respirations 30. On November 23rd there was dullness over the left lower lobe, with rales over the right side. The sputum was scanty and rusty. She complained a good deal of frontal headache, and had difficulty in swallowing. After November 24th she began to have incontinence of urine and faeces, which continued until her death. On November 26th there appeared to be paralysis of the left side of the body and the right side of the face, but this passed off in a couple of days. Gradually, however, nervous symptoms became more marked, together with abdominal tumescence, drowsiness, and symptoms generally reminiscent of typhoid fever. In fact, during the last five days of her life, the patient was in a typhoid state, more or less unconscious, and with a subnormal temperature. She died on the morning of December 3rd.

Two other nurses in attendance on the first two cases remained well, and there were no other cases in the home of the original patients.

SUMMARY

The sequence of events in these cases was as follows:

1. At the end of September or the beginning of October, 1930, patient No. 1 nursed a sick budgerigar.
2. October 11th, patient No. 1 fell ill when away from home on a visit. She eventually recovered, but as late as January 15th, 1931, was reported still to be suffering from insomnia, lack of energy, and occasional depression.
3. October 26th, patient No. 2 fell ill. She had nursed patient No. 1, had shared her bed, and was probably infected by her.
4. November 8th, patient, No. 2 died.
5. November 19th, patient No. 3 fell ill. She was a hospital nurse in attendance on the previous patients from October 23rd, and was infected by them.
6. December 3rd, patient No. 3 died.

The source of infection of the budgerigar was not definitely traced. A number of other birds, budgerigars, foreign finches, and a blue and white canary, had died in the aviary from an unknown cause during September and the beginning of October, and the dealer who had supplied the birds admitted to deaths among the birds in his shop. Later on this dealer was found to have been importing budgerigars from the Continent, but he maintained that the birds he had sold to these ladies were home-bred.

SUMMARY OF NECROPSY (DECEMBER 4TH, 1930)

BY

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Haemorrhagic broncho-pneumonia of lower lobe and of lower third of upper lobe of left lung. Early broncho-pneumonia of lower lobe of right lung. Congestion and emphysema of lungs. Anthracosis, engorgement, slight subacute inflammation and sinus catarrh of bronchial lymph glands. Acute and subacute inflammation without enlargement of spleen. A few streaks of submucous haemorrhage in caecum close to ileo-caecal valve. Slight injection of mucosa throughout intestinal tract. Slight fatty degeneration of myocardium. Considerable ischaemic atrophy of kidneys. Albuminous degeneration of tubular epithelium in kidneys; fatty degeneration of a few groups of second convoluted tubules. Severe degeneration of hypertrophied media and intima in large and small arteries. Ante-mortem thrombus adherent to ulcerated intima of anterior wall of very atheromatous abdominal aorta 3 cm. above bifurcation. Focal microscopic areas of bone formation in atheromatous and calcified intima beneath thrombus. Foramen ovale closed. Cardio-vascular hypertrophy. Focal ischaemic fibrosis of myocardium. Very severe atheroma of coronary arteries. Almost complete obliteration of right coronary artery by calcareous atheroma 1 cm. from its origin. Small area of softening and gliosis in right pulvinar. Area of gliosis and infiltration with pigment granule cells in ventral border of optic thalamus. A few petechial haemorrhages in basal ganglia. Congestion of brain. Central congestion of lobules of liver. Slight back pressure congestion of kidneys and spleen. Pitting oedema of left leg. Ante-mortem thrombosis of left femoral vein at brim of pelvis. Slight fatty infiltration of parenchyma and conspicuous fatty infiltration of Kupffer cells in liver. Fine granules of lipochrome in centres of lobules of liver and in myocardium. Brown atrophy of thyroid gland. Fibrous peritoneal adhesions between omentum and loops of small intestine obliterating pouch of Douglas. Slight focal chronic perisplenitis. Slight dilatation and injection of pelvis of right kidney. Aberrant branch of right renal artery entering lower pole of right kidney. Pancreas and suprarenal bodies normal. No macroscopic abnormality in muscles of abdominal wall. No enlargement of Peyer's patches or of solitary follicles.

MACROSCOPIC APPEARANCES

Lungs.—There was considerable injection of the trachea and bronchi. The pleural sacs contained no free fluid. Both visceral and parietal layers of the pleura were uniformly smooth and glistening. The lungs appeared small and congested. The upper lobes were conspicuously emphysematous, while the lower lobes felt boggy and slightly crepitant. The lower lobe of the left lung was heavier and fuller than the right, and felt unevenly nodular. On section the right lung appeared very congested. The upper and middle lobes were emphysematous. In the lower lobe there were numerous small, irregular, apparently peribronchial, areas of haemorrhage; there was no evidence of bronchitis or of consolidation; a little blood-stained frothy fluid exuded from the cut surface on pressure, and the tissue was aerated and floated in water. The left lung, on section, appeared different. With the exception of the upper two-thirds of the upper lobe the lung looked less aerated. At the apex of the lower lobe was an area of rather firm, swollen, finely granular, dusky, pinkish-grey consolidation. No fluid was expressed from this by gentle pressure. A similar area occupied the adjacent middle third of the upper lobe. In the remainder of the lower lobe there were numerous, sometimes confluent, finely granular areas of pinkish-grey peribronchial consolidation lying in a haemorrhagic ground. Dirty greyish-yellow slime exuded from the centres of these areas on pressure. The intervening lung tissue was deeply congested, and on pressure exuded a little fluid and very little air.

Bronchial Lymph Glands.—These glands were small and firm. The cut surfaces were flat and grey, and mottled with deposits of soot.

Spleen.—The spleen was small and moderately elastic. The capsule over the diaphragmatic surface showed a few irregular patches of fibrous thickening, between which were numerous pin-point glistening fibrous granulations. On section the cut surfaces were flat and firm. The trabeculae were easily seen, but the Malpighian bodies were indistinguishable. The pulp was a dull pink mottled with numerous small patches of deep red. There was no macroscopic evidence, therefore, of inflammation.

MICROSCOPICAL APPEARANCES

Lungs.—Blocks from the right lower lobe, the consolidated areas in the middle third of the left upper lobe and the apex of the left lower lobe, and from the broncho-pneumonic part of the left lower lobe, were taken for examination. In the right lower lobe some bronchioles were partly or completely filled with red corpuscles; most were filled with necrosed desquamated epithelium, ghosts of round cells, amorphous granular lumps, a few red corpuscles, and masses of cocci and bacilli. A few alveoli at the periphery of the section were emphysematous or partly collapsed; the remainder were filled with albuminous coagulum and a few red corpuscles, occasionally with many red corpuscles. They contained no fibrin, but everywhere were large numbers of Gram-positive cocci and Gram-positive and Gram-negative bacilli. Of these,

streptococci were the most abundant. In a few places were groups of Gram-negative bacilli of the influenza type. Immediately round some of the bronchioles the alveolar walls were necrosed and contained brown pigment. The pleura was unchanged. In the apex of the left lower lobe the bronchioles were either filled or lined with albuminous coagulum, desquamated epithelium, and red corpuscles, or a similar exudate containing neutrophil leucocytes. The walls of the bronchioles were very congested, and conspicuously infiltrated with large mononuclear cells, neutrophil leucocytes, and small lymphocytes. A similar infiltration was seen in the septa of the lung. The respiratory bronchioles occasionally contained coagulum and red corpuscles alone, but usually they contained numerous neutrophil leucocytes. Some of the adjacent alveoli were also crowded with neutrophil leucocytes, but mostly they showed coagulum, red corpuscles, a few neutrophil leucocytes, and desquamated epithelial cells, many of which were remarkably large. Other groups of alveoli were stuffed with red corpuscles, and were less distended. The distribution of these haemorrhagic areas appeared fortuitous: occasionally they encircled bronchioles or respiratory bronchioles, but in other instances they were of larger size and did not appear to have any special relationship to other structures. In these larger areas there were often poorly defined foci in which the alveolar walls were necrosed. Very little fibrin was present. The tissue was crowded with a great variety of Gram-positive and Gram-negative cocci and bacilli, among which streptococci were predominant. In one small area many minute bacilli resembling the influenza bacillus were present. The pleura was not affected. In the lower part of the left lower lobe there was great distension of the bronchioles and respiratory bronchioles with neutrophil leucocytes, and sometimes with red corpuscles as well. The walls of the bronchioles were engorged and infiltrated as in the section from the apex already described. There was great purulent infiltration of the alveoli about the bronchioles, and around these was an outer zone in which the alveoli were slightly collapsed and occupied by albuminous exudate, red corpuscles, and occasionally a little fibrin. In other peripheral areas the alveoli contained less blood and more numerous neutrophil leucocytes and large epithelial cells. In some of the more haemorrhagic areas there was necrosis of the alveolar walls. Organisms were abundant as before. In the left upper lobe many of the bronchioles were empty ; a few contained purulent exudate. Their walls were congested, but were less heavily infiltrated with cells than in the lower lobe. The respiratory bronchioles were distended with neutrophil leucocytes, and about these the alveoli were conspicuously infiltrated with neutrophil leucocytes, mononuclear leucocytes, desquamated epithelial cells of the remarkably large size seen in other sections, and a few red corpuscles. These pneumonic areas were sometimes confluent. In other places the alveoli were less distended and filled either with red corpuscles or with bubbly coagulum and occasionally a little fibrin. The septa of the lung were infiltrated with many neutrophil leucocytes and large lymphocytes. A great many organisms were present throughout the tissue as before. The pleura was unaffected.

Lymph Nodes.—The left bronchial lymph nodes were considerably engorged, and in a few places there were minute haemorrhages. Many large lymphocytes and plasma cells were present in the lymphadenoid tissue, but there was no emigration of leucocytes. There was an increase in the number of endothelial cells in the sinuses, and many had been desquamated. The glands contained considerable deposits of soot.

Spleen.—In a section of the spleen there was focal engorgement of the pulp. In the venous capillaries or sinuses there was an excess of neutrophil leucocytes and some large macrophages, a few of which contained red corpuscles. There was also an infiltration of the Malpighian bodies with neutrophil leucocytes. These were found round the central arteries and in the periphery, where they were accompanied by a few eosinophil leucocytes. In the pulp strands there were many plasma cells and large lymphocytes, a considerable number of neutrophil leucocytes, and a few macrophages. There was severe hyaline degeneration of the media and intima of the arterioles.

DISCUSSION

The condition present in the lower lobe of the right lung appeared to be an early broncho-pneumonia. The necrosis associated with brown pigmentation of the contents of the bronchioles and of adjacent alveolar walls was probably due to acid digestion. The broncho-pneumonia may have been due to the inhalation of stomach contents before death, or it may have been an early stage of the condition seen in the apex of the left lower lobe complicated after death by acid digestion. In the left lung there was a broncho-pneumonia, characterized by purulent bronchiolitis of respiratory rather than of larger bronchioles, and a pneumonia which began with haemorrhage and marked albuminous exudate and later became leucocytic. There was extremely little fibrin formation and no thrombosis of vessels. The changes present in the apex of the lower lobe appeared to represent a stage earlier than those seen in the lower part of the left lower lobe and in the upper lobe. The pneumonia differed from an ordinary broncho-pneumonia in the absence of any marked degree of collapse, in the great abundance of albuminous and haemorrhagic exudate, and in the predilection of the inflammation for the respiratory bronchioles. It differed from a pneumonia in the concentration of the inflammatory reaction about the respiratory bronchioles. The presence of such large numbers of bacteria in all the sections could be explained by the lapse of over twenty-four hours between the time of death and the necropsy without storage of the body in a cold chamber ; and also, perhaps, by the inhalation of stomach contents immediately before death. The great variety of bacteria found in the tissues made the task of identifying the pathogenic organism a hopeless one.

There was only a slight subacute inflammation of the bronchial lymph glands. The absence of enlargement of the spleen suggested that the acute inflammation found on microscopical examination was early and therefore a terminal event. The inflammation was probably due to a bacterial invasion of the lungs in the later stages of the illness. The septicaemia, therefore, was probably a late event. The only evidence of toxaemia was the presence of a little fatty degeneration of the myocardium, and albuminous and slight fatty degeneration of the kidneys. There was therefore little evidence of toxaemia.

A contributory cause of death may be found in the condition of the cardio-vascular system. Necropsy revealed extreme degeneration of the arteries and hypertrophy of the heart. In addition, there was almost complete occlusion of the right coronary artery by atheroma. Microscopically there was hypertrophy of the myocardium and of the muscular arteries, associated with very severe degeneration of both media and intima. In the abdominal aorta a section of the wall taken through a mass of adherent ante-mortem thrombus showed foci of bone formation in the degenerated intima. Further, the arterial change was correlated with ischaemic fibrosis of the myocardium and kidneys, and with microscopic patches of softening, gliosis, and rusty pigmentation in the basal ganglia. A moderate degree of terminal heart failure was indicated by the central congestion of the hepatic lobules, and slight congestion of spleen and kidneys, and perhaps by the few recent petechial haemorrhages in the brain. Ring-haemorrhages, evidently of toxic origin, have been observed in this laboratory in two brains from cases of psittacosis (Sturdee and Scott, 1930). The haemorrhages in the case under discussion were exceedingly scanty, were not ring-haemorrhages, and were associated with evidence of a few old haemorrhages. It is probable that they were due to the chronic vascular

degeneration, and not to an acute toxic change. The slight degree of fatty degeneration of the myocardium has already been quoted as evidence of toxaemia. It might, however, be argued that the degeneration was the sequel and not the precursor of the heart failure. The short duration of the heart failure, as estimated by the microscopical as well as the macroscopical changes in the organs, does not support such an argument. The thrombosis of the left femoral vein may either have been secondary to the heart failure or it may have been caused by the action of the psittacosis virus. Some support for the latter view lies in the finding of extensive pulmonary thrombosis by Turnbull (1930) in the first case of this disease reported from the London Hospital.

The conclusion drawn from the examination as a whole is that death was caused by a haemorrhagic broncho-pneumonia, acting upon a subject in whom the cardio-vascular system was already greatly impaired by degeneration.

The inflammation of the lung resembled that described in the first case of psittacosis examined in this hospital in the abundance of albuminous and haemorrhagic exudate and the presence of conspicuously large desquamated epithelial cells; but it differed in being a broncho-pneumonia rather than a pneumonia, in the almost complete absence of fibrinous exudate, in the absence of capillary and arterial thrombosis, and in the presence of bacteria in great number and of great variety. It was also complicated by acid digestion.

In impression preparations made from the spleen and stained by Giemsa the elementary virus bodies described by Levinthal, Lillie, and Coles were found.

NOTE ON THE BACTERIOLOGICAL FINDINGS IN THE ABOVE OUTBREAK OF PSITTACOSIS

BY

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The material received for examination consisted of: (1) blood from patient No. 2; (2) a budgerigar (*Melopsittacus undulatus*) belonging to patients Nos. 1 and 2; and (3) organs obtained post mortem from patient No. 3.

Blood of Patient No. 2.—This was collected in an equal amount of 2 per cent. citrate on November 3rd, 1930, the seventh day of disease. It was received in the laboratory November 5th, and proved to be free from cultivable bacteria. Two mice, M. 235 and M. 236, were inoculated with this citrated blood, each animal receiving 0.5 c.cm. subcutaneously and 0.5 c.cm. intraperitoneally. One mouse, M. 236, died on the thirty-fifth day after inoculation, the other was killed when very ill on the thirty-sixth day. The post-mortem findings were in keeping with the death having been due to the virus of psittacosis. The spleen of Mouse 236 was suspended in 5 c.cm. tyrode and proved to be free from cultivable bacteria. Two mice, M. 255 and M. 256, inoculated intraperitoneally with 0.5 c.cm. of this suspension on December 11th, are still alive and well, February 23rd, 1931.

The Budgerigar B. 157.—This bird, belonging to patients Nos. 1 and 2, and nursed by patient No. 1 before her own illness, had been suffering from diarrhoea, and though it was in fair condition when seen by Dr. Sturdee of the Ministry of Health, November 3rd, he decided to have it killed and examined for the presence of psittacosis virus. Post-mortem examination of the bird showed injection of the intestines, a chamois-leather liver (fatty change), and enlargement of the spleen. The lungs appeared normal. The spleen and a small portion of liver—0.25 gram in all—were suspended in 5 c.cm. N/50 phosphate *p*H 7.6. The suspension was culturally sterile, and two mice were inoculated with it. The results obtained in this primary transmission experiment and subsequent passages are given in Table I.

TABLE I

Passage	Material	Mouse	Result
Primary transmission	Suspension of spleen and liver of budgerigar in phosphate; unfiltered; culturally sterile	M.233	Killed, moribund, tenth day
		M.234	Killed, very ill, tenth day
1st passage	Spleen of M.233 suspended in 10 c.cm. tyrode; filtered Chamberland L1 bis	M.241	Died seventh day.
		M.242	Killed, moribund, seventh day
2nd passage	Spleen of M.242 suspended in 5 c.cm. tyrode; unfiltered; culturally sterile	M.249	Died fifth day
		M.250	Killed, moribund, fifth day
3rd passage	Spleen of M.250 suspended in 5 c.cm. tyrode; unfiltered; culturally sterile	M.257	Killed, moribund, third day
		M.258	Ditto
4th passage	Spleens of M.257 and M.258 suspended in 10 c.cm. tyrode; unfiltered; culturally sterile	M.261	—
		M.262	Killed, very ill, fourth day
5th passage	Spleen of M.262 suspended in 5 c.cm. saline; spleen had been kept frozen from Dec. 23rd, 1930, to Feb. 10th, 1931; unfiltered; culturally sterile	M.275	Killed, very ill, fourth day
		M.276	Ditto
6th passage	Spleens of M.275 and M.276 suspended in 10 c.cm. saline; unfiltered	M.281	Killed, very ill, fourth day
		M.282	Died fourth day
7th passage	5 per cent. suspension of spleens; M.281 and M.282 in saline; unfiltered; culturally sterile	M.287	Ill, second day, still under observation
		M.288	Ditto

Post-mortem Material from the Nurse (Patient No. 3).—This consisted of lung, liver, and spleen obtained at the post-mortem examination carried out by Dr. Dorothy Russell. A 5 per cent. suspension in tyrode made from the pooled organs gave a copious growth of a variety of organisms accounted for by the presence of numerous secondary invaders in the lung. This suspension was filtered through a Chamberland L1 bis candle, and two mice, M. 253 and M. 254, were inoculated with the filtrate, each receiving 1 c.cm. intraperitoneally. Both mice became ill ten days after inoculation. One, M. 254, died on the twentieth day, the other recovered. The spleen of M. 254 was suspended in 5 c.cm. N/50 phosphate *p*H 7.6, and proved to be free from cultivable bacteria. With this suspension further mice were inoculated, with a fatal result, and the strain has now been carried to the tenth generation in mice. This strain rapidly increased in virulence, and from the fifth passage onwards killed mice in two days. This is a point of some interest, for the great majority of human strains of psittacosis virus never attain any high degree of virulence and are difficult to maintain.

Identification of the Strains of Virus by the Neutralization Test.—The death of the two mice inoculated with the blood of patient No. 2 was in all probability due to psittacosis virus, but positive passage was not obtained; so this point remains unsettled. The two strains of virus, B. 157 and "Bangor" obtained from the budgerigar and the organs of the nurse (patient No. 3), were almost certainly psittacosis virus; but in order to settle this point beyond dispute the effect of neutralization with a specific serum was determined. The serum employed was one produced in mice, M. 176, M. 177, and M. 178, with a strain of virus "G.B." isolated from budgerigars. Previous work (Bedson and Western, 1930) had shown that this serum neutralized not only the homologous strain, but a strain isolated from a parrot and one from a Java sparrow as well. Mixtures of serum and virus (spleen suspension in saline) were made in which the final concentration of serum was 1 in 100, and the concentrations of virus 1 in 1,000 and 1 in 10,000. These mixtures were allowed to stand at room temperature and then inoculated intradermally in the guinea-pig in a dose of 0.2 c.cm. At the same time titrations of the two viruses were made in the same animal. The results of this experiment are given in Table II. The signs denote the degree of reaction in the guinea-pig's skin.

The strain "Bangor" is obviously the stronger, and probably the end point was not reached, but the strain B. 157 would certainly have gone no further than the 1 in 10,000 dilution. The serum therefore neutralizes approximately 100 m.l.d. of each strain of virus, a finding in