(2) that arising from external or local irritation, the peripheral or traumatic.

This classification indicates the line which the treatment should follow with success. Though there is no drug or set of drugs whose action can be called specific in a complaint with manifestations so diverse as in this, there are a select few we can use with confidence to obtain the necessary control over the neural disturbance, either directly or indirectly, be the exciting cause what it may.

Thus, if a storm of gout has upset the sympathetic nerves, with the result of an eczematous eruption, the usual treatment for gout must be adopted, plus a direct nerve sedative. In this instance potassium iodide and acetanilid act well; but colchicum should be avoided, as it dilates the capillaries and tends to increase the exudation, whilst it often has a distinctly irritative effect upon the skin.

In eczema of an asthenic type, from anaemia, the indication is the liberal administration of iron with such nerve tonics as strychnine and quinine, to brace up the vasomotors. If alcohol is the irritant, abstinence, with the bromides and atropine, will bring speedy alleviation, the latter because of its peculiar control over the capillaries and power of checking perspiration. It must be given in small doses, however, as increased amounts paralyse the termination of the secretory nerves and relax the capillaries. Dyspepsia, so frequently the exciting cause, calls for careful dieting, attention to the bowels, and correction of the alimentary disturbance, plus such nerve sedative as the bromides, in sufficient doses to arrest the gastric nerve irritation.

The eczema that accompanies uterine trouble disappears, as a rule, with its removal, just as the eczema of pregnancy terminates with the parturition; but a nerve sedative is essential to its immediate relief, and chloral and belladonna are the best here.

As in the above so in all others, of whatever nature, whilst carefully devoting attention to the exciting cause, the necessary nerve sedatives must form the one chief element in the treatment.

Local applications must be resorted to in addition, and of the thousand and one which have at different times been lauded, there are two or three only which are of assured and permanent benefit. Analgesic action is the desideratum to meet the peripheral irritation. Nothing can compare, for the immediate and permanent relief which it confers, with carbolic acid if properly utilized, but as it has hitherto been applied in almost futile style, its real practical value has not been realized. In almost every treatise on the subject, while it has been highly recommended as a relief to the distressing pruritus, the strength in which it has been prescribed has rendered it useless as a curative agent. Now, carbolic acid, as demonstrated long ago by Dr. Bill, is a most powerful local anaesthetic if used in sufficient strength, and the anaesthesia which it produces is persistent for a longer period than any other. The burning sensation it causes at first soon passes off, leaving a painless surface. The pure (liquid) carbolic applied to a red inflamed eczema gives sharp but short punishment and leaves the part practically dead, and this dries rapidly, forming a scab under which the previously raw surface heals quickly; the scab on falling off leaves the surface clean and sound. This is heroic treatment, and must be applied to only limited areas at one sitting; the pain of the application can be obviated by cocaine if the subject is sensitive, and before the effect of the cocaine has passed off the part will be anaesthetized by the carbolic. For small patches, such as appear on the hands, feet, scalp and ears, it is particularly serviceable. For general use in all eczematous eruptions at every stage the 1 in 11 solution should be used, and though it certainly smarts for a time, it gives immediate relief to the symptoms and rapidly checks and arrests the progress of the eruption.

Tincture of iodine also smarts somewhat, but gives great relief to the itching and burning, and lessens the infiltration. The two together make a happy combination —℥j of tinct. iodi to ℥ix of the 1 in 11 carbolic solution for a lotion, to be kept applied on lint under oiled silk. In the intertrigo which so commonly occurs between the toes and extends into the tough skin of the feet, a bath of this for the feet, frequently repeated, gives wonderful relief. Starch poultice makes a good vehicle for the application of this lotion, and is useful on tender surfaces, such as the face and neck, painted on.

Suprarenal extract is a good application previous to the carbolic, owing to its power of reducing the turgescence and exudation, thus leaving the surface fit for its action; whilst, applied in the very beginning of the initial erythematous stage, it will often entirely arrest it. Adrenalin is undoubtedly the best form of this substance.

Greasy applications should only be applied in the dry desquamative stage. Used in the moist stages, they only aggravate the trouble by retaining the acrid irritating exudation. This exudation should be constantly washed away with pure cold water, which should be poured very gently over the part, and all friction avoided. Soap, whether medicated or otherwise, should be religiously avoided. Suprarenal added to the water greatly increases the relief it gives.

These remarks are based on observations extending over the last fifteen years, during which I have met with very considerable success in following out my deductions on the neurotic character of eczema, and I commend the treatment as worthy of trial.

DIVING AND CAISSON DISEASE.

A SUMMARY OF RECENT INVESTIGATIONS.

BY SURGEON N. HOWARD MUMMERY, M.R.C.S., R.N.

[Communicated by the DIRECTOR GENERAL, R.N.]

As I believe that the recent and most important researches into the most interesting subject of diving have not been published in any form in the medical press which circulates amongst members of the medical profession in general, I may, I hope, be pardoned for attempting to enumerate them in brief form, and point out that the work done at the Lister Institute by Dr. Haldane, Dr. Boycott, and Lieutenant Damant, on behalf of the Special Committee appointed by the Admiralty, has completely revolutionized both the procedure of diving and the treatment of those morbid conditions which are met with among divers, and attributable to that occupation. In H.M. navy diving operations are continually being carried out for instruction, for periodical exercise, and for all kinds of practical work, though seldom at greater depths than 17 fathoms, and usually at much less. Medical officers of the navy are at times called upon to treat cases of so-called caisson disease, and a knowledge of the principles and practice of diving, and also of the best way to deal with any symptoms which may arise, is essential to them. Until quite recently, if anything went wrong with a diver he was at once brought to the surface, and was on no account permitted to go down again on that occasion. Now, on the other hand, should a diver come up suffering from the effects of too great a depth, too long a stay below, or too rapid an ascent, he is invariably sent down again, kept there for a certain time, and thereby cured.

When a man is subject to the normal atmospheric pressure of 15 lb. to the square inch, his tissues are saturated with nitrogen at that pressure. Suppose, now, that this man goes down in a diving dress to a depth of 28 fathoms; he will then be subject to the pressure at that depth—namely, 75 lb. plus the atmospheric pressure of 15 lb., making a total of 90 lb. The tissues, which were previously saturated with nitrogen at a pressure of 15 lb., will now have to become saturated at the new pressure of 90 lb., or six times as much as before. The blood will therefore take up nitrogen from the inspired air until that point is reached. This change that takes place in the amount of nitrogen in the tissues is called the "process of saturation," and there are three chief factors in its causation—"atmospheric pressure," or the normal one of 15 lb.; "positive pressure," or pressure in excess of atmospheric pressure; and "absolute pressure," or the total pressure at the time being plus atmospheric pressure. Therefore absolute pressure equals positive pressure plus 15 lb. The process of saturation takes place as follows: The arterial blood in the lungs takes up nitrogen from the inspired air, supplied by the pump, and conveys it to tissues, returning in the venous state to the lungs devoid of nitrogen and again absorbing it. The tissues, being only saturated with nitrogen at atmospheric

pressure, must naturally absorb more nitrogen from the blood passing through them which is saturated at a much higher pressure (90 lb. at 28 fathoms, as compared with 15 lb. at the surface). This process goes on until the tissues can absorb no more nitrogen, when, they containing the same amount as the blood, the body is said to be saturated fully at that pressure. Rate of saturation in man: Remembering that the volume of blood in man is nearly 5 per cent. of the volume of the body, and that the whole of this blood passes through the lungs once in one minute when the man is at rest, it is correct to suppose that the rate of saturation will be much as follows:

In a quarter of an hour saturation will be halfway.
In half an hour saturation will be three-quarters of the way.
In three-quarters of an hour saturation will be seven-eighths of the way.
In one hour saturation will be fifteen-sixteenths of the way, or complete.

Thus, after a diver has been working at 12 fathoms for one hour (that is under a pressure of 32 lb.) he would be saturated to 30 lb. As, however, owing to their difference in blood supply, some tissues will become saturated in man much quicker than others, it is obvious that saturation will be unequal, and in consequence, in actual practice, the human body is not fully saturated even after three hours' exposure to pressure. This process of saturation is known as "compression"; "decompression," or the reverse process, consists in bringing the diver up again to atmospheric pressure, and thus lowering the degree of saturation of his tissues to the normal amount at atmospheric pressure. This latter process is by far the more important, and on its proper management depends the chief responsibility for the health and comfort of the diver; the only other precaution, in a healthy man, being that he should not remain down too long, the rapidity with which he descends being of little importance—in fact, usually the quicker the better. The difficulty with regard to decompression that the investigators had to deal with was to bring the man back to atmospheric pressure as quickly as possible, without at any time allowing the amount of nitrogen dissolved in his blood to dangerously exceed the amount which corresponds to full saturation at the pressure to which the man is at that time exposed. If the pressure at which he was working were suddenly lowered to atmospheric pressure, the excess nitrogen would begin to diffuse out at once, and would, were it possible, escape again in the same time that it went in, the process getting slower and slower as the saturation of the body gradually approached that of the normal atmospheric pressure. This, however, cannot take place without the formation of bubbles in the blood and tissues, due to the liberation of excess nitrogen, which by forming emboli and causing blocking of vessels in various parts of the body would lead to grave or fatal results. A limit must therefore be placed on the speed with which decompression can be carried out. Dr. Haldane gives the following as a fundamental maxim: "The absolute air pressure on a man can always be reduced to half the absolute pressure at which his tissues are saturated at the time without risk of bubble formation." The correct way, then, to decompress a man is to reduce the air pressure on him by half at a time, giving him sufficient pause at each stage of reduction for his body to give off nitrogen until the amount left is only enough to produce saturation equivalent to the pressure to which he then is subjected. The pressure is thus reduced half at a time until he reaches the surface, and once again is subject only to normal atmospheric pressure, but, and this is most important, the nearer the diver approaches to the surface the longer the time allowed for his getting rid of the excess nitrogen must be.

From this it is evident that, in the case of a man who, diving, has been subjected to a pressure of, say, 75 lb., the process of decompression would occupy hours and the whole system be impracticable. To meet this difficulty, however, divers are not allowed to get fully saturated at high pressures, and the time limits are so arranged that the man diving starts to ascend saturated at a much lower pressure than that at which he has been working, and the process of decompression is graduated accordingly. In ascending it is important that the diver should come up between each "stage" as rapidly as possible and remain at each stage long enough—the longer the better in reason—and if he has been working at any appreciable depth he should exercise his muscles, especially those he has been using at his work, whilst waiting before the next stage of the ascent.

As any symptoms of caisson disease that may arise are due almost entirely to the time that the diver remains down, and not so much to the depth that he has gone down, it is important that the descent should be as rapid as possible. The only difficulty he meets with on going down is due to trouble with his ears, which difficulty is usually overcome by swallowing, and thus equalizing the pressure between the mouth and the tympanum by opening up the Eustachian tube. Another difficulty, which exists now only in theory—though it used to exist in practice—is that of keeping the pressure of air inside the diving dress equal to the pressure outside it. In theory this equalization of pressure is much mentioned and great stress is laid on its importance. It can, however, be easily understood that, were a diver's dress blown out with air at a sufficient pressure to attain that object at any depth below a few fathoms, he would be unable to move his limbs in any but the most restricted degree, and would be thereby prevented from doing the work that he went down to do. In diving at the lesser pressures in the navy it is common to employ partial inflation; but experienced divers and those working at greater depths use another means of avoiding injury from pressure. A strong wicker frame covered with felt, and shaped convexly to stand away from the body, is worn round the trunk under the dress, and thus keeps the pressure outside the latter from exercising any undue force on the thorax and abdomen. This frame also has an extension which protects the testicles and guards them from injury. Round the limbs the dress fits tightly and allows the diver free movement.

A single cylinder of a diving pump has a capacity of one tenth of a cubic foot. Ten revolutions of the pump should therefore produce 1 cubic foot of air. The diver at all depths will require 1.5 cubic feet of air every minute for respiration in comfort; it should, however, be remembered that in practice some divers are more comfortable with more or less than that amount, and that two divers down at the same depth and being supplied by the same pump may require different amounts. If the pressure (absolute) were counteracted by the method of dress inflation, instead of by the wicker frame, it would be obvious that the amount of air required for that purpose would vary accordingly as the depth varied. To guard against injury to divers it is most important that all parts of the diving "gear" should be in good working order, and that no possibility of air escape exists, as, in cases where divers suffer distress and show symptoms of fainting, such symptoms are almost invariably due to an insufficient air supply, caused by the pumps not being worked fast enough, air leaking past the pistons, or, as has lately been found to happen, air escaping at the junction of the pipe with the pump owing to the nut securing the former working loose. Should decompression take place too rapidly and slight bubble formation occur in the tissues, it takes considerable time for them to completely disappear from the system, and this should be borne in mind before allowing a diver who has been exposed to pressure, though apparently well, to go under pressure again until some long interval has elapsed. The length of this interval must depend upon the depth and the time that he has been down, but as a rough rule it may be taken that a diver who has been down in 15 fathoms for one hour should remain on the surface for three hours, and one who has been down in 25 fathoms or more for a quarter of an hour or less should not again go down on the same day.

The time a diver is "down" is counted as from the moment he leaves the surface to the beginning of the ascent. The time he may remain down is, of course, influenced by the depth that he has gone down and by the nature of the work that he is doing there, to a less degree. In any depth not above 7 fathoms there is, in reason, practically no limit to that time. The time taken over the ascent, in stages, is determined by the depth and the time spent at that depth, as the longer the diver is down the slower must he ascend, because the longer the time spent below the greater will the saturation with nitrogen have become, up to the full amount of saturation at the pressure to which he has been exposed. If working at 10 fathoms, he will have been subjected to a pressure of 26½ lb.; he

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.

Dyspnœa, 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 otorrhœa.
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 dyspnœa, 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 CO_2 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