

The Role of Radiology in Influenza: Novel H1N1 and Lessons Learned From the 1918 Pandemic

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The pandemic of swine-origin H1N1 influenza that began in early 2009 has provided evidence that radiology can assist in the early diagnosis of severe cases, raising new opportunities for the further development of infectious disease imaging. To help define radiology's role in present and future influenza outbreaks, it is important to understand how radiologists have responded to past epidemics and how these outbreaks influenced the development of imaging science. The authors review the role of radiology in the most severe influenza outbreak in history, the "great pandemic" of 1918, which arrived only 23 years after the discovery of x-rays. In large part because of the coincidental increase in the radiologic capacity of military hospitals for World War I, the 1918 pandemic firmly reinforced the role of radiologists as collaborators with clinicians and pathologists at an early stage in radiology's development, in addition to producing a radical expansion of radiologic research on pulmonary infections. Radiology's solid foundation from the 1918 experience in medical practice and research now affords significant opportunities to respond to the current H1N1 pandemic and future epidemics through similar interdisciplinary strategies that integrate imaging science with pathology, virology, and clinical studies. The broad range of current imaging capabilities will make it possible to study influenza at the cellular level, in animal models, and in human clinical trials to elucidate the pathogenesis of severe illness and improve clinical outcomes.

Key Words: Radiology, infectious disease imaging, influenza, great pandemic of 1918, epidemic, chest CT, plain film, chest radiograph, history, pulmonary infection

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INTRODUCTION

The novel H1N1 influenza virus that emerged in early 2009 has spread throughout the world, causing large numbers of mild illnesses and a much smaller, but still significant, number of fatal cases. Radiologists have responded to the outbreak through efforts to characterize pulmonary changes that accompany severe infection [1-4]. In considering how radiology might contribute

further to the medical response, and what impact the pandemic could have on the future development of imaging science, it is useful to look back at the most severe influenza outbreak in history, the pandemic of 1918 to 1919.

Even though it occurred nearly a century ago, the "great pandemic" is still remembered for its extremely high death toll of 50 million people and the unexpected concentration of deaths among young adults [5,6]. Less well recognized is the stimulus the catastrophic outbreak gave to medical research and practice, particularly to the young science of radiology. The present review demonstrates that the 1918 pandemic strengthened radiology's role as an integral component of clinical practice and research at a time (only 23 years after the discovery of x-rays) when radiologic capability was still highly undefined, resulting in widespread acceptance of chest radiography for managing pulmonary disease. Using this historical precedent from 1918, we consider the question of how the 2009 pandemic could potentially affect the future development of radiology and radiology's response

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to epidemics. After reviewing the status of radiology in medical practice before, during, and after the 1918 pandemic, we consider how the new influenza outbreak may stimulate further progress in imaging science for pulmonary infection.

RADIOLOGY AND RESPIRATORY INFECTIONS BEFORE 1918

Although radiology is an integral part of contemporary clinical medicine, the role of radiology was quite undefined a century ago. Given Roentgen's background as a physicist, there was initial debate over whether the discovery and development of x-rays would be primarily the domain of physics or find more translational applications in medical practice [7]. Similarly, there was speculation about the role of x-rays in the practice of medicine during the early 1900s. Some suggested that x-ray imaging could potentially supplant physical examination by establishing a unique image pattern for each disease, whereas others argued that the technology merely provided pictures of abnormalities that could readily be diagnosed by history and physical examination [7,8]. Even the eminent clinician Sir William Osler claimed that radiology offered little that could not be learned through physical examination [8,9].

Significant inquiry into the value of radiology focused on the role of the chest radiograph in clinical diagnosis. Less

than a year after Roentgen's discovery, radiographic examination of the lungs had revealed air bronchograms, and the first images of pneumonia were published in 1903 [10-14]. These clinical observations were supported by technological innovations from 1901 to 1918, such as the Coolidge tube in 1913, which improved radiographic imaging, and the Bucky grids developed from 1913 to 1920, which reduced scatter. Given such rapid progress, it was hoped that radiology could help turn the tide against the major scourge of the early 20th century, tuberculosis, which led to the Trudeau group in 1916 establishing radiographic criteria for diagnosing pulmonary tuberculosis. Although physicians could recognize advanced cases of tuberculosis, it was clear that effective treatment would require earlier detection, which imaging might provide. However, experience and data from a wide range of infections was still scarce and anecdotal at that time [8].

RADIOLOGY IN WORLD WAR I AND THE PANDEMIC INFLUENZA OF 1918

The entry of the United States into World War I had a significant impact on the development of radiology and coincidentally set the stage for radiology to play a large role in the concurrent influenza epidemic. Radiology was adopted as an integral part of the US military's medical establishment and mobilization for war in 1917 and 1918 (Figure 1). When the United States declared war on

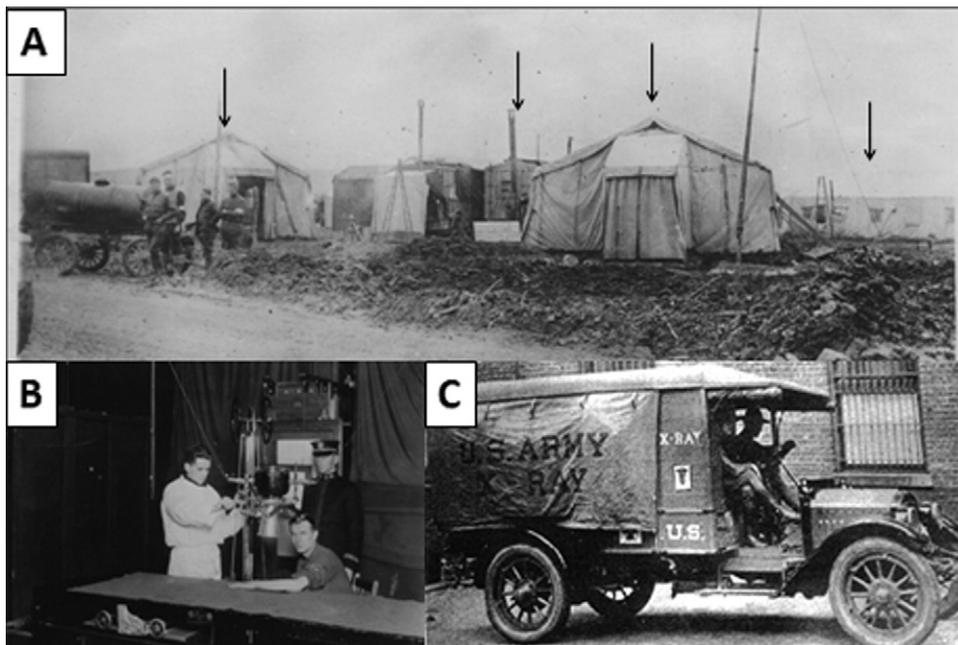


Fig 1. (A) Military hospital (1914-1918) with radiology station. Mobile Hospital No. 6, Varennes Station, France. Structures shown left to right (arrows): evacuation ward, radiology station, shock tent, postoperative ward. (B) US Naval Hospital No. 1, Brest, France (1914-1918) during World War I; personnel configuring x-ray equipment. (C) US Military Mobile X-Ray Unit, World War I. Source: National Museum of Health and Medicine, Armed Forces Institute of Pathology, Washington, DC.

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