a subject exhausted by a severe attack of tetanus which, though recovered from, had made a deep impression on the patient.

REFERENCE.

¹ Dean and Mount, BRITISH MEDICAL JOURNAL, January 15th, 1916.

THE TREATMENT OF TETANUS.

WITH SPECIAL REFERENCE TO THE USE OF ANTITETANIC SERUM AND THE LOCAL TREATMENT OF THE WOUND.

BY

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As a result of his recent statistical analysis of 231 cases of tetanus Sir David Bruce¹ comes to the conclusion that the therapeutic value of the antitetanic serum is doubtful, although he still recommends its use.

The study of individual cases, however, may sometimes serve to supplement the statistical method, and a series of four cases of tetanus recently under my care are of interest, for in them the serum appeared to be of unmistakable value. In two the symptoms subsided under treatment by large doses of serum; on the reduction of the dose the symptoms reappeared with great violence, and on the renewal of large doses the symptoms once again subsided.

The four men were all wounded last autumn. None of them had received a prophylactic dose of serum.

CASE I.

Granulating shell wound of buttock; fragment of shell palpable beneath skin over sacrum. Incubation period, ten days. The symptoms were trismus, rigidity of neck and abdomen, painful spasms of legs. Respiration not affected; able to swallow fluids.

The patient stated that slight stiffness of the jaws had been present on the day preceding the beginning of serum treatment, which therefore commenced on the second day of the disease. From the second to sixth day 9,000 units were given daily; on the second, fourth, and sixth days 3,000 units of this dose were given intrathecally, the remainder being divided equally between the intravenous and subcutaneous routes.

Seventh day: Improved; able to open mouth; 5,000 units given subcutaneously. Eighth and ninth days: Improvement continued; serum omitted. Tenth day: Improvement maintained; 4,500 units given subcutaneously, with the aim of preventing relapse. This was insufficient for its purpose, for on the eleventh day a severe relapse occurred, with agonizing spasms of the legs; 3,000 units given intrathecally, 7,000 units intravenously. Twelfth day: Symptoms subsided; 7,500 units given subcutaneously. Recovery.

Duration of symptoms, twelve days; this period is reckoned up to the last day upon which slight tetanic spasms were present, although in this and the succeeding cases slight stiffness of the affected muscles persisted for several days longer.

CASE II.

Bullet wound of thorax; fractured ribs; small effusion into left pleura, regarded as sterile haemothorax. Incubation period, twelve days. Trismus; severe respiratory spasms with deep cyanosis; deglutition impossible.

For the first five days 9,000 to 12,000 units were given each day, part subcutaneously and part intravenously; for the first three days 3,000 units of this dose were given intrathecally. Sixth day: Marked improvement; spasms few and slight; deglutition easy; 7,500 units given subcutaneously. Seventh day: Improvement continued; serum omitted. Eighth day: 5,000 units given subcutaneously to prevent relapse. Ninth day: Severe relapse; 10,000 units given intravenously, 6,000 subcutaneously. Tenth day: Considerable improvement; spasms less frequent; 7,500 units given intravenously and repeated in afternoon. Eleventh day: Large haemorrhage from rectum, and death.

Duration of symptoms, eleven days.

Post-mortem Examination.—A superficial erosion in rectum; lower gut packed with scybala, although an enema had been given on alternate days. Small septic effusion in left pleura.

CASE III.

Shell wound of thigh. Two days after the injury the wound had been freely incised for gaseous cellulitis. At the time of the onset of tetanus large sloughs of muscle were in process of separation by granulation.

Symptoms of tetanus occurred ten days after the date of original wound. Trismus and backward curvature of spine; deglutition and respiration unaffected. The patient stated that slight stiffness of jaws had been present on the day preceding the initiation of serum treatment, which thus commenced on the second day of disease.

Second day: 3,000 units intrathecally, 3,000 intravenously, 3,000 subcutaneously. Third and fourth days: 6,000 units intravenously, 3,000 units subcutaneously. Fifth day: No

definite spasms, but occasional twitchings; 4,000 units intravenously, 2,000 units subcutaneously. This dose repeated on sixth day. Transferred to England, having been free from tetanic symptoms for twenty days. Duration of symptoms, six days.

The muscular sloughs were allowed to separate by granulation.

CASE IV.

Granulating shell wound of thigh. Incubation period, nine days. Trismus, rigidity of neck, painful spasms of wounded leg, tongue frequently bitten. Respiration and deglutition unaffected.

First day: 3,000 units given intrathecally, 4,000 units intravenously, 2,000 units subcutaneously. Second to eighth days: From 7,500 to 10,000 units given daily, chiefly intravenously; on the fourth day 3,000 units of this dose were given intrathecally. Ninth day: Spasms absent; serum omitted. Tenth day: Slight spasms present; 4,000 units intravenously, 1,000 subcutaneously. Eleventh to thirteenth days: Spasms absent, serum omitted. Fourteenth day: Very slight spasms; 4,500 units subcutaneously. Transferred to England, having been free from spasms sixteen days. Duration of symptoms, fourteen days.

In Cases I and II formidable symptoms subsided under large doses of serum, reappeared when the doses were diminished, and again subsided when the large doses were repeated; in each case the relapse occurred on the day following the injection of about 5,000 units subcutaneously. Hence it appears probable that small doses may fail where large ones succeed. Although Case II ultimately died from complications, the effect of the serum in influencing grave tetanic symptoms was marked. The cause of the rectal haemorrhage is not clear; it would be of interest to learn whether purpuric symptoms have followed large doses of serum in other cases.

The value of intrathecal injection was shown in the relapse of Case I; after the injection, the agonizing spasms of the legs completely subsided, and did not recur. Possibly the intrathecal route is specially valuable when the wound is in the lower part of the body and the spasms localized to the lower limbs, for by this route the serum is brought into immediate relation with the affected lower part of the cord.

Daily Dose.

The effectual daily dose would appear to be about 10,000 or 12,000 units; this may be given twice a day in critical cases. The major portion of this dose should be given intravenously; subcutaneous injections being also used to maintain the effect. Intrathecal injections should be given daily, or at such intervals as the symptoms demand. The dosage must be reduced gradually, in order to avert relapse.

It is worth noting that three of the above cases exhibited a characteristic narrowing of the palpebral fissure, a symptom which I have also observed in several other cases of the disease. This is probably due to a slight continuous contraction of the orbicularis, although the drooping upper lids may sometimes resemble bilateral parietic ptosis. It is more persistent than the risus sardonicus and occurs earlier in the disease, and may therefore be of diagnostic value.

Local Treatment of the Wound.

All will agree as to the desirability of the vigorous treatment of soiled wounds as a preventive of tetanus; but when once the disease has declared itself, I consider that operative surgical interference with the surface of the wound, although recommended by several authorities, is a proceeding of considerable danger. This view is based on theoretical considerations, and on the study of eleven cases during the war.

Tetanus usually shows itself after an interval of a week or more from the time of the injury. By this time there will have been formed the protective inflammatory barrier, the function of which is to check absorption from the surface of the wound. Any active surgical treatment, such as scraping, incisions for drainage, or the removal of sloughs, is likely to make breaches in the inflammatory barrier, and to expose the tissues to the access of the tetanus toxin; and this will hold good whether the toxin gains entrance by way of the nerves, the circulation, or the lymphatics.

The following case illustrates this point:

A patient with septic compound fracture of the leg was well on the road to recovery from a severe attack of tetanus; a

simple incision was made for the evacuation of a collection of pus and the removal of a fragment of dead bone. Although a precautionary dose of serum had been given, the operation was followed within eight hours by a violent relapse of the tetanus.

It is probable that the relapse was not due to the shock of the operation, but to the exposure of a fresh absorbent surface, for I have not observed any similar recrudescence of tetanic symptoms following the administration of an anaesthetic for such purposes as lumbar puncture or the dressing of a wound.

In another case the patient had been wounded in the back; six days after the wound an operation was performed for the removal of a missile lying upon the lamina of the first lumbar vertebra. For a few hours before the operation the patient had complained of severe pain in the wounded portion of the back; this was not at the time recognized as due to the onset of tetanus, although subsequent events showed that the pain had probably been due to that cause, for it increased after the operation, and in six hours was accompanied by trismus. Death from rapidly developing tetanus took place within sixteen hours of the operation.

MacConkey² has recently collected several instances of operations upon wounds followed after a short interval by the development of tetanus in patients who had previously shown no signs of the disease. It is probable that these cases illustrate the danger of making breaches in the inflammatory barrier.

That the policy of non-interference with the wound may be followed without detriment to the patient is proved by Case I and Case III above. A fragment of shell in one case and large muscular sloughs in the other were left undisturbed; both patients recovered. In each case the belief was justified that it was safer to trust to the protective power of the inflammatory zone than to risk the exposure of a fresh absorbent surface.

While avoiding injury to the granulation tissue, every effort should be made by gentle means towards the removal of debris and the cleaning of the wound; for this purpose irrigation with hydrogen peroxide, followed by irrigation with the hypochlorite of soda solution, may be employed.

The objections to interfering with the infected surface of the wound do not apply to amputation above the site of injury. In cases of tetanus associated with septic compound fracture the patient is exposed to danger from the sepsis as well as from the tetanus, owing to the impossibility of preventing movements of the fractured bones; I have observed two such cases in which the patient survived the tetanus but ultimately died from septicaemia. In cases of this nature early amputation probably affords the best chance of recovery; this course was followed successfully in a case under my care. Antitetanic serum was injected into the nerve trunks exposed in the stump at the time of operation.

In an account of the German experiences of tetanus, Pribram³ recommends radical excision of the wound. Owing, however, to the extensive nature of the injuries usually associated with tetanus during the present war, complete excision of the wound would almost invariably be quite impracticable; any attempt to perform it would be necessarily incomplete, and would probably do more harm than good. The case-mortality of tetanus amongst the Germans appears to have been very high.⁴

CONCLUSION.

When tetanus has declared itself, operative surgical interference with the infected surface of the wound is dangerous, and should be a matter for grave consideration; it is preferable to imitate nature's methods—namely, to promote the formation of granulation tissue, and simultaneously to reinforce the patient's production of antitoxin by the injection of large doses of antitetanic serum.

REFERENCES.

¹ Bruce, *BRITISH MEDICAL JOURNAL*, October 23rd, 1915. ² MacConkey, *ibid.*, December 11th, 1915. ³ German Experiences of Tetanus, *ibid.*, December 18th, 1915. ⁴ German Surgical Experiences, Kümmell, *ibid.*, July 17th, 1915.

It is reported from Sweden that the actual delivery of the Nobel prize in chemistry for 1914, awarded to Professor Theodore W. Richards of Harvard University, together with the other Nobel prizes for 1914 and 1915, will be postponed until June 1st next. The prize winners are invited to go to Sweden in person to receive their prizes and to give their Nobel lectures.

VISUAL NEUROSES OF MINERS IN THEIR RELATION TO MILITARY SERVICE.

BY

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THE visual defects of miners have been the subject of careful investigation by members of the profession, and miner's nystagmus in particular has received close attention, and the monograph on this subject by Dr. T. Lister Llewellyn, entitled *Miner's Nystagmus, its Causes and Prevention*, may be thought to have said the last word on this peculiar affection. It may, however, be of interest to record some of the cases which have been met with recently among miners coming from the counties of Northumberland, Durham, and Yorkshire, who have found their way into the army. There may also be some advantage in noting the persistence and, in some cases, the aggravation of these defects in men removed far from the scene of their former work and employed entirely above ground. I had not previously had the opportunity of noting cases of this disease, and therefore approached the subject with some freshness. I have purposely abstained from using the term "miner's nystagmus" for reasons which will be stated, but nevertheless the series of cases given are, in my opinion, examples of the affection which usually bears this name.

It is obvious that the cases quoted are too few to be of themselves of great value, but the fact that they are corroborative of cases quoted by Dr. Llewellyn seems to indicate their similarity to the condition which he describes.

1. In the first place, there can be little doubt that the group of associated symptoms which are present in what is usually known as "miner's nystagmus" constitute a distinct "disease."

2. On the other hand, the name seems to be unfortunate, seeing that the nystagmus is at most only one symptom out of a group which may be absent even when the "disease" is present in a marked form.

3. The symptoms noted in the series of cases given below correspond very closely with those described on pp. 1 and 2 of Dr. Llewellyn's monograph, and it may be convenient to refer to these seriatim, taking them in the order of apparent importance.

(a) Defect of Vision.

This is variable in different cases, and probably is due to a variety of causes, but it has usually been the chief reason which has led to the man in question being sent for examination. There is usually some error of refraction present, but this is insufficient to account for the defective vision, and it will be seen that some of the cases were hypermetropic, some myopic, and some astigmatic in different degrees. In no case was any abnormality of the fundus detected to which any of the disturbance of vision could be attributed, but it was not possible to make an ophthalmoscopic examination in the cases where there was marked photophobia.

(b) Temporary Giddiness.

Next to the visual disability, the occurrence of more or less pronounced attacks of giddiness was a reason for the cases coming under observation. In two instances men complained that they found it dangerous to be on horse-back, and one man came into hospital suffering from bruises because he had fallen from his horse and been dragged along by it. Case 1, which was much the worst of the series, used to have attacks of giddiness, in which he would often have fallen if he had not been held up by attendants in hospital. Others would simply complain of feeling "dizzy," often in the early morning; in no instance could it be proved that there was any absolute loss of consciousness.

(c) Photophobia.

Intolerance of light was present in some measure in practically every case, and this symptom may be responsible for the blinking of the eyelid in some cases, the drooping of the lids in others, and the difficulty which was generally experienced in looking upwards. Judging from the occurrence of this symptom in other forms of disease