Malaria and other parasites

Public Health WORKS – Speaker Series
Edmonton, January 16/2007

J Dick MacLean
McGill Centre for Tropical Diseases

Reported malaria in Canada

Alberta
Ontario
Canada
BC
Quebec
The Montreal General Hospital

North America in 1825

MONTREAL GENERAL HOSPITAL ADMISSIONS 1822-5 (3665 ADMISSIONS)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Admissions</th>
</tr>
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<tbody>
<tr>
<td>Hibernus</td>
<td>66</td>
</tr>
<tr>
<td>Canadensis</td>
<td>12</td>
</tr>
<tr>
<td>Anglus</td>
<td>8</td>
</tr>
<tr>
<td>Scotus</td>
<td>8</td>
</tr>
<tr>
<td>Americans</td>
<td>2</td>
</tr>
<tr>
<td>Germanicus</td>
<td>1</td>
</tr>
<tr>
<td>Welsh</td>
<td>1</td>
</tr>
<tr>
<td>Swiss</td>
<td>0.1</td>
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</table>
Most frequent Infectious Diseases
% of total admissions

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>februm cont. 17</td>
<td>tuberculosis 10</td>
<td>respiratory 3</td>
</tr>
<tr>
<td>synochus</td>
<td>malaria 7</td>
<td>cellulitis 1</td>
</tr>
<tr>
<td>ulceea</td>
<td>pneumonia 6</td>
<td>urinary 1</td>
</tr>
<tr>
<td>typhus</td>
<td>meningitis 5</td>
<td>misc ID/parasitol. 1</td>
</tr>
<tr>
<td>pneumonia</td>
<td>hepatitis 3</td>
<td>female genital 1</td>
</tr>
<tr>
<td>diarheea</td>
<td>typhoid 2</td>
<td>otitis media 1</td>
</tr>
<tr>
<td>malaria</td>
<td></td>
<td>sepsis 1</td>
</tr>
</tbody>
</table>

Post-mortem of missed epidemics: an analysis of malaria surveillance.

JD MacLean*, E Kokoskin*, M Ndao*, BJ Ward*, S Joseph#, TW Gyorkos#

*McGill University Centre for Tropical Diseases, Montreal General Hospital and #Department of Epidemiology, McGill University, Montreal, Quebec, Canada.

The inquiry

To examine 20 years of malaria surveillance in Canada.
To explain the wild fluctuations in total and species numbers.
Methods

Local
1. McGill University Centre for Tropical Diseases (TDC), National Reference Centre for Parasitology (NRCP)

Provincial
2. Ministère de la santé et des services sociaux, Direction de la santé publique, Québec
3. Disease Control and Epidemiological Service, Ontario Ministry of Health and Long Term Care, Toronto
4. Epidemiological Services, British Columbia Centre for Disease Control

National
5. Division of Disease Surveillance, Centre for Infectious Disease Prevention and Control, Health Canada
6. Medical Services Branch, Field Operating Support System, Citizen and Immigration Canada

International
8. Malaria surveillance---United States. In: CDC surveillance summaries. MMWR
9. US Census Bureau. IDB Data Access
10. Computerized information system on infectious diseases (CISID) Copenhagen, WHO Regional Office for Europe
11. World Tourist Organization, Madrid
12. Dept. of Communicable Diseases, WHO Regional Office for South East Asia, New Delhi, India

Local

Tropical Disease Centre, Montreal
Geographic origins of TDC malaria (n=553) (1980-2002)

- Africa: 65%
- South Asia: 23%
- South East Asia: 6%
- Central America: 5%

1. McGill Centre for Tropical Disease data base

Malaria in TDC and USA (1990-2000)

Malaria cases at Tropical Disease Centre (n=553)

- P. falciparum
- Plasmodium
- Total
Regional Province of Quebec population 7.5 million

Local (TDC) and regional (Quebec) malaria cases

Quebec, QA and Tropical Disease Centre malaria reporting

1. McGill Centre for Tropical Disease data base
2. Ministère de la santé et des services sociaux, Direction de la santé publique, Québec
3-fold increase in malaria in Quebec in last half of 1990s

In 1994 a malaria Quality Assurance Program jointly started by TDC and Quebec Provincial Health Laboratory (LSPQ)

…..malaria reference laboratory, biannual workshops, and annual proficiency testing

Conclusion: Pseudo epidemic due to increased malaria reporting
2-fold increase in falciparum malaria in 2000-1

Plane loads of refugees brought to Quebec from Tanzanian refugee camps
Active surveillance of 330 refugees Quebec 2000-1 (14% positive)

Conclusion: Epidemic of refugee related *P. falciparum* malaria

**Evolution of malaria ‘epidemic’ in Quebec**
Slides received at TDC Reference Laboratory, MGH
Sept-Oct 2000

**Active surveillance 4 months after arrival**
210 subjects
- Microscopy: 11.4%
- Antigen capture (ICT): 8.8%
- PCR: 22.8%

Preliminary data - May 1, 2001
3-fold increase in vivax malaria in 1995-7

Conclusion: Epidemic of *P. vivax* malaria unexplained

Polyprovincial

Quebec
Ontario
British Columbia

Malaria rates in 3 provinces

1. Ministère de la santé et des services sociaux, Direction de la santé publique, Québec
2. Disease Control and Epidemiological Service, Ontario Ministry of Health and Long Term Care, Toronto
3. Epidemiological Services, British Columbia Centre for Disease Control
1. Ministère de la santé et des services sociaux, Direction de la santé publique, Québec
2. Disease Control and Epidemiological Service, Ontario Ministry of Health and Long Term Care, Toronto
3. Epidemiological Services, British Columbia Centre for Disease Control

Species cases by province

Species rate by province

P. vivax cases/100,000

Ont., Que., B.C.
Interim conclusions

1. Malaria epidemic in Canada in 1995-7
2. Epidemic was *P. vivax*
3. Smaller simultaneous increase in USA but not in European countries
<table>
<thead>
<tr>
<th></th>
<th>Quebec</th>
<th>Ontario</th>
<th>B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (millions)</td>
<td>7.0</td>
<td>10.6</td>
<td>3.7</td>
</tr>
<tr>
<td>Punjabi mother tongue (% of province)</td>
<td>0.1%</td>
<td>1%</td>
<td>3%</td>
</tr>
<tr>
<td>Punjabi mother tongue (% of Punjabi-Canadians)</td>
<td>4</td>
<td>41</td>
<td>45</td>
</tr>
</tbody>
</table>

Conclusion: Epidemic of *P. vivax* malaria related to a *vivax* epidemic in the Indian Punjab

**Conclusions**

1. Three malaria epidemics described in Canada
   i. 1995-2002 surveillance artifact associated with new QA program
   ii. 2000-2001 *P. falciparum* associated with influx of Tanzanian refugees
   iii. 1995-1997 *P. vivax* associated with Punjab epidemic and Canadian VFRs

2. Local, provincial, national and multinational surveillance systems are required for **timely** recognition of malaria dynamics
Conclusions

3. Lack of travel and/or malaria species information in Canadian government surveillance data severely limits interpretation and public health response.

4. Malaria surveillance databases have become more complete since 1990 and offer increased opportunities for research.

Parts of the province of Ontario were hot-beds of the disease, which within my memory has disappeared from the districts about the western end of Lake Ontario and the northern shores of Lake Erie. The marshes are there, and the anopheles are there, but the disease has gone. As in parts of Italy the important factor appears to have been the chinchonising of the inhabitants. I retain lively recollections of the buzzing ears of my boyhood from the large doses of quinine administered to us in the spring and autumn.


Malaria is not the only surveillance-challenged parasitic disease in Canada.
# Intestinal protozoa

<table>
<thead>
<tr>
<th>Endemic</th>
<th>Imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclospora</td>
<td>Giardia, E. histolytica, Cryptosporidium</td>
</tr>
<tr>
<td>Intestinal protozoa</td>
<td></td>
</tr>
<tr>
<td>Giardia, E. histolyta</td>
<td>Cryptosporidium</td>
</tr>
<tr>
<td>Systemic protozoa</td>
<td></td>
</tr>
<tr>
<td>Toxoplasma</td>
<td>Malaria, Chagas, Babesia, Leishmania, African trypanosomiasis</td>
</tr>
<tr>
<td>trematodes</td>
<td>avian Schistosoma, Metocheis, Fasciola</td>
</tr>
<tr>
<td>cestodes</td>
<td>fish tapeworm, sylvatic hydatid</td>
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</table>

# Systemic helminths

<table>
<thead>
<tr>
<th>Endemic</th>
<th>Imported</th>
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<tbody>
<tr>
<td>Schistosoma</td>
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<tr>
<td>Systemic helminths</td>
<td></td>
</tr>
<tr>
<td>Fasciola</td>
<td></td>
</tr>
<tr>
<td>Strongyloides</td>
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<tr>
<td>Toxoplasma</td>
<td>Malaria, Chagas, Babesia, Leishmania, African trypanosomiasis</td>
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# Imported helminths

<table>
<thead>
<tr>
<th>Endemic</th>
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<tbody>
<tr>
<td>Trichinella nativa</td>
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</tr>
<tr>
<td>Trichinellosis</td>
<td></td>
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</tbody>
</table>

## Trichinellosis

**Trichinella nativa**
*Trichinella spiralis*

*Trichinella nativa*

- Man
- Bear
- Walrus
- Pig
- Rat
- Cat
- Dog
- Lion
- in fact any carnivore

- *Trichinella spp.*
  - reservoir...muscles of all carnivorous animals (bear, walrus, rat, man, pig)
  - location...encysted in individual striated muscle cells
  - longevity...years
  - biology...*T. nativa* resists freezing
  - transmission...raw meat ingestion
Myopathic (classic) (primary) muscle pain, weakness
fever
edema

↑↑ CPK
↑↑ eosinophils
↑↑ trichinella IgG
↑↑ trichinella IgM
positive muscle biopsy
EMG abnormal

Diarrheic (secondary) diarrhea
no fever
no edema

normal CPK
↑↑ eos
↑↑ trichinella IgG
neg muscle box
EMG normal

MacLean JD et al. Epidemiologic and Serologic definition of primary and secondary trichinosis in the Arctic JID 165; 908-912;1992

Community | year | cases | source | diagnosis
--- | --- | --- | --- | ---
Salluit | 1982 | 10 | walrus | Epid
Ivujivik | 1983 | 3 | walrus | Epid
Salluit | 1984 | 8 | walrus | Epid
Ivujivik | 1984 | 15 | walrus | Epid
Salluit | 1987 | 42 | walrus | Epid/lab
Inakjuak | 1995 | 1 | Walrus | Epid
Inakjuak | 1996 | 1 | Walrus | Epid
Puvirnituq | 1996 | 1 | Fox | Epid
Inakjuak-Puvirnituq | 1997 | 3 | Walrus | Epid/lab
Inakjuak | 1998 | 1 | Polar bear | Lab
Kuujjuaq | 2004 | 4 | Black bear | Epid/lab
George River | 2005 | 12 | Black Bear | Epid/lab
Kuujjuaq/Cape Dorset | 2006 | 2/50 | Walrus | Epid/lab

2. MADO
3. Maclean JD. JID 160; 513-519, 1989
Prevention program for trichinellosis in Inuit communities


Only primary prevention program for trichinellosis based on laboratory testing of wild animals.

Supported by local and regional Inuit organizations because:

– raw walrus consumed often
– there is promotion of local food sources
– community is aware of trichinellosis

Effective Partnership

• Department of Public Health, Nunavik Regional Board of Health and Social Services
• McGill University Tropical Disease Centre
• Makivik Corporation, Nunavik Research Centre
• Inuulitsivik Health Centre, Inukjuak Local Community Service Centre
• Canadian Food Inspection Agency (CFIA)
Prevention program

• Training session for hunters
• Pamphlet and video for communities
• Tagging hunted meat on site
• Holding walrus until clearance
• Analysis of pooled sample of meat (locally)
• Communication of result to communities
• If pooled sample positive → CFIA
  – separate laboratory analysis of each walrus
  – communication of results to communities

Reasons for success...

• Hunters compliant
• Confirmatory testing rapid
• Education and communication necessary for continued program effectiveness

• Major outbreaks prevented
  – (known by community)

Walrus harvest and analysis in Nunavik

Manon Simard, MSc, Nunavik Research Centre, Makivik Corporation, Kuujjuaq
Jean François Proulx, MD, Nunavik Health Board and Social Services, Kuujjuaq
<table>
<thead>
<tr>
<th>Community</th>
<th>Year</th>
<th>Cases</th>
<th>Source</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salluit</td>
<td>1982</td>
<td>10</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Ivujivik</td>
<td>1983</td>
<td>3</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Salluit</td>
<td>1984</td>
<td>8</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Ivujivik</td>
<td>1984</td>
<td>15</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Salluit</td>
<td>1987</td>
<td>42</td>
<td>Walrus</td>
<td>Epid/lab</td>
</tr>
<tr>
<td>Inukjuak</td>
<td>1995</td>
<td>1</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Inukjuak</td>
<td>1996</td>
<td>1</td>
<td>Walrus</td>
<td>Epid</td>
</tr>
<tr>
<td>Puvirnituq</td>
<td>1996</td>
<td>1</td>
<td>Fox</td>
<td>Epid</td>
</tr>
<tr>
<td>Inukjuak/Puvirnituq</td>
<td>1997</td>
<td>3</td>
<td>Walrus</td>
<td>Epid/lab</td>
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<tr>
<td>Inukjuak</td>
<td>1998</td>
<td>1</td>
<td>Polar bear</td>
<td>Lab</td>
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<tr>
<td>Kuujjuaq</td>
<td>2004</td>
<td>4</td>
<td>Black bear</td>
<td>Epid/lab</td>
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<tr>
<td>George River</td>
<td>2005</td>
<td>12</td>
<td>Black Bear</td>
<td>Epid/lab</td>
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<tr>
<td>Kuujjuaq/Cape Dorset</td>
<td>2006</td>
<td>2/50</td>
<td>Walrus</td>
<td>Epid/lab</td>
</tr>
</tbody>
</table>

Echinococcus granulosis
Sylvatic hydatid disease

To survey or not survey
Selection criteria (Public Health Agency of Canada)

1. Diseases of interest
2. 5-year average incidence
3. Severity
4. Communicability
5. Potential for outbreaks
6. Socioeconomic burden
7. Preventability
8. Risk perception
9. Necessity for a Public Health response
10. Increasing or changing pattern

Each weighted 0 to 4

MADO
Maclean JD. JID 160; 513-519, 1989

CCDR 32: October 1, 2006
141 autochthonous cases of hydatid disease in Canada (1949-53)

Max Miller CMAJ 68:423-434; 1953
Canadian hydatid prevalence studies

<table>
<thead>
<tr>
<th>year</th>
<th>case definition</th>
<th>region</th>
<th>prevalence</th>
</tr>
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<tbody>
<tr>
<td>1956</td>
<td>clinical cases</td>
<td>Yukon, Alta, NWT</td>
<td>2.7%</td>
</tr>
<tr>
<td>1953</td>
<td>sheep hydatid ag</td>
<td>Yukon to Ontario</td>
<td>15%</td>
</tr>
<tr>
<td>1954</td>
<td>caribou hydatid ag serology</td>
<td>Southern Yukon</td>
<td>45%</td>
</tr>
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Meltzer H, Kovacs L, Mikhail F et al. [CMAJ 75, 12] 1956
Miller MJ [CMAJ 68, 423] 1953

Indigenous Echinococcal granulosis

<table>
<thead>
<tr>
<th>region</th>
<th>N</th>
<th>year</th>
<th>study</th>
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<tr>
<td>Man &amp; Ont</td>
<td>17</td>
<td>2001</td>
<td>Al Sughie M et al. Can J Inf Dis</td>
</tr>
<tr>
<td>BC</td>
<td>5</td>
<td>1992</td>
<td>Finley JC et al. Ped Infect Dis J</td>
</tr>
<tr>
<td>NWT</td>
<td>9</td>
<td>2005</td>
<td>Somly A et al. BMC Inf Dis</td>
</tr>
<tr>
<td>Central Quebec</td>
<td>3</td>
<td>(2005-6)</td>
<td>MacLean JD personal</td>
</tr>
</tbody>
</table>

Is disease in humans different?
1. Lack of mortality and morbidity (1 in 300, Alaska)
2. Lack of daughter cysts and few to absent protoscolices
3. Immunogenicity is poor? and serology with southern antigen poorly sensitive
4. Northern biotype has different genotype (G8)
5. Looks different; surgeons describe a blue hue

3. Rausch RL Parasitology 127; S73-S85 2003
Challenges

1. Incidence in humans, no Canadian surveillance
2. Clinical distinctiveness of sylvatic (cervid) form (presentation, treatment)
3. Genotype markers of phenotypes
4. Lack of a cervid Echinococcus antigen for serology

Some conclusions

1. Almost all indigenous Canadian parasites are zoonoses that require a multidisciplinary approach to understanding and control.
2. Canada is becoming a nation of “VFRs” and as such has changing public health responsibilities and challenges.
3. Provincial governments have a direct responsibility for citizens’ health and infectious disease monitoring. A better federal surveillance system is needed to meet provincial needs.