under discussion, and it requires the same careful adjustment and takes the same length of time for dressings as (a).

In order to eliminate these and other objections I have devised the splint shown in the accompanying drawings. It is suitable for all fractures in the lower two-thirds of the femur.

In effect it is a double Thomas bed knee splint, an outer and an inner. The outer is the ordinary Thomas splint, and to its end the extension is fixed in the usual way. At the junction of the ring with the inner bar, and at the same level on the outer bar, is a pivot, to which is attached another—the inner Thomas splint (minus its ring); it fits easily within the outer, and is bent four inches from its lower end, so as to raise the whole off the bed (Fig. 1).

FIG. 1.

By raising the outer splint by its end the patient's thigh and leg are also raised, but the inner splint turning on the pivots remains resting on the bed (Fig. 2).

FIG. 2.

On this inner splint are metal slings made of the usual perforated zinc, which are held in the proper position by a few turns of narrow strapping wrapped round the bars above and below; if the posterior wound be small, one sling only is necessary. On the sling or slings a large pad of cotton-wool is placed in such a position that when the outer splint is lowered and both are in the same plane, it is under the site of the fracture. The rest of the limb is slung in bandage supports, taking the usual precautions against genu recurvatum by another smaller pad beneath the knee.

It will be seen that all the pads and slings which support the limb are on the inner splint, although in practice it is found useful to have one sling under the knee on the outer splint, not to act as a pad but rather as a support during dressing.

To dress the posterior wound, the outer splint is raised and held by the nurse or orderly; by this means flexion at the thigh is possible to 50 or 60 degrees, and a good view of the wound obtained. The pivoted inner splint with its

FIG. 3.

pad and slings remains on the bed. The pad, if soiled, is removed, and a fresh one of the same size put in its place. If necessary, also, the zinc slings can be removed quickly and boiled or replaced by similar ones already sterilized. The outer splint is then lowered again, and is fastened at the end to the inner by clips or a piece of bandage (Fig. 3). In most cases it is unnecessary to fix the dressings by

bandages, as they are held in place between the pad and the thigh.

It may be argued that while the outer splint is raised the fracture has no support except that which is provided by the extension. This is, however, sufficient for the short period during dressing, and in addition it may be noted that the extra tension put on the hamstrings by flexion of the thigh, the knee being extended, in itself tends to lessen posterior bowing.

I have found by using this arrangement that dressings can be done in less than half the time and with a great deal more ease, that the pads are always in the proper place and remain fixed there, that there is no discomfort to the patient, and that all tendency to posterior bowing is obviated.

It will be obvious that although this splint is primarily designed for cases with a posterior wound it can equally well be applied to those in which there is only an anterior wound which is being chemically sterilized. It is also suitable for those numerous cases met with in this country which are already healed, the bone being recently united with little shortening but posterior bowing and in which there is still tenderness on pressure over the site of fracture. This tenderness is an exceedingly important clinical sign, and indicates, no matter how long since union commenced, that the callus is still soft and can be moulded, and that the patient, even after the deformity is corrected, should only be allowed to walk in a caliper splint.

I would point out also that the method is unnecessary in simple fracture, where perfect results can be obtained by a straight Thomas bed knee splint with fixed extension and coaptation splints.

I am indebted to the Inspector of Special Military Surgery, Major-General Sir Robert Jones, C.B., A.M.S., for permission to describe this splint.

(It will be noticed that the ring of the splint shown in the accompanying drawings is too large for the patient on whom it is being temporarily used. This is a defect which it is important to avoid whenever possible.)

DELAYED PRIMARY SUTURE OF WOUNDS.

BY

H. H. HEPBURN, M.C., TEMP. MAJOR R.A.M.C.

THE medical history of the war will probably acknowledge "delayed primary suture" as the fashionable treatment of wounds for the year 1918. It is a procedure applicable also to casualty work of civilian practice. This method of treating wounds, which came into general use in the British military hospitals in the early summer, was, I believe, first extensively employed by the French surgeons, who proved its worth. There has been a considerable range of variation amongst different surgeons as to the time limit of what should be termed "delayed primary suture" and what "secondary suture." The period for delayed primary suture, hereafter referred to as D.P.S., might be defined as any time up to the appearance in a wound of granulations visible to the naked eye; but the term should, in my opinion, be confined to those cases in which suture is undertaken on the day of removal of the original packing, all others being classed as secondary suture.

The success of delayed primary suture depends largely upon three factors: (a) The thoroughness of the primary operation of cleansing or excision of the wound, (b) careful attention to technique at the operation of suture, and (c) post-operative care, especially as regards rest and splinting. Owing to the necessity for rapid evacuation it has been impossible to follow all my cases of D.P.S. to a conclusion, but for the purpose of obtaining some definite information on the subject I have kept under observation fifty consecutive cases, in each of the three groups referred to below, until the wounds were completely healed, or the degree of failure established beyond doubt.

Before proceeding to a discussion of the second operation, with which we at the base hospitals are most concerned, I will deal briefly with the preparatory or primary operation. The three ideals to be aimed at in the operation are: (1) The removal of all foreign material and disorganized tissue; (2) sterilization; and (3) absolute dryness of the wound.

A wound from which missiles and shreds of clothing have not all been removed may reasonably be expected to suppurate. The removal of all disorganized tissue, while devoutly to be wished, does not warrant the ruthless destruction of essential structures by massive block excision. I have seen more than one case of a wound, completely excised and perfectly clean, where approximation of the tissues was a physical impossibility, and wondered if a less radical excision, with Carrel treatment, and healing by granulation or secondary suture, might not have given a more satisfactory result. The oedema and infiltration of muscle which is so frequently seen during the first few days after injury render the approximation of the retracted ends of a muscle extremely difficult when complete transverse section has been complicated by extensive resection. It should also be borne in mind that every fraction of an inch of skin is valuable, particularly on the forearm and the lower part of the leg, where the skin is usually found to be under considerable tension at the time of suture. It has already been demonstrated that many wounds can be satisfactorily cleansed for suture by the vigorous application of soap and water without complete excision.

Sterilization is largely effected by the mechanical measures referred to above. When a wound has been completely excised under aseptic conditions I can see no necessity for the introduction of antiseptics, but when there is a doubt about the thoroughness of the excision or wound toilet, an antiseptic pack may have a decided advantage over plain gauze. Most of my cases have been packed with flavine gauze, which to my mind leaves on removal a cleaner and drier wound than either eusol or bismuth-iodoform paste.

Dryness of the wound is essential. In my experience a wound arriving at the base with a large blood clot under the pack invariably does badly. The time spent in ligaturing small vessels is by no means wasted, and indeed is imperative unless the pack be firmly stitched in.

It is important that the primary operation of wound toilet, or excision should be carried out as early as possible. The chance of successfully cleansing a wound appears to diminish slowly during the first twelve hours, and rapidly after the first twenty-four.

The elapse of time between the primary operation and delayed suture has varied in my cases from twenty-four hours to five full days. I can see no difference in the cases of twenty-four and forty-eight hours, but there is undoubtedly a difference between the cases of forty-eight hours and those of four days' interval. Consequently I regard the optimum period for D.P.S. as being within fifty hours of the primary operation, and preferably on the second day. With an interval of forty-eight hours the patient has had time to recover from the first anaesthetic, also if a virulent infection be present it will probably have asserted itself by that time, in which case we are warned against attempting to suture.

So far I am unable to state any scientific index of suitability for D.P.S., and am of the opinion that one must be guided entirely by the naked-eye appearance of the wound, coupled with general clinical observations. I attempted to work out a bacteriological index, but gave it up after a series of 50 cases, as several wounds, showing one or less than one pyogenic micro-organism per microscopic field, suppurated, whereas others showing from ten to twenty healed perfectly.

Bacteriological Table of Smears from 50 Cases Immediately before Final Toilet.

No. of Micro-organisms per Microscopic Field.	No. of Cases.	Complete Success.	Partial Success.	Complete Failure.
One or less than one per field	37	33	3	1
Two to four per field	5	4	1	—
Five per field	1	—	1	—
Ten to fifteen per field	3	1	2	—
Twenty per field	3	3	—	—
Forty per field	1	—	—	1

Streptococci were present in every case except one.

A wound which is suppurating mildly may be partially stitched, with provision for drainage, and do well, but I

have not seen a wound containing pus completely sutured without failure. Consequently the indications on which I decide to carry out complete D.P.S. are: (1) A wound free from macroscopic pus, and (2) the absence of general contra-indications, such as toxæmia, rapid pulse-rate, or undue elevation of temperature. I do not defer suture on account of temperature unless both the morning and evening temperatures are above 100° F., or one of them is above 101°.

The presence of a compound fracture does not contra-indicate D.P.S. provided one is reasonably sure of cleansing the damaged bone. Compound fracture of the femur is probably an exception. I have had bad results in every case of D.P.S. complicated by compound fracture of the femur, and am of the opinion that it is too dangerous to be justified, even by the report of an occasional success. Fracture cases where there has been an unobliterated cavity in the bone, frequently, but not invariably, suppurate, and require removal of one or more stitches for drainage, without complete failure.

In dealing with patients prepared at a casualty clearing station for D.P.S., and labelled as such, my procedure has been as follows:

As most of the cases have arrived during the night, I have two pulse and temperature records available at my morning visit. If the general condition of the patient does not contraindicate operation or the administration of a general anaesthetic, he is taken to the operating theatre without having his dressings removed. He is anaesthetized, and all dressing except the pack removed. A wide area of skin surrounding the wound is vigorously swabbed with a 5 per cent. solution of picric acid in spirit, care being taken that the skin edges about the pack do not escape the application. The pack is then removed, and if there is obvious pus in the wound the case is declared unfit for D.P.S. A dressing of eusol or flavine gauze is applied, and the patient returned to his ward for further treatment with a view to secondary suture. If no pus is visible on removal of the pack the wound is considered fit for D.P.S. In dealing with a very large wound, part of which is clean, it is frequently justifiable, as I have already intimated, to do a partial suture in order to reduce the absorbing surface and the pain of dressings, but it has been my experience that wherever possible complete closure of the wound should be carried out. Small drains of rubber tissue may be inserted between stitches and removed after forty-eight hours. Flakes of coagulated lymph, small blood clots, and a certain amount of fresh blood are usually seen in a wound after removal of the pack, and the question of final cleansing arises. This will be discussed below. After the final toilet the wound is closed, preferably in layers, approximating the deeper tissues with interrupted sutures of catgut and the skin with silkworm gut. Where tension on the skin is excessive it is advisable to introduce at some distance from the line of suture one or more tension stitches, having the ends guarded by buttons or bits of rubber tubing. These stitches may be removed on the second day. When stitching has been completed the area is again painted with a solution of picric acid in spirit and a dry dressing applied, with sufficient bandage or splinting to ensure absolute rest to the part.

To determine whether an antiseptic lavage had any advantage over wiping with plain dry gauze in the final toilet of the wound, after removal of the pack I carried out observations on three series of fifty cases each, where the final toilet was (a) an aqueous solution of flavine (1 in 1,000), (b) ether, and (c) wiping with dry sterile gauze.

The following table shows the comparative results:

Three Groups of Fifty Cases each, of Similar Severity.

Final Toilet.	Percentage of Primary Union.								Average.
	100 %	90 %	80 %	70 %	50 %	30 %	20 %	Complete Failure.	
Flavine	38	7	3	—	—	—	—	2	93.40 %
Ether	39	5	—	—	2	1	1	2	90 %
Dry wipe	25	14	1	6	2	1	—	1	87.80 %

It would appear that flavine is slightly more efficacious than ether, and both are better than simple dry toilet. Flavine undoubtedly delays healing in a wound, and it is seldom safe to remove all the stitches inside of fourteen days.

For the skin preparation I originally used tincture of iodine, but found frequent suppuration about the stitches and a moist dermatitis along the edges of the wound. On the suggestion of Major-General Sir Berkeley Moynihan, who saw some of these cases with me, I discontinued the use of iodine and substituted a 5 per cent. solution of picric acid with entire satisfaction.

Classification of the above 150 Cases.

Nature of Wound.	No. of Cases.	Complete Success.	Partial Success.	Complete Failure.
Wounds of soft tissues—				
Slight	18	17	1	—
Severe	83	57	24	2
Wounds complicated by compound fracture of—				
Humerus	5	2	3	—
Ulna	4	3	1	—
Radius	—	—	—	—
Femur	2	—	—	2
Tibia	8	6	1	1
Fibula	3	3	—	—
Other bone	5	4	1	—
Wounds complicated by penetration of joint—				
Elbow	2	2	—	—
Knee	8	4	4	—
Ankle	1	1	—	—
Amputation stump—				
Arm	1	—	1	—
Forearm	2	2	—	—
Thigh	4	1	3	—
Leg	4	—	4	—
	150	102	43	5

The post-operative treatment of cases of D.P.S. should be carried out as though dealing with fractures. The patient should be confined to bed and the part splinted, if possible, until healed, when graduated movements should be ordered.

The conclusions drawn from my experience of the last five months with D.P.S. are as follows:

1. That a large number of wounds considered by surgeons at casualty clearing stations to be unfit for immediate primary suture may be safely closed a couple of days later at a base hospital without intermediate treatment, thereby materially reducing the disability and shortening the stay of patients in hospital. Over 90 per cent. of the prepared wounds which I have seen were fit for D.P.S.

2. That the primary cleansing operation should be carried out as early and completely as possible, without undue sacrifice of tissue, and with careful attention to haemostasis. The wound should be firmly packed, and the patient labelled, "For D.P.S."

3. That the best results may be expected from complete D.P.S. carried out between twenty-four and fifty hours after the primary operation.

4. That there is at present no reliable bacteriological standard of suitability for D.P.S., but that any wound which is free from macroscopic pus after having been packed for forty-eight hours may safely be closed in the absence of grave constitutional signs.

THE Bedfordshire County Council has purchased Mogerhanger Park of 27 acres, with the mansion, for a county sanatorium. It has also purchased certain huts at Amphill military camp. It is estimated that the sanatorium, which will provide 80 beds, will cost £12,000, including £2,000 for furnishing.

THE DETECTION OF SACCHAROSURIA, INOSITURIA, AND LACTOSURIA BY A MYCOLOGICAL METHOD.

BY

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SOME time ago (BRITISH MEDICAL JOURNAL, December 29th, 1917) we described a mycological method for the detection and determination of various sugars and other carbon compounds, mostly Fehling reducing, met with in physiological and pathological work.

We thought that just as various carbohydrates and other carbon compounds are used in the identification of certain bacteria and higher fungi, the reverse process might also be carried out and bacteria and higher fungi used for the detection of certain chemical substances. For many years ordinary baker's yeast (so-called German yeast) has been, of course, used to detect glucose, but this is the only sugar for which a purely mycological method has been used in pathological work, and, as a matter of fact, it is an unscientific method, as ordinary yeast almost constantly ferments maltose, saccharose, and other sugars in addition to glucose. Our method might be called "conjugated or parallel mycological method," as we do not use one species of germs only; we generally use two or more and compare their action on the substance to be determined.

The simplest way of carrying out our method to determine whether a substance is or is not a certain carbohydrate is to test on that substance, whenever possible, the action of two germs known to be identical in all their biochemical reactions except on that particular carbohydrate. For instance, in order to see whether a certain chemical substance is maltose, we test it with two germs which are known to be identical in all their biochemical reactions except on maltose, one fermenting this sugar, the other not. To carry out the method an exact knowledge is necessary of the biochemical reactions of a certain number of bacteria and higher fungi.*

SACCHAROSURIA.

Spontaneous saccharosuria is an extremely rare condition, but artificial saccharosuria is not so very rare among malingersers; we have come across three cases in which saccharose had been added to the urine with the object of misleading the medical officer. The medical man who uses as routine the usual Fehling's method is not apt to diagnose such cases as glycosuria, as saccharose does not reduce, at any rate not very clearly, Fehling's solution; but the medical man who uses what is considered to be, by most authorities, the more exact method of yeast fermentation will very likely fall into error, because though in so many textbooks it is stated that glucose is the only substance fermented by ordinary baker's yeast, we have found that a very large number of specimens of baker's yeast will ferment saccharose and also levulose, maltose, etc., in addition to glucose.

Mycological Tests to Determine Saccharose.

According to our method various tests may be evolved to determine whether a certain carbohydrate of those found in pathological urine is or is not saccharose; we give here a few of these tests in the convenient shape of mycological formulae:

I. *B. coli* Escherich 0
B. neapolitanus Emmerich + } = Saccharose.
 + = Presence of gas. 0 = Absence of gas.

The explanation lies in the fact that *B. coli* and *B. neapolitanus* are identical as regards their biochemical

* The reader may perhaps find it useful to consult the tables of biochemical reactions of various fungi and bacteria published by one of us in various medical journals; some of the more recent one may be found in a paper by one of us in the *Journal of Tropical Medicine*, August 15th and September 15th, 1917. Similar tables may be found in Castellani and Chalmers's *Manual of Tropical Medicine*, second edition, pp. 822 (moniliae) and 1380 (bacteria); and as regards the bacteria, Hewitt's *Manual of Bacteriology*, sixth edition, pp. 428-433.