Pulmonary Tissue Response in Septic Multyisystemic Failure after Long-term Artificial Ventilation

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Summary

A study is presented by clinical, microbiological and histological lung tissue response to sepsis in 14 high risk patients who had artificial ventiltion for over 6 days and died. It demonstrates 3 dominant risk factors (1) depression of normal immune mechanisms, (2) aggressive role of anaerobic pathogens (3) harmful effect of prolonged artificial ventilation.

Introduction

Malignant sepsis with multisystemic failure represents the most frequent cause of death in intensive care[1] Pneumonia is responsible for 25% mortality in the ITU even if the original lesion is not a pulmonary one.[2]

The pulmonary tissue rsponse reflects the clinical development of the syndrome known as acute respiratory distress. It may be initiated under three different conditions:

(A) Toxic or septic shock with microvascular pulmonary injury and secondary pulmonary dysfunction [3,4,5,6,7].

(B) Pneumonia accompanied by numerous lung abscess formation developing mainly in patients with primary lung disease.

(C) Aggressive pneumonitis in patients under chronic immunosuppresive therapy or with secondary immunodeficiency.

Diffuse pneumonia with extensive fibroproductive and indurative changes and with a fall of P_aO_2 is a typical response to a long lasting septic syndrome with long-term artificial ventilation in patients dependend on a relatively high FIO_2 and PEEP[8].

Initial clinical and laboratory findings compared with patho-morphological ones usually differ due to the cause of the process. Nevertheless continued sepsis - both of primary pulmonary origin and from primary lesion of other distant organs - gradually induces combined and nearly uniform pulmonary histopathology[9].

Patients, Material and Methods.

We have compared clinical findings with microbiological results and histological profile in 14 non-survivors 7 male, 7 female forming a group of high risk adult patients age 30-75 years (mean = 49 years). The period of the study was limited to 1983 and 1984. All had malignant sepsis with multisystemic failure until the lung failure gradually supervened and was responsible for the demise. All were ventilated for longer than 6 days, - minimum 7 to maximum 82 days (mean = 23.6) with the Elema - Siemens 900 C Servoventilator with an anlogous ventilatory regimen and applied therapy.

Dominant pulmonary complications with definite lung failure and significant histological findings followed primary pneumonia in 6 patients. In 8 patients pulmonary dysfunction developed as a secondary complication in a previously noninfected lung tissue.

Out of the 14 patients studied 7 were exposed to pulmonary risk factors due to chronic immunosuppressive therapy established because of myasthenia gravis, corticosteroids given for bronchial asthma and azathioprine use. In 4 patients the septic focus was of surgical origin and in 3 patients virus infection and hypoxia were the trigger factors in the chain of multisystemic failure.

Intravital clinical and postmortem pathomorphological studies executed are summerized: Table 1.

Intravital Clinical Parameters and Factors

1. Serial Chest X-Ray pictures.
2. Duration of artificial ventilation necessitating $F10_2$ higher tha 0.4 and "PEEP higher than 0.5 kPa

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3. Microbiologic Studies on:-

tracheal secretions
blood samples
urine
peritoneal drainage

4. **Haematology:**

White blood cells count,
lymphocytes, platelets count.

Postmortem Pathomorphological Findings

1. **Lungs**
Histology for lung abscess formation hyaline membranes, megacaryocytes in fibroproductive changes.

2. Microbiologic studies of:-
lung parenchyma,
airway secretions

3. **Haematology**

White blood cells count,
Lymphocytes and platelets couunt from blood recovered from lung parenchyma and blood vessels.

Results and Discussion

Histological findings demonstrated typical secondary bronchopneumonia in 10 cases. In these cases we have found no correlation with the duration of artificial lung ventilation, (the mean being 16.5 days) whereas in 7 patients without typical infectious inflammatory signs artifical ventilation had lasted twice as long (the mean being 33 days).

Large but single lung abscess were identified both in chest X-Ray pictures and post mortem in 2 patients under immunosuppressive therapy and in 1 patient following a metastatic process from peritonitis.

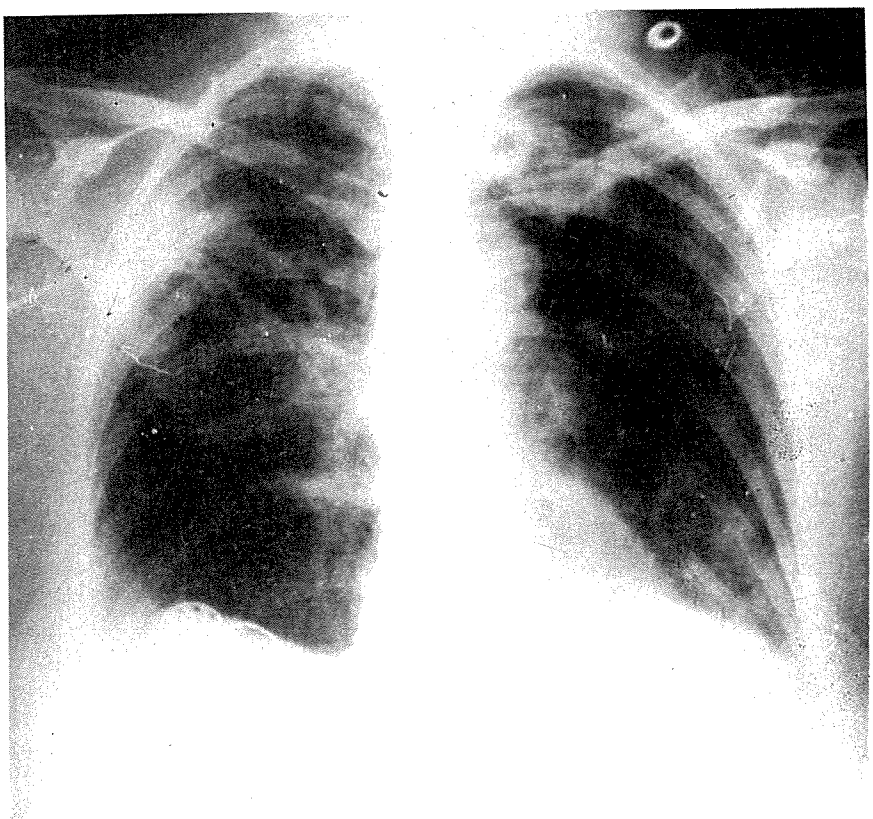
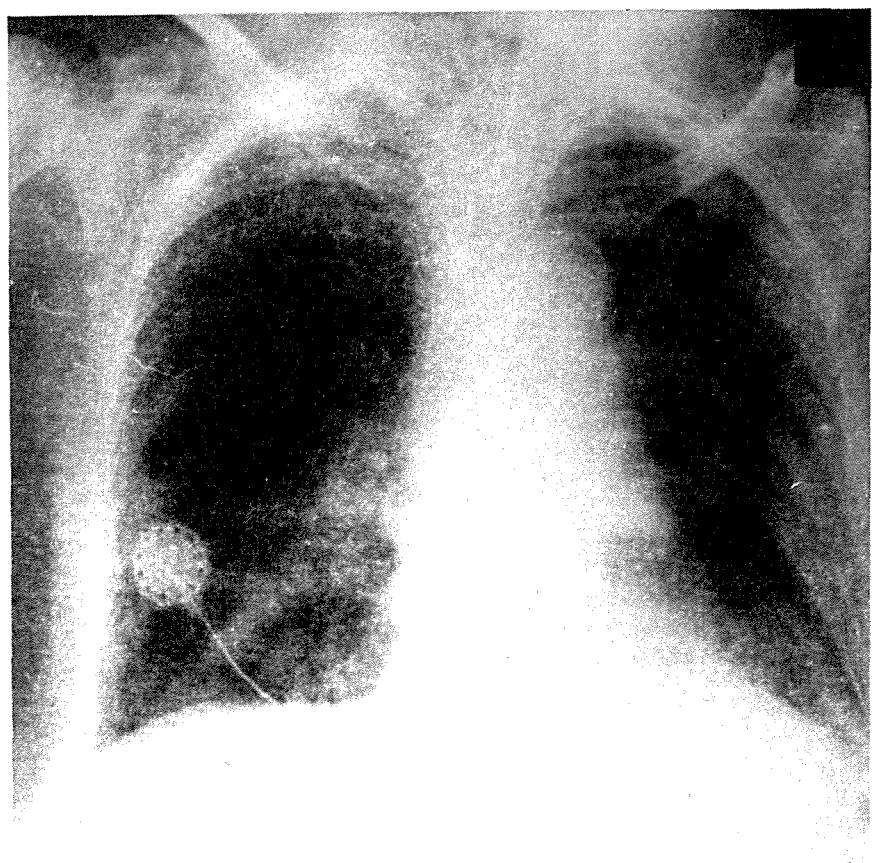


FIG 1. illustrates an abscess with a diameter of 8 cm in the right middle lobe in an asthmatic patient.

FIG. 2 presents an abscess of 4cm diameter in the parahilar space of the left lung with pneumonia in the right lower lobe and signs of interstitial and edema mainly in the left lung.



These radiological changes were present in the second week of the artificial ventilation and a frank abscess appeared on the X-Ray by the 19th day.

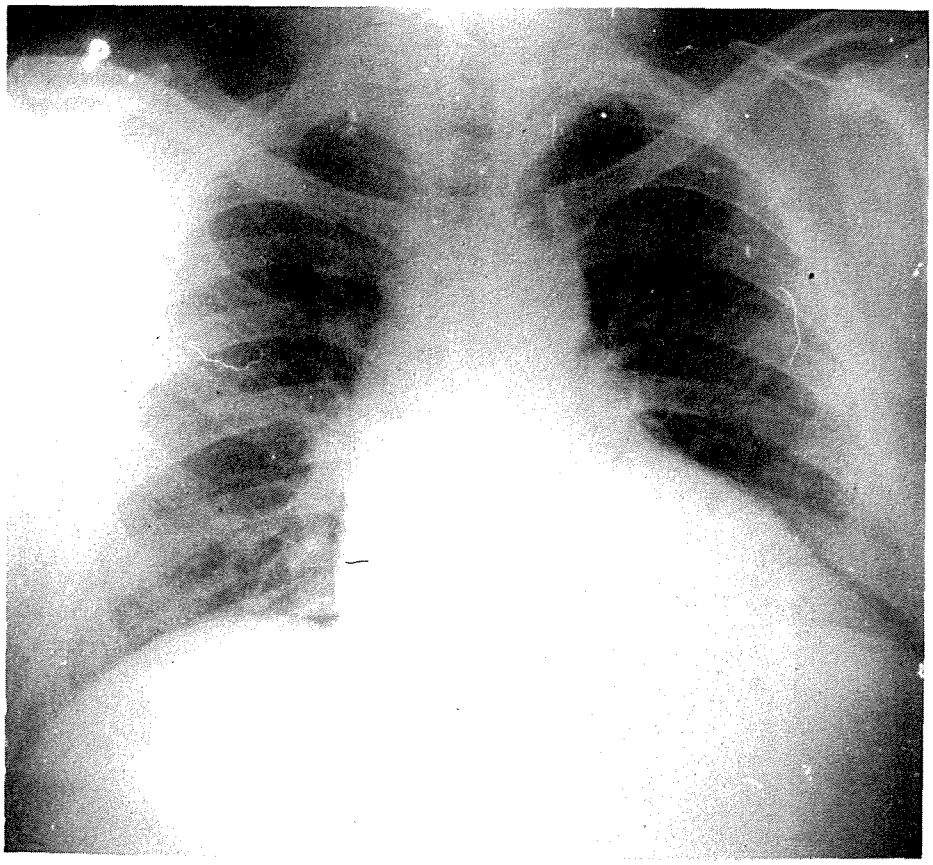


FIG. 3 represents a typical X-Ray picture in peritoneal sepsis with a general pulmonary response but without a local metastatic complication. In cases comming to post mortem, interesitial lung edema, megacaryocytes and hyaline membrane were the main histological findings. Nevertheless a combination of all three factors could be detected in less than half of these cases.

Additional fibroindurative changes were found in-only 8 patients.

The fibroproductive process and presence of hyaline membranes were assessed from three clinical aspects of artificial ventilation: duration, FIO_2 and PEEP.

Fibroplastic changes correlated in our material only with the duration of the artificial ventialtion that exceded 16 days. FI02 higher than 0.4 and PEEP higher than 0.5 kPa were of no significance. Hyaline membranes showed no correlation with any of the above mentioned parameters.

Intravital microbiological results were positive in all cases from the tracheal secretions but only in 50% from blood samples. The survey of pathogens is summarized.

Table2

Class of Pathogens obtained from:	Tracheal Secretions	Blood Samples	Urine	Peritoneal Drainage	Lung Tissue obtained at Post-Mortem
Klebsiella	11	2	3	1	3
Pseudomonas	10	2	1		2
E. Coli	6	1	4	2	
Proteus	5		4	1	1
Enterobacter			1		1
Staph. prog. aur.	2	2		1	1
Staph. epiderm	1	1			
Strept. virid	5	1			1
Haemophilus		1			
Acinobacter	5		1		
Serratia	1				
Citrobacter			1		
Anaerobic pathogens	6		2		1
Candida Species	6				
Viruses		1			1

Combination of pathogens was a typical finding from tracheal aspirated material. In patients with a low and decreasing P_aO_2 anaerobic pathogens joined the previous flora.

In spite of adequate antibiotic and chamotherapeutic treatment we could identify typical nosocomical pathogens i.e. Klebsiella, Pseudomonas anaerobic andmycotic species. Viral infection was an exceptional one.

Postmortem studies for pathological bacterial flora were positive only in tissue sections from the lung parenchyma and even so not in all cases. They reflected reliably intavital results.

No correlation was found between the study of while blood cells, lymphocytes, platelets count and the type and identity of pathogens present.

Conclusions

Differentiation and limits of secondary septic lung and primary inflammatory pulmonary lesion were related only in initial phase of illness whereas in long continued ventilation combined features were present.

Previous chronic immunosuppressuve therapy, viral infection and infectious surgical foci are high risk factors.

The chances of finding anaerobic pathogens increase with decreasing P_aO_2. Aerobic pathogens represent typical nosocomial flora and are present as a mixed flora in tracheal secretions.

FIO_2 higher than 0.4 and PEEP higher than 0.5 kPa beyond 16 days are not followed by specific fibroplastuc changes. Fibroproductive tendency can be documented in prolonged ventilation by development of pneumonia and by changes in artificial ventilation.

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