Mosquito Borne Diseases: How should we protect crew?

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• Consultant: MoD, ExxonMobil, WHO.
Diseases and highlights

- Malaria
  - Policy and practice of crew
- Dengue & Chikungunya and Zika
- Prevention
Malaria Distribution 2016
Malaria Prevention

Awareness  Bite prevention  Chemoprophylaxis  Diagnosis

Malaria prevention
Duration of Use and safety of Chemoprophylaxis

- Mefloquine
  - Long term
  - Safe

- Atovaquone & proguanil
  - Long term
  - Safe, $$$$$$

- Doxycyline
  - Long term
  - Safe
Annual imported Malaria in air & sea crew

- USA 35 deaths in 5 years
- UK 9 cases in 5 years
- Deaths 2-3 in 5 years
Malaria in aircrew

- BA 1991 compliance with recommended prophylaxis during layovers ~5%

- 2011, USA airline self administered questionnaire, 4% Cabin and 50% Pilots used chemoprophylaxis during high risk layovers


Dunlop J. 1991 Malaria Prophylaxis in Flying Staff: Compliance with Advice
Risk estimate BA crew in West Africa 1994-2003

- Average 1990’s annual risk of falciparum malaria is 1.6 cases per 100,000 nights of exposure (95% CI 0.5-3.7)
- Disparity between urban and semi-urban rural risk?

(Byrne and Behrens 2004, *J Travel Med*) Airline crews' risk for malaria on layovers in urban sub-Saharan Africa: risk assessment and appropriate prevention policy,
(Byrne 2007, *Travel Med Infect Dis*) Urban malaria risk in sub-Saharan Africa: where is the evidence?
Malaria Risk Assessment

- Gradation of malaria transmission risk between urban, peri-urban & rural
- All hotels centrally located, vector controlled
- Crew exposure between dusk & dawn in endemic destinations was highly predictable
  - Security constraints
  - Predominantly daytime tourist attractions
  - Crew remain in the hotel during the evening
## Policy change

<table>
<thead>
<tr>
<th>Category of Hazard</th>
<th>Recommended Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard layover, predominantly indoors: protected environment of normal operations including ground transport and designated urban crew hotel</td>
<td>Adherence to staying in air-conditioning (air-conditioning of airports, ground transport, and crew hotels provides significant protection)</td>
</tr>
<tr>
<td>Standard layover with outdoor, local activities: predictable local activities between dusk and dawn (outdoors dining/sport/beach) either within the hotel environs or the local community</td>
<td>Either undertake the activities only during the daytime or resort to wearing insect repellent and protective clothing</td>
</tr>
<tr>
<td>Non-standard layover: overnight stay/visit @ remote sites, from designated urban hotel</td>
<td>Prophylaxis with atovaquone-proguanil plus rigorous mosquito avoidance; caution during rainy season</td>
</tr>
</tbody>
</table>

(Byrne and Behrens 2004, *J Travel Med*) Airline crews’ risk for malaria on layovers in urban sub-Saharan Africa: risk assessment and appropriate prevention policy,
A Guide to Malaria Management Programmes in the oil and gas industry

Vector control in malaria: ‘stopping Anopheles—a moving target’

- Anopheles response
  - changes in behaviour
  - resistance to insecticides

- Anopheles
  - identification
  - behaviour
  - density

- Vector density
  - environmental modification
  - environmental manipulation
  - biological solutions

- Vector longevity
  - chemical spraying of:
    - breeding sites
    - resting areas
  - bednet impregnation

- Vector-man contact
  - personal protection:
    - clothing
    - repellents
    - screens
    - bednets
  - community protection

study the Anopheles
## Effectiveness of Measures

<table>
<thead>
<tr>
<th>Measures</th>
<th>Effectiveness @ typical compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemoprophylaxis</td>
<td>Reduces likelihood of infection &lt;= 95% . Adherence ~ 5-50%</td>
</tr>
<tr>
<td>Use of repellent on exposed skin</td>
<td>Reduces likelihood of infection &lt;= 45% adherence ~ 30-50%</td>
</tr>
<tr>
<td>Use of impregnated bed nets</td>
<td>Reduces transmission by 68–95%</td>
</tr>
<tr>
<td>Permethrin impregnated clothes + DEET repellent</td>
<td>Reduces bites by up to 99%, adherence &lt; 20%</td>
</tr>
<tr>
<td>Long sleeve shirts and trousers</td>
<td>Reduces infection by &lt;= 60%</td>
</tr>
<tr>
<td>Vector control measures, + residual insecticide spraying, space spraying, + elimination of breeding sites, larviciding, biological control + use of air-conditioning.</td>
<td>Highly effective all measures would virtually eliminate malaria risk</td>
</tr>
</tbody>
</table>
Policy challenges for Aircrew & Malaria.

- Poor chemoprophylaxis adherence
- Inadequate understanding of malaria, particularly recognising symptoms and seeking urgent treatment
- Access to diagnostics and expert treatment when away from home or base
- Environmental control in layover accommodation
- Layover excursions
- Reporting and surveillance to employer of illness
Estimating the malaria risk of African mosquito movement by air travel

Countries reported in which confirmed or probable cases of airport malaria occurred

(Tatem, Rogersbeen et al. 2006, Malaria Journal) Estimating the malaria risk of African mosquito movement by air travel,
Emerging diseases with arthropod vectors

<table>
<thead>
<tr>
<th>Infection</th>
<th>Distribution</th>
<th>Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barmah Forest virus</td>
<td>Australia</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Cat flea typhus</td>
<td>United States</td>
<td>Fleas</td>
</tr>
<tr>
<td>Cat-scratch disease</td>
<td>Global</td>
<td>Fleas, Ctenocephalides felis</td>
</tr>
<tr>
<td>Dengue hemorrhagic fever</td>
<td>Americas, Asia</td>
<td>Aedes (Stegomyia) mosquitoes</td>
</tr>
<tr>
<td>Human ehrlichiosis—monocytic</td>
<td>Americas, Asia, Europe</td>
<td>Ticks</td>
</tr>
<tr>
<td>Human ehrlichiosis—granulocytic</td>
<td>United States, Europe</td>
<td>Ticks</td>
</tr>
<tr>
<td>Kyasanur forest disease</td>
<td>India</td>
<td>Ticks</td>
</tr>
<tr>
<td>O'nyong-nyong fever</td>
<td>East Africa</td>
<td>Anopheles mosquitoes</td>
</tr>
<tr>
<td>Oriental spotted fever</td>
<td>Japan</td>
<td>Ticks?</td>
</tr>
<tr>
<td>Oropouche virus</td>
<td>South America, Panama</td>
<td>Culicoides midges</td>
</tr>
<tr>
<td>Potasi virus</td>
<td>United States</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Rocio virus</td>
<td>Brazil</td>
<td>Mosquitoes</td>
</tr>
<tr>
<td>Zika</td>
<td>Indonesia, Brazil, Uganda</td>
<td>Mosquito</td>
</tr>
</tbody>
</table>
Dengue
Construction of the Sanofi Pasteur dengue vaccine

live, attenuated vaccines (CYD-1–4) based on a yellow fever vaccine 17D (YFV 17D) backbone,

Bruno G. et.al., Vaccine. 29, 2011; 7229 - 7241
Dengue vaccine efficacy and safety

vaccine efficacy 56.5% (95% CI 43.8–66.4)

against dengue haemorrhagic fever of 80% (95% CI 52.7–92.4)

Serotype 1 54.5% (40.9 to 64.9)
Serotype 2 34.7% (10.4 to 52.3)
Serotype 3 65.2% (43.3 to 78.9)
Serotype 4 72.4% (58.8 to 81.7)
Unserotyped 56.3% (38.0 to 86.5)
Chikungunya

Tanzania’s Makonde: “the bending disease”
Countries and territories where chikungunya cases have been reported
Sequelae of Chikungunya infection

Grande Comore, 2005

- Seroprevalence: 63% (341,000 inhabitants)
- About 80% of the CHIKV-seropositive population had been hospitalized or stayed at home in bed for a mean of 6 days
- Half missed school or work for a mean of 7 days (1-40d)

Reunion 2005

- 340,000 estimated cases
- 53% symptoms 4 months
Areas of Zika Transmission
Zika Virus Transmission Cycle.
### Clinical Features of Zika

<table>
<thead>
<tr>
<th>Sign or Symptom</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>macular or papular rash</td>
<td>90%</td>
</tr>
<tr>
<td>fever</td>
<td>65%</td>
</tr>
<tr>
<td>arthritis or arthralgia</td>
<td>65%</td>
</tr>
<tr>
<td>conjunctivitis</td>
<td>55%</td>
</tr>
<tr>
<td>myalgia</td>
<td>48%</td>
</tr>
<tr>
<td>headache</td>
<td>45%</td>
</tr>
<tr>
<td>retro-orbital pain</td>
<td>39%</td>
</tr>
<tr>
<td>oedema</td>
<td>19%</td>
</tr>
<tr>
<td>vomiting</td>
<td>10%</td>
</tr>
</tbody>
</table>

- 10% of infections symptomatic
- Incubation period <1 week
- Febrile illness of 4 days’
- Signs present 3-10 days
- Zika birth defects in foetuses or infants occurring during pregnancy ~ 6%; (95% CI, 4%-8%).
**Repellents**

- **DEET**— Concentration of 20-50%
  
  Complete protection by of *Aedes*, *Culex*, and *Anopheles* for 6-13 hours.

- **PMD**— 30% PMD
  
  Protection for 4-6 hours against *Aedes*, *Culex*, and *Anopheles* shorter duration of action, efficacy is similar to DEET.

- **Icaridin** = DEET 20%
  
  Protection for up to 6 hours against *Aedes*, *Culex*, and *Anopheles* species

- **IR3535** = DEET 20%
  
  Several mosquito species including *Aedes*, *Culex* for 7-10 hours

(Stanczyk, Behrens et al. 2015, *BMJ*) Mosquito repellents for travellers,
<table>
<thead>
<tr>
<th>Product name</th>
<th>Repellent type</th>
<th>Active ingredient(s)</th>
<th>Claim protection time (h)</th>
<th>Protection distance⁴</th>
<th>Aedes biting pressure reduction (%)</th>
<th>Culex biting pressure reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF!® Clip-On™</td>
<td>Personal diffuser</td>
<td>Metofluthrin (31.2%)</td>
<td>12</td>
<td>50 sq. ft</td>
<td>92</td>
<td>97</td>
</tr>
<tr>
<td>Termimx® ALLCLEAR® Sidekick</td>
<td>Personal diffuser</td>
<td>Cinnamon oil (10.5%) Eugenol (13%) Geranium oil (21%) Peppermint (5.3%) Lemongrass oil (2.6%)</td>
<td>18</td>
<td>N/A</td>
<td>95</td>
<td>92</td>
</tr>
<tr>
<td>Super Band™</td>
<td>Wristband</td>
<td>Philippine geraniol oil (15%) Indonesian lemongrass oil (5%) Citronella oil (2%)</td>
<td>200</td>
<td>N/A</td>
<td>11.51</td>
<td>−2.03</td>
</tr>
<tr>
<td>PIC® Citronella Plus</td>
<td>Wristband</td>
<td>Geraniol (15%) Lemongrass oil (5%) Citronella oil (1%)</td>
<td>200</td>
<td>-</td>
<td>-18</td>
<td>7</td>
</tr>
<tr>
<td>Sonic Insect Repeller</td>
<td>Ultrasonic device</td>
<td>Sound</td>
<td>N/A</td>
<td>6–8 ft</td>
<td>-22</td>
<td>-15</td>
</tr>
<tr>
<td>Mosquito Guard Patch</td>
<td>Sticker</td>
<td>Oil of Lemon Eucalyptus 80 mg (12%)</td>
<td>8</td>
<td>N/A</td>
<td>-12</td>
<td>9</td>
</tr>
<tr>
<td>Mosquito Patch</td>
<td>Transdermal patch</td>
<td>Vitamin Bl (300 mg)</td>
<td>36</td>
<td>N/A</td>
<td>2</td>
<td>25</td>
</tr>
</tbody>
</table>

(Revay, Junnila et al. 2013, *Acta Tropica*) Evaluation of commercial products for personal protection against mosquitoes,
Summary

- Malaria remains the most significant threat to aircrew
- Rational and practical policies are not straightforward or easy to implement.
- Arboviruses are a widespread threat but rarely fatal.
- New threats are likely to present in the future