Emerging Threats to Public Health
Dr. Paul Sockett, Public Health Agency of Canada
A Webber Training Teleclass

Estimated Life Expectancy UK – by Gender 1901-2011

Life Expectancy at Birth (years) 1951 - 2001

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>69.1</td>
<td>71.4</td>
<td>73.2</td>
<td>75.9</td>
<td>77.9</td>
<td>79.9</td>
</tr>
<tr>
<td>UK</td>
<td>69.2</td>
<td>70.8</td>
<td>72</td>
<td>74</td>
<td>76.4</td>
<td>78.3</td>
</tr>
<tr>
<td>USA</td>
<td>68.9</td>
<td>70</td>
<td>71.5</td>
<td>74.1</td>
<td>75.2</td>
<td>77.3</td>
</tr>
<tr>
<td>India</td>
<td>38.7</td>
<td>45.5</td>
<td>50.3</td>
<td>54.8</td>
<td>59.5</td>
<td>63.1</td>
</tr>
<tr>
<td>China</td>
<td>40.8</td>
<td>49.5</td>
<td>63.2</td>
<td>66.6</td>
<td>68.1</td>
<td>71.5</td>
</tr>
<tr>
<td>Africa</td>
<td>38.4</td>
<td>42.6</td>
<td>46.7</td>
<td>50.3</td>
<td>50.8</td>
<td>49.1</td>
</tr>
</tbody>
</table>


Percentages of Urban Population by Census Year 1851-2031

Plague (Yersinia pestis)

<table>
<thead>
<tr>
<th>“Plague”</th>
<th>Year</th>
<th>Location</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 BC</td>
<td>Mesopotamia</td>
<td>185,000</td>
<td></td>
</tr>
<tr>
<td>430 BC</td>
<td>Greece</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>166 BC</td>
<td>Roman Empire</td>
<td>25 36%</td>
<td></td>
</tr>
<tr>
<td>1340s</td>
<td>Europe</td>
<td>~50%</td>
<td></td>
</tr>
<tr>
<td>Black Death</td>
<td>London</td>
<td>&gt;100,000</td>
<td></td>
</tr>
</tbody>
</table>

Systematic collection of population mortality and morbidity statistics

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…"Of lessening ye Plague of London"
William Petty, 7th October 1667

“given the value of an individual and the cost of transporting people outside of London and caring for them for three months, thus increasing the probability of survival, every pound expended would yield a return of £84.”

Distribution of Cholera cases: London 1849
John Snow’s map of cholera deaths, originally published in 1855 in his book *On the Mode of Communication of Cholera*, led Snow to propose that cholera is a water-borne illness.

Number of Reported Smallpox Cases Worldwide, 1920 - 1979

Convergence of Factors Leading to Emerging Public Health Threats (19th – 20th Centuries)
- Increased size of the population
- Increased concentration of the population in urban settings, and the rates of that increase.
- Poorly planned and regulated building of homes leading to crowding and poor living conditions
- Increased poverty in many urban concentrations
- Poorly regulated working conditions
- Increased international trade

Early Economic Assessment of Public Health
- Calkins (1891) commenting on the value of lives saved ($650m) compared with costs of sanitary improvements ($584m) between 1880 and 1890: “Thus in ten years the country has more than regained the sum spent for sanitary improvements... and in this calculation nothing figures for maladies avoided... spared grief, better health and happier life.”
- Chave (1980s) commenting on Chadwick’s promotion of the MOH... “The principal reason in Chadwick’s mind in bringing the MOH to birth was not humanitarian, but economy, because it promised to be cost effective.”

Organised (and disorganised) response to “Plague”

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Convergence of Factors Leading to the Public Health Revolution (19th-20th Centuries)

- Realization that specific preventative measures could be effectively applied to protect populations
- Growing understanding of the microbial cause of disease and the link between disease and poverty
- Systematic collection of population mortality and morbidity statistics
- Economic imperatives to increase the life expectancy of the working population and maintain the health of the military
- Political accountability

Measles: Approximate Death rates per million in children under age 15  
England and Wales 1900 to 1970

Public Health Mistakes

- To under-estimate and under-value the impact of public health approaches leading to a comparatively greater focus on individual health care delivery
- To assume that, in our “developed” society, the impact of infectious agents is contained

“Emerging” Diseases of the late 20th Century

<table>
<thead>
<tr>
<th>1970s</th>
<th>1980s</th>
<th>1990s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotavirus</td>
<td>HTLV L II</td>
<td>Guanarito virus</td>
</tr>
<tr>
<td>Parvovirus B19</td>
<td>HIV (AIDS)</td>
<td>Hantavirus</td>
</tr>
<tr>
<td>Ebola virus</td>
<td>Human Herpesvirus 6</td>
<td>Sabiá virus</td>
</tr>
<tr>
<td>Hantaanvirus</td>
<td>Hepatitis C</td>
<td>Influenza viruses</td>
</tr>
<tr>
<td>Campylobacter sp</td>
<td>Staphylococcal toxin</td>
<td>Vibrio cholerae O139</td>
</tr>
<tr>
<td>Legionella sp</td>
<td>E. coli O157:H7</td>
<td>Bartonella henselae</td>
</tr>
<tr>
<td>Borrelia burgdorferi</td>
<td>Cryptosporidium</td>
<td>E. coli O157:H7</td>
</tr>
<tr>
<td>Helicobacter pylori</td>
<td>Campylobacter sp</td>
<td>E. coli O157:H7</td>
</tr>
<tr>
<td>Ehrlichia chaffeensis</td>
<td>Cyclospora sp</td>
<td></td>
</tr>
</tbody>
</table>

Plus numerous multiple antibiotic resistant strains (e.g. staphylococcus aureus, tuberculosis, salmonella, etc.)

Key Areas of Threats to Public Health

- The microbe, plus
- Human Environment
- Physical Environment
- Technological Environment
- Political/Public Sector Environment
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The Microbe: Mechanisms for Microbial “Emergence”
(Microbial Adaptation and Change)
• Recognized disease – new environment
• Reemergence or reintroduction of previously controlled disease
• Diseases linked to a specific artificial environment
• Greater exposure to animal reservoirs
• Linkage between a known microorganism and a specific pathology
• Genetic recombination/selective pressures

West Nile virus Spread:
August 1999 to September 2005

Year Canada USA
1999 42 (2)
2000 50 (2)
2001 90 (2)
2002 626 (26) 6156 (264)
2003 1409 (14) 9882 (241)
2004 30 (2) 3670 (100)
2005 5 (0)* 1700 (50)*

*To October 4, 2005
**To October 1, 2005

(number of deaths in brackets)

Human Environment: Social and Demographic Change

Five Factors:
• Population growth
• Population age
• Population movement
• Population prosperity
• Population education

World Population Growth Projections

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### Human Environment: Population of Canada

#### Proportionate Distribution by Age Groups for Census Years: 1951 to 2001

<table>
<thead>
<tr>
<th>Year</th>
<th>Total (millions)</th>
<th>0-14</th>
<th>15-34</th>
<th>35-59</th>
<th>60+</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>14.009</td>
<td>30</td>
<td>31</td>
<td>27</td>
<td>12</td>
</tr>
<tr>
<td>1961</td>
<td>18.238</td>
<td>34</td>
<td>28</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>1971</td>
<td>21.568</td>
<td>30</td>
<td>32</td>
<td>27</td>
<td>11</td>
</tr>
<tr>
<td>1981</td>
<td>24.900</td>
<td>22</td>
<td>37</td>
<td>27</td>
<td>13</td>
</tr>
<tr>
<td>1991</td>
<td>28.753</td>
<td>20</td>
<td>32</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>2001</td>
<td>31.002</td>
<td>19</td>
<td>28</td>
<td>37</td>
<td>17</td>
</tr>
</tbody>
</table>

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### Human Environment: International Contact and Commerce

- **International travel**
  - Tourism
  - Business
- **Immigration**
  - Region of birth
- **Globalization of food supply and other commodities of biological origin**

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### Factors Influencing the Smallpox Epidemic in Montreal (1885)

- Index case arrived from another country (USA) by means of mass transportation (train)
- Initial focus of spread was in a hospital environment
- Containment in the community was hampered by lack of public cooperation and compliance with quarantine orders
- Insufficient public health and infectious disease infrastructure to cope with the epidemic
- Controversy over the safety of the vaccine led to suspension of its use at a critical point
- A large proportion of children were unvaccinated, and anti-vaccination hysteria resulted from poor communication on adverse reactions.

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### Human Environment: Significant Human Pathogens Imported in North America in the last Six Years

- *West Nile virus* (imported mosquito or bird)
- *SARS* (traveller from Hong Kong)
- *Monkeypox* (imported African rodents)
- *Cyclospora cayetensis* (imported soft fruit from S. America)
- *Various Salmonella spp.* (imported fruits, fruit juice, salads, nuts, etc.).

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### Human Environment: Immigrant Population of Canada

#### Region of Birth and Period of Immigration (% Distribution)

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>3</td>
<td>6</td>
<td>7</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Central</td>
<td>1</td>
<td>8</td>
<td>16</td>
<td>16</td>
<td>11</td>
</tr>
<tr>
<td>S. America and Caribbean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Europe</td>
<td>73</td>
<td>69</td>
<td>36</td>
<td>26</td>
<td>19</td>
</tr>
<tr>
<td>Africa</td>
<td>&lt;1</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>W. Central Asia and M. East</td>
<td>&lt;1</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Other Asia</td>
<td>2</td>
<td>10</td>
<td>30</td>
<td>40</td>
<td>49</td>
</tr>
<tr>
<td>Oceania and Other</td>
<td>&lt;1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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### Climate Change: Global Temperature Increase

[Graph showing global temperature increase over time from 1960 to 2000]

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Physical Environment: Climate Change
Potential Effects

- Change in the range of disease reservoirs and vectors (altered vector migration patterns)
- Introduced species can establish and become endemic
- Extreme weather events/natural disasters resulting in re-emergence of “disaster” diseases (typhoid, cholera, dysentery, typhus, TB).

Physical Environment: Climate Change
Infectious Disease Priorities

- Diseases which are possible priorities for Canada
  - Diseases we have now that could contribute to increased burden of illness (enteric and waterborne diseases)
  - Diseases we have now that are severe, or have the potential to create a large burden of illness (Lyme disease, WNv)
  - Diseases we don’t have yet, but that occur nearby (Eastern Equine Encephalitis, St Louis Encephalitis)
  - Diseases that are completely exotic but which we might see emerge or re-emerge here in focal or more widespread occurrences (Malaria, Dengue)
  - Surprises!!

Physical Environment: Economic Development and Land Use

- Encroachment
- Agriculture
  - Husbandry practices
  - Land management
- Water source protection
  - Dams and droughts
  - Deforestation/re-forestation
- Pollution

Technological Environment: Technology and Industry

- Medical technology
  - Tissue and organ transplantation
  - Laboratory diagnostics
  - Widespread use of anti-microbial drugs
- Developments in Industrial/Agricultural practices
  - New food processing technologies (scales of production)
  - Air conditioning: a micro-environment for Legionnaire’s disease
  - Occupational exposure

Political/Public Sector Environment

- Political/public perception of the importance of Public Health
  - Health care vs public health
  - All it takes is Walkerton, North Battleford, SARS, bioterrorism…
- Public Health infrastructure
  - Resources (people, $, technology)
  - Legal frameworks
  - Quality of data
- International perspective
  - Contribution to international analysis of risk

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Focus for the Future

- Research
  - Mechanisms of emergence
  - Climate impacts
  - Wildlife reservoirs
- Resources
  - Recognition of the breadth of public health expertise
  - National plan for development of human resources (Naylor) – enhance training Public Health Planning and Evaluation
  - Financial (Naylor)
- Surveillance
  - Clear rationales for surveillance
  - Networks for surveillance
  - Innovation in analysis

November 2005 Teleclasses
For more information, refer to www.webbertraining.com/schedule.cfm

November 8 - Benefits of CIC Certification and How to Become Certified

November 10 - Infection Control in Doctors’ Offices

November 15 – UK Teleclass – ESBL Management in Healthcare Facilities (Rebroadcast on New York Bridge Line)

November 17 – Bloodborne Pathogen Control

Questions? Contact Paul Webber paul@webbertraining.com