

Relationship between “purulent bronchitis” in military populations in Europe prior to 1918 and the 1918–1919 influenza pandemic

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These data were presented at the October 2011 meeting of the Infectious Disease Society of America in Boston MA as poster 1123.

Accepted 11 October 2011. Published Online 28 November 2011.

Purulent bronchitis was a distinctive and apparently new lethal respiratory infection in British and American soldiers during the First World War. Mortality records suggest that purulent bronchitis caused localized outbreaks in the midst of a broad epidemic wave of lethal respiratory illness in 1916–1917. Probable purulent bronchitis deaths in the Australian Army showed an

epidemic wave that moved from France to England. Purulent bronchitis may have been the clinical expression of infection with a novel influenza virus which also could have been a direct precursor of the 1918 pandemic strain.

Keywords Influenza, military, mortality, pandemic, pneumonia.

Please cite this paper as: Shanks *et al.* Relationship between “purulent bronchitis” in military populations in Europe prior to 1918 and the 1918–1919 influenza pandemic. *Influenza and Other Respiratory Viruses* 6(4), 235–239.

Introduction

The 1918–1919 influenza pandemic is the most lethal natural disaster in modern history. Insights regarding the events that preceded the pandemic are important because recurrent pandemics are inevitable. Yet, the origin of the pandemic is uncertain; and because it occurred prior to the advent of virology, its precise genesis will likely never be determined. The recovery of viral nucleic acid from naturally preserved tissues and archived pathologic specimens enabled definition of the genome of the 1918 A/H1N1 pandemic strain.¹ The findings of other studies have suggested that the three major lineages of influenza A/H1N1 (pandemic, seasonal, and swine) separated prior to 1910. If so, precursor viruses to the 1918 pandemic strain likely circulated for years prior to 1918.²

A clinically distinctive, life-threatening acute respiratory illness termed purulent bronchitis caused large outbreaks with high case fatality rates among British soldiers at Aldershot, England and Etaples, France in 1916–1917.^{3,4} In late 1917, a similar illness affected large numbers of US soldiers who had recently arrived in France; the clinical and pathologic characteristics of the illness “were essentially the

same” as those that had been attributed to purulent bronchitis.⁵ Contemporaneous and modern authors have suggested that the purulent bronchitis outbreaks of 1916–1917 represented the herald wave of the 1918 pandemic; if so, the highly pathogenic virus that caused the focal outbreaks of purulent bronchitis in 1916–1917 evolved transmission characteristics that enabled its worldwide spread in 1918–1919.^{6–8} We reviewed military mortality records and published reports regarding purulent bronchitis to assess the natures, locations, and lethal effects of respiratory illnesses in the military forces of the British Commonwealth and the United States prior to 1918.

Methods

The two primary data sources for the analysis were a near complete digitalized listing of all United Kingdom soldiers who died during the First World War, 1914–1919, and the “Debt of Honour Register” of the Commonwealth War Graves Commission (CWGC) (accessed on 4 January 11 at: http://www.cwgc.org/debt_of_honour.asp).⁹ The information recorded on the records included name, rank, regimental number, date of death, place of burial, and cause of

death. Records of non-combat deaths from October 1, 1916–April 30, 1917 of British soldiers with burial locations in Europe known to the CWGC were collected and reviewed. Indian and South African soldier deaths could not be classified by their causes; hence, they are not included in the analysis. New Zealand soldiers are the subject of a separate study. Soldiers who died of disease in Belgium/France were typically buried near the medical facilities where they died; however, soldiers who died in the UK were eligible for burial in their home towns (subject to the wishes and at the expense of surviving family members).

Results

During World War I, the AIF (AIF) and Canadian Expeditionary Force (CEF) were relatively small subsets of the British Expeditionary Force (BEF) in France. Together, the Australian and Canadian Armies consisted of more than 500 000 men who were assigned at various times to training bases in England, logistics centers in France, and battlefields in France and Belgium. Deaths because of pneumonia/influenza were specifically reported in both the Australian and Canadian Armies. This enabled confirmation of the causes of death of interest among nearly all Australian and most Canadian fatalities during the war. In both the AIF and CEF, there were dual peaked epidemics of lethal respiratory illnesses during the winter 1916–1917 and fall-winter 1918–1919. During both periods, the epidemics in the CEF and AIF were temporally closely related (Figure 1A). In contrast, during the 1916–1917 period, overall mortality was much less in the CEF than the AIF.

During World War I, there were continuous changes in the numbers of deployed UK, Australian, and Canadian soldiers and continuous movements of troops to, from, and within England, France, and Belgium. Because person-time at risk in various Armies could not be precisely determined from the data sources used for the analysis, we could not calculate absolute values or trends of mortality rates over time. We did estimate, however, that respiratory illness-related mortality (at least partly because of purulent bronchitis) peaked at approximately 0.5 deaths/1000 men/month during the 1916–1917 epidemic period and approximately 2.5 deaths/1000 men/month during the late 1918 pandemic period.

Because of the lack of specificity of cause of death reporting among United Kingdom (UK) soldiers, respiratory illness-specific mortality could not be determined among them. As a result, mortality trends among UK soldiers were assessed based on non-combat deaths (all causes).⁹ Among UK soldiers in England and Belgium/France, numbers of non-combat deaths per week

were approximately twice as high (250–300 during week ending 17 February 1917) during the winter of 1916–1917 compared with the fall 1916 (approximately 100 non-combat deaths per week). Using the most specific data from the Australian Army, there was a spatiotemporal trend of increasing non-combat deaths in late 1916 that started in France and moved to England before tapering off by April 1917 (Figures 1B and 2).

Discussion

In the early 20th century, purulent bronchitis among British soldiers was described as a febrile respiratory infection marked by an influenzal prodrome, an unusual “heliotrope” cyanosis, and a virulent and often lethal clinical course.^{3,4,10} The condition was further defined by post-mortem findings of patchy pneumonitis with pus that was expressible from the smaller airways. The earliest reports of purulent bronchitis as a distinct clinical entity were from the Canadian Army during the first months of the First World War in late 1914. A Canadian Army physician stationed at a military hospital in southern England described an unspecified number of lethal purulent bronchitis cases which he clearly differentiated from lobar pneumonia. In his report, he noted that “In long hospital experience in Canada, I have not seen such virulent cases in young and robust adults.”¹¹ In a summary of his experience in 1915–1916, the same physician stated that “No cases were observed of the extremely severe and sometimes fatal purulent bronchitis seen during the previous winter in both England and France.”¹²

During the severe winter of 1916–1917, British military physicians reported outbreaks of purulent bronchitis at a large logistics base (Etaples) in northern France and a large training center (Aldershot) in southern England.^{3,4,8} Both reports characterized purulent bronchitis as a distinct, life-threatening clinical entity. Also, both reports considered “heliotrope cyanosis” a characteristic and distinctive clinical sign of purulent bronchitis and a grave prognostic indicator.^{3,4} Several hundred autopsies were conducted during the outbreaks (total numbers affected during the outbreaks were not specified). By the end of 1917, purulent bronchitis had also been seen in US soldiers who had recently arrived in France.⁵

By the beginning of 1918, purulent bronchitis had become an established diagnosis. For example, the diagnosis was used to describe post-measles pneumonias among New Zealand soldiers during the first 3 months of 1918.¹³ More than one-third of the cases died, but it is unclear whether all of these cases occurring in recruits recently arrived from New Zealand followed measles infection. This happened several months prior to the spring-summer 1918 epidemics of low-mortality, influenza-like-illness which are

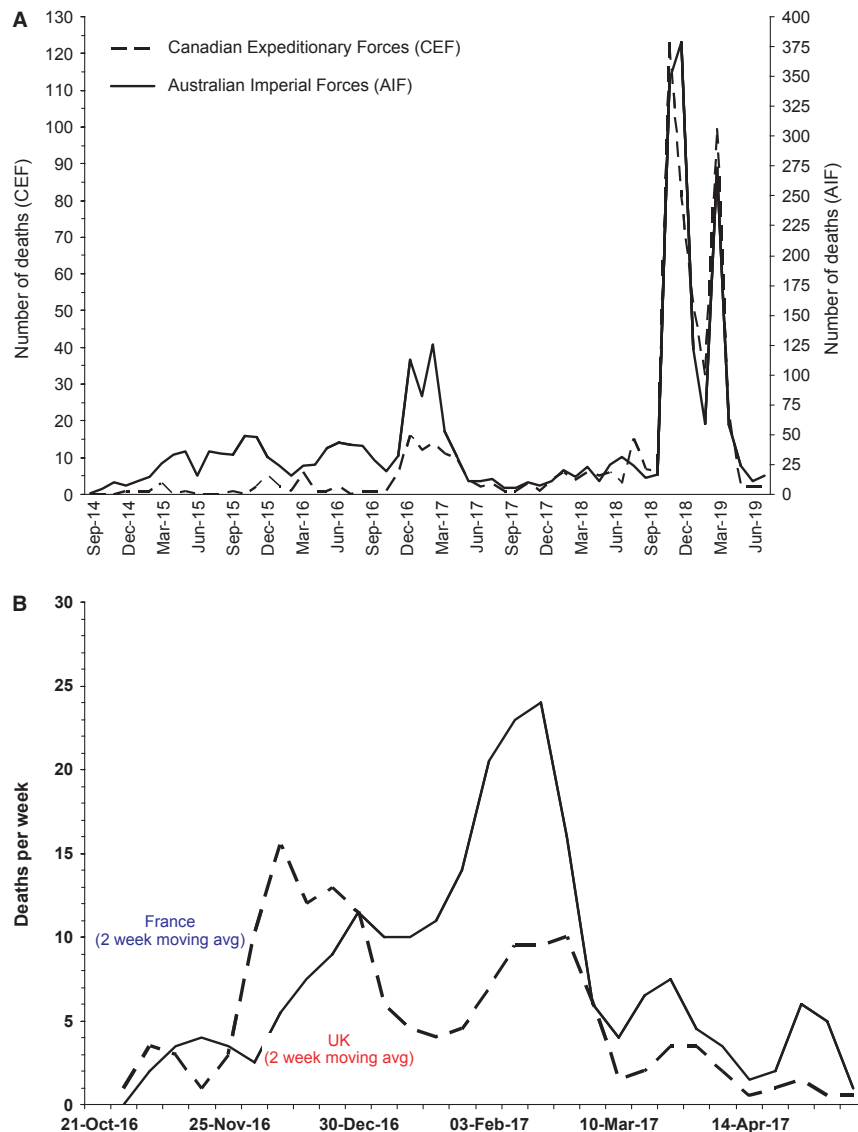


Figure 1. (A) Monthly pneumonia/influenza deaths in both the Australian Imperial Force (AIF) and Canadian Expeditionary Force (CEF) in Europe during 1914–1919. Rates are not shown as it is likely that many pneumonia/influenza deaths in the CEF were only reported as disease and not specifically pneumonia deaths. (B) Probable “purulent bronchitis” deaths in Australian soldiers in England and France by week October 1916–April 1917. Solid line shows deaths in England, and dotted line are deaths in France depicted as a moving 2-week average.

often designated as the first wave of the 1918–1919 pandemic. The first lethal epidemic of respiratory illness that can be identified confidently as belonging to the “second wave” of the 1918–1919 influenza pandemic also affected New Zealand troops; the affected soldiers encountered influenza in Freetown, Sierra Leone on the troopship *Tahiti* in mid-August 1918.¹⁴ The military physicians who examined the sick soldiers from the *Tahiti* when it arrived in England diagnosed the disease as purulent bronchitis. Physicians who published reports regarding both purulent bronchitis and pandemic influenza thought, in retrospect, that purulent bronchitis was a clinical subset of the 1918–

1919 influenza pandemic and likely was caused by the same unknown infectious agent.^{10,15}

The remaining question then is whether the purulent bronchitis epidemics described in the British and American soldiers were caused by a lethal influenza virus that gradually became more transmissible over several years or another infectious agent. The epidemiologic characteristics of the purulent bronchitis epidemics in the winter 1916–1917 were consistent with those expected from a novel influenza virus that was adapting to its human hosts. Although one cannot be certain after >90 years, the distinctive clinical character of purulent bronchitis which many

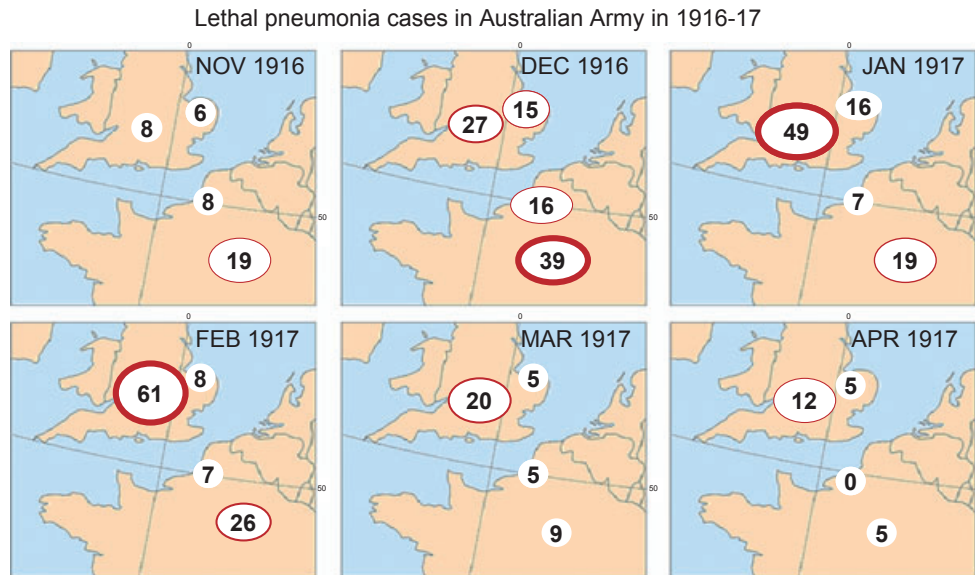


Figure 2. Epidemic map of England and France showing time series because of probable “purulent bronchitis” mortality in Australian soldiers October 1916–April 1917.

experienced clinicians described as being new and the remarkably lethality in otherwise healthy young adults suggests that the separately classified epidemics of purulent bronchitis and pandemic influenza were both caused by H1N1 influenza with subsequent secondary bacterial pneumonia. This hypothesis is supported by the genomic data indicating that the pandemic influenza H1N1 of 1918–1919 had been circulating in some mammalian host(s) for several years prior to the pandemic.² The clinical and epidemiologic characteristics of the purulent bronchitis that caused focal outbreaks in England and France prior to 1918 closely resemble those associated with emerging influenza virus strains.⁶ The finding suggests that the epidemics of purulent bronchitis among British, Australian, Canadian, and American forces in England and France prior to 1918 may have been precursors of the 1918–1919 influenza pandemic.

Acknowledgements

The authors have been privileged to access information concerning the soldiers of the First World War 1914–1919 and recognize the extraordinary sacrifices they made. We thank the Commonwealth War Graves Commission for providing data, Professor Peter Dennis of the University of New South Wales at the Australian Defence Force Academy, Canberra, Australia for his work with the Australian Imperial Force and many medical librarians including Odette Hopwood at the Australian Defence Force library at Gallipoli Barracks for help in locating references.

Author Contributions

GDS conceived and designed the epidemiological study, gathered the initial data, assisted in the analysis, and wrote the first draft of the manuscript. AM, MW, and JB assisted with the study design, data collection, analysis, interpretation and writing of the manuscript.

Funding

This work was supported by the Global Emerging Infections Surveillance and Response System (GEIS) at the Armed Forces Health Surveillance Center of the United States Department of Defence (<http://afhsc.mil/geis>).

Conflicts of interest

No author claims any conflict of interest.

Disclaimer

The opinions expressed are those of the authors and do not necessarily reflect those of the Australian Defence Force or the US Department of Defense.

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