of phage typing, he can be identified no less precisely than can the criminal by his finger-print. Moreover, like the criminal, he is apt to leave this "finger-print" at the scene of his crimes, where it may provide a specific clue leading to his detection. It is therefore important that the criminal's "finger-print"—the phage type of the infecting organism—should be obtained from every sporadic patient with typhoid and from a few representative patients in every outbreak. From the preventive point of view, the diagnosis of enteric is incomplete if it rests on a positive Widal reaction only.

In the case of Type D4 the carrier's activities were far from parochial, and his influence was detected in four counties and ten administrative areas during the course of two years. Since infection, like the criminal, does not respect administrative boundaries, there is clearly a need for the equivalent of the Central Criminal Investigation Department. In the matter of enteric infections the way to the finger-print bureau is through the Emergency Public Health Laboratory Service. But finger-prints and phage typing are no more than valuable clues, and the apprehension of the miscreant still depends on the observations and deductions of the field investigators. Without determined field work and the help of what may be a large team of practitioners and medical officers of health mysteries like "D4" are not easily solved.

Summary

The first sustained attempt to apply typing with Vi bacteriophages to a field study of endemic typhoid fever in England is described.

Apparently sporadic cases occurring over a period of two years were traced to a persistent carrier on a farm 100 miles away.

Milk which had passed through a wholesale depot and numerous retail dairies was the vehicle.

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SURGICAL TREATMENT OF OSTEOMYELITIS DUE TO A PENETRATING WOUND*

BY

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An almost inevitable sequel to a penetrating wound associated with a fracture is infection of the bone. The inflammation is unlike that caused by a blood-borne organism in that local symptoms and general toxæmia are both less, the probable reason being that from the very beginning there is free drainage from the broken bone. The osteomyelitis pursues one of five courses: (a) The inflammation may die down within a reasonable time and never again trouble the patient. (b) The inflammation may continue for a long time; let us call this *persistent acute osteomyelitis*. (c) The acute inflammation may subside, leaving behind a *sinus*, which extends down into the interior of the bone. (d) The inflammation may die down and the wound heal; but later, after an interval of months or years, the acute inflammation recurs. We express this by saying that *the wound has flared*. (e) The patient may have a chronic sinus and also be subject to recurrent attacks of acute inflammation in the bone. The problem therefore resolves itself into treating one of four conditions—namely: (1) per-

sistent acute osteomyelitis; (2) a sinus; (3) recurrent acute osteomyelitis (a flare); (4) a sinus with flares.

Persistent Acute Osteomyelitis

In the treatment of persistent acute osteomyelitis we have little to offer surgically. The closed-plaster technique has shown clearly that surgery is not essential to the cure of inflammation. It is true that surgery is of use in acute inflammation—in affording an exit to pent-up pus, as in the opening of an abscess, and in excising *in toto* an inflamed area, as in appendicectomy. And these successes have tended to make the surgeon forget his limitations. In osteomyelitis due to a penetrating wound there is nearly always adequate drainage, and surgery is not required to give an exit to pus. Nor can we hope to excise the whole of the acutely inflamed bone without grossly infecting the surrounding tissues. We are therefore forced to the conclusion that there is no surgical treatment for persistent acute inflammation of bone.

However, although the inflammation does die down at last, it may by its prolongation endanger the life of the patient. Moreover, other disabilities may be present that would render the limb of little use even when the osteomyelitis had subsided: for example, an ununited fracture, an unsuturable nerve lesion, stiff deformed joints, damage to main vessels, wide destruction of skin. In persistent acute osteomyelitis amputation of the limb is therefore often advisable, either to save life or because an artificial limb will be of more use to the patient than his own crippled leg.

A Sinus

The active inflammation of the bone may subside, leaving behind a sinus. A sinus is a nuisance because it condemns the patient to wear a dressing to protect his clothing, and also because the smell from the discharge (particularly if the wound has become secondarily infected by *Bacillus proteus*) is offensive. And patients often clamour for treatment in the belief that a surgeon can easily get a sinus to heal. Sometimes he can; more often he cannot. A sinus indicates either (a) the presence of a foreign body or a sequestrum, which the patient is endeavouring to wash out of the wound, or (b) the continuation of a mild chronic infection of the bone. And it is often difficult for the surgeon to decide which of these two conditions confronts him. A radiograph gives valuable information because it reveals metallic foreign bodies and often sequestra. It is not decisive, however, for the foreign body may not be opaque (an unabsorbable suture, for example), and not all sequestra are dense.

As a rule a sinus heals after the removal of a foreign body or a sequestrum; and whenever the radiograph shows either, the surgeon should operate. When the radiograph reveals neither, it is justifiable to operate once and once only; for if the sinus recurs, as often happens, further operations are unlikely to be successful. It is important, however, to realize that the type of operation differs in the two cases.

Operation when a Sequestrum or a Foreign Body is Present

The aim of the operation is the removal of the sequestrum or foreign body. A probe is inserted into the sinus and the surgeon cuts straight down (anatomy permitting) on to the point of the probe. If this has entered the bone a small coffin-shaped piece of cortex is removed and discarded, revealing a cavity within which the foreign body or sequestrum is lying. The sequestrum is picked out and the wound is lightly sewn up without drainage. No attempt is made to excise the track or to obliterate the bone cavity. Should the wound later show signs of inflammation the stitches are removed and the wound is allowed to gape. The object of the operation is to remove the cause of the irritation, and if this is achieved the sinus closes.

The question arises—At what time after the onset of the osteomyelitis should one remove sequestra? I believe this should be determined not by the length of time that has elapsed but by the cessation of acute inflammation in the bone. But how are we to know whether the bone is still acutely inflamed? There are so few signs of active inflammation in bone. The radiograph does not help, and providing the products of inflammation are not under tension there is little pain. In fact, the only clinical sign is tenderness of the bone.

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However, with osteomyelitis due to a penetrating wound there is always infection of the soft tissues as well as infection of the bone; and inflammation of skin, cellular tissues, and muscles can be detected clinically. And we may assume that when the defences of the body have overcome the infection of the soft tissues they have simultaneously overcome the active infection in the bone. If the soft tissues are still inflamed, so is the bone; if the soft tissues are no longer inflamed we may assume that active inflammation has also subsided in the bone. And so, in my judgment, sequestrectomy should be deferred until the soft tissues around the sinus are free of heat, redness, swelling, and tenderness. As soon as the inflammation of the soft parts has subsided sequestrectomy can be safely undertaken. One need have no fear that the sequestrum will not be loose, because, in my experience, sequestra are already detached by the time they are disclosed by radiographs.

Operation when there is no Sequestrum or Foreign Body

In this case the object of the operation is the removal of all infected bone, the assumption being that the sinus exists to give an exit to the products of the continuing inflammation. The plan of operation is entirely different from that of sequestrectomy.

The sinus track is excised and as much of the surrounding fibrous tissue removed as is safe, having regard to the presence of main nerves and vessels. A large extent of bone is exposed subperiosteally, and up to a half of the circumference of the cortex is chiselled away piecemeal until healthy bone is reached. Sometimes the whole diameter of the bone is permeated with chronic inflammatory tissue; if this is so the operation will probably fail, since the aim of the operation—the complete removal of all infected bone—cannot be attained. Care must be taken not to fracture the bone, and the limb should be well supported on sandbags during the operation to minimize the risk. The walls of any cavity should be removed, for unless the soft tissues can fall in and obliterate all dead spaces the operation is unlikely to succeed. The operation entails hard work and much chiselling.

The immediate sequel to the operation is an acute inflammation of the bone that is left, and in order to prevent further necrosis there must be free drainage from the bone. The wound is therefore lightly packed with gauze soaked in paraffin, and this is renewed every few days. The first dressings are painful and should be done under nitrous oxide or intravenous anaesthesia. It is erroneously supposed that the object of packing the wound is to induce it to heal from the bottom, and accordingly the packing is often continued long after it is necessary. The packing is intended to act as a safety-valve so that the tension in the bone does not rise high enough to cut off the bone's blood supply.

The acute inflammation in the bone soon subsides and the safety-valve is no longer required; the packing should then be discontinued. If the packing is continued for too long the soft tissues form a tunnel with fibrous incollapsible walls, and the bone at the bottom remains exposed and is covered with a thin fibrous layer that is always ulcerating.

It sometimes happens that the radiograph shows a foreign body in the soft parts and old osteomyelitis, and the surgeon is not sure whether the sinus is caused by the foreign body or by smouldering inflammation in the bone, and in consequence is undecided which type of operation to perform—whether a simple removal of the foreign body or a resection of the diseased bone. In these circumstances useful information is sometimes obtained by x-raying the area after the injection of lipiodol into the sinus: when the opaque track leads to the foreign body it is a safe assumption that the foreign body is the cause of the sinus, and the simple operation is indicated; when the track leads into the bone the bone should be resected.

Recurrent Acute Osteomyelitis (a Flare)

These flares, although associated with local signs of inflammation and often with intense pain, are peculiar in that they are not accompanied by severe or lasting toxæmia. The patient's temperature is raised and he may feel ill; but this phase passes off quickly, and within a few days his health is restored. In this respect a flare is not unlike a bout of malaria.

There is no explanation for these flares and no known method of avoiding them. A patient may not have had any symptoms for years—perhaps 20—then, after a blow or excessive muscular exertion, or sometimes for no obvious reason, the wound flares. The rapidity and ease with which these are overcome show that the body has a strong defence, but seemingly the defence is not strong enough to prevent an attack although capable of smothering it when it occurs. Immunizing the patient with vaccines has not met with any success; indeed, an interesting fact is that once the patient starts having flares he may have several in quick succession in spite of not having had any trouble for years previously.

The inflammation may or may not be confined to the bone. Clinically, the skin, the deep tissues around the bone, or the bone itself may appear to be the principal (or sole) site of the inflammation. Of particular interest is the subcuticular inflammation that spreads far up and down the limb and resembles an erysipelas.

Treatment consists of rest, and the patient should be kept in bed. Locally, hot poultices such as antiphlogistine are soothing. Surgery is not indicated unless an abscess forms. An abscess should of course be opened, but there is no urgency. The longer the abscess can be left the nearer it approaches the surface and the smaller need be the opening. It is sufficient to give an exit to the pus and to leave the wound open; it is not necessary to establish prolonged drainage. As a rule within a few weeks the wound heals, and the patient's condition is then much what it was before the flare. Even when an abscess arises within the bone the bone rarely needs to be touched, because cloacae allow the pus to escape. Only exceptionally, when a high temperature and severe pain persist, is exploration of the bone advisable.

A Sinus with Recurrent Flares

These cases as a rule defy treatment. The sinus indicates a continuous grumbling inflammation, and the flares indicate that the bone is riddled with organisms that are potentially active. Operation rarely does any good, particularly when the ends of the shafts are involved, in which case for anatomical reasons an adequate removal of diseased bone is not feasible.

Most of these patients have undergone many extensive bone operations without any benefit, each one invaliding them for many months. Excluding an operation on the bone, there are two courses open to the patient: one, to accept his lot and to be resigned to periodic flares which will keep him from work for several weeks once or twice a year; and the other, to lose his limb. Luckily the leg is more often the seat of the trouble than the arm, since with a well-fitting artificial leg a man is but slightly handicapped. Many a pensioner of the last war is to-day thankful that he was at last persuaded to have his leg amputated.

When amputation is decided upon it is wise to proceed in two stages. The first amputation is done through the extreme lower limit of the healthy bone, and the skin flaps are lightly held together by two or three stitches. Should the wound become inflamed the stitches are removed and the wound allowed to granulate. Then, when all sepsis has been eliminated, the final amputation is done at the site of election.

The treatment described above is summarized in the following table:

	Bone Surgery	Other Surgery
1. Persistent acute osteomyelitis	None	Amputate if life is in danger or if limb is crippled
2. Sinus	Remove sequestra or excise infected bone	None
3. Flare	(Rarely) drain bone	Open superficial abscess
4. Sinus and flares	None	Amputate if a nuisance

J. Schwartzman (*Arch. Pediat.*, 1942, 59, 466) studied the relation between pallor and anaemia in 943 adolescents with the following results: (1) Of 106 cases of pallor only 22 had true anaemia, while 84 had pseudo-anaemia. (2) 84 cases of true anaemia had no clinical pallor and would not have been detected without the blood count. (3) There was a total of 106 cases of anaemia, or a percentage of 11.3. The male incidence was 2.1% and the female incidence 20.7%. (4) The haemoglobin estimate corresponded to the anaemic state in 98.1%. Schwartzman concludes that routine haemoglobin determinations should be made in all cases regardless of appearance.