A CASE OF COMPRESSED-AIR ILLNESS CURED BY RECOMPRESSION.

BY

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THIS case of compressed-air illness occurred during salvage operations for recovering the guns and torpedoes of H.M. torpedo boat destroyer *Blackwater*, which sank in 17 fathoms of water off Dungeness after collision with a merchant vessel.

In the course of the operations ninety descents were made by divers to the wreck, the general circumstances being similar to those described below, but in no other case did any symptoms of "caisson disease" appear.

On April 25th, Carpenter's Mate Thomas Milne, together with another diver, went down to the wreck to clear away her anchors and cables. Milne is forty years of age, and of excellent physique. He has been a diver for seventeen years, and never previously suffered from any complaint attributable to his work. He reached the wreck two minutes after leaving the surface, and from then till the time he began to ascend he was very actively exerting himself. In the course of his work he had to clamber right down to the sea bottom and crawl under the fore-foot of the *Blackwater*, the gauge at that instant showing the depth to be 98 ft.; but for the greater part of the time he was engaged on her fore-castle, which stood up 16 ft. above the sand. The excess of air pressure on his body, therefore, varied between $43\frac{1}{2}$ lb. and $36\frac{1}{2}$ lb. to the square inch. By the time he was ready to return to the surface the weather had become ugly, and a heavy sea threatened to part the wire hawsers by which the diving vessel was moored over the wreck; it therefore became desirable to shorten the time taken in his ascent—that is, the period of decompression—as much as possible consistently with safety from compressed-air illness.

In the whole of the operations the decompression of divers was effected by the system adopted by the Admiralty more than two years ago,* pressure being reduced rapidly at first, and then very slowly, as atmospheric pressure is approached. In practice the diver climbs up a rope towards the surface till on reaching a certain depth he is stopped by a signal from above. He waits for some minutes until a signal is made to ascend, when, after climbing 10 ft. nearer the surface, he is again stopped by signal and for a longer period. The number and depth of the stopping places, and the time to be spent at each, are precisely laid down in the Admiralty Diving Manual, and depend on the depth at which the diver has been working, and the length of time he has been down. An officer manages the ascent of each diver.

The diver had been down under water for exactly one hour when he commenced to ascend, and the following are the extracts from Admiralty tables which apply to the circumstances:

Depth in Feet.	Time Spent under Water.	Stoppages in Minutes at Different Depths.			Total Time for Ascent in Minutes.
		At 30 Ft.	At 20 Ft.	At 10 Ft.	
78 to 84 ft. ...	$\frac{3}{4}$ hour to $1\frac{1}{2}$ hours	—	10	20	32
84 to 90 ft. ...	40 to 60 minutes	3	10	15	30
90 to 96 ft. ...	55 minutes to $1\frac{1}{2}$ hours	5	15	30	52
96 to 108 ft. ...	40 minutes to 1 hour	10	15	20	48

In the Navy it is the custom when a diver varies his depth during work, to use the decompression times tabulated for the greatest depth he has attained. On this occasion, however, considering the somewhat dangerous

*For a full description of this see Report of an Admiralty Committee on Deep Water Diving, published as a Blue Book in 1908, or "The Prevention of Compressed-air Illness," Boycott, Haldane, and Damant, *Journal of Hygiene*, 1908, page 342.

state of the sea, and allowing for the fact that far more of his time under water had been spent at 82 ft. depth than at 98 ft., it was decided to hasten matters by using the decompression laid down for the case of one hour spent at 90 ft., but to extend the stoppage at 30 ft. from three to five minutes. Unfortunately, owing to the rolling and pitching of the diving vessel, caused by the heavy sea, it was found extremely difficult to keep the diver at the proper distance from the surface during his stops at 10 and 20 ft., and on one occasion, through misunderstanding a signal, he came right up to the surface, and two or three minutes elapsed before he could be got down again to 20 ft. In our opinion, it is to these irregularities in the decompression that the subsequent illness is to be attributed.

The diver was taken on board at 1 p.m., and the diving dress removed as usual. He appeared perfectly well, and gave a clear account of what he had been doing on the wreck. Soon afterwards, according to his own account, he felt pain in the chest, and began to cough; and a quarter of an hour later he was suddenly attacked by giddiness while walking the deck, and found himself unable to stand. At 2 o'clock his condition was first observed. He was found lying down and pale, with violent nystagmus; though intensely giddy, he was quite clear-headed, and answered questions readily. Arrangements were made at once to transfer him to H.M.S. *Edgar*, which was lying close to the diving vessel, and had the recompression chamber on board ready for use. In the meantime Milne became worse. The pulse, good at first, was now imperceptible, and his condition caused the gravest anxiety. There was no cyanosis or dyspnoea at any time.

In the rough sea it was a matter of considerable difficulty to transfer him from the diving vessel to a steam pinnace, and thence on board the *Edgar*, and the movement made him obviously worse; but by 2.45 he had been got into the recompression chamber, one of us remaining inside it to attend to him, while another worked the air valves from outside, communication being effected by pencil notes held up to the round glass window of the chamber.

Compressed air was admitted without delay, and the pressure within the chamber raised to 17 lb. per square inch. He became much better at once, the pulse returned, and he began to talk, spontaneously describing a sensation of warmth flowing down into his arms and legs, which was no doubt due to the rapid improvement of the circulation.

Owing to the existence of a small leak, the pressure in the chamber began to fall gradually when the admission of air was stopped, and, the rate of leakage being appropriate, decompression was allowed to go on in this way, no manipulation of valves being required. By 3.35 p.m. the pressure had fallen to 7 lb. to the square inch, the patient remaining well and bright; but a few minutes later, while the chamber was being ventilated and the pressure unsteady, he became ill again. The pressure was promptly raised to 15 lb., when he immediately recovered, and the pulse again became good.

At 4 p.m. he was given brandy (passed into the chamber by a small air lock), and the pressure was once more allowed to fall by leakage, the rate of which was now slower, as the door was screwed up more tightly. At 5 p.m. pressure was 7 lb. per square inch, and he was given a cup of soup, having had nothing to eat since 7 a.m. He continued well and bright, though the cold and discomfort of the chamber were obviously telling on him. The pulse was normal, but the nystagmus was still present, though in a far less degree than at first, and he preferred to keep his eyes shut, saying that he did not then see objects "swinging round him," which produced giddiness. At 6.15 p.m. pressure was zero, and the door was opened. As slight exertion (such as a change of posture) had produced faintness while he was inside the chamber a stretcher was employed to carry him to the sick bay of the ship, where he was made comfortable in bed with hot-water bottles.

On examination the heart was regular; the second aortic sound was accentuated. He said he felt quite well. He passed normal urine soon afterwards, and, after taking some soup, fell asleep and passed a good night.

The next morning he said he felt quite well except for tenderness over chest and back where the leaden diving

weights rest. (This is not uncommon after hard diving work.) There was puffiness over both temples and cheek bones, which quickly subsided. The heart sounds were normal, but the heart was slightly irregular. The following day, April 27th, he was quite well and was allowed up for three hours. On April 28th he was up all day, and he returned to duty on April 29th.

The recompression chamber was an upright steel cylinder, 7 ft. high and 5 ft. in diameter, the bottom being convex upwards. It had been constructed somewhat hastily in case of illness resulting from the very deep experimental dives carried out three years ago for the Admiralty Committee. Owing to its small diameter and the convexity of the floor, it was extremely uncomfortable and exhausting to the patient, besides being very cold.

The case presents several features of special interest. The probable cause of its occurrence has already been referred to, and it is evident that in very rough weather great care is necessary to prevent the diver from being prematurely brought up in consequence of the movements of the vessel. A comparatively slight recompression was successful, although one and three-quarter hours had elapsed since the diver came to the surface. In case of illness caused by rapid decompression from great pressures, recompression is often unsuccessful. This is evidently due to the fact that the volume of the air bubbles liberated in the blood and tissues is too great to be successfully dealt with. There seems every reason to believe that the more dissolved air has been got rid of in consequence of precautions taken in decompression, the greater will be the probability of recompression promptly relieving any symptoms, even after a considerable time from their first occurrence. Another point well shown is the extreme caution and deliberation required in decompression after recompression, and the consequent desirability of being able to keep the patient comfortable during this tedious process. The roomy "medical air locks," designed and first used by Mr. E. W. Moir in connexion with tunnelling work in compressed air, are in this respect far superior to the chamber which we employed. As a result of the above experience the Admiralty have initiated the construction of an improved chamber of the same dimensions, but designed to lie on its side, and to be fitted with a bunk, thus making recompression a far less exhausting and anxious experience for all concerned.

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Memoranda :

MEDICAL, SURGICAL, OBSTETRICAL.

CALOMEL IN ASTHMA.

LIVING in a small fishing town where asthma is rather prevalent, I have been much impressed by the beneficial effects of a dose of calomel as a curative for the attacks of this distressing malady. My patients have been mostly women, and of varying ages, and the attacks present the usual features in varying degrees of severity.

I prescribe a powder of calomel $\frac{1}{2}$ to 2 grains according to the habit of the patient, accompanied, of course, by some of the usual antispasmodic remedies, and my experience is that relief is rapidly obtained, even before purgation takes place.

Other cathartic drugs do not seem to have the same effect or certainly not so rapidly, and the ease with which the powder or tablet is taken is an important factor.

One patient, a widow of about 35, is so pleased with herself after being a martyr to attacks of dyspnoea for years that she is habitually armed with a supply of $\frac{1}{2}$ grain tablets, of which she takes one whenever she feels the slightest "tightness in her chest," and she was most anxious to treat her niece on the same lines for an attack of whooping-cough!

I am sure there is nothing very original in this line of treatment, but it may be interesting to other practitioners who, like myself, are brought into contact with cases of asthma more frequently than usual.

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A SIMPLE METHOD OF TREATING CERTAIN FRACTURES OF THE MANDIBLE.

THE method to be described is especially applicable to fractures at the angle of the mandible or in the region of the last molar tooth.

For various reasons it may be undesirable in such cases always to cut down from the outside and wire or screw the fragments in apposition; the only treatment then consists in fixing the mandible to the maxilla in its normal position and maintaining it so until union has occurred. This fixation may be attempted by means of a four-tailed bandage or some modification of the same, which usually fails to immobilize the jaw, and is, moreover, exceedingly uncomfortable for the patient. Interdental splints are practically of no use in such cases, as they fail to secure the smaller fragment and cause too much separation between the upper and lower jaws, which separation may possibly be permanent.

The following method has none of the above disadvantages and has the merit of being so extremely simple that no specialized skill is required in its application, and it can be carried out in a very short time and without any special appliances. It consists simply in fixing the lower to the upper jaw by means of horizontal ligatures passing round the crevices of two or more teeth in each jaw, the ligatures being securely connected by a third vertical ligature.

Reference to Fig. 1 shows the arrangement of these ligatures. They should be of silver gilt wire, but copper or German silver gilt or gold may be used. (Gauge 21 or 20, B.W.G.) The premolar teeth are the most suitable to which to affix the ligatures;

Lateral ligatures on the premolar teeth.

they are not so far back to be inaccessible, and the comparative narrowness of their necks make them suitable for holding the horizontal ligatures. All three ligatures are first applied loosely. The horizontal ligatures are next tightened by twisting the wire.

The lower teeth are then made to articulate absolutely accurately with the upper teeth, and whilst in this position the vertical ligature is tightened. Ligatures should be placed on both sides of the jaws, as otherwise a small lateral movement may be possible. The method may be used as a temporary measure in all kinds of fracture of the mandible, in which case ligatures of silk or silkworm gut may be placed round the anterior teeth, as shown in Fig. 2. This affords the patient much relief, and is much more reliable than a four-tailed bandage. The method may also be used as an adjunct to the open surgical methods of wiring the fragments, when fixation of the temporo-maxillary joint may be desirable for a time at least. Even if all teeth are present, the patient does not suffer from inability to take sufficient nourishment.

Anterior or temporary ligatures.

There is always sufficient space between the teeth and behind the last molars for liquid food to pass. Patients do not suffer very much from a diet of milk, porridge, arrow-root, soups, etc., for five or six weeks. In a similar way a patient can use an antiseptic mouth-wash, and use the tongue as a toothbrush on the lingual surfaces of the teeth.

The vertical wire ligature may be left on for a month, after which it may be removed and passive movements allowed; it may be replaced by silk ligatures, as being easier to apply. A vertical ligature should be continued until the sixth week, especially during the time or times the patient sleeps in order to prevent yawning, as the latter does far more harm than even a slight amount of mastication.

The method is, of course, only applicable to those cases in which there is a sufficient number of sound teeth present, but such fractures usually seem to occur in strong vigorous patients with a good set of teeth.

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