



Contents lists available at ScienceDirect

## Journal of Infection and Chemotherapy

journal homepage: <http://www.elsevier.com/locate/jic>

## Original Article

## Long-term sequelae after lung abscess in children – Two tertiary centers' experience

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## ARTICLE INFO

## Article history:

Received 29 August 2017

Received in revised form

6 December 2017

Accepted 26 December 2017

Available online xxx

## Keywords:

Children

Community-acquired pneumonia

Lung abscess

Lung function testing

Lung ultrasound

## ABSTRACT

**Aim:** The aim of the study was to describe the epidemiology and clinical characteristic of children hospitalized with pneumonia complicated by lung abscess, as well as to evaluate the long-term sequelae of the disease.

**Methods:** A retrospective review of medical records of all patients treated for pulmonary abscess in two tertiary centers was undertaken. Pulmonary function tests and lung ultrasound were performed at a follow-up.

**Results:** During the study period, 5151 children with pneumonia were admitted, and 49 (0.95%) cases were complicated with lung abscess. In 38 (77.5%) patients, lung abscess was treated solely with antibiotics, and in nine cases (16.3%) surgically. In 21 (51.21%) children complete radiological regression was documented. The mean time for radiological abnormalities regression was  $84.14 \pm 51.57$  days, regardless of the treatment mode.

Fifteen patients were followed up at  $61.6 \pm 28.3$  months after discharge. Lung ultrasound revealed minor residual abnormalities: pleural thickening, subpleural consolidations and line B artefacts in 11 (73.3%) children. Pulmonary function tests results were abnormal in eight (53.3%) patients, the most frequent abnormality being hyperinflation. We did not find a restrictive disorder in any of the children. There were no deaths in our study.

**Conclusions:** Lung abscess is a rare but severe complication of pneumonia in children. Most children recover uneventfully with no significant long-term pulmonary sequelae.

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## 1. Introduction

Lung abscess is a relatively rare complication of community-acquired pneumonia in immunocompetent children with incidence rates below one per cent (1%) of all cases [1]. It consists of a

thick wall enclosing a cavity of at least 2 cm in diameter, filled with purulent material of infected necrotized lung parenchyma. Based on the previous medical history of the patient, lung abscess is defined as primary in otherwise healthy patients and secondary – in patients with underlying conditions. The therapeutic approach for lung abscess differs from medical treatment and surgical intervention when deemed ineffective [2–4], abscess drainage by pigtail catheter inserted percutaneously under CT-guidance [5] and originally aggressive management. Surgical options include wedge resection, lobectomy via thoracotomy or thoracoscopic drainage [6]. There is also a number of reports on adjuvant fibrinolytics to small bore catheter drainage for loculated collections [7]. Authors advocating for interventional procedures point to their role in shortening antibiotic courses and the hospital stay with minimal risk of adverse outcomes [5].

**Abbreviations:** ATS, American Thoracic Society; BTS, British Thoracic Society; CRP, C-reactive protein; CT, computed tomography; ERS, European Respiratory Society; FEV<sub>1</sub>, forced expiratory volume in 1 s; FVC, forced vital capacity; IDSA, Infectious Diseases Society of America; IOS, impulse oscillometry; IQR, interquartile range; M-W, Mann–Whitney test; PFT, pulmonary function tests; RV- residual volume, SD; standard deviation, TLC; total lung capacity, t-t Student's t-test.

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<https://doi.org/10.1016/j.jiac.2017.12.020>

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BTS (British Thoracic Society) and IDSA (Infectious Diseases Society of America) guidelines on community-acquired pneumonia in children recommend medical treatment for LA, as in most patients that leads to an uneventful recovery. They suggest ultrasound- or CT-guided percutaneous drainage as an alternative treatment [8,9]. In the case of lung abscess coexisting with empyema, British experts suggest considering abscess drainage during decortication of the empyema, provided that LA is close to parietal pleura and it is large [8]. Aspiration or drainage, either percutaneous or thoracoscopic, has the advantage of higher bacterial yields, facilitating treatment which is targeted at causative microorganisms.

Because of the low incidence of lung abscess in pediatric patients, there are only several series of cases reported in the literature. There are hardly any randomized studies comparing treatment modes and our knowledge of the long term respiratory outcomes of lung abscess in children is scarce. This is of special interest considering the reported risk of 13.6% of at least one pulmonary sequelae in hospitalized children with pneumonia [10].

Therefore, **the aim** of the study was to describe the epidemiology and clinical characteristic of children hospitalized with pneumonia complicated by a lung abscess, compare the groups of children treated surgically and medically and to investigate long-term sequelae of the lung abscess in children.

## 2. Patients and methods

A retrospective review of medical records of all patients treated in the Department of Pediatric Pulmonology, Allergy and Clinical Immunology of Karol Marcinkowski Medical University in Poznań from January 2004 to December 2016 and in the Department of Pediatric Pneumology and Allergy of Medical University of Warsaw from January 2007 to December 2016 with the diagnosis of pneumonia was carried out. Both hospitals are tertiary reference centers for the western and central part of Poland and therefore the cases described are representative of the pediatric population of the region populated by 8 847 523 (3 481 625 + 5 365 898) people, 1 759 671 (703 871 + 1 055 800) of whom are children and adolescents [11].

Lung abscess was defined as a thick wall cavity of at least 2 cm in diameter in the lung parenchyma, containing purulent material and the diagnosis was based on radiological tests results (conventional X-rays, computed tomography or both). Medical treatment was defined as exclusively antibiotic therapy or accompanied with a chest tube insertion for empyema. Surgical treatment was defined as any procedure aimed at the removal of the abscess, including percutaneous drainage. Thoracoscopic procedures for empyema were not treated as abscess surgical management. Radiological resolution was defined as no residual changes in the place where the abscess had previously been situated.

The data analyzed included demographic parameters, clinical presentation, comorbidities, diagnostic studies (microbiology, X-rays, CT scans) results, treatment regimens including type and duration of antibiotic therapy, length of hospital stay, time until radiological resolution as well as presence and type of complications. The data regarding pneumococcal vaccination status and the type of vaccine received were recorded in all cases.

The second part of the study consisted of a prospective analysis of long-term sequelae of the lung abscess. From February 2016 until February 2017, we tried to contact all the patients diagnosed with lung abscess by telephone and by mail. At the follow-up visit, we performed a clinical examination, took the detailed history, including a number of respiratory tract infections in the period following the hospital discharge, performed spirometry, impulse

oscillometry and bodyplethysmography as well as a lung ultrasound.

**Lung function measurements:** The forced expiratory volume in 1 s (FEV<sub>1</sub>), forced vital capacity (FVC) and the FEV<sub>1</sub>/FVC ratio were measured using Lung Test 1000 (MES 1000, Poland in Poznań and MasterScreen Pneumo and Body Care Fusion, Germany in Warsaw) Spirometer and Bodyplethysmograph according to ATS/ERS (American Thoracic Society/European Respiratory Society) standards [12]. Residual volume (RV) and total lung capacity (TLC) were determined with the same device, in accordance with the manufacturer's guidelines. Impulse oscillometry (IOS) (Masterscreen IOS, Germany in both centers) was also performed in accordance with the manufacturer's guidelines. An average of three adequate measurements was analyzed.

The Bioethic Committees of both Poznań University of Medical Sciences and the Medical University of Warsaw approved the study. All the parents and children taking part in the second part of the study gave their informed consent.

### 2.1. Statistical analysis

A statistical analysis was performed using STATISTICA version 12.0 (StatSoft Poland). The results are expressed as mean  $\pm$  SD for numerical data with a normal distribution or medians with interquartile range. Data distribution was assessed using the Shapiro–Wilk test. The differences between groups were analyzed using the Student's *t*-test for parametric data and the Mann–Whitney test for nonparametric data. Categorical variables were analyzed using the  $\chi^2$  test. The statistical significance was accepted at the level of 0.05.

## 3. Results

During the study period, 5151 children diagnosed with pneumonia were admitted to hospital, and 49 (0.95%) of these cases were complicated with a lung abscess. The clinical characteristic of the children is given in Table 1. In six patients, the underlying lung defect was detected: in three of them, who underwent a surgical procedure, lung sequestration was diagnosed based on a histological examination. In all the cases, sequestrators were localized in the left lower lobe. Three patients had congenital lung cysts and two of these were treated surgically. Asthma, heart defect, epilepsy and cerebral palsy were present in three (6.1%) patients each, three (6.1%) children also were immunocompromised: one due to nephrotic syndrome and two during the course of leukemia. One patient had Down syndrome with thyroid insufficiency and one had severe dental carries. In one case, the lung abscess complicated the pneumonia in the course of varicella and in another, an abscess formed in the *Echinococcus* cyst. There were no statistically significant differences in the clinical characteristic of the children with primary and secondary lung abscess (data not shown). Only three children with primary lung abscess and none with secondary abscess were vaccinated against *Streptococcus pneumoniae* with 7-valent conjugate vaccine.

The median time from the onset of the symptoms to the radiological diagnosis of the abscess was 14.0 (from 1 to 60) days and this was longer in patients who finally needed surgical procedures: 20.5 vs 12.5 ( $p = .036$ ). Most children presented with elevated laboratory inflammatory indices, though procalcitonin was negative in five children and there were two children with normal values of all inflammatory markers and additionally three with a slightly elevated ESR as the only abnormality in laboratory tests results at the time of the abscess diagnosis.

In 28 (57.1%) cases, CT scans were performed and in the other children, the diagnosis was based solely on X-rays. Other

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