at the Cardiff Infirmary, and it was through the accident of my going into the ward during visiting hours and seeing him converse with his wife in the deaf-and-dumb language that I obtained his singular history.

He was one of the few survivors in a big colliery explosion. He remembered nothing of the accident, but on recovering consciousness found that he could neither hear a sound nor articulate a word. After remaining in this condition for a considerable time he went to a school for the deaf and dumb, and eventually married a congenital deaf-mute. He lived happily in this state for some years, and resumed work until the occurrence of a second underground explosion, which was followed by his recovery from deaf-mutism; he stated that he distinctly remembered "hearing the ground tremble" before lapsing into unconsciousness which lasted a few days. When he regained consciousness he got very excited upon discovering that his powers of speech and hearing had returned. The late Dr. Naunton Davies, J.P., of Porth, told me that he knew the man well, and that in his opinion there was a strong hysterical strain in him; Dr. Davies said also that there was no evidence of direct injury to the head.

The present war has added to our knowledge of the causation of symptoms which are clinically so well known, and are described in the textbooks in chapters on concussion of the brain. It is no longer necessary to assume that "*commotio cerebri*" must have taken place, due either to a direct force—a "whack" or "crack" on the head—or to indirect force transmitted through the atlantoid articulations with the occiput producing a jarring of the skull and its contents. It can now be easily realized by those who have seen and studied the effect of high explosive shells upon the buildings of a town or village in the vicinity of which explosions have taken place. The damage which *atmospheric disturbances* alone can do to buildings, even at great distances from the site of the explosion, has strikingly illustrated the effect such air currents must have upon human beings, whether standing or lying down, awake or asleep. To me the damage done to buildings carries the conviction that the general shock to the whole surfaces of skin and mucous membrane which protect the exterior of man may be sufficient to disturb the nervous machinery to a degree which may vary from slight symptoms of concussion of the brain by stages which may reach the extremity of sudden death, without showing evidence of any appreciable naked-eye pathological signs.

I have had the opportunity of seeing the effect of air disturbances caused by colliery explosions, and these are in some aspects as powerful as those of "shell concussion." Further, I am of opinion that many of the freaks of lightning can be best explained upon the hypothesis that the tracks of lightning sparks cause sudden violent air currents, in the nature of vortices, ripples, or waves. These air blasts are often of a weirdly powerful intensity; the most striking example that has come under my own observation since I recorded—at the Oxford Meeting of the British Medical Association in 1902—the cases of two men struck by lightning, was one in which a key that had not been turned on the inside of a door was driven right across a room several feet high, marking by its impact the wall against which it struck; at the same time the beading on the exterior of one of the door-boards was stripped off and carried in an opposite direction to that taken by the key. I do not wish to weary the reader by quoting further illustrations of the effects of lightning air-currents in splitting dry wood or in blowing bark off dead trees. I want merely to emphasize the fact that in a large number of cases violent air-currents striking against skin and mucous membranes, whether originating in war by high explosives, or in civil life by colliery explosions, and by lightning, play *per se* the principal part in the etiological factors which cause disturbances of function in the psychic, physiological, and automatic centres situated in the brain itself through impulses conveyed to it. The special intermediate organs existing between the exterior of man and his brain, such as the eyes and ears, are frequently put out of gear by these air-currents or "shell concussion," and Mr. Jameson Evans, in the number of the BRITISH MEDICAL JOURNAL referred to above, gave some striking illustrations of such damage to vision. On the other hand, cases of severe labyrinthine trouble of the ears have been found to exist after patients recover from

the unconsciousness of severe concussion of the brain, as exemplified by the experiences of a young man who was "blown up" at Loos, and discovered that he could not direct himself to getting out of the side of the bed he wanted to, and that when he did get out he found himself staggering and reeling; these symptoms disappeared in two or three days, leaving in the course of a few weeks only partial deafness of one ear.

It will be noticed in the history of the case of deaf-mutism in a collier related above that he suffered from two types of shock—or symptoms of concussion of the brain—the first one occurring suddenly or instantaneously, that is, without consciousness of the accident on his part; whilst the second one had a latent period, that is, consciousness of the action before he lapsed into unconsciousness. I have observed the same two types of shock in cases of lightning stroke.

It is manifest that it is only in the type of "shell shock" in which a latent period occurs before the onset of the state of unconsciousness that the psychic centres can exert any influence upon the nervous machinery of the emotions.

The grim reality of the misnomer, "hysterical manifestations in a neurotic," is dramatically portrayed in the case related above, where the collier, upon recovering his power of speech and hearing, found himself married to a congenital deaf-mute!

OBSERVATIONS ON CASTELLANI'S "TETRAVACCINE" AND "PENTAVACCINE."

BY

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To Castellani is due the credit of having first proposed prepared, and used, combined vaccines. The preparation of such vaccines is based on the experimental work he carried out in 1901-1902, when he was able to demonstrate that an animal (rabbit) inoculated with more than one species of bacteria, within limits, elaborated agglutinins and immune bodies for the various species injected, and that the amount of such protective substances for each species was not distinctly less than in control animals inoculated with one species only.

Castellani's best-known mixed vaccines are the tetra-vaccine "typhoid + paratyphoid A + paratyphoid B," which he began using in man on a large scale in 1905; the tetra-vaccine "typhoid + paratyphoid A + paratyphoid B + cholera"; the tetra-vaccine "typhoid + paratyphoid A + paratyphoid B + Malta fever"; the pentavaccine "typhoid + paratyphoid A + paratyphoid B + cholera + plague."

It may be of interest to put on record the experience I have had in Serbia of two of Castellani's vaccines—namely, the tetra-vaccine, typhoid + paratyphoid A + paratyphoid B + cholera; and the pentavaccine typhoid + paratyphoid A + paratyphoid B + cholera + Malta fever.

The two vaccines were obtained from Dr. Castellani, who was preparing them in Serbia on a large scale for the American Red Cross Sanitary Commission and for the Serbian army. The details of technique for the preparation of such vaccines may be found in his own publications; I limit myself to stating the results I have had.

Tetra-vaccine.

The tetra-vaccine was used by me to inoculate 3,000 persons, most of whom I was able to follow for two months after inoculation. Two injections only were given ($\frac{1}{2}$ c.cm. each) at an interval of five to seven days. The injection was done subcutaneously in the arm, after sterilizing the skin by means of tincture of iodine. The local reaction was generally mild, a few hours after injection a small patch of redness developing, with slight pain, which lasted one to two days. The general reaction was also, as a rule, mild. All the inoculated persons were able to attend to their duties twenty-four to forty-eight hours after the injection. I was able to keep in touch for two months with 2,000 of the inoculated persons; no case of typhoid, paratyphoid A, paratyphoid B, or cholera developed among them. With the kind assistance of Dr. Castellani, I

examined the blood of four of the inoculated persons. I have collected the results in the following table:

Tetravaccine.						
Individuals Inoculated.	Blood tested against	Limits of Agglutination. Weeks after First Injection.				
		1	2	3	4	5
No. 1.	<i>B. typhosus</i> ...	1/40	1/1200	1/500	—	1/200
	<i>B. paratyphosus</i> A ...	1/20	1/400	1/200	—	1/100
	<i>B. paratyphosus</i> B ...	1/20	1/300	1/200	—	1/100
	<i>V. cholerae</i> ...	1/20	1/100	1/80	—	1/60
No. 2.	<i>B. typhosus</i> ...	1/20	1/1200	1/400	1/300	1/200
	<i>B. paratyphosus</i> A ...	1/20	1/200	1/150	1/150	1/100
	<i>B. paratyphosus</i> B ...	1/20	1/200	1/200	1/150	1/100
	<i>V. cholerae</i> ...	1/20	1/60	1/40	1/40	1/40
No. 3.	<i>B. typhosus</i> ...	1/40	1/600	1/600	1/300	1/200
	<i>B. paratyphosus</i> A ...	1/20	1/500	1/400	1/200	1/150
	<i>B. paratyphosus</i> B ...	1/20	1/500	1/400	1/150	1/150
	<i>V. cholerae</i> ...	1/10	1/60	1/100	1/40	1/40

Comparing the results collected in the above table with the results obtained in control individuals inoculated with monovaccines by Dr. Castellani and Dr. Mendelson, I find that the amount of agglutinins present is not distinctly smaller.

Pentavaccine.

The pentavaccine I used was the typhoid + paratyphoid A + paratyphoid B + cholera + Malta fever. I obtained it from Dr. Castellani. As regards the technical preparation of this vaccine I refer the reader to Dr. Castellani's own publications. I inoculated with this vaccine 2,000 individuals, mostly at the inoculating department attached to the Uskub American Clinic, with no untoward accident of any kind. The injections were given ($\frac{1}{2}$ c.cm. each) at an interval of five to eight days, with the usual technique. The reaction, local and general, was not more severe than in individuals inoculated with the tetravaccine. The blood of two of the inoculated persons was examined with the kind assistance of Mr. D. de Silva.

The results are given in the following table.

Pentavaccine.						
Individuals Inoculated.	Blood tested against	Limits of Agglutination. Weeks after First Injection.				
		1	2	3	4	5
No. 1.	<i>B. typhosus</i> ...	1/40	1/800	1/500	1/300	1/150
	<i>B. paratyphosus</i> A ...	1/20	1/400	1/300	1/200	1/150
	<i>B. paratyphosus</i> B ...	1/20	1/400	1/400	1/200	1/200
	<i>V. cholerae</i> ...	1/10	1/60	1/40	1/40	1/40
	<i>M. melitensis</i> ...	—	1/40	1/80	1/80	1/20
No. 2.	<i>B. typhosus</i> ...	1/20	1/1200	1/400	1/250	1/200
	<i>B. paratyphosus</i> A ...	1/20	1/500	1/400	1/300	1/200
	<i>B. paratyphosus</i> B ...	1/20	1/500	1/300	1/300	1/150
	<i>V. cholerae</i> ...	1/20	1/100	1/80	1/40	1/40
	<i>M. melitensis</i> ...	1/10	1/40	1/200	1/150	1/80

CONCLUSIONS.

The use of Castellani's tetravaccine, typhoid + paratyphoid A + paratyphoid B + cholera, is harmless, and the inoculated persons develop protective substances for the four diseases. My results are therefore identical to those obtained by Castellani, Mendelson, and Randon, who have used that vaccine on a very large scale.

The use of the pentavaccine, typhoid + paratyphoid A + paratyphoid B + cholera + Malta fever, is also harmless, and, according to my experiments, the inoculated persons develop protective bodies for the five diseases. In my opinion, these mixed vaccines should be used as a matter of routine in all countries where such diseases exist already or may be easily imported.

BIBLIOGRAPHY.

Castellani: *Zeit. f. Hygiene*, 1902; *Centr. für Bakt.*, 1905; *BRITISH MEDICAL JOURNAL*, 1913, 1914, 1915; *Sperimentale*, 1915.
Castellani and Mendelson: *BRITISH MEDICAL JOURNAL*, November 13th, 1915.

DR. HENRY MACDONALD CHURCH, Demonstrator of Anatomy in the University of Edinburgh, left personal estate in the United Kingdom valued at £17,400.

REPORT OF A CASE OF SEVERE TETANUS SUCCESSFULLY TREATED BY ANTITOXIN.

BY

T. P. KILNER, CAPTAIN R.A.M.C.(T.F.).

THOUGH the following report was written in the earlier months of the war, when tetanus was much more commonly seen than it is now, it still may be justified in its publication in that it may give some little guidance to those who are called upon to treat the cases of a similar type which still occasionally appear.

At the time of writing much discussion was in progress around the whole subject of tetanus and its treatment, but the views and suggestions put forward were so numerous and so extremely varied that it was quite obvious that no very definite "best" line of treatment had been found.

Up to the commencement of the war reported cases in England were comparatively few, and even in America, where statistics of antitoxin treatment are particularly abundant, detailed reports are scarce, so that one is unable to get clear ideas of the severity of a particular case, the doses of antitoxin required, and the precise nature of the effects of the treatment on the patient.

It would seem, however, that insufficient patience and perseverance are exercised in many cases, and that one settles down too easily to the conclusion that all cases with a short incubation period are hopeless from the onset—a statement certainly borne out by a report in the *BRITISH MEDICAL JOURNAL* about the time of writing, which said: "The result (death) seems to agree with what was already fairly generally recognized—namely, that if the disease has an incubation period of less than twelve days it is fatal in spite of treatment, whether by antitoxin or other means."

A private, aged 31 years, was admitted to the Manchester Royal Infirmary in the early morning of October 31st, 1914. He gave a history of having been wounded at Ypres at 8 a.m. on October 27th by the explosion of a shrapnel shell, and on examination was found to have a large suppurating crateriform wound, extremely foul-smelling, occupying a position on the inner side of the right leg immediately below the knee-joint. A small punctured wound was also present on the anterior aspect of the joint, but the two had apparently no connexion, and the joint itself was not opened.

He stated that after receiving his wounds he had to drag himself, his leg trailing along the ground, for a distance of about fifty yards before reaching cover, and that it was not until 8 p.m. that the wound received its first dressing. He had lost large quantities of blood, and was very anaemic and toxæmic looking when he arrived in hospital, four days after the injury. The wound was dressed with boracic fomentations every four hours, and irrigated frequently with hydrogen peroxide solution. The cavity involved the upper end of the tibia, and from time to time fragments of necrosed cancellous bone were removed.

The wound cleared up somewhat, but the question of amputation was under consideration on account of the bad general condition of the patient and the obvious impossibility of preserving a useful limb, when at 9.30 on the morning of November 5th, nine days after the injury, rigidity of the masseters was first noticed, the patient complaining of a sore throat and being found unable to open his mouth for inspection.

Previous to this, one had been on the outlook for signs of tetanus, for the patient had shown those profuse sweats which are apparently frequently the precursors of the condition, and which had been particularly marked on the previous evening.

The trismus increased rapidly and spread to the muscles of the neck and abdomen. Perspiration was profuse, so that the bed linen was soaked. At noon of the same day the leg was amputated at the middle of the thigh, partly with a view to removing the focus of infection and partly because hopes of preserving the leg were obviously small. At the time of operation about 1,000 units of antitoxin were injected into the spinal theca, and a further 2,000 units given subcutaneously. At 6 p.m. the patient had recovered from the anaesthetic, but was still very rigid about the head and neck.

The abdominal muscles were also tightly contracted, and there had been some clonic contraction of the arm muscles associated with stertorous breathing. A second anaesthetic was administered, and 4,500 units of antitoxin were injected spinally and 9,000 units given subcutaneously in the abdominal wall. Two teeth were extracted at the same time in order to facilitate the anticipated difficulty in feeding. The foot of the bed was raised and the room kept as quiet as possible.

At 1 a.m. of the following day 6 oz. of chloretone in olive oil were administered by the rectum for the continued clonic contractions of the arm muscles. Potassium bromide and chloral (aa gr. xx) were then given by the mouth at intervals of four hours. At 4 p.m. a further 15,000 units of antitoxin was given subcutaneously.