healed exit wound one and a half inches below the internal epi-condyle. A small diffuse swelling chiefly on the inner side immediately below the bend of the elbow. Pulsation was palpable in a localized small area on the inner side of the swelling. There was no thrill, but a high-pitched bruit not heard beyond the limits of the tumour. The radial pulse was, if anything, fuller on the affected than the sound side. No change in the veins and no neuralgia pains.

Operation, August 19.—The incision was commenced in the line of the brachial artery, two inches above its bifurcation, following its course downwards and then curving inwards over the swelling. The artery was clamped above the bifurcation. As it was thought that the aneurysm arose from the ulnar artery, an incision and dissection were then made to expose the ulnar artery in its upper third, directly below the aneurysm. However, in spite of prolonged search, the ordinary ulnar artery running inwards to join the ulnar nerve could not be found, and the ulnar nerve coursed down the forearm unaccompanied by any artery of recognizable size. This absence of the normal ulnar artery was afterwards explained by finding a large superficial ulnar artery which probably took the place of the deep vessel. The sac was then opened and the clot turned out, but no bleeding took place until the clamp was released from the brachial artery, and this hemorrhage escaped from a wound of the superficial ulnar artery, which passed over the sac. The sac was small, and superficial to the origins of the ulnar and radial arteries. A ligature was placed around the brachial artery above the bifurcation, and also around the superficial ulnar artery above and below the lesion.

The wound was closed and healed by first intention. The hand remained warm and there was a complete recovery.

A ligature was applied to the brachial artery on account of the uncertainty felt as to whether the deep ulnar artery had also been wounded, but probably it was not necessary.

REMARKS ON A CASE OF SHRAPNEL WOUND OF THE POSTERIOR WALL OF THE PERICARDIUM WITH AN ACCOUNT OF THE OPERATION FOR THE REMOVAL OF THE MISSILE.

By HONORARY MAJOR R. SCOT SKIRVING, M.B.
Royal Army Medical Corps;
Honorary Surgeon to St. Vincent's Hospital, Sydney, N.S.W., and at present Surgeon to the Queen Alexandra Military Hospital (Census), Millbank, S.W.

The management of injuries to the heart and pericardium is now set forth in all treatises on surgery, but the actual number of recorded cases is not, in the aggregate, very great. I hope, therefore, I am justified in publishing the following example, which shows some of the difficulties
Clinical and other Notes

of X-ray diagnosis, as well as anatomical and physiological risks in operative interference with this part of the body.

The patient, a strong, wholesome-looking young soldier, aged 22, was wounded, somewhere in France, on October 11, 1915. He was hit under the left axilla about the posterior axillary line. The missile travelled obliquely through his lung and there was no wound of exit. He suffered much from shock, remained practically unconscious for three days, and spat blood profusely for over a week. During that period I gather that the physical signs of pericarditis were present. He was sent to England on October 27, and after periods of rest in several hospitals he was ordered back to his regiment. It was then seen that he was quite unfit for duty because of his shortness of breath on exertion, and the presence of deep-seated pain in his chest. Under these circumstances, he came under my care at the Queen Alexandra Military Hospital (Extension) on February 7, 1916. He had the above-mentioned complaints, and stated that if he walked briskly or attempted to go upstairs "he was brought up all standing."

On examination, the scar of an irregular lacerated wound in the left axilla was seen. It had soundly healed and need not detain us further. His general health was excellent, and he had no physical abnormality other than those connected with his heart and breathing. The lungs presented no pathological change demonstrable by physical examination, except that, owing to his former occupation as a coal-miner, the X-ray shadows in the pulmonary area were considered darker than usual. As to his heart, his pulse was small and rather soft, always fast, usually over 100 per minute, and occasionally a beat was missed. The heart dullness was not outside the normal limits, nor was the apex beat. The first sound in the mitral area was replaced by a soft blowing systolic murmur, not specially conducted into the axilla. I did not like to make him actively exert himself for purposes of comparison, still, on the whole, the murmur was probably loudest when the patient was at rest.

There was very marked reduplication of the second sound, especially in the pulmonary area. No pericardial friction was now to be heard.

The X-ray examination showed a foreign body situated apparently at or about the upper reflection of the pericardium, to the left of the middle line, posteriorly. This object, on the screen, could be seen to move—probably with the heart's movements—but some of those who witnessed this strange sight thought the excursions were slower than those of the heart itself. Possibly the movements were of both cardiac and pulmonary origin, for it seemed to move vertically with the respiratory and laterally with the cardiac excursions. Also it rotated on its vertical axis, as if one part was more fixed than the other. In these examinations I had the assistance of the special skill of Mr. Reid of St. Thomas's Hospital, as well as that of Mr. Henry and Mr. Pooley of Queen Alexandra Hospital, also expert and experienced radio-

**Plate I.**—This plate shows the antero-posterior view of the chest, in which the foreign body lying with its sharp edge end on, looks rather like a rifle bullet. All the other marks seen are merely metal objects placed on the skin as landmarks.
Clinical and other Notes

The clinical and radiographic examination revealed that a piece of metal, probably a bit of shrapnel casing, had gone obliquely through the left lung, perforated the pericardium from behind, at its upper reflection, and was now imbedded, partly within the sac, partly without, lying upon or between the pulmonary veins. The risks of any effort to remove it were explained to the patient, also the chance of failure, and the possibility that even its successful removal might fail to remove his breathlessness and pain. He, very pluckily, decided in favour of the operation, on the ground that neither delay nor rest had done him any good, and that he was incapable of earning a living or, indeed, of any sustained exertion.

I accordingly operated on March 21, 1916; Colonels Pilcher and James, with Lieutenant Lock, assisting me. Major Starling, F.R.S., was present, and gave me valuable advice regarding the manipulation of the living heart, a matter with which his researches in cardiac physiology in animals had made him familiar.

There are various ways of fully exposing the pericardium, but the method used in this case was found thoroughly satisfactory. It gave most ample access.

There are a few practical details, not dwelt upon in textbooks, that I think worth mentioning. An incision was made from the centre of the sternum at the level of the 6th costal cartilage, following the line of that structure outwards and downwards to its union with its rib. This incision should be bellied downwards to demonstrate the lateral bridge joining the 6th to the 7th cartilage. The soft parts were now suitably retracted and the cartilage laid bare. The pleura lies closely below the outer part, so the separation of the cartilage should begin at its inner end which lies over the "triangle of safety," where the pleura does not reach.

The perichondrium is difficult to separate on the external aspect of the cartilage, but it is happily easier to do so on the internal, where the risk of wounding the pleura is a very real one. I cut the cartilage at its inner end and at its lateral union with the seventh cartilage, using the point of the scalpel, carefully avoiding any sudden plunge of the knife through the cheese-like cartilage. After removal of the whole of the pericardium, the triangle of safety has been applied to that little area of pericardium which is normally not covered by the pleura. Internally, its base lies between the 5th and 7th chondro-sternal joints, and the root of the xiphoide cartilage, while the apex of the space is about 2 inches out in the 5th interspace.

1 "The triangle of safety" is the term which has been applied to that little area of pericardium which is normally not covered by the pleura. Internally, its base lies between the 5th and 7th chondro-sternal joints, and the root of the xiphoide cartilage, while the apex of the space is about 2 inches out in the 5th interspace.
sixth cartilage, the fan-like triangularis sterni, muscle come into view. It was divided, and the internal mammary vessels dealt with. I cut the artery, and tied both ends. It was very small, and gave me no trouble.

The pleura now was clearly recognized, and the presenting part pushed upwards and outwards with gauze. A vertical incision rather to the left of the mid-sternum was then made to the level of the second rib, and a little later the skin incisions were completed, by a third cut outwards and nearly horizontal for about 2½ or 3 inches. This marked out an irregularly shaped box-like flap.

The periosteal and other tissues covering the sternum were pushed outwards, with Farabouf's rugine, carrying this clearance beyond the insets of the cartilages of the 5th, 4th and 3rd ribs, which were carefully cut through vertically.

I dare say it would be quite a neat plan to divide them in such a V-shaped way that on replacement a piece of the outer end would dovetail into the corresponding aperture in the inner fixed portion. I now raised this whole flap of cartilage, muscle and skin, at the same time gently stripping the underlying pleura off its inner surface as far back as was necessary. The flap so raised could be held well up, and I did not find it necessary to crack the cartilages at their outer extremities.

One could now see the dark obliquely placed edge of the lung like a shadow, about 1½ inches external to the left side of the sternum, rising and falling under the thin veil of the pleura, which still covered the upper part of the pericardium. Colonel Pilcher wisely reminded me at this stage that the pleura was here still in situ, hiding its actual reflection under cover of the sternum—a most timely warning, for one is apt to forget that the lung itself does not overlap the pericardium to the extent its investing pleura does so. It is, indeed, very easy to wound the pleura in this operation, although doing so need not make one unduly sad. However, I managed to sweep it safely from below upwards and outwards. It came easily from under the sternum and was pushed, uninjured, well out of the way. The pericardium was now fully exposed. An opening in it was made, and it was seen that the cavity was largely occupied by soft sticky blood-stained adhesions. This, in a way, was hopeful, as it suggested that the metal was probably within the sac. The pericardium was now slit nearly throughout its whole extent from above downwards. The adhesions, which were many, were fortunately soft, and I swept them all asunder with my finger without difficulty or any bleeding to signify.

On passing my hand behind the heart up to the base, posteriorly, I felt a hard substance embedded in soft cicatricial tissue. Professor Starling advised me now to give the heart little spells, by withdrawing my fingers from within the sac. This is quite an important point, for although the heart will stand quite a lot of handling, including turning it out of the pericardium, as long as you avoid actually kinking its base or

Plate II.—This plate shows a lateral view of the chest, and the lozenge-shaped appearance of the missile is plainly visible. The other objects on the surface are only landmarks.
keeping your hands touching it for too long at a time, yet it needs a rest from mechanical stimulation at short intervals. The value of these intermissions was specially noticed by the anaesthetist at this period of operation. I soon was made happy by scraping the hard mass with my finger and feeling a sharp point of metal against it. With a curved blunt dissector I began to gently free it from the embrace of the posterior wall of the pericardium. About two-thirds of the whole mass seemed to lie without that structure, and rested, as I thought, on, or between, the pulmonary veins—not a comfortable neighbourhood. It was really quite a thrilling sight to see the heart heaving and writhing before one's eyes like a squirming hairless reptile, and this effect was increased by the thought that, perhaps, when I had actually freed the metal, a fatal gush of blood might follow its delivery.

However, all went well; I got it free, and brought it out of the body without any bleeding worth bothering about. I knew of no means worth trying to prevent the pericardial adhesions reforming. I can only hope that the removal of the exciting cause may have a quieting effect on their growth. The pericardium was sewed up with catgut—using Halsted's sutures, and taking great care to avert the lips of the incision so as to leave only a clear serous surface within. The displaced pleura was then encouraged to take up its normal position. The flap, containing skin, muscle and cartilage, was allowed to fall back into its proper place, the cartilages anchored with stout catgut stitches, and the periosteal tissues over-sewed at the points of section. The edges of the incisions were closed in the usual way without any drainage. It is, perhaps, worth while saying that I kept in place the dressing of gauze and wool pads with strips of adhesive plaster; then, to keep the pectoral muscles quiet, the left arm was laid alongside the body and fastened there by a broad flannel binder, embracing it and the chest, leaving the right arm free. The patient was nursed throughout in the semi-recumbent position. These points are of importance, because the union of cut cartilage is unsatisfactory, and by immobilizing the arm the fixation of the divided ends by suture and over-sewing was given a better chance to make a fairly firm join.
Clinical and other Notes

Regarding anaesthesia, in cases like this, in which the pleura is likely to be opened, the choice of anaesthetic and the method of its administration are important questions. With this case, I had the kind help of Mr. Rood, of University College Hospital, who gave the anaesthetic, ether and oxygen in varying proportions, through a tracheal tube connected with the usual apparatus for insufflation (Meltzer's method). This was employed mainly in view of any possible accidental opening of the pleura. If I had failed to get the metal out through the pericardial route, I intended to open the pleura and seek for it in the anterior cul-de-sac of that cavity. This would have meant some collapse of the lung. My reading and experience of pleural operations (chiefly in hydatid disease) leads me to believe that this event is not by any means so serious a matter as had been supposed. To begin with, the free collapse of the lung needs more than merely opening the pleura, for the stickiness of the layers keeps them together, and so maintains the condition necessary to prevent any extensive collapse. Moreover, pleural adhesions in adults are not uncommon and also hinder general collapse of the lung. Again, granting that partial collapse does take place, it is not an unmixed evil in cases like mine, for it diminishes the excursions of the heart's movements, and makes more room in the chest manipulations of or about the heart.

However, admitting all this, one does not willingly wish to open the pleura in this operation, and if by accident one does so it makes one's mind easier to have the intra-tracheal method of giving anaesthesia in action to keep the lungs inflated, and maintain normal pulmonary ventilation.

Moreover, by keeping the lungs distended and the pleura in its normal state, one is less likely to wound it accidentally, when turning back the big flap and sweeping the surface of the pericardium of its overlying reflexion of pleura, which, recollect, is very thin and fragile.

My judgment, therefore, on this matter of tracheal anaesthesia, is to try and obtain the added comfort (I refer to the operator, not the patient) of this apparatus, and a competent man to use it. If, however, these "counsels of perfection" be not obtainable, I see no reason why one should hang back from doing the operation without them if the necessities of the case demand it.

The after-history of this case has been, happily, quite uneventful. There was hardly any post-operative shock, no temperature, but the former quick pulse persisted, nay, rose to 126 per minute, and lasted for several days. By the tenth morning it had fallen to 80, and the patient felt perfectly comfortable, and the wound was well healed. I propose keeping him in bed for forty-two days.

I think I ought to have some sort of breast-plate of aluminium or felt made to act as a shield to his weakened chest-wall.
I am under no illusions about the future of this patient. I am not so sanguine as to think that because I had the luck to remove this bit of metal all his disabilities will disappear. I think, indeed, that his chest pain is likely to be relieved, and that his pericardial adhesions will not increase, but I certainly expect some permanent "hobbling" of the heart to persist from their re-forming and getting firm. I wish I could have tried, with faith, some means of preventing the re-growth of these adhesions in this rather sacred region.

Lastly, although I do not think it likely, I can imagine that one or other of the great vessels against which the foreign body lay pressed may have had the integrity of its wall damaged, and some sort of aneurysmal change might yet develop.