AN INVESTIGATION OF THE CAUSE OF DEATH IN CERTAIN CASES OF EARLY FATALITY SEEN AT A CASUALTY CLEARING STATION.

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THESE notes give a brief résumé of certain points of pathological importance that have been observed at various autopsies which were made in order to ascertain the cause of death in each case, and so to throw light upon future questions of diagnosis and treatment. The casualty clearing station in France, at which this work was performed, was situated at a distance of less than ten miles from the front. It therefore received casualties with very severe wounds which, in the worst cases, might be fatal within the first twenty-four hours after their infliction. It is for the latter reason especially that the facts recorded in these notes are of interest, because the lesions which prove fatal at this early time present a different appearance from those that have been described elsewhere in pathological observations made on wounds that proved fatal at a later date.

WOUNDS OF THE CHEST ONLY.

The cases examined were 14 in number, 3 having been caused by high-velocity bullets, and the remaining 11 either by shell-fragments or shrapnel.

The cases fall into two main groups, namely :—

1. Ten who died within twenty-four hours after the wound from the immediate effects of the injury.

2. Four who survived this stage, but succumbed to later septic complications on the fifth, ninth, and twelfth days.

A hæmothorax was found in each of the 14 cases, and in no one of those who died in the first twenty-four hours was there evidence of the presence of air together with the blood in the pleural cavity. The blood in these early cases (*Group 1*) was fluid, and practically free from clot. Its quantity varied greatly; but the lower measurements are of little value, because they were often spoiled by the free leakage of fluid through the external wound in the chest. The maximum volume found on one side was 4½ pints; from 1 to 2 pints was found in several cases.

The lung was found to be wounded in 12 out of the entire 14 cases; but the type of this wound varied in proportion as the chest wall was more or less lacerated by the entering missile. When the entry wound in the chest wall was a tiny track through an intercostal space, a similar track through the lung substance would be found; but even in these simplest of wounds, the lung around this narrow lumen was found to have been infiltrated with clotted blood over an area of about one inch in diameter. With severer wounds that had caused comminuted fractures of the ribs, the subjacent lung was found to present an irregular lacerated wound, often containing splintered portions of rib, clothing, and dirt, while the whole of the wounded lobe was infiltrated with extravasated blood, and looked and felt firm and solid.

There were 3 cases of bilateral hæmothorax, and in each of these the missile (in 1 case a bullet and in the 2 other cases a piece of shell) had passed through the bodies of the 7th, 8th, or 9th thoracic vertebræ without causing any injury to the spinal canal, and without producing any clinical phenomena indicative of damage to the cord.

Septic Hæmothorax.—The outstanding feature of all the four cases in *Group 2* was the large size of the empyema cavity, which was practically coterminous with that of the pleural

sac. The infection was apparently free to spread in every direction, as it was not limited by earlier adhesions, but only by the reflexions of the pleura. Thus a very large abscess cavity and surface for absorption is formed, which is doubtless the factor which makes the prognosis in this condition serious, although the absence of earlier adhesions must facilitate the establishment of free drainage surgically. The case of a man who died on the fifth day from infection of a hæmothorax with gas-forming organisms is worth quoting in detail.

Case 1.—The patient was admitted with a shell wound of the left side of the chest, and in extremely bad condition—much collapsed and very dyspnoeic: pulse-rate 140, respirations 56, and temperature 102°. After two days he had improved slightly. On the fourth day some of the hæmothorax blood was drawn off in the hope of giving relief. This blood was offensive, and was found to contain a large Gram-positive bacillus which was identified with *B. perfringens*. The patient was so ill that it was impossible to attempt surgical drainage of the pleural cavity, and he died the following day. At the autopsy, gas under pressure was found in the left pleural cavity, and the lung was completely collapsed against the vertebral column, being reduced to an airless mass about the size of a fist. The pleura contained two and a half pints of brownish-tinged, most offensive blood, in which there were a few flocculi but no clots. The surfaces of the lung and parietal pleura were covered with soft shreddy fibrin, enmeshing bubbles of gas which gave it the general appearance of a mass of frog's spawn. A fragment of shell covered with khaki cloth was found with some spicules of bone in the upper lobe of the atelectatic lung, which it had entered through the third and fourth ribs posteriorly.

WOUNDS OF CHEST AND ABDOMEN COMBINED.

The cases examined were 22 in number, 6 having been caused by bullets, and 16 by shell and bomb fragments. A hæmothorax resulted in 20 out of the 22 cases. The remaining 2 showed a plastic pleurisy at the base of the lung, but no evidence of a hæmothorax. In each of these last two cases the missile had entered the left side of the chest low down posteriorly, and had perforated the lowest part of the pleural cavity in the immediate neighbourhood of the costodiaphragmatic reflection of the pleura, so that they could hardly be regarded as chest wounds.

In only 6 out of the 20 hæmothorax cases could wounds of the lung be found, and in three of the six the thin free margin of a lobe had been only just touched by the missile. Of the 14 in which the lung was not wounded, 4 presented a small localized bruise, while in the remainder no abnormality could be found beyond a varying degree of collapse.

The hæmothorax in this series of cases must therefore have been derived either from bleeding viscera in the abdomen, or from injured vessels in the chest wall. If it came from the abdomen, a natural assumption would be that such a hæmothorax would be more frequent on the side of the liver. Yet in this group of 20 cases the collection of blood occurred on the left side in 11, and on the right in only 6 examples, while it was bilateral in the remaining 3.

The frequency of the occurrence of a traumatic hæmothorax without any wound of the lung in this last group of abdominal cases therefore suggests strongly that in the majority of examples it is the chest wall which is the source of bleeding. It should be noted that even in the cases in which the lung had been wounded, the extravasated blood within and around the wound was seen to form a firmly-clotted mass within twenty-four hours of the infliction of the wound, so that it is at any rate improbable that prolonged hæmorrhage can continue from this source. On the other hand it was observed that, taking all the 36 cases together, namely those with wounds of the chest only and those of chest and abdomen combined, the missile in entering the chest had caused no fracture of the ribs in 11 cases. A fracture of one or more ribs was seen in 25 cases. It is, however, difficult to draw a clear conclusion from these latter figures, because rib fracture was generally associated with laceration of the lung, and each of the two possible sources of hæmorrhage was therefore fully developed.

For purposes of description the 22 cases in the group of combined abdominal and chest wounds may be divided as follows:—

1. Fourteen who died from the initial lesion (9 within twenty-four hours, and 5 within three days).

2. Six who underwent operation for abdominal injury.

3. Two who died from the rapid development of septic complications.

1. Of the 14 cases, 8 presented a wound of the kidney, 8 of the liver, 6 of the spleen, 1 of the stomach, 1 of the transverse colon, and 5 of the bodies of the dorsal or lumbar vertebræ without injury to the spinal canal. The wounds of these organs occurred in various combinations, the most frequent being a wound of the liver together with a wound of a kidney or the spleen. Some degree of retroperitoneal or intraperitoneal hæmorrhage was found in most of them, but in no case was there a large amount of blood extravasated below the diaphragm. The cause of death appeared in general to be that of shock together with combined hæmorrhage into the thorax and abdomen.

2. A case may be quoted under this heading to show how extensive these combined injuries may be, and how hopeless is the nature of the work that may confront a surgeon when he attempts to save life by operation on a man whose outward appearance may not suggest that his condition is in any way more desperate than that of others in whom the surgical repair of internal wounds has been performed with brilliantly successful results.

Case 2.—Laparotomy was performed, a wound on the anterior surface of the pylorus and three lacerations in the jejunum being discovered. The bullet was lying loose in the lumen of the bowel. The wounds were rapidly sutured, but the patient died four hours later.

It was then found that the bullet had perforated the upper lobe of the left lung, and passed in and out of the posterior wall of the pericardium, where it had made a wound $\frac{3}{4}$ in. long in the left auriculoventricular wall of the heart and half-way through its thickness, so that in addition to a hæmothorax there was distention of the pericardium with blood and air, which entered freely from the pleural cavity. The bullet had then passed on to the abdomen and had caused, in addition to the wounds revealed by operation, an in-and-out wound of the right half of the extra-peritoneal surface of the transverse colon, and a perforating wound of the posterior aspect of the pylorus.

3. One of these cases was a striking illustration of the rapidity with which an infection by gas-forming organisms may spread and cause death.

Case 3.—Admitted three hours after he had received a shell wound of the right arm and chest. His condition was then good, with a pulse-rate of 110, and this state continued for the first twelve hours after infliction of the wound. An hour later he had passed rapidly into a condition of extreme danger, being pale, sweating, and without radial pulse. He died just within twenty-four hours of the wound, with much swelling and discoloration of the chest wall, neck, head, and scrotum.

It was then found that a small shell fragment had passed through the muscles of the right arm, where the wound was perfectly clean, and entered the right side of the chest through the 9th space in the posterior axillary line. A hæmothorax was present, though the lung was not wounded. The missile had then passed through the diaphragm, right lobe of the liver, and upper pole of the right kidney, and had buried itself in the lumbar muscles. The liver (examined two hours after death) was so distended with bubbles of gas that it floated in water. Gas bubbles were also found in the substance of the spleen and throughout the right kidney. The discoloured subcutaneous tissues and a large retroperitoneal hæmorrhage in the right loin were all crackling and full of gas.

PLEURAL ADHESIONS.

A somewhat surprising fact was noticed in regard to the frequency with which old pleural adhesions were found at autopsies upon all subjects. The majority of these examinations were made for wounds received in battle or for acute disease in men who previously had not been in any way disabled for active service. Yet, in a series of 104 consecutive autopsies, old pleural adhesions were found in 34 of the cases. These adhesions varied widely in degree and distribution, from a few bands at one apex to dense universal bilateral adhesions binding both lungs firmly to the chest wall. In only a small minority could evidence of healed tuberculous foci be found in the lungs or elsewhere.

Soldiers upon active service, and especially those who are working in the fighting area, are presumably the healthiest possible collection of individuals, and it is surprising that 30 per cent of them should present evidence of past pleurisy.

WOUNDS OF THE ABDOMEN ALONE.

During the period dealt with in these notes there are records of 32 autopsies upon penetrating or perforating wounds of the abdomen; for purposes of description and comparison these cases are divided into two main groups, viz. :—

1. Thirteen men who were not subjected to operation.
2. Nineteen who underwent laparotomy.

1. These cases lived long enough to be brought down to the casualty clearing stations, where they arrived for the most part within a few hours of being hit. They all died within twenty-four hours of being wounded, except one who died within thirty-six hours. It may be said of them that their general condition was so bad, and showed so little improvement with rest and warmth in bed and other restorative measures, that it proved impracticable to subject them to an abdominal operation. They died of a combination of shock and hæmorrhage, and it is difficult to apportion the share which each of these factors took in causing death.

As will be seen later, many of those who rallied sufficiently to undergo laparotomy and succumbed later to various complications, presented lesions apparently of the same nature and extent as those for whom it proved impossible to attempt any operative relief; this is also true of the numerous cases in which the operation was successful and the patient recovered.

In the group under consideration there were 9 bullet wounds (4 penetrating and 5 perforating) and 4 shell wounds (all penetrating). The wounds of the abdominal wall were usually quite small: the entry wound about the size of the cross-section of a lead pencil in most cases, and the exit in perforating wounds being generally somewhat—but not much—larger than that of entry. Protrusion of abdominal contents through the wound is exceptional in patients brought back as far as a casualty clearing station; when it occurred, omentum or a coil of gut was usually found, the protruding portion itself often presenting no injury.

The following notes are quoted as exemplifying an average case of this group.

Case 4.—Pte. S. was admitted for bullet wound of the abdomen; he had been hit four hours previously, and on admission was much collapsed, cold, and had a feeble rapid pulse. He was at once put to bed, and the usual restorative measures were applied; these, however, failed to improve his condition enough to make laparotomy possible, and he died within twenty-four hours of being wounded.

At autopsy he presented a small entry wound over the upper part of the left sacro-iliac synchondrosis and a slightly larger exit wound midway between the umbilicus and right anterior superior iliac spine. On opening the abdomen, the parietal peritoneum showed a slit $1\frac{1}{2}$ cm. long over the left side of the brim of the pelvis corresponding to the entry wound, and a similar slit, $\frac{1}{2}$ cm. long, corresponding to the exit wound.

The peritoneal cavity was 'full of blood'—four pints measured. The greater part of this was fluid, containing some dark-red clot; this appeared to have come chiefly from vessels in the left side of the pelvis and the mesenteric vessels.

The small intestine presented in its lower two-thirds four lacerated perforations, separated from each other by lengths of a foot or more of uninjured gut. Two of these perforations were irregular lacerations involving half the circumference of the tube, and through these the cut edges of the mucous membrane pouted, filling up the tear in the remaining coats; at the other two 'perforations' two or three inches of the whole circumference of the gut had been blown out of continuity. There were two tears about an inch and a half long in the mesentery from which bleeding had taken place, and also two characteristic slits involving only one layer of the peritoneum forming the mesentery. There was no other injury of any viscus.

Of the 13 cases in this group, 8 had lacerations of the small intestine (7 of the ileum and 8 of the jejunum, multiple in each case), 5 of the large intestine—single in each case except one—1 of the stomach, 2 of the liver, 1 of the bladder; 2 had a perforation of the inferior vena cava, 1 of the right external iliac vein. These lesions occurred in various combinations.

Rents and slits in the mesentery, and hæmorrhage into it, were frequently found, and these must have an important effect upon the power of recovery of the corresponding

portion of the intestine. Extensive and well-marked gas gangrene of the abdominal wall and of a large retroperitoneal hæmatoma was found in two of these cases, another instance of the extreme rapidity with which this formidable complication may develop.

Hæmorrhage, both retroperitoneal and intraperitoneal, was a feature common to every one of these wounds. The blood behind the peritoneum frequently presented a large mass of solid clot several inches thick, while that within the peritoneal cavity was fluid, with numerous clots floating in it. In most cases the abdomen was what is usually described as 'full of blood'; measurements, which were difficult to carry out with accuracy, showing that this means as a rule the presence of from 2 to 4 pints of blood.

From this description it will be seen that, broadly speaking, there are three conditions in respect of coagulation in which the effused blood may be found. First, there is the massive clot of the retroperitoneal collection; secondly, the fluid blood with much mushy clot floating in it, which occurs in the peritoneal cavity; and, lastly, the blood in the pleural cavity, which is almost entirely fluid and with only a few visible clots. The difference in these conditions finds a natural explanation in the view that has been put forward by Elliott and Henry¹ to account for what is found in a hæmothorax, for they have argued that the effused blood rapidly undergoes the process of coagulation in all cases of wound, but that where there is much mechanical movement of the blood, as by the respiratory action in the chest, this coagulation is interfered with, and the fibrin is partly 'whipped out', leaving a fluid blood behind.

Wounds of the small intestine were the most frequent lesion in both *Groups 1* and *2*, and they were usually multiple. There was seldom any visible leakage of intestinal contents, even when a portion of the tube had been blown completely out of continuity. Where the intestine was perforated, a lacerated wound, varying in size from a small puncture to a tear involving half the circumference of the bowel, was produced, and the everted edge of the torn mucous membrane pouted into the wound and plugged it. When the gut was completely divided or a portion blown away out of continuity, the severed ends above and below were found to be collapsed and flaccid.

The multiplicity of the wounds is often difficult to understand. Five or six perforations are often found in a few inches of the gut, while in other cases similar wounds may be separated by several feet of uninjured gut. In one case there were no less than ten distinct lacerations in the last few feet of the ileum. These observations suggest that some of these lacerations may be caused by bursting, the intestinal wall having given way as a result of the splash of the blow rather than of having been directly injured by the missile. But no special feature in the lacerations themselves was noticed to lend colour to this suggestion.

Wounds of the large intestine were less frequent, and less often multiple. Leakage of contents was the rule, even with small lacerations; and, with a large tear, fæces have been found freely scattered about the peritoneal cavity.

2. Laparotomy had been performed on 19 cases. These operations were all performed within eight hours of the receipt of the wound, and some of them after an even shorter lapse of time.

Death occurred at various intervals thereafter, namely:—

Within forty-eight hours of wound—6 cases—

5 from hæmorrhage and shock, 1 from gas gangrene.

On the fifth, sixth, and seventh day—6 cases—

4 from ileus, 1 from general peritonitis, and 1 from general peritonitis and bronchopneumonia.

On the eighth, ninth, and eleventh days—3 cases—

From general peritonitis and bronchopneumonia.

On the twelfth day—3 cases—

1 from ileus, 1 from general peritonitis, and 1 from bronchopneumonia.

The remaining case died after a month of general septic infection.

Of the fatal complications, ileus and bronchopneumonia are deserving of remark.

Ileus caused the death of 5 patients who died from the fifth day onwards. It would seem that this condition is attributable in some way to injury to the intestine, its vessels or nerves, and not to septic infection. It was found in various forms, most frequently following resection of the small gut and anastomosis, in which case the distention affected the segment of gut (6 to 12 inches in length) immediately above the line of union, at which point it ceased abruptly. In a case of double resection, this had happened at the upper anastomosis, while the gut on either side of the lower anastomosis showed no signs of paralytic distention. The unions by suture had held soundly in this, as in all the other cases examined.

That the condition is not invariably due to local traumatism to a limited portion of the intestine was shown by a case in which the only wound of the intestine was a single laceration of the splenic flexure which was successfully converted into a colostomy. The patient died on the eighth day, and at autopsy the small intestine was found to be distended. This distention affected the whole ileum, being greatest at the upper end, where the gut was quite six times the calibre of the lower end. The transition was perfectly gradual throughout as the gut was traced downwards to its normal dimensions a few inches above the ileocaecal valve, there being no sudden alteration in calibre anywhere. No injury to the abdominal viscera other than the laceration of the splenic flexure found at operation was discovered, nor was there any peritonitis except the local changes around the colostomy.

Bronchopneumonia was of a definite and uniform type. It was confined to the lower lobes of the lungs, though these do not appear to be simultaneously affected, for the condition was generally found to be more advanced on one side than on the other. In its typical form the whole lobe was almost solid, deeply congested and oedematous, and containing very little air; portions sank rapidly in water. Areas of solidified lung substance, varying in size from a small marble to a walnut, could be seen and felt, giving the lobe a knobby appearance and feel. On section, these nodules showed a central bead of pus, which exuded from the bronchiole on pressure, and around this was an area of solidification, deep purple or whitish in colour according to the length of time the condition had existed. The tubes throughout the affected lobe showed intense inflammatory changes with abundant secretion. It may be observed that this condition appeared also to be common, clinically, in cases which recovered after laparotomy for abdominal wounds. Probably the initial condition following upon the abdominal lesion was that state of massive collapse which Colonel W. Pasteur was the first to describe.² Following upon this collapse, a bronchial infection may have developed into a bronchopneumonia in the fatal cases.

MISCELLANEOUS CASES.

Case 5.—*Meningococcus septicæmia.* Death in twenty-four hours.

Pte. A. E. W. Marched eleven miles with his battalion on April 4, 1916, and did not feel ill enough to report sick till midday on April 5. When first seen a few hours later, he was obviously extremely ill—temperature 101·6°; pulse 144, small and irregular; respirations 44; tongue brown and furred. On examining his legs (in which he complained of great pain) the hæmorrhages described below were seen all over the lower limbs and buttocks, and fewer scattered about the arms. These bluish-black blotches, many of them the size of a penny but of irregular shape and varying size, scattered thickly all over the lower limbs, presented a most striking appearance, and at once showed that we were face to face with some very unusual condition. His ankles and feet were exceedingly tender: knee-jerks were brisk and equal, plantar reflexes flexor in type; Kernig's sign was not obtained, nor was there any stiffness or pain in the neck muscles. He complained of slight headache, but apart from this no symptoms or sign of cerebrospinal irritation could be elicited. The heart was normal in size and position, and the only abnormal physical signs in the lungs were those suggesting early pneumonia, or a thin layer of fluid with some collapse of the left lower lobe. His condition showed no material change during the remaining few hours of his life, and at 2.15 a.m. on April 6 he died, *well within twenty-four hours of the time at which he first felt ill enough to report sick.*

An autopsy on the same day showed: The lower limbs and buttocks present numerous pale blue-black blotches, which are of various sizes and irregular shapes, varying from a pin's head to 3 cm. in diameter. They are present on both surfaces of the lower limbs, being more numerous and larger towards the lower part, and especially upon the feet. A few are scattered

on the arms and forearms, where they are for the most part smaller; there are none upon the hands, trunk, face, or neck. On section they are seen to be hæmorrhages into the deeper layers of the skin, and not raised above the general surface of the skin.

The left pleural cavity contains 10 to 15 oz. of brownish-yellow clear fluid, the right pleural cavity the same quantity of blood-stained fluid; the parietal pleura shows universal injection, the visceral pleura a few tiny scattered hæmorrhages. Both lungs are firm; the cut surface is firm to the touch, and exudes much frothy fluid on squeezing; portions float in water. The spleen is large, soft, and friable. The kidneys are unusually large, pale, and firm; on section the substance bulges and curls up over the cut edge of the capsule, and that of the cortex is covered with glistening slightly-raised points and streaks. The liver presents a similar appearance.

Brain and Cord.—The cortical veins are distended with dark fluid blood; this congestion is specially evident all over the vertex, and gradually diminishes over the lateral aspects of the cerebrum till it disappears at the margin of the cisterna magna. There is no flattening of the cerebrum. No excess of fluid in the ventricles, no hæmorrhages, stickiness, or lymph to be found anywhere. The cord appears perfectly normal, both externally and upon section at various levels. In short, with the exception of the above vascular condition, the brain and cord are quite devoid of any naked-eye abnormal appearances. No other abnormal condition was found in the other organs.

Captain A. W. M. Ellis, C.A.M.S. (No. 5 Mobile Laboratory), examined the blood and cerebrospinal fluid before death at 10 p.m. on April 5. and reported: The blood was inoculated into plain broth, which showed a fairly profuse growth of a Gram-negative diplococcus in eighteen hours. Prolonged search of film preparations from the blood failed to show any micro-organisms. A blood-count was not made, but the appearance of the films suggested the existence of a leucocytosis; a differential count of 500 cells showed a considerable relative increase of large mononuclear cells.

Cerebrospinal Fluid.—From lumbar puncture: Fluid absolutely clear, limpid, no clot on standing, no sediment on centrifugalization. Cell-count, 12 per cm., of which 11 were polynuclear leucocytes. The fluid was centrifuged and then poured off, after which the tube was inverted and allowed to drain. The small amount of fluid remaining adherent to the tube was then picked up with a fine capillary pipette, and smeared on a glass slide. This sediment when stained showed a few cells, chiefly polynuclear leucocytes, and large numbers of diplococci, morphologically meningococci. They were practically all extracellular, and were so numerous that 50 to 90 pairs were frequently present in one microscopic field.

Culture and inoculation showed the organisms isolated from the blood and cerebrospinal fluid to be identical, and to be Type I meningococci.

Staphylococcus Aureus Pyæmia.—In civil life it is by no means a rare event to meet with a case in which a local infection by staphylococci, e.g., in a boil, has gradually infected the circulation and led to the development of scattered pyæmic abscesses, particularly in the kidneys, which ultimately prove fatal in the course of an illness of many weeks' duration. The two cases described below illustrate an overwhelmingly rapid development of what is essentially a similar condition. Staphylococcal infections at the front as a rule are benign and local. Occasionally blood septicæmias from staphylococci, mixed with streptococci, have been met with, which caused prolonged fever mimicking enteric, but ultimately cleared up without leaving any local focus of suppuration. The fulminating pyæmia described here is uncommon, but it has occurred also in the experience of other medical officers in France.

Case 6.—Sergt. C. was admitted with a suppurative condition of his upper lip, which had originated in an abrasion a week previously. He was anesthetized and the lip freely incised, with apparent benefit to the local condition. The following day, however, he developed symptoms and signs of acute pulmonary disease with profound toxæmia. *Staphylococcus aureus* was grown from the lesion in the lip and also from the circulating blood. He died on the third day after admission. At autopsy it was seen that the incised suppurating area lay chiefly to the right of the mid-line of the upper lip, with some swelling of the adjacent skin. Incisions showed in the subcutaneous facial tissue numerous tracks containing dirty-yellow pus; they were distinct from each other, and extended up under the nose and almost to the lower margin of the right orbit, back almost to the right ear, just over the inferior margin of the right horizontal ramus of the mandible, and upon the left side of the face an inch out from the left angle of the mouth. The lower lip appeared normal.

The *pleurae* were intensely inflamed throughout, with some recent (as well as old) adhesions; there was about an ounce of yellowish fluid in the right pleural cavity.

The *lungs* were oedematous and studded throughout with abscesses; many of these were so small as to be only just visible; the largest were as big as a small cherry; and between these extremes they were of all sizes. They were more numerous in the upper lobe. The lower lobes showed a good deal of collapse. There was general bronchitis and bronchiolitis. The remaining

viscera, including the heart and pericardium, showed no macroscopic departure from normal. The brain appeared healthy, except that on the vertex there was evident lymph along the main vessels in the sulci.

The second case, which was admitted within three days of the other, presented very similar features.

Case 7.—Spr. S. was admitted for 'pneumonia'. Although he was evidently suffering from acute pulmonary disease, the case did not appear to be quite straightforward. It was noticed that he had a boil upon the left shoulder; this had been incised, and was, in the patient's opinion, getting better, but during his first three days in hospital it took on a more active appearance, while the surrounding skin became tense and inflamed. Free incisions were made into this area, and *Staphylococcus aureus* was grown from the pus so obtained, and also from the circulating blood. The patient died on the fifth day after admission. The ultimate findings were, in essential, almost identical with those in the foregoing case. Incisions showed pus tracks running from the boil on the shoulder for a radius of 4 in. throughout the surrounding subcutaneous tissues. The condition within the thorax was almost exactly the same: intense bilateral universal pleurisy; lungs studded throughout with abscesses of the same size and distribution; heart and pericardium normal. The only different feature was a circumscribed abscess in the cellular tissue beneath the sternum. The only abnormality found in the brain was evident congestion of the vessels of the vertex.

These two cases were remarkably similar, and it is curious that they should have occurred within a few days of each other. Clinically they differed in that the first case did not show signs and symptoms of acute pulmonary disease until thirty-six hours before death, whereas the second presented them unmistakably for six and probably seven days; at autopsy the lungs of the two cases presented an almost identical appearance, and one could not but believe that the condition had existed for approximately the same length of time in both.

Case 8.—Thrombosis of internal carotid artery, following contusion by shell fragment. Hemiplegia. Death.

Pte. L., admitted for shell wound of neck; he presented a wound the size of a sixpence just beneath the right angle of his jaw; on the second day he developed left hemiplegia, and died the following day.

At autopsy it was found that a quadrilateral piece of metal, roughly 1 cm. $\times$ 1 cm. $\times$ $\frac{1}{2}$ cm., had entered as above, and passed to the opposite side of the neck; it had penetrated the side wall of the pharynx just above and behind the right tonsil, and on the left side was lying upon the fractured upper portion of the ascending ramus of the lower jaw.

On examining the vessels in the right side of the neck, a small piece of metal was found impacted in the outer layers of the wall of the external carotid artery; this had not injured the intima, and the interior of the vessel was normal. Half an inch above the bifurcation of the common carotid artery the lumen of the internal carotid was completely filled with ante-mortem thrombus; this extended in direct continuity through the remainder of this vessel and into the right middle cerebral artery and all its main branches, which were thrombosed for a distance of 3 in. from their origin. Neither anterior nor posterior communicating arteries were thrombosed. There was no fracture of the skull.

The surface veins of the brain—both in sulci and on convolutions—were unusually full of blood. The brain substance corresponding to the area of distribution of the thrombosed arteries was soft and diffuent; this condition was most evident in the region of the island of Reil; upon section it appeared to be limited to an area 3 in. $\times$ 2 in in size; but little evidence of softening could be found on examining the external surface of the cerebrum. The only other pathological condition found was a moderate degree of œdema of the lower lobes of both lungs.

There can be little doubt that the thrombosis in this case was due to a blow upon the artery by the metal fragment in its progress through the neck, though no naked-eye evidence of injury to the arterial wall could be found. It would seem probable that in such cases the blow must cause a tear or split in the intima, and that this tear provides the starting-point of the thrombosis.

A series of clinical cases of a similar nature, but without autopsy findings, has recently been published by Surgeon-General Sir George Makins.³

Case 9.—Infection of atheromatous carotid artery. Embolism. Hemiplegia. Death.

Pte. E. F., age 32, was admitted with a shell wound of the soft parts of his right arm; this was freely opened up and drained, and twenty-four hours later he suddenly developed complete left hemiplegia and hyperpyrexia, in which condition he died fifty-four hours after

admission. Clinically this was attributed to a cerebral hæmorrhage, but at autopsy no naked-eye abnormality could be discovered in the brain. However, in the right internal carotid in the interpeduncular space there was some pink fibrinous clot, which could not be traced beyond the origin of the right middle cerebral artery. The right carotid arteries in the neck were then examined, and at the origin of the right internal carotid was found a nodular mass in the wall of the artery, narrowing its lumen so as almost to obliterate it. Within this narrowed lumen was a small patch of pinkish endarteritis, with a small tag of fibrinous clot attached. Sections showed severe medial degeneration, partly calcareous, and a ring of very severe fatty and calcareous atheroma in the common carotid immediately beneath the bifurcation, very slight intimal hypertrophy of the proximal portion of the internal carotid, and a mixed thrombus containing masses of Gram-negative coliform bacilli on the atheromatous bifurcation and the non-atheromatous common carotid. There were similar bacilli on the surface of the intima and in clefts in the atheromatous intima, extending in one spot as far as the media. Similar bacilli were also present on the surface, and in the outer layer, of the adventitia.

The distribution of the bacilli was doubtless a post-mortem phenomenon to a large extent; but there can be little doubt that infection by bacilli derived from the wound in the arm caused a thrombus to form upon the atheromatous area at the bifurcation of the right common carotid; a portion of this thrombus then broke off and blocked the right middle cerebral artery, causing hemiplegia. The rapidity with which death followed the onset of hemiplegia (thirty hours) probably furnishes an adequate explanation of why no naked-eye changes could be observed in the brain substance, for anæmic softening may be difficult to detect even after an interval of two or three days.

REFERENCES.

- ¹ ELLIOTT and HENRY, *Brit. Jour. Surg.*, 1915, iii, 250.
- ² W. PASTEUR, *Ibid.*, 1914, i, 587.
- ³ SIR GEORGE H. MAKINS, *Lancet*, 1916, ii, 543.