PARAPNEUMONIC EMPYEMA *

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The term "*pleuresie parapneumonique*" was first proposed by Lemoine¹ in 1893, to describe the occurrence of fluid in the pleural cavity coincident with pneumonia. He pointed out the fact that the occurrence of fluid in the chest during the early part of an attack of pneumonia is more frequent than is generally supposed, occurring in possibly five to six per cent. (Grisale, 12.6 per cent.; Deustl, 16 per cent.; Fismar, 15 per cent.; Magnus Hus, and Jugenser, 4 or 5 per cent.). He further states that the fluid of parapneumonic pleurisy is always serous, while that of metapneumonic pleurisy, that following the crisis, is always purulent.

Le Damnay² in a thesis on pleurisies, in 1897, also calls attention to the occurrence of fluid in the thoracic cavity coincident with pneumonia, and gives histories of four such cases. Since these researches a large number of cases of parapneumonic pleurisy has been reported.

For his thesis in 1901 Siems³ collected twenty-six cases. All patients were adults. The amounts of fluid obtained varied from a few drops to 700 c.c. In two cases no puncture was made. From his data Table 1 is made with regard to the character of the fluid and the bacteriologic findings.

TABLE 1.—CHARACTER OF FLUID AND BACTERIOLOGIC FINDINGS

Type of Fluid		Micro-Organisms Present (Smears, Cultures, or Animal Inoculation)
Serous	8	4
Serofibrinous	11	2
Blood stained	1	0
Seropurulent	2	1
Purulent	2	1

In four of these cases the fluid obtained from the pleural cavity was purulent or seropurulent. They were as follows:

1. A patient 39 years of age with pneumonia. Puncture gave "5 c.c. of a liquid seropurulent, cloudy, very rich in pus cells." No micro-organisms in

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1. Lemoine: *Semaine méd.*, 1893, p. 12.

2. LeDamenay: *Recherches sur les pleuresies sero-fibrineuse primitives et secondaires*, Thèse, Paris, 1897.

3. Siems: *Les Pleuresies Contemporaines de la pneumonie*, Thèse, Paris, 1901.

smears or cultures. Inoculation into a mouse gave no result. The patient recovered, the fluid being absorbed.

2. Two days before death puncture gave 100 grams of "seropurulent fluid" containing many pneumococci. Inoculation of mice caused death, the pneumococci being recovered from their blood. At necropsy the patient showed gray hepatization of the right lung and a fibrinopurulent pleurisy.

3. A laborer four hours after a blow on the side was brought into the hospital with hemoptysis. Pneumonia started four days later and puncture gave 10 c.c. of sterile "pus." On the sixth day 10 c.c. of "purulent fluid," also sterile, was obtained. There was spontaneous absorption and uneventful recovery.

4. Patient aged 45 years. Puncture gave a few drops of "yellow fluid" from which a pure culture of pneumococci was obtained. Inoculation of mouse caused death in twenty-four hours. The patient died on the seventh day of his pneumonia. At autopsy "purulent fluid" was found encapsulated by fresh adhesions between the lung and mediastinum. Virulent pneumococci were found in this fluid also.

Widal and Gougerot,⁴ in 1906, describe two cases, comparing the fluid to that found in the cerebrospinal canal after certain syphilitic affections. They call especial attention to the presence in the fluid of large numbers of polymorphonuclear leukocytes which retain their morphologic and functional integrity, and the complete absence of any micro-organisms, as shown by smears, cultures and animal inoculation. They say also that these fluids resemble closely those resulting from the injection of sterile bouillon into the peritoneal cavity of guinea-pigs.

Their patients were 24 and 34 years of age, both having typical lobar pneumonia.

1. On the fourth day of the disease 5 c.c. of fluid was obtained by puncture. Two days later none could be obtained.

2. On the fourteenth day while the disease was still actively present 100 c.c. of fluid was obtained. Four days later only a few drops of "blood-stained fluid" could be removed. The fluids of both cases were sterile but opaque, containing many polynuclear cells.

Pende,⁵ in 1909, describes three cases, ages 13, 14 and 15 years, in which "purulent" fluid was obtained by puncture. These contained no organisms but many polymorphonuclear cells. They were absorbed spontaneously, one in three and the other two in four days.

Neuman,⁶ in 1912, reviews the literature and reports two cases which are later included in those reported by Gerhardt.⁷ He lays special stress on the fact that parapneumonic fluids are usually sterile.

4. Widal and Gougerot: *Bull. et mém. Soc. d. hôp. de Paris*, 1906, vii.

5. Pende: *Policlinico*, Rome, 1909; ref. *Zentralbl. f. inn. Med.*, 1910, p. 513.

6. Neuman, K.: *Parapneumonic Empyema*, Inaugural Dissertation, Wurzburg, 1912.

7. Gerhardt: *Mitt. a. d. Grenzgeb. d. Med. u. Chir.*, 1913, xxvi.

Dumont,⁸ in 1912, observed three cases.

1. A patient 26 years old had active signs of pneumonia. Punctures on the first and third days gave only blood. On the fourth day by puncture 20 c.c. of opaque "pus" was removed, which on centrifugalization gave a sediment and an opalescent supernatant fluid. The cells were 70 percent polymorphonuclear leukocytes. No organism could be found by cultures and inoculations gave no results.

2. A patient 52 years old. On the fifth day of pneumonia "some pus" was removed by puncture. On the eighth day "more pus" was removed. On the fourteenth day the Roentgen ray showed a shadow and on puncture "sero-fibrinous fluid" was obtained. On the thirty-second day there was evacuated completely 40 c.c. The fluid contained no micro-organisms.

3. A patient 24 years old. Puncture on the tenth day gave 20 c.c. of "purulent fluid," 70 per cent. polymorphonuclear cells. No micro-organisms by smears, cultures or inoculation. No fluid was found the following day.

Gerhardt,⁷ in 1913, reports five cases.

1. A patient 46 years old. Puncture on the second day of pneumonia gave 1 c.c. of "sterile pus."

2. A patient 14 years old. Puncture on the first day of pneumonia gave 1 c.c. of "pus."

3. Patient 18 years old. Puncture on the day before crisis, the seventeenth day, gave a "purulent exudate."

4. Patient 28 years old. On the fourth and sixth days puncture gave a "purulent exudate."

In all four cases the fluids were sterile by smears, cultures and inoculation.

5. Patient 15 years old. Puncture on the fourth day gave "pus" containing gram-positive, encapsulated, diplococci, which by inoculation were shown to be of very low virulence. All five cases recovered with spontaneous absorption.

Vaughan, Jr.,⁹ says that "Maragliano demonstrated serofibrinous or fibrinopurulent exudate in 65.5 per cent. of cases of typical pneumonia, by puncture. Marin found 41.5 per cent. of 978 cases at autopsy to have pleural fluid, and Kerr found in 178 autopsies 69 per cent. with fluids, 74 fibrinous, 38 serofibrinous and 6 acute purulent."

Levy¹⁰ mentions cases with fluid from the pleural cavities in pneumonia, bronchopneumonia and influenza, in which ten were serous and nine "purulent." Three of the serous fluids were free from organisms; the others all contained organisms. Unfortunately his data are very scanty.

Sauer,¹¹ in 1914, observed two cases in children, the only cases reported in children.

1. Four years old. The patient had pneumonia involving the lower and middle right lobes. Puncture two days before crisis gave a few drops of "pus" which contained gram-positive diplococci. The next day 7 c.c. of similar "creamy pus" was withdrawn. Gram-positive, encapsulated diplococci were shown by

8. Dumont and Mossy: Bull. et mém. Soc. d. hôp. de Paris, June 14, 1912; ref. Semaine méd., 1912, p. 299.

9. Vaughan, Jr.: Jour. Michigan State Med. Soc., 1914, xiii, 573.

10. Levy, E.: Arch. f. exper. Path. u. Pharmakol., 1890, xxvii, 369.

11. Sauer: Arch. Pediat., March, 1915, xxxii.

smears and cultures. By puncture six days after crisis no fluid was obtained. The patient recovered, the fluid being spontaneously absorbed.

2. Patient 3 years old. Puncture was made on the fifth day and 0.5 c.c. of "pus" aspirated. It contained leukocytes but no organisms. Cultures were sterile. On the following day there could be heard on deep inspiration, a friction rub. The patient recovered.

AUTHOR'S CASES

In a series of fifteen cases of typical lobarpneumonia or bronchopneumonia, in children under 4 years of age, seen in The Children's Memorial Hospital during January, February and March, exploratory punctures of the chest were made as early as possible in the course of the disease. The needle was put in over the area of greatest impairment as shown by physical signs and roentgenograms. In only one of the cases where fluid was not found at the first puncture, were subsequent trials made, and no fluid was found until the twenty-second day, when a typical metapneumonic empyema was found.

In six of these fifteen cases (40 per cent.) fluid was recovered by puncture before the seventh day of the disease, always before the crisis. Five of the six fluids were opaque and yielded a large clot. They contained a large number of cells, between 70 and 80 per cent. polymorphonuclear leukocytes. No micro-organisms could be demonstrated in them by smears. Cultures on agar, milk, bouillon, and with some on blood-agar, gave no growths. Inoculations into mice were without harmful results, except in one case in which the mouse died within twenty-four hours, but no lesions were found and no organisms could be grown from its heart's blood or serous cavities. In all five cases the fluids were absorbed spontaneously, as was shown by later punctures and roentgenograms. The clinical course of the disease was never noticeably affected by the presence of these fluids.

In one case two **days after fluid** had been found the patient died **from other causes** than the pneumonia. The autopsy showed no fluid in the pleural cavity. There were several large areas of bronchopneumonia. Over one of these areas, in about the region where puncture had been made and fluid obtained, the pleural surface was somewhat dulled and showed a thin, very fresh, slight deposit of fibrin.

In the sixth case, on the second day of the disease, about 5 c.c. of purulent fluid was removed by puncture. It was opaque, did not coagulate, but on standing separated into a heavy sediment and a semiopaque supernatant fluid. It contained many polymorphonuclear cells and also cocci in diplo- and double-chain form. On all ordinary mediums cultures grew well. Inoculation of 1 c.c. into the peritoneal cavity of a mouse caused death in less than twenty-four hours, the organism being recovered from its blood and serous cavities. The group of pneumococci to which this organism belonged was not determined.

The patient was operated on and the pleural cavity freely drained, but death occurred in a few days. No necropsy was obtained.

In brief the histories of these cases follow:

CASE 1.—Peter O., aged 6 months, was admitted to the hospital January 1. His mother was at that time in a hospital with pneumonia. Birth and previous history negative. Breast fed until the onset of mother's illness.

Present Illness.—For two weeks preceding admission there was coughing, restlessness and loss of appetite, slight diarrhea and loss of weight.

Examination.—On admission examination showed a well nourished, well developed, rachitic baby boy. Occasional cough. Chest symmetrical, expansion good, respiration neither rapid nor labored. Percussion note of normal relative intensity over entire chest. There was no tubular breathing anywhere, but a few moist râles in the interscapular region. Otherwise negative.

On the third day in the hospital, January 3, cough continued. Respirations somewhat increased in rate. Lungs: Anteriorly no dulness, no râles, no bronchial breathing. Over the left lower back percussion note slightly high pitched, many medium moist râles and a few large dry râles. Occasional râles over the right back. White blood cells 26,000.

Roentgenogram of Chest: A rather broad mediastinal shadow and rather profuse, though not intense mottling throughout both lungs—about the same on both sides.

Von Pirquet test negative.

January 6, marked dulness at the left base with distant tubular breathing. A needle was put into the left pleural cavity in the sixth interspace and 5 c.c. of fluid drawn off. This fluid was thin, cloudy and coagulated. Smears showed large numbers of leukocytes, but no organisms. Cultures gave no growth.

January 7. Roentgen ray showed a shadow at the left base.

January 8. Dulness still present at the left base with distinct tubular breathing. A needle was put into the pleural cavity near the point of previous puncture. Only a few drops of fluid could be obtained. Sterile as previously.

January 11. Dulness as before. Roentgen-ray shadow at left base of same density as on former exposure.

January 15. Dulness less marked. No more tubular breathing. Crisp crepitant râles.

January 23. Roentgen examination: Chest clear. Other signs returning to normal. From this time on the chest remained normal.

CASE 2.—Harriet J., aged 6 months, admitted to the hospital in October, 1914, with bronchitis and nutritional disturbances. Family history unimportant.

Previous History.—Birth normal. Had never been strong. Always had gastro-intestinal disturbances, and one convulsion.

Examination.—Showed a poorly nourished baby girl. Dec. 25, 1914, the lungs were clear.

Jan. 12, 1915. Patient had been coughing for several days. Throat rather red. Chest: no dulness on percussion, no tubular breathing, but diffuse coarse, moist râles.

January 13. High pitched moist râles over left back.

January 18. Over the left base quite marked impairment of the percussion note. Breath sounds over this area faintly tubular. Many râles throughout both lungs.

A needle was put into the pleural cavity in the seventh interspace at the angle of the scapula and about 1 c.c. of thin cloudy fluid, which coagulated, was obtained. Smears showed many pus cells; no micro-organisms. Cultures gave no growth. Injection of 0.75 c.c. into the peritoneal cavity of a mouse caused no appreciable result.

January 19. Marked dullness at the left base and distinctly tubular breath sounds.

January 20. Patient died. Immediately after death a needle was put in the chest at about the point of first puncture, but only a few drops of fluid were obtained. This was found sterile by smears and cultures.

Note at Necropsy (Dr. Riley).—On opening the chest there was no free fluid in the pleural cavities and no adhesions. Over the left lower lobe was a slight, sticky, thin fluid. The left lung showed nodules of bronchopneumonia in posterior portion of upper lobe and much consolidation of the paravertebral portion of lower lobe. Over this region the pleural surface was slightly dulled by a thin fibrinous exudate.

CASE 3.—Harold Mc., aged 4 years, admitted to the hospital Jan. 22, 1915. Family history unimportant. Previous history negative.

Present Illness.—This began five days before admission, with cough, fever and vomiting.

Examination.—On admission examination showed a well developed, well nourished child. Respirations rapid with expiratory grunt. On percussion there was marked dullness from the third left interspace in the axilla to the base of the lung posteriorly and anteriorly. Over this area were crepitant and subcrepitant râles and bronchial breathing. Remainder of the lungs normal. White blood cells 34,000. Polymorphonuclears 92 per cent.

January 23.—Roentgen examination of chest showed uniform dullness at the left base below the seventh space.

January 24.—Dullness over left back with distant tubular breathing. A needle was put into the thoracic cavity in the ninth interspace below the angle of the scapula and 5 c.c. of greenish-yellow, viscid fluid obtained. It coagulated quickly after removal. Polymorphonuclears 66 per cent. No organisms in smears: cultures gave no growth; 1 c.c. injected into a mouse gave no results.

January 25. Area still dull. Bronchial breathing has disappeared. White blood cells 27,000.

January 27. By puncture 0.5 c.c. of bloody fluid was obtained. It was sterile.

January 29. Impairment less marked. Many râles, but no tubular breathing. Roentgen-ray examination of chest showed shadow over entire lower left.

January 30.—Temperature now continually normal.

February 2.—Patient has entirely recovered. Dullness has disappeared.

CASE 4.—Edwin Z., aged 17 months. Admitted to hospital January 31. Family and previous history not remarkable.

Present Illness.—This began one week before admission, with diarrhea, cough, fever, loss of appetite and vomiting.

Examination.—This showed a well-nourished boy, coughing much. Chest symmetrical; respirations accelerated but not labored. Dullness on percussion over the right back and axilla. Fine high-pitched râles, tubular, diminished breath sounds. Remainder of lungs normal. White blood cells 16,000.

February 2. Puncture made at two points below the right scapular; 1.5 c.c. of bloody, serous fluid, which coagulated, was obtained. Smears showed no organisms. Cultures remained sterile. One c.c. injected into the peritoneal cavity of a mouse was followed by death in twenty-four hours. No lesion of organs. No cultures obtainable from blood or serous cavities.

February 3.—Roentgen-ray examination of chest showed slight dullness at the right base below the angle of the scapula.

February 7. Puncture made but no fluid could be obtained.

February 12. Patient in good condition, left the hospital.

CASE 5.—Thomas M., aged 9 months, admitted to hospital March 31. Family history unimportant. Previous health good until last two months.

Present Illness.—This started six weeks before admission with fever, cough, vomiting and diarrhea.

TABLE 2.—PNEUMONIA CASES WITH PLEURAL FLUID

No.	Name	Age Months	Clinical Diagnosis	Admit- ted	Date of Explor- atory Puncture	Probable Day of Disease of Puncture	Amount c.c.	Type of Fluid	Cultures	Animal Inoculation
1	Peter O.	6	Lobar pneumonia, enteritis, otitis media	1/ 1/15	1. 1/ 6/15 2. 1/ 8/15	Fourth Sixth	5 1	Turbid; slightly coagulating; containing many pus cells; no bac- teria.	No growth on agar, milk, or bouillon.	.....
2	Harriet J.	6	Bronchitis, broncho- pneumonia, enteritis	11/27/14	1. 1/18/15 2. 1/20/15	Sixth Eighth (post- mortem)	1 †	Thin, cloudy, coagulating; many pus cells; no bac- teria.	No growth on ordi- nary me- diums.	0.75 c.c. into peritoneal cav- ity of a mouse; no develop- ments.
3	Harold McM.	48	Lobar pneumonia	1/22/15	1. 1/24/15 2. 1/27/15	Sixth Ninth	5 0.5	Green, yellow, viscid, coagu- lating; many cells; 62 per cent. P. M. N.; no bacteria.	No growths	1 c.c. into peri- toneal cavity of a mouse; no developments.
4	Edwin Z.	17	Lobar pneumonia	1/31/15	1. 2/ 2/15 2. 2/ 7/15	Fourth Ninth	1.5 0	Blood stained serous fluid, coagulating; no bacteria.	No growth	1 c.c. into peri- toneal cavity of mouse; death in 24 hours; no lesions; no bac- teria from heart's blood or peritoneum,
5	Thomas N.	9	Lobar pneumonia, empyema	3/31/15	1. 3/31/15 2. 4/ 1/15 3. 4/ 2/15 4. 4/ 5/15 5. 4/ 6/15*	Fourth Fifth Sixth Ninth Tenth	3 2 0 2 0	Thin cloudy, coagulating; many pus cells; no bac- teria; (4) bloody.	No growth on agar, blood agar, milk, broth	
6	Lena B.	9	Broncho- pneumonia, empyema	3/ 9/15	1. 3/11/15 2. 3/12/15 3. 3/13/15 Operation	Fourth Fifth Sixth	5 †	Thin pus; cream pus; not coagulat- ing; cocci in diplo- and chain form.	Profuse growth on agar and in milk and bouil- lon	1 c.c. into peri- toneal cavity of mouse; death in 20 hours; cocci recovered from heart's blood and ser- ous cavities.

* Alboline injected. † Few drops. ‡ Very much.

TABLE 3.—PNEUMONIA CASES WITHOUT PLEURAL FLUID

No.	Name	Age Years	Clinical Diagnosis	Date Admitted	Date of Explora- tory Puncture	Probable Day of Disease of Puncture	Amount c.c.	Character of Fluid	Cultures
7	Maurice C.	5½	Lobar pneumonia; empyema	1/13/15	1. 1/18/15	7	*	Blood stained	No growth
					2. 1/24/15	13	0	.....	.....
					3. 2/ 2/15	22	30	Creamy pus	Streptococci
					4. 2/ 4/15	24	5	Creamy pus	Streptococci
					5. Oper- ation	25	++	Creamy pus	Streptococci
8	Eleanor F.	2	Lobar pneumonia	1/15/15	1/17/15	..	†	Blood stained; no organ- isms	No growth
9	Marie O.	3	Lobar pneumonia	2/ 6/15	2/ 7/15	7	0	.....	.....
10	Chessie R.	1½	Bronchopneumonia	2/25/15	2/26/15	4	†	Blood stained; no organ- isms	No growth
11	Dorothy F.	2	Lobar pneumonia	2/ 6/15	2/12/15	..	0	.....	.....
12	Herman G.	2½	Bronchopneumonia	2/24/15	2/26/15	5	0	.....	.....
13	Kosta P.	2	Lobar pneumonia	3/16/15	3/17/15	5 (?)	0	.....	.....
14	John O.	3	Bronchopneumonia	3/16/15	3/19/15	6	0	.....	.....
15	Helen C.	6	Lobar pneumonia	3/23/15	3/27/15	6	0	.....	.....

* Few drops. † Less than 1 c.c.

TABLE 4.—SUMMARY OF CASES BY VARIOUS AUTHORS

Collected by	No. Cases	Type of Fluid	Amount of Fluid c.c.	Cultures	Results	Ages
Siems	26	Serous 9 Sero-fibrinous 11 Purulent 4	A few drops to 700	Sterile, 14; pneumococci, 8	Recovered, 18; Died, 8	All adults
Widal	2	Seropurulent (?)	5 and 100	Sterile	Recovered	24 years 34 years
Pende	3	Purulent fluid	.....	Sterile	Recovered	13 years 14 years 15 years
Dumont	3	"Pus" 2 (?)	20 to 40	Sterile	Recovered	26 years 52 years 24 years
Gerhardt	5	Pus and purulent fluid (?)	0.5 to 5	4 sterile; 1 pneumococci	Recovered	26 years 14 years 18 years 28 years 15 years
Sauer	2	Pus (?) Pus	1	1 sterile; 1 pneumococci	Recovered	4 years 3 years
Gerdine	6	Serous or seropurulent Pus 1	1 to 5	5 sterile; 1 pneumococci	Recovered, 4; Died, 2 *	6 months 6 months 9 months 9 months 17 months 4 years

* Death due to other complications in one case.

Examination.—On admission examination showed a well nourished, well developed baby, very ill. Respiration rapid. Dulness, suppressed breath sounds and many medium, moist râles over lower left back.

March 31. A puncture was made over the lower left lobe and about 3 c.c. of thin turbid coagulating fluid was obtained. Smears showed no organisms. Cultures gave no growth. Animal inoculation with no results.

April 1. Puncture over left base 2 c.c. of thin blood-stained sterile pus obtained.

April 4. Dulness less over left base. Breath sounds clearer. No fluid obtained by puncture.

April 5. Dulness more marked. Puncture gave 2 c.c. of very bloody fluid. Sterile as before. April 6. Puncture. No fluid could be found. The patient recovered.

CASE 6.—Lena B., aged 9 months, admitted March 9, 1915. Family history and previous history unimportant.

Present Illness.—This started the day before admission, with vomiting.

Examination.—On admission examination showed a well nourished, well developed baby. Chest dulness over left side and lower lobe in back. Bronchial,

distant breath sounds over area of impairment. Moist râles over entire side. Right lung normal. White blood cells 14,900.

March 11. Puncture made at angle of left scapula and 5 c.c. of true pus separating into layers without coagulation, were removed. Smears showed leukocytes, endothelial cells and cocci in groups, double chains and pairs. Cells 40,000 per c.mm. Cultures showed rapid growths.

Roentgen-ray examination of chest showed on the entire left side a uniform shadow.

March 12. Dulness over left side more marked.

Puncture made; 6.5 c.c. fluid removed. It was exactly as that of the previous day. One c.c. injected into the peritoneal cavity of a mouse was followed by death in less than twenty hours. Cultures from the heart's blood and serous cavities of the mouse showed the same organism in pure culture as obtained from the pus from the baby's chest.

Roentgenogram showed shadow of entire chest on left side.

March 13. The chest opened and pus evacuated at operation (Dr. Buford). Pus continued to discharge through drainage tube during next four days.

March 17. Patient died. No necropsy obtainable.

Tables 2 and 3 summarize the findings in my series of cases.

Table 4 shows the findings in all cases reported, including my group.

Table 5 shows the grouping according to the nature of the fluids and the bacteriologic findings.

TABLE 5.—GROUPING ACCORDING TO NATURE OF FLUID AND BACTERIOLOGIC FINDINGS

Total number of cases collected.....	47	Cultures made in.....	42
Definitely serous or serofibrinous.....	28	Pneumococci	4
		(Death in 3)	
		Sterile	22
Definitely purulent or seropurulent.....	4	Pneumococci	3
		Sterile	1
Without sufficient description indefinitely		Pneumococci	3
"purulent"	13	Sterile	10
No puncture (physical signs)	2		

In many of the cases reported the description of the fluids obtained are not sufficient to determine their exact nature. They are called "seropurulent," "purulent fluids," "purulent exudate," and "pus," or are mentioned as "cloudy," "opaque" or "rich in pus globules," while others are "cloudy fluids which are apparently seropurulent." Many times the fluids are said to be "very rich in fibrin." It would seem that these fluids are probably similar to some of ours, which, though cloudy and containing many pus cells, were not true pus, since there was definite coagulation. In some instances fibrin deposits took place in the pleural cavity, as was shown by one case at necropsy (this series), and suggested in another case (Sauer) by the presence of a friction rub on the day after fluid had been found. In some cases, however, there was no coagulation, the fluid dividing into a cellular sediment and liquid serum.

For the formation of pus two conditions are necessary according to Opie;¹² the accumulation of leukocytes and the necrosis and liquefaction of cells and tissue elements. Pus consists of: (1) the constituents of the exuded blood plasma; (2) the constituents of leukocytes and tissue cells that exist free in the pus; (3) the products of digestion of the proteins of the leukocytes and necrosed tissues. It divides into two chief parts, pus corpuscles and pus serum. This pus serum differs from blood serum chiefly in the substances added to it through the proteolytic changes that occur in pus, and also in that it has lost its antiproteolytic property, containing instead free leukoprotease. The fibrinogen that escapes from the vessels into suppurating areas becomes so altered that pus will not coagulate even on the addition of fibrin ferment.

In the majority of cases where the fluids were serofibrinous, they were free from bacteria in smears, by cultures and by animal inoculation (for instance, in 14 of 20 cases from Siems). In the cases in which the description permits us to speak of truly purulent exudate (four in all) micro-organisms were found in three. There remain a number of cases (thirteen) in ten of which the fluids designated as seropurulent or purulent were found sterile. The descriptions of these fluids are not sufficiently detailed to determine whether they were real pus or not. It is probable that in some of these cases an actual purulent exudate was present in spite of the negative bacteriologic findings. From the available data it would seem where we are dealing with frankly purulent fluids, micro-organisms are likely to be present. This is in contradiction to the statement made by Gerhardt, for instance, who, like others, seems to regard the absence of micro-organisms more or less characteristic of the "parapneumonic empyema." The frequency or rarity with which micro-organisms are present in such empyema can not be decided at present, but we have sufficient data to warrant the statement that the absence of bacteria certainly cannot be regarded as characteristic of this complication of pneumonia. It is reasonable to suppose that the fluids will show a gradual transition from serous to purulent. If no organisms are present in the pleural cavity, the fluid may remain serous or serofibrinous with few or many leukocytes, whereas the presence of organisms may lead to the formation of pus. So when a purulent exudate is found, it is probable that in the majority of these cases organisms have been present at one time or another.

The organisms were not always of a high grade of virulence, as shown by animal inoculation. This difference in virulence of the

12. Opie, *Inflammation*, Arch. Int. Med., 1910, v, 541; and *Jour. Exper. Med.*, 1903, ix.

organisms may be of use in prognosis. A possibility of error must be kept in mind. The introduction of this foreign fluid into the peritoneal cavity may kill the mouse, as in one of our cases. The mouse died in twenty-four hours, but no lesions were found and no organisms could be grown from the heart's blood or serous cavities. In the cases where death of the mouse occurred in a short period and with inoculation of small amounts of fluid, the patient also died; while when the animal survived, the patient recovered and the fluid was absorbed spontaneously. It is evident, therefore, that the cases in which a real parapneumonic empyema occurs need not all be of a benign type as Gerhardt claims.

This is of further importance in its bearing on the treatment of these cases. Since the serous fluids and the purulent ones in which the organisms are of low grade virulence are, as a rule, spontaneously absorbed, surgical interference is not needed unless the amount is so large as to cause discomfort. On the contrary, where organisms of high grade virulence are found, surgical treatment may perhaps enter into consideration.

Although the literature on this subject seems large, we feel that the actual number of cases with sufficient description of the fluid found is too small for very definite deductions. However, we may put forward tentatively the following conclusions:

CONCLUSIONS

1. Fluid is present in the pleural cavity in a large number of cases of pneumonia before the crisis and can be demonstrated, sometimes by physical signs, sometimes by Roentgen ray, and by puncture, even when other physical signs are not apparent.

2. The clinical course of the pneumonia may not be altered by this complication.

3. In the majority of cases the fluid is serofibrinous in character, though perhaps containing a large cellular element, polymorphonuclear in type. These fluids are sterile as a rule.

4. True pus is present much more rarely and may contain organisms of more or less virulence. The frequency of the presence of organisms in these cases cannot be decided on the data as yet secured.

5. The virulence of the isolated organisms determined by animal inoculation seems to be of value in prognosis.

6. Only in cases with serofibrinous and purulent fluids containing organisms of a high grade of virulence should surgical interference enter into consideration.