The potential significance of co-circulating pathogens on patterns of spatial spread: insights from the historical record





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Substantial epidemics affecting Newfoundland during the early 20th century



Year	Disease	# deaths
1915-16	measles	508
1918-19	flu/pneum	1903
1921	pertussis	130
1924	measles	94
1924	scarlet fever	82
1925	pertussis	127
1930	measles	83
1931	pertussis	136
1935	flu	186
1935	pertussis	209
1937	measles	72
1940	pertussis	139
1941	flu	164

About 700 additional deaths occurred each year from tuberculosis

What might suggest the presence of an interaction between the 1915-16 measles and 1918-19 flu epidemics?

a) The two districts with the highest measles mortality were among the lowest for flu mortality during the second wave
b) Pneumonia is a common severe secondary infection for both diseases

Hypothesis

Prior exposure to the measles epidemic reduced the impact of the influenza epidemic

Expectation

Districts with high measles mortality should exhibit low flu mortality

Possible mechanism

Female caregivers of children who died from measles-related pneumonia may have developed immunity to pneumonia and may have had lower mortality from flu and flu-related pneumonia

Deviations from island-wide averages for measles and flu deaths by district



Correlations by community

Flu/pneumonia versus measles

Presence/Absence

• Simple index to indicate status in each community

Two sets of tests

- "Raw All": includes all communities
- "Raw Small": includes only those communities where both epidemics were present

Omit St. John's

- "Raw All"
- "Raw Small"

Standardized death rates

- "Standard all"
- "Standard small"

	Correlation
Presence/Absence	-0.4875
Raw all	0.9428
Raw small	0.9856
Raw all, no SJ	0.2386
Raw small, no SJ	0.4797
Standard all	0.0030
Standard small	0.3537

The impact of tuberculosis in Canada

- TB reached epidemic proportions in the Canadian north and in other North American (esp. indigenous) groups by the end of the 19th century
- Remained largely uncontrolled in Canada until well into the 20th century
- During early 20th century Newfoundland, "Pulmonary tuberculosis ... heads the list as the most frequent cause of admission and requires almost as much time and care to treat as all other illnesses combined (Hodd 1937:53-54)."
- Steep declines occurred in most areas after the middle of the century, but remained persistent problem in Newfoundland well into second half of 20th century



Source: updated from 1st edition of *Aboriginal Health in Canada by Waldrum, Young, & Herring (2006)*; data since 1990 from *Tuberculosis in Canada 2002* (Public Health Agency of Canada 2004b); Figure drawn by Kue Young.

Evidence for interactions between TB and flu in 1918-19

Flu deaths, 1911-1941 — under 45, without infants, US







Other factors influencing the impact of infectious disease epidemics

- Malnutrition
- Local sanitary conditions
- Crowded living situations
- Access to health care



Source: http://www.shingwauk.auc.ca/photogallery/Morrow/Morrow_p12.html

Issues to ponder

- 1. How does the context within which epidemics occur influence the estimation of disease-specific parameters (e.g., infectivity, susceptibility)?
- 2. Do the benefits of the added realism associated with considering multiple epidemics/diseases justify the cost?
 - Historic analyses probably; no infectious disease epidemics were isolated events
 - Modern developing countries probably (e.g., HIV and TB in southern Africa; malaria and many other conditions)
 - Modern developed countries not so clear, but might be worth considering in light of growing problems with antibiotic resistance