In selecting a retort, one should be chosen with a beak of not less than an inch in diameter. If the beak has been drawn out by the glass-blower to a smaller bore than the above, it should be broken off at the proper point. This is effected by filing around a portion of the circumference of the beak with a sharp-cornered file, and administering a decided rap. The sharp edge of fracture should afterwards be rounded by fusion in the flame of a lamp. When the beak has the above width, the nitrate drops in easily and glides gently down into the bottom of the retort.

The retort may be connected with the purifier in two ways. A cork is fitted tightly into the beak of the retort, and pierced with a glass tube. This is the simplest method, and would probably be the best, if it were easy to get and retain a close fit with cork. But this is difficult, and especially so when the opening of the beak widens inward. It is better, therefore, to obtain about a foot of rubber tubing, which is large enough to stretch over the opening of the beak. This large tube may be connected with the smaller one, which passes to the purifier, by an adapter. The latter is easily made by drawing out one end of a glass tube, which has about the same diameter as the opening of the beak.

2. *Purifier*.—The gas is washed in one or more quart bottles. Through the cork, an ingress-tube is passed, reaching nearly to the bottom of the vessel, and an exit-tube which stops short of the washing-liquid. If the gas is collected in a bell over water, one wash-bottle is sufficient; if in a rubber bag, two had better be employed.

3. *Receiver*.—The receiver ordinarily has a capacity of thirty or forty gallons. India-rubber bags are generally employed, but they are not as serviceable perhaps as a floating bell. They are liable to decay from the action of acid vapours; and the mellowing of the gas when allowed to stand in them for a day or more, is probably due to the absorption of acid by the rubber, and is obtained at the expense of the bag.

A cylindrical bell, of galvanised iron, two feet six inches in height, and eighteen inches in diameter, contains about thirty-three gallons, and is of convenient shape and dimensions. The top of the bell is a cone of about two inches in height, and is terminated at its vertex by a stop-cock. Such a bell weighs about sixteen pounds. It is counterpoised by three nine-pound weights, fastened at the end of as many fixed pulleys. The wheels of the pulleys are arranged on top of three standards, which are riveted at equal distances around the side of the tank, and rise two feet seven inches above it.

When fresh water is run into the tank, it absorbs, at common temperatures, about its own volume of laughing gas. The water loses its gas very slowly, however, and the rate of subsequent absorption is correspondingly slow. This form of gasometer has the very great advantage that it finishes the purification of the gas. It is a matter of question, whether gas which has been allowed to stand for a number of hours over water in such a gasometer would not be pure enough for inhalation without the aid of a single wash-bottle; certainly, one wash-bottle for conversion of whatever nitric oxide, which has been formed, into nitrous oxide, is sufficient.

Materials.—The crystallised appears to answer as well as the fused nitrate of ammonia, and is from fifteen to twenty-five cents per pound less in price. A pound of either may be safely heated to ebullition in twenty minutes. As the bulk of material diminishes, the boiling correspondingly increases, and must be restrained by cautious regulation of the temperature. If, as sometimes occurs, the steam which arises from the decomposition of the nitrate of ammonia is formed in alarming quantities, the flame should not be entirely withdrawn. It should be lowered, but not to such a point that bubbles of gas cease to arise from the ingress-tube of the wash-bottle. Otherwise, an unexpected condensation of steam in the retort will create a vacuum, into which the contents of the wash-bottle will be projected by atmospheric pressure. The retort is disconnected with the wash-bottle at the adapter, and this is done immediately on withdrawal of the heat. And the boiling is not pushed to dryness, which would be fatal to the retort.

Each particle of the nitrate of ammonia, when heated to a temperature of about 480 deg., is decomposed into two particles of nitrous oxide and four of water. In a pound therefore of nitrate there would be 28.8 gallons of gas, and a little over five ounces of water. This is not quite true in practice, since the temperature cannot be regulated with sufficient accuracy, and various amounts of nitric oxide and hyponitric and nitric acids are formed along with the laughing gas.

The first wash-bottle should contain about a pint of saturated solution of protosulphate of iron, and a small quantity of free sulphuric acid. The nitric oxide yields up one of its two equivalents of oxygen to the iron, which is converted into sesquioxide, and passes out of the wash-bottle as nitrous oxide.

The free sulphuric acid is to facilitate the conversion of the sesquioxide of iron into persulphate.

If a second wash-bottle is used, it is filled with a pint of solution of

potash or soda to take up the acid vapours. It is well to allow the gas to stand for one or more hours over the surface of the water before inhalation.

My thanks are due to Mr. Walter Jackson and Professor Ellis for their kind assistance in the preparation of this article.

CARBOHÆMIA, THE ONE AND ONLY POSSIBLE SOURCE OF TUBERCLE AND TUBERCLE INDUCED MALADIES.*

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If the presence of pus, if waste nitrogen in the form of urea and uric acid, as accumulating in the blood, merit separate titles, assuredly the accumulation of waste and excrementitious carbon warrants a similarly distinctive appellation. I would commend, therefore, to the acceptance of all physiologists—in fine, to every one interested in a real as opposed to an absurd and spurious pathology—the term carbohæmia, as suggestive of a condition as real and distinct as are the several terms uræmia and pyæmia.

The kidneys are the great if not the only outlet of excrementitious nitrogen in the form of urea and uric acid, as they likewise are of the excrementitious phosphates; one resulting from the disintegration of the azotised soft parts, the other from that of the hard. On the other hand, the lungs are the main outlet, if not the only or exclusive one, for the excrementitious carbon furnished by the retrograde metamorphosis, or, in other words, the death of the animal tissues. There is no other source for the waste or excrementitious nitrogen and phosphates than the old or effete and dead particles of flesh and bone, removed during each several instant to make way for living and new. The blood which conveys away the old and used particles, also brings back the new. The excrementitious carbon itself is derived from the destruction of the living tissues. The blood, in fine, conveys away the old carbon and brings back the new.

The waste nitrogen, waste lime, and waste phosphorus have nothing to do except to get out of the economy with all convenient speed. This they do through the medium of the kidneys; but the waste carbon has yet something to do, another function to discharge, before it is got rid of. Just as West India planters burn the sugar-cane, the trash, when the sweet juice is squeezed out of it, in order to heat their boilers, so the excrementitious carbon, when the juice of life is squeezed out of it, is also burnt by wise Mother Nature, to keep up, cheaply and economically, the heat of the organism.

When certain abnormal states hinder the sufficient elimination of waste nitrogen, in the form of urea and uric acid, from the economy, then is the blood brought into the condition known to pathologists and practitioners in medicine by the term uræmia. When the accumulation proves excessive, there ensues speedy death to the entire organism; but when the accumulation is less urgent and excessive, we have that state of the economy which is called gout. The skin and kidneys do not discharge their duties sufficiently, and some of the waste azote is deposited in a dead and effete state in one or more of the joints, forming what the old physicians used to term chalk-stones, or what their successors have learned to designate as concretions of urate of ammonia.

If, again, pus find its way abnormally into the blood, we have the condition known by the name pyæmia. And, if this state of things do not prove immediately or speedily fatal, it very often happens that the pus-laden blood lays down its pus, now here now there throughout the organism; a fact too well known to need any demonstration or insisting upon by me. It was not always so, however. Time was, when this most important and interesting pathological fact was unknown utterly.

Not to advert more particularly to the occasional displacement of the lime phosphates, I now come to the more important matter, upon which I here more especially desire to insist, and which I claim to have first determined. The excrementitious carbon, in fine, by reason of insufficient oxidation, may gather unduly in the blood, and give rise to the condition which I would name carbohæmia. I have incurred ridicule, contradiction, and abuse for this statement, but let us look facts in the face and see wherein I err.

No one, I suppose, now-a-days, will venture to assert that the living tissues are not decomposed during each and every act of life. The waste nitrogen and waste phosphates take themselves off as I have said, but the waste carbon, what becomes of it? It is first burnt, that

* Read before the Physiological Section at the Annual Meeting of the British Medical Association in Dublin, August 1867.

is to say, it unites with the oxygen of the atmosphere, heats the body up to 100° Fahr., and, having discharged this] all important, and in truth, amazing function, disappears in the act of respiration in the guise of carbonic acid gas.

If, however, the air which is habitually respired have been but in part respired before, for air wholly respired is quite irrespirable, and produces immediate death, the result is the accumulation of the effete carbon in the blood, and its final deposit as tubercle in the tissues, where, sooner or later, it induces local irritation, followed by general hectic, winding up with the destruction of the entire organism. If, indeed, tuberculation be not owing to the unnatural retention of the carbonaceous waste, and if tubercle itself be other than this waste, I should like to know from what source it springs, or what becomes of the unoxidised carbonaceous waste, unless it turn into tubercle, since there is no other or obvious practicable outlet whatever. This question I have often asked those who objected to my theory, but no objector has attempted to answer it. I submit, then, that tuberculation is alone the result of carbohæmia, and that carbohæmia itself is induced by the respiration of air that has been respired before.

The term tubercle is quite conventional, and was at one time, indeed, applied to any rounded morbid growth whatever. It is now, however, by common consent, restricted to the deposits invariably present in consumption and scrofula, as well as cognate maladies, and, in fact, constitutes their entire *raison d'être*. Tubercle, as thus, may be deposited in any gland, or bone, or nerve structure, or joint, on the mucous, serous, and cutaneous surfaces, as well as in the various viscera. It has been detected in the blood, and may be transported emboli-wise from one situation to another. Otherwise, and without a doubt, as we witness in the disappearance of scrofulous tumours and obsolescence, coupled with admixture of the earthy salts of degradation, of tuberculous masses, tubercle may be absorbed. In this case, it may be dissipated by oxidation, or possibly deposited afresh. I entertain, indeed, little doubt that a continual process of tubercle absorption and redeposit goes on in all cases of scrofula and phthisis until death, or until, haply, recovery ensue. Unquestionably, recoveries in phthisis would vastly oftener take place were it not for the continuance of the destructive habit, particularly at night, of breathing prerespired air, the very practice which, as I allege, invariably induces the disease. As for the alleged production of tubercle from inoculation otherwise than as emboli or as predisposed subjects affording a nucleus, just as the particles of injected mercury have been known to form a nucleus for tubercle, I must be permitted to express my utter dissent. For how could dead effete matter, as tubercle confessedly is, thus propagate itself? In short, recent tubercle is a carbo-hydrogenous mass made up of waste or retrograde carbon and hydrogen, not oxidised, because of respiring already breathed air, and therefore necessarily and inevitably deposited in the organism.

Tubercle, it must be recollected, consists of dead, and therefore inorganic matter, with whatever residue of effete tissue structure, and has, in fact, no more vitality than the mud in the street or the stone in the wall. It may subsist for a long period of years even when in minute quantities, without entailing much, if any, disturbance. But the cause which first induces it, leads also, in general, to its further development, until it become a burthen too intolerable to be borne, and suffering nature in her anguish resorts to every expedient, alas, for the most part vainly, in order to get rid of it.

Ancient physicians, unaware of the reality, looked on the results of tubercle as so many different maladies, according to the locality in which the pressure of its presence was most felt. They did not know that "water on the brain" was but a result of tubercular meningitis. They did not, and too many after them do not, know that "white swelling" was no other than tubercular synovitis. They did not know that caries of the spine and other bones, was tubercular osteitis. They knew not the real character of phthisis of the larynx, of *tubes* of the mesentery, or indeed of phthisis itself. And they were unaware, as too many to this day are unaware, that consumption and scrofula are absolutely identical maladies, save that in scrofula tubercles are deposited externally, whereas in consumption they are deposited internally, while, in other respects, these greatly destructive maladies are only too often united. For ages, until William III discountenanced the mummery, it was believed that the king's touch dissipated the "king's evil." The litany for scrofula, indeed, may still be read by the curious. Even in our own day, fish-oil is insanely administered to the neglect of the one and only remedy which nature supplies at once for removing and preventing the disease.

Tubercle, under the circumstances productive of it, that is to say when the excrementitious carbon is not oxidised by sufficient congress with the oxygen of the air, is liable to implicate every breathing creature. It is only, however, when the inferior animals participate in

the forced and unnatural conditions to which man also subjects himself, that they become liable. The creatures of the waste, under nature's guidance, are exempt always.

Notwithstanding the infinitely simple and reasonable theory which I have propounded, and, as I believe, amply proved, so far at least as anything in this world is capable of proof, almost every other unreal and illusory origin, each one more unreal and illusory than the other, has been and still is adduced. It was, however, a step in the right direction when it came to be admitted by Carswell, Rokitansky, Bérard, and others, that tubercle was perfectly devoid of life and organisation; but this led to no useful or practical inference until I had further pointed out that tubercle was not merely inorganic and lifeless, but that it was an effete mass, the resultant of the waste hydrogen and waste carbon of the organism. That tubercle, however, had in some way to do with perverted and incomplete respiration, was long overlooked, and still continues to be overlooked. And yet Baudelocque, in the case of scrofula, and Fourcault, in that of phthisis, both declared that these diseases had to do with a foul and tainted atmosphere. Without this, affirms Baudelocque, in sentences of emphatic utterance, there can be no scrofula, with it the malady is inevitable. Fourcault is hardly less emphatic with respect to phthisis; but neither of these inquirers was quite aware of the common nature of consumption and scrofula, or how it is that fouled air is productive of them. They did not know, any more than my opponents and detractors now know, that it is not every species of fouled atmosphere that is productive of phthisis, but only that which is laden with the products of respiration. For if an atmosphere already breathed do not abound, air otherwise how much soever foul and stenchy will not induce tubercle, will not cause consumption.

It was observed that men and animals from warm climates contracted phthisis readily in cold; but this was ascribed simply to the influence of cold, instead of being referred to the foul medium in which such men and animals in colder regions were apt to be enveloped. Lombard, Ancell, Carmichael Clark, and others, showed the great liability of children, artisans, and persons pursuing indoor occupations generally. Baly dwelt on the frequency with which prisoners and inmates of asylums, confined night and day to a more or less close and stagnant atmosphere, were implicated. But in all these cases imaginary influences—at least, influences falling short of, and going beside the real ones—were assigned. Roche pointed out that rabbits reared in barrels became tuberculous; and Rayer, though otherwise ill aware of the great realities at issue, declares emphatically that those animals alone incurred tubercle, which had also incurred the pains and penalties of domesticity in man. How different might now be the results, if only a rational pathology and sound therapeutics which it dictates had prevailed.

It is some twelve or thirteen years since I first promulgated the theory that the unexcreted—because unoxidised—carbonaceous waste was in reality the exclusive source of tubercle. The effete tissues, tissues which have passed from life to death, are thus arrested in the blood, and finally, so to speak, silt up as tubercle within the living organism. Oxidation is nature's indispensable agent for getting rid of the effete carbon. But if the breath—any part of it—be respired again, complete oxidation becomes impossible, and tubercle inevitable. One follows the other as closely as the shadow follows the substance. Direct observation and induction, otherwise the method of reasoning termed exclusion, dictate, I aver, no other issue. Air may be fouled in a thousand ways and yet not cause tubercle; but air breathed before, and consequently loaded with the products of respiration, hinders oxidation and induces tubercle inevitably.

Let me repeat. By a striking and wondrous economy each several act of life entails death in a portion of the hitherto living tissue, which, now become defunct, is replaced by newer tissue to die in turn, and so on, while life and organisation endure. The waste nitrogen, oxygen, sulphur, lime, and phosphorus escape most part by the kidneys, but the outlet, mainly, for the waste carbon and waste hydrogen are the lungs, provided always that air not prerespired forms the aliment of life. For in this case carbohæmia results, and the unoxidised carbon, finding no adequate issue, gravitates of necessity within the economy, and, unless the process can be arrested, consummates its destruction. And thus it is that air already breathed and breathed anew, proves the single source of tubercle and tubercle engendered maladies. And thus, too, is at last explained, a hitherto quite unresolved problem, the destination of the unoxidised carbonaceous waste; for this solid *caput mortuum*, this uneliminated waste, is, in fact, tubercle; and, conversely, tubercle is no other than the uneliminated carbonaceous waste.

These conclusions, if substantiated, and I believe, with my most entire conviction, that I have substantiated them all, realise an enormous advance in respect of the pathology of consumption, involve, indeed, nothing short of its extirpation along with that of the various cognate maladies from the world.