The only way out of the difficulty is to follow the example of the naturalists, and classify objects according to their structural characters; their name in such a classification will then give the key to the recorded experience about their properties. Whether the term cancer should be applied to an anatomical group, that is, to a special type of structure, or to a class of tumours growing in a particular way, that is, to a physiological type, is a question chiefly of convenience; but the term "malignant tumour" seems adequate for the latter. Cancer, or its Greek equivalent carcinoma, will then be an anatomical, not a clinical term. Of anatomical definitions of cancer, that of Virchow remains the most complete; viz., a tumour containing epithelial or epithelioid cells enclosed in an alveolar stroma; other peculiarities in the arrangement of the cells being also a part of the definition. It is difficult to define precisely what are epithelial cells; but the essential thing is the existence of two kinds of structural elements, and a certain contrast between them. Ranvier, laying stress upon one of these elements—the stroma—calls cancer a species of fibroma. Waldeyer, on the other hand, attaching more importance to the cells, regards it as an essentially epithelial growth, extending into the connective tissue. The stroma and cells are, on this view, of distinct origin, and take their rise, even on principles explained in the former lecture, from different embryonic layers.

It is at present a point of much controversy whether this supposed duality of origin exists, or whether all the elements, as Virchow supposes, arise from connective tissue. On the one side, it is urged that cancers in this sense arise only in parts where there are epithelial elements, and that continuous outgrowth may be traced thence into the tumour, while no transitional forms are met with. On the other hand, it is urged that there are actually transitional forms between the cells of cancer and connective tissue-cells, and that the latter are only stimulated by some infection communicated from neighbouring parts to take on a particular kind of growth.

The case appears to be rather different with respect to epithelioma and the more deeply seated cancers. In the former, there seems to be much reason to believe that all the epithelial portion of the tumour is an outgrowth from pre-existing epithelium, leaving out of account for the time the extremely rare cases of supposed epithelioma originating elsewhere than on epithelial surfaces.

Waldeyer and other pathologists extend the same principle to other forms of cancer, supposing that these originate in glands, and bear the same relation to them as epithelioma to the epithelium. At all events, it is contended they never originate except from epithelium of some kind; and accordingly the name of cancer is refused to tumours springing from bone, connective tissue, lymphatics, or other non-epithelial parts. The details of this question admit of much discussion; but it may be said generally that the mode of origin is not so clearly demonstrated in the case of other cancers as in epithelioma. Moreover, instances may be quoted of tumours with the structure of cancer growing from non-epithelial tissues, and the difficulty is not wholly surmounted by calling such tumours alveolar sarcoma. The conclusion is, that the exclusively epithelial origin of any special type of structure called cancer is not proved. To take the origin as the basis of classification, and to call only such tumours cancer as arise in or from epithelial parts, is of course to shift the basis of nomenclature and to destroy, in effect, the anatomical definition of cancer.

Malignancy is not a property of cancer only, but belongs to different classes of tumours in different degrees.

With respect to the occurrence of cancers in several parts of the body, one of these tumours is believed to be always primary, the others secondary. Secondary growths are excited by some material substance carried to the new site from the primary cancer. Whether this substance consists of cells or of some seminal principle (*seminium* of Virchow) which stimulates the tissue-elements to new growth, is a subject of controversy. It may be said that the transport of cells certainly occurs in some cases, while the *seminium* is a perfectly hypothetical substance. Anyhow, there seems reason to believe that the tissue-elements of the new site participate in the new growth, which is not formed (as Waldeyer asserts) wholly after the manner of a graft by growth of the transplanted elements.

These considerations suggest an answer to the question often proposed, whether cancer is local or constitutional; for, if this be the true history of cancer, then it is clearly, in its origin, local; whether or not, there are characters superadded to it which make it constitutional in any one of the many senses in which that word has been used. This is the moral of the whole story, and the story must have been badly told if it have not suggested it.

ON CERTAIN POINTS CONNECTED WITH THE TREATMENT OF CASES OF NECROSED BONE.*

By H. G. HOWSE, M.S.,

Senior Assistant-Surgeon at Guy's Hospital.

It is well that in a paper of this kind the writer should be as explicit as possible in enunciating the *principle* which he wishes to support. I will, therefore, first state my proposition, and afterwards bring forward facts and arguments, as far as time will permit, in its support. It is that, in operating upon a case of necrosed bone, where the sequestrum is surrounded by a large mass of new bone, often of considerable density and thickness, it is most conducive to the success and speedy cure of the case to cut away the new bone very freely, so as to leave the cavity in which the sequestrum is placed freely exposed, and thus to allow it to close by granulating from the bottom.

This, then, is my proposition. It stands opposed to the surgical teaching of the present day, as I shall show directly. I will cite only one authority, but it is from a work more widely read, perhaps, than any other English surgical work of its size. Mr. Erichsen (6th edit., vol. ii, pp. 152-3) says:—"Care, however, should be taken not to remove more of the new case than is absolutely necessary, as the aperture so made will not be filled up again by osseous matter, but by fibrous tissue, and thus the ultimate soundness of the limb might be endangered. . . . If the sequestrum be too large to be removed entire through the cloacæ, it may, perhaps, best be extracted piece-meal, having been previously divided by passing the points of narrow but strong cutting pliers into the interior of the bone."

Such being the present surgical teaching, I must bring forward the facts and arguments which seem to me to prove conclusively that it is wrong. In the first place, why is such a view maintained—why, in an operation for the removal of necrosed bone, does the surgeon seem as if he were anxious to preserve every particle of new bone that he possibly can? I believe the answer simply to be, that this is an age of conservative surgery. We save arms and legs that our forefathers would have ruthlessly lopped away; we resect joints that would have subjected their owners to the same forfeiture; we perform plastic operations on lips, noses, perinæums, and even bladders, and, because the result has been highly satisfactory in these cases—beneficial alike to the profession and to the public—therefore we must apply the same rule to the saving of new bone; therefore, the result will be to us as satisfactory in the one case as in the other. But there is no rule without an exception, and the present case is, I submit, an exception. Let me narrate a typical case illustrating my proposition.

H. H., a lad aged 12 years, was struck on the leg by a cricket-ball. The blow caused him sharp pain, and he left off playing for the day; but he was able to walk about that and the following day or two. It became, however, much swollen, and an abscess formed and burst after some time. He was brought to me ten weeks after the accident. There were then two or three sinuses about the middle of the leg, and there was thickening of the tibia extending from the upper third right down to the internal malleolus. He could, however, move the ankle pretty freely. I told the parents that the blow had killed a large part of the bone, and that an operation was necessary, to which they readily consented; but, as it was not certain whether the sequestrum had yet separated, I put it off for six weeks longer, so as to ensure this result. At the operation, the sinuses were laid into one, some new bone cut through, and a piece of sequestrum readily removed. A long iron probe then passed upwards quite as high as the thickening extended, and downwards into the interior of the internal malleolus (the lower cavity being much the longer), but no more dead bone could anywhere be felt, the whole of the cavity being lined with soft granulation-tissue. In order to satisfy my mind upon that point, I traced out the upper sinus to its end, cutting through the plate of new bone covering it in, so as to expose its cavity freely. The lower sinus was also traced down for about an inch and a half. The wound was washed out with a dilute solution of carbolic acid, and the cavity filled with lint soaked in carbolic oil; this dressing being repeated every day. What was the result in this case? The wound granulated up to perfection in its upper part, but left a sinus at its lower part communicating with the large cavity in the new bone. This remained open, though, after probing, I felt satisfied that no more dead bone remained. I lost sight of the patient for awhile, but he was at length brought to me again, after about six months' absence, the sinus still remaining open and running as

* Read before the South-Eastern Branch.

deeply as ever. Under these circumstances, I decided to operate again, and open up the lower sinus as in the case of the upper one. This was done a day or two afterwards, the new bone was cut through, and the cavity laid freely open. No more sequestrum was found. In removing the new bone close by the internal malleolus, a small portion of the epiphysal cartilage was cut through; but, as the operation was performed antiseptically, I did not mind this. In the course of a few weeks, the whole of the wound granulated up from the bottom, and, when I last saw him, no trace of anything wrong remained except the large scars on the leg. The bone had resumed its original size, and he expressed himself as being quite as well as before the accident.

This case will also illustrate the second proposition to which I wish to draw your attention: that, in a case of necrosis, it is not only advisable to cut through the new bone bridging in the sequestrum cavity, but also to scrape completely away the granulations lining that cavity.

Thus both my propositions are *destructive*, not *conservative*. But why is it prejudicial to leave the new bone and the granulations? I have given you a case where it proved practically injurious to do so, and this case is not an isolated one, as far as I have seen. I think the treatment depends on facts which are readily verified. The first reason is a very obvious one—merely mechanical.

A. It is advisable to lay the whole cavity bare, because there may be a very small piece of bone concealed amongst the granulations; this escapes detection by the probe, and will quite prevent the closure of the sinus until it is removed.

Examples of this may be seen so frequently in operations for necrosis, that it is scarcely worth while to refer to any individual case. The sinuses, in a case of necrosis, especially when the formation of new bone is considerable, are often very tortuous, and, unless they be laid open, it is impossible with the probe to reach their end. Hence a piece of sequestrum may very readily escape detection.

B. The structure of the granulation-tissue lining a sequestrum will of itself often prevent such a cavity from closing. I have on several occasions cut sections from the large fringe-like granulations lining necrosis sinuses. The usual structure that they possess is a blood-vessel in the centre, surrounded by very imperfect connective tissue, and, externally, several layers of pyoid cells. But on some occasions I have found that, in place of the pyoid cells, the sinus-wall was covered over with a beautiful squamous epithelium just like a mucous surface. In fact, the passage had become a *permanent way*, and, while the granulations possessed that structure, there was no more likelihood of its closing than there was of a bit of bowel or the duct of some gland obliterating itself. This, I think, must be the reason why, after removal of necrosed bone, sinuses, if left untouched at the time of the operation, will remain *statu quo* for months. Thus I have often seen sinuses, in cases of cured hip-joint disease, remain open even for years without any very obvious reason—I mean, as passages for the exit of discharge. But, viewed in the light of the structure just described, the reason becomes plain, and the treatment equally so; viz., the destruction of the epithelial surface. And this is best done by scraping away the granulations bodily.

Certain cases of fistula in ano, salivary fistula, etc., are curable by the introduction of irritating injections, or of a red-hot wire. It is probable that at least part of the good effect attending this treatment is due to the removal of the epithelial layer lining the sinus. The beneficial result of the red-hot wire is usually attributed to the contraction which a burnt tissue always sustains in the process of cicatrization; but there is reason to believe that quite as much may be due to the destruction of the epithelial surface as to the gradual contraction.

C. Another reason for scraping away the granulation-fringes is, that they very frequently entangle in their folds *débris* from the sequestrum, which will act as a foreign body and prevent the sinus from closing. It may be considered that this is rather a remote and unlikely cause, but it is not so, as may be shown by a consideration of what I may call the *natural history* of a case of necrosis. Supposing, then, that we have a sequestrum contained in its case of new bone—supposing also that no surgical interference is applied to the case, how does nature herself set to work to cure the patient? Partly, no doubt, through the suppuration which goes on around the dead bone. The pus so formed tends to push the sequestrum out through the sinus-openings, or by forming fresh abscesses to form new apertures, and thus to get rid of it. But, in the majority of cases, it is impossible to dispose of all the necrosed bone in this way; and hence we find that partly the sequestrum is removed through the agency of the granulation-fringes lining the cavity in which it is contained. These fringes are very vascular, and, lying in contact with the dead bone, erode and absorb it, just as a thoracic aneurism will hollow out and finally remove the sternum or the dorsal vertebrae. This is the reason why we see so many little pits and depressions on the surface of a sequestrum. Each little hollow probably at one time corresponded with a little granulation which fitted into it. In the case of the larger

hollows, I have often seen, at the time of performing a sequestrum operation, the fringe as above described fitting into it, and I could not reasonably doubt that it had formed the hole. Indeed, on two or three occasions, I have found the tip of the fringe so fitting into the hollow that it could not be withdrawn without tearing it off at the constricted neck. In this case, it was probable that the deeper bone was softer, and thus more easily absorbed, than the superficial, so that the end of the fringe grew more rapidly than the constricted neck. The dead bone being absorbed in this way, it will be evident that numerous little scales and spicules will become separated in course of time, and, lying loose in among the granulations, and surrounded more or less with pus, will tend to prevent them from uniting, and thus keep open the cavity.

D. A third reason for the removal of the granulations is, that they occasionally undergo caseous degeneration in old cases of necrosis, where they have attained a considerable size. This is probably due to some alteration in the blood-supply to their interior, whereby a deficient amount is sent to it, and they consequently undergo this peculiar kind of fatty degeneration.

Time will not permit, to-day, my bringing forward illustrative cases; but I should like to deal with one or two objections that may possibly be made to the treatment. First, there is the one already quoted here, that the cavity made by cutting away the new bone so freely does not fill up with bone, but with fibroid tissue, and that thus the ultimate strength of the bone becomes endangered. I believe this to be an entire mistake. The cavity first fills up with granulation-tissue; this speedily ossifies, and thus the outline of the bone is restored. In a great number of cases of necrosis on which I have operated, I have cut away the new bone very freely indeed, and have always found the cavity fill up very rapidly in the way described. The only precaution which it is necessary to take is to leave a bridge of the new bone by the side of the cavity, so as not to divide the continuity of the bone. In a case of this kind operated upon some months ago at the Evelina Children's Hospital, I cut away all the new bone right through to the white shining periosteum at the opposite side, leaving only a bridge of new bone so delicate and flexible that it left the impression on the mind of the casual observer that the limb was broken. This was a second operation. At the first, I had laid open several sinuses leading into cavities of new bone, but failed to find any sequestrum. It had probably been absorbed by the process already described. The cavity healed, all but one sinus, which led into another hollow placed in rather a different position from the first; this must have escaped observation at the first operation, as it lay quite at the posterior aspect of the bone. To reach it, I had to cut away most abundantly all the new bone formed since the first operation, and then removed the shell of the cavity as before mentioned. In this case, I was rather apprehensive as to the result; but the rapidity with which the cavity closed was something marvellous. In a few weeks, the opening had quite filled up, the tissue ossified, and the wound healed, and the last time I saw the child the outline of the limb was very little different to the other.

The only exception to this rule of rapid bone-formation, that I know of, is in adults who are the subjects of some dyscrasia, such as tubercle or syphilis. But, then, what surgeon would think of performing sequestrotomy upon a patient far advanced in consumption? The case is different with syphilis. We know full well that no wound will heal readily in patients suffering from this poison. Indeed, the condition of the viscera is often so bad, that no operation at all is advisable. In any such case, the age of the patient, the activity of the poison, and the condition of the viscera, must be the main things taken into consideration in determining the extent to which it is safe to remove the bone or incise the soft parts.

The last objection to which I shall refer is the fear of what is called "osteomyelitis", which, we are told, nearly always terminates fatally by pyæmia. The risk of this is, I think, quite removed by practising a modified form of antiseptic surgery. In all such cases, directly after the operation, if it be not performed under the spray (which, however, I generally make use of at the present time), I wash out the wound with a solution of carbolic acid in water (1 in 40), and then plug it with lint soaked in a mixture of carbolic acid and olive oil in the proportion of 1 to 20. The dressings are changed each day, and the wound bathed in a similar solution of carbolic acid until it is quite clean, when it may be dressed every two or even three days, especially if Lister's antiseptic gauze be applied externally. Treated in this way, I have never seen a case of osteomyelitis, except in one patient who was the subject of syphilitic necrosis of the whole of the tibia, with lardaceous viscera and nodes on the skull; in fact, in such a condition (though a country-woman) as is rarely seen save in the worst inmates of our syphilitic wards. In this case, a slight operation for the removal of a

large projecting sequestrum sufficed to cause severe erysipelatoid inflammation of the whole of the leg, followed by sloughing, uncontrollable by any treatment that we could adopt. I am bound to confess, however, that the dressings in this case were neglected for two or three days, during which circumstances prevented my personal supervision of it, and the erysipelas appeared to arise as a direct consequence of this neglect. Clearly, then, this case is not an exception to the rule enunciated above.

ON A PORTABLE PNEUMATIC APPARATUS FOR THE MECHANICAL TREATMENT OF DISEASES OF THE LUNGS AND HEART.

By L. WALDENBURG, M.D.

Professor in the Royal University in Berlin.

By means of pneumatometry, introduced by me as a means of diagnosis (see *Berlin. Klin. Wochen.*, No. 45, 1871), it has been shown how important it is to distinguish between the different diseases of the respiratory organs, to study inspiration and expiration as two separate acts. It appears that in one class of diseases the inspiratory power may be intact, or even increased, while expiration alone is interfered with. This condition is seen principally in emphysema.

In another class of diseases—as phthisis in the first stage, stenosis of the trachea, etc.—only the inspiratory power is diminished, while expiration is quite or nearly normal. Finally, in the advanced stages of phthisis, inspiration as well as expiration may suffer. The idea naturally suggests itself, that it would be of importance for therapeutics to operate upon inspiration and expiration separately. Several years ago, an apparatus was constructed by Hauke, which permits both the inspiration of compressed air and expiration into rarefied air. This latter method is indicated for emphysema of the lungs, while inspiration of compressed air is recommended by Hauke for phthisis and croup. Later on, Berkart constructed an apparatus for the treatment of emphysema, in which, by means of a suction-pump, he produced a space with rarefied air into which the patient expired. Hauke's apparatus, which I used first, and which is dependent upon a pump-arrangement, proved to be insufficient, since it works with a very limited and continually varying power, aside from other lesser defects. I therefore constructed another apparatus, which I demonstrated in September last before the German Congress of Physicians in Wiesbaden, and which, I believe, satisfies all reasonable demands. I do not think it necessary to describe this apparatus, the annexed cut being sufficient to explain it; and I will only mention that both the inner and outer cylinders are one *mètre* (39 inches) high, and that the diameter of the former measures 27 *centimètres* (10.6 inches), that of the latter being 30 *centimètres* (11.8 inches). The mode of using it is exceedingly simple. The apparatus is filled with water to the height of about 20 *centimètres* (7.8 inches). Weights being attached to the cords, these tend to draw up the inner cylinder, and thus rarefy the air therein. The pressure of the atmosphere upon the cylinder amounts to 591.7 *kilogrammes* (about 1,300 English pounds). According to the weight attached, the air is rarefied in a ratio which may be exactly calculated; the weight of the inner cylinder, which amounts to about ten pounds, being allowed. When, for instance, thirty pounds are attached, this gives a net weight of twenty pounds, which corresponds to about one-sixtieth of the atmospheric pressure (= 12 *millimètres*) of mercury. The mercury-manometer attached to the apparatus

shows the same number. From the inner cylinder, a tube proceeds to a mask which may be firmly adjusted upon the face, and which is provided with a cock in such a manner that either the air in the cylinder is shut off, and only communication with the outside air exists, or, *vice versa*, the connection with the latter is broken, and the mask communicates only with the air of the cylinder. If the cock be opened while the weights are attached, the cylinder sucks air in with a constant force (in the above example, one-sixtieth of atmospheric pressure), and rises. If the mask be now firmly held before the nose and mouth, and an expiration made while the cock is open, the air is drawn out of the lungs with constant force, and expiration assisted; and we may likewise, by working in opposition to the suction, inspire rarefied air. Should it be desired, on the contrary, to employ compressed air, the cylinder is first raised by attaching weights; these are then taken off, and weights laid upon the cylinder. If, for example, ten pounds be laid on, we work with a power of twenty pounds (= one-sixtieth of an atmosphere), and again the mercury-manometer shows a pressure of 12 *millimètres*, but in the opposite direction. The cock being opened, the condensed air streams out under constant pressure, and may be employed for inspiration.

I have investigated the effects of condensed and of rarefied air on healthy and diseased persons, and arrived at very important results, which followed with almost the certainty of a physical experiment. I may state that the power which I employ, both for the rarefaction and for the condensation of the air, amounts generally from one-sixtieth to one-fortieth of an atmosphere (20 to 30 lbs.); that I have, however, in exceptional instances, gone as high as one-twentieth of an atmosphere.* I will in this place merely give a short statement of the results. For details, I must refer the reader to the *Berliner Klinische Wochenschrift*, Nos. 39, 40, 46, 47, of last year.

A. *Effects upon Respiration.*—1. By inspiration of condensed air, and by expiration into rarefied air, the ventilation of the lungs is for the time being increased. Persons, for example, with a vital capacity of the lungs of 4,000 cubic *centimètres*, inspire or expire several hundred cubic *centimètres*, or even 1,000 to 2,000 *centimètres* more than their vital capacity amounts to. The thorax is, therefore, by the inspiration of condensed air, more widely expanded than is otherwise possible by the deepest inspiration; on the other hand, by expiration into rarefied air, the lungs contract more than is otherwise the case in forced expiration—or, in other words, by the expiration into rarefied air, a part of the residuary air is drawn mechanically from the lungs.

2. By continued employment both of inspiration of compressed and expiration into rarefied air, the vital capacity of the lungs is gradually considerably increased. I have in several cases of emphysema seen the vital capacity within a few weeks increase by more than 1,000 cubic *centimètres*; in the case of one gentleman, it rose within fourteen days from 2,800 to 4,000 cubic *centimètres*. In accordance with this, it could be proved by percussion that the previously abnormally expanded lung gradually contracted and returned to its normal limits.

3. By means of the pneumatometer, we may show with certainty that the power of inspiration, as well as the pressure in expiration, increase by the use of the pneumatic apparatus, and often very considerably so. For instance, a person suffering from emphysema had, when he came under treatment, an inspiratory power of 130 *millimètres*, and exerted by expiration a pressure of 100 *millimètres*; within fourteen days, the former increased to 150 *millimètres*, the latter to 140 *millimètres*. In the case of a phthisical patient, with inspiration of 60 *millimètres*, and expiration of 90 *millimètres*, both increased within six days to 110 *millimètres*.

From these results, the indications for treatment become self-evident. Expiration into rarefied air is chiefly useful for emphysema of the lungs; and retraction of the expanded lungs, which may be shown by percussion to have taken place, is with certainty to be accomplished. Anatomical lesions cannot, of course, be done away with. Inspiration of compressed air is indicated where it is desired to enlarge the thorax and expand the lungs, especially as a prophylactic against phthisis in the first stage of consumption, in conditions consequent upon pleurisy, in pleuritic effusions after tapping, for inducing artificial respiration, stenosis, etc.

B. *Effects upon the Heart and Circulation.*—Physiology teaches us that the mechanism of respiration has an essential influence upon that of circulation. The lungs, enclosed air-tight in the thorax, exert a negative pressure upon the heart and the great vessels, and this is greatest during inspiration; the blood is, as it were, sucked out of the veins, and pressure in the aortic system is diminished, as seen in the kymographion. Two well known physiological experiments (Johannes Müller, Ed. Weber, Donders) prove that by changing the pressure in the lungs,

* For inspiration of rarefied air, I employ a much smaller force, usually one-three-hundredth to one-hundredth of an atmosphere.