Meningococcal Disease

- *Neisseria meningitidis*
- Meningitis, meningococcemia, arthritis, pneumonia, pericarditis, other
- Acute, life threatening disease.
- ~10% fatality rate; ~15% sequelae (deafness, mental defects, loss of limb, etc.)
- Vaccine
- 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Global Health Statistics & J Schillinger, unpublished data
<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Adapted from Control of Epidemic Meningococcal Disease, WHO Practical Guidelines, 2nd edition and CDC, unpublished data.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 meningitidis* in northern Nigeria in 1905
- Evidence that epidemics not prevalent previously

Global Serogroup Distribution

- B, C, Y
- B, C
- A
- B, C
- A, C
Intercontinental Spread of an Epidemic Group A *Neisseria meningitidis* Strain, 1980s

- Nepal 1983-4
- New Delhi 1985
- Mecca 1987
- N’Djamena 1988
- N’Djamena 1988
Sub-Saharan African Meningitis Belt*

*Sahara dessert

Rain forest

*“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
Weekly Rates of Meningitis in the Africa Region, 1995-2006

*WHO/AFR, October 2006*
Meningitis in the Africa Region, 1965 – 2006*

*NWHO/AFR, October 2006*
Ecologic Zones

Molesworth et al, EID, 2003
Meningitis Belt, 2004

Areas Outside the Meningitis Belt With Epidemics of Meningococcal Meningitis, 2000-2004

*Yellow Book 2005-6
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
  - Y
  - W135

N. meningitidis

White Blood Cell
Meningococcal Disease in Saudi Arabia, February 17–May 4, 2000

*Lingappa, EID 2004
International W135 Outbreak 2000

- Scotland 1
- England & Wales 50
- Belgium 1
- Netherlands 9
- Germany 10
- Norway 1
- Sweden 2
- Finland 2
- Denmark 1
- USA 4
- Morocco 3
- Kuwait 3
- Oman 18
- S. Arabia 241
- Indonesia 14
- Singapore 4

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

- Serogroup C: 28%
- Serogroup Y: 34%
- Serogroup B: 33%
- Serogroup W: 2%
- Other: 3%

*ABCs data, CDC

Niamey, Niger** 1981-96

- Serogroup A: 86%
- Serogroup C: 7%
- Serogroup B: 1%
- Serogroup W: 2%
- 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
Cases of Meningitis, Burkina Faso 2001-2002-2003
Weeks 1 - 28*

*Burkina Faso, MOH and WHO
Molecular Studies on W135 Isolates, 2002

- All isolates tested almost identical to 2000 Hajj W135 epidemic strain
- All isolates members of same W135 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
<table>
<thead>
<tr>
<th>Sequence Type</th>
<th>Disease</th>
<th>Carrier</th>
<th>Odds Ratio* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-11</td>
<td>93</td>
<td>10</td>
<td>52 (20–135)</td>
</tr>
<tr>
<td>ST-269</td>
<td>15</td>
<td>7</td>
<td>6.1 (0.5–72.8)</td>
</tr>
<tr>
<td>ST-41/44</td>
<td>44</td>
<td>42</td>
<td>1.1 (0.5–2.3)</td>
</tr>
<tr>
<td>ST-23</td>
<td>7</td>
<td>32</td>
<td>0.2 (0.1–0.7)</td>
</tr>
<tr>
<td>ST-32</td>
<td>54</td>
<td>18</td>
<td>0.9 (0.4–2.2)</td>
</tr>
<tr>
<td>ST-35</td>
<td>6</td>
<td>18</td>
<td>0.3 (0.1–1.1)</td>
</tr>
<tr>
<td>ST-162</td>
<td>16</td>
<td>17</td>
<td>0.8 (0.4–1.18)</td>
</tr>
</tbody>
</table>

Yazdankhah, et al JCM 2004

* Adjusted OR
Categorization of Risk Factors for Meningococcal Disease

Noncarrier → Exposed → Infected → Disease

Noncarrier → Exposed → Not Exposed → Carrier

Noncarrier → Not Exposed → Not Infected → Carrier
Risk Factors Necessary But Not Sufficient to Cause Epidemics

- Individual & population risk factors (i.e., crowding)
- Appropriate climatic conditions
- Transmission of a virulent strain
- Immunological susceptibility
  - Waning herd immunity
Risk Factors that Initiate Epidemics

- Large population movements
- Exceptional climatic conditions
  - Excessively dry season
  - Dust storms
- Spread of infectious co-factors
  - Respiratory pathogens
  - Priming by cross-reacting enteric bacteria
Epidemiology of Meningococcal Disease -- Discussion

- Burden of disease and fatality remain high
- Broad age distribution
- Predicting epidemics remains difficult
- Laboratory-based serogroup surveillance critical
- No good prevention strategies based on risk factors
Questions?

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