Meningococcal Disease: The African Meningitis Belt

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Meningococcal Disease

- *Neisseria meningitidis*
- Meningitis, meningococccemia, arthritis, pneumonia, pericarditis, other
- Acute, life threatening disease.
- ~10% fatality rate; ~15% sequelae (deafness, mental defects, loss of limb, etc.)
- Vaccines
- Antibiotic
- Carriage
## Endemic Rates by Region

<table>
<thead>
<tr>
<th>Region</th>
<th>Annual rates per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America/ Europe</td>
<td>1-3</td>
</tr>
<tr>
<td>Asia</td>
<td>1-3</td>
</tr>
<tr>
<td>Latin American</td>
<td>2-3</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>10-25</td>
</tr>
</tbody>
</table>

Global Health Statistics & J Schillinger, unpublished data
# Meningococcal Disease Epidemics, Africa, 1970-1997

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Cases</th>
<th>Incidence (/100,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nigeria, Zaria</td>
<td>1977</td>
<td>1,257</td>
<td>360</td>
</tr>
<tr>
<td>Rwanda, Kigombe</td>
<td>1978</td>
<td>248</td>
<td>729</td>
</tr>
<tr>
<td>Burkina Faso, Diapaga</td>
<td>1979</td>
<td>539</td>
<td>517</td>
</tr>
<tr>
<td>Cote d’Ivoire, Boundiali</td>
<td>1983</td>
<td>414</td>
<td>107</td>
</tr>
<tr>
<td>Ferkessedougou</td>
<td>1985</td>
<td>251</td>
<td>217</td>
</tr>
<tr>
<td>Chad, N’Djamena</td>
<td>1988</td>
<td>4,542</td>
<td>826</td>
</tr>
<tr>
<td>Sudan</td>
<td>1988</td>
<td>32,016</td>
<td>133</td>
</tr>
<tr>
<td>Kenya, Nairobi</td>
<td>1989</td>
<td>3,800</td>
<td>250</td>
</tr>
<tr>
<td>Burundi, Ruyigi</td>
<td>1992</td>
<td>1,615</td>
<td>608</td>
</tr>
<tr>
<td>Burkina Faso, Yatenga</td>
<td>1996</td>
<td>7,221</td>
<td>1,249</td>
</tr>
<tr>
<td>Kebbi, Nigeria</td>
<td>1996</td>
<td>10,089</td>
<td>426</td>
</tr>
<tr>
<td>Ghana, Upper E Reg</td>
<td>1997</td>
<td>1,4277</td>
<td>1,260</td>
</tr>
</tbody>
</table>

Adapted from Control of Epidemic Meningococcal Disease, WHO Practical Guidelines, 2nd edition and CDC, unpublished data
Evolution of Meningococci Caused Emergence of Epidemics in Africa

- First epidemics reported in Geneva in 1806
- First reports in Africa in 1840 (soldiers)
- First major epidemics in Africa in early 1900s
- First proven epidemic of *Neisseria meningitis* in northern Nigeria in 1905
- Evidence that epidemics not prevalent previously

Global Serogroup Distribution

- B, C, Y
- B, C
- A
- B, C
- A, C
- B, C
Sub-Saharan African Meningitis Belt*

*Redefined by Greenwood in 1987

Rain forest

Sahara desert

“Meningitis belt” defined by Lapeyssonnie in 1963

*“Meningitis belt” defined by Lapeyssonnie in 1963
Redefined by Greenwood in 1987
Figure 8. Relation of seasonal climatic factors to hospital admissions for meningococcal disease in Zaria, Nigeria, during 1977-1979

*Greenwood, Trans Roy Soc 1979
Ecologic Zones

Molesworth et al, EID, 2003
Disease Risk

Molesworth et al, EID, 2003
Incidence of Meningococcal Meningitis by Age Groups, Niamey, Niger, 1981-1994*

Neisseria meningitidis

- Gram-negative diplococcus
- Enveloped by polysaccharide capsule
  - Determines serogroup
  - A determinant of immunity
- Common disease-causing serogroups
  - A
  - B
  - C
  - W
  - Y

N. meningitidis  White Blood Cell
Lingappa, EID 2004
International W Outbreak 2000

France 21
Finland 2
S. Arabia 241
Singapore 4
USA 4
Indonesia 14
Morocco 3
Sweden 2
Norway 1
Denmark 1
Kuwait 3
Germany 10
Scotland 1
England & Wales 50
Belgium 1
Netherlands 9

Mayer et al, JID 2002, WHO
Cases of Suspected Meningitis, Burkina Faso 2002*

- 13,368 cases
- 1,549 deaths
- Overall incidence rate: 112 cases/100,000 pop
- Overall CFR: 11.6%

*Burkina Faso, MOH and WHO
Serogroup Distribution in the United States and Africa

USA* 1995-98
- C 28%
- Y 34%
- B 33%
- Other 3%
- W 2%
- *ABCs data, CDC

Niamey, Niger** 1981-96
- A 86%
- B 1%
- W 2%
- C 7%
- Other 5%
- **Campagne, Bull WHO 1999
Enhanced Surveillance, Burkina Faso: Laboratory Results, 2002 (n=144)*

*144 of 411 (35%) samples positive for a pathogen
*Burkina Faso, MOH and WHO
Molecular Studies on W Isolates, 2002

- All isolates tested almost identical to 2000 Hajj W epidemic strain
- All isolates members of same W clone
- Circulating worldwide since at least 1970
- So, why have these outbreaks occurred?
- Why did a large outbreak not happen before 2000?

Mayer, JID 2002
Meningococcal Polyaccharide Vaccines: Bi- Tri- and Quadrivalent

- Safe with mild adverse reactions
- Good efficacy in older children & adults
- Poorly immunogenic (C>A) in children
- Immunity of limited duration
- Possible immunological tolerance
- No long term impact on carriage
- Not recommended for routine use
Meningococcal conjugate vaccines offer the opportunity for improved meningitis control

- Protect young children
- Generate immunity of longer duration
- Prime for immunologic memory
- Protect from acquisition of carriage
  - Interrupt transmission
  - Protect unvaccinated (herd immunity)
- Boosts anti-tetanus immunity
Questions?

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