BRITISH MEDICAL JOURNAL

LONDON SATURDAY APRIL 7 1945

CONTROL OF INFECTION IN RECENT WOUNDS BY SURGERY AND LOCAL CHEMOTHERAPY

BY

F. H. BENTLEY, F.R.C.S.

SCOTT THOMSON, M.D.

Lieut.-Col., R.A.M.C.

AND

Major, R.A.M.C.

(Penicillin Control Team, Central Mediterranean Force)

In the present organization of war surgery wounds are treated by a two-stage operation. At the first operation, at a casualty clearing station, contaminated and grossly damaged tissues are removed, and the wound is laid open so that there is free drainage, with an absence of tension, while the patient is being evacuated to the base. Several days later the wound is examined in hospital and is sutured if possible.

The main object of the first operation is the control of infection, and the subsequent progress of the case is determined by the success with which this object is achieved. No one with experience of war wounds will deny that adequate surgery at the first operation is of paramount importance. After surgery is completed, however, some degree of infection is likely to remain, and it is in connexion with this residual infection that a bacteriostatic may be of value. Although sulphonamides have been in use for many years, evidence of their true worth in the control of infection in wounds has never been obtained. With the advent of penicillin it was of increased importance to decide, by a large-scale clinical trial, the precise value of these two bacteriostatics in the treatment of recent wounds.

Evidence of the comparative effects of penicillin-sulphanilamide and sulphanilamide alone as bacteriostatics was given by Thomson (1944), from observations made during the invasion of Sicily. In 85 wounds operated upon at casualty clearing stations and treated with sulphanilamide powder 57% were infected on arrival at the base several days later; whereas in 61 wounds that had received penicillin-sulphanilamide powder 26% were infected.

This survey was a limited one. It was necessary to carry out a more extensive inquiry in which comparison was also made with wounds not treated with a bacteriostatic. The battle for the Gothic Line provided the opportunity. This battle was fought in wet weather on cultivated ground. Casualties were heavy and casualty clearing stations were working under pressure. The treated wounds were therefore a fair sample of what could be expected from experienced forward surgeons under battle conditions. The difficulty of comparing one type of case with another was simplified, since all external conditions such as terrain, weather, forward surgeons, lines of communication, and base surgeons were the same throughout the period of this inquiry.

The purpose of this investigation was to determine the value of sulphanilamide and penicillin when applied locally in the treatment of recent wounds. In the course of the inquiry information was also obtained of other factors in wound treatment—in particular, the importance of the interval between wounding and the first operation, and of the re-dressing of wounds between C.C.S. and base hospital.

Methods

The casualties from the battle were sent from C.C.S.s to a port, and were conveyed by ship to the hospital area, arriving about the fifth to seventh day after injury. Within the next day

or so they were taken to the operating theatre and the wounds were examined and sutured if possible. The following data were considered relevant:

1. *Interval before Operation at C.C.S.*—This could usually be obtained from the field medical card or by inquiry from the patient. Only cases in which it was possible to determine the interval with accuracy were included in the assessment of this time interval.

2. *Chemotherapy at C.C.S.*—It was arranged with forward surgeons at the start of the battle that penicillin-sulphathiazole powder would be applied to wounds alternately with sulphanilamide, and that in a number of cases no bacteriostatic would be employed. There were therefore, initially, three groups of cases, depending on the wound chemotherapy. In addition there was eventually a fourth group comprising those cases in which no entry was made on the field medical card and which were most probably treated with sulphanilamide. It was found convenient for the purposes of tabulation to include with this fourth, or "miscellaneous," group a number of wounds that had been dressed with an antiseptic—e.g., acriflavine or sulphathiazole-proflavine powder. It should be stated at the outset that the casualties in which no bacteriostatic was employed were carefully watched along the lines of communication and at the base hospital. In no case was the wounded part endangered by this omission, and there was no instance of spreading sepsis.

3. *Age of Wounds at Time of Examination and Suture at Base Hospital.*—This information was readily available, and was measured in days.

4. *Severity of Wounds.*—Wounds were divided into three classes:

Class A.—Gutter wounds of skin and fat alone, or with superficial muscle injury.

Class B.—Wounds with penetrating tracks; or through-and-through wounds with deep muscle injury, sometimes associated with a minor fracture.

Class C.—Large lacerated wounds with extensive muscle destruction; amputations; or major fractures.

5. *Condition of Wound.*—The clinical appearance of the wound was noted and a swab was taken for bacteriological examination at the time it was first examined in hospital. It is convenient to describe here the terms employed in collecting material for this report.

"*Clean.*"—A clean wound was one that had the naked-eye appearances of a wound recently operated upon and showed no reactive changes.

"*Dirty.*"—A dirty wound was one in which the surface was covered by tissue exudates.

"*Infected.*"—The term "infected" indicated only the presence of pyogenic cocci in a wound—*Staph. pyogenes aureus* or *Str. pyogenes*.

"*Septic.*"—Those dirty wounds that were infected with pyogenic cocci were called "septic." About half the dirty wounds came into this category.

6. *Dose of Sulphanilamide by Mouth.*—Tablets of sulphanilamide were given to many of the wounded men at the C.C.S. and during the period of travel to hospital. Administration of the drug and entries on the medical cards were irregular. Further information was obtained by questioning the patients; but, even so, the data often remained incomplete.

7. *Re-dressing of Wounds.*—The majority of wounds had not been touched or disturbed in any way between the operating theatre in the C.C.S. and examination in the base hospital theatre. Such wounds are discussed separately in the report. A number of wounds, however, had been re-dressed; evidence was obtained to show that it was not necessarily the septic wounds that had been subjected to this intervention.

8. *Bacterial Flora.*—The swab was taken from the surface wound and any deep track, without touching the skin edges. A wound-swab was accepted as the best method of obtaining a representative sample of the bacterial flora and of providing a qualitative examination of obvious wound infection. The energies of the laboratory were directed towards isolation and precise identification of pyogenic cocci, but with sufficient attention to other bacteria to establish at least their bacteriological group. All strains of *Staph. pyogenes aureus* and *Str. pyogenes* were examined for the property of resistance to penicillin. In addition to this examination of wounds on arrival at the base hospital, swabs were taken from 100 wounds at a C.C.S. before operation was begun in order to determine the original rate of infection in this battle. The swabs were examined by Major H. E. Hutchinson, of No. 1 Mobile Bacteriological Laboratory, to whom we are indebted.

9. *Result of Suture.*—The majority of wounds were sutured at the time of their first examination in the operating theatre at the base hospital. Penicillin was given as a routine either by insufflation of penicillin-sulphathiazole powder at operation or by subsequent instillation of a solution of penicillin through tubes into the sutured wound. The results were expressed in terms of percentage of wound union. It was obviously not possible to determine the figure with a high degree of accuracy, and in assessing the results of suture only three grades were adopted: Grade I, 85% union or better; Grade II, 70 to 85% union; Grade III, less than 70%.

Value of Chemotherapy in Control of Infection

Staph. pyogenes aureus was found to be by far the most common pyogenic coccus. *Str. pyogenes* (haemolytic streptococcus) was isolated from 6% of all wounds, and from only 1.5% in the absence of the staphylococcus. In the 100 wounds from this battle that were examined in the operating theatre at a C.C.S. before operation was begun pyogenic cocci were found in 51 (figures provided by Major Hutchinson). This was the basic infection rate which surgery and chemotherapy had to combat, and the figure with which to compare the results of treatment. These results were studied in 706 wounds in which the dressing had not been disturbed between the operating theatre at a C.C.S. and examination in the base hospital. In wounds treated at C.C.S.s the rates of infection according to the chemotherapy previously employed were:

- Operation only, without bacteriostatic: 49% of a total of 116 wounds were infected.
- Operation and sulphanilamide powder: 43% of a total of 213 wounds were infected.
- Operation and "miscellaneous" chemotherapy: 40% of a total of 122 wounds were infected.
- Operation and penicillin-sulphathiazole powder: 25% of a total of 255 wounds were infected.

Thus operation alone did not appreciably reduce the incidence of infection compared with the infection rate before operation, and the introduction of sulphanilamide into the wound produced little further improvement. The use of penicillin-sulphathiazole powder, however, caused a significant reduction in infection rate to one-half of the pre-operation figure.*

It was necessary to inquire whether this difference was due to selection of special cases for penicillin treatment; in

particular, whether the apparent advantage of penicillin might be due to its having been used for selected wounds and for those coming under treatment early. The significance of the time at which a wound was first operated upon is discussed below. At present it can be stated that penicillin-sulphathiazole showed an advantage over sulphanilamide irrespective of the time the wound came under treatment. It was possible also to demonstrate that the severity of the wound did not influence the relative rates of infection. If the wounds were classified according to their severity it was seen that, while more of the large and serious wounds received penicillin-sulphathiazole powder, the reduced incidence of infection following penicillin treatment occurred equally in superficial trivial wounds and in extensive ones. There was no tendency for the result to be influenced by the severity of the wound.

Wound Sepsis

It is emphasized that the above figures refer to rates of infection as determined by a bacteriological examination of the wound. There was no correlation between the clinical appearance of the wound and the presence of pyogenic cocci, many clean wounds containing *Staph. pyogenes aureus* and many dirty wounds yielding no pyogenic bacteria on culture.

Of the undisturbed wounds 20% were dirty, being covered with exudate, and about one-half of these contained pyogenic cocci (septic). The septic wounds were of special importance in this investigation into the control of infection because they were the wounds in which the infecting bacteria had "taken hold." Of the wounds treated by operation alone and without a bacteriostatic, 23% were septic; in those in which sulphanilamide was locally employed this incidence was reduced by one-half (11%); and in those treated with penicillin-sulphathiazole 7% of the wounds were septic (Table I).

TABLE I.—Rates of Infection and Sepsis in Relation to Chemotherapy†

	No.	Infected (%)	Septic
Penicillin-treated wounds	255	25	19 (7%)
Sulphanilamide-treated wounds ..	213	43	23 (11%)
Wounds untreated with a bacteriostatic ..	116	49	27 (23%)

The precise value of operation and local chemotherapy in this series of wounds can thus be stated in the following terms. Operation alone, without the use of a bacteriostatic, did not appreciably reduce the incidence of infection compared with the original infection rate that followed wounding. This is what would be expected, for unless a mutilating excision was performed not all potentially infected tissues would be removed. The aim of the forward surgeon is to remove only those tissues that are grossly damaged, and by adequate incisions to leave the wound in the best possible condition for dealing with the infection that remains. The value of this treatment is seen in the wounds that were treated by operation only; although one-quarter of them were septic, the sepsis was confined to the surface layers of the wound, and there was no instance of the septic process spreading along the limb or tracking deeply.

Sulphanilamide applied locally had a bacteriostatic effect; for, although the infecting bacteria persisted, their activity was depressed, so that the incidence of sepsis was reduced compared with wounds in which no bacteriostatic was employed. Penicillin-sulphathiazole powder had a greater effect, for its use was followed by the destruction of the pyogenic organisms in one-half of the infected wounds and by an equally low incidence of sepsis.

It is obviously of value to use sulphanilamide or penicillin-sulphathiazole powder at the operation at the C.C.S., and of the two bacteriostatics penicillin-sulphathiazole is shown to be the more potent.

Effect of Re-dressing of Wounds on the Infection Rate

Of 869 consecutive wounds examined 163 had been re-dressed between operation at the C.C.S. and examination in the operating theatre at the base hospital. If these wounds had

* The difference in incidence of infection between wounds treated with penicillin-sulphathiazole powder and any of the other three groups exceeds three times its standard error. There is no significant difference between the other three groups.

† The difference in incidence of sepsis between wounds untreated with a bacteriostatic and those receiving sulphanilamide or penicillin exceeds three times its standard error. The difference between penicillin- and sulphanilamide-treated wounds is not significant.

been re-dressed because they were septic, it would be expected that they would include a large proportion still septic on examination at the base hospital. This was not found to be so, as only 15% were septic, which is an incidence of sepsis no greater than that shown by the general series of undisturbed wounds (Table I). If the re-dressed wounds were classified according to their severity the following distribution was found:

Class A (superficial wounds): 122 wounds = 25% approximately of all Class A wounds.

Class B (deep penetration): 41 wounds = 12% approximately of all Class B wounds.

Class C (deep and extensive wounds): None.

It appeared, therefore, that the more accessible wounds had been selected for dressing.

The re-dressed wounds were found to have a higher incidence of infection than had wounds which had not been disturbed during evacuation of the patient. In 67 re-dressed wounds treated originally with penicillin-sulphathiazole powder the infection rate was 42%, compared with 25% in undisturbed wounds; and where the original treatment had been with sulphanilamide the incidence was 55% of 60 wounds, compared with 43%. The importance is confirmed of sealing off the wound with an occlusive dressing at the end of operation at the C.C.S., and of refraining from further dressings, in the absence of obvious complications, until the patient is in the operating theatre at the base hospital.

Significance of Time of Operation in Control of Infection

In the history of a wound there are two intervals of importance—the number of hours that elapse between wounding and operation at the C.C.S., and the number of days before the second operation in the base hospital.

It had already been found that the rates of infection were influenced by the use of different bacteriostatics and by re-dressing of the wounds. These two conditions had therefore to be taken into account in considering the importance of a third factor—the time of operation. This was done by showing in the 706 undisturbed wounds the relation between infection and time intervals in each of the chemotherapy groups. The following terms are employed:

"Early C.C.S.": An interval of 12 hours or less between wounding and operation at C.C.S.

"Late C.C.S.": An interval of 12 to 24 hours between wounding and operation at C.C.S.

"Early Hospital": An interval of 5 days or less to time of examination of wound in hospital.

"Late Hospital": An interval of more than 5 days to time of examination of wound in hospital.

The time of arrival at the base hospital was not related to the time of the first operation.

Incidence of Infection According to Time of Arrival at Base Hospital.—There was no significant difference in infection rate between wounds admitted to the base hospital in the first 5 days after wounding compared with those admitted late. This finding is not brought forward to suggest that delay in evacuation is unimportant. It indicates, however, that if the forward treatment is completed and the wound is sealed off, infection does not readily gain access or develop during the following 10 days.

Incidence of Infection According to Time of First Operation.—There was a lower incidence of infection in wounds that had been operated upon in under 12 hours compared with those that had been treated between 12 and 24 hours, in all the chemotherapy groups. The figures of comparison are presented in Table II.

TABLE II.—Incidence of Infection According to Time of First Operation

Treatment	No. of Infected Wounds	
	Early C.C.S.	Late C.C.S.
Penicillin-treated ..	27 out of 150 (18%)	24 out of 63 (38%)
Sulphanilamide-treated ..	38 out of 108 (35%)	35 out of 66 (53%)
No chemotherapy ..	29 out of 64 (45%)	18 out of 35 (51%)
Total ..	94 out of 322 (29%)	77 out of 164 (47%)

This table summarizes the figures of Early and Late Hospital.

There was thus a marked difference in infection rate according to the interval between wounding and operation. One of the features of the organization of surgery in this war has been the efforts to take surgery speedily to the wounded man, and it is of particular interest to confirm the value of early surgery in the control of wound infection.

Advantage of Penicillin over Sulphanilamide in the Different Age Groups.—It is convenient here to consider whether the advantage of penicillin-sulphathiazole powder over sulphanilamide in the control of infection occurred irrespective of the time that the wound came under treatment. To make this comparison the incidences of infection after the use of the two bacteriostatics are shown side by side in the four possible age groups.

(i) Early C.C.S.: Early Hospital		
Penicillin-treated wounds ..	4 infected out of 44 (9%)	
Sulphanilamide-treated wounds ..	10 " " 32 (31%)	
(ii) Early C.C.S.: Late Hospital		
Penicillin-treated wounds ..	23 infected out of 106 (22%)	
Sulphanilamide-treated wounds ..	28 " " 76 (37%)	
(iii) Late C.C.S.: Early Hospital		
Penicillin-treated wounds ..	5 infected out of 17 (Figures too small for comparison)	
Sulphanilamide-treated wounds ..	6 " " 17	
(iv) Late C.C.S.: Late Hospital		
Penicillin-treated wounds ..	19 infected out of 46 (41%)	
Sulphanilamide-treated wounds ..	29 " " 49 (59%)	

In each age group penicillin-sulphathiazole-treated wounds had a lower infection rate than had wounds treated with sulphanilamide. The results claimed for penicillin-sulphathiazole powder are thus shown to be valid irrespective of the time the wound came under treatment.

Effect of Sulphanilamide by Mouth

Entries in the field medical card showed that nearly all the wounded men received 2.5 g. of a sulphonamide at the advanced dressing station. Thereafter, administration of the drug and entries in the records were irregular. Although many patients were questioned about taking the tablets, the available information remained incomplete. Few of the men had a full course of the drug, but records were obtained of 127 men who had received 7.5 g. or more and whose wounds were undisturbed. The incidence of infection and that of septic wounds in these patients were the same as in the general series.

Relation Between Infection and Results of Suture

So far in this report the incidence of infection has been used to measure the value of the different factors that were under investigation (bacteriostatic, time of operation, etc.). This infection is of more than laboratory interest. The justification of our use of infection as the criterion by which to assess forward surgery and chemotherapy, and the practical importance of pyogenic bacteria in a wound, are seen when the presence of infection is related to the results of suture.

Seven hundred and fifteen of the wounds were sutured. Wound repair was the work of a group of surgeons (specialists, graded surgeons, and trainees), so that the results were representative of what can be achieved in the large-scale suture of wounds when penicillin is used as a routine. Seventy-five per cent. of wounds achieved the first grade of union (i.e., above 85% union); of the remaining 25% one-half obtained an intermediate grade of healing (70 to 85% union) and one-half were relative failures.

When the results were arranged according to the presence or absence of infection in the wounds at the time of operation it was found that the presence of pyogenic organisms had an adverse influence. This was seen most clearly when the clean and dirty wounds were considered separately.

Of 614 clean wounds 424 were free from pyogenic organisms, and 85% of these obtained Grade I union; 190 wounds were infected, and only 62% of these attained the first grade. Of 101 dirty wounds 52 were free from pyogenic bacteria, and 80% of these obtained Grade I healing—that is, almost the same degree of success was obtained as in the suture of uninfected clean wounds. The 49 infected dirty wounds did not do well, only 37% reaching the first grade. The full results are given in the Appendix (Tables A and B).

Thus the results of suture were related less to the appearance of the wound than to the presence of pyogenic bacteria. This does not mean that a bacteriological examination of the wound should be carried out before suture is performed. On the contrary, the surgeon is encouraged to suture wounds (in the presence of penicillin) whether they appear clean or dirty. The significance of these findings is to confirm the importance of pyogenic bacteria in the wound at the time of arrival at the base hospital, and thereby to emphasize the value of the control of infection by early operation at the C.C.S., by the use of penicillin-sulphathiazole powder as a bacteriostatic at the forward operation, and by avoidance of dressing of the wound between forward and rear surgeons.

Influence of Resistant Strains of *Staph. pyogenes aureus* on Suture

All strains of *Staph. pyogenes aureus* were examined for the property of resistance to penicillin. Of the strains 20% were resistant to the concentration of penicillin that is produced by parenteral therapy (1/10 unit per c.cm.), but only one-half of these strains grew in 10 units of penicillin per c.cm., and few grew in broth containing 50 units per c.cm. Thus while 20% of strains of *Staph. pyogenes aureus* could fully resist the concentration of penicillin that obtains in parenteral therapy, many of these strains could be influenced by the increased concentrations that local therapy might provide.

It will be recalled that of the 614 clean wounds 190 were infected. Among these 190 strains of *Staph. pyogenes aureus* 33 were "resistant." Suture of the 33 wounds, accompanied by the local use of penicillin, was followed by the same standard of union as was the suture of clean wounds infected with "sensitive" strains.

The high concentration of penicillin that is obtained by local penicillin therapy has been shown to be of advantage in some situations—e.g., in the pleural cavity (d'Abreu *et al.*, 1944) and in compound fractures (Bentley *et al.*, 1944). These present results of suture indicate that it is also of value in dealing with strains of staphylococci possessing some degree of resistance to the drug.

Summary

In an investigation of 1,000 wounds during the battle for the Gothic Line the organism of initial sepsis was found to be *Staph. pyogenes aureus*. *Str. pyogenes* (haemolytic streptococcus) was rarely found.

The incidence of infection in wounds before operation at the C.C.S. was about 51%.

In wounds undisturbed during transit, and treated at the C.C.S. by operation alone, 49% were infected and 23% were septic; by operation and sulphanilamide powder, 43% and 11%; by operation and penicillin-sulphathiazole powder, 25% and 7%, when examined in the base hospital 5 to 10 days later. Thus operation alone did not completely remove infection from a recent wound. Its effect was to leave the wound in the best possible condition for dealing with the infection that remained. Sulphanilamide applied locally had a bacteriostatic effect; for although the infecting bacteria persisted, their activity was depressed, so that the incidence of sepsis was reduced. Penicillin-sulphathiazole powder similarly applied was more effective; for its use was followed by the destruction of the infecting cocci in about one-half of the infected wounds, with an equally low incidence of sepsis.

Wounds operated upon at the C.C.S. in under 12 hours had a lower incidence of infection than those operated upon between 12 and 24 hours, in all the chemotherapy groups. The length of time between wounding and arrival at the base hospital was found to make no significant difference in the infection rate.

Wounds that had been re-dressed between C.C.S. and base hospital had a higher incidence of infection than had those that had not been disturbed.

The importance of control of infection by operation and chemotherapy at the C.C.S. is illustrated by the results of suture. The presence of pyogenic organisms in the wound at the time suture was performed had an adverse influence on the result obtained. Of wounds uninfected with these organisms 80 to 85% obtained Grade I union, whether appearing clean or dirty; whereas wounds that were infected, even if appearing clean, showed a lower rate of success.

The presence in wounds of staphylococci possessing some measure of resistance to penicillin did not influence the results of suture when penicillin was employed locally in the wound.

APPENDIX

TABLE A.—Results of Suture of 614 Clean Wounds in Relation to Infection

Condition	Total No.	Degree of Success of Suture		
		No. Achieving Grade I Union	No. Achieving Grade II Union	No. Achieving Grade III Union
Infected	190	118 (62%)	37 (20%)	35 (18%)
Non-infected	424	362 (85%)	33 (8%)	29 (7%)

TABLE B.—Results of Suture of 101 Dirty Wounds in Relation to Infection

Condition	Total No.	Degree of Success of Suture		
		No. Achieving Grade I Union	No. Achieving Grade II Union	No. Achieving Grade III Union
Infected	52	19 (37%)	9 (17%)	24 (46%)
Non-infected	49	39 (80%)	9 (18%)	1 (2%)

Grade I union = 85% union or better. Grade II union = 70 to 85% union. Grade III union = Under 70% union.

The data on which this paper is based are taken from a report to the Director of Pathology, War Office, by Thomson and Bentley (1944). We are grateful to Major-Gen. L. T. Poole, D.S.O., M.C., for permission to publish from the War Office report.

REFERENCES

- Bentley, F. H., Thomson, S., Bingham, A. K., Key, J. A., and Wostenholm, M. H. (1944). "The Treatment of Compound Fractures by Early Wound Suture and Penicillin," Report to the War Office. In the press (*Lancet*).
d'Abreu, A. L., Litchfield, J. W., and Thomson, S. (1944). *Brit. J. Surg.*, **32**, 179.
Thomson, S. (1944). *Ibid.*, **32**, 129.
— and Bentley, F. H. (1944). "Survey of 1,000 Wounds in Respect of Chemotherapy, Bacteriological Flora and Healing," Report to the War Office.

BLAST INJURY TO THE LUNGS CLINICAL AND RADIOLOGICAL FINDINGS AND THEIR RELATION TO CERTAIN SYMPTOMS

BY

G. R. FEARNLEY, M.D., M.R.C.P.

(From a War Hospital)

The effects of explosive blast on the lungs have been studied by Zuckerman (1940) in animals, and clinical and post-mortem findings during the present war, recorded by a number of observers, correspond in the main with those found experimentally. The lesion as it affects the lungs is haemorrhage due to capillary rupture, or possibly diapedesis (Hadfield, 1940-1). According to their severity, Zuckerman has classified the lesions as: (1) a few small haemorrhages on surfaces of lungs; (2) patchy haemorrhages throughout the lungs; (3) complete hepatization of the lungs by haemorrhages. His explanation that the lesions are produced by the wave of positive pressure acting directly on the chest wall would appear to be generally accepted and is convincingly supported by his work. The general clinical picture is definite enough in the groups of cases reported, but both individual symptoms, such as haemoptysis, and radiological evidence of blast injury have a varied incidence.

The Cases

Among the large number of chest injuries, penetrating and non-penetrating, admitted to this hospital 21 appeared to have been caused by blast, and were unaccompanied by additional trauma. No case has been included in which fractured ribs might account for damage to the lung or pleura or in which there was a history of burial by debris together with bruising of the chest wall. A certain amount of selection was inevitable, as only patients fit to travel reached this hospital, the interval between injury and arrival being on the whole proportionate to the severity of the condition. Only one of the cases was seen here earlier than three days after wounding; the majority arrived three to five days and several as long as 10 to 14 days after. It was thus possible to observe cases at different intervals after injury and watch their progress for a few days before sending them on to base hospitals.

The explosive sources were hand-grenades, mortar bombs, land mines, aerial bombs, and in two cases flying bombs.