respectively. Of the 28 cases, the site of disease was pulmonary in 20 (71%), nodal in 7 (25%) and peritoneal in 1 (4%). A majority of the cases were among men (61%), and those aged 20 to 49 (57%) (Figure 2). Of note is the high proportion of cases which were children under the age of 10 years (25%) including 3 of the last 6 cases in the period. This reflects recent transmission of TB in these communities as well as diagnosis of early disease due to active screening.

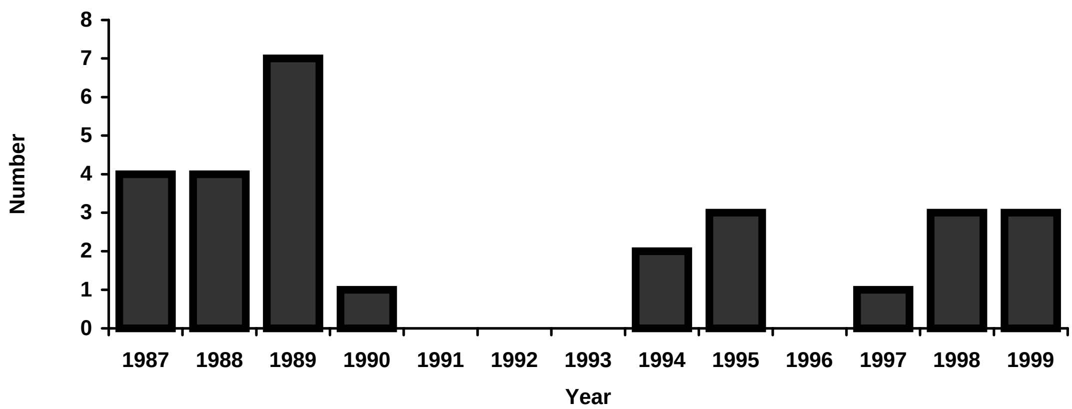
Figure 2. Age distribution of 28 cases of TB, 1987-1999.



The mean number of contacts followed up for the 28 cases was 31 (range 2-81). Additionally, 2 community-wide screens have been performed (since 1992) of both communities, in 1995 and in 1999.

Statistical modelling predicts that persons with a positive Mantoux test who are household contacts of an active case, or who have recently

Figure 1. Notifications of TB in Communities A and B, 1987-1999.



converted from a negative to a positive test have a lifetime risk of active TB of up to 20%.[1] The completion of a course of treatment for LTBI can reduce this risk by approximately 90%.

Community screening in 1999

In December 1999, 3 cases of pulmonary TB were notified, 2 smear positive and 1 culture positive. The finding of 2 unrelated smear positive cases prompted a TB screen of both communities in accordance with NT protocols. Of 385 people screened, 60 had a previously recorded positive Mantoux and required a chest x-ray, and 325 required a Mantoux test. No additional cases of TB were found. However, 35 persons with latent TB were identified as priorities for preventive treatment, 3 because of recent acquisition of infection (Mantoux conversion), and 32 who had pre-existing latent TB but were recent contacts of infectious cases.

Following discussions between Katherine CDC staff and a community elder, the communities became supportive of the need for those with both TB disease, and latent TB infection, to be adequately treated and monitored. This required a person to distribute directly-observed treatment three times each week who was not involved in the day to day running of the clinic. In March 2000 a local enrolled nurse, well known to the communities, was employed on a part-time basis for this purpose and the outcomes have been excellent. Of 35 persons with latent TB, 33 (94%) completed a 6-month course of preventive treatment substantially reducing their risk of active TB in the future. The 3 cases also received curative courses of treatment. In June 2001 funding for this position ceased including the leasing costs of a car to follow patients up.

Extra resources provided for TB control in Communities A and B allowed positive outcomes to occur, and the incidence of active TB in these communities will be reduced in years to come. On the other hand, failure to comprehensively treat LTBI identified among contacts leads to ongoing smouldering endemicity in communities.

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The Australian Immunisation Handbook 8th edition 2003

Christine Selvey, Head Immunidsation, CDC Darwin

The *Australian Immunisation Handbook* 8th Edition 2003 was endorsed by the National Health and Medical Research Council (NHMRC) on 18 September 2003.

The Australian Standard Vaccination Schedule (ASVS), the National Immunisation Program (NIP) and the Northern Territory Childhood Vaccination Schedule

- The Australian Standard Vaccination Schedule (ASVS) is the new recommended schedule in the 8th edition of the *Australian Immunisation Handbook*. It is different to the National Immunisation Program (NIP) and to the NT Childhood Vaccination Schedule. The ASVS lists "best practice" recommendations for vaccinations made by the Australian Technical Advisory Group on Immunisation. Not all the vaccines on the ASVS are funded. The NIP and the NT Childhood Vaccination Schedule list all standard vaccinations funded by the Australian Government and provided free to the Australian population.

What's new for the NT Childhood Vaccination Schedule and the NIP?

- The 18 month dose of diphtheria-tetanus-acellular pertussis (DTPa) has been removed from the NT schedule and the NIP. This is the recommendation made in the 8th Edition Handbook and is effective immediately. Please note that children who have already received DTPa dose 4 at 18 months of age still need another dose of DTPa at 4 years of age. This is because immunity to pertussis wanes with time, and a dose at 18 months of age will not provide protection in late childhood and early adolescence. However, the primary course of DTPa vaccination at 2, 4 and 6 months of age will provide protection against pertussis until 4 years of age, when the next booster is due.
- The 15 year old adult diphtheria and tetanus vaccine (ADT) will be replaced by the adult/ adolescent formulation diphtheria-tetanus-acellular pertussis (dTpa) vaccine (Boostrix™) due at 15-17 years. It is hoped that this additional pertussis immunisation will help prevent the spread of whooping cough. This will be effective from 1 January 2004.
- The list of medical risk factors that predispose children to invasive pneumococcal disease has been expanded. Children with these risk factors are eligible to receive conjugate pneumococcal vaccine funded by the Australian Government under the NIP. These conditions include diabetes, Down's syndrome, premature infants born at less than 28 weeks gestation and cystic fibrosis. The complete new list of medical risk factors is in the 8th Edition Handbook and on the Immunise Australia website at http://immunise.health.gov.au/pneumococcal/index.htm. NT information on medical risk factors for pneumococcal disease will be updated and available in the near future.
- Vaccination requirements for the assessment of immunisation status to determine eligibility for the Maternity Immunisation Allowance and Childcare Benefit will use the NIP schedule. This means that the 4th dose of DTPa at 18 months will not be required for a child to be considered fully immunised. Similarly, the calculation for NT immunisation coverage rates, and for General Practice Immunisation Incentives (GPII) Scheme coverage will not include the 18 month DTPa.
- All vaccinations administered to children up to 7 years of age, including those that are not on the NT Childhood Vaccination Schedule or the NIP should be reported to the NT Childhood Immunisation Database in the usual way. If an immunisation provider reports directly to the Australian Childhood Immunisation Register (ACIR), data on all childhood vaccinations should be submitted to ACIR with a copy forwarded to the NT database. This will ensure that the NT immunisation database and the ACIR maintain a complete immunisation history for each individual child.

What's new on the ASVS?

- The revised ASVS records "best practice" vaccination recommendations. Not all vaccines on the ASVS are funded and parents/ caregivers can purchase these vaccines if they wish their child to receive them. The ASVS includes several new childhood vaccine recommendations as follows.

- ♦ Conjugate pneumococcal vaccine is recommended for all infants at 2, 4 and 6 months with no booster required. The 8th Edition Handbook states that catch-up for low risk children aged 3 –23 months can be considered. The previous recommendations for high risk groups are unchanged, so in the NT the recommendations (and funding) for Indigenous children (booster of 23-valent polysaccharide vaccine at 18 months) and for non-Indigenous children in Central Australia are unchanged.
- ♦ Inactivated poliomyelitis vaccine (IPV) is recommended on the ASVS at 2, 4 6 months and 4 years. However, notes to the ASVS state that "IPV is preferred to OPV, subject to the availability of IPV-combination vaccines, but both IPV and OPV are acceptable for use in the ASVS". The 8th Edition also states that "Although both OPV and IPV are appropriate alternatives, providers should inform parents/caregivers that IPV-combination vaccines are preferred because of the proven but extremely rare risk of VAPP following OPV". IPV-combination vaccines are **not** yet available in Australia. If parents/carers elect not to have any polio containing vaccine they should be advised that their Maternity Immunisation Allowance and child care benefit may be affected.
- ♦ Varicella vaccine is recommended at 18 months of age, with catch-up at 10-13 years for those without a clinical history of chicken pox or previous varicella vaccination.
- ♦ Diphtheria-tetanus-acellular pertussis (dTpa) vaccine for adolescents (as for the NIP above).
- ♦ The ASVS also no longer recommends the 18 month dose of DTPa vaccine. This is effective immediately

What's new in the handbook

- Booster doses of 23-valent polysaccharide pneumococcal vaccine are no longer required every 5 years. Instead, 1 to 3 re-vaccinations are recommended, depending on the age of first vaccination and on the risk of disease. NT information adult pneumococcal re-vaccination will be updated and circulated as soon as possible.
- 23-valent polysaccharide pneumococcal vaccine is now recommended for all adults who smoke tobacco.
- The Handbook contains new information on vaccines for Aboriginal and Torres Strait Islander people, international travel, certain occupational groups and other special risk groups.
- Information on vaccine preventable diseases has been updated, as has information on adverse events following immunisation.
- Levels of evidence for new recommendation have been included in the fully reference electronic version of the 8th Edition Handbook. The print version of the 8th Edition will not be fully referenced nor include levels of evidence.

Obtaining the new Handbook

- A PDF version of the 8th Edition Handbook is now available on the Immunise Australia website: http://immunise.health.gov.au
- Printed versions of the 8th Edition Handbook will be distributed by December 2003 to all immunisation providers listed on the Australian Childhood Immunisation Register (ACIR) and Medicare databases.
- Each printed version of the 8th Edition Handbook will be distributed with an interactive CD-ROM version. This interactive version will be available on the Immunise Australia website from October 2003 onwards.
- If you have not received a copy of the new 8th Edition Handbook by the end of the year and you would like one, visit Immunise Australia at http://immunise.health.gov.au, email handbook@health.gov.au or contact the Immunisation Infoline on 1800 671 811.

Further information

- Contact your local Centre for Disease Control.

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Will SARS re-emerge? The epidemic part 2.

Peter Markey, CDC Darwin

Introduction

Between mid-March and mid-July this year, the world was gripped by the global epidemic of Severe Acute Respiratory Syndrome (SARS). Emerging from south-eastern China in late February, SARS spread to North America and Europe within days and triggered an unprecedented global public health response. In Australia, development and implementation of national policies and guidelines was done by the Communicable Diseases Network Australia (CDNA). The Network is constituted under the National Public Health Partnership and consists of representatives from the communicable diseases units of each jurisdiction and other peak bodies. The Northern Territory's Department of Health and Community Services' response has been documented in a previous edition of this bulletin.[1] This article summarises the final stages of the SARS epidemic, describes the process of scaling down the national guidelines and outlines the current strategies in place to help maintain a degree of vigilance in case SARS re-emerges.

The epidemic ends

On the 5th July 2003 the last country was removed from the list of 'SARS affected areas' and WHO declared that transmission had ceased.[2] In the following weeks CDNA developed new guidelines allowing for relaxation of health service and airport screening but still maintaining some baseline vigilance. In the NT, signs at hospitals were removed on 25th of July and nurses remained at airports until 15th August.

The latest WHO table of SARS cases (to the end of July) revealed that there were 8099 cases reported from 32 countries with 774 deaths.* There were 1707 cases in health care workers or 21% of the total and the overall case fatality rate was 9.6%.[3]

In Australia, there were, in the end, only 6 probable cases of SARS reported to WHO. The last of these was an interesting case notified and confirmed only after the epidemic was over. A 26 year old female German tourist, who had stayed at the Metropole Hotel in Hong Kong at the same time as the original index case, flew to Melbourne in early March. She travelled by road up the east coast of NSW to Queensland and became ill during the trip, visiting a GP but not requiring hospitalisation. She had recovered and returned home to Germany before the world-wide alert for SARS was announced by WHO on 14th March. It was only after the serological test for SARS became available some months later that she tested positive. Neither the GP nor her travelling companion showed evidence of exposure to the virus.[4]

The control of the epidemic demonstrated that traditional disease control measures such as isolation, quarantine, community awareness and the co-ordination of government action were still the most effective tools to reduce transmission. It was also notable that countries with limited resources such as Vietnam were more successful at containing the epidemic than other more developed countries.[5] Speculation still remains whether other natural factors assisted in controlling the spread of the virus, such as the changing season or a natural loss of virulence or communicability.

The origin of SARS and the chance of its re-emergence

The most likely explanation of the origin of the SARS coronavirus was that it arose through a mutation in an animal coronavirus. The markets of south-eastern China, where large numbers of multiple species of live animals are sold for food, have often been considered as environments favourable to trans-species migration of viruses. Researchers have recently focussed their attention on several exotic species of mammal sold at the live animal market in Shenzhen. Investigations on animals in the markets revealed coronaviruses similar, but not identical, to the SARS coronavirus, and antibodies to these viruses in market traders.[6]

* The number of total SARS cases reported to WHO has been decreasing presumably due to the results of serological blood tests establishing other diagnoses.

There have been 2 episodes in recent weeks which raised the anxiety of public health officials. Firstly, there was an outbreak of a respiratory illness in a nursing home in Vancouver with high attack rates but low mortality and which was associated with positive SARS coronavirus serology. This turned out to be caused by another coronavirus which cross-reacted with the SARS coronavirus. Secondly, there was a laboratory worker in Singapore who didn't quite fulfil the case definition of SARS but nevertheless had a positive PCR test. It was concluded that this was indeed a case, acquired from cross contamination in the laboratory.

Two possibilities exist for SARS to re-emerge. Even though transmission has ceased and a carrier state does not seem to exist, there may be parts of the world where low rates of unrecognised disease is still occurring. On the other hand, re-emergence of the virus may occur from an animal reservoir. If the decline of SARS transmission has been due to seasonal weather changes we could see a re-emergence of the disease this November. We can only speculate on this until the season arrives.

National preparedness

Following the relaxation of hospital screening protocols and incoming passenger screening it was apparent that there needed to be some continued vigilance for SARS in case of sudden re-emergence of the disease. However, it was also understood that the intensity (and associated cost) of the surveillance should be commensurate with this substantially reduced risk. CDNA drew up and distributed new guidelines in mid-July and these were updated on 15th September taking into account the latest WHO guidelines.[7]

The new recommendations make it clear that it is unlikely, although not impossible, that Australia will be the first place where SARS re-emerges; the most likely scenario being that we will have some warning of the re-emergence. The guideline recommends maintaining surveillance for 'alert' clusters of cases, with a SARS 'alert' being 2 or more health care workers fulfilling the new case definition or hospital-acquired illness in three or more persons.[7] Until SARS re-emerges the emphasis is now on hospital acquired disease and less focussed on travellers. Disease control units are implementing passive surveillance for requests for SARS-coronavirus testing, with laboratories being asked to contact disease control units, either directly, or indirectly through the requesting doctor, on receipt of a request.

The new (public health) case definition does not include a travel condition. It has 4 requirements;

- fever (>=38^{o}C)
- lower respiratory tract symptoms
- X-ray changes
- no alternative diagnosis

The guideline also emphasised that clinicians should remain vigilant and be suspicious about SARS in all cases of atypical pneumonia and seriously consider isolating cases of severe illness without apparent cause.

Outcomes for policy

The SARS epidemic generated some unexpected benefits that have already shaped future policy directions in the public health and disease control environment. Firstly, the outbreak response emphasised the importance of a close relationship between hospital infection control teams and disease control units and illustrated both the similarity and the differences in the work that they do. This has laid the foundation for further projects and policy development in the future.

Secondly, the threat posed by SARS to the borders strengthened the relationship between the Australian Quarantine and Inspection Service (AQIS) and jurisdictional disease control units. While these bodies have, in the past, worked together as required and have had standing arrangements for the management of quarantinable diseases, the fact that they were bureaucratically and physically distant, meant that they rarely met. SARS broke the ice and allowed for a firmer working relationship to be developed for the future.

Finally, SARS arrived during a period in history where countries around the globe are preparing emergency public health responses as part of disaster management, in particular for disasters caused by infectious agents, both natural (the influenza pandemic) and man-made (bioterrorism). The epidemic allowed jurisdictional disease control units, infection control teams and other agencies to gain unrivalled experience and practice in a real but less hurried setting.

Fortunately, SARS wasn't highly contagious and transmission was mostly limited to close contacts of cases with advanced disease. If it re-emerges it is likely that, with a world now well prepared and sensitive to the condition, the outbreak will be quickly controlled. The real challenge for public health bodies, national governments and world agencies is to be ready for bigger and nastier threats. There seems to be no question that bioterrorism, if it happens, or the influenza pandemic, when it happens, will be SARS 'writ large'.

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The response to SARS: Building infection control capacity in the Pacific

Meredith Hansen-Knarhoi, CNC TB/Leprosy, CDC Darwin

Introduction

"Is there SARS in Fiji?" This was the typical response from colleagues in Darwin when it became known I had been chosen to work in the South Pacific as an infection control nurse as part of the WHO global response to the SARS epidemic. It was a big step from tuberculosis in the Top End, but, on the grounds that the basic principles of isolation and hospital hygiene apply universally, I considered my background in public health and TB work to be more than adequate for the task ahead.

Infection control as a discipline is in its infancy in many countries in the Pacific, due mainly to the competing pressures in building sustainable health systems. Some hospitals have infection control practitioners, but with limited resources and poor access to education their efficacy is limited. Many of Australia's neighbours do not have the luxury of separate isolation rooms, negative pressure facilities (for most, this means a decent draught from the afternoon sea breeze) and functioning ventilators with equipment and staff who know how to use them. Many Pacific Island countries deal with outbreaks of vaccine preventable illness on a day to day basis. Nosocomial infection of dengue occurs due to unscreened wards, lack of mosquito nets and insufficient hospital environmental health controls. Infections like TB, typhoid and suspected measles cases are commonly managed in the general ward environment with no separate isolation facilities.

Many hospital wards do not have sufficient hand washing facilities for staff and soap is a luxury. Laboratories are not able to perform more than basic blood tests, even doing blood cultures is dependent on the hospital having culture medium. Many more complicated immunological analyses are sent to other countries such as New Zealand, Australia and

Japan for testing. Results become available weeks after the event, instead of 24 hours as in Australia! This makes it difficult when determining the cause of a rash illness or early identification of the beginning of an epidemic.

The Pacific reaction to SARS

The Pacific Island countries and territories are comprised of a huge variety of cultures, languages and traditions. Despite the fact that 96% of SARS cases were occurring in the Western Pacific region, countries reacted in differing ways to the crisis on their doorstep. Many instituted health screening at airports very quickly (as early as April 2003), with passengers completing questionnaires prior to arrival. Some chose to ban flights completely from affected countries, some imposed home quarantine to all visitors who had travelled to SARS affected countries in the last 14 days or insisted that returning residents had 14 days quarantine in Australia or New Zealand prior to returning home. The political, economic and diplomatic ramifications of the decisions made by these countries had wide reaching implications. WHO worked closely with the Pacific Public Health Surveillance Network (PPHSN) via Epinet to keep countries up to date with the constantly changing epidemiological scenario. This enabled countries with limited resources to make reasoned decisions when reacting to the crisis. For many countries the risk of importing SARS was relatively low, but the threat to the health system, where there were no local resources available and no functioning infection control committees to help hospitals react appropriately to a suspect SARS case, made it imperative that these fragile systems were protected.

The situation for Fiji was made even more precarious by the imminent arrival, in June, of competitors for the South Pacific Games, a 4 yearly event held in the Pacific, with 2003 being Fiji's turn. Purpose built sports facilities had been constructed and a large economic upturn anticipated. There were 5000 visitors expected from the 22 participating countries with many athletes travelling from their home country via training facilities in South East Asia. The overriding concern was the importation not just of SARS but also diseases like dengue, measles and malaria. WHO worked closely with the organizers to ensure that a surveillance system was in place, with close collaboration and training of hospital and volunteer medical staff in infection control. The Colonial War Memorial Hospital in Suva (the largest hospital in Fiji) set aside a ward from March through to the end of the Games in July specifically to manage possible SARS cases.

There had been several trial runs with SARS suspects in Fiji following the return of the rugby sevens teams from Hong Kong at the height of the SARS epidemic in April. Japan International Cooperation Agency (JICA) in consultation with WHO arranged for donations of N95 masks, gloves, and other infection control materials ensuring that Pacific Island countries had the basic equipment to contain SARS. WHO assisted the various governments in the development of locally appropriate infection control guidelines, ensuring that staff were familiar with the management of a SARS case. In some instances facsimile machines were purchased by individual countries to allow immediate and accurate dissemination of information from the WHO website.

My role in building capacity

The terms of reference for my mission were to assess current infection control measures, assess current local stock levels of personal protective equipment (including the contingency planning for further purchases), assist in rapid development of guidelines (given a resource-poor environment) and enable rapid dissemination of new developments in the SARS epidemic.

When I arrived in mid May 2003, 'unknown' local transmission was occurring in Hong Kong and Canada and cases were still increasing in Taiwan, while Vietnam and Singapore were having success in bringing the epidemic under control. WHO was concerned about the potential spread of SARS to the Pacific, and sought to strengthen the preparedness of the Pacific nations by building their capacity in surveillance and infection control.

During the course of the mission, concentration on the development of local capacity was paramount in SARS preparedness and response. Fundamental to my role was active participation in the Fijian National SARS taskforce (with key stakeholders including customs, quarantine, tourism and the Ministry of Health), initiation of weekly meetings and coordination with the other Fijian health divisions. Training and meetings with hospital boards were also held in other parts of Fiji; namely Lautoka hospital in the west (the hospital receiving patients from Nadi international airport) and Labasa in the north (the third largest hospital). Assessment and training was also held in Savu Savu, a favorite overseas tourist destination. Staff of the Colonial War Memorial Hospital in Suva had set aside an empty ward specifically to manage potential SARS cases. Weekly infection control meetings were attended as well as infection control training (a total of 8 trainings), culminating in a mock exercise where a 'suspect' passenger was identified at the airport, transferred, admitted and isolated in hospital. Laboratory and radiology staff were included as well as housekeeping staff, as these sectors had often missed out on any infection control training. Suva Private Hospital was also included as it was a key health facility for overseas visitors. The use of scenarios and mock exercises enabled hospital staff to assess their own performance and correct the flaws discovered in their contingency plans. Liaison with the local health promotion unit allowed this activity to be filmed for further training and media purposes for the Ministry of Health.

Another core activity was also compiling bi-weekly faxed updates for Fijian authorities, utilizing data from the WHO website, because many airport and hospital staff did not have access to the internet. This update was also emailed to other island neighbours, particularly those with no local WHO office.

Whilst most of my time was spent in Fiji, I also undertook an assessment and training visit to Tuvalu, Tonga and Samoa. In each country meetings were held with local WHO staff, Ministry of Health officials and national taskforce stakeholders to reinforce the recommendations already communicated by WHO and PPHSN on SARS. The visit also allowed information distribution to other key stakeholders (such as infection control staff), training of hospital staff and inspection of the identified hospital isolation facility.
Recommendations had to be practical and appropriate to the available resources. For example, in Tonga the hospital had only one ventilator and the major preoccupation of medical staff was whether or not they would ventilate a SARS patient. Staff were encouraged to 'walk' through scenarios, to try and anticipate the needs of a SARS case. Creative local solutions were found for both the supply of alcohol handrub – pharmacy concocted its own from a mixture of methylated spirits and chlorhexidine – and for its dispensing – with dispensers recycled from aloe vera moisturizer bottles.

Lessons learnt from the SARS epidemic

1. *Travel history is important.*

Where have you been? A fundamental lesson learnt the hard way was that ALL 'cough/fever/ pyrexia of unknown origin' admissions to a hospital environment should routinely be screened for recent travel history **as part of the triage history**. This allows for the earliest recognition and isolation of possible SARS cases, minimising further contact with staff and other patients or visitors.

2. *Infection control works!*

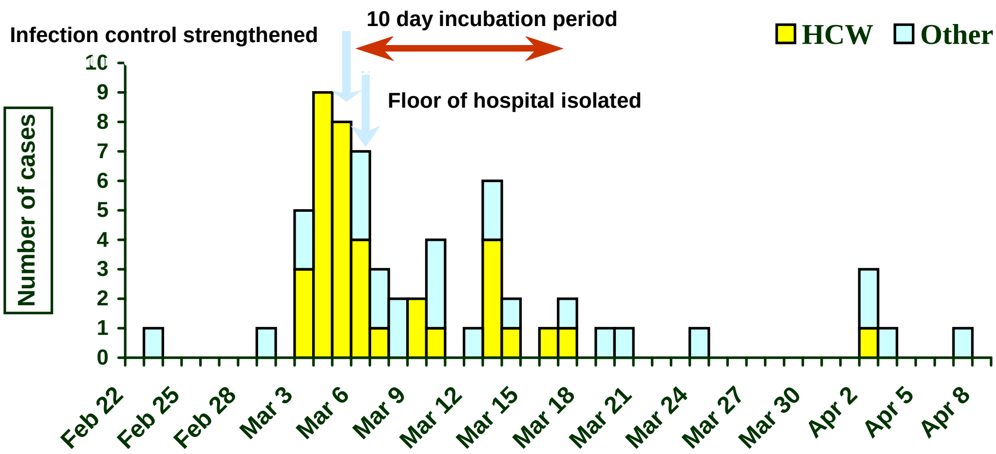
The evidence from the experiences of hospitals in Vietnam, Singapore, Canada and China suggests that SARS can be contained in a hospital environment, where adequate procedures are put in place.[1] The graph illustrates the impact on SARS cases of basic infection control practices such as isolation and decontamination in a Vietnamese hospital where resources were limited. Complacency amongst hospital staff and decreased vigilance on the part of infection control staff ensured, in some cases, that SARS persisted in the hospital environment.[2] Preliminary research has begun on the most important aspects of infection control, shedding light on the key factors in controlling for secondary spread.[3]

A primary part of my role in infection control with WHO was to raise the profile of infection control as a core activity of hospitals.

3. *Human resource management is critical*

Globally, 21% of SARS cases occurred in health care workers.[4] This means that quality human resource management is vital to the prevention

Figure 1. No of cases by date of onset of symptoms, Viet Nam



Source: Professor Aileen Plant, Team Leader WPRO, Vietnam

of local transmission in the hospital environment. It is essential that hospital staff are fully trained in the use of infection control equipment, that the equipment is available, the appropriate policies and contingency plans are in place and hospital staff caring for SARS patients are supported by hospital management, particularly in staff rostering. In this scenario the potential SARS case can be managed safely and effectively.

Infection control staff in hospitals should ensure that national guidelines on SARS preparedness are followed, with the policies readily adaptable in the event of new developments and findings on the nature of SARS. Practice drills and exercises are fundamental in ensuring staff are familiar with all aspects of the infection control equipment and procedures. Many of these recommendations are available via the Communicable Disease Network Australia, WHO and PPHSN websites.

Summary

There were no cases of SARS or probable SARS in the Pacific. As a result of training and the elevated profile of infection control staff, the future impact of diseases like SARS in countries such as Fiji will be minimised. This is wholly dependent on a number of factors including the sustained political commitment of countries to fighting SARS, ongoing investment in equipment and vigilance on the part of infection control and admitting staff in all health facilities.

Much is still unknown about SARS. The most important lesson learnt was that ALL health facilities have to be trained and prepared for the accidental or deliberate importation of an unidentified infectious agent. It is only with global collaboration and open international communication that diseases like SARS can be contained, a salutary lesson for the inevitable influenza pandemic.

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An audit of malaria management in the Top End

Geoffrey Menzies and Peter Markey, CDC Darwin

Introduction

There has been no local transmission of malaria in the Northern Territory (NT) since 1962, despite the presence of Anopheles mosquitoes and the steady influx of malaria cases into the Top End particularly from tropical South East Asia and Papua New Guinea. Credit for this goes to a well developed surveillance system, strict treatment and isolation measures, the expertise of infectious disease physicians and public health personnel and the diligence of entomologists in keeping mosquito numbers to a minimum in populated areas.

Malaria is a notifiable disease, so that cases are notified to the Centre for Disease Control (CDC) by both clinician, when the diagnosis is suspected, and laboratory, following the result of a positive test. Cases are managed according to locally developed guidelines and are routinely followed up by CDC staff; where appropriate, entomological investigation is done by the Medical Entomology Branch (MEB).

The third edition of the Northern Territory CDC Malaria Guideline[1] was developed in 1997 by the Malaria Working Group (MWG), which included infectious diseases clinicians and staff from CDC, MEB and the Royal Darwin Hospital (RDH) laboratory. It was consistent with the nationally developed therapeutic guidelines.[2] In 1999, a supplementary note made some revisions to the guideline.[3]

As a prelude to the scheduled revision of the guideline this year and as a commitment to continuous quality improvement in the management of malaria, it was thought that a clinical audit of a series of cases be made to assess the adherence to the 1997 guidelines. Previous work in Queensland had noted that as few as 20% to 50% of malaria patients were being treated in accordance with the relevant guideline.[4,5] This paper describes a clinical audit of malaria management at CDC Darwin, conducted by a final-year medical student (GM) under the auspices of the MWG, in March 2003.

Methods

The audit included confirmed malaria cases in Darwin during 2001and 2002, as listed in the notifiable diseases database in CDC. The NT Hospital Morbidity Database (HMD) and data in MEB were also checked to see if there were any cases that were not notified. Cases with no RDH casenote record of malaria were excluded. To conform to the CDC database format, concurrent infections with of multiple *Plasmodium* species were considered to be multiple 'cases'.

The audit considered the question 'Have malaria patients been treated in accordance with the 1997 (amended 1999) NT CDC Malaria Guideline?' Methodology included a review of literature and a brief search for auditing tools used elsewhere which may have been applicable. A meeting of the MWG, consisting of three infectious disease physicians, an epidemiologist, an entomologist and two public health physicians, was arranged and the key performance criteria by which the records were to be assessed were decided by consensus of the group. Data were retrieved from the CDC database, RDH casenotes and the MEB database and analysis performed in Microsoft Excel. Incomplete documentation of management decisions in hospital notes was interpreted as 'not done' where it was thought that the action should have been documented in the record (Questions 3, 5).

There was an emphasis on patient privacy, through de-identifying of data and indexing by Hospital Reference Number (HRN). Data storage was protected through use of password-accessed files. There was also a strong emphasis on documentation of the audit process to allow repeatability in future audits. The findings were later presented to the MWG.

Results

There were 87 cases of malaria notified in 2001-02 in the NT. In 2 cases records could not be found; therefore they were excluded, so the audit examined 85 malaria cases, 61 in 2001 and 24 in

2002, in 70 individual patients. There were 64 cases of *P. vivax* and 21 cases of *P. Falciparum* with 5 cases of concurrent infections. Relapse of *P. vivax* occurred in 5 patients, a total of 10 times (1 with 5 separate admissions). There were no cases of *P. ovale* or *P. malariae*.

The audit considered 14 key questions which are listed in Table 1 along with results. Most procedures were correct in at least 70 percent of cases, with a more detailed analysis providing explanations for some apparent deficiencies. Access to medical records and the integrity of the record affected the completeness of the audit. Cases transferred to a private hospital, treated within the military system, or imprisoned or deported as illegal immigrants had incomplete data (Question 1). Likewise it was often difficult to glean answers from the medical record and, for certain questions, even the notifiable disease data did not allow verification. (Question 2). Infrequently, there were inconsistencies between the database and hospital record. (Questions 12, 13). Only 18 patients had records of a 14-day follow-up appointment. There were no cases found through MEB data or the HMD which had not been notified to CDC.

Discussion

The scope of the audit was confined to CDC and clinical responsibilities and excluded prophylaxis, antimalarial drug choice and other external activities. The emphasis was on procedural compliance, which contributed to patient treatment. There was no formal audit of actual patient outcomes, such as symptom control, cure, recrudescence, outbreaks or mortality. There were, however, no documented fatalities.

Differences between the 1997 NT Malaria Guideline, with or without the 1999 amendment and updates to Therapeutic Guidelines provided varying management recommendations and this was reflected in decreased adherence to the audit questions (Questions 2, 5, 9). For example, a stat dose of primaquine for *P. falciparum* infection, introduced in 1999, was not well adopted. Whether this was due to clinical decision-making or not being aware of the guidelines could not be ascertained as decisions such as these were not consistently documented in casenotes (Questions 10, 11).

The audit gave rise to several recommendations.

- Inconsistencies, which developed between the Malaria Guideline and the associated documents, could be avoided by referring readers to the external document (e.g. Therapeutic Guidelines[6]) and not duplicating their contents within the guidelines, as they may become outdated.
- The possibility for recommendations to be tailored by clinical judgement in special circumstances, should be indicated in the guidelines and discussion with CDC recommended to help clarify and inform these decisions.
- The importance of adequate documentation of patient casenotes with clinical considerations and decisions was emphasised.
- Ongoing dialog between RDH, CDC and MEB as well as with GPs, military and other agencies should continue to ensure adequate coordination and information exchange.
- The continuing quality improvement cycle will involve further audits or the establishment of continual performance monitoring system, with trigger levels for reviews. Data routinely gathered by CDC should facilitate future audits.
- Future audits might examine patient follow-up and the measurement of clinical outcomes, in addition to process compliance.

Overall, the audit showed that the management of malaria in Darwin is consistent with guidelines, with procedural compliance in the majority of cases. Understanding the performance limitations may further improve the care of malaria patients in the Top End.

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Table 1. Analysis of Malaria Guideline procedures as performance against 14 key questions

No	Question	Justification	Data Source	Denom	No	%
1	If the species was *P. falciparum*, was the patient admitted?	Possibility of complications	RDH	16	12	**75**
			CDC	21	15	**71**
2	If the species was *P. falciparum*, was the patient treated with a gametocidal single dose primaquine prior to discharge?	Eradication of gametocytes		16	5*	**31***
3	For all patients, was glucose-6-phosphate dehydrogenase (G6PD) enzyme deficiency checked?	Primaquine is contraindicated in patients with G6PD deficiency.		58	43	**74**
4	If species was *P. vivax*, was there 'no evidence of' *P. falciparum* before discharge?	Check for co-infection – treatments are different.	Not collected			
5	If species was *P. vivax* and management was as an outpatient, was the patient able and advised to remain in screened or air-conditioned accommodation from dusk to dawn?	Patients with *P. vivax* may convalesce at home, if they are isolated from *Anopheles* mosquitoes.		15	7*	**47***
6	If species was *P. vivax*, was the patient notified to CDC for a public health risk assessment prior to decision to treat as an outpatient?	The patient is notified to CDC for assessment of public health risk.		14	10	**71**
7	If species was *P. vivax*, did the ID consultant physician review the patient before discharge?	Consultant review is advised.		15	14	**93**
8	If species was *P. vivax*, and patient resides in malaria receptive area, was 14/7 radical treatment with primaquine recommended?	Prevention of recurrence.	RDH	42	36	**86**
			CDC	64	57	**89**
9	If species was *P. falciparum*, was the patient treated with 3/7 of doxycycline, tetracycline or Fansidar or, as an alternative, mefloquine before discharge?	Check for correct treatment.	Not collected			
10	If species was *P. falciparum*, was the patient's blood slide negative before discharge?	Treatment effectiveness.		16	8*	**50***
11	If species was *P. falciparum*, was the patient well and afebrile for 24/24 before discharge?	Proof of treatment effectiveness		16	11	**69**
12	Was Medical Entomology Branch (MEB) advised of the case?	CDC coordinates with MEB to contain public health risks.	RDH to CDC	56	54	**96**
			CDC to MEB	85	74	**87**
13	What was the timescale in advising Medical Entomology Branch (MEB) of the case?	Prompt MEB notification important for response.	RDH to CDC	54	40	**74**
			CDC to MEB	74	52	**71**
14	Was each element of required information passed to MEB correctly, including gametocytes and travel information, etc?	MEB rely on correct information and travel history.		76	62	**82**

* Likely to be an underestimate due to difficulties with ascertainment

Notes: RDH – based on data obtained from review of RDH patient casenotes
CDC – based on data obtained from CDC malaria database
MEB – based on data obtained from MEB database

Fact sheet

Hand Foot and Mouth Disease

What is Hand, Foot and Mouth Disease?

Hand, Foot and Mouth Disease is an infection caused by the human coxsackievirus, or enterovirus family, in which blisters appear on the hands and feet and inside the mouth. It affects all age groups, but commonly children aged less than 10, and is found all over the world.

How is it spread?

Hand, Foot and Mouth Disease is spread by airborne droplets of respiratory secretions (saliva, sputum), when people sneeze or cough, by direct contact with the fluid in blisters and by the faeces of infected people. It only affects humans, and is not related to the similar sounding “foot and mouth” disease in cattle.

Symptoms of Hand, Foot and Mouth Disease

Within 3 to 5 days of exposure to the virus, the person may have the symptoms of fatigue, loss of energy and appetite, a sore throat and mouth and a mild fever. In a baby, this may present as a decreased interest in feeding.

Several days after these initial symptoms a non-itchy rash develops on the palms, hands, soles of the feet and on the inside of the mouth. Mouth lesions can be widespread and occur on the inside surfaces of the cheeks and gums and sides of the tongue.

How serious is Hand, Foot and Mouth Disease?

For most people with the infection, the rash disappears and they feel better within about a week. Very rarely, the illness can be more serious, so if the person complains of severe headache, or their fever persists and they are not getting better, it is advisable to contact your doctor immediately. Fatal cases have been reported.

Treatment

There is no specific treatment and antibiotics are not helpful.

For most people, symptomatic relief with fluids, paracetamol and rest is all that is required.

How can Hand, Foot and Mouth Disease be controlled?

There is no vaccine for Hand, Foot and Mouth Disease. On recovery from the illness, a person will develop immunity against the one specific type of virus that caused the infection. However, as there are several viruses which can cause Hand, Foot and Mouth Disease, further episodes of the disease are possible from a different virus.

Promoting good hygiene is the best way to stop the spread of the virus. Therefore, practise frequent hand washing, especially when changing nappies and other stool-soiled material. Wash toys contaminated with saliva, and cover the mouth when sneezing and coughing.

People with Hand, Foot and Mouth Disease are infectious during the acute stage of the illness and perhaps longer, since these viruses persist in stools for several weeks after recovery.

The blisters should be allowed to dry naturally, and should not be pierced as the fluid inside them is infectious.

Children with Hand, Foot and Mouth Disease should be excluded from school, preschool and childcare until all blisters have dried.

Further fact sheets and treatment protocols are available at:
http://www.nt.gov.au/health/cdc/fact_sheets/fact.shtml

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Gastroenteritis outbreak due to *Staphylococcus aureus*

Karen Dempsey (CDC), Kelly Monaghan (Environmental health)

Background

At 10am on the 1st of August 2003 a rural health nurse alerted the Darwin Centre for Disease Control (CDC) to an outbreak of apparent food poisoning. She reported that 5 (3 children and 2 adults) of 11 passengers travelling on a bus to a destination in Arnhem Land had just presented to the community health clinic for treatment of severe abdominal cramps, prostration, vomiting and diarrhoea. Foodborne intoxication (food poisoning caused by bacterial toxins) was suspected because of the abrupt onset of explosive gastro-enteric symptoms in a group of people within 2 hours of consuming breakfast at a roadhouse.

Initial investigations

The patients were asked to recall what they had eaten at the roadhouse, what they had eaten on the bus prior to arrival and what they had eaten the previous night. Attempts to gain an accurate food history were challenging in view of the level of prostration in the patients and the clinical imperative to initiate fluid replacement therapy as soon as possible. Consequently the following history transpired via the non-ill passengers. The bus picked up the 11 passengers between 4 and 5am that morning to travel back to Arnhem Land. None had eaten breakfast prior to leaving so the bus stopped at the roadhouse for breakfast around 7-30am. Of the eleven passengers, 7 had bacon and egg sandwiches while the remaining passengers ate pies and chips. One and a half hours later 1 of the 7, a 3 year old child, became violently ill with severe abdominal cramps, explosive vomiting and diarrhoea. Within 30 minutes 4 more of the 7 became ill with similar symptoms triggering the bus driver to seek medical assistance at the nearest health facility. All passengers, including those who became ill, had ‘empty stomachs’ before consuming food at the roadhouse, a fact that was reiterated repeatedly. Food eaten on the previous evening was not implicated as the sick children and adults had each eaten different meals. Since none of the passengers who ate pies and chips were ill, the bacon and egg sandwiches appeared to be the prime suspect.

The 5 patients were given intravenous fluids at the community health clinic. Despite this intervention 4 of the 5 (2 children and 2 adults) were still unwell by late afternoon prompting clinic staff to organise their evacuation by Aerial Medical Services to the Royal Darwin Hospital. Specimens of vomitus and stool were collected and sent with the patients to a Darwin pathology laboratory.

Public health interventions

The implication that a roadhouse was possibly involved in a food poisoning incident meant that swift instigation of a public health investigation was essential. The manager of the Darwin Environmental Health Branch immediately allocated an environmental health officer (EHO) to facilitate interventions in conjunction with CDC personnel.

The initial investigation involved contacting health clinics and bus companies and the manager/owner of the roadhouse. The 3 clinics in adjacent communities were contacted and asked to inform CDC of any presentations of foodborne gastroenteritis. All commercial tourist bus companies who regularly stop for breakfast at the roadhouse were asked to get in touch with their drivers for details of ill passengers. The manager/owner of the roadhouse was asked to cease selling bacon and egg sandwiches and hold any left over sandwiches for testing. He was informed that personnel from environmental health and CDC would be visiting later that day to conduct an investigation involving inspection of the roadhouse and an examination of the food handler(s).

Results of initial investigations

There were no presentations of foodborne gastroenteritis to any clinic that day and there were no incidents of illness reported among passengers of the commercial bus companies

A Hazard Analysis of Critical Control Points (HACCP) auditing approach was used in investigating the process of producing a bacon and egg sandwich. Hazard analysis involves the identification of ingredients and products that might have a pronounced effect on food safety.[1,2] The audit followed the process of an egg and bacon sandwich from food transport, reception and cold storage through to preparation, cooking and handling of the final product before sale. The audit also included an inspection of the roadhouse in terms of cleanliness and hygiene as well as structural aspects that may involve a risk to food safety and could contribute to, or be the cause of, the outbreak.

All hazards identified within this process were being controlled; food transport and storage temperatures were below 5°C for cold food storage and above 60°C for hot-bain maire foods.

The main preparation area was found to be generally clean and uncluttered however there were several areas that were identified for improvement. There was evidence to suggest that the hand wash basin was not being utilised even though it was well located, equipped with soap and handtowels, and the staff were aware that they should be washing their hands frequently. The investigation also revealed that a staff member working in the food roadhouse had diarrhoea. The staff member was not directly involved in preparing the bacon and egg sandwich, however as a precautionary measure and in line with the Food Safety Standards he was requested to perform other duties.[3] These duties included those not associated with food handling, preparation and storage and were required until the diarrhoea had ceased.

Information and advice on food handling practices and temperature control and monitoring was provided to the proprietors and staff at the time of the investigation. The proprietor was also provided with copies of the Australia New Zealand Food Authority, Food Safety Standards.[3]

Foods that are frequently involved in staphylococcal food poisoning are those that require considerable handling during preparation and that are kept heated in temperature less than 60 degrees for prolonged periods.[4] Furthermore, in classical staphylococcal foodborne outbreaks purulent skin lesions may be found on the hands and/or face of food handlers.[5]

The bacon and eggs went through a 'cook' process before being assembled and were not handled with bare hands at any time during the preparation process. In addition none of the food handlers had lesions on their hands or faces. A printout of the morning's takings was examined to determine the time between preparation and consumption. This information revealed a rapid turnover of sandwiches and that the average length of stay in the bain-marie was 30 minutes.

In summary the investigation did not identify any reason to implicate the roadhouse as the source of infection and it looked as if that another source might be involved. In view of this we decided to reinterview the patients evacuated to RDH.

Follow-up investigation

Later that evening the 4 patients who had been evacuated to RDH had recovered and were able to provide more history regarding their food intake. They recalled that a small take-away meal of fried rice and beef and black bean sauce was taken onto the bus that morning. It was at least 24 hours old and had not been refrigerated since purchase the previous day. The 4 patients plus 1 other passenger who subsequently became ill shared the meal prior to stopping at the roadhouse for breakfast. The other passengers did not eat on the bus nor were they aware that food was eaten, hence the repeated denial of food consumption other than that eaten at the roadhouse. Since there was no left over rice and the source was not established in order to test food handlers the diagnosis of food intoxication hinged on the detection of *Bacillus cereus* (*B. cereus*) or *Staphylococcus aureus* (*S. aureus*) in the faecal and/or vomitus specimens.

Results

No organisms were isolated in the faeces and *B. cereus* was not isolated in the vomitus. A very heavy growth of *S. aureus* grew in the vomitus fitting the clinical picture of staphylococcal food intoxication. For further confirmation the vomitus specimens were sent for toxin testing but staphylococcus enterotoxin was not detected, possibly due to delay in specimens reaching the appropriate laboratory.

Discussion

From the outset this outbreak had all the hallmarks of food poisoning. The short incubation period, the sudden onset of violent gastro-enteric symptoms in a group of people, and the self limiting nature of the illness all pointed to the consumption of a food containing a toxin.

S. aureus and *B. cereus* both produce pre-formed toxin causing food poisoning syndromes which include nausea, vomiting, abdominal cramps and diarrhoea.[5,6] In addition fried rice is frequently implicated in *B. cereus* food poisoning outbreaks, particularly if left in warm conditions for prolonged periods.

Public health interventions, including an investigation of the roadhouse were based on the presumption that bacon and egg sandwiches were the source, and were initiated early to prevent further illness. The investigation failed to implicate the bacon and egg sandwiches as the source of infection and a more plausible source ensued implicating a meal of fried rice and beef and black bean sauce eaten shortly before the bacon and egg sandwiches. The likelihood that the meal was the source of *S.aureus* is borne out by 2 factors; the meal was not refrigerated from the time of purchase until consumption the following day, at least 24 hours later. Secondly infected lesions were observed on the hands of both affected children by the clinic staff. It is possible that the children handled the meal during the previous evening causing the *S. aureus* to be present in the meal. The combination of warm tropical conditions and the prolonged delay between purchase and consumption would have ensured the proliferation of S. *aureus* to the concentration required to produce a toxin dose.

The clinical diagnosis was supported by the isolation of *S.aureus* in the vomitus specimens but could not be confirmed since no leftover food was available for entertoxin testing. Vomitus is not routinely collected for testing in gastroenteritis outbreaks, however in the case of suspected food intoxication recommended specimens include faeces and vomitus from the patient(s) and leftover food. Additional specimens including nasal and wound swabs from food handlers may also be taken if *S. aureus* is suspected. Staphylococcal food intoxication is confirmed if *S.aureus* is isolated from the vomitus or faeces and the phage type matches that isolated from nasal orifice or wound lesion swabs; where more than 10^5 organisms per gram are isolated from the food; or if staphylococcal enterotoxin is demonstrated in the food. Bacillus food intoxication is confirmed if *B.cereus* is isolated from the vomitus or faeces or more than 10^5 organisms are isolated in the food.[5]

S.aureus is not a common cause of foodborne disease outbreaks in Australia (7% of foodborne disease outbreaks[8]). The incidence of *S.aureus* outbreaks in the Northern Territory (NT) is unknown but likely to be significant given the high rate of skin infections and the favourable climatic conditions.

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Quarterly notifiable disease surveillance

In this edition of the bulletin we are introducing a new way of illustrating notifiable disease data. In addition to the usual table, we have displayed a selection of notifiable diseases from the April-June quarter on a bar graph. Each bar represents the ratio of the number of cases of the disease in the last quarter to the mean number of cases in the same quarter for the preceding 4 years. This allows a comparison of the actual number of cases with the number you might expect for that quarter based on previous years' experience. For example the number of cases of malaria notified in the second quarter this year was 17, whereas the mean number for the second quarter for the 4 previous years was 13. Therefore the ratio of actual to expected was 17/13 = 1.31.

We have also employed a method to establish whether the difference between actual and expected is "significant". This is by seeing whether the number of cases observed in the last quarter falls outside a range of 2 standard deviations either side of the mean of the previous four years. This method is very similar to that used by the Morbidity and Mortality Weekly Review in its regular reporting. However, it is only one of many, at times complicated methods to examine the significance of a difference in case numbers.

We hope that trialing this method will allow us to gain a greater understanding of the trends we observe in notifiable disease occurrence. We would welcome feedback from readers of the *Bulletin* on this new system of reporting and analysis.

In examining the April-June data there are a number of diseases worthy of some comment. There were four diseases that fell outside the two standard deviation limit: trichomonas and tuberculosis showed reductions while chlamydial conjunctivitis, and hepatitis C showed increases. When observing such differences we must explore whether they represent true changes in the occurrence of disease or can be explained by other factors.

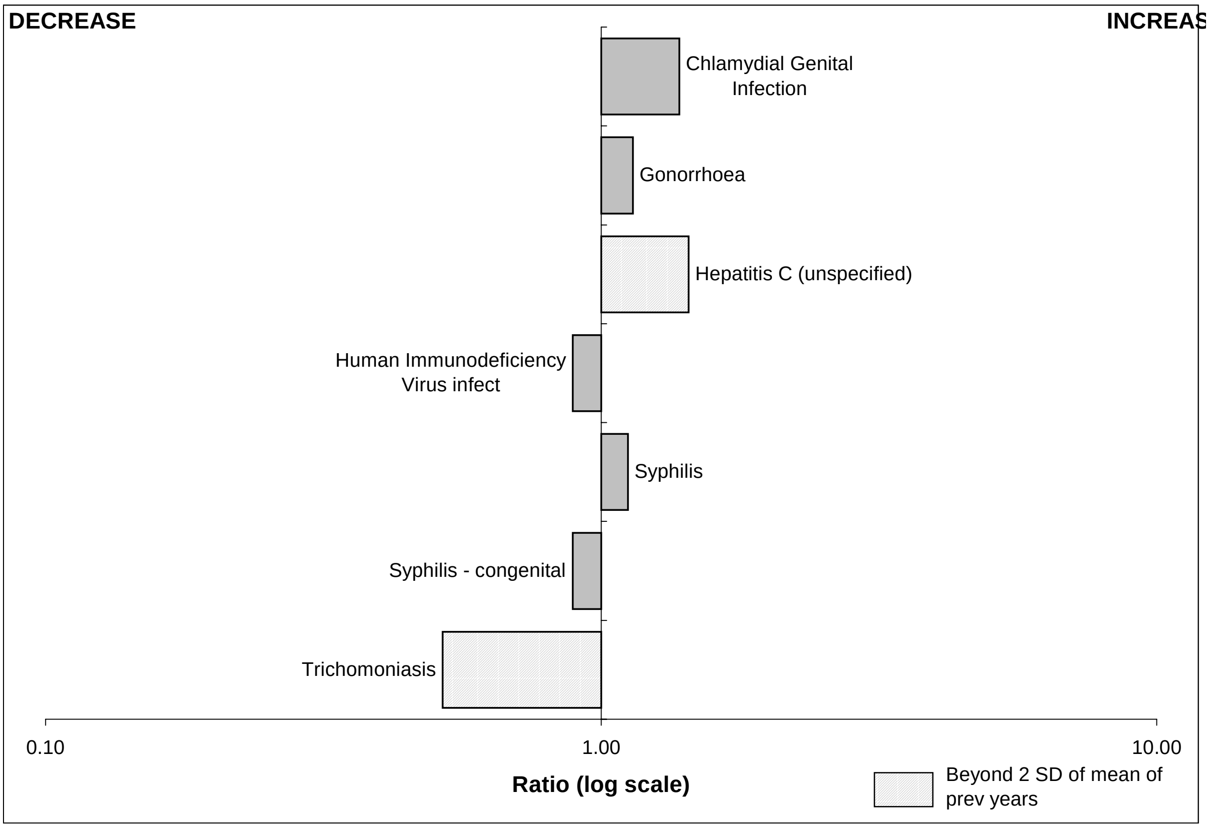
Chlamydial conjunctivitis: Notifications of this have increased each year over the past 3-4 years. The vast majority is in young children in remote communities. Reports from those communities, the eye health committee and pathology laboratories indicate that the number of PCR tests for chlamydia taken from eyes has dramatically increased during the same period. Many practitioners are now doing PCR tests on kids with possible trachoma or conjunctivitis. The overall impression is that the increase is due to extra testing and not an increase in trachoma.

Hepatitis C: It is likely that this increase is related to increased testing. Since the Opiate Pharmacotherapy Program (buprenorphine and methadone program) began in September 2002 in both Darwin and Alice Springs over 100 people presenting to that program have been tested for hepatitis C approximately 70% of whom were positive. During this quarter 11 of the 60 cases detected in the NT came from the Opiate Pharmacotherapy Programs. Without these 11 cases the number for this quarter would not have been in excess that expected from previous years.

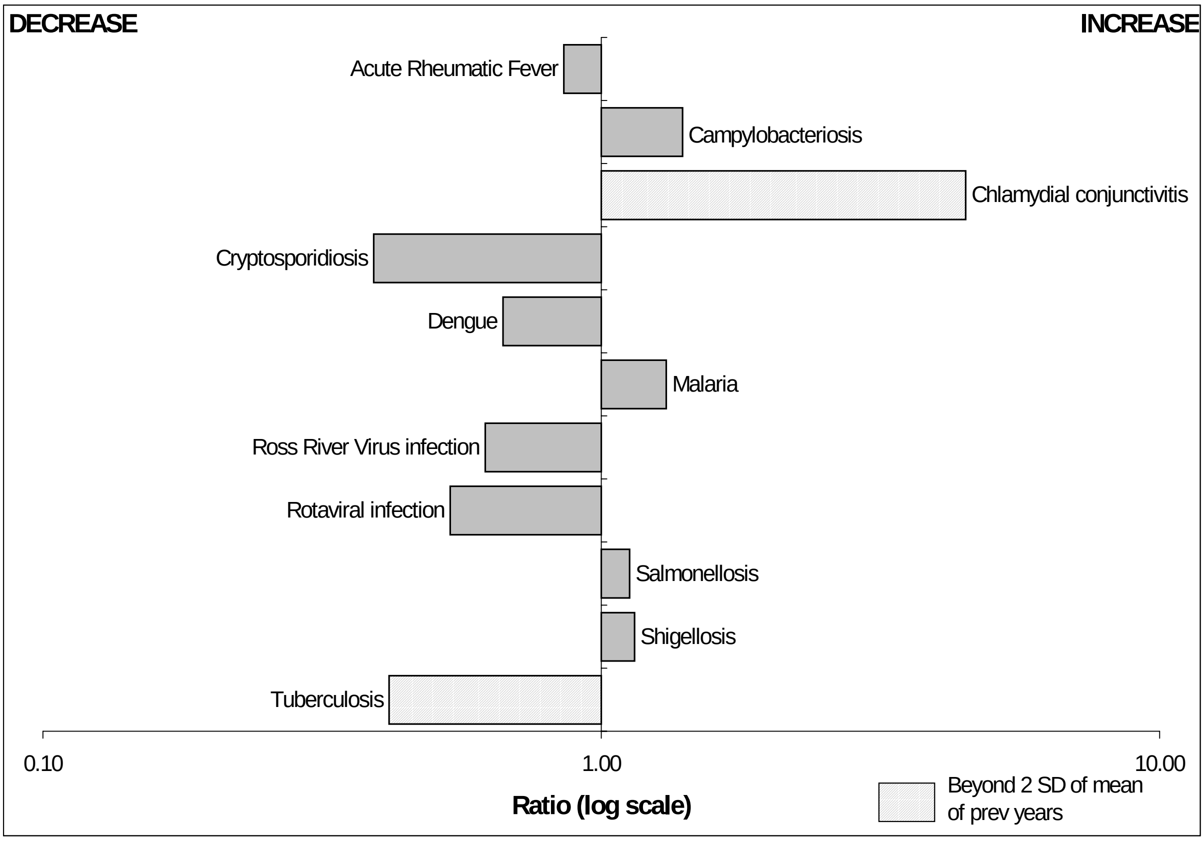
Trichomonas: Notifications of trichomonas for this quarter have declined in the Darwin, East Arnhem and Katherine regions particularly since 2001. They have remained stable in Alice and the Barkly. Detection of STIs, particularly trichomonas which is very often asymptomatic, is very dependent on the amount of testing done. We will need to explore whether the amount of testing done and proportion of tests that were positive in these regions has changed before drawing any conclusions about the change in notifications.

Tuberculosis: Not only does this quarter show a reduction, but the year to date total is down compared to previous years with only 19 notifications compared to 40 last year, 35 in 2001 and 60 in the year 2000. Nathan Zweck of the TB program believes we may be starting to reap the benefits of seriously applying latent TB treatment to infected persons. He feels there has been significant improvements in screening for latent infection and in people completing isoniazid treatment in the past few years.

Change in April June quarter 2003 compared to mean of corresponding quarter of previous four years: sexually transmitted infections and blood borne viruses



Change in April June quarter 2003 compared to mean of corresponding quarter of previous four years: selected diseases



Enteric diseases in the Northern Territory April – June 2003

Karen Dempsey, CDC Darwin

Gastroenteritis outbreaks

There were no confirmed foodborne gastro-enteritis reported to Northern Territory (NT) Centre for Disease Control (CDC) during the April-June 2003 quarter.

A large national outbreak of hepatitis A was linked to the NT in June 2003. Hepatitis A was diagnosed in 29 interstate residents within 24 to 42 days of participating in a 4-day youth camp in Central Australia.

An outbreak of non-foodborne gastroenteritis occurred in a Darwin Childcare Centre. The attack rate was high with 12 out of 16 children under 2 years of age becoming ill with gastroenteritis within 24 to 48 hours of exposure to a child vomiting in the nursery. The symptoms were consistent with a viral infection; vomiting was the dominant symptom followed by diarrhoea. In addition the attack rate was high in older siblings and adults with 15 people (3 siblings and 12 parents) became symptomatic following exposure. Stool testing identified the causative organism as a calicivirus, which was subsequently typed as norovirus.

Campylobacteriosis

During the April-June 2003 quarter there were 87 *Campylobacter* notifications (45 males and 42 females). The median age was 1 year reflecting the high proportion of cases among the 0 to 4-year old age group.

The number of *Campylobacter* notifications reported this quarter exceeded the number reported during the same period in 2002. This is consistent with the trend observed during the first quarter of this year, although for females only. Female notifications were 3 times higher (14 in 2002 and 42 in 2003) and male notifications were similar for both periods (41 in 2002 and 45 in 2003). Indigenous notifications increased markedly (20 in 2002 and 51 in 2003) while non-Indigenous cases remained the same. Alice Springs region, including Alice Springs City and rural communities, reported the largest rise in C*ampylobacter* notifications increasing from 18 to 48. It is not known why this region has experienced such a large increase and the cause is currently undergoing investigation.

Cryptosporidiosis

There were 22 *Cryptosporidium* notifications reported during the April-June 2003 quarter. All were sporadic cases and none were associated with swimming pools or child-care centres.

The number of *Cryptosporidium* notifications for this quarter were fewer in number compared to the same period in 2002 (40 in 2002 and 22 in 2003).

Hepatitis A

Only 6 hepatitis A notifications reported during the April-June 2003 quarter, mostly in the Alice Springs region. This was far fewer than the number notified during the first quarter of this year (18 notifications). None of the 4 NT cases detected during June were linked to the previously described nation-wide outbreak.

The number of hepatitis A notifications for this quarter were slightly less than recorded for same period in 2002 (9 in 2002 and 6 in 2003).

Rotavirus

There were 125 rotavirus notifications (77 males and 48 females) significantly higher than the previous quarter (12 notifications). The majority of cases were Indigenous children aged less than 5 years of age living in the Alice Springs region.

The NT has experienced biennial epidemics of rotavirus gastroenteritis since 1995 and it was anticipated that the 2003 winter incidence would match this trend. This was not the case and the number of notifications recorded this quarter were considerably less than that recorded for the same period in 2002 (262 in 2002 and 125 in 2003). The decline was observed in all regions.

Since peak activity during past epidemic years has occurred during April, June, July and August it is possible that the peak is late this year and may occur during the ensuing month.

Salmonellosis

There were 95 *Salmonella* notifications reported during the April-June 2003 quarter. More males than females were reported (51 males and 44 females) and the median age was 2 years reflecting the high incidence of salmonellosis among children aged less than 5 years of age.

Salmonella Ball (14 notifications) was the dominant serovar followed by Salmonella Saintpaul (9 notifications). One notification of Salmonella Paratyphi B var Java was reported in a 21-month-old Indigenous child living in an Arnhem Land community. There were no notifications of Salmonella Enteritidis.

The number of *Salmonella* notifications was similar during this quarter to the same period in 2002. Male notifications were down slightly (57 in 2002 and 51 in 2003) while notifications among females increased by ten (34 in 2002 and 44 in 2003). There was no significant change in the number of notifications by Indigenous status over the two periods. For most regions the incidence was relatively unchanged with the exception of Alice Springs region where there was a slight reduction.

Shigellosis

During the April-June 2003 quarter there were 35 *Shigella* notifications (13 males and 22 females). The majority of cases were children aged less than 9 years of age and the median age was 7 years.

The number of *Shigella* notifications reported this quarter exceeded the number reported during the same period in 2002. Female notifications were three times higher (6 in 2002 and 22 in 2003) and male notifications were similar for both periods (16 in 2002 and 13 in 2003). The majority were Indigenous and there was little change in the ethnic distribution of cases over the two periods. Alice Springs region, including Alice Springs City and rural communities, reported the largest increase in *Shigella* notifications, increasing from 8 during the second quarter of 2002 to 24 during the second quarter of 2003.

Other enteric diseases

There were no notifications of yersinia, listeria or haemolytic uraemic syndrome during the April-June 2003 quarter.

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NT Malaria notifications April - June 2003

Merv Fairley, CDC, Darwin

There were 17 notifications of malaria received for the second quarter of 2003. The following table provides details about where the infection was thought to be acquired, the infecting agent and whether chemoprophylaxis was used.

Number of cases	Origin of infection	Reason exposed	Agent	Chemoprophylaxis
10	West Guinea	refugee	P.falciparum	no
1	East Timor	working	P.falciparum	no
1	East Timor	working	P vivax	yes
1	? South Africa	holiday	P.falciparum	yes
1	Uganda	refugee	P.falciparum	no
2	PNG	holiday	P.falciparum	no
1	PNG	holiday	P vivax	yes

NT NOTIFICATIONS OF DISEASES BY ONSET DATE & DISTRICTS 1 APRIL TO 30 JUNE 2003 AND 2002

Diseases	Alice Springs		Barkly		Darwin		East Arnhem		Katherine		NT	
	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002
Acute post-Streptococcal GN	1	0	0	0	0	0	0	0	0	1	1	1
Acute Rheumatic Fever	3	8	1	0	3	7	0	2	2	1	9	18
Adverse Event after Immunisation	0	1	0	0	4	4	3	2	0	0	7	7
Barmah Forest Virus infection	1	0	0	0	2	5	1	0	0	0	4	5
Campylobacteriosis	48	18	4	2	29	29	3	0	3	6	87	55
Chlamydial conjunctivitis	25	0	18	0	45	26	0	9	1	0	89	35
Chlamydial Genital Infection	201	175	2	8	159	129	23	27	25	40	410	379
Cryptosporidiosis	18	7	0	0	3	25	1	5	0	3	22	40
Dengue	0	0	0	0	6	6	1	0	0	2	7	8
Donovanosis	0	1	0	0	0	1	0	0	0	1	0	3
Gonococcal conjunctivitis	0	1	0	0	2	0	0	0	1	0	3	1
Gonococcal ophthalmic neonatorum	0	0	1	0	0	0	0	0	0	0	1	0
Gonorrhoea	223	198	4	13	122	120	18	19	35	42	402	392
Haemophilus influenzae (not type b)	0	0	0	0	0	0	1	0	0	0	1	0
Haemophilus influenzae (type b)	1	1	0	0	0	0	0	0	0	0	1	1
Hepatitis A	4	2	0	0	1	3	0	0	1	4	6	9
Hepatitis B (incident)	1	0	0	2	3	1	0	0	1	1	5	4
Hepatitis C (unspecified)	12	2	1	1	42	37	1	1	4	2	60	43
Human Immunodeficiency Virus infect	0	0	0	0	2	3	0	0	0	0	2	3
Human T-Cell Lymphotrophic Virus	5	6	0	0	2	0	0	0	2	0	9	6
Influenza	0	1	0	0	1	0	0	0	0	0	1	1
Leptospirosis	0	0	0	0	1	1	0	0	0	0	1	1
Malaria	2	1	0	0	15	4	0	0	0	1	17	6
Melioidosis	0	0	0	1	1	2	0	0	0	0	1	3
Meningococcal infection	4	0	0	0	0	2	0	2	0	0	4	4
Mumps	0	0	0	0	0	1	0	0	0	0	0	1
Pertussis	0	0	0	0	0	6	0	0	0	0	0	6
Pneumococcal Disease (Invasive)	10	9	4	0	1	5	1	0	3	1	19	15
Ross River Virus infection	0	1	4	1	5	9	0	0	3	1	12	12
Rotaviral infection	58	97	2	17	25	83	11	9	30	56	126	262
Salmonellosis	18	24	6	1	54	48	5	3	12	15	95	91
Shigellosis	24	8	4	4	4	6	1	2	2	2	35	22
Syphilis	58	73	1	2	13	23	7	3	16	5	95	106
Syphilis - congenital	2	7	0	0	0	0	0	0	0	0	2	7
Trichomoniasis	62	56	2	5	32	76	16	27	10	33	122	197
Tuberculosis	0	1	0	0	4	5	0	0	1	5	5	11
Typhus (scrub)	0	0	0	0	1	0	0	0	0	0	1	0
Total	781	698	54	57	582	667	93	111	152	222	1,662	1,755

Points to note regarding notifications:

Amoebiasis, Anthrax, Murray Valley Encephalitis, Kunjin, Kokobera, Atypical Mycobacteria, Botulism, Brucellosis, Chancroid, Cholera, Congenital Rubella Syndrome, Diphtheria, Gastroenteritis, Haemolytic Uraemic Syndrome, Hepatitis C (incidence), Hepatitis D & E, Hydatid Disease, Legionnaires Disease, Leprosy, Listeriosis, Lymphogranuloma venereum, Measles, Orthithosis, Plague, Poliomyelitis, Q Fever, Rabies, Rubella, Tetanus, Typhoid, Vibrio Food Poisoning, Viral Haemorrhagic Fever, Yellow Fever, Yersiniosis and SARS are all notifiable but had "0" notifications in this period.

NOTIFIED CASES OF VACCINE PREVENTABLE DISEASES IN THE NT BY ONSET DATE 1 APRIL TO 30 JUNE 2003 AND 2002

DISEASES	TOTAL		No. cases among children aged 0-5 years	
	2003	**2002**	**2003**	**2002**
Congenital rubella syndrome	0	0	0	0
Diphtheria	0	0	0	0
Haemophilus influenzae type b	1	1	1	1
Hepatitis B	5	4	1	0
Measles	0	0	0	0
Mumps	0	0	0	0
Pertussis	0	6	0	2
Poliomyelitis, paralytic	0	0	0	0
Rubella	0	0	0	0
Tetanus	0	0	0	0

* Mumps is largely under-reported.

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Disease control staff updates

CDC

Darwin: Vicki Krause has taken sabbatical leave until January 2004 with **Peter Markey** acting Director of Disease Control during this time.

Alice Springs: Jackie Glennon has moved to Noosa, with **Alex Brown** covering her position part time until it is filled.

Surveillance

Darwin: Steven Skov is working part time as surveillance medical officer.

Immunisation

Alice Springs: Dyan Kelaart is now working as a remote area nurse at Yuendumu and **Helen Tindall** has returned to the Public Health Nurse position after her time overseas. A short term immunisation catch up program is being completed by **Beth Rowan**.

Katherine: Nancy Nyberg has moved to fill an audiometry nurse position with **Ruth Baillie** joining the team from Aerial Medical Services.

AIDS/STD

Darwin: Brian Hughes has joined The AIDS/ STD Program with the departure of **Sarah Huffam**. Brian has Previously worked at Sydney Sexual Health Centre and the Albion Street Centre in Sydney. He is a dual fellow of the Royal Australasian College of Physicians (Infectious Diseases) and the Australasian College of Sexual Health Physicians. The coordination position for the remote sexual health team has been filled by **Sandra Downing** on return from her overseas work with a polio eradication program in Ethiopia and an obstetrics program in Sri Lanka. **Di Clare** and **Darryl Thomas** are moving to the Aboriginal Medical Alliance Service Northern Territory (AMSANT) working with health boards and councils promoting HIV/AIDS awareness. **Andrew Seymour** is moving on from the administration position in October.

Katherine: Greg Henschke has accepted a position with Katherine West Health Board as programs manager to develop annual plans, assist with implementing programs and liason with other health services,

Non Communicable Diseases

Darwin: Tarun Weeramanthri will be leaving as Community Physician on returning from his leave to fill the Principal Medical Advisor position. **Angela Kelly** has returned as the Rheumatic Heart Disease project officer for 6 months developing a model of best practice ‘tool kit’ for the TopEnd of Australia and will be presenting workshops in the NT, Queensland and Western Australia. A Change of paediatric registrars brings **Rhys Parry** with **Alison Cupitt** returning to RDH. **Brad Palmer** will be taking leave to work overseas leaving the Community Child Health position to be filled.

Alice Springs: Lynette Purton is moving to a public health nurse position in Broome leaving the Rheumatic Heart Disease Program.

TB/Leprosy

Alice Springs: Jeannette Berthelsen’s return to the Emergency Department has brought **Minnie Blythman** as Public Health Nurse TB/Leprosy. Minnie previously worked with the Centre for Remote Health. Recruitment to this position is currently underway.

Katherine: Maria Chandler is returning to a new position with clinic administration. **Kerry Bettison** joins the team as administration support and **Margaret Richards** will be leaving in the next month.

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Centre for Disease Control Conference

The CDC conference planned for the 28th-30th October 2003 has been cancelled. We hope to be able to convene another conference next year. Apologies to anyone that may have been inconvenienced.

Appendix P Draft Biting Insects Management Plan

Attachment D: Personal protection from mosquitoes and biting midges in the Northern Territory

CENTRE FOR DISEASE CONTROL
NORTHERN TERRITORY

PERSONAL PROTECTION FROM MOSQUITOES & BITING MIDGES IN THE NT

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April 2004*

Published in "Australian Mosquito Control Manual" by a panel of authors, Editors C. Morris and P. Dale. Australian Mosquito Control Association, 1998, ISBN 0-646-35310-1.

* Minor revisions 2004

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PERSONAL PROTECTION FROM MOSQUITOES & BITING MIDGES

P. I. Whelan,
Department of Health and Community Services
April 2004

Adapted from paper by P. Whelan in "Australian Mosquito Control Manual" by a panel of authors, Editors C. Morris and P. Dale. Australian Mosquito Control Association, 1998, ISBN 0-646-35310-1.

1 Mosquito & biting midge bites

Mosquitoes and biting midges (genus Culicoides and sometimes erroneously called sand flies) can reach sufficient numbers in various localities to be considered serious pests. The bites themselves can be painful and extremely annoying, and people suffer varying degrees of reaction to bites.[1] However the possibility of the spread of various diseases by their blood sucking habits to either humans or animals is a more serious outcome. Mosquitoes can carry viruses such as Murray Valley encephalitis, Kunjin, Ross River, and Barmah Forest virus, which cause human disease.[2] Biting midges do not carry any pathogens in Australia that cause human disease.

Female mosquitoes or biting midges bite to take blood from their hosts, which is necessary for the development of eggs.

Mosquitoes and biting midges show considerable variation in their preference for hosts. Some species feed selectively on cattle, horses, marsupials, amphibians, birds or humans, while other species are relatively indiscriminate feeders.

The time of feeding varies for different species. Many mosquitoes feed just after sunset while others are more active at other times including late in the night, in the late afternoon, or in the early morning. Biting midges are most active in the evening and early morning.

The place of feeding by mosquitoes or biting midges is varied. Some species, such as the brown house mosquito, readily entering houses to feed on people, while others will only bite people outdoors.

When a mosquito or biting midge bites, fine stylets sheathed in the proboscis are inserted into the skin. Blood is sucked up through one of the channels in the stylets, while saliva is injected down an adjacent channel. This saliva contains substances that the human body recognises as foreign and often stimulates a bite reaction. Sometimes the saliva can contain viruses or other pathogens that can cause disease.

Some people can become very sensitive after being bitten and suffer a general reaction from further bites. The bites may itch for days, producing restlessness, loss of sleep and nervous irritation. Scratched bites can lead to secondary infections and result in ugly scars. On the other hand, some people become tolerant to particular species and suffer little after-effects from repeated bites.

Biting insects create problems in the enjoyment of outdoor activities, causing a reluctance to enter certain areas after sundown or forcing people to be confined to insect-proof areas at certain times of the year. Personal protection and avoidance measures can offer considerable protection from bites, as well as offering protection against mosquito-borne disease.

2 Mosquito & biting midge avoidance

A sensible precaution to prevent biting insect attack is to avoid areas that are known to have high biting insect activity.

The upper high tide areas near creeks or low-lying areas, particularly near salt marsh habitats, can be significant sources of salt marsh mosquitoes (particularly *Aedes vigilax* and various other pest mosquitoes.[2] The period of high salt marsh mosquito activity is usually during the late dry season and early wet season in tropical latitudes. Generally they are prevalent for one to two weeks after the highest tides of the month or significant rain. Dense vegetation near the breeding sites should be avoided during the day over this period. Pest problems during the evening and night can occur within 3 km of productive breeding sites.[3]

Other areas of high mosquito activity are the large seasonally flooded areas associated with rivers or drainage lines, flooded coastal swamps, extensive reed swamps and lagoons, ill defined or poorly draining creeks, extensive irrigation areas, and wastewater disposal facilities. Densely shaded areas near these habitats should be avoided during the day, and accommodation areas should be at least 3 km from extensive areas of these habitats.

Extensive areas of mangroves or estuarine areas with sandy beaches are potential sources of biting midges. These midges have seasonal and monthly population peaks with the monthly peaks usually associated with the tidal regime. When camping or choosing a permanent living site, a separation distance of at least 2 km from these areas is recommended unless specific biting insect investigations indicate there are no seasonal pest problems.[4,5]

If camping or selecting house sites near creeks, rivers or lagoons, choose localities of the water body which have steep margins or little marginal emergent vegetation, have swiftly running water with little marginal pooling or vegetation, or do not arise from or empty into a nearby swamp area. Exposed beaches or cliffs away from mangrove or estuary areas are preferred sites to avoid both mosquitoes and biting midges. In more inland areas, locations on hills or rises at least 3 km from ill defined drainage lines, poorly flowing creeks and seasonally flooded areas should avoid the worst mosquito problems.

In residential areas, a local source of mosquitoes may be the cause of the problem. Check nearby potential artificial sources of mosquitoes such as disused swimming pools, receptacles such as tyres and drums, blocked roof gutters, old fishponds, or localised ponding of drains. Sites with mosquitoes breeding can be rectified by physically removing the source or through the use of insecticides.

3 Screening

The best method of avoiding attack at night is to stay inside insect-screened houses. Screens can be made of galvanised iron, copper, bronze, aluminium or plastic. Near the coast, iron or copper screens are not recommended because of the corrosive action of salt sprays. Homes near biting midge breeding sites require either fine mesh screens or lightproof curtains.

Screens should be of the correct mesh, fit tightly and be in good repair. Biting insects frequently follow people into buildings and for this reason, screen doors should open outward and have automatic closing devices. Insecticides such as permethrin or deltamethrin sprayed on or around screens may give added protection against mosquitoes or biting midges, but care is needed as some insecticides affect screens.

It is advisable to use an insect proof tent when camping near potential biting insect areas. Coastal areas subject to attack by biting midges require tents to be fitted with a finer mesh screening.

4 Mosquito nets

Mosquito nets are useful in temporary camps or in unscreened houses near biting insect breeding areas. Generally standard mosquito nets are not sufficient to prevent biting midge attack. White netting is best as mosquitoes accidentally admitted into the net are easily seen and killed. The net is suspended over the bed and tucked under the mattress. An aerosol pyrethrin spray can be used to kill mosquitoes that enter the net. Care is needed not to leave exposed parts of the body in contact with the net, as mosquitoes will bite through the net. Nets can be made more effective by impregnation with permethrin.[6]

5 Insect proof clothing

Head nets, gloves and boots can protect parts of the body, which are not covered by other clothing. Head nets with 1-1.5 meshes to the centimetre are recommended for good visibility and comfort, and additional treatment of the net with a repellent will discourage insect attack. Thick clothing or tightly woven material offers protection against bites. Light coloured, long sleeved shirts and full-length trousers are recommended. For particular risk areas or occupations, protective clothing can be impregnated with permethrin or other synthetic pyrethroid insecticides such as bifenthrin to give added protection.[7] Sleeves and collars should be kept buttoned and trousers tucked in socks during biting insect risk periods. Protection is very necessary near areas of salt marsh, mangroves, or large fresh water swamps where the various species of mosquitoes may be very abundant during the day in shaded situations, as well as at night.

6 Repellants

Relief from biting insect attack may be obtained by applying repellents to the skin and clothing.[8] Many repellents affect plastics and care is needed when applying them near mucous membranes such as the eyes and lips.

Repellents with the chemical diethyl toluamide (DEET) or picaridin give the best protection. Some specific repellent products, such as Aerogard, which are formulated to repel flies, are generally not efficient against mosquitoes or biting midges. Brands such as Rid, Tropical Strength Aerogard, Bushman’s, Muskol, or Repel include specific products that are effective. Those products with higher amounts of DEET or picaridin are usually the most efficient.

Application of repellents over large areas of the body or on extensive areas of children is not recommended particularly those repellents with high concentrations of DEET. Protection from mosquito penetration through open weave clothes can be obtained by applying a light application of aerosol repellent to the exterior of clothing. Repellents should be supplementary to protective clothing and should not be regarded as substitutes.

Personal repellents are available as sprays, creams or gels. The creams or gels usually last longer than the aerosol formulations. Repellents can prevent bites from 2 to 4 hours, depending on the repellents, the species of biting insect, or the physical activity of the wearer.

Electronic insect repellers that emit ultrasonic or audible sounds do not offer any protection against mosquitoes or biting midges. They are based on a false premise and have been found to have no repellent effect under scientific testing.[9] Electronic ultrasonic repellers do not repel mosquitoes or biting midges and should not be relied upon for personal protection.[10]

Plants with reported insecticidal properties such as neem trees and the citrosa plant have not been shown to act as mosquito repellents just by growing in the vicinity of people.[10,11] Growing or positioning these plants near evening activity areas will not prevent mosquito attack. However some plants have some repellency effects as smoke or liniments (see section 12, emergency biting insect protection)

7 Animal diversion

Camping upwind near congregations of stock or domestic animals will serve to divert mosquitoes or biting midges to alternative hosts. Similar considerations can be made when planning residential sites and animal holding areas in a rural situation. Dogs of darker colour tend to attract some species of mosquitoes more than lighter colours and can divert some pest problems from people in close vicinity in outdoor situations in the evening.

8 Lighting diversion

Many mosquito and biting midge species are attracted to light. This can cause pest problems in unscreened houses or when camping. The use of yellow or red incandescent bulbs or fluorescent tubes rather than white light will reduce the attractiveness of lights to insects. An incandescent or ultra violet light placed at a distance from a house or camp can serve to attract insects to an alternative area. This is more effective if the light is close to the breeding site, or between the breeding site and the accommodation area. The attractive lights should not be close to accommodation or directly down wind of accommodation areas. Light proof curtains or similar screening can be very effective in reducing the attraction of biting insects to areas that are illuminated at night.

9 Adult insect control

If mosquitoes or biting midges have entered a screened area they can be knocked down with pyrethrin aerosols. Care should be taken by reading the label to ensure only knockdown aerosols suitable for spraying in the air are used in proximity to people or food.

Other devices that can be effective at killing and/or repelling biting insects include mosquito coils[12] and electric insecticide pads. These devices are only effective in relatively closed areas such as inside buildings or where there are only slight breezes. They should be backed up with other measures such as suitable protective clothing or repellents.

Large scale adult biting insect control can be achieved for short terms (hours) by using portable or industrial fog generators, backpack misters, or heavy duty ultra-low-volume aerosol generators to knock down active adult insects. The insecticides of choice in these machines are Maldison or Bioresmethrin. Control relies on good access, open vegetation, and light breezes in the direction of the breeding or harbouring sites. Application should only be during the peak biting insect activity period of those insects actually causing the problem, which is usually the late evening and early night.

There are some synthetic pyrethroid aerosol products available as outdoor yard or patio repellents. Control will only be temporary (hours) and re-invasion will usually occur within hours or from one to a few days, depending on the species, nearby vegetation, proximity to breeding sites, environmental conditions and times of activity of the pest species.

Application of residual insecticides such as maldison, permethrin or other synthetic pyrethroids sprayed as a mist spray to point of run off on building surfaces or nearby vegetation can sometimes give short term (a few days) relief. This method is useful as a barrier protection when large numbers of mosquitoes or biting midges are present near accommodation or outdoor use areas.[13] There are some longer term residual synthetic pyrethroids such as bifenthrin that can be used as barrier sprays and provide a number of weeks protection.[14] These residual insecticides can be applied according to label recommendations with the aid of a garden sprayer. Care must be taken with all synthetic pyrethroids around fishponds, fish tanks and other nearby fish habitats to avoid spray drift or run off, as these insecticides are efficient fish poisons.

10 Insectocutors and insect traps

Electric insect insectocutors and other trap or killing devices utilising an attracting light or carbon dioxide have been claimed to clear areas of biting insects and thus protect people. These claims have not been substantiated in outdoor situations with people nearby. While trap devices can attract biting insects, as well as a range of other insects, these devices can not be relied on for protection from biting insect attack.[10] When used in outdoor situations it is possible that they can increase local problems by attracting insects to the vicinity of people. Attractive odours and carbon dioxide emitted by humans then divert the insects from the trap device to the people.

11 Treatment of bites

Relief from bites and prevention of secondary infection can be obtained by the application of various products, either to the skin or internally. The effectiveness of various products is variable, depending on individual reaction. Skin application products include proprietary products such as Eurax, Stingose, Medicreme, Katers lotion, Dermocaine and Paraderm creme, and non-proprietary products such as tea tree oil, eucalyptus oil, aloe vera gel, ice, or methylated spirits.

Ice packs to the general bite site will give usually give immediate relief for painful and itchy bites and swelling or blisters from of mosquitoes and biting midges in particular. The sooner the ice pack is applied after bites or reactions, the better the relief, and can often avoid more intense reactions.

Other products for internal application for more general symptoms include antihistamine products such as Phenergan, Telfast and Vallergan. Check with your doctor or pharmacist for any products for the latest product and safety information.

12 Emergency biting insect protection

There are a number of emergency measures that can be taken when exposed to biting insects with no protection. Sheltering downwind next to smoky fires can offer considerable protection. Burning dung or aromatic and oil producing foliage from plants such as Hyptis (horehound), Vitex (black plum), Calytrix (Turkey bush), Melaleuca species (Paper bark) and Eucalyptus species (gum trees) can make the smoke more effective. A small native plant Pterocaulon serrulatum (warnulpu) has sticky strongly aromatic leaves, and branches are burnt or the moist leaves are rubbed on the skin by Aborigines in the Katherine district to repel mosquitoes.[15] Climbing relatively high trees or choosing locations exposed to the wind can also offer protection from some species.

Some protection can be obtained by rubbing exposed skin areas with the leaves of certain plants such as eucalypts, turkey bush, warnulpa, paperbarks or tea-trees that contain volatile oils. However these are not as efficient as proprietary repellents containing deet or picaridin. Other emergency protection measures include coating the skin with mud, or burying yourself in shallow sand with some form of head protection. If all else fails, keep running. The best form of protection, and the most comfortable, require an awareness of the potential problems and adequate preparation.

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