ALLEGED DANGERS OF INTENSIVE ALKALINE TREATMENT.

No medical man need be afraid to use this treatment. In some patients it may give rise to slight symptoms, especially during the earlier stages, but generally these symptoms rapidly subside, and the system accommodates itself to the comparatively large amounts of alkali ingested. According to American writers, the chief symptoms encountered are, first of all, dryness of the mouth and throat, followed by headache, anorexia, nausea, and vomiting. There may also be mental depression and loss of energy. Analysis of the blood in some of these patients shows that the nitrogenous waste products may be somewhat increased, while there may be some interference with the "acid-base equilibrium" of the body. This so-called "alkalosis" following the use of very large doses of sodium bicarbonate has been described, among others, by Hardt and Rivers⁷ in 1923, by Brown, Eusterman, Hartmann, and Rowntree⁸ in 1923, by Ellis⁹ in 1924, by McVicar¹⁰ in 1924, by Houghton, Venables, and Lloyd¹¹ in 1925, and by Jordan¹² in 1926.

From a careful perusal of the literature on alkalosis it seems fairly clear that the medical practitioner need not fear in the slightest degree to use the intensive alkaline treatment as indicated here. That certain symptoms may occasionally appear is admitted, but they are exceedingly rare. Indeed, it is obvious that, in many cases where the symptoms were described, quite excessive doses of sodium bicarbonate were used. The exact dose is not always given, but where it is recorded it often amounted to about 30 grams a day over long periods. When the treatment is used as indicated here there is practically no risk of alkalosis in otherwise healthy people, and even if symptoms should intervene there is no harm done. If the patient complains of headache, nausea, vomiting, anorexia, and excessive dryness of the mouth it is quite easy to stop the treatment for a few days. So far, as already indicated, I have never seen anyone who had any symptoms. If followed on the lines indicated here the amount of sodium bicarbonate taken daily is too small to cause any damage in ordinary cases. That there may be some danger when the patient is suffering from chronic nephritis is admitted (see Stieglitz¹³ and others), and the same may be true when very marked pyloric stenosis with excessive vomiting is present.

SPECIAL TREATMENT IN PYLORIC STENOSIS.

In ordinary cases of mild pyloric stenosis with little or no vomiting, but showing marked x-ray changes, the ordinary alkaline treatment may be used. In severe cases, however, with excessive vomiting, there is practically no communication between the stomach and the intestine, and in such cases hydrochloric acid is constantly being lost to the body by vomiting. This results in a decrease of acid and a consequent relative increase of alkali, so that the body fluids may tend to pass to a more alkaline condition than normal. This "alkalosis" may be accompanied by severe symptoms, the most pronounced being tetany. If the symptoms are dependent on relative or absolute excess of alkali in the body, it is obvious that it might be dangerous to give more alkali, especially a soluble alkali such as sodium bicarbonate, for this would tend to make the condition worse. Theoretically we should really give an acid to make up for the acid loss.

Now in cases of practically absolute obstruction the giving of sodium bicarbonate could do no harm, for it could not get through into the intestine and so reach the blood. It would simply neutralize the acid in the stomach and then be thrown out, either as bicarbonate or chloride. From the stomach, absorption of sodium bicarbonate does not take place. It is true, however, that the effect of the sodium bicarbonate in neutralizing the acid might result in a subsidence of the oedema and spasm of the pylorus, so that some gastric contents might pass on into the intestine. At this stage an excess of sodium bicarbonate would tend to increase the alkalosis, and what we really want is something to favour acidosis.

Haldane¹⁴ has shown that calcium chloride when taken by the mouth acts as an acid, and is equivalent in effect to giving hydrochloric acid, because most of the calcium remains in the intestine while the chloride is absorbed.

Gamble, Ross, and Tisdall¹⁵ showed that about 40 per cent. of the chlorine of CaCl_2 acted inside the body as HCl . Indeed, instead of causing an alkalosis the bivalent cations (calcium and magnesium) produce an acidosis in the body (McDonald and Godfrey¹⁶).

Therefore, in a case of very severe pyloric stenosis it would obviously be best to use as an antacid, not sodium bicarbonate, but calcium carbonate, or this along with magnesium carbonate. The carbonate would be changed into chloride by the gastric acid, and some of this would act as hydrochloric acid in the body, and so tend to prevent the drain of acid. That calcium carbonate acts quite efficiently as an antacid has been demonstrated by Loevenhart and Crandall.¹⁷ The safest treatment for severe pyloric stenosis would therefore appear to be by means of a powder consisting largely of calcium carbonate with some magnesium carbonate to help the bowels. Teaspoonful doses of such a powder should be given on the lines indicated above for the ordinary powder. In addition to this, small doses of calcium chloride would help the alkalosis.

Generally speaking, the intensive alkaline treatment is not associated with any real danger under ordinary conditions, but the treatment must be carried out on the general lines indicated here, and the vastly excessive doses of sodium bicarbonate sometimes used should be avoided.

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DEBATABLE ASPECTS OF THE SURGERY OF GASTRO-DUODENAL ULCERATION.*

BY

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So long as the innate nature of gastro-duodenal ulceration is still ranked among the unknown phenomena of pathology there is bound to be disputation about the manner of its control. Controversy arises over many problems of the disease and its complications, but the greatest of these is the problem of the uncomplicated ulcer.

THE NEED OR IMPROPRIETY OF SURGERY FOR THE UNCOMPLICATED ULCER.

It is most perplexing to read the writings of physicians and surgeons, for they are often directly contradictory in their views and recommendations; but their very discordancy engenders the suspicion that the conclusions of the extreme enthusiasts of medical or surgical measures must largely cancel each other out, and that the truth lies somewhere between them. The relevant facts upon which alone a sound judgement can be based are simply stated.

(a) Ulcers of the stomach and duodenum can and do heal without the aid of surgery when conditions are favourable. This has been proved by actual visual inspection through a gastroscope,¹ by the x-ray disappearance of the ulcer niche under medical treatment,^{2,3} and by the finding of the scars of ulcers after death at necropsy.

(b) Certain ulcers fail to heal with the most careful medical treatment, or they heal and break down again so that the symptoms recur. The number of ulcers which will heal without surgical help is large. It has been stated that *post mortem* as many scars as open ulcers are to be found.⁴ But one pathologist discovered nine times as many scars as ulcers in the stomach.⁵ This is the highest

* A lecture delivered to the Kensington Division of the British Medical Association on March 23rd.

proportion of scars to open ulcers I have been able to find reported. Quite possibly scars in the stomach get overlooked at necropsy, and this higher figure more nearly approaches the truth. At any rate, it is certain that the tendency to healing is great. So a most important rule, to which there are a few exceptions, may be laid down: *No ulcer patient should be subjected to operation until medical treatment has proved a failure.*

It is pertinent to ask what proportion of ulcers respond to medical treatment. One observer, in 944 cases, found the percentage for gastric ulcer to be 62.5, and for duodenal ulcer to be 79.5.⁶ These facts should be graven upon the mind of every operating surgeon. However, certain of these immediately cured cases will relapse. There are not many records of the late results of medical treatment. Forman,⁷ in 32 cases followed up and subsequently x-rayed, found 57 per cent. failures. The number of permanent cures is certainly much smaller than the number of immediate successes. Is it possible to select those cases which will prove resistant to treatment? Several observers have said that there is no relation between the rate of healing and tendency to relapse and the length of history or size of the niche, but this last statement is open to doubt. When the niche is large, with a rounded extremity, healing is not so likely to occur or remain permanent, particularly as the gastric or duodenal wall in its neighbourhood is often fixed by the ulcer having invaded the pancreas and caused much surrounding fibrosis. Therefore it seems right to conclude that, while the tendency to repair is great, a significant percentage of ulcers cannot be induced to heal by medical means alone, and that of those that do heal a certain number break down again. It is thus justifiable to resort to surgical measures when medical treatment has failed, provided always that the mortality of operation is not too high—a consideration which will be dealt with in the next section.

CHOICE OF THE TYPE OF OPERATION.

Having decided that there is occasion for surgery, it will be necessary to select the type of operation. A simple operation, gastro-enterostomy, can alter local conditions in the stomach so that healing may be assisted; or more can be effected by the removal of the diseased part of the stomach, whereby the tendency to ulcer formation in the future is very greatly diminished. Both of these are indirect methods, though the latter is often spoken of as a radical procedure. To choose between these we must know how effective each is, and what is its accompanying mortality.

Gastro-jejunostomy.

In the case of gastric ulceration there have been a number of reports of what success gastro-enterostomy can bring. Emanating from all parts of Europe, from America, and from this country, they show a surprising agreement in all essentials. It is found that about 75 per cent. of open ulcers at the pylorus are made to heal, but only about 50 per cent. or less of ulcers away from this region. There can be no doubt at all that gastro-jejunostomy does not meet with really striking success in gastric ulcer, yet it would not be right to leave the matter here without asserting the fact that sometimes unexpectedly large ulcers have healed when this operation has been performed. It obviously has its place, and should be considered when other methods are either impossible or fraught with grave risk.

When we consider the use of gastro-jejunostomy in the treatment of duodenal ulcer there is no such general agreement. Thus Moynihan,⁸ Walton,⁹ Balfour,^{10 11} and Sherren¹² obtained complete cures in 85 to 92 per cent. of their patients. But other clinicians have not achieved anything like the same success. Wylder,¹³ Forsyth,¹⁴ Lewisohn,¹⁵ Smithies,¹⁶ and myself¹⁷ can only count upon 50 to 70 per cent. of cures at most. The mortality of gastro-jejunostomy ranges from none in 500 cases (Moynihan¹⁸) to 8 per cent. by such a skilled operator as von Haberer.¹⁹ It is bound to be higher in the statistics of those surgeons who reserve it for the worse risks, but I believe it fair to assess it at 4 to 5 per cent.

The liability to haemorrhage from a gastric, but particularly a duodenal, ulcer is about as great after an

operation as before. Perforation of a gastric ulcer may occur subsequently, but very rarely that of a duodenal ulcer, though this is not unknown. There is also a very definite incidence of gastro-duodenal ulceration, the frequency of which is estimated from 22⁰ to 18 per cent.¹⁵ Sometimes a gastro-jejunostomy performed for duodenal ulceration will cause this lesion to heal, but subsequently an ulcer will form on the lesser curvature of the stomach. I have known this happen in 4 cases. Curiously enough, Rowlands mentions a similar case in a recent paper upon gastro-jejunal ulcer.²¹ If we accept the hypothesis I put forward²² as to the conditions favourable to the formation of peptic ulcers—namely, admixture of the duodenal with the pyloric secretions—it is easy to see how cure of the duodenal ulcer will lead to relaxation of pyloric spasm and so to duodenal regurgitation along the gastric sulcus once more during the later stages of digestion, a phenomenon which is absent when a duodenal ulcer exists. Conditions thus become favourable to ulcer formation on the lesser curvature.

Resection Operations.

We may now turn to the facts about resection operations. The properly conceived operation of this type not only removes the ulcerated area, but also takes away so much of the pyloric part of the stomach that the second stage of gastric secretion is very much interfered with, thereby lessening the disposition to further ulceration. I have knowledge more particularly of three types of such operations—the Péan resection, the sleeve resection, and the Moynihan variety of Polya's procedure. They all meet the requirements stated above, and are indicated in different circumstances. There are many reports of late results of resections for stomach ulcers (see references 13, 20, 23, 24, 25, and 26). The successes range from 70 per cent. to well over 90 per cent., most observers giving the higher figures. My own late results give 80 per cent. perfectly well. At any rate, it may be said that, with the same standard of cure, these resection operations give half as many good results again as gastro-enterostomy. It is widely held that a high mortality is associated with gastric resection, a very much higher death rate than with gastro-enterostomy. But this is not so. Amongst 59 gastric resections for ulcer I had 3 deaths. One of these, due to a technical fault at the operation, was preventable; the others were from lung complications, which are very imperfectly under control. This makes a mortality of 5 per cent. It is quite a serious mortality, but not so very high when it is remembered that 83 per cent. of all cases submitted to me had the resection operation performed on them, though many were in a poor condition from malnutrition or a previous severe haemorrhage.

Let us now turn to the much debated subject the resection of duodenal ulcers. At one time the removal of the affected segment of the duodenum was regarded as impossible;¹⁷ but it was shown by the work of von Haberer, Finsterer, and Clairmont that this is not so. Some surgeons who claim good results from gastro-enterostomy at the same time recommend excision of the anterior ulcer when it is simple and easy. The operation of partial duodenectomy is not performed by many men because of the belief that it is an extremely dangerous one. I have done a partial duodenectomy for duodenal ulcer 61 times with 2 deaths, both from lung complications. Moreover, this series includes the very first cases, in which the technique was anything but perfected. The mortality rate is, therefore, 3.3 per cent. I have only tried the operation in bad cases. Sometimes it cannot be done because the callous mass has extended too far down the duodenum; sometimes it seems undesirable because the ulcer is small and soft. So I have performed a resection in only 72 per cent. of cases. The results of the procedure have been much more satisfactory than those of gastro-enterostomy. Of 21 cases operated upon for more than two years 18 (86 per cent.) were perfectly well, in contrast with 69 per cent. by the latter operation. One other patient had such very slight symptoms that he may almost be regarded as a complete cure. Counting him, the percentage would be raised to 90. To ensure success, it is necessary to take away a sufficient portion of the pyloric region of the stomach; more than a simple pylorotomy must be done.

Having brought out the facts, it is now possible to adjudicate upon the question of operation in the uncomplicated ulcer. With few exceptions, every gastric ulcer patient should be submitted to a course of medical treatment. When, by proper rest, diet, and medication, the pain cannot be controlled, vomiting continues, and weight is lost, then surgery is indicated. If there has been a single haemorrhage of any volume in the past, and an ulcer can be demonstrated by the x rays, an operation should be carried out without a trial of medical measures. When a Haudek's diverticulum is large, with a rounded, blunt end, it is often wise to advise an operation, as relapse in many cases occurs. Finally, economic conditions may require that the patient should be got well with as little loss of time as possible. Perhaps he must work to live, or he is performing such valuable work for the community that his services can ill be spared. Such circumstances must be very carefully weighed before a decision to operate is made, remembering always that there is about 5 per cent. mortality associated with the procedure.

THE BLEEDING ULCER.

The controversy on this problem cannot be so easily dismissed as some surgeons would wish by accepting the statement of many of our medical colleagues that a patient seldom dies from such loss of blood. The truth is quite otherwise. Haemorrhage from a chronic ulcer of the stomach or duodenum is a serious menace to life. Bulmer recently, in 500 cases, reported a mortality of 8.3 per cent.²⁷ From our point of view the clinical course of the event is important. Sometimes the victim will die in a few hours from a single massive haemorrhage. He is at once beyond human help. More often he rallies from this first haemorrhage, but his immediate future is full of peril. Bleeding from an ulcer is of the secondary type and follows the characteristic course of this affection. The uncertainty of the arrest of haemorrhage is great; very frequently after a few days a further loss of blood occurs, and this may be repeated until the patient's strength is sapped to his extinction. Cannot ordinary surgical principles be applied to this gross complication? The answer is not quite simple to give.

Arrest of haemorrhage means a rather big operation which the patient may not be in a condition to stand, and this, combined with the undoubted fact that numbers of patients recover under expectant treatment, has led to the majority of surgeons deciding against operating. The mortality from it has been so high that it is held that the lives saved do not compensate for those lost when operation is adopted as a routine. Of late years, however, conditions have somewhat changed. Not only have operations upon the stomach become safer, but the transfusion of blood allows us to operate in circumstances which formerly would have proved fatal. Immediately a haemorrhage has occurred the patient falls into such a state of shock that any kind of surgical procedure is precluded. This shock, with its lowered blood pressure, is the natural method by which haemorrhage is arrested and clotting in the eroded vessels allowed to occur. When this has actually happened the patient can, with some degree of certainty, be considered safe for a few days. Therefore steps to combat the loss of blood, including a transfusion, should be taken. As the victim rallies from his shock an estimate of his general state should be made by observing the fall in pulse rate and estimating the percentage of haemoglobin in his blood. A pulse rate which remains over 100 means that there has been a very great loss of blood. Operation is risky, but is often possible. A patient with only 50 per cent. of his haemoglobin is in a very poor state to withstand a resection, but in favourable circumstances it can be employed. A blood transfusion will always be necessary in such a grave case. Local anaesthesia is regarded as essential by Finsterer, but I have employed only general anaesthesia, being somewhat afraid of the lowering of blood pressure which the splanchnic block produces. Once within the abdomen the type of operation must be decided upon. A partial gastrectomy or duodenectomy is the ideal, and should always be done whenever it is technically possible. Fortunately a resection by proper methods can now be performed with very little

further loss of blood. Sometimes it will be decided that resection is too dangerous; then the arteries supplying the ulcer must be tied, a procedure which may necessitate the opening of the viscus and ligation from within. A gastro-jejunostomy is useless for stopping haemorrhage from a gastric ulcer.

To sum up: Every case of bleeding from a gastric or duodenal ulcer should be looked at from a surgical point of view from the first. There should be a disposition to operate as soon as ever the condition of the patient will allow. Though the step is a serious one, the adoption of this policy, taking the precautions which I have mentioned, will save more lives than the pursuit of a solely expectant attitude. It is fatal to wait for successive haemorrhages before considering operative treatment. The patient will only be reduced to such a state of weakness that he is unlikely to stand it and survive.

THE PERFORATED ULCER.

The problem of the perforated ulcer is not whether an operation should be performed, but whether any other procedure should be added to the essential closure of the perforation. On the Continent operators have actually, of late, been performing typical resections of the stomach in cases of perforation—a development in gastric surgery so amazing that it must be passed in review. In this country there are many surgeons who hold that a gastro-enterostomy should be done at the time the ulcer is sutured. These surgeons claim that the anastomosis is frequently necessary because the suture of the ulcer leads to pyloric stenosis; they say that convalescence is smoother and the risk of the new suture line failing to hold diminished, as the stomach cannot become distended. They also make a great point of the fact that by doing a gastro-jejunostomy they are performing a curative operation upon the ulcer. What, once more, are the facts?

It is recognized that many ulcers which perforate are acute lesions, they have a different pathology from the chronic ulcer, and once the crisis is over conditions leading to the formation of such ulcers may never recur. Unless the technique is very clumsy the pylorus will not be obstructed by the in-turning of the stomach wall necessary to close the perforation.²⁸ It is also proved by late investigations^{28 29 30} that many patients after simple suture are permanently cured and never again suffer from their ulcer. I believe that this recovery rate is perhaps overestimated and that the true percentage of cures is probably about 50. Gastro-jejunostomy is, therefore, unnecessary from this point of view in one-half of the patients; as a fine stomach tube will relieve distension of the stomach should blocking of the pylorus by the suture have occurred, it is not to be recommended on this account. Should the ulcer give trouble later another operation will be necessary, but it will not preferably be a gastro-enterostomy. The patient with a perforation is so ill that the less done to him the better. For this same reason I think resection in the presence of a perforation is not to be recommended. It would obviously be wrong treatment for an acute ulcer, and certainly too severe as a routine method for a perforated chronic lesion.

THE LATE CICATRIZED STOMACH.

When an ulcer has cicatrized it may leave the stomach with a narrow pyloric canal, or if it has been on the lesser curvature an hour-glass constriction deformity may result. Sometimes the two deformities occur together. When there is pyloric constriction alone a simple gastro-jejunostomy will often give an excellent result. The operation has its place, and should be done when there has been so much vomiting that the patient is dehydrated and is suffering from chloride starvation, which cannot be remedied by the injection of salt solution. In every other case I believe a Péan type of resection is preferable in pyloric stenosis. For hour-glass constriction, though a simple gastro-gastrostomy will frequently meet the case, I prefer a sleeve resection or the Péan operation. Chloride starvation must always be investigated in every patient in whom there is some defect in the passage of the contents of the stomach into the duodenum. It should be corrected before any serious operation is undertaken.

Surgery is not likely to say the final word in the treatment

of gastric ulcer. In the present state of knowledge it is the only method which brings relief to a number of victims of the disease. While such is the case there is sure to be controversy as to methods. I have striven to present these problems to you, and have suggested what I regard as the best solutions to them.

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THE TYPE OF TUBERCLE BACILLUS COMMONLY PRESENT IN TUBERCULOUS LESIONS IN BONES AND JOINTS.

Two Cases with Unusual Numbers of Tubercle Bacilli in the Discharges.

BY

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THE question whether tuberculosis of bones and joints is commonly caused by drinking milk from a tuberculous cow, or by inhaling tubercle bacilli derived from some human being, is, for the sake of prevention, not without practical importance. Yet it is one on which current medical opinion seems to be imperfectly informed, for, in conversation, one too often hears it taken for granted that such cases are usually caused by tubercle bacilli of bovine type. This is assuredly not the case.

The Royal Commission on Tuberculosis of 1901-11, Park and Krumwiede in the United States, and the committee of the Gesundheitsamte appointed in 1901 to investigate the role of the bovine type of tubercle bacillus in human tuberculosis, all agreed in finding that the tubercle bacillus present in the great majority of the cases of bone and joint disease which they investigated was of the human type. Cases from which the bovine type of bacillus was obtained occurred, but they were uncommon.

Then in 1912 came J. Fraser, who, having investigated 70 cases of tuberculosis of bones and joints in the Research Laboratories of the Royal College of Physicians in Edinburgh, came to the surprising conclusion that no fewer than 41, or 57 per cent. of them, yielded tubercle bacilli of bovine type alone; that 3 gave a mixture of both mammalian types; and that only 26, or 37 per cent., yielded the human type alone.

These findings were so different from those of all other observers, who agreed in putting the proportion of such cases infected with the human bacillus as high as 80 per cent. or more, that they were not received without criticism by bacteriologists who had worked in this field. Nevertheless, it seems that it is just these exceptional results obtained in Scotland that have attracted the attention of English physicians, rather than the far more extensive investigations made in this country.

It therefore seems worth while calling attention to the fact that A. S. Griffith, F. Griffith, and A. Eastwood, than whom no more experienced workers in this field (all trained in the school of the Royal Commission, 1901-11) could be

found, working for the old Local Government Board and the Medical Research Council, have made a most comprehensive study of the types of tubercle bacilli present in various kinds of human tuberculosis. This study, which has extended over twenty years, and, so far as bone and joint tuberculosis is concerned, embraces five different investigations, now includes close on six hundred (598) cases of this kind in which the type of tubercle bacillus has been fully determined.

This is the total dealt with by A. S. Griffith in his dissertation for the degree of Ph.D.Camb. in 1926. It includes 14 cases investigated by the Royal Commission, as well as a number in which the cultures were made, not from material taken directly from the bone or joint, but from some other lesion. For this reason I prefer to quote from a paper by the same author entitled "Tuberculosis of bovine origin in the human subject," read at the eleventh National Conference on Maternity and Infant Welfare held in London on July 5th to 7th, 1927. It deals with 541 cases of bone and joint tuberculosis, with the result that 81.3 per cent. of them were found to be caused by tubercle bacilli of the human type. This percentage refers to patients of all ages; if one takes only children under 5 years of age (102 cases), the percentage so infected naturally falls; but even here it is over 70 per cent. Under 10 years (327 cases) it is 75 per cent. This total includes a few cases from Scotland. These, in a somewhat earlier paper by the same author,¹ are separated from the English cases, with the result that a lower proportion of infections with the human type of bacillus is found in them than in those from England and Wales. The difference, however, is not great; for Scotland the percentage of infections with the human type of bacillus is 71.4 (28 cases), while for England and Wales it is 81.7 (389 cases). For children under 10 the corresponding percentages work out at 63.6 and 75.4 respectively.

Frequency of Tubercle Bacilli of Human Type in Tuberculosis of Bones and Joints.

	No. of Cases.	Percentage with Human Type.
All ages	541	81.3
Under 10 years	327	74.6
Under 5 years	102	70.6

English and Scottish Cases Compared.

	No. of Cases.	Percentage with Human Type.
Scottish cases, all ages	28	71.0
English cases, all ages	389	81.7
Scottish cases, under 10	22	63.6
English cases, under 10	288	75.4

Thus from this exhaustive and competent investigation we may conclude, indeed, that infection from the tuberculous cow is a good deal commoner in Scotland than it is south of the border. But it must be pointed out that the proportion of human infections in Scottish cases found by the English authors—namely, 71.4 per cent.—is very different from the 37 per cent. (or if we include the mixed cases, 41 per cent.) found by Fraser.

The fact is that bone and joint tuberculosis commonly results from tubercle bacilli being transported to the part from some tuberculous focus (often a small and unsuspected one in some lymphatic gland) by the blood stream. In this respect it falls into line with other haematogenous kinds of tubercle—namely, with general tuberculosis, tuberculous meningitis, and genito-urinary tuberculosis, in each of which the proportion of infections caused by the human type of tubercle bacillus has been found to be in the neighbourhood of 82 per cent. In tuberculous meningitis it is even a little higher still.

It can therefore be stated positively that in England and Wales the great majority of cases of bone and joint tuberculosis are caused by bacilli of human type, derived from another case of human tuberculosis, and that they have nothing to do with the cow. Cases of bovine origin do indeed occur, and in very young infants constitute nearly a third of the total, but taking all ages together they do not amount to one-fifth.

It is interesting to note that in tuberculosis of the vertebral column bovine infections are rather commoner than in tuberculosis of the hip, and that in this latter condition they are somewhat more frequent than in tuberculosis of the knee. The higher incidence in the spine is