RESUSCITATION OF LIMB AND ABDOMINAL WOUND CASES IN THE FIELD

BY
A. D. MILNE, M.R.C.S., L.R.C.P.
(Late Captain, Royal Army Medical Corps.)

The following are some conclusions derived from experience as a transfusion officer in the field, in the European campaign from D-day onwards, through France, Belgium, Holland and Germany; and confirmed by a study of the fatality rate of cases with limb or abdominal wounds, a rate which in my view might be lowered considerably. The cause of this relatively high fatality rate I believe to be inadequate transfusion.

I have seen several transfusion officers at work, and have seen the results of the work of others (in those cases that had not died) in large numbers of wounded who had already had transfusions and surgical treatment, when working at the Casualty Evacuating Post (C.E.P.), through which 40,000 to 60,000 men, mainly wounded, were evacuated by sea to England from the Normandy Beachhead in the early part of the campaign. I was struck by their relative conservation both as regards the volume transfused and the rate of transfusion, and by the frequency with which I saw cases at the C.E.P. which required further blood transfusion, not from the point of view of correcting anaemia—for which there is no urgency providing the blood volume has been restored (i.e. with plasma), but of counteracting persistent shock of varying degrees.

The remarks made here refer only to wounds of the limbs and penetrating abdominal wounds or to wounds of the body that have not involved the pleura or dura mater. Penetrating head or chest wounds and thoraco-abdominal wounds belong to an altogether different category as regards resuscitation and require conservative transfusion.

WOUND SHOCK IN LIMB AND ABDOMINAL WOUND CASES.

The cardinal signs of shock are: (1) A diminished volume of the pulse in systole and diastole, and (2) a diminished diastolic tension and systolic force of the pulse. It is extremely unfortunate that emphasis is always placed on the pulse volume alone. Usually both signs co-exist, but if one sign alone is present, as occurs after inadequate transfusion, shock is still present whatever the blood-pressure reading, and further transfusion is necessary.

Blood-pressure readings can be ignored except when they are low—and a systolic pressure of 115 mm.Hg or a diastolic pressure of 75 mm.Hg is low (in this case the pulse volume and tension are also low, either one or both). Many think that a systolic blood-pressure of 100 mm.Hg is a safe one. This is not so, there is nothing static about wound shock; even without further loss of
blood the blood-pressure may fall, and any degree of shock is potentially dan-
gerous. As far as the patient is concerned a mistake in the treatment of shock is only made once.

A pulse of poor volume and good tension in shock—the so-called “hard” pulse—may be a comparatively safe pulse, but even so transfusion is necessary to restore the volume to normal. Again, in shock, a patient with a soft pulse of good volume requires further transfusion to increase its tension and force: omission to do this leads frequently to a relapse of shock.

After transfusion the ideal pulse is either the “febrile” pulse of good volume, firm diastolic tension and vigorous systolic force, or the hypertensive pulse—terms which are self-explanatory—or, better still, the bounding pulse (and this may not appear until a short time after transfusion). With such an ideal pulse there is no possibility of a relapse of shock, unless of course further surgery is necessary or haemorrhage occurs. In pulmonary edema from over-transfusion a bounding pulse is present, but development of the former can always be prevented by making sure that the respiration rate does not rise above 20/minute during transfusion. If it does, the transfusion rate is slowed to a slow drip—perhaps, only temporarily—and if the respiration rate does not return to normal within a few minutes, the transfusion is stopped altogether.

When during transfusion the patient’s colour returns it is not necessarily an indication to discontinue transfusion at once.

Rapidity of the pulse is indicative of a dangerous degree of shock (with certainty) for which a rapid transfusion of a large volume of protein fluid will always be necessary. Yet with a slow pulse an equally dangerous degree of shock may be present.

It appears that whatever the causes of shock in these cases the circulation is depressed, and this depression is counteracted mechanically by the transfusion of protein fluid, so that it may not be of importance to know whether the shock is one chiefly to a diminished circulating blood volume, or otherwise. For this reason transfusion may lower the fatality rate in cases with perforated gastric or duodenal ulcers. It is necessary to transfuse frequently a greater volume of protein fluid than that which the patient would appear to have lost.

The moving of a patient from one place to another by any form of transport is undoubtedly the most important cause of an exacerbation of shock, but this will not occur if the initial transfusion was adequate.

Death from shock usually occurs from within a few minutes up to twenty-four hours; therefore in severe cases of these types transfusion must be rapid. Shock which persists will be aggravated by operation, and if he survives this, will lower the patient’s resistance to infection. However, death from shock can probably occur even after some weeks.

**Notes on Resuscitation.**

Morphia ¼ gr. intravenously, repeated if necessary, relieves pain within a few seconds.

Detection of haemorrhage is important from the point of view of priority of operation. Failure of resuscitation (where there is a very slight or no im-
provement in volume and tension of the almost imperceptible pulse of a patient following rapid transfusion of 4 pints or more of protein fluid) is due usually either to external hemorrhage from a limb wound or internal haemorrhage from a penetrating abdominal wound (the missile perhaps entering the body posteriorly in the chest, buttock or thigh), or to gas gangrene or to irreversible shock.

The severely shocked case should be given oxygen by the B.L.B. mask—6 litres a minute being the usual minimum—and should be put in the “head-low” position. To do this, it is necessary to raise the end of the stretcher, operating table or bed as high as is possible without the patient sliding off. Those who feel thirsty, shiver, or complain of feeling cold may have lost a considerable amount of blood. The latter should be given extra blankets, but should not be “heated up” with stoves. It is unnecessary to warm a bottle of blood before transfusion.

Regarding choice of fluid, the more I used plasma the more I preferred blood, which I found to be more effective, probably in part owing to its greater viscosity. Many think that plasma alone is equally as life-saving as blood, but in any case a relatively larger number of bottles of the former has to be used, as there is a lesser volume of protein fluid in a bottle of plasma than in one of blood. Blood should always be used for severely shocked limb cases, all abdominal cases and for cases of gas gangrene. The fact that it is preferred for all serious cases is a tacit admission of its superiority to plasma. However, blood has the disadvantage that it does not run out of the bottle so easily, and some means must be found of overcoming this. It may not be available in quantity in which case it is usual to begin transfusion with two or three bottles of plasma and to continue with alternate bottles of blood and plasma.

I have seen cases who had been well resuscitated with plasma alone who were white as sheets, had bounding pulses and probable blood haemoglobin estimations in the region of 30 per cent. Such cases would later require further transfusion of 8 or 9 pints of blood to restore the haemoglobin to normal, or even half that volume if a “packed cell” transfusion was given. The use of blood alone would therefore have been preferable initially. Also, since on wounding blood is lost, it is more reasonable to replace the loss by blood than by plasma. Further, since with blood transfusion there is greater oxygenation of the tissues not only is shock immediately counteracted more effectively, but the body is later able to overcome more easily infections, such as a septic wound, gas gangrene, peritonitis or pneumonia. However, it is impracticable to provide blood alone for transfusion, although if it were not, I would use it alone for all wound shock cases.

Plasma is used for cases with burns, with an occasional bottle of blood.

The worst cases are always seen and transfused first. One reads occasionally of how cases, which are thought to have little chance of survival, are left in a corner whilst other less serious cases are treated. This is to be deplored since the really hopeless cases are rare. Recently I read of 2 cases with penetrating abdominal wounds on whom operation was not undertaken because they could not be fully resuscitated; and who later died. Again, one reads occasionally the phrase “too ill for operation.” It should be remembered
that, for example, a case with a penetrating abdominal wound with intraperitoneal hemorrhage will not resuscitate fully with transfusion until the internal bleeding points have been tied or packed off. If the pulse cannot be improved sufficiently with rapid transfusion into one arm, blood must be transfused into both arms.

Limb wound cases with severe tissue damage should have priority over cases with penetrating abdominal wounds.

**Rate of Transfusion.**

Results of the treatment of wound shock cases were apparently disappointing in the early part of the blitz in England which was attributed to the fact that blood or plasma was transfused too slowly, being put up too frequently as a drip transfusion.

*The correct rate of transfusion for limb or abdominal wound cases which are shocked is a transfusion of blood or plasma given as rapidly as is possible without causing a rise in respiration rate (the presence of which implies an incipient pulmonary edema) until the pulse has been restored to the condition previously described.*

It is of interest that the Americans appreciate the importance of a rapid rate of flow during transfusion, for on their plasma-giving sets there is no screw to control the rate of flow of the plasma, which therefore runs into the vein.

Unfortunately, in order to make the blood or plasma run (i.e. not drip) into the veins through the British giving sets positive pressure, sometimes considerable, usually has to be applied, and there is a very real danger of death from air embolism, if the bottle is allowed to empty completely.

In practice, the moderately shocked limb wound case will tolerate the first two pints of protein fluid run into circulation, but with blood or plasma from the third bottle running in, the respiration rate begins to rise, and the rate must be altered to a slow drip for a few minutes, when the respiration rate will fall to normal. Again the fluid is run in for a few minutes, and this process of alternate "dripping" and "running" is continued until the pulse, volume and tension are fully restored, when the case is sent to the theatre with a drip transfusion.

The severely shocked limb wound case who has, for example, a traumatic amputation, multiple severe injuries, or much tissue damage, may tolerate the rapid transfusion of 10 pints of protein fluid (preferably blood) without a rise in respiration rate, the fluid being run almost continuously (i.e. not dripped) into the circulation within an hour or two, through intravenous sets put up on both arms simultaneously, before the pulse is restored and the case fit to undergo operation.

The more rapid the transfusion the more quickly the pulse volume and tension increases, and the more quickly the shock is overcome.

With the failure of resuscitation from hemorrhage, or where there is a relapse of shock it is necessary to run in (i.e. not "drip") the blood during transfusion and to transfuse simultaneously into both arms.
A slow rate of transfusion in the above types of cases may cause death, since the patient dies from shock before the requisite volume has been transfused.

**RIGORS.**

Rapid transfusion may cause a rigor, in which case the rate should be slowed—perhaps temporarily—and the patient given extra blankets. The patient should always be asked if he has backache at the same time as, if present, this is indicative of the transfusion of incompatible blood. In this case, the transfusion is stopped at once, and a small quantity of compatible blood is transfused, followed by intravenous alkalis. The only case of apparent incompatible transfusion, which I saw, had no backache, but a few cases which had a deterioration of the pulse in “association” with a rigor caused me to replace the bottle of blood with a fresh one, since usually a rigor did not affect the quality of the pulse.

If a rigor occurred immediately a new bottle of blood was put up, the latter was always replaced by another bottle.

Rapid transfusion sometimes causes abdominal pain and vomiting, and where there is a penetrating abdominal wound may give rise to an exacerbation of abdominal pain. It may therefore be of value of preventing ileus by promoting peristalsis, but this effect may be only temporary.

**The Volume of Protein Fluid Transfused.**

The average volume of protein fluid given to each case transfused was 3 pints (bottles) in the African campaign, and again 3 pints in the Italy and Sicily campaign. That the average for each campaign was found afterwards to be the same might be a cause for satisfaction that the average volume transfused was “correct” and sufficient. My own average in the B.L.A. including head and chest cases, would have been perhaps double this, perhaps more.

It is customary to refer to a bottle of blood or plasma as a pint bottle; however, of this pint or so of fluid, only about two-thirds is protein fluid, the remainder being citrate solution, glucose solution or distilled water, which has been added. Therefore 3 bottles of blood or plasma contain approximately only 2 pints of blood or plasma.

I found that cases with limb wounds who were moderately shocked would usually require a transfusion of from 4 to 8 bottles of protein fluid before operation, the average case being fit for operation with the fifth or sixth pint dripping into the circulation. Two cases of wound shock might have exactly similar pulses as regards volume, tension and force, but one might require double the volume of fluid transfused compared with the other, in order to transform the pulses to a precisely similar safe level. Allowing for quick surgery without excessive haemorrhage 5 to 9 pints (bottles) of protein fluid may be sufficient.

The severely shocked case, with one or more limb wounds, such as a traumatic amputation, who has an almost impalpable and perhaps rapid pulse, may not be fit for operation until 10 pints or more of protein fluid have been transfused rapidly, and may have been given 11 or 12 pints by the end of
One double amputation case was given 16 pints in six or eight hours.

Cases with penetrating abdominal wounds, usually with associated internal hæmorrhage, were usually given about 6 pints or more before operation, performed one and a half to two hours after transfusion was begun, and a total of 8 to 12 pints by the end of the operation, the average usually being 9 or 10 pints. Some of the blood transfused before operation would be lost into the peritoneal cavity, but this is no indication for conservative transfusion.

One exceptional case with a perforated cæcum which had prolapsed through a wound of the right iliac fossa was given a transfusion of a pint only before operation, and it was probably not necessary even to have given this.

Each case is different from the next, and requires the exercise of judgment regarding the rate and volume to be transfused. Volume and rate of transfusion go hand in hand—a case requiring a large volume being transfused rapidly.

One should consider not the probable volume of blood lost by the patient (for histories are notoriously inaccurate), nor the volume of blood or plasma already transfused, nor the blood-pressure—unless low, but the degree of shock of the patient, paying particular attention to the pulse volume, tension and force, and to the respiration rate.

Blood is only wasted if the patient develops a pulmonary òedema.

In all these cases the pulse should be restored to the ideal condition described before operation. This will not be so easily achieved with abdominal cases, or where there is hæmorrhage.

Resuscitation During Operation.

Transfusion begun by the transfusion officer is generally continued by the anæsthetist, who is usually content to allow the blood or plasma to drip into the patient's circulation. Rapid transfusion tends to neutralize the effect of the anæsthetic, and is therefore not very popular since the patient may begin to “come round,” but nevertheless if the pulse warrants it transfusion should be rapid even if more anæsthetic has to be given. Since pentothal affects the pulse adversely some, but not a considerable, allowance may be made in assessing the degree of shock present when this anæsthetic is used.

The condition of the pulse would of course be very good if pulmonary òedema begins to occur from over transfusion.

Where possible oxygen should be given liberally in conjunction with transfusion, for the purpose of transfusion even of plasma alone is to improve the circulation of the blood so that the tissues and particularly the vital centres of the brain, and the heart, are provided with an adequate supply of oxygen.

The presence of a relapse of shock is rather a reflection on the transfusion officer than on the anæsthetist or surgeon, and is not usually a relapse at all, but merely a progressive development of shock which has never been properly overcome by transfusion of an adequate volume of protein fluid. In this case the head end of the patient should be lowered temporarily (or perhaps for some hours) even if the surgeon is inconvenienced. It is a waste of time to do a beautiful operation on a patient who dies shortly afterwards. Frequent blood-
pressure readings are popular—however, in spite of them patients still die from shock during or soon after operation, and the anaesthetist should ensure that the blood or plasma runs continuously into the circulation, preferably with rapid transfusion into both arms simultaneously. Probably, in relapse, a minimum of a further 6 pints should be transfused no matter how much blood or plasma has been given previously.

**Post-Operative Resuscitation.**

From 2 to 5 pints of blood was usually transfused to cases with limb wounds, such as amputation cases—where after operation shock was still present without haemorrhage; one such case was given 9 pints. In all these cases the previous transfusion (by someone else) which had been discontinued, had been inadequate; my own cases would have required much less.

Patients became much more vigorous mentally and physically post-operatively, and subjectively felt very much better after adequate transfusion.

For cases with penetrating abdominal wounds some surgeons unfortunately have a habit of ordering saline or glucose saline drip transfusion immediately after operation. The choice of fluid should be left to the resuscitation officer—many cases require many more pints of blood or plasma. Again, the present practice of most surgeons is to give one or two bottles of plasma daily for at least a week following operation, in addition to saline and glucose saline, to counteract hypoproteinaemia. Certainly, most of these abdominal cases require intravenous protein fluid post-operatively—the volume depending on the degree of shock that remains, and this should be given as quickly as it can be tolerated as death from shock usually occurs within twenty-four hours. The case that will tolerate 7 or 14 pints of plasma in the week following operation owing to inadequate transfusion should also tolerate such a volume of plasma (or of blood) in the day or two following operation. Dehydration of the patient need not be considered whilst transfusing protein fluid. If there is no medical officer to supervise the transfusion—for example, at night—plasma may be used, and the patient put on a half-hourly respiration chart, the nurse being given strict instructions that the respiration rate must not exceed 20/minute. If during the week the pulse again deteriorates a further transfusion of 2 to 5 pints might be given. That shock is often severe after operation is indicated by the fact that it was found to be the cause of death in nearly two-thirds of the cases in a series of abdominal wound cases investigated at post-mortem by Major Blackburn, R.A.M.C., and Major Robb, R.A.M.C.

In considering his fatality rate in limb and abdominal wound cases the surgeon should pay attention not to the skill or lack of it of either himself or his anaesthetist, but rather to the volume of protein fluid transfused, and to the rate of transfusion.

**Irreversible Shock.**

I saw only two such cases in association with severe tissue damage, both of whom died as the seventh and eighth pint was being transfused respectively, with transfusions running into both arms.
More rapid transfusion of a large volume of blood might save such cases. It would be worth while transfusing 4 pints simultaneously into the circulation, with blood from 2 bottles running into each arm, transfusing 4, 8, 12, 16 and even 20 pints in an hour or two. A pressure pump might be devised to give really rapid transfusions.

Out of an indefinite number of limb cases transfused—such as amputation cases and cases with compound fractures—only one died, and here inadequate transfusion was partly responsible, succeeding haemorrhage being the immediate cause of death.

Out of perhaps 40 or 50 cases with penetrating abdominal wounds 6 died, and 2 of these deaths were due to shock after operation and were avoidable. The first of the latter cases was, in my absence, given oxygen alone, whilst I was too slow to transfuse further the second whose condition seemed to be no worse than that of three of other cases who required post-operative transfusion at the same time.

The importance of having a transfusion officer for post-operative work is stressed by the fact that cases of shock tend to die within the first twenty-four hours after operation, even if such a necessity is due usually to inadequate transfusion before and during operation.

The following excerpts are from the fatality figures from June 6, 1944, to August 1944, in Forward Surgical Units of the B.L.A.:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Deaths</th>
<th>Total</th>
<th>Approx. Fatality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetrating abdominal wounds</td>
<td>505</td>
<td>1,503</td>
<td>1:3</td>
</tr>
<tr>
<td>Non-penetrating abdominal wounds</td>
<td>23</td>
<td>197</td>
<td>1:9</td>
</tr>
<tr>
<td>Amputations (arm)</td>
<td>9</td>
<td>198</td>
<td>1:22</td>
</tr>
<tr>
<td>Amputations (leg)</td>
<td>67</td>
<td>474</td>
<td>1:7</td>
</tr>
<tr>
<td>Compound fractures of femur</td>
<td>38</td>
<td>644</td>
<td>1:17</td>
</tr>
<tr>
<td>Penetrating knee-joint wounds</td>
<td>4</td>
<td>240</td>
<td>1:60</td>
</tr>
<tr>
<td>Maxillo-facial wounds</td>
<td>26</td>
<td>887</td>
<td>1:34</td>
</tr>
<tr>
<td>Gas gangrene</td>
<td>48</td>
<td>167</td>
<td>1:3</td>
</tr>
</tbody>
</table>

The corresponding figures for all limb wound cases which comprise 80 per cent of all wounds—including cases with compound fractures of the limb bones—were not given, unfortunately.

However, the fatality rate of these cases is seen to be high, and to explain this a considerable percentage of deaths must have been due to shock. The fatality rate from gas gangrene was surprisingly high, and inadequate transfusion must have been a main cause of this since penicillin was available—except initially for German P.O.W.s—although the dosage may not have been sufficiently heavy. One writer, Lieut.-Colonel Wood Power, R.A.M.C., found that arterial injury was always present in association with gas gangrene, so that one would expect blood loss to be severe.

Major Blackburn and Major Robb describe post-mortem findings on 78 cases with abdominal wounds out of 210 abdominal cases on which operation was undertaken. In 48 of these cases (61 per cent) death was due to “shock and haemorrhage” and in 8 cases to bronchopneumonia or pulmonary oedema (the numbers of each were unspecified), so that for every one who died from over-
transfusion perhaps 12 to 24 died from inadequate transfusion. Such a ratio
would probably not be dissimilar in limb wound cases. It is as much an error
of judgment to allow a case to die from shock owing to under-transfusion as
it is for a case to die from pulmonary oedema from over-transfusion. When the
number of deaths from pulmonary oedema begin to approximate in number
those from shock—which will decrease correspondingly—it will at least be an
advance, although it will indicate bad resuscitation. Major Blackburn and
Major Robb concluded that “an elucidation of the problem of shock is the
most likely road to improvement in the fatality rate of abdominal wounds.”

Again in the Field Surgery Pocket Book (January 1944) it is stated that “the
chief cause of death in cases with penetrating abdominal wounds is
hæmorrhage.

Further, a medical research team in Italy found that “Blood volume studies
show that medical officers generally underestimate the extent of blood loss.”

Suggestions and Criticisms.

1) Some means must be found whereby blood (and plasma) can be made
to run (i.e. not drip) out of the bottle into the veins more easily with the
minimum use of positive pressure, for even with the use of considerable pressure
it does not always flow easily, whether by the use of wider needles or a more
course mantle filter or by other means. If this can be done, not only will there
be fewer deaths from air embolism but also; far more important, fewer deaths
from shock, for it is the dangerous necessity of the frequent and sometimes ineffectual use of the Higginson’s syringe to make the fluid flow quickly that
causes many to be content with a slow rate of transfusion. Again, if one is
doing many transfusions simultaneously one may not have time to use positive
pressure persistently on all, and this has to be delegated to an orderly who
cannot appreciate the importance of a rapid rate of flow.

The bottles might also be provided with valves by means of which, when the
bottle is nearly empty, the flow is stopped.

2) Quart bottles of plasma, and if possible of blood, might be made up. These
could be used initially for all cases with severe limb wounds or with
penetrating abdominal wounds, pint bottles being used later on. The frequent
changing of bottles means that a fewer number of transfusions can be attended
to at the same time.

It is unfortunate that many have a fear of giving too much blood or plasma,
and it may take years for this conservative attitude to give way.

3) At the time of the invasion we were supplied with only 30 or 40 bottles
of blood, although the refrigerator would have held many more bottles. More
blood was unobtainable, although a request was made for it. This blood was
soon expended, as in two or three days we used nearly 400 bottles of blood and
plasma. For a short time therefore we had only plasma available for abdominal
cases and severely shocked limb cases. Where the future is uncertain, there
is all the more reason to be well stocked with supplies.

4) There was at all times a marked shortage in the supply of oxygen. This
may not have been easily available in England, but if that was not the case, it should have been supplied in far greater quantity.

(5) Two types of trestles of different height are supplied to the Army for the support of stretchers, enabling the patient to be put in the "head-low" position. The difference in the height of the trestles at present only 5 in., should be increased.

(6) At the beginning of the invasion for the first few days there was an insufficiency of surgeons in our sector, who were actually operating. It is said that 30 British surgeons were landed at this time. During the month of June nearly 1,200 operations—admittedly major ones—were done out of 21,000 surgical casualties, an average of 1.6 (one point six) operations per surgeon per day.

Later, even many weeks after D-day cases who had compound fractures were being evacuated to England by sea without operation which they would not have had until the wound was two to four days old. Evacuation was good from the front line but initially the surgeons could not cope with the number of casualties, although these were a third of those anticipated. The number of operating surgeons operating initially might have been doubled or trebled to advantage, so that all except the slightly wounded might have had an early operation. What must be done in war can be done without attributing its impossibility to the exigencies of the service. Naturally the medical part of an Army has the lowest priority in battle, but more Field Surgical Units might have been functioning earlier, their transport being substituted for a part of that belonging to the evacuating Field Ambulances or Field Dressing Stations.

Those who object that highly skilled men should be exposed to danger unnecessarily should regard this as a compliment to the value of their work, and that in any case there is in Britain a profusion of good surgeons.

(7) All anesthetists, surgical general duties officers (the equivalent of house surgeons), and battalion medical officers should attend a course in blood transfusion.

A larger number of medical orderlies in C.C.S.s and hospitals should be trained in transfusion work. There is at present only one transfusion orderly on the establishment of a 200-bedded hospital. An orderly who could be relied upon to change bottles of blood or plasma, and to keep transfusions running was invaluable. This meant that one could transfuse a greater number simultaneously. In all major surgical wards there should be full-time resuscitation orderlies for day and night post-operative work, with at least one spare orderly.

(8) An analysis of the average volume of blood and plasma given to those limb and abdominal wound cases who died from shock, and other causes, including gas gangrene, pneumonia and peritonitis, for comparison with the average volume given to those who lived, might be instructive. If the former volume is less than the latter the moral is obvious—and would perhaps stress the importance of a rapid rate of transfusion, and if the same or greater it still does not prove that a greater volume should not have been transfused in the former cases since, in those cases who died, shock was probably more severe.

(9) To what extent did avoidable deaths occur in wounded men before they
could reach a surgical centre? To what extent did battalion medical officers (R.M.O.s) give transfusions? The majority of cases admitted to the advanced surgical centre requiring transfusion had been given none previously. R.M.O.s were in fact discouraged from giving transfusions as it was said that a case which has been resuscitated should be operated upon without delay, as otherwise a "relapse" of shock occurs, which further transfusion does not overcome so easily. As already stated this conception may be erroneous, a relapse of shock occurring (before, during or after operation) in a case that has never been fully resuscitated. But even R.M.O.s could give no answer to the above question for, although they know the numbers of men who died "on their hands," having had no real experience in most cases in blood transfusion, they could not know which of them might have been saved by really vigorous transfusion.

In Italy a research team, investigating the cause of death in those wounded who died on the battlefield, did post-mortems on 33 such cases. They found that in 42 per cent of cases haemorrhage was the essential cause of death, and in a further 18 per cent of cases haemorrhage was second in importance; and that there was a good prospect of recovery if medical attention had been available immediately after wounding—in 9 per cent of the cases and a fair prospect of recovery in 12 per cent (making a total of 21 per cent) of those cases who did in fact die. Their conclusion was that "although an important minority of deaths may be due to wounds that do not seem to be inherently lethal, the evidence favours the generally accepted belief that, having regard to the conditions of battle, very few men die who might have been saved."

Conditions of battle vary, as regards terrain, and are different for tank and infantry units, but by organization these adverse conditions may be partly overcome. The ideal is early arrest of haemorrhage and transfusion, to ensure which it may be necessary to train stretcher bearers to give transfusions. For these urgent cases even a relatively "non-sterile" transfusion is better than none at all. This, I believe, is done in the American Army.

There may be a possibility of lowering considerably the mortality rate on the battlefield, by organization which provides the R.M.O. with a liberal supply of plasma and perhaps a dozen stretcher-bearers (divided amongst the companies) who have been trained to give transfusions. In order to save this 21 per cent of cases it is more likely that R.M.O.s would have to give to such cases a rapid transfusion of, not two or three bottles of plasma; but rather perhaps ten bottles before evacuation of the case to the surgical centre. These cases would comprise those wounded in which the pleura or dura mater had not been involved in the wound.

**Conclusions.**

I have endeavoured to show the need for transfusion which is adequate in rate and volume in wound cases where neither the pleura nor dura mater has been involved in the injury, where such transfusion should eliminate death from shock.

Other advantages are a lowering of the fatality rate in gas gangrene cases, and in infections such as post-operative pneumonia and peritonitis; a lessened
incidence of cases with hypostatic congestion of the lungs—for a person who is adequately resuscitated is much more active in bed—and of cases with venous thrombi owing to the improvement of circulation—thrombi which on becoming dislodged causes sudden death. It may be of value in the prevention of traumatic anuria by raising the glomerular blood-pressure in the capillaries, and in the prevention of paralytic ileus in abdominal cases.

The same principles of transfusion apply in the transfusion of civilian casualties in peacetime although in cases with compound fractures, tissue damage, and therefore shock, would tend to be less severe.

Whereas transfusion has saved many thousands of lives in this war I think that considering the numbers of casualties of the blitz and of the campaigns in Africa, Italy, France and Germany and of the Far East more adequate transfusion might have saved more.

With thousands of deaths on the road yearly, it should not be necessary to wait for the next war for transfusion to be put on a sound basis, and, if practised with greater skill and less timidity there may be a considerable improvement in the fatality rates of the types of cases described.

**SUMMARY.**

(1) These remarks apply only to wound shock cases where neither the pleura nor the dura mater has been injured.

(2) In wound shock the cardinal signs are a diminution of the volume tension and force of the pulse. The blood-pressure, unless low, can be ignored, and if low the patient will require rapid transfusion of a large volume of protein fluid. In all cases one should endeavour to restore the pulse to a condition similar to that of a febrile, hypertensive, or bounding pulse. Restoration of the tension and force of the pulse is almost as equally important as of the volume.

(3) Blood is preferable to plasma transfusion in cases in which shock is severe.

(4) The blood or plasma should be given as quickly as is possible without causing a rise in the respiration rate. If the shock is severe, or there is a relapse of shock, the fluid should be run into the veins from 2 transfusion sets simultaneously. In relapse rapid transfusion of a minimum of 6 pints of protein fluid is probably necessary, whatever the volume already transfused.

(5) Limb wound cases who are moderately shocked are generally fit for operation with the fourth to the eighth pint—usually the fifth or sixth pint—dripping into the circulation, with speedy operation and little haemorrhage 5 to 9 pints (bottles) may be sufficient.

Where shock is severe as in cases with traumatic amputations, etc., the patient may not be fit to undergo operation until the 10th pint is being transfused, and may have had 11 or 12 pints by the end of the operation.

Post-operative transfusion even of a large volume may be necessary even where there is no further haemorrhage.

Where there is continued haemorrhage, there is no limit to the volume that may be transfused.
Resuscitation of Limb and Abdominal Wound Cases in the Field

(6) For cases with penetrating abdominal wounds, where intraperitoneal haemorrhage is usually present, transfusion of 6 pints of protein fluid is a reasonable volume to give before operation, with a total of 8 to 12 pints (usually 9 or 10) given by the end of the operation.

Depending on the degree of shock still present blood or plasma transfusion may be continued immediately after operation, and if it is intended to give one or two pints of plasma daily for a week, it is more reasonable to give this total volume in the day or two following operation, since death from shock usually occurs within twenty-four hours.

(7) The view that transfusion is frequently inadequate in these cases is based on my experience, on the observation of cases transfused by others, on the fact that further transfusion was frequently necessary on arrival of cases in England, and on the fatality rate of casualties in the B.L.A. In my opinion the value of transfusion is underestimated and the importance of complete resuscitation of cases hardly realized, even by surgeons.

(8) It is fitting here to pay a tribute to those, such as Brigadier Sir Lionel Whitby, who were responsible for the first class organization of the Blood Transfusion Service.

REFERENCES.

Resuscitation of Limb and Abdominal Wound Cases in the Field
A. D. Milne

J R Army Med Corps 1948 90: 72-84
doi: 10.1136/jramc-90-02-04

Updated information and services can be found at:
http://jramc.bmj.com/content/90/2/72.citation

These include:

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/