Epidemic louse-borne typhus among immigrants to Québec in 1847-1848

The hope of a New World

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Meet the history session
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Learning goals

At the end of this conference, the participants should:

- Know the characteristics of the etiologic agent and the main modes of transmission of epidemic (or louse-borne) typhus
- Be able to describe the epidemic of typhus in Québec and Canada among immigrants and their close contacts, from May 1847 to December 1848
- Understand the principal contributing factors for this epidemic
- Appreciate the control measures and preventive strategies that had an ultimate impact on the propagation of this infectious disease
Description of epidemic typhus
Epidemic louse-borne typhus – Description of the disease (1/7)

Epidemic or louse-borne typhus

Etiologic agent:

- *Rickettsia prowazekii*:
  - part of *Rickettsiaceae* family *Alphaproteobacteria* and typhus group (TG) genus (*R. prowazekii* and *R. typhi* species)
  - obligately intracellular Gram Ø small (0.3-0.5 x 1-2 µm) coccobacillus
  - extracellular dormant form remaining infectious in louse feces for weeks, months or longer
  - extrahuman reservoir in north America:
    - *Glaucomys volans* (flying squirrel)
Epidemic louse-borne typhus – Description of the disease (2/7)

Epidemic or louse-borne typhus

**Transmission:**

- Mostly person-to-person propagation
- Arthropod vector (*Pediculus humanus corporis* [human body louse]):
  - infected while feeding on rickettsemic patient (5 blood meals/day)
  - agent excreted in louse feces 2-7 days after ingestion (infective earlier if crushed)
  - inoculation of the micro-organism through skin (scratching) and mucous membranes (rubbing) or inhalation of contaminated dust
  - lice leave febrile patients for new hosts; infected lice die within 2 weeks
- Squirrel’s flea (mucous membrane or inhalational exposure)
Epidemic or louse-borne typhus

Epidemiology:

- Epidemics associated with conditions that promote lice infestations through poor hygiene and promiscuity:
  - extreme poverty, homeless peoples, beggars, slum dwellers
  - jails and concentration or prisoners camps
  - cold climate, soldiers, sailors, migrant peoples
  - natural disasters (earthquakes, floods), displacement of populations (wars, revolutions, civil conflicts, other calamities)

- Endemic in mountainous regions (Peruvian Andes, Mexico, central America, central and eastern Africa) and Asia; epidemics in Burundi, Rwanda; present in some part of Russia, Algeria, Senegal and France, but probably under-diagnosed and under-detected

« The history of typhus is the history of human misery. »
- August Hirsch (1817-1894)
Epidemic or louse-borne typhus

Clinical manifestations *:

- Incubation period of 8-16 days (mean: 11 days); low infectious dose
- Fever, chills, headache, myalgia, petechial maculopapular rash, cough, neurological signs (confusion, drowsiness, coma, seizures, hearing loss)
- Primary untreated illness may progress to interstitial pneumonia, pulmonary edema, encephalitis and death; occasionally thrombosis
- Lethality (case-fatality proportion) of 13% (10-40%) in the preantibiotic era, increasing with age
- Recrudescent and flying squirrel-associated typhus with similar syndrome, but less severe
- Long-lasting immunity, but latent infection can persist after recovery and potential of reactivation with rickettsemia

* Associated with increased vascular permeability and focal petechial hemorrhages; *fleckfieber* (spotted fever).
Epidemic or louse-borne typhus

Laboratory diagnosis:

- Thrombocytopenia and elevated serum liver enzymes indicative
- Indirect immunofluorescence (IFA) assay (fourfold rise of IgG antibodies titer between acute and convalescent serums or presence of IgM antibodies in a single serum)
- Nucleic acids amplification and detection (polymerase chain reaction [PCR]) in blood
- Immunohistochemical (IHC) staining of tissues
- Isolation by cellular culture in biosafety level 3 laboratory (rarely done)
- Identification usually done by molecular methods (PCR or sequence analysis)
- Antimicrobial susceptibility tests not routinely performed
Epidemic or louse-borne typhus

Treatment:

- Antibiotic (empirically and promptly given on reasonable suspicion of the diagnosis):
  - doxycycline
  - chloramphenicol
  - (tetracycline)

- Keep immediate contacts under surveillance for 2 weeks
Epidemic louse-borne typhus – Description of the disease (7/7)

Epidemic or louse-borne typhus

Control and prevention measures:

- Basic hygiene and elimination of body lice:
  - changing and washing garments, bedclothes and linen in hot water
  - regular bathing
  - delousing with insecticides with residual effect for cases and contacts

- No vaccine currently available

- Notifiable to public health authorities

- Reportable to the World Health Organization (WHO) as disease under international surveillance
History of epidemic typhus
Epidemic or louse-borne typhus

Main historic events:

- 430, 429 and 427 B.C.: « plague of Athens » and other epidemics during Peloponnesian War probably due to typhus
- 1083: first description of probable typhus during an epidemic in a Salerno monastery, Italy
- 1489-1490: ≈17,000 Spanish soldiers die of a « malignant spotted fever » during the siege of Granada; the disease probably originated from Moors of the Cyprus island
- 1492: « modorra » (drowsiness or stupor) affect Spaniards during the ship voyages to the Indies
- 1494 and/or 1528: French troops near Naples, Italy, lose ≈30,000 soldiers to typhus
Epidemic or louse-borne typhus

Main historic events:

- 1528: description by Hieronymus Girolamo Fracastorius * (≈1476-1553) of an epidemic in Florence, Italy:
  - petechial rash appearing 4-7 days after the onset of fever, accompanied by stupor and delirium
  - term *typhus* derived from the Greek *typhos* (smoky or hazy [confusion and stupor])
- 1542 and 1566: respectively ≈30,000 and ≈80,000 German soldiers die of « morbus hungaricus » in Hungary
- 1552: Charles V abandon the siege of Metz, France, because of the loss of ≈10,000 men

* *De Contagione et Contagiosis Morbis* book, 1546.
Epidemic or louse-borne typhus

Main historic events:

- 1557: description of typhus by Luis de Toro (≈1530-?) among soldiers in Spain (winter seasonality and association with contact with clothing of the ill)
- 1557: ≈10% of the population die of typhus in England
- Second half of XVI\textsuperscript{th} century: « cocolitzi » possibly contribute to the total of 2 M deaths due to contagious diseases among Amerindians in south and central America; Spanish conquistadors probably protected because of prior exposure to « tabardillo » (red cloak) during a previous epidemic (1576)
- 1618-1648: typhus epidemics during the Thirty Years War in Europe
- 1629 and 1634: William Bradford (1590-1657) describe « fevers » cases arriving by ship, provoking epidemics in Salem, Massachussets, and Amerindians living nearby
Epidemic or louse-borne typhus

Main historic events:

- 1643: typhus epidemic during the English Civil War
- 1659: first typhus epidemic in New France, coming from 150 immigrants of France aboard the ship Saint-André
- 1665: second typhus epidemic in Québec, introduced by French immigrants, with ≈100 deaths aboard the ship La Justice
- 1685: 20 (7%) deaths among 300 cases of typhus in New France
- Mid XVIIIth century: James Lind (1716-1794) gives the recommendations to strip, scrub and shave sailors as a control measure against « shipboard fever »
Epidemic or louse-borne typhus

Main historic events:

- 1740/1743-1759: 6-9 epidemics of typhus in New France and Lower-Canada, among others:
  - ≈2,400 (76%) of 3,150 French soldiers die of typhus during the expedition to reconquest Port-Royal (1746)
  - >⅓ of Micmac tribe members die of typhus in Acadia (1746)
  - >80% of the population of Halifax, Nova Scotia, die probably of typhus, linked to 250 German immigrants arriving aboard the ship Ann (July 13th, 1750)
  - typhus and dysentery strike British troops in Charlevoix region while attempting to cut all provisions going in Québec city (1759)

- 1754: major epidemic of typhus in Philadelphia, Pennsylvania, linked to immigration from Germany
Epidemic or louse-borne typhus

Main historic events:

- 1760: differentiation from typhoid by François Boissier de Sauvages de Lacroix (1706-1767), based on clinical characteristics; term *exanthematic typhus* proposed

- 1812: typhus responsible for ≈⅓ of the 40,000 deaths of the 700,000 troops of Napoléon Bonaparte emperor (1769-1821); aftermath typhus epidemics across Europe linked to severe cold weather and widespread crop failure (1815-1819)

- 1816-1819: ≈700,000 (12%) cases of typhus reported among 6 M Irish

- 1818, 1825, 1837 and 1847: typhus in New York, brought by immigrants

- 1827: typhus in Halifax, Nova Scotia, introduced by Irish immigrants

- 1836: William Wood Gerhard (1809-1872) distinguish typhus from typhoid by the presence of intestinal lesions in cases of typhoid fever

- 1838 and 1847: typhus in Boston, Massachusetts, brought by ships
Epidemic louse-borne typhus – History of the disease (7/9)

Epidemic or louse-borne typhus

Main historic events:

- 1845-1849: typhus « famine fever » during the Great Hunger in Ireland *
- 1854-1856: nearly twice as many soldiers die from diseases such as typhus as die from their wound during the Crimean War
- 1909: Charles Nicolle (1866-1936) experimentally demonstrate the vectorial transmission of typhus by human body louse
  - use microscopy, xenodiagnosis and histochemistry to establish the bacterial aetiologic agent

* Covered in more details in the next section of the present conference.
† Died of « tabardillo » in Mexico.
‡ Died of typhus in Serbia.
§ Propose the appellation *Rickettsia prowazekii* in the honor of Ricketts and Prowazek.
Epidemic louse-borne typhus – History of the disease (8/9)

Epidemic or louse-borne typhus

Main historic events:

- 1914-1922 (WWI, Bolshevik revolution and its aftermath *): ≈30 M cases including 3 M (10%) deaths of typhus in Soviet Union; in Serbia, 150,000 deaths among soldiers, ≈½ of 60,000 Austrian prisoners die, 126 (32%) of 400 doctors die of typhus

- 1934: based on Nathan Edwin Brill (1860-1925) descriptions in 1896 and 1910, Hans Zinsser † (1878-1940) demonstrate the recrudescence of long-latent *R. prowazekii* infection (Brill-Zinsser disease)

- 1937: first killed *Rickettsia* vaccines (Rudolf Stephan Weigl [1883-1957] and Herald Rea Cox [1907-1986])

- WWII: epidemics of typhus:
  - eastern Europe, north Africa, southern Italy, concentration camps
  - vaccination
  - first use of dichlorodiphenyltrichloroethane (DDT) against lice

* « Either socialism will defeat the louse, or the louse will defeat socialism. »
- Vladimir Ilyich Lenin (1870-1924)

† *Rats, Lice, and History* book.
Epidemic or louse-borne typhus

Main historic events:

- ≥WWII: control and prevention measures:
  - vaccine (poor protection against infection, but milder disease)
  - insecticides (DDT, others)
  - antibiotic treatment (tetracycline and chloramphenicol)

- Actual situation:
  - lice resistant to various insecticides
  - biothreat as aerosol-transmitted *R. prowazekii*
  - detection of the agent in other arthropod vectors (ticks) and flying squirrels in eastern United States
Epidemic typhus among immigrants to Québec, 1847-1848 – *The hope of a New World*
Epidemic louse-borne typhus, 1847-1848 – *The hope of a New World* (1/7)

**Typhus epidemic, 1847-1848**

**Context and origin:**

- May 1847: onset of immigrants massive arrival in Québec port (≈98,500 souls [78,700 Irish, 8,500 English, 7,500 German and 3,700 Scottish]) in 1847) coming from diverse sea ports * aboard ≈442 sailing-boats
- Triple number of immigrants comparing to the previous years mean
- Worst year of the « Great Famine » in Ireland (Irish Potato Famine [*An Gorta Mór*]), from 1845 to 1849, causing severe malnutrition and scurvy (≈1 M [12%] deaths among ≈8.2 M habitants)
- « Mildiou » (*Phytophthora infestans*), a microscopic mushroom, destruct extensively the monoculture of potato (peasant’s basic nutrient)
- Poor peoples deprived of their lands and required to pay their farming rights with wheat to great landlords

* Dublin, Belfast, Londonderry, Limerick, Cork and Liverpool.
Epidemic louse-borne typhus, 1847-1848 – The hope of a New World (3/7)

Typhus epidemic, 1847-1848

Epidemic in Lower and Upper-Canada:

- 1847-1848: death rate on ships during sea crossing varying from 15 to 44%
- ≈50% of those arriving hospitalised
- 18% of those embarking for Québec die (typhus and diphteria)
- ≈18,000 (20%) deaths *† due to typhus and other diseases ‡ among 89,734 persons coming from Liverpool, England:
  - 5,293 during sea crossing
  - 8,070 at Grosse-Île quarantine station and Québec city
  - 7,000 at Montréal and beyond
  - 38 sailors
  - 15 to 44 employees at the quarantine station

* Varying numbers according to different sources of statistics.
† The estimated number of cases, based on 10-40% lethality, is ≈45,000-180,000.
‡ Including dysentery and diphteria.
Number of passengers and deaths by site and day of arrival at Grosse-Île and Québec, May 9th to November 8th, 1847.

Source: Charbonneau et al, 1997 (adaptation and illustration by Dion R).
Weekly number of deaths at Grosse-Île by group, May 8th to October 23rd, 1847.*

Numbers including 3,228 deaths registered at the hospital and 214 others recorded in the health camp established at the east of the island.

Source: Charbonneau et al, 1997 (adaptation and illustration by Dion R).
## Deaths frequency distribution among immigrants for Québec, December 1847 to March 1848.

<table>
<thead>
<tr>
<th>Site of death</th>
<th>Number</th>
<th>Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In quarantine at <em>Grosse-Île</em></td>
<td>3,452</td>
<td>19,8</td>
</tr>
<tr>
<td>On ships during sea crossing and quarantine *</td>
<td>5,293</td>
<td>30,3</td>
</tr>
<tr>
<td>At the <em>hôpital de la Marine et des Émigrants</em> of Québec</td>
<td>1,041</td>
<td>6,0</td>
</tr>
<tr>
<td>At the <em>hôpital de la Pointe-Saint-Charles</em> †</td>
<td>3,579</td>
<td>20,5</td>
</tr>
<tr>
<td>At Saint-Jean (Québec)</td>
<td>71</td>
<td>0,4</td>
</tr>
<tr>
<td>At Lachine</td>
<td>130</td>
<td>0,7</td>
</tr>
<tr>
<td>At the Immigrants hospital of Toronto ‡</td>
<td>863</td>
<td>4,9</td>
</tr>
<tr>
<td>In other cities of Upper-Canada</td>
<td>3,038</td>
<td>17,4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17,477</strong></td>
<td><strong>100,0</strong></td>
</tr>
</tbody>
</table>

* Numbers including 842 peoples died on quarantined ships and buried in one of the Grosse-Île cemeteries.

† On January 1st, 1848.
‡ On February 2nd, 1848.

Source: Charbonneau A et al, 1997 (adaptation by Dion R).
Typhus epidemic, 1847-1848

Epidemic in Lower and Upper-Canada:

- Only 200 beds for the sick and ≈800 for the well passengers are available at the Grosse-Île quarantine station (Dr George Mellis Douglas [1809-1864], superintendent)

- On mid-May 1847, the 4 first ships disembark 285 sick and >1,200 other persons; at the end of the month, ≈1200 patients among >12,000 persons are detained on the Grosse-Île facilities

- ≈40-50 (maximum: 90) bodies are buried each day; hundreds of military tents and the arrival of supplementary medical personnel can’t reverse this desperate situation

- Other barracks are constructed during the coming months; at the end of the navigation season, the Grosse-Île facilities (closed on November 3rd) have the capacity for 2,000 patients, 300 convalescents and 3,500 well persons
Epidemic typhus in Montréal, 1847-1848
– *The Black Irish Rock*
Epidemic louse-borne typhus, 1847-1848 – *The Irish Rock* (1/8)

**Typhus epidemic, 1847-1848**

**Montréal:**

- Overwhelmed, the authorities allow some ships with apparently well passengers to go at Montréal
- In May, the immigrants, suffering of hunger and sick with typhus and other diseases, dies on the piers and in the streets, begging water and food on the churches parvis
- Dr Michael Mc Culloch (≈1797-1854) notify the first cases discovered in the port to the municipality *Commission de santé*
- A temporary *Bureau de santé* is created on May 27th, but its real powers are limited
Typhus epidemic, 1847-1848

Montréal:

- Dr John Easton Mills (1796-1847), Montréal maire, order the construction of 22 wood sheds (150 x 50 feet) disposed in 3 ranks at Pointe-du-Moulin, in Pointe-Saint-Charles, near Lachine canal; the first admission of cases are on Mai 26th
- The sheds are garded by militaries, restricting (partially) the escape of patients outside the facilities
- Other (thousands?) cases are admitted in Montréal hospitals
- The congregation of Gray Sisters (June 17th), then of Providence and Hôtel-Dieu de Montréal Sisters, some physicians, and catholic, anglican and jesuite priests take care of the patients in the sheds, including for spiritual assistance *

* Guérir le corps pour sauver l’âme.
Typhus epidemic, 1847-1848

Montréal:

- Sick and dying patients share beds (3 persons each); the barracks become « fever-sheds », and about 20 cases die each day (maximum 54 deaths on July 4th)
- A total of ≈6,000-8,000 cases die and are buried in a cemetary on the premises, near Saint-Lawrence river
- During the summer 1847, a new municipal regulation require counting of deaths in cemeteries, including age, sex, civil status, address, country of origin and the cause (disease)
- The moving of the facilities to the Boucherville islands is considered temporarily
Weekly number of deaths at Montréal by group, June 6th to November 14th, 1847.*

* Missing data for deaths in sheds for weeks beginning on June 6, August 8 and 15, and October 24.

Source: Compilation from 9 newspapers and The British American Medical and Physical Journal by Charest-Auger M, 2012 (adaptation and illustration by Dion R).
Epidemic louse-borne typhus, 1847-1848 – *The Irish Rock* (6/8)

**Typhus epidemic, 1847-1848**

**Montréal:**

- The recommendation to build a *cordon sanitaire* around the sheds by the *Bureau de santé* is refused by the city Corporation

- Priority is given to draining the swampy zones of Griffintown nearby

- Dr Mills (November 12th, 1847), 7 Gray Sisters (30 cases [beginning on June 24th] among 40 persons), many priests and some volunteers, including brigadiers and member of the Royal Navy, die of typhus

- The St-Patrick’s orphanage is open to take care (by the Gray Sisters) of hundreds of orphans wandering in the streets

- Mgr Ignace Bourget (1799-1885), Montréal Bishop, make contact with families asking them to adopt Irish orphans; many accept
Epidemic typhus in 1847-1848 – Contributing factors
Typhus epidemic, 1847-1848

Contributing factors:

- Host related (extreme poverty et malnutrition)
- Environment related (prolonged trips on sailing-ships, promiscuity and insalubrity)
- Travelers already infected before embarking on ships and undetected cases and asymptomatic or subclinical infections
- Propagation of infection amplification
- No clear knowledge and many misconceptions of transmission modes
- Insufficient and wrongly oriented preventive and control measures
- Jurisdiction battles (britanic or colonial, United-Canada, provincial and municipal governments), conflict of interests and lack of necessary funding for basic public health infrastructures and disaster response
Typhus epidemic, 1847-1848

Contributing factors:

- **Myasmatics** defended the position of an aerial transmission of epidemic diseases due to changing atmospheric conditions.

- **Contagionists** proposed the mechanism of person-to-person propagation, and sometime through a food or water vehicule, without considering the possibility of a vector, such as an insect.

- Partisans of **microbian** theory were able to explain the observations from the later and discover other transmission modes of infections, while proving the absence of spontaneous generation of micro-organisms advanced by the former.

- Some ardent defenders of the aerial theory converted lately to the contagionist one, as William Farr, who recognized his errors about cholera modes of transmission years after John Snow deaths.

- Myasmatics, such as Edwin Chadwick and Florence Nightingale, were at the origin of social and sanitary reforms that had very positive impact on population health of vulnerable and poor peoples, sometimes for the wrong logical reasons.
Epidemic louse-borne typhus, 1847-1848 – References (1/2)

Principal references

Book and documents:

Epidemic louse-borne typhus, 1847-1848 – References (2/2)

Principal references

Books and et documents:


