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B.L.A. SURGERY

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Just eleven months of war surgery—from the tents and grubby outbuildings of the semi-demolished villas and farmhouses of the Normandy coast to the modern well-equipped German hospitals of the Baltic coast. But what a fascinating series of surgical as well as tactical situations those eleven months produced! For let it be said at the outset that the closer the links between the clinical and administrative sides of a medical organization, the better the results. And the more the administrators keep the clinicians in the tactical picture, the more intelligent and productive becomes the co-operation. Such a happy state of affairs existed and persisted throughout the whole of this campaign; and when to this stimulating atmosphere are added excellent equipment, what can only be called lavish supplies, extremely well organized evacuation, a first-class transfusion and resuscitation service, and a group of young surgeons whose surgical efficiency and clinical common sense were equalled only by their loyalty to a common cause and a common policy, and whose patients were drawn from armies superbly led, with morale and health at their highest pitch, well equipped, well clothed, and well fed—it will be seen that N.W. Europe was indeed the war surgeon's paradise.

Results

To give some idea of what B.L.A. surgeons achieved in the time the following figures are quoted. Realizing that figures are essentially fallacious, we give them only approximately. During the campaign there were 406,000 admissions to medical wards; of these, 258,000 (64%) were treated in the theatre and 148,000 (36%) evacuated to the United Kingdom. Of these evacuations it is worthy of note that over 50% were by air. Of the total admissions 181,700 (45%) were battle casualties. Of these, more than 50,000 received their surgical treatment in forward areas (approximately 28%), two-thirds of this group being serious major wounds. Of the total battle casualties, 39% were evacuated to the U.K., 61% were treated in B.L.A., and only 6.7% died of wounds. One other interesting comparison may be made between this campaign and the last war. In the latter, 41 of every 1,000 troops became a casualty each month (i.e., killed, missing, prisoner, wounded, or died of wounds); in this theatre only 21. It will of course be realized that a surgeon's work in the Army extends considerably beyond the limits of battle casualties alone—accidents and "ordinary" surgical conditions accounting for a very large number of cases. There can be little question, therefore, of the quantity of work done by our 170-odd surgeons; of the quality, an overall recovery rate in an active theatre of war of approximately 94% seems to speak for itself.

History

Let us now briefly follow this campaign through its salient phases and observe the varying effects of different tactical situations on surgical organization and policy. Some 30 surgeons actually took part in the epic of D Day—surgeons of the forward units (C.C.S.s and F.S.U.s) which landed immediately behind the invading troops. Their adventures were legion and stirring, their work as arduous as it was excellent. In any building affording a minimum of cover to the cacophonous accompaniment of shells, bombs, mine explosions, artillery and anti-

aircraft fire they worked steadily, fulfilling by rapid but careful selection of cases as important a function as they did by their excellent surgical technique. For even when tents could be erected the holding capacity of the beach-head—and for those first weeks a very thin beach-head it was, especially on the left flank by the River Orne—was minimal. Every case that had a reasonable chance of reaching the U.K. alive was evacuated, chiefly by the ubiquitous "ducks" to specially fitted L.S.T.s, and later by air. This amphibious evacuation proved up to the hilt the enormous value of the pre-D-Day practice landings when we got to know, and on the actual beaches to appreciate, the full and cheerful co-operation of the Royal Naval Medical Service—and, at that time, particularly of Surg. Capt. Miller. And yet in that first month of June, 1944, out of 21,000 surgical casualties, nearly 1,200 were operated on in Normandy. Five hundred of these were abdominal wounds, 130 chest wounds, 200 amputations, 150 compound fractured femurs, 60 penetrating knee-joint wounds, and 50 gas gangrenes. Under the conditions existing, that 80% of the 1,200 should have survived is a tribute to the surgical pioneers of B.L.A. Incidentally, they held and saved 70% of their 500 abdominal cases. At this stage it is fitting that we should remember the air-borne surgeons who dropped on D Day on the far bank of the Orne. Their results are included in the above excellent figures. And then gradually—very gradually—the beach-head became a bridgehead. Fighting was intense and continuous. The weather was hot, but there were few days without showers. Either mud or dust was always with us; the few roads, all the lanes, and most of the fields were full of transport; enemy air activity persisted at night, but most casualties were due to mines, mortars, and artillery.

In the midst of all this a medical organization soon took shape. The remains of the original beach units became evacuation centres; a line of small hospitals, their surgical potential boosted up by the addition of F.S.U.s, were established a few miles inland, and ahead of this the C.C.S.s and their attached F.S.U.s bore the main brunt of the surgery. These "surgical centres" consisted usually of two C.C.S.s lying together and working alternately—to each of which were attached 2 F.S.U.s and an F.T.U.—the whole being screened by an F.D.S. filtering off sick, exhaustion cases, and minor wounded. Such a set-up in the restricted confines of the bridgehead worked admirably and smoothly. Lines of evacuation were short and cases were dealt with relatively soon after wounding. At this period several other events of importance were taking place. Nursing officers started to arrive from D + 8 onwards, resulting in an immediate and obvious improvement in post-operative care. No words of praise can be too high for these sisters, who at that stage and throughout the campaign, often under the most uncomfortable and unpleasant conditions, cheerfully and efficiently carried out their excellent work. In the midst of the Second (British) Army, the First (Canadian) Army began to take shape, and their various medical units were fitted into the scheme of things to come. At the same time more and more general hospitals were filtered in and set up under canvas in the pleasant orchards of Bayeux—so that limited holding of cases became possible. In these hospitals—and during that period they were nothing but glorified C.C.S.s—the will to work was enormous, and is well exemplified

by our lady physiotherapists, who, having no physiotherapy to practise, toiled long gruelling twelve-hour shifts to prove themselves first-class and invaluable receptionists.

Such was the picture for the first eight weeks—a gradually increasing orderly congestion which steadily reached bursting-point in early August. Meanwhile the battles of the Odon, of Caen, of Caumont and the woody Bocage country, and of the Orne, had been grimly fought and won. And so to the American break-out on the right flank, which wheeled left, advancing south and east. Much of the German Army was trapped in the resulting pocket; the rest poured out through the now famous "Falaise Gap," there to be decimated by Allied air forces. The carnage of men and animals, the litter of wrecked vehicles of every description, the masses of discarded equipment and arms, are sights which will never be forgotten by those who saw them. Then started the first "motoring war"—a rapid advance from Normandy into Belgium from Aug. 12 to Sept. 3. The Second Army pushed on steadily and rapidly across the Seine to Beauvais, Amiens, Lille, Brussels, and Antwerp. The Canadian Army's advance up the coast was more chequered by the "fortresses" of Havre, Boulogne and Calais, Dunkirk—which held out beleaguered to the end—and Ostend. Casualties were relatively light—morale was at its highest. Scenes of the greatest enthusiasm accompanied the advance, culminating in the tumultuous welcome given by Brussels on its liberation. The underground movement of both France and Belgium gave invaluable help during this period, harassing the retreating enemy, capturing and holding strategic bridges and buildings, clearing up residual enemy pockets, and giving information about mines and booby-traps. So precipitate was the advance that little trouble was given by these devices. Prisoners poured in—many of them wounded—and for the first time we took over and used German military hospitals. This was the beginning of the transition from tents to buildings. At that time we had not got used to the filthy condition in which the Germans left their evacuated hospitals—nor had we become acclimatized to the pitifully low standard of German war surgery. Chronic sepsis and toxæmia everywhere; pale, drawn patients and the all-pervading smell of pus; major joints drained; dozens, hundreds of empyemata; wounds sewn up, guillotine amputations, brain fungi, metallic fixation of compound fractures, heavy uncomfortable plasters, bed-sores galore—such was the German war surgery of 1944–5, for later in Belgium, in Holland, and in Germany itself we found the same sad state of affairs.

One surgical point of interest in the 300-mile advance was the different use of forward units made by the two armies. The Second Army kept its C.C.S.s "leap-frogging" one another; the Canadians used advance surgical centres (field dressing stations with attached field surgical units). Both in fact were eminently satisfactory. We feel that the principle of segregating forward surgery to C.C.S.s is still the right one in that conditions and facilities existing at this level are so much more suitable for both patient and surgeon; but there is no doubt that in a rapid advance the advanced surgical centre has a definite and valuable place. In this phase air evacuation really came into its own, and without it evacuation of casualties back over the war-scarred congested roads to Normandy would have been virtually impossible. As it was, the R.A.F., with the able guidance of Air Commodore Murphy and Group Capt. Bruce Harvey, appeared with a Dakota and almost magical regularity on what seemed quite impossible fields almost alongside C.C.S.s and surgical centres. We, as surgeons, then and on many subsequent occasions had every reason to be grateful to the R.A.F.—both its medical service and its air crews—for their whole-hearted co-operation.

Automatically the enormously stretched line of communication slowed up the advance, and in the pause a medical centre of forward units was established in the muddy fields of Diest (40 miles east of Brussels), a 600-bed hospital by herculean efforts was brought up from Bayeux and established in a luxurious Brussels hospital, and the Canadian units in Belgium increased rapidly. But air evacuation became a vital necessity, and it was provided either direct from Brussels to the U.K. or down the coast to Normandy.

Once again for a short period of two to three weeks the evacuation problems were almost those of D Day over again. During this period the lively battles—the recuperative power of the German Army then was extraordinary—of the Albert and

Escaut Canals were fought and won and the way paved for the Second Army's dramatic drive through Eindhoven to Nijmegen and on towards, but sadly not to, Arnhem. The part of the airborne troops, both American and British, in this operation is too well known to require comment. And so was established the "Nijmegen corridor," a narrow hazardous projection, several times cut by German troops escaping eastwards, which needed three months' solid fighting before it was sufficiently expanded to allow a further major advance, and at the top of which from the very beginning were two C.C.S.s whose work was a surgical epic in itself. There cannot have been many occasions when a C.C.S. actually formed part of an attacking column?

During those same three months of hard gruelling fighting the Canadians cleared the coast north of Ostend and the bloody pocket of the south Scheldt, they won through the toughest of all small amphibious operations—the taking of Walcheren—and they lined the south bank of the Meuse up to the corridor. So was the great port of Antwerp really freed to perform its vital function in the campaign, only to find itself almost immediately the chief target of Hitler's newest devilish device—the "V" bomb. Meanwhile to the east and the west the corridor was broadened, and such now famous places as s'Hertogenbosch and Tilburg, Venlo, Venray, and Sittard slowly fell; the line was firm up to the Meuse right down to our junction with the American Ninth Army at Maastricht. Many times we worked with our American colleagues—either alongside or actually under the same command—a symbiosis which was always as happy as it was fruitful. So also were our frequent meetings with Col. E. Cutler, the Chief Surgical Consultant of E.T.O.U.S.A.

These dour battles over the waterlogged flats of northern Belgium and south-east Holland produced a steady flow of casualties—chiefly from mortar fire and from the ubiquitous mine-fields. Forward surgical units were always in the van; evacuation was good, by air and by train; and a large and efficient organization of hospitals, transplanted from Normandy, became established in Belgium and northern France to deal with all except the long-term casualties.

And so to the brief hectic interlude of Rundstedt's breakthrough in the Ardennes and those weeks of heavy snow and freezing cold and bitter defensive fighting once again. The almost entire absence of "trench feet" during this time was a point of noticeable interest, as was the increased difficulty in resuscitating wounded previously exposed to the rigours of the weather.

Then a mounting crescendo of activity—tempered by a rapid thaw and the consequently appalling condition of the roads—until on Feb. 8, 1945, the First Canadian Army, heavily reinforced with units of the Second Army, began their brilliant drive down from Nijmegen through the mine-strewn heavily fortified (Siegfried Line) Reichswald Forest to clear the territory between the Meuse and the Rhine: fighting in Germany—a devastated belt as the result of previous R.A.F. bombings—and fighting as bitter as any since D Day. Large concentrations of forward surgical units at Nijmegen and Venray had a hectic time. One C.C.S. alone dealt with 5,000 cases in three weeks. But the result was achieved early in March, and we sat on the banks of the Rhine. A short period of regrouping and then the triumphant crossing of the Rhine on March 23, 1945, accompanied by its "biggest-yet" airborne landing—a "crossing so beautifully planned strategically that the resulting casualties were surprisingly and unexpectedly light."

And so to the "Second Motoring War"—a streaming out over the Westphalian plain north and east against weakening opposition; short pauses for determined isolated pockets of resistance and at the major rivers—the Weser and the Elbe; a relatively easy capture of Bremen and a simultaneous surrender of Hamburg and arrival on the Baltic coast—and the final surrender in the first week of May. Meanwhile the Canadians had crossed the Rhine, below the famous Arnhem, and pushed on to the North Sea, thereby cutting off the entire German armies in Holland. They rapidly advanced north to take part in the Battle of Bremen and so share the concluding victory.

All this last stage saw steady but relatively small casualty lists—being dealt with by the rapidly leap-frogging C.C.S.s and small hospitals, and with advanced surgical centres again in the limelight. Problems greater than surgical casualties soon

emerged: masses of German prisoners, both wounded and unwounded, numbers of displaced persons of every conceivable nationality wandering in every direction in various stages of disease and starvation, and the ghastly horrors of Belsen, Sandbostel, and other smaller concentration camps. Even before hostilities ceased three large general hospitals had been moved into Germany to assist in dealing with these problems and to speed the last of our battle casualties on their way.

Units

It is not our intention to deal in any detail with the various surgical units involved in this stirring picture, but simply to stress some salient points that seem of importance. It was a great pleasure to us to note the increasing interest of divisional units (field ambulances and field dressing stations) in surgical policy. We firmly believe that the correct initiation of sound first aid and judicious but limited resuscitation at this level is of vital importance in the subsequent success of surgical treatment proper. Every possible effort was made by Army Surgical Consultants to contact and to advise forward medical officers.

The C.C.S., practically always with attached field surgical units, has borne the brunt of the serious forward surgery. As at present constituted, it is rather too small, but in any planned action two C.C.S.s were brigaded together and screened by a F.D.S., which took off lightly wounded, sick, and exhaustion cases. Such an arrangement worked admirably, the two C.C.S.s functioning in rotation according either to the number of admissions or, more frequently, to the number of cases awaiting operation. It was of interest to note that a steady 15 to 20% required operation at this level. To all such set-ups one or more of those invaluable little units—the field transfusion units—were added, and were responsible not only for the resuscitation of operative cases but also very largely for the choice of priority in operation and for assistance in post-operative care. Each C.C.S. carried 8 to 10 nursing officers, whose work, as already mentioned, was beyond praise. The type of case dealt with at this level became quite stereotyped: haemorrhages; severe multiple wounds; traumatic amputations; abdominal, thoracic, and abdomino-thoracic wounds; severe compound fractures, especially femurs; and suprapubic drainage for paraplegias. Of such cases the average surgeon could do approximately 15 in his tour of duty. This we found was optimum at "12 hours on and 12 hours off." The latter period included ward visits as well as rest.

The siting of C.C.S.s of armies varied with the tactical situation from 2 miles behind the "line" to 80 miles, but the vital time interval between wounding and surgical care remained at a remarkably steady average of just under 12 hours in all conditions. We believe firmly that the right place for forward surgical treatment—from the patient's, the surgeon's, and the nurse's points of view—is just out of enemy artillery fire and behind our own big guns. This ideal was by no means always achieved.

The advanced surgical centre (F.D.S. and F.S.U.s), as has been already pointed out, was used on many occasions, but as a surgical entity it is definitely "second best" to the C.C.S. Its value in a rapid advance of a very mobile type of warfare has become more and more appreciated, not only by medical administrators but also by combatant generals.

The 200-bed general hospital was in this campaign used as a glorified C.C.S.—and as such fulfilled a most valuable role. To allow this, surgical potential had to be boosted by the addition of F.S.U.s. We feel that this unit would be better employed in producing slightly larger C.C.S.s and that its intended semi-static functions might well be carried out by an F.D.S. On the other hand, the inclusion of a 1,000-bed convalescent depot in Army areas was of inestimable value in saving man-power and in ensuring rapid rehabilitation.

A word about the special neurosurgical and maxillo-facial teams. We officially had one each of these per army and we had one thoracic team per Army Group. In fact, by incorporating specialists in ordinary hospital establishments we possessed extra neurosurgical and thoracic teams. But compare this with the Americans' 12 to 15 neurosurgeons and 7 to 8 maxillo-facial surgeons per army! However, the work done by these few special teams was relatively as great in quantity as it was excellent in quality. The value of adding an otologist to maxillo-facial teams was amply proved. The advantage of the neurosurgical and maxillo-facial teams working close together, and with an

ophthalmologist readily available, was already known—and the policy was adhered to. Luckily, the cases treated by these two teams do not require urgent operation; after preliminary first-aid surgery and the provision of chemotherapeutic prophylaxis they can safely await definitive operation for several days if necessary, without undue risk; and they travel well.

Hence in the Normandy days many cases were sent to the U.K. for definitive treatment; in the Belgian period the teams remained in Brussels and Antwerp almost until the Rhine crossing—air evacuation providing their pabulum in good shape and relatively quickly. Nevertheless, to cope with the urgent "special case," and more particularly with the special wound combined with another wound requiring immediate surgery, we felt that further "special" cover was necessary, and this was provided by training a proportion of F.S.U. surgeons in elementary maxillo-facial and neurosurgical work and by giving them minimal special equipment—a policy which in the latter part of the campaign paid good dividends. There is no doubt, too, that the base areas of any theatre of war require cover in these specialties as well as the armies.

The work of the thoracic teams was limited by our proximity to the U.K.; for their problems are essentially those of the complicated chest wound or the chronic case. It is essential that all forward surgeons should be able to deal with the preliminary treatment of a penetrating or sucking chest wound, and even more essential that well-trained chest physicians should be attached to forward units.

Clinical Lessons

What have we learnt clinically from the surgery of this campaign? We will not enter into a description of all the various types of war wound, but simply list a series of facts that have emerged from the mass of clinical material and of questions that have been raised and still await solution.

Extensive Flesh Wounds.—These have a high operative priority—at least equal to that of the "bellies." Massive tissue damage leads to a severe degree of "shock," against which resuscitation is often of no avail and for which urgent radical surgery is the only life-saving measure. One other valuable lesson learnt was the great importance of rest and immobilization in these cases, either in transport or post-operatively, and irrespective of whether they are complicated by bony injury or not.

Gas Gangrene.—Compared with previous campaigns this nightmare condition was conspicuous by its absence. The majority of the relatively few severe cases were in German prisoners, who often took some time to collect. In an operation of this magnitude, to have recorded something less than 300 cases of anaerobic myositis can only be described as phenomenal. The reasons which may possibly account for this different picture are discussed in general terms later. When it did occur it still carried a 20% mortality. "Gas-gangrene cellulitis" became recognized more and more as a clinical entity as experience increased. Some 70 cases were reported, with a mortality of 10%. Gas gangrene at hospital level was negligible.

Abdominal Wounds.—This group of cases—a large one of approximately 5,000—has also produced extraordinarily good results. An overall mortality of around 30%—a figure which reports from the United Kingdom suggest is not markedly raised in the later stages of treatment—is highly creditable. This improvement is, we feel, not due to any one factor. Little change has been made in actual technique, but principles of treatment have been both standardized and adhered to. Penicillin has been used, and has certainly favourably affected post-operative complications, but has probably had little to do with the lowered death rate, as two-thirds of deaths from penetrating abdominal wounds occur within two days of operation. A strict routine of post-operative care has undoubtedly been an important factor.

Suturing of individual small-intestine wounds as against resection, unless the latter procedure is demanded by mesenteric vascular injury or massive damage, remains a firm principle; as does also exteriorization of large gut wounds—although this on the right side is by no means the ideal answer. Latterly in the smaller right colon wounds, suture with drainage, attachment of the sutured gut to the peritoneum, and even ileo-colostomies have been performed with success in well-selected cases. The formation of a good spur in colostomies wherever possible greatly facilitates secondary procedures.

Liver wounds that reach surgery have not given great cause for concern, and what trouble there has been is from bile more often than from blood. Fibrin foam as a haemostatic in this region is worthy of more extensive trial. A more conservative attitude regarding wounds of the renal parenchyma has produced good dividends—and we have learnt that the thoracic approach to the spleen is as good as any when the nature of the wound allows it. Of approaches in general, the rectus muscle split has steadily grown in popularity; but

the golden rule of an incision sited as far as possible over the suspected lesion and big enough to give good exposure still holds. The value of a posterior drain, if necessary after removal of the coccyx, in rectal and pelvic colon wounds became obvious; and of drainage in general we would say, "Avoid drainage if possible, but if in doubt, drain."

Radiological examination has, in the presence of the very common multiple small wounds of present-day explosive missiles, assumed a relatively far greater importance.

Burns.—The conspicuous absence of severe burns has been one of the welcome and noticeable features of this campaign. Only about 1,000 burns were admitted to forward units, and only one-third of these were identified as serious. In this latter class there was a mortality of 5%. From the hospital angle, burns accounted for 3% of all admissions (surgical) and for 2% of all battle casualty cases. This very marked difference in comparison with the M.E. campaign leads one to suppose that climatic conditions, both directly and indirectly, must have a very big effect on the incidence of burns.

Treatment was of the simplest, and was standardized: as a preliminary (apart of course from the necessary resuscitation), gentle cleaning and the application of an oily dressing containing a bacteriostatic (sulphonamides or, later, penicillin). Burns were immobilized so far as was possible, and dressed as infrequently as possible. Cases which were considered too severe to be treated under this regime were skin-grafted during a course of parenteral penicillin—the most severe being, whenever possible, referred to plastic surgeons for treatment.

Chest Wounds.—In this field improvement came from the better appreciation of certain simple facts rather than any new technique. For example:—(a) That chest wounds do *not* travel well in the first five or six days and should be held in forward units until stabilized. (b) That there is no danger in emptying a pleural cavity far earlier than was previously considered advisable—i.e., within 12 to 24 hours. This emptying applies as much to air as to blood. In certain units the use of an apical tube for draining a pneumothorax was proving "practical politics." Many surgeons were emptying the pleura by catheter previous to inserting the last stitches closing a sucking wound, and at the same time the anaesthetist would expand the lung by positive pressure. The slogan produced by our medical colleague (Brig. E. Bulmer)—"Having saved the life, save the lung!"—has governed our policy in these chest wounds, and by far the majority of cases have shown a reasonably well expanded lung before transference to base hospital. When it has been difficult to achieve this, the cause is frequently a lung haematoma—a condition, it is felt, not hitherto sufficiently appreciated. What the late effects of this early definitive treatment will be in comparison with those of the last war and previous campaigns only time can tell—but we are hopeful. (c) That once a sucking wound is closed, penetrating chest wounds are better dealt with and supervised by a physician. Considerable time is required to produce optimum results—and for the forward surgeon time is usually at a premium. The forward physicians have in this campaign done yeoman service. (d) That chest cases, like all other serious wounds, are shocked and require resuscitation. Admittedly, in view of the site of the lesion, this should be carried out carefully and rather more slowly than is now accepted as usual. For the immediate resuscitation of chest cases blood is much safer and more valuable than plasma. The risks of producing pulmonary oedema by giving intravenous fluids are infinitely less than the risks run by not giving them at all.

At the end of the campaign the general impression regarding thoracic wounds is that there has been a very marked improvement in treatment and results as confidence grew from increased experience. So much is this the case that we feel, and have the agreement of our thoracic surgeons, that forward surgeons might well, with suitable direction, be a little more ambitious in the early stages, both with safety and with advantage to the patient.

Vascular Injuries.—Here is a surgical field still in the throes of exploratory tilling—and a very important field in its inevitable (at the moment) wastage of limb and life. The majority of our fatal cases of gas gangrene have been those associated with vascular damage, and a considerable percentage of the total amputations have resulted from irremediable injury to main vessels. No fewer than 1,150 cases (i.e., 2% of the total) were specifically recorded by forward surgeons. This group carried a 5% mortality. And at the end of it all we were still relying on ligature as the mainstay of treatment. The success or otherwise of this procedure depended upon a number of factors, such as length of time between wounding and operation, amount of associated muscle damage (i.e., obliteration of potential collaterals), site of vessel injury, amount of sepsis in the wound producing the vascular damage, and, even more important in distal wounds on the same extremity, extent and severity of accompanying wounds elsewhere and the patient's general condition. Even allowing all these variables, one often saw almost comparable cases—one viable, the other gangrenous. Arterial spasm is most certainly an entity, and the individual's sympathetic response to various stimuli is undoubtedly yet another factor.

Little benefit was achieved in these cases either by sympathectomy or by local stripping of vessel coats. Sporadic good results following

arteriectomy were reported in cases of so-called spasms. The local and primary repair of a partial tear of a major vessel was also occasionally successful, but one felt always that there was too much of an element of luck in these cases to make them of any scientific value. The calf fascia-splitting incision (as popularized in C.M.F.) was found useful, but only in selected cases—where the lower leg was markedly swollen and cold and the skin glazed. The most stimulating line of advance was the work of certain surgeons (in particular Major W. Mustard, R.C.A.M.C.) in performing primary intubation of damaged major vessels. Tubes of glass and acrylic resin were used, the rationale being to restore circulation through the main vascular channels of a limb at the earliest possible moment, with the idea of removing the tube and carrying out definitive treatment (e.g., suture, venous graft, ligature) within a few days when circulatory stability had been regained and collaterals opened up. Results of this technique produced some unexpected and occasionally disquieting secondary phenomena—e.g., the effect of suddenly washing into the general circulation the metabolites of a limb in which the circulation had been stagnant for several hours. However, it is felt that along this line there is most chance of a material advance.

In the meantime, ligature, with all its chanciness, is still the accepted treatment. The ligatured popliteal still gives far too many bad results, the femoral prognosis is fifty-fifty, and the brachial good. We have learnt that it pays to keep these cases in forward areas for several days, until a definite decision as to the future of the limb has been arrived at.

Knee-joints.—A series of 1,365 penetrating wounds of the knee-joint, with only 7 deaths, would have sounded like the worst kind of fairy-tale in 1940, and even in the Middle East a large proportion developed pyarthrosis, with subsequent toxicity and disability. And yet these are the B.L.A. figures. The cases were treated by careful excision, by suture of the synovial layers without drainage, by the instillation of local penicillin (50,000 units) into the joint cavity, and by careful immobilization in a Tobruk splint for transit. At the same time a course of parenteral penicillin was instituted. Practically all these cases were transferred direct to the U.K. Later reports from orthopaedic centres there underline the really amazing change in the picture of these cases. So good was their general and local condition on arrival that there was at first a tendency to push convalescence a little too fast. A series of local, but unimportant, flare-ups in the joints with an effusion were evidence of this quite understandable over-enthusiasm. As examples of the later results extracts from two reports from the U.K. may be given.

(a) Series of 78 cases in a transit E.M.S. hospital in the first month of June, 1944. 44 had serious accompanying bone injury, 4 required amputation (2 for joint infection, 1 for popliteal artery damage, 1 for gas gangrene). At eight months 33% had flexion better than 90°, and another 15% better than 45°.

(b) A later series of 101 cases at an orthopaedic centre: Normal knee, 67; expected to be normal, 10; useful range, 13; ankylosed, 11; no deaths; no amputations. Only 9 cases had suppurative arthritis; 4 of these were healed within six months, three of them much earlier. Of the 11 ankylosed knees, 9 had marked bone damage. No drainage of an actual joint was ever necessary.

This is a stimulating picture, for which, of course, we must undoubtedly to a large extent thank penicillin; but, as ever, this invaluable agent should be thought of only as the handmaiden of good surgery. A comparison with German knee-joints is tragic. They perform large numbers of primary excisions, they drain every joint with outside tubes, and their immobilization is minimal. Hence all their knee-joint cases are septic, and those who do not die of toxæmia either have to lose a limb or accept a deformed and useless one. So there is credit due elsewhere than to penicillin!

Amputations.—Little need be said on this subject. Approximately 3,200 amputations (excluding digits) were performed in this theatre—2,600 in forward areas with 7.5% of mortality, and 600 in base hospitals with 1.3% mortality. The principles of flap formation, of avoidance of primary suture, and of the use of delayed suture have been strictly adhered to. We have considered a guillotine amputation a surgical crime (it is the accepted German method!), and we have preached that amputations through joints should be performed only in cases of dire emergency.

Delayed Suture (with which should be grouped simple skin-grafting).—There is nothing dramatic about these techniques, but the results achieved have led to a saving of man-power, a reduction in wound complications, and an economy in hospitalization, in supplies of drugs and equipment, and in surgeons' and nurses' time which it is quite impossible either to compute or to appreciate fully. As holding capacity increased towards the end of 1944 in Belgium, more and more cases of at first simple flesh wounds and later of more complicated wounds (e.g., compound fractures) were rendered "simple" before evacuation to the United Kingdom) were sutured in base hospitals. During the last six months of the campaign these cases provided more than 50% of the work in base hospitals, and during the process a great deal of interesting and valuable clinical and scientific research was carried out. This has been fully reported

elsewhere ("21 Army Group Penicillin Therapy"). Results were universally satisfactory—90% sutures being considered not quite good enough!

It is impossible here to enter into the many points of detail which have been of interest, but perhaps one example may be quoted as being indicative of the saving of time, equipment, and energy resulting from such simple measures. Let us always remember, however, that it is only the laying of the bogy of wound sepsis by good preliminary surgery and by penicillin and its allies which makes this mass repair a practical proposition. The simplest type of wound—a "through-and-through" bullet wound of the soft tissues of the thigh—was produced by an officer (accidentally!) shooting his batman through both legs. The surgeon applied local penicillin and a sterile dressing to one entry wound and one exit wound; the other entry and exit he excised and three days later sutured. At the end of 10 days (i.e., a week after suture) stitches were removed from the sutured wounds, leaving a linear pliable little scar. The other two wounds remained perfectly clean and ran a normal course of healing; but they took 23 days before dressings could be discarded, and left "threepenny" slightly depressed scars, one of which was adherent to deeper tissues. A simple example of a very important advance!

Post-operative Complications

Most of these are too well known to merit discussion here, but we would like to record the very noticeable absence of post-anaesthetic chest complications throughout the campaign—even in the bitter weather of last Christmas in the snow of the Ardennes and the mud and chill of eastern Holland—and at the same time to pay tribute to the very high standard of anaesthesia that was maintained. But two complications probably remain in the forefront of the minds of most B.L.A. surgeons—fat embolism and so-called "anuria."

(a) *Fat Embolism*.—The occurrence of a small series of 5 cases (4 of which were fatal and 3 proved by post-mortem examination) in the early battles around Caen aroused our interest and prompted the thought that this little-understood and rather dire complication of trauma (or should one say mechanical and surgical trauma, and even add anaesthesia to the list?) was perhaps more frequent than had previously been thought the case. Subsequent investigations have certainly confirmed this supposition—but have unfortunately done little to elucidate the problem. We have learnt to recognize fat embolism clinically with much more accuracy, and hence can say that a larger proportion than 20% (as in the "warning" series) survive. Over 100 cases have been reported during the campaign, and doubtless many more have occurred. It would seem that the mortality is approximately in the neighbourhood of 50%. The following facts of interest have been noted often enough to be worth recording:

(i) Although usually the sequel of a major wound involving large masses of soft tissue, this is by no means always so. Cases have been reported several times after retroperitoneal haematoma, once or twice following chest wounds, and once with a straightforward penetrating abdominal wound involving small intestine only.

(ii) The old theory that the embolic fat is derived from the marrow of a broken bone is quite exploded.

(iii) The predominance of cerebral symptoms over pulmonary has been a striking feature.

(iv) Petechiae, most commonly seen over the shoulders, upper chest, and neck, were the exception rather than the rule.

While a considerable amount of research has been done in the theatre on this problem, it must be admitted that little light has been shed on the possible aetiology. Apart from symptomatic measures, the only definitive attempt at treatment, to our knowledge, was the intravenous injection of 90% alcohol. The patient recovered, but whether from fat embolism or acute alcoholic poisoning is not related!

(b) *Anuria*.—This aetiotologically vague but clinically very definite syndrome was seen all too often in many of our more serious cases. During the V-bomb raids on Antwerp cases of "crush syndrome" were relatively common, but, apart from this better-known variety, cases were continually being discovered in which there was no suggestion of "crush" but in which anuria developed. Not by any means all were fatal, but, once established, the outcome of the case appeared to be in the lap of the gods. As time went on we had reason to doubt the value of intravenous alkalis, which we at first strongly recommended. Likewise, no success was obtained from high-spinal anaesthesia or from splanchnic block. The consensus of opinion at the moment would seem to favour the conjecture (and that is all it is) that a circulating toxin is produced by massive tissue damage—the effects of which are widespread. The kidney tubules are possibly one of the affected parts. It has been noted that the same toxin may act on normal blood fat in such a way as to change its physical state and render it more likely to be deposited in pulmonary and cerebral capillaries.

Naturally, in war, trauma—and severe trauma—is very much with us; but the possibility of both the above conditions occurring relatively far more frequently in civilian life than was previously recognized should be borne in mind. They offer a rich field for future research.

The Surgeons

Two out of every three B.L.A. surgeons—the men responsible for the work described above—had never met a war wound face to face before D Day and their arrival in Normandy. The remaining third were veterans of the M.E. campaign. The effect of the latter on the former, the effect of six months' training as a surgical team before D Day, the value of a routine procedure standardized so far as was possible and based on previous practical experience, are all borne out by the recorded results. The conservatism and judgment of the smaller group and the loyalty and willingness to learn of the larger—and, let it be fairly said, the excellent surgical technique of both—produced an atmosphere which was as stimulating and provocative as it was efficient and friendly. War surgeons are really quite an individual class—and are bred as much as they are born. They must be essentially competent technicians, with a good anatomical background—not too slow, not *too* meticulous—capable of endurance, blessed with common sense (which gives sound judgment) and human understanding, adaptable and cheerful—doctors as well as surgeons! Naturally there are many varieties of this prototype, and most of them are good. The war surgeon acquires enormous confidence. If he ever aspires to become a good surgeon he must possess or acquire a corresponding amount of clinical and technical knowledge.

In this thought lies a description of the three main classes of war surgeon: the one who will always be a menace, possessing only confidence; the one who was a surgeon before he was a war surgeon and will only have to readjust on return to civil life; and the one who has become, or, even more important, *may* if properly handled become, a good surgeon on the basis of his war experience together with a desire to acquire a wider knowledge.

Such were the surgeons of B.L.A., though Class I was almost conspicuous by its absence. They were good war surgeons, they were good friends, and they made a good team.

Summary

It has intrigued us to probe into the reasons for these improvements and for the general high standard of surgery in this campaign, considering that very little new has been added in technique and very little new has been discovered in research. Many are the discussions we have had on this subject in many weird places. The following points summarize our opinions:

1. *Man-power*.—Probably no group of surgeons ever worked on better material. The men of 21 Army Group were fully immunized and fully trained; their morale was at its highest—"the last lap" feeling; they were well clothed and well fed, fighting in a climate to which the average British soldier is more accustomed; hygiene, both personal and unit, was exceptionally good; and welfare services were excellently organized to cope with the leisure hours.

2. *Tactical Situation*.—21 Army Group was always a winning army! It had the initiative and could dispose of its units as required. Air cover was to all intents and purposes complete, enabling patients to be held or transported in safety more or less at will. The modern type of warfare—essentially mobile and rapidly moving—ensured that units were never overwhelmed with cases.

3. *Surgical Policy*.—The standardization of policy, based on practical experience and inculcated into a united team previous to the beginning of the campaign, has already been discussed. To obtain optimum results we have attempted so far as was possible to have the individual surgeon working with compatible people at the right type of unit and at the right level. Having laid down a policy, which must of course be elastic enough to cope with changing circumstances and not so hidebound as to throttle reasonable initiative, we feel this placing of personnel and the dissemination of clinical (and topical!) news by constant personal contacts to summarize the duties and responsibilities of a consultant to his surgeons.

4. *Evacuation*.—Speedy collection of wounded has made early surgery possible, and the remarkable development of air evacuation has permitted early and more definitive surgery to be performed sooner than in any previous campaign. Provision for interim treatment during evacuation, whether by road, rail, sea, or air, has been brought to a high pitch of efficiency—and in this respect we would stress the importance of adequate immobilization, wherever possible, of a wounded part during transit.

5. *Forward Surgery*.—The gradual pushing forward of surgical potential (a process initiated in the desert by the first "mobile surgical teams" of Major-Gen. D. C. Monro) until an optimum level has been reached, considered by us to be C.C.S. level or theoretically

just on the corps side of the corps-divisional boundary, has ensured the wounded man getting as soon as possible to surgical care—the latter being provided in circumstances which afford the maximum facilities for surgeon and nursing staff and the maximum comfort for patient. This potential to-day is provided by that invaluable little self-contained unit the "field surgical unit."

6. *Pre- and Post-operative Treatment.*—There is no doubt that on both sides of the operating table considerable, if not dramatic, advances have been made. Resuscitation as provided by the Blood Transfusion Service has been in every respect admirable. They were responsible not only for actual resuscitation, both pre- and post-operative, but also for the selection of priority cases awaiting operation—a task demanding the soundest clinical judgment and common sense. They also delivered to all units requiring them supplies of blood, plasma, saline, glucose, and penicillin as if by divine inspiration, no request ever having to be made and no notification having to be given of change of location—even to the most out-of-the-way spot. Indeed, the supply system as interpreted by our Base Transfusion Unit might well serve as a model for the cutting of red tape during action. The gay good humour of all the B.T.U. personnel, even under the most trying and difficult circumstances, was an inspiration to all with whom they came in contact.

So also was the presence of nursing officers in forward surgical units. Much of the vast improvement in post-operative treatment (and with its penicillin injections and drips, its intravenous infusions, its gastric suction, its morphine, its sera, apart from all other routine nursing requirements, this is a complicated ritual to-day) was due to their excellent work. Added to this, too, is the undoubted value of a woman's presence both beside the bed of a recently wounded man and in the wards and theatres with the male personnel. In both spheres they have done much to raise morale, and their cheerful but quite obviously genuine enjoyment of their arduous and often dangerous work is deserving of the highest praise. In this connexion, too, mention must be made of our B.R.C.S. services, under the able and kindly direction of Major-Gen. Lindsay. They never failed, even in the most forward areas, to provide those little comforts and that personal attention which mean so much to a wounded man, and incidentally to his surgeon, who benefits from his patient's raised morale.

7. *Penicillin and Sulphonamides.*—Sulphonamide therapy was well established previous to this campaign, but in our lavish supplies of penicillin we have certainly been most fortunate, and to its beneficent effect must go considerable credit for the results achieved. Its prophylactic use on the scale employed in Normandy was an entirely new venture and paid handsome dividends. Since then both prophylactically and therapeutically it has been used to an increasing extent with consistently good effect. Among other clinical researches carried out in Army Group (and described in full in "21 Army Group Penicillin Therapy") was one which proved that penicillin alone offered as good protection against wound infection as did a combination of penicillin and sulphonamide.

8. *Surgeons and Surgery.*—By no means least has been the effect of consistently good surgery carried out by an enthusiastic and capable team of surgeons. We had but two women surgeons; we had many women anaesthetists, radiologists, and surgical general-duty officers—far more than any other theatre of war had ever dreamt of. Let it be said that their part in this saga was not one whit less praiseworthy than that of their male counterparts. We were very, and we think justifiably, proud of our whole team.

Conclusion

As was stressed at the beginning of this article the success of a medical service depends essentially on close collaboration and mutual understanding between the administrative and clinical sides, and it is with very genuine feeling that we express our gratitude for their unflinching and full co-operation, to our two Ds.M.S. (Major-Gens. Sir Percy Tomlinson and E. Phillips), to the D.Ds.M.S. Armies (Brigs. E. Phillips, Galloway, and Glyn-Hughes of Second British Army, and Brigs. Fenwick and Elder of First Canadian Army), to the D.Ds.M.S. Corps and to the Consulting Physician (Brig. E. Bulmer), all the clinical advisers of Army Group, and to the surgeons, nursing officers, and other ranks, both male and female—all of whom have contributed materially to making our task as pleasant personally as it was fascinating surgically.

B. M. Schwartz (*J. Amer. med. Ass.*, 1945, 128, 704) records his observations on 14 cases of Vincent's angina treated with penicillin. The recommended dose is 100,000 units, administered intramuscularly in 20,000 units every three hours, and was found to be of definite value. P. L. Shallenberger, E. R. Denny, and H. D. Pyle (*ibid.*, p. 796), who also treated 14 cases of Vincent's angina with penicillin, obtained equally good results from intramuscular injection.

THE MIKULICZ RESECTION OPERATION FOR GANGRENOUS INTUSSUSCEPTION IN INFANTS

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When in an infant an acute intussusception becomes irreducible and gangrenous, not only is the choice of a suitable operation difficult but the results are usually bad. The operation commonly chosen in these cases is either resection of the gangrenous mass with end-to-end or lateral anastomosis, or exteriorization of the mass with the formation of an enterostomy, with a later attempt to close this if the child survives. Suture of the proximal part of the intussusciens to the intussusceptum has also been suggested, leaving the gangrenous mass to slough and pass per rectum. These operations are far from satisfactory; very few children survive.

In view of these results we have recently chosen to treat the irreducible gangrenous intussusception by a modification of the Mikulicz type of resection, and we are able to report here two successes. We recognize the danger of generalizing from two cases, but the results in these were so much better than we have experienced with other methods that we feel justified in publishing this report. At this point, however, we wish to make clear our view that no major operation of this sort in an infant will be successful unless the child is given special pre-operative and post-operative treatment by those who are experienced in modern paediatric methods and can judge from hour to hour what measures are required to be taken. A note by Dr. Brenda Morrison on these measures is included in this paper.

The Mikulicz type of resection which we recommend is made possible in infants because at that age the caecum, ascending colon, and transverse colon are very mobile. In both of our cases it was found easy, after a small incision of the peritoneum on the outer side of the intussusception, to mobilize the mass and to bring it out of the abdomen with very slight trauma, thus leaving the next steps of the operation to be performed expeditiously and with relative ease. The operative procedure followed in both cases was similar. A preliminary attempt at ordinary methods of reduction having failed, the intussusception was found to be gangrenous, and some form of resection was therefore necessary. The viable portions of the ileum and colon were quickly joined together, in the usual double-barrelled Mikulicz colostomy method, by two layers of continuous catgut sutures, and the abdominal incision was closed around the bowel by interrupted sutures. The condition of both cases at the end of operation was satisfactory. After six days the spurs were crushed and removed by the ordinary Mikulicz method with small crushing clamps. Six days later—i.e., on the twelfth day after operation—the stomata were closed after the bowel ends had been freed and returned.

Case I has now made an excellent and permanent recovery. The patient has gained satisfactorily in weight, and a slight tendency to diarrhoea, due to loss of the ileo-caecal junction, has cleared up. The second case has made an excellent recovery after operation, and it is anticipated that this patient also will return to normal health.

Case I

On Oct. 11, 1944, two and a half days before admission to hospital, the patient, a female child aged 5½ months, started to cry suddenly and became deathly pale. Towards evening she became drowsy and difficult to feed. The doctor was sent for, and he put her on a glucose mixture. She was thought then to be suffering from a chill due to her teeth. The next day she appeared to revive to some extent. At 10 p.m. she was violently sick and the vomit was bright green. She looked very white and it was difficult to rouse her. She slept intermittently on the night of Oct. 12, and on the morning of the 13th she whimpered and vomited repeatedly, but did not appear to be in severe pain. Later in the day she was admitted to the children's department of the Royal Victoria Infirmary under Prof. Spence. No blood had been passed per rectum before admission and there had been only one small motion.