Modern History of Surgical Management of Lung Abscess: From Harold Neuhof to Current Concepts

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Harold Neuhof was one of the pioneers of thoracic surgery in the early decades of the last century. Inspired by his preceptor Howard Lilienthal he proposed an entirely new concept for surgery on acute lung abscess. The aim of his one-stage procedure was adequate drainage of the abscess cavity. His approach proved to be the first major breakthrough in the treatment of acute lung abscess. Therapy of pulmonary abscess was again radically changed by the advent of antibiotics in the late 1940s. However, the basic principles of Neuhof's concept still influence modern-day management of putrid lung abscess.

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Modern history of surgery for primary lung abscess begins with the dawn of thoracic surgery in the first decades of the 20th century. Although lung abscess as a disease entity was known since the days of Hippocrates, successful surgical therapy had yet to be invented. Harold Neuhof, when he was surgeon to the Mount Sinai Hospital in New York during the 1920s and 1930s, was the first thoracic surgeon to develop a valid and reliable therapeutic concept for surgery of acute pulmonary abscess. Based on the preliminary work of his surgical preceptor Howard Lilienthal he proposed an entirely new one-stage open drainage operation for lung abscess [1]. Although contemporary series regarding lung abscess reported mortality up to 75% [2], Neuhof's series of 162 cases managed by his one-stage open drainage operation showed mortality of only 2.47%. His findings were soon generally accepted and displayed reproducible, good results in series from other thoracic surgical services [3]. With the advent of antibiotics in the late 1940s, the spectrum of disease shifted toward chronic pulmonary abscess. Acute lung abscess, the original indication for Neuhof's surgical procedure, became a domain of medical therapy. Neuhof himself realized that chronic and particularly multilocular lung abscess were poor candidates for open drainage procedures [4]. Henceforth pulmonary resection for mainly chronic lung abscess was considered the treatment of choice. Protagonists of this new era were, among others, Robert R. Shaw, Richard T. Myers, and David H. Waterman [5–7]. However, the basic principles of Neuhof's work are still present in modern-day management of putrid lung abscess, and his concept of open drainage was occasionally advocated throughout the last decades. This historical overview reports on the pioneering work of Harold Neuhof and its consequences up to present times.

Early Years: Studies by Harold Neuhof

In the first two decades of the 20th century, the outcome of patients with putrid lung abscess was nearly always fatal. Acute lung abscess was a crushing and life-threatening disease entity. Mortality reached 75% in a series from the Massachusetts General Hospital covering the years 1909 to 1923; 169 of 227 patients admitted to the hospital for acute lung abscess died in spite of conservative treatment efforts [2]. Nonoperative management in that era mainly consisted of unspecific drug therapy and recommendation of fresh air and rest, as well as postural drainage and occasionally bronchoscopic treatment. However, those measures often failed to provide cure, and thus lung abscess remained an unsolved medical problem with substantial morbidity and mortality.

Doctor Harold Neuhof graduated from the College of Physicians and Surgeons of Columbia University in 1905. In the same year he began his internship at the Mount Sinai Hospital in New York. At Mount Sinai, Dr Howard Lilienthal, one of the most renowned surgeons of that time, became his preceptor [8]. During a time when thoracic surgery was trying to find its feet, Lilienthal applied himself to this new field of surgical practice [9]. In the early decades of the last century, thoracic surgery was mainly concerned about procedures for tuberculosis and all kind of suppurative lung disease. Lung cancer was not yet a topic of interest. Instrumentaria, operative technique, and anesthesia were just emerging. One of the pioneers in that field was Lilienthal. In 1910 he reported the "first case of thoracotomy in a human being under anaesthesia by intratracheal insufflation" in a 55-year-old man with a pulmonary abscess [10]. This technical advance considerably improved the possibilities of lung surgery, and in February 1914 Lilienthal performed his first successful lobectomy [11]. His patient was a small

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boy who had accidentally aspirated a nut and subsequently experienced an abscess of the right lower lobe. After an initial ineffective drainage procedure, the boy's condition deteriorated and so finally lobectomy was performed [11]. Lilienthal had also much interest in the treatment of pleural empyema, and in 1917 he published a series comprising 100 consecutive patients who had undergone surgical therapy of pleural empyema at the Mount Sinai Hospital [12].

During his internship and residency Neuhof became familiar with the work of Lilienthal, who acted as his preceptor and clinical teacher [8]. In World War I, Neuhof served with the Presbyterian Hospital Unit (Base Hospital No. 2) in France. Here he gained further experience in dealing with chest wounds and empyema as a result of infected thoracic injury. After the war he became Associate Surgeon at Mount Sinai, and after the retirement of Lilienthal, he took charge of the thoracic surgery department [8].

Based on the extensive preliminary work of his predecessor, Neuhof became especially interested in the surgical management of acute putrid abscess of the lung. His research included the etiology, bacteriology, and pathology of pulmonary abscess [13]. He recognized that "an acute putrid abscess usually is solitary, of substantial proportions, superficially situated within the lung and overlaid by well-developed visceroparietal agglutinating adhesions" [1]. In the early 1920s no commonly accepted therapy for lung abscess existed. It was considered to be an almost inevitably fatal illness. Neuhof proposed the entirely new concept of a one-stage open drainage procedure, which had tremendous effect in decreasing morbidity and mortality of acute lunge abscess and was therefore generally adopted by his contemporaries in very short time.

Neuhof realized the importance of "precise roentgenologic localization" for accomplishing his one-stage operation [1]. Together with his Mount Sinai colleague Dr Rabin he developed a method of spot localization using the radiologic possibilities of that time [14]. After diverse radiographs, the "assumed point of contact of the pulmonary abscess with the thoracic parietes is determined. ... The intercostal musculature at this point is injected with a small amount of a mixture of iodized oil and methylene blue. A new set of roentgenograms is taken. There is then revealed the exact relationship of the spot to the abscess" [1]. This simple procedure enabled Neuhof not only to localize the abscess very precisely but also to approach it directly by a limited incision without touching the free pleural cavity.

Neuhof performed his operation mainly under local anesthesia. Subperiosteally, "a two- or three inch segment of one rib" was removed and the underlying lung was carefully exposed [1]. "The adhesions are delicately traversed over a small area down to adherent lung" [1]. He was especially concerned about preserving enough adhesions to keep the free pleural cavity sealed to avoid pleural empyema. The abscess was then aspirated with a short aspirating needle [1]. After the correct position of the needle was ascertained, the abscess was unroofed with special equipment developed by Neuhof and his coworker Touroff [15]. "The aspirating needle being held in place, we follow with a cutting grooved director and cutting scissors, urging the patient to avoid coughing at this stage. ... Under full visualization the shell of lung over the abscess is generously excised within the limits of pleural adhesions" [1]. All suppuration and clotted blood was then removed by suction, and the operation terminated by gauze tamponade of the cavity. "Tamponade is a correct term for the gauze pack of the cavity for the purpose is to avoid collapse and consequent shutting off of any part of the abscess" [1]. The chest wound itself remained unclosed.

Postoperatively the prompt termination of expectoration of foul pus was considered to confirm successful treatment, whereas persistence of the former indicated in all probability an inadequate procedure [1]. Furthermore, Neuhof was considerably concerned about wound closure. "We have learned that after an adequate operation the premature closure of an abscess cavity may, and often will, lead to recurrence of the manifestation of pulmonary abscess" [1]. Therefore, the wound was usually kept open until the patient had clinically and radiographically recovered.

During the procedure Neuhof regularly encountered bronchial fistulas within the abscess cavity. "The disclosure of one or more bronchial fistulae is clear evidence that the main chamber of the abscess has been opened. A fistula often can be demonstrated by having the patient cough or strain" [1]. Thus, the discovery of bronchial fistulas indicated a sufficient procedure with unroofing of the main part of the abscess cavity. Neuhof kept the fistula together with the wound open until definite healing of the abscess was achieved. He was particularly concerned about premature closure of either wound or fistula. "Therefore, the wound is kept open and the bronchial fistula maintained until the patient is free from cough and expectoration. ... Failure to adhere to these standards has led to recurrence of the pulmonary abscess" [1]. Neuhof did not report on any problems related to persisting peripheral bronchial fistula. After cure had been accomplished the fistulas healed naturally. "We stressed the fact that in case of acute abscess practically all bronchial fistulae closed spontaneously, and that one of the chief problems in postoperative management was that of keeping the fistula open for a sufficiently long period" [4].

With strict adherence to this procedure Neuhof achieved excellent results. In 1943 he reported a series of 162 patients who had been managed by his one stage open drainage operation at the Mount Sinai Hospital since 1925 [1]. He encountered only 4 death which means an overall mortality of 2,47%. The late results of his series were also encouraging. Some sufferers who had died years later of reasons unrelated to the former lung abscess were autopsied. Upon postmortem examination complete healing of the pulmonary abscess was confirmed. Hence prompt recovery following the procedure and reassuring long-term results rapidly led to a widespread acceptance of Neuhofs one stage open drainage