REPORT ON THE LATER RESULTS OF GUNSHOT WOUNDS OF THE HEAD.

By Lieutenant-Colonel P. Sargeant and Lieutenant-Colonel G. Holmes,
Royal Army Medical Corps.

(I) MATERIAL AVAILABLE FOR REPORT.

According to instructions, we proceeded to England to investigate, as far as is possible at this stage, the later results of gunshot wounds of the head, and to obtain any information which might be of service in the early treatment of these injuries.

Having reported to Sir Alfred Keogh, D.G., and having obtained from him the necessary authorization, we visited the following hospitals:

The First London General Hospital.
The Fourth London General Hospital.
The Fifth London General Hospital.
The King George Hospital.
The London Hospital.
The National Hospital for the Paralysed and Epileptic.
The Hospital for Epilepsy and Paralysis, Maida Vale.
The Empire Hospital for Officers.

In each of these institutions we saw the patients then under treatment in the wards, and examined the notes and records of all patients who had been admitted with the diagnosis of gunshot wounds of the skull.

We also took to England a nominal roll of 700 men, almost all of whom had severe head injuries, whom we had had the opportunity of observing in France and of whose early condition and history we possess full clinical notes. Through the kindness of Surgeon-General Sir Launcelot Gubbins, who gave us access to the records of the Chelsea Commissioners, we were able to see the later medical reports on, and learn the fate of many of these patients.

We attempted also to obtain special information on the occurrence of serious complications, particularly epilepsy and insanity. In the first place we searched as far as was possible the out-patient and in-patient records of the National Hospital for the Paralysed and Epileptic, and of the Hospital for Epilepsy and Paralysis, Maida Vale, the two largest special institutions in London which treat epilepsy, and noted all cases of this condition which had
developed in men, already discharged from the Army, who had suffered from gunshot wounds of the head.

Finally, at Sir Alfred Keogh's suggestion, we visited the Napsbury War Hospital, which has received for observation and disposal from May, 1915, to January, 1916, all soldiers with serious mental symptoms, except general paralytics, epileptics and the chronically insane; and since January 1916 all cases except those occurring in the Scottish, Irish and Northern Commands.

Major F.W. Mott, F.R.S., Pathologist to the London County Council Asylums, also kindly obtained at our request, from the London County Council asylums, a return of all cases that had been admitted to these institutions with mental disease which could be attributed to gunshot wounds of the head, inflicted during the present War.

By these means we succeeded in determining the condition of 1,239 patients between two and eighteen months after the infliction of the wound; in many of these cases, however, our information is incomplete. The fact that many of them reached England without any record of the nature of the wound, or the clinical symptoms, or of the operation performed at the Front or in the Base hospitals, made them difficult to classify, and in many others there was not sufficient information available to decide upon the nature and severity of the wound. We have, however, tried to exclude from our list mere scalp wounds, unless these led to death or were followed by the development of serious complications.

After excluding scalp wounds without any bony or cerebral injury, and cases in which the nature of the injury was uncertain, as well as those in which the latest information was too recent to be of value, we still have sufficiently accurate records on 610 patients, more than seventy-five per cent of whom were seen or had been examined more than three months after the infliction of the wound.

We have, however, in attempting to estimate the percentage of mortality amongst cases of head wounds evacuated to England, included all patients who have died, at whatever interval, after their arrival.

It is also necessary to point out that information on a large proportion of the cases in our list was obtained from the records or wards of the five hospitals (the King George Hospital, the London Hospital, the National Hospital for the Paralysed and Epileptic, the Hospital for Epilepsy and Paralysis, Maida Vale, and the Empire Hospital for Officers) to which serious cerebral injuries are
sent labelled by a green ticket, and that a large number were traced through the Chelsea Commissioners, who are concerned only with wounds sufficiently severe to necessitate invaliding from the Army. There can consequently be no doubt that the cases included in our list are more severe than the average of cases diagnosed as gunshot wounds of the head.

We wish to express our thanks to the commanding officers and to the medical staffs of the hospitals which we visited, and to the Chelsea Commissioners, for the courtesy with which they received us and for the help they gave us in our investigation.

(II) Mortality after evacuation to England.

Of the 1,239 cases of gunshot wounds of the head which have been admitted to the eight London hospitals above mentioned, forty-six or 3.7 per cent have died. This figure includes a certain number of serious and hopeless cases which were evacuated to England from the Base hospitals as quickly as possible, on whom no operation was performed, or in whom exploration showed that there was no reasonable prospect of recovery. Nine of the patients died within two weeks of their arrival at home and at least four within this period after the infliction of the wound. In the large majority of the other cases death occurred within three months; we have found records of only five patients who succumbed after this period.

It was possible to ascertain the immediate cause of death in a considerable number of these cases; in twenty-two, records of post-mortem examinations were available. In almost all spread of septic infection was the cause of death, but in a few other complications were responsible for, or contributed to, the fatal issue. One remarkable case, in which a rifle bullet entered in the right frontal region, passed through the base of the brain, ricocheted off the petrous bone and then passed through the third ventricle and the posterior third of the corpus callosum into the left occipital lobe, died suddenly three and a half months later, when the cerebral symptoms had almost disappeared, owing to the bursting of an aneurysm of the posterior communicating artery. In one case a fatal secondary haemorrhage occurred during the journey to England, and another died from an extensive intra-cerebral haemorrhage without intracranial infection. In two other cases pneumonia and hemothorax were found on post-mortem examination, but in both the cerebral wounds were severe.

Eleven patients succumbed after operation in England; in two
cases after excision of the cerebral herniae which existed, in two others after primary operations immediately on their arrival from France, in one after an attempt to remove a shrapnel ball which was lodged deeply in the brain, and in others after operations to relieve herniae or to evacuate cerebral abscesses.

In ten of the seventeen other cases of which post-mortem records were available, death was due to meningitis, and in seven to cerebral abscesses, which in most cases had led to infection of the meninges or to spread of infection to the ventricles. In two of the cases which died of meningitis the ventricles had probably been opened by the original wound, as cerebrospinal fluid escaped in large quantities.

Thirty-four of the forty-six fatal cases had been operated upon before their evacuation to England; in six no operation had been performed, and in six other cases we were unable to obtain definite information on this point.

We have traced and have heard of no case in which death has occurred in England when the dura mater had not been lacerated by the wound and had not been opened by operation.

(III) Physical Disabilities.

The physical disabilities that result from gunshot injuries of the brain naturally depend on the severity and the position of the wound. It is impossible to deal with these statistically, and as yet, due especially to the fact that the award of pensions is only conditional, the wage-earning capacity cannot be taken as a standard.

It is generally recognized now that much of the paralysis, sensory and visual disturbances, etc., seen in the early stages is due not to local destruction of the brain, but to concussion, oedema and vascular disturbances that often extend widely beyond the primary injury. The symptoms which diminish or subside early are mainly due to these factors.

Disappearance of those symptoms due to actual destruction of brain tissue does not seem on a priori grounds probable in many cases, and yet we have been on the whole surprised at the amount of improvement that has later occurred. A small proportion of men with penetrating and perforating wounds of the skull whom we originally saw with paralysis, sensory disturbances, hemianopia, etc., have already returned to active service, and others are employed in wage-earning capacities. As improvement is generally slow and continuous over long periods, it may be expected that a considerable proportion of men with even severe head injuries will be able to lead useful and active lives.
The amelioration of symptoms has been especially striking in many of the cases of hemiplegia, diplegia or quadriplegia due to injury of the superior longitudinal sinus.

(IV) NEUROLOGICAL COMPLICATIONS.

The opinion has been generally held that a large proportion of the patients with severe cerebral injuries who survive would be subject to serious complications or sequelæ, particularly insanity and epilepsy. It is still too early to affirm or deny definitely the frequency of these after results, but if they were likely to be common many cases should already have occurred among the very large number of men who have returned to England with gunshot wounds of the head. As far as we have seen, however, the proportion of cases in which either insanity or epilepsy has yet developed is surprisingly small.

(1) Insanity.—There can be no doubt that many patients present symptoms of some degree of mental deterioration, and especially dullness, loss of memory, irritability and childishness, during the early stages after the infliction of the wound, but the reports we have obtained in the later stages, and the records we have been able to examine, tend to show that in the majority of cases these symptoms disappear or diminish.

On the other hand, serious mental disturbances or actual insanity which necessitates confinement under certificate seems to be surprisingly rare. During a period of twelve months only eight patients who had been wounded in the head were admitted with mental symptoms to the Napsbury War Hospital, the special institution to which cases of insanity attributable to conditions of service are sent for observation and disposal. Four of these had already been discharged cured, or sufficiently improved to be at large; of the rest one had been previously invalided from the Army as insane, but rejoined for the War, and a second was regarded as a case of dementia praecox which was in all probability independent of the injury. In only two cases, therefore, could the persisting mental symptoms be attributed to the head injury. Seven of these eight patients had been operated upon before their arrival in England.

Through the help of Major F. W. Mott we have received from all the London County Council Asylums returns of the number of cases of insanity associated with gunshot wounds of the head that have been admitted to them; only one case is reported, a Belgian soldier, who died from septic infection of the cerebral ventricles.
This fact is the more surprising when it is remembered that all cases of insanity in invalided soldiers who belong to the London County Council area, which includes about one-seventh of the population of the United Kingdom, are transferred or admitted to these asylums.

These facts are supported by Major Mott's weighty opinion; he writes to us: "Personally I am very sceptical of a large number of cases (of insanity) arising from traumatic causes. I went into this subject very fully some years ago, and came to the definite conclusion that head injury, apart from syphilis, alcohol and hereditary neuropathic taint, was seldom the cause of the mental affection."

(2) Epilepsy.—The comparative rarity of generalized or Jacksonian epileptiform seizures in patients suffering from recent head wounds has been surprising, and even in the later stages fits have been as yet less common than has been generally feared.

We have found that fits have occurred after evacuation to England in 37, or six per cent, of the 610 cases on which we have complete notes. In 8 of these, however, only one convulsion had occurred; in 12 only "a few"; 5 men are reported to have had "five or six fits"; while in only 11 were the convulsions frequent.

It is impossible to ascertain from the records at our disposal in what proportion of the cases the attacks were local Jacksonian seizures, and in how many they were general convulsions. In eight of the patients they were described as "Jacksonian," but in the others only the general term "fits" is employed.

In a considerable proportion of these cases only one or two seizures occurred soon after their arrival in England, and in several of the others they were arrested by the administration of bromide. The practice of giving bromide regularly to all serious cranial injuries until the wound is healed, and for some months afterwards, seems advisable.

In five cases secondary operations were performed with good results; in two of these small abscesses were drained and in three spicules of bone were removed.

In 33 of the 37 cases in which fits have occurred there were severe compound fractures of the skull with laceration of the dura mater and direct injury of the brain, and in 4 of these a missile was still present in the brain. Of the remaining 4 patients one had been an epileptic since 8 years of age; in 2 only a few attacks had occurred; and one had been for six, in the other for nine, months free from seizures. This patient had been wounded only two and a half months previously, and no injury was found
at an exploratory operation: In 33 of the 37 patients operations had been performed before arrival in England.

As it might be expected that if epilepsy were a frequent complication many of the men already discharged from the Army would seek relief at the special hospitals that treat this condition, we searched the in-patient and the out-patient records of the National Hospital for the Paralysed and Epileptic, but could discover notes of only two patients who had attended for epilepsy; one in whom a fragment of shell casing which had penetrated from the right occipital region to the right frontal lobe twelve months previously is included in the above statistics; the second had had only a scalp wound and developed later indefinite attacks of giddiness, which were probably epileptic, after a fall that produced cerebral concussion. Dr. Fearsides kindly informed us that, as far as he is aware, only one case of epilepsy, a man with a gutter wound of the skull, had attended the out-patient department of the Hospital for Epilepsy and Paralysis, Maida Vale, and he had remained free from attacks since the administration of bromide five months ago.

(3) Other Neurological Complications.—Various forms and degrees of paralysis, sensory and visual disturbances, etc., due to the primary cerebral injury or to further damage to the brain by septic infection, hernia formation, or in the course of treatment, are naturally very common, but various subjective symptoms, which cannot be attributed to any local injury, are also remarkably frequent and necessitate the invaliding of many men from the Army. The most common of these is headache, which generally takes the form of a feeling of weight, pressure or throbbing in the head, and is increased by noise, fatigue, exertion or emotion; attacks of dizziness, and nervousness or deficient control over the emotions and feelings. Many, too, exhibit a considerable change in temperament; they are depressed, moody, irritable or emotional, and unable to concentrate attention on any physical or intellectual work. A few have had major hysterical symptoms, such as paralysis, anaesthesia, or visual disturbances.

These symptoms are very similar to those seen in neurasthenia, and especially when this condition has been of traumatic origin. They certainly incapacitate the subjects from active service, but they are, on the other hand, recoverable. They are entirely independent of the site or severity of the original wound, and are often as severe when the scalp only has been injured as in serious compound fractures of the skull, and they seem to develop equally whether an operation has been performed or not.
(V) Healing of Wounds: Cerebral Hernia.

A large number of cases of penetrating or perforating gunshot injuries reach England with the wounds still open, and many with hernia cerebri, but as a rule they heal so rapidly that among the 610 patients on whom we possess notes, and upon whom no further operation was performed, in only 19 were the wounds still open three months after their arrival in England, and in only 4 of these were they still unhealed six months after the infliction of the wound. In 3 of these 4 cases there had been large hernie and extensive defects in the scalp and skull; 18 of the 19 patients had been operated upon abroad.

Cerebral Hernia.—One hundred and twenty of our 610 patients reached England with a cerebral hernia. Their progress and fate can be most conveniently referred to according to the different types of wounds.

(i) Ninety-six cases had had penetrating wounds with retained missiles; in 27 the missiles had been removed either in the casualty clearing stations or in the Base hospitals; 6 of these developed hernie, of whom 2 died. Of the remaining 69 cases which were evacuated with the missile still retained, 14 developed a hernia and 2 of these died. Consequently in 20, or 20·8 per cent, hernie occurred; in 4 of these a fatal termination ensued. In 13 the hernia had shrunken and the wound was healed when the patient was last heard of, and in 2 the hernie were smaller and the wounds healing rapidly at periods of three and four months respectively after the infliction of the injury.

(ii) Of the 68 cases of perforating or “through and through” wounds, 14, or 20·6 per cent, had a cerebral hernia. Ten of these had been submitted to operation and 2 were operated upon again in England. Four of the 14 patients died, and in 8 of the others the wounds were already completely healed at the date of the latest information.

(iii) There are 310 cases of penetrating wounds without retained missile in our list; 86, or 27·7 per cent, reached England with a cerebral hernia. Nineteen of these died and in 49 the wounds were completely healed. Sixty-two of the 86 patients had been operated upon abroad.

Death has consequently resulted in 24·16 per cent of the cases evacuated to England with cerebral hernia.

We obtained information of 12 patients with cerebral hernie who were operated upon after reaching England; in 9 of these a previous operation had been performed abroad. Six died of
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generalized meningitis; in 2 of these the opening in the skull was enlarged and the wound explored; in 1 a subdural abscess was opened; in another an attempt was made to remove a bullet; and in 2 cases the hernias were excised. In the 6 patients who recovered, the operations were: "abscess evacuated" in 2 cases; "spicules of bone removed" in 2 others; while "the hernia explored" and "the hernia shaved off" were the operations in the remaining 2.

(VI) Bullets, Shrapnel-balls, and Fragments of Metal Lodged in the Brain.

Ninety-seven cases of this class were traced. Of these twenty-seven had had the foreign body removed before their transference to England, but the results in these cases must be taken with much reserve, from the fact that in many the bullet or piece of metal was only just inside the skull and was removed along with the fragments of bone. Of these, 3 died (all within three months), 2 were alive and well within three months, 12 between three and six months, 8 between six and twelve months, and 2 over twelve months after the infliction of the wound.

The fate of those cases sent to England with the missile still in the brain is a matter of considerable importance, bearing as it does upon the question whether deliberate attempts should be made at any period to remove such foreign bodies. In all the cases reviewed in this connexion the foreign body was at some considerable distance from its point of entry; a few were rifle-bullets and a few were shrapnel-balls, but the great majority were smaller or larger fragments of shell, often multiple and inaccessible. We have traced sixty-nine such cases, of which four died.

The analysis of these fatal cases is interesting. Two were sent home in what appeared to be a hopeless condition, one with a large hernia and one with cerebrospinal fluid escaping from the wound, and both died within two months; one died six weeks later after an unsuccessful attempt to remove a bullet which lay close to the falx cerebri; and the fourth died from a rupture of a cerebral aneurysm, the fatal issue being wholly unconnected with the continued presence of the missile.

Of the 65 surviving cases, 12 had been wounded less than three months previously, 25 between three and six months, 21 between six and twelve months, and 7 over a year ago.

In seventy-six per cent the wounds were soundly and completely healed.

In thirty per cent, complete recovery had occurred, and no symptoms of cerebral lesion were present.
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In forty per cent the neurological symptoms had improved to a remarkable extent.

In 10.5 per cent much disability (hemiplegia, hemianopia, neurasthenia, etc.) still persisted, but its existence depended on the damage done by the missile in its course and not on its presence. Fits had occurred in only four cases, and in two of these the fits were early and transient while the patients were still in France.

(VII) Cases operated upon after reaching England.

Amongst the total number (610) of cases of which we have complete records, fifty-two were submitted to operation in England. They may be arranged in groups according to the type of wound.

(1) Scalp Wounds, whether with or without fracture of the skull. No operations.

(2) Depressed Fracture without Laceration of the Dura Mater. — Three operations as follows:

(a) Removal of sequestra from wound; two cases, one of which had been previously operated upon. Both recovered.

(b) Sub-temporal decompression for increased intracranial tension; one case (frontal), previously operated upon at site of injury. Recovered.

(3) Penetrating Wounds without retained Missile. — In this group there are thirty-four cases, which may be set out according to the nature of the operation.

(a) Removal of sequestra from wound; ten cases, of which seven had already been operated on. All recovered.

(b) Drainage of cerebral abscesses; ten cases, of which seven had been operated upon abroad. Two died.

(c) Drainage of epidural abscess; one case, previously operated upon. Recovered.

(d) Removal of bony fragments from brain; two cases, one previously operated upon. Both recovered.

(e) Exploration of brain; one previously operated upon; one died (three cases).

(f) Hernia cut off; three cases with two deaths. Two had been operated upon abroad.

(g) Nature of operation not stated; five cases, three previously operated upon. One died.

(4) Penetrating Wounds with retained Missile. — The eleven operations were as follows:

(a) Removal of sequestra from wound; one case, previously operated upon. Recovered.
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(b) Drainage of cerebral abscess; two cases, both already operated upon; both recovered.

(c) Removal of bony fragments from brain; one case previously operated upon. Recovered.

(d) Exploration of brain; two cases, both previously operated upon. One died.

(e) Removal of fragment of shell from brain; one case not previously operated upon. Recovered.

(f) Unsuccessful attempt to remove bullet from brain; two cases, one already operated upon. One died.

(g) Nature of operation not stated; two cases, both previously operated upon. Both recovered.

(5) Perforating or "Through and Through" Wounds.—Four operations as follows:

(a) Exploration of brain; two cases, one previously operated upon, both died.

(b) Nature of operation unknown; two cases, neither of which had been previously operated upon. One died.

(6) Summary of Cases operated upon after reaching England.—Among the fifty-three cases tabulated above there are eleven deaths. Thirty-five patients had already been operated upon, of whom six died; in eight there had been no previous operation, and of these one died; in the remaining ten cases we could not ascertain whether there had been a previous operation or not, and four of these patients died.

The nature and results of these later operations are interesting. Thirteen were clearly of a trivial character, consisting merely in the removal of sequestra from an unhealed wound. Twelve were for intra-cerebral abscess, and it is very remarkable that ten of these patients should have recovered, especially in view of the very much higher rate of mortality in cerebral abscess of otitic origin. In only three of the cases so far had an operation been performed for the removal of a projectile; one proved unsuccessful and the patient succumbed; in a second the attempt was also unsuccessful, but the patient did not die; the third was successful and the patient recovered. In three cases a cerebral hernia was shaved off; two of the patients died of meningitis, whilst the third, although cerebrospinal fluid escaped for some time after the operation, fortunately survived; he still has a hernia cerebri.

CONCLUSIONS.

We recognize that a certain margin of error is possible in the observations and conclusions presented in this report, but we have
attempted to exclude all cases on which sufficient facts were not available, and those in which the wound was too recent to warrant definite conclusions on the fate of the patient. The information obtained has been presented as objectively as possible.

The later results of head wounds seem to be much more satisfactory than had been generally expected; the proportion of patients who die after transference to England is small; later complications such as cerebral abscesses are relatively rare, and serious sequelæ, as insanity and epilepsy, are as yet much less common than has been foretold. It must be recognized, however, that a large percentage of the patients dealt with in this report have been seen or heard of within some months only after the infliction of the wound. In only fifteen per cent of them have we been able to learn their condition after more than one year. But even such facts as are available are a safer guide than opinions based merely on a priori reasoning.

It should be also remembered that the cases on which this report is based were on the average more serious than the total of cases transferred to England with the diagnosis of "gunshot wounds of the head," since our records were collected mainly in the special London hospitals to which severe neurological cases are sent. Further, we have included in our list cases in which death or serious complications ensued, even when the records on the nature of the wound scarcely warranted inclusion.

One of the chief conclusions that can be drawn is that there are no grounds for supposing that more radical operations abroad are called for. It seems extremely doubtful if surgical intervention other than that necessary for the drainage and healing of the wounds diminishes appreciably the risk of later complications, or can modify, except in a harmful direction, the course of these cases from the functional standpoint. Every possible step should, however, be taken to prevent the development of a hernia cerebri.

Our records also show that many patients with foreign bodies lodged deeply in the brain recover, and are scarcely more liable to serious complications than men in whom the brain has been merely exposed and lacerated. Any attempt to remove them which may involve spread of infection or further destruction of brain tissue is consequently inadvisable.

From the point of view of further treatment and in the interest of the patient we would emphasize the importance of brief clinical notes, dealing particularly with the early state and treatment, being sent to England with each patient.