Topics

- Global burden of meningococcal disease
- Trends in disease
  - Non-vaccine factors
  - Vaccine factors
- Men W emergence
Global Burden
The changing and dynamic epidemiology of meningococcal disease

Scott A. Halperin, Julie A. Bettinger, Brian Greenwood, Lee H. Harrison, Jane Jelfs, Shamez N. Ladhani, Peter McIntyre, Mary E. Ramsay, Marco A.P. Sáfadi

Fig. 1. Proportion of meningococcal disease by serogroup by geographic region.
**WHO classification of meningococcal disease burden**

<table>
<thead>
<tr>
<th>Category</th>
<th>Incidence rate per 100,000 total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epidemic</td>
<td>&gt; 100</td>
</tr>
<tr>
<td>High endemic</td>
<td>10 - &lt; 100</td>
</tr>
<tr>
<td>Moderate endemic</td>
<td>2 - &lt; 10</td>
</tr>
<tr>
<td>Low endemic</td>
<td>&lt; 2</td>
</tr>
</tbody>
</table>
Recent Global Incidence of Invasive Meningococcal Disease

Incidence Rate Per 100,000

- **Central Australia (1987 - 1991)**
- **African Meningitis Belt**
- **UK (5.4)**
- **Netherlands (4.5)**
- **Australia (3.5)**
- **Denmark (3.5)**
- **Canada (1.4)**
- **USA 0.8**

Country Pre-Vaccine Post-Vaccine

- New Zealand 17 2.6
- Ireland 14.33 3.5
- UK 5.4 2.1
- Netherlands 4.5 1.1
- Denmark 3.5 1.2
- Australia 3.5 1.4
- Canada 1.4 0.42
- USA 0.8 0.28

Epidemic (Pre-Vaccine)

Endemic (Post-Vaccine)

Central Australia (1987 - 91)
Australia’s century of meningococcal disease: development and the changing ecology of an accidental pathogen

Mahomed S Patel

Annual notification rates and deaths from meningococcal disease for all states/territories in Australia, 1915–2003

The annual number of deaths from meningococcal disease was obtained from the compilation of mortality data collected by the Australian Bureau of Statistics
Incidence rates of IMD by serogroup, Australia, 1999 -2016

Source NNDSS (Feb 2017)
Disease trends - non-vaccine factors
Epidemiology of invasive meningococcal disease in the Netherlands, 1960–2012: an analysis of national surveillance data

Merijn W Bijlsma, Vincent Bekker, Matthijs C Brouwer, Lodewijk Spanjaard, Diederik van de Beek*, Arie van der Ende*
Declining incidence of meningococcal disease in Denmark, confirmed by a capture–recapture analysis for 1994 and 2002

M. F. Howitz*, S. Samuelsson and K. Mølbak

Fig. 1. The incidence of meningococcal disease (MD) and the serogroup-specific incidence from the notification system for meningococcal disease (NSMD), 1980–2006, and the incidence of registered cases in the National Patient Registry (NPR) with ICD-10 code A39, 1995–2002 (–•–). (The MD incidence rate from the NPR is based on notified cases and has not been scrutinized to verify the diagnoses, as was done for years 1994 and 2002.)
Secular trends in invasive meningococcal disease, Massachusetts, 1988–2011: what happened to invasive disease?

A. H. PERUSKI, P. KLUDT, R. S. PATEL AND A. DEMARIA Jr.

Fig. 1. Age-specific incidence rates of reported invasive meningococcal disease in Massachusetts, 1988–2011. Note the different scale on the y-axis for the 0–4 years age group. For the 5–24 years age group the introduction and uptake of MCV4, with coverage measured in 13- to 17-year-olds in Massachusetts is shown in the line graph. Arrows also indicate the American College Health Association (ACHA) recommendation for MPSV4 vaccination for college freshman (1997), Advisory Committee on Immunization Practices (ACIP) recommendation for MPSV4 vaccination for college freshman (2000), and ACIP recommendation for MCV4 in 11- to 12-year-olds (2005). Arrows in the graph of the 0–4 years age group indicate the introduction of conjugate Hib vaccine for children aged >18 months (1988), introduction of conjugate Hib vaccine for infants aged >2 months (1991) and introduction of PCV7 vaccine for children aged <23 months (2000).
Association between population prevalence of smoking and incidence of meningococcal disease in Norway, Sweden, Denmark and the Netherlands between 1975 and 2009: a population-based time series analysis.

Gunnstein Norheim, Manish Sadarangani, Omar Omar, Ly-Mee Yu, Kåre Malbak, Michael Howitz, Per Olcén, Margaretha Haglund, Arie van der Ende, Andrew J Pollard

Trends of incidence of invasive meningococcal disease in children <5 years of age and prevalence of daily smokers in Norway (A and B), Sweden (C and D), Denmark (E and F) and the Netherlands (G and H) between 1975 and 2009.
<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Gender</th>
<th>Relative risk of IMD associated with a 1% increase in prevalence of smoking (95% CI)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>16–24</td>
<td>M</td>
<td>0.93 (0.90 to 0.95)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>0.94 (0.91 to 0.96)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>25–34</td>
<td>M</td>
<td>0.97 (0.95 to 0.99)</td>
<td>0.002*</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.05 (1.01 to 1.08)</td>
<td>0.005*</td>
</tr>
<tr>
<td>35–44</td>
<td>M</td>
<td>1.11 (1.07 to 1.15)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.07 (1.04 to 1.10)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>45–54</td>
<td>M</td>
<td>1.04 (1.00 to 1.08)</td>
<td>0.043*</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.06 (1.04 to 1.09)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>55–64</td>
<td>M</td>
<td>0.95 (0.93 to 0.98)</td>
<td>0.004*</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1.01 (0.98 to 1.04)</td>
<td>0.376</td>
</tr>
</tbody>
</table>

Table 4
Adjusted relative risk of invasive meningococcal disease in children and adults (all ages included) according to annual percentage of daily smokers in different genders and age groups in Sweden between 1980 and 2007, after adjustment for year and household crowding.

*Statistically significant (p<0.05) association between prevalence of smoking and incidence of IMD.

IMD, invasive meningococcal disease; F, female; M, male.

Gunnstein Norheim et al. BMJ Open 2014;4:e003312
Percentage of the population living in a crowded household during 1980–2007 in Norway.
Disease trends
- vaccine factors
### Countries with meningococcal vaccine programs post 2000

<table>
<thead>
<tr>
<th>Country</th>
<th>Vaccine</th>
<th>Year Introduced</th>
<th>Incidence Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa (Burkina Faso, Niger)</td>
<td>Serogroup A conjugate</td>
<td>2010</td>
<td>&gt;100 pre-vaccine</td>
</tr>
<tr>
<td>Belgium</td>
<td>Serogroup C conjugate</td>
<td>2002</td>
<td>3.69 pre-vaccine, 0.8 post-vaccine</td>
</tr>
<tr>
<td>France</td>
<td>Serogroup C conjugate</td>
<td>2010</td>
<td>0.8 post-vaccine</td>
</tr>
<tr>
<td>Germany</td>
<td>Serogroup C conjugate</td>
<td>2006</td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>Serogroup C conjugate</td>
<td>2002</td>
<td>7.58 pre-vaccine, 1.3 post-vaccine</td>
</tr>
<tr>
<td>Ireland</td>
<td></td>
<td>2001</td>
<td>14.8 pre-vaccine, 4.5 post-vaccine</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Serogroup C conjugate</td>
<td>2002-3</td>
<td>4.51 pre-vaccine, 1.1 post-vaccine</td>
</tr>
<tr>
<td>Portugal</td>
<td>Serogroup C conjugate</td>
<td>2001</td>
<td>3.74 pre-vaccine, 1.3 post-vaccine</td>
</tr>
<tr>
<td>Spain</td>
<td>Serogroup C conjugate</td>
<td>2001</td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>Serogroup C conjugate</td>
<td>2005</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>Serogroup C Conjugate</td>
<td>2002</td>
<td>1.38 pre-vaccine, 0.42 post-vaccine</td>
</tr>
<tr>
<td>USA</td>
<td>A, C, Y, W conjugate</td>
<td>2005</td>
<td>0.8 pre-vaccine, 0.28 post-vaccine</td>
</tr>
<tr>
<td>Australia</td>
<td>Serogroup C conjugate</td>
<td>2003</td>
<td>3.5-7.9 pre-vaccine, 1.4 post-vaccine</td>
</tr>
<tr>
<td>New Zealand</td>
<td></td>
<td>2004</td>
<td>17.4 pre-vaccine, 2.6 post-vaccine</td>
</tr>
</tbody>
</table>
The Global Meningococcal Initiative: global epidemiology, the impact of vaccines on meningococcal disease and the importance of herd protection


Mustapha M. Mustapha, Jane W. Marsh, Lee H. Harrison

Infectious Diseases Epidemiology Research Unit, University of Pittsburgh, A525 Crabtree Hall, 130 Desoto Street, Pittsburgh, PA 15261, USA

Fig. 5. Distribution of capsular groups among confirmed invasive meningococcal disease cases, African meningitis belt, 2003–2015.
Indirect effects of Men C campaigns in UK and Netherlands

Figure 3: Case numbers by age group and all-age incidence of invasive Neisseria meningitidis serogroup C disease in England and Wales\textsuperscript{a} and the Netherlands\textsuperscript{a} before and after conjugate meningococcal C immunisation campaigns.
Serogroup C disease in Denmark – no vaccine program

Fig. 4. Notification System for Meningococcal Disease: age-specific incidence rate of serogroup C meningococcal disease in Denmark, 1994–2006.
Reductions in C vs other serotypes post Men C campaign

Table 2. Meningococcal disease in Australia by age group, serogroup and year, adjusted for untyped cases

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Serogroup</th>
<th>Adjusted* total cases and average annual incidence rate/100,000 population</th>
<th>IRR 2010–2012 vs. 2000–2002</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2000–2002</td>
<td>2010–2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cases (raw) Rate</td>
<td>Cases (raw) Rate</td>
</tr>
<tr>
<td>&lt;1</td>
<td>C</td>
<td>22 (17) 2.93</td>
<td>3 (3) 0.34</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>204 (161) 27.15</td>
<td>97 (89) 10.96</td>
</tr>
<tr>
<td>1–4</td>
<td>C</td>
<td>95 (70) 3.10</td>
<td>0 (0) 0</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>278 (204) 9.07</td>
<td>126 (107) 3.59</td>
</tr>
<tr>
<td>5–14</td>
<td>C</td>
<td>120 (79) 1.49</td>
<td>3 (2) 0.04</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>180 (118) 2.24</td>
<td>68 (53) 0.82</td>
</tr>
<tr>
<td>15–24</td>
<td>C</td>
<td>282 (225) 3.57</td>
<td>6 (6) 0.07</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>309 (247) 3.91</td>
<td>171 (162) 1.86</td>
</tr>
<tr>
<td>25–39</td>
<td>C</td>
<td>116 (79) 0.89</td>
<td>5 (5) 0.03</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>106 (72) 0.81</td>
<td>48 (44) 0.33</td>
</tr>
<tr>
<td>≥40</td>
<td>C</td>
<td>114 (86) 0.46</td>
<td>21 (19) 0.07</td>
</tr>
<tr>
<td></td>
<td>Non-C</td>
<td>172 (130) 0.69</td>
<td>144 (135) 0.47</td>
</tr>
</tbody>
</table>

1–24
| C         | 497 (374) 2.61 | 9 (8) 0.04 | 0.02 0.01–0.032 |
| Non-C     | 767 (569) 4.03 | 365 (322) 1.73 | 0.43 0.38–0.49 |

≥25
| C         | 230 (165) 0.60 | 26 (24) 0.06 | 0.10 0.06–0.14 |
| Non-C     | 278 (202) 0.73 | 192 (179) 0.43 | 0.58 0.48–0.70 |

All ages
| C         | 749 (556) 1.30 | 38 (35) 0.06 | 0.04 0.02–0.06 |
| Non-C     | 1249 (932) 2.16 | 654 (590) 0.97 | 0.45 0.41–0.50 |

IRR, Incidence rate ratio; CI, confidence interval.
* Adjusted for untyped meningococcal disease cases.
Men W emergence

Mustapha M. Mustapha, Jane W. Marsh, Lee H. Harrison*

Infectious Diseases Epidemiology Research Unit, University of Pittsburgh, A525 Crabtree Hall, 130 Desoto Street, Pittsburgh, PA 15261, USA

Fig. 4. Global occurrence of capsular group W cc11 meningococcal disease, 2000–2014. Blue boxes represent strains with known epidemiologic and/or genetic link to the Hajj 2000 outbreak; red boxes represent strains not linked to the Hajj outbreak and gray boxes represent W cc11 clusters with unknown link to the Hajj outbreak.
Chile: ACWY 9m – 5 yrs (2012; 95% coverage), 1 dose at 12 months from 2014

Figure 4. Incidence of MD in Chile in children between 9 months and ≤5 years of age before and after introduction of quadrivalent *Neisseria meningitidis* (MenACWY) vaccination in 2012 (unpublished data from Instituto de Salud Pública de Chile, Laboratorio de Agentes de Meningitis Bacteriana, Santiago, Chile). MD: meningococcal disease; Men: *Neisseria meningitidis* serogroup.
Summary and conclusions

- With the exception of Central Australia, Australia has only ever reached moderate endemicity by WHO criteria.
- Declines in meningococcal disease observed in a number of low endemicity countries – smoking rates
  • Especially Men B
- Emergence of Men W disease has been both Hajj related and non Hajj related.
- Impact of ACWY vaccination in children so far limited to target age groups (Chile).
- Impact of ACWY in adolescents?