

should be down not over three and a half hours at the most (counting from the time he left the surface), and should take thirty-two minutes to ascend. At a depth of 34 fathoms he should not be down over twelve minutes, and will still require thirty-two minutes for the ascent. The times necessary for various depths are all laid down with great accuracy in the instructions issued by the investigators.

SYMPTOMS OF CAISSON DISEASE.

Mild symptoms of discomfort met with on the man first commencing the descent are really due, as stated, to the initial difficulty of equalizing the pressure at each end of the Eustachian tube, and consist of noises in the ears, a "bursting feeling" in the head, and pain in the frontal region and eyes. Swallowing usually relieves these symptoms speedily, but many divers find that they persist until the feet touch the bottom, when they are at once relieved. "Bends"—this name is applied to pains, more or less severe, which a diver experiences in his joints and muscles after working at the greater depths or for long periods below, and they are usually felt in those joints and muscles which he has been using at his work. They are, as a rule, prevented by the diver exercising his muscles, specially those he has used most, whilst waiting at the stages of his ascent. These pains come on most frequently after the diver has been up half an hour or more, and last a variable time. Sometimes they are very severe.

Dyspnoea, faintings, and syncope, if mild, and only noticed temporarily or on coming up, may be due to insufficient air supply caused by a defective pump, or to the diver not having learnt to control his valve properly. If severe, they are almost certainly due to his having come up too quickly, and in consequence to the formation of nitrogen bubbles in the circulation, tissues, and organs of the body.

Death.—Certainly due to embolism and blocking of cerebral or pulmonary vessels by the bubbles of nitrogen set free in the circulation by the too rapid decompression.

Paralysis.—This is not at all an uncommon symptom, and may be either unilateral or bilateral, and, again, may be merely transient or permanent. It nearly always affects the lower limbs.

Nausea and vomiting usually occurs directly the diver has come to the surface and has had the helmet removed. Generally seen in men who have had a heavy meal just previous to descent, or are not in good condition; also occurs quite often in novices after their first dip.

Bladder troubles, such as pain and retention of urine, may occur subsequent to diving, and urinary incontinence has been known to occur whilst the diver has been down, owing to pressure on the abdomen. Pain in the testicles is also sometimes complained of, and would follow deep diving where those organs have not been adequately protected.

Subcutaneous Haemorrhage—I have seen one case of this accompanied by subconjunctival ecchymosis.

Prophylaxis.—All divers should be examined medically before being allowed to undertake such duties, especially with a view to ascertaining their chest capacity and the absence of any cardiac weakness or arterial disease. This examination is always most carefully carried out in the navy. The following subjects are unfit to become divers:

- Those addicted to alcohol in any but the mildest degree.
- Those who are heavy cigarette smokers.
- Those with any tendency to pulmonary tuberculosis.
- Those who have had syphilis.
- Those who have any ear disease, especially otorrhoea.
- Those who are ruptured, and men who have adenoids, suffer from rheumatism, or have any tendency to arterial disease or varicose veins.

After any specific febrile disease, especially pneumonia, it is wise to forbid diving for some months, and then only after careful examination of the heart and lungs. I would draw special attention to syphilis; it is a disease which is widespread throughout the navy, though, owing to improved methods of treatment, more careful observation of syphilitics, and the declining virulence of the disease, much less so than it was a few years ago. These men are never safe as divers, and it is highly probable that diving may bring on those syphilitic arterial changes which lead to such grave late lesions of the disease. Most careful inquiry should be made to exclude all such candidates from diving classes. Men with urethral stricture and

those subject to attacks of retention of urine are also obviously unsuitable.

TREATMENT.

The treatment of "bends," as already mentioned, is mainly a question of prophylaxis, and should that not prevent their occurrence, resort must be had to massage and friction to ease the pains; the use of morphine is undesirable and seldom necessary. For the more serious symptoms of dyspnoea, fainting and syncope, the correct treatment—on the supposition that these symptoms are due to too rapid decompression—is to recompress the man. Send him down again at once to the last "stage" he halted at before coming to the surface, or if the case be very severe, pointing to the nitrogen saturation being that equivalent to a greater pressure than that of twice the pressure at the last stage, send him down further still, and then, after allowing plenty of time, decompress him very slowly. Even should the diver come up "black in the face" from cyanosis, he must have the helmet put on again and go down instantly.

For the *paralysis* little can be done, and, as mentioned, it is generally transient. Should it persist, it should be treated in the usual way by massage and electricity.

Apparent Death.—In cases of apparent death, where it would appear to be quite useless to recompress, artificial respiration and the other usual means of restoring animation should, of course, be resorted to, but it would seem likely that artificial respiration could only be employed with any real measure of success if done by another diver below the surface at half the depth the man had been working at, and this, though difficult, should not necessarily be impossible.

A FEW CASES OF COMPRESSED-AIR ILLNESS, WITH REMARKS.

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OUR present knowledge of compressed-air illness is so imperfect that I feel bound to report to the profession upon my experience as Medical Officer to the Rotherhithe Tunnel Works, however incomplete my investigations may have been.

There was at the works a large cylinder with compressed-air pipes laid on, which was called "the Medical Lock," and kept always ready for use; into this the affected worker was introduced, and rapidly recompressed to the amount of the pressure then existing in the tunnel. This process occupied about two minutes, and the air was then allowed to leak out; the lock was apparently airtight; but it got out somehow in about three-quarters of an hour. Ergotin was then injected and the patient sent home to bed, where morphine, massage, and electricity were exhibited as required. This was the traditional treatment, and there seemed to be no reason to alter it, although one or two men complained that the recompression made them worse, and many asserted that recompression in the tunnel itself was superior in its action to the medical lock.

Bearing in mind Snell's view that faulty ventilation was the principal factor, and Hill's opinion that too rapid decompression was chiefly to blame—I trust I quote these competent observers correctly—I directed my attention in considering causation first to these points. Samples of the air were taken once a month, and varied in the amount of CO₂ from 0.054 per cent. to 1.36 per cent. The County Council allowed the contractors a minimum of 0.08, but the men blocked the ventilators with their jackets to stop the draught, and this amount was seldom maintained. There were no closets or urinals, and the workers passed their excreta where they happened to be working, which did not improve the sanitary conditions. Earth closets were supplied at my request and were regularly used for a time, but the men fell back on their old habits as soon as the foreman relaxed his supervision; matters improved, however, as the cubic space increased.

As far as the initial compression was concerned the effect seemed to be merely one of aural discomfort, and as long as the Eustachian tubes opened to Valsalva's method of inflation, the rapidity with which the process was conducted was apparently of little moment. It must in this

connexion be noted that, going through the lock, as I generally did alone, it was easy for me to regulate the taps to meet my own comfort; but when thirty men went through together it is probable that the tympanic membranes in some of them were considerably stretched.

In the matter of decompression there was no discomfort at all, and therefore, as far as the men could understand, there was no reason why this process should be prolonged, especially as they were packed like herrings—sometimes thirty-two men in a space of 470 cubic feet. It only required one devil-may-care man to get in charge of the tap, turn it on to its full capacity, and bring them all through at a dangerous rate. I have been decompressed myself—a foreman at the tap—at the rate of one and three-quarter minutes for 15 lb., and this in face of my instruction that the decompression rate of one minute for every 5 lb. should be enforced. As a matter of fact, the conditions in the lock were so unpleasant—a confined space, no seats, a dense vapour, and overcrowding—that every minute seemed like five. To reduce the number of men entering the lock from thirty-two to sixteen was a matter of no small difficulty, and caused some friction. Further, one of the principal officials informed me “he thought that decompression should be conducted as quickly as it could be done.” This opinion he was, of course, unable to support by any convincing reason, but no doubt the expression of such a view would largely influence the workmen if he opened his mind to them as freely as he did to me.

For this, that, and the other reason, decompression was conducted at too rapid a rate if our present knowledge of the subject is correct—a danger that can only in practice be avoided by providing larger, more numerous, and more comfortable locks, these being fitted with taps carefully timed. Taps might even be made to conduct the graduated stage decompression recommended by Haldane, but the great practical difficulty is found in the workman himself.

I select a few of the more interesting cases, in the hope that, even with all their imperfections, the notes may be of some value to those studying the subject.

CASE I.

A. F., aged 36, entered the tunnel—then under a pressure of about 16 lb.—at 6 a.m., worked as usual till 2.30 p.m., and came out. He had left the lock about ten minutes when he was seized with acute pain in the abdomen, knees, and ankles. He re-entered the tunnel, and immediately felt quite well; he asserted that he “instinctively felt” that such a relief would be obtained. He walked about for an hour, and, believing himself to be all right, he passed through the lock again. On his way home the pains returned, causing him to retrace his steps for recompression, which this time relieved the abdominal pain, but left the pains in the knees and ankles unmitigated. At this stage he was examined, ergotin was injected, and he was placed in the medical lock under a pressure of 16 lb. The pains had subsided into numbness, the pulse was 60 and compressible, the temperature normal, the tongue clean, and the signs in joints negative; the superficial veins in the legs were somewhat congested, and there was impaired sensation to pin-pricks. The recompression was maintained for half an hour, and slowly reduced. The sensation he then declared to be normal, but the legs were still numb. As he lived close at hand he started, between two of his mates, to walk home, refusing the aid of a cab or other conveyance. He dragged his right foot, eventually catching it behind the left heel, and would have fallen if unsupported.

Seen at his home next morning, his pulse was 60 and the temperature normal. The paresis of the legs was more marked in the right, the superficial veins were still congested, the right leg was markedly dragged, sensation to pin-pricks was normal, but heat sensation was diminished; the knee-jerks were exaggerated, especially in the right leg; the heart sounds were normal; there were no signs of syphilis or other constitutional disease.

He was confined to his home for ten days, and then got about with the aid of sticks, but with great difficulty, his right leg still dragging. As massage and faradism failed to improve this state of affairs, he was admitted to the Hospital for Epilepsy and Paralysis on December 21st, 1906, three months from the date of his attack. He left the institution on December 24th at his own request, and refused to go back. When examined on June 1st, 1907, he was still obliged to use a stick; there was some wasting of the thigh muscles generally in the right leg and the limb was still dragged to some extent.

I give this case as one to my mind typical of compressed-air illness, and it was at the same time the most serious of those that came under my notice.

CASE II.

G. S., aged 45, on July 16th, 1907, on rising from bed at 4.30 a.m. experienced a slight pain in his left hip. He went to work, and seemed worse on passing through the lock into the tunnel; by 8 a.m. he was in so much discomfort that he went home. As there was no improvement during the day, he returned to the works, and was placed in the medical lock under a pressure of 16 lb., which was allowed to leak out. This was repeated several times, with complete relief, but the pains returned on the way home.

The knee-jerks were slightly exaggerated and the left leg dragged; there were no other signs. Pain was a marked symptom, and was not referred in this case to the knee, the usual seat, but to the hip and ankle. He was incapacitated for a fortnight, and then resumed work. He had worked in compressed air for many years at both high and low pressures, and never previously felt any ill effects. He was warned not to return to the compressed air, but he did so and remained well.

CASE III.

E. T. W., aged 36, on August 2nd, 1907, left the tunnel in his usual health, but was seized with pain in his back and legs before he reached home. He passed a sleepless night. Beyond exaggerated knee-jerks and ankle clonus his signs were negative, but, his pains persisting, he was sent into the local infirmary and was treated there and by me for over two months. On October 14th he re-entered the compressed air in defiance of warning, and was similarly attacked on October 16th. The relapse lasted a month, and, while the signs and symptoms were identical, it was greatly relieved by electricity, which had no apparent effect on his initial seizure.

CASE IV.

E. B., aged 34, on May 22nd, 1907, was seized on his return from work with severe pains in the legs, back, shoulders, and elbows. His signs and symptoms were similar to those of the cases already cited, and he dragged his right leg for some ten days. This case was singular in the respect that he had pain above the waist.

Cases in which pain in the legs lasted a few days were of daily occurrence, and were called by the workers “an attack of the bends”; they were entirely subjective in character, and one attack did not seem to predispose to another. A few cases of pain in the testicles came under my notice, but beyond the physical distress they showed nothing worth recording.

Conducting the medical charge of this great engineering work in conjunction, as I did, with many other duties, I fear the opportunities for studying compressed-air illness were much neglected, and it may be long before as large an area is again enclosed. In a confined space the elements which go to make up this interesting and curious condition are not to be found. There were many fewer cases of compressed-air illness in the Rotherhithe Tunnel than in the Blackwall, and I certainly think our efforts to produce a better sanitation and a longer period of decompression met with a measure of success.

Since writing the above I have enjoyed the pleasure and instruction of reading the able lecture by Dr. Greenwood, reproduced in the columns of the BRITISH MEDICAL JOURNAL, and I much regret that I, being ignorant of the fact that he was conducting these experiments, took no steps to bring his theory and my opportunity for practice into line. I was uniformly decompressed at an average rate of four minutes for 16 lb. scores of times, and the heads of the contracting firm were treated in the same way every day. Further, I have good reason to suspect that at the end of the shift the men turned the “muck tap,” and came out in a time that might be best stated in seconds. If Dr. Greenwood's views are correct, it is quite clear that in future operations in compressed air, medical arrangements should be made which the men not only may not, but cannot, infringe.

THE MENTALLY DEFECTIVE IN PRISON.

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THE inside of our English prisons is to the vast majority of the people a *terra incognita*. Nevertheless prisons and the prisoners have not received in the past the consideration that their importance demands, and it is very satisfactory to see that a commission of thoroughly competent gentlemen has been appointed to inquire into the treatment of certain classes of cases, and I venture to say that when the public realize the large percentage of mental