TRANSFUSION OF BLOOD IN CASES OF HÆMORRHAGE.

By JAMES M. GRAHAM, Ch.M., F.R.C.S., Assistant Surgeon, Royal Infirmary.

One of the first effects of hæmorrhage is to cause a lowering of blood-pressure in proportion to the amount and rate of loss of blood. When the hæmorrhage is not immediately fatal and the bleeding is arrested there is a tendency, as the tone of the vessels recovers and the volume of the blood is increased by the body fluids, for the blood-pressure gradually to rise again. Death may be due to loss of corpuscles but may equally well result from continuance of low blood-pressure. Bayliss has pointed out that a diluted blood at moderate pressure is much more efficient for maintaining the vitality of the tissues and organs than a concentrated blood at low pressure.

It is important, therefore, in all cases where the patient is reduced to a dangerous condition by loss of blood, to increase the amount of fluid circulating in the vessels. The question then arises as to what solution is best adapted to form a substitute for the lost blood. In cases of exsanguination my experience indicates the superior value of homologous blood over other solutions. The value of transfusion in cases of hæmorrhage was impressed upon me in the first instance by experimental work carried out before the opportunity had occurred of employing this method of treatment clinically.

The following brief note of an experiment shows how an animal rendered moribund by hæmorrhage can be restored by transfusion.

Experiment I.—20th Nov. 1913.—Donor—dog, 13.5 kilos. Recipient—dog, 7.2 kilos. The operation was performed with aseptic precautions under general anesthesia. A paraffined glass canula was used for the transfusion from carotid artery to external jugular vein. Approximately half of the recipient's blood was withdrawn by repeated bleedings from the femoral artery. The blood-pressure, observed on a continuous tracing taken from the carotid artery, fell from 151 mm. to 41 mm. of mercury. Transfusion was commenced when the animal was in extremis. The following figures show the effect of bleeding and of transfusion upon the blood-pressure:

| Before Bleeding | . . . . . . | 151 mm. |
| After Bleeding, 100 c.c. | . . . . . . | 114 mm. |
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| Blood Pressure. |
|-----------------|
| 105 mm. |
| 84 " |
| 52 " |
| 41 " |
| 151 " |
| 190 " |

After transfusion for one minute.
After transfusion for three minutes.

The blood-pressure was readily restored by transfusion to its normal level and was still further raised by over-transfusion. The wounds were sutured and the animal made an excellent recovery.

In a similar experiment the effects of intravenous infusion of normal saline upon the blood-pressure were noted.

EXPERIMENT II.—27th Nov. 1913.—Dog—10.35 kilos. The experiment was performed under general anaesthesia. Blood was withdrawn from the femoral artery and equivalent amounts of saline were infused into the jugular vein. The following figures show the changes in the blood-pressure produced by hæmorrhage and infusion of saline:

| Blood-pressure. |
|-----------------|
| 120 mm. |
| 75 " |
| 88 " |
| 120 " |
| 90 " |
| 118 " |
| 100 " |
| 80 " |
| 74 " |
| 47 " |

Further infusion of saline, in excess of the amount of blood withdrawn, failed to raise the blood-pressure or to prevent death.

The experiment shows that a marked fall in blood-pressure follows immediately on profuse hæmorrhage, but that the pressure gradually rises again although it remains considerably below normal. Infusion of the same amount of saline will at first restore the pressure to the same level as before the hæmorrhage. After subsequent hæmorrhages infusion of saline will restore the pressure almost to normal, but the effect is only temporary. A stage of depletion is reached at which the pressure steadily falls and the volume of fluid within the vessels is diminished in spite of the replacement of the blood by saline. When hæmorrhage is excessive, infusion of normal saline fails to keep the blood-pressure at a level necessary to maintain life, and also fails to replace the lost corpuscles.

A further experiment may be quoted to show that transfusion
is successful in reanimating an animal after haemorrhage when infusion of saline has failed to maintain the blood-pressure at a level compatible with life.

EXPERIMENT III.—16th Dec. 1913.—Donor—Dog, 15 kilos. Recipient—Dog, 8.25 kilos. The experiment was designed in order to compare the effects of infusion of saline and transfusion of blood on the blood-pressure, and as a means of treatment in cases of profuse haemorrhage.

At the commencement of the experiment the recipient's blood-pressure, taken from the carotid artery, was 140 mm. The animal was repeatedly bled and the blood lost was replaced by equal amounts of saline solution. By this method of alternate bleeding and infusion of saline it is possible to withdraw the maximum amount of blood. The method of withdrawing the blood at intervals permits also a more gradual and more complete depletion of the animal. After eight successive bleedings followed on each occasion by injection of the same amount of saline the animal was reduced to an extreme degree of exsanguination. Respiration was embarrassed through deficient oxygenation and the blood-pressure was reduced to 28 mm. The animal at this stage was moribund and it took 3 minutes, 10 seconds to withdraw 35 c.c. of blood, about one-sixteenth of the volume which would have been delivered at the commencement of the experiment. This gradual withdrawal of a further amount of blood reduced the pressure to 22 mm. Further infusion of saline failed to raise the blood-pressure, and as the animal could not longer be maintained alive, it was decided to try the effects of transfusion. From the commencement of the transfusion the blood-pressure steadily rose till it reached 130 mm., in three minutes time, when the transfusion was stopped.

The blood-pressure thus restored was maintained at this level for several minutes, and accordingly the animal was again bled to the extent of 200 c.c. This further loss of blood caused the pressure to fall to 90 mm., but after a second transfusion it again rose to 120 mm. and the experiment was concluded. The recipient's wounds were closed, after ligation of the vessels, and the animal made an excellent recovery. The donor was killed.

Further experiments showed that an animal infused with saline after a moderate haemorrhage makes a more gradual recovery after the operation than an animal which has been transfused with blood after excessive haemorrhage. The duration of the anæmia in my experiments, examples of which are quoted above, did not exceed seventy-five minutes, and the rapid restoration and the maintenance of the blood-pressure by transfusion showed that the vaso-motor centre and
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the heart muscle were not injuriously affected. By raising the blood-pressure mechanically after severe haemorrhage and by replacing the lost corpuscles, transfusion will succeed in saving life when saline has failed to do so.

My clinical observations in cases of haemorrhage or of haemorrhage combined with shock have fully confirmed the advantages of transfusion indicated by the experimental work.

The following immediate signs of benefit following transfusion may be noted in cases of haemorrhage or of profound anaemia from other causes.

1. Colour.—One of the first results of transfusion is the appearance of colour in the patient's face in the form of a slight capillary flush. The improvement in colour usually appears first in the lobes of the ears or on the cheeks, and is generally noticed, both in the skin and mucous membranes, within five minutes after the commencement of the transfusion. The fresh colour in the patient's complexion, at first scarcely perceptible, soon becomes obvious, and the pallid or waxy skin may finally assume a healthy pink colour; but this, of course, will depend on the amount of blood transfused. At the conclusion of the operation the patient's colour frequently suggests a richer blood than is shown by the haemoglobin count and the improvement in colour may be less pronounced later. As the colour improves the face seems to fill out, losing its pinched and sunken look, and, at the end of the operation, it is not unusual for the appearance of the donor to suffer in contrast with that of the patient.

2. Mental.—Nothing can be more striking than the effect of transfusion on the patient's cerebral functions, especially when he is unconscious at the commencement of the transfusion. My cases have often been lifted on to the operating table in a more or less comatose condition, and have awakened during the transfusion to a knowledge of what was going on. Even as small an amount of fresh blood as 200 c.c. may suffice to restore consciousness. With returning consciousness the patient takes an interest in the proceedings and soon begins to understand and answer questions. Occasionally such cases take a lively part in the conversation and actually appear exhilarated. The circumstances are more dramatic when the patient and donor are in close contact than when the blood is simply introduced through a funnel and tubing, and the patient is ignorant of the nature
of the treatment. Even when the patient is not unconscious, he is usually dull and apathetic and often oblivious to his surroundings. In such cases the improvement in the mental condition is also striking.

The relief of symptoms shows itself in different ways. As a rule the patient states that he feels better and stronger at the conclusion of the transfusion. Various symptoms may be mitigated, such as numbness and tingling of the limbs, and impaired vision; and the annoyance of audible pulsation may be removed. One patient stated that the main difference she noted was a sensation of warmth and comfort, lacking before.

Many semi-conscious patients are restless, and their uncontrolled movements are apt to interfere with the operation. Such movements may be due to air hunger or simply to the fractious or irritable condition of the patient; these cases usually become quiet and placid as the transfusion takes effect.

3. Changes in the Pulse.—The pulse is usually rapid, and may be either very small or imperceptible at the wrist. In some cases of haemorrhage the pulse rate may be 150 or 160 per minute. The strength of the pulse increases pari passu with the improvement in the patient's colour, and as the vessels become filled the heart itself contracts more strongly. It is not unusual for the pulse at the conclusion of the transfusion to be diminished from 150 to 120 per minute. Improvement in the pulse rate is more marked in cases of profound anaemia from recent haemorrhage than in cases of chronic anaemia. The increasing facility with which blood for haemoglobin estimation can be obtained by pricking the ear is a further sign of the improved condition of the circulation; and, if an operation is in progress during the transfusion, the tissues will be found to bleed more freely in proportion to the amount of blood transfused.

4. Blood-pressure.—A distinct change is noticed in the blood-pressure, particularly in cases of primary or secondary haemorrhage. In most of the cases requiring transfusion the blood-pressure is low, generally below 100 mm. and often 70 mm. or less. The increase of pressure may be as much as from 50 to 60 mm. to 90 or 100 mm. or more; shortly after transfusion the blood-pressure may return almost to the normal level. The combination of a rise in blood pressure and a fall in pulse rate is characteristic of a successful trans-
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fusion in cases of hæmorrhage. The rise in the blood-pressure naturally varies with the amount of blood introduced, and if an over-transfusion is given, the pressure may rise to a remarkable degree, as shown by experimental work.

5. Respiration.—The respirations are apt to be fast and laboured if the patient is suffering from air hunger. The signs of deficient oxidation gradually diminish or disappear as the donor’s corpuscles increase the oxygen-carrying capacity of the blood. Cases gasping for breath, so much so that it is difficult to keep them still, may be completely relieved of their respiratory embarrassment during the course of the transfusion, the respirations falling from 50 to less than 30 per minute.

6. Increase in the Hæmoglobin percentage, and in the Red Corpuscle Count per Cubic Millimetre.—Repeated examinations of the hæmoglobin were made during transfusion in the great majority of my cases, the only exceptions being in cases where there was no assistance available.

The average increase in the hæmoglobin count, taken from a series of pernicious anaemia cases which were completely observed, was 19 per cent. The greatest increase noted was in one case where the hæmoglobin was raised from 28 to 73 per cent., an increase of 45 per cent.

The average increase in red corpuscles in the same cases was about one million per cubic millimetre, so that the hæmoglobin and corpuscles were increased by transfusion in the same proportion.

The actual risks associated with transfusion of blood in cases of anaemia from hæmorrhage are so slight that they need not be regarded, when preliminary tests have excluded the dangers of agglutination and haemolysis. With rare exceptions the transfused blood acts as a grafted tissue, and the corpuscles are at once available in the recipient’s blood for performing their physiological function. The serum of the blood also plays an important part in compensating for the volume of fluid lost by hæmorrhage.

There has been no evidence of haemolysis or of destruction of the corpuscles in any of my cases of primary or secondary hæmorrhage treated by transfusion. The corpuscles appeared to functionate exactly like those of the recipient, and presumably their duration in the recipient’s blood is that which is normal to the individual patient.

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The great advantages of blood transfusion compared with infusion of normal saline or other artificial solutions are:—

(1) The blood-pressure is immediately raised; (2) The blood-pressure is likely to be maintained; (3) The oxygen-carrying capacity of the blood is increased.

Naturally one would not recommend transfusion as a routine treatment for loss of blood. It is remarkable how completely and even quickly an individual can recover from loss of blood without special treatment, but there still remain numerous cases where the patient dies from the effects of sudden or prolonged haemorrhage in spite of all treatment, including the usual injections of saline, intravenously or otherwise. My experiments showed that a stage of depletion could be reached, beyond which intravenous injection of saline or Locke's fluid failed to produce any permanent or even temporary response, and which was not compatible with life. Similar cases may be seen in practice, uncomplicated by shock or toxæmia, where collapse from haemorrhage may be so great that the patient's death is inevitable within a few hours. Apart from extreme cases, where death is obviously imminent, it is impossible to lay down any definite rule as to when transfusion is indicated. In traumatic or operation cases the degree of shock present should be taken into consideration, and anti-shock treatment employed in the first instance, if the blood loss has been slight. When, however, the haemorrhage has been considerable, and the patient's condition is critical, transfusion should be preferred.

In recent cases of haemorrhage haemoglobin estimations and blood counts are not of much assistance. The best indication for transfusion is the presence of signs of serious collapse, such as pallor, subnormal temperature, a small fast pulse with low blood-pressure, restlessness, sighing and rapid respirations, syncope or other symptoms of deficient oxygenation. The syncope and collapse which follow a sudden profuse haemorrhage frequently yield rapidly to simple measures, such as raising the foot of the bed and administering fluids; the pulse may be imperceptible only for a few minutes, and quickly recovers its tone and quality. If each case, therefore, is considered on its own merits, transfusion will not be employed unnecessarily. In doubtful cases the blood-pressure is the most valuable index of the gravity of the case. Continuance of collapse and a rapidly falling blood-pressure, when the
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Hæmorrhage is controlled, are signs of serious significance, and strongly suggest the necessity for transfusion, particularly when saline infusions and other measures have been tried.

According to Bruce Robertson,¹ the patient's condition is precarious if the blood-pressure is below 70 mm. and when it is below 90 mm. the patient is a bad subject for operation. My own observations confirm these views regarding the significance and dangers of low blood-pressure in cases of hæmorrhage.

The following cases may be quoted to show the effect of transfusion in critical cases of hæmorrhage. Cases I., II., and III. were examples of primary hæmorrhage uncomplicated by shock or sepsis. Cases IV., V., and VI. were examples of secondary hæmorrhage uncomplicated by shock.

Case I.—Melæna neonatorum. Beatrice B., aged 10 hours. This case was under the care of the late Mr Scott Carmichael. The child was passing blood per rectum and was profoundly anaemic, cold, and collapsed. Direct transfusion of blood was performed, as the case seemed hopeless and death appeared to be imminent. The father acted as donor, the radial artery being connected to the femoral vein by a silver cannula. The effect of the transfusion was immediate. Within a minute the child became rosy, and began to struggle and cry vigorously, in striking contrast to its previous limp and moribund condition. Its pulse during the transfusion was identical in rate with the father's. The recovery was immediate and permanent, and there was no further hæmorrhage from the bowel.

Case II.—Mr M., aged 51. Gastric hæmorrhage. 26th December 1918. The cause of the hæmorrhage in this case was uncertain. For several years the patient had been drinking to excess and suffered from chronic gastritis. He had during the previous year noticed tarry material in the stools, and on a former occasion had collapsed from gastric hæmorrhage and required subcutaneous salines.

On 23rd December 1918 the patient again suffered from profuse haemorrhage from the bowel. It was reckoned that six pints of blood were passed in two days' time, and in addition there was a great deal of blood vomited.

On 26th December 1918 the patient collapsed completely. He was now blanched, cold, clammy, pulseless, restless, and gasping for air, and had lapsed into a semi-conscious condition. Transfusion of blood was advised by Professor Gulland, and this was carried out immediately. 700 c.c. of citrated blood were collected from a convalescent soldier, previously tested and known to be a group IV. donor, and transported to the patient's house. During the transfusion
the colour improved, the pulse became palpable, the blood-pressure was considerably raised, and complete consciousness was regained. The greatest change noted was in the relief from air hunger, the patient becoming quiet and breathing easily before the transfusion was completed. No further bleeding occurred after the transfusion and the patient made a gradual but steady recovery.

Case III.—Mr F., aged 49. Haemorrhage following gastro-enterostomy. 11th January 1919. The patient vomited a large quantity of coffee-ground material a few hours after gastro-enterostomy had been performed for duodenal ulcer. He was kept under the influence of morphia, but the bleeding continued. On the day following operation he was feeble, collapsed, and occasionally sick. Thirty-three hours after operation the stomach was washed out and a large quantity of brown-stained contents were syphoned off; but it was impossible to get the wash-out clear. Apparently active bleeding was still going on as the fluid was reddish tinged and contained fresh blood. At this stage the patient's condition gave cause for anxiety, the pulse was barely perceptible and he was suffering severely from loss of fluid and of corpuscles. Arrangements were therefore made to obtain blood from a tested donor at short notice, should his condition not improve. Two hours later it was reported that his extremities were cold, and that he was pulseless and semi-conscious. Transfusion of blood was therefore performed at the request of the surgeon in charge of the case. 500 c.c. of citrated blood were introduced slowly into the median basilic vein. During the transfusion the patient regained consciousness and the blood-pressure was increased. The improvement in the general condition was maintained and no further haemorrhage occurred.

Case IV.—Mr A., aged 18, medical student. 28th June 1917. Secondary haemorrhage following compound fracture of leg. As the result of a motor bicycle accident the patient sustained a compound comminuted fracture of both bones of the leg. Both tibial arteries were torn and there was profuse bleeding at the time. Sepsis followed and the patient developed a swinging temperature and suffered from toxic absorption. Secondary haemorrhage occurred ten days after the injury and also during the subsequent days. Sixteen days after the injury a profuse haemorrhage reduced the patient to a low condition. Salines both per rectum and subcutaneously were given, but there was little response, and the patient was in a critical condition. Transfusion of blood was performed at the request of the surgeon in charge of the case. 600 c.c. of blood were transfused by the indirect method with syringes and two-way stopcock apparatus with satisfactory result.
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During the operation, which lasted fifteen minutes, the patient's colour improved. Mentally and physically also he became more vigorous. At the commencement of the transfusion the blood-pressure was from 60 to 70 mm.; at the conclusion it was increased to 105 mm. The pulse rate was reduced from 150 to 120 per minute. The transfusion proved a turning-point in the patient's illness. No further hæmorrhage occurred, and the septic condition of the wound rapidly diminished. One week after the operation the temperature became normal and remained at that level.

Case V.—Sergeant A., aged 44. Secondary hæmorrhage from axillary artery. 12th December 1918. The former history of this case is referred to later (see Case XI).

The secondary hæmorrhage occurred from the stump of the axillary artery, fourteen days after the arm had been disarticulated at the shoulder for gun-shot injury. The wound had been left open and the hæmorrhage occurred from an apparently healthy granulating surface. The bleeding was controlled by deep sutures passed around the artery. No anaesthetic was required. As the patient's condition was critical one and a half pints of normal saline were immediately infused into the right long saphenous vein. While this was being done a suitable donor was selected and 700 c.c. of citrated blood were prepared. The transfusion was continued after the infusion of saline was completed. The effect of the saline was slightly to improve the patient's condition, but he still remained collapsed and semi-conscious. He was apparently suffering from a lack of corpuscles. Before the third of the citrated blood had been given the patient's colour began to return, his respirations became quieter, and he regained consciousness; at the conclusion of the transfusion he felt almost as well as before the hæmorrhage.

After the transfusion the blood count was as follows:

| R.B.C.s.         | Hb.    |
|------------------|--------|
| 2,560,000        | 44 per cent. |
| Four days later, 4,050,000 | 63 |

No hæmolysis occurred and the blood counts show that fresh corpuscles were rapidly formed. The patient's subsequent progress was satisfactory and there was no further hæmorrhage.

Case VI.—Female, aged 25. Secondary hæmorrhage from branches of the internal iliac artery. 16th November 1918. The patient was suffering from tuberculous disease of the left sacro-iliac joint, of several years' standing. Her health has been much affected by the presence of discharging sinuses, and the diseased area had been exposed by an open operation. There was much bleeding at the operation, and subsequently profuse secondary hæmorrhage occurred.
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necessitating ligation of the internal iliac artery. Four days later a severe haemorrhage again occurred, and the patient, who was previously in a feeble condition, became collapsed. The haemorrhage was controlled by packing. When I saw the case two hours later she was completely blanched and the pulse was felt with difficulty. She was unconscious, and the systolic blood-pressure was 55 mm. Rectal and subcutaneous salines had been given without any apparent benefit. Her condition was obviously hopeless and transfusion seemed to offer the only chance of prolonging life. As no relations or other likely donors were at hand, it was decided to ask a student to volunteer as donor. It was not considered desirable to take the necessary amount of blood from any of those who volunteered, as the individuals were either not sufficiently fit to justify the loss of more than a small amount of blood, or were appearing for their final examination in two days' time. The only justifiable means of obtaining the blood seemed to be to collect it from several individuals, and, in view of the patient's hopeless condition, it was decided to risk the many incompatibilities which such a mixture could produce. 700 c.c. of blood were taken from one nurse, two residents, three students, and the writer. While the blood was being collected and mixed with citrate, the patient became pulseless and appeared to be sinking, and it was a question whether the preparations could be completed before the patient died. A superficial vein was exposed ready for the transfusion while the blood was being obtained. There was no bleeding from the tissues and on opening the vein only a few drops of blood escaped.

After a third of the blood had been introduced, colour appeared in the patient's finger-nails and the pulse became palpable. When half the solution had been given the patient's breathing became somewhat rapid and the rate of flow was retarded. The transfusion occupied 15 minutes. Before its completion breathing was again quiet and the patient was conscious and able to speak and answer questions. At the conclusion of the transfusion the blood-pressure was 90 mm.

No reaction of any kind followed the transfusion and the patient continued to improve till the fifth day, when fresh haemorrhage occurred. Several profuse hemorrhages occurred on the following day and the patient died from exhaustion. With our present knowledge of the dangers from transfusion of untested blood it is remarkable that the mixture of the blood of seven donors not only failed to cause any toxic symptoms, but succeeded in saving the patient from imminent death.

My clinical cases have shown that patients reduced to an extreme degree of collapse from haemorrhage, with air hunger, without pulse, and a blood-pressure reduced to from 50 to 60 mm., can be immediately revived by transfusion of blood.
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when other means have failed to ameliorate their condition. Normal saline cannot be regarded as the best solution for raising the blood-pressure. In many cases of severe hæmorrhage the improvement which follows is only temporary, and within a short space of time the blood-pressure again falls to the original level or even lower than it was before. My own experience with colloidal solutions, which are better adapted for mechanically raising the blood-pressure when injected intravenously, is too small to speak from; but in the type of case mentioned simple elevation of blood-pressure, although necessarily improving the circulation and the oxidation of the tissues, may be insufficient to maintain life. Not only the volume of the blood must be increased but corpuscles also are needed, and these requirements can best be obtained by transfusion of compatible blood, combined if necessary with infusion of saline or colloidal solution to increase further the amount of fluid within the vessels. I believe, therefore, that both clinically and experimentally blood transfusion affords a means of saving life in cases of severe hæmorrhage when all other methods of treatment have failed.

During the last year or two of the recent war, military surgeons employed transfusion freely, and the papers published by Archibald, Primrose and Ryerson, O. Robertson, Bruce Robertson, Hull and others have amply demonstrated once and for all the wonderful results which may follow transfusion in suitable cases of hæmorrhage or of hæmorrhage combined with shock. Improvements in technique, and particularly the introduction of the citrate method, have widened the scope for transfusion so that it can be safely performed by those without special skill or experience. Finally the introduction of simple and reliable tests for selection of suitable donors by Moss, Brem, and Lee has removed the last objection which can be raised to the employment of transfusion on the ground of the danger arising from the use of incompatible blood. In spite of the brilliant results recorded by recent writers on the subject, there is reason to believe that the scope and indications for transfusion are not yet thoroughly realised by civil practitioners, and there must be many surgical, medical, and obstetrical cases which die from loss of blood without transfusion having been attempted or even thought of. Looking back on my own limited experience I can recall patients who died from hæmorrhage after prostatectomy, thyroidectomy, gastroenterostomy,
splenectomy, nephrectomy or from injury, in spite of injections of saline and other measures, whose lives I feel now might possibly have been saved if blood had been transfused.

**Transfusion in Cases of Hæmorrhage Complicated by Shock.**

The risks to which the patient suffering from the effects of hæmorrhage is exposed are aggravated when, as so often happens, an operation under general anaesthesia is necessary, possibly to arrest bleeding, or to permit of amputation of a limb, or simply to disinfect the parts.

Patients with a low blood-pressure, whether from hæmorrhage or shock, are notoriously bad subjects for operation, and particularly so if, in addition, sepsis is present. Every surgeon has had experience of cases of secondary hæmorrhage, in which the patient's death has been accelerated by an operation, in spite of subcutaneous or intravenous salines, and other methods to combat shock. Local anaesthesia is seldom practicable, and these patients are specially liable to suffer an increase of shock from the anaesthetic, as well as from the manipulations during the operation. The question again arises whether transfusion of blood is not the most valuable addition to our other means of combating shock in such cases. Certain of my cases bear upon this point.

Cases VII., VIII., IX., X., and XI. were all examples of patients suffering from loss of blood, combined with shock, due to an operation. In four of these cases, the transfusion was performed after operation, as the patient's condition seemed desperate. In each case the usual anti-shock treatment had been tried, and the cases, therefore, served as an excellent test of the comparative value of blood transfusion. Except in Case VII., transfusion proved to be life-saving. In the remaining case, blood was transfused during an operation in order to minimise the anticipated shock, and this it did successfully.

**Case VII.—Mrs A., aged 40. 4th March 1917. Ruptured ectopic gestation.** This patient was suffering from extreme exsanguination following a ruptured ectopic gestation. She had been collapsed for twenty-four hours prior to admission, and was only partly conscious when she went on to the operating table. The operation was prolonged and difficult, and there was therefore in her anæmic condition an increase of shock which further lowered her vitality. Intravenous
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Salines had failed to raise the blood-pressure and transfusion was suggested as a dernier ressort by the surgeon in charge of the case. Indirect transfusion by syringe and two-way stopcock apparatus was performed and caused a distinct improvement in the patient's condition. The pulse became palpable but the blood-pressure remained low and the pulse small and fast, and death occurred within twenty-four hours without the patient having recovered from her collapse. The transfusion had to be stopped when 500 c.c. of blood had been given, as the donor was becoming faint. In such cases of extreme anæmia following hæmorrhage 1000 c.c. are probably the ideal amount. While it is impossible to say that a larger amount would have saved the patient's life, it is reasonable to conclude that transfusion was not properly tested in this case, although it certainly prolonged life for a few hours.

Case VIII.—J. M., aged 9. 23rd November 1917. Lacerated wound. This was a case of severe shock combined with a moderate loss of blood. Shock was the predominant feature, and the loss of blood in the absence of traumatic and operation shock would have been of slight consequence. The patient, a boy aged 9, was admitted suffering from a severe injury of the right leg, as the result of the limb being run over and dragged by the wheel of a motor car. He was suffering from such severe shock that the extent of the injuries could not be immediately ascertained. Anti-shock measures improved his condition sufficiently to permit of his being anaesthetised four hours later. The skin and fascia had been split down the inner side of the limb from the lower part of the abdomen to within three inches of the internal malleolus, and were almost completely detached, so that the underlying muscles on the postero-lateral aspect of the limb were exposed. The capsule of the knee-joint was torn and the joint cavity exposed behind the outer edge of the patella. After clipping away the soiled tissues, and cleansing the raw surfaces with eusol, the knee-joint was closed and the skin flaps sutured and drained.

On returning to bed the patient, in spite of rectal and subcutaneous salines, remained collapsed. No improvement followed intravenous injection of saline, and, some hours later, as it was apparent that the child was sinking, it was decided to perform transfusion, the boy's father acting as donor. While 400 c.c. of blood were being transfused with the syringe method the pulse became palpable, and at the conclusion the blood-pressure was much higher than it had been before. The immediate improvement following transfusion was maintained, and the subsequent recovery from the condition of profound shock was rapid and complete. The knee-joint escaped infection, but large areas of skin subsequently sloughed and required to be replaced by skin grafts.
Case IX.—Miss C., aged 47. 11th July 1918. Profound anaemia from haematemesis, perforation of a gastric ulcer, laparotomy. This patient had been under observation for several weeks. Symptoms of gastric ulcer had developed shortly after the operation of nephrectomy performed for pyonephrosis. Repeated attacks of haematemesis had reduced her to a profoundly anæmic condition, and in addition she was suffering from the effects of starvation for several days during which she had been kept on rectal salines. When in this reduced condition her gastric ulcer perforated during the night. When her condition was reported to me on the following morning I found the recti rigid, the abdomen distended, and loss of liver dulness. The general condition of the patient was extremely feeble. Reduced in strength by several weeks of illness, exsanguinated from repeated loss of blood, collapsed from the pain and shock of the perforation, it seemed almost hopeless to subject her to operation, especially as no suitable donor was available for transfusion. As she had, however, already shown wonderful stamina I decided to give her the chance of operation. After closure of a large perforation and suprapubic drainage the patient was returned to bed. Four hours later she was semi-conscious, the pulse was just palpable and 160 per minute; blood-pressure 65 mm., respirations 50. Having obtained a donor, it was now arranged to perform transfusion.

750 c.c. of whole blood had the immediate effect of restoring the patient to consciousness, and of saving her life for the time being. The blood-pressure was raised to 95 mm. and the respirations fell to 28 per minute. The patient was apparently well on the way to recovery when, five days later, a second perforation occurred (confirmed post-mortem), which proved fatal within twelve hours. Prior to transfusion the patient had absorbed as much saline as was possible without producing œdema. The effect of the transfusion was to supply the deficiency in corpuscles and to raise the blood-pressure and maintain it at a level compatible with life.

Case X.—R. C., aged 23. 5th January 1917. Secondary haemorrhage from axillary artery, post-operative shock. The patient suffered from recurrence of secondary haemorrhage from the axillary artery following a gun-shot wound. The third part of the subclavian artery was ligated, but after the operation the patient remained unconscious, collapsed, and suffered from air-hunger. His vitality had previously been reduced by considerable suffering and loss of blood. The recent haemorrhage had been profuse, and the operation, although neither difficult nor prolonged, had added the effects of shock to those of loss of blood. The pulse rate was 140 and the systolic blood-pressure 65 mm.; the skin was cold and the respirations were sighing. Subcutaneous and rectal salines failed to improve his condition, and it
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was decided to transfuse in order to give him a chance of recovery. 700 c.c. of blood were given by the syringe method. The patient rallied during the transfusion. His pulse, respirations, and colour were markedly improved, and towards the close of the transfusion he became quite normal mentally.

He was able to take a hearty meal the same evening. Unfortunately a fresh haemorrhage occurred seven days later, when he was apparently making excellent progress, and he died within an hour from loss of blood before steps could be taken to transfuse him again.

Case XI.—Sergeant A., 44. 28th November 1918. Secondary haemorrhage from axillary artery following gun-shot wound. Disarticulation of shoulder and simultaneous transfusion of blood.

In this case the patient was reduced to the last degree of exhaustion by repeated secondary haemorrhages from the axillary artery, and by septic absorption from gun-shot wounds involving the shoulder and upper arm. In spite of previous ligation of the third part of the subclavian artery, a profuse secondary haemorrhage had again occurred from the upper part of the axillary artery. The patient’s condition was desperate as the bleeding point was inaccessible for ligation. In addition the hand was becoming gangrenous and the entire upper arm was paralysed. The artery could not be ligated without an operation under general anaesthesia, but his condition made it extremely doubtful whether he would stand the operation. It was further obvious that simple ligation was insufficient, as the arm was useless and becoming gangrenous, and a source of serious danger from the extent and septic nature of the wounds. Disarticulation at the shoulder was indicated both to facilitate ligation of the artery and to remove the sources of septic absorption. As the patient’s condition seemed hopeless if he were left alone, and as his chances of recovery appeared to be remote if his arm were amputated, unless his general condition could be improved, it was decided to risk the major operation and to perform simultaneously transfusion of blood. 800 c.c. of citrated blood were injected while the arm was disarticulated at the shoulder. Improvement in the circulation and blood-pressure was noticeable while the operation was in progress. At the beginning of the operation the tissues were almost bloodless, but towards the close numerous bleeding points required to be caught. When the patient returned to bed, minus his arm, he was in better condition than before the operation. Transfusion restored the patient from extreme collapse due to loss of blood, and also diminished the degree of shock from the operation and general anaesthetic, the effects of which would otherwise almost certainly have been fatal. Fourteen days later, when the patient was apparently progressing favourably, a fresh profuse haemorrhage occurred,
from the effects of which the patient was again rallied by transfusion (see Case V.).

Cases VIII., IX., X., and XI. demonstrate that transfusion of blood is a most valuable procedure in cases of hæmorrhage complicated by shock.

In all except Case VIII. hæmorrhage was the main cause of the collapse, although there is no doubt that, owing to the loss of blood, the degree of shock caused by the operations was considerable. I have had little experience of treating cases of pure shock by transfusion. Case VIII. was one in which shock was the primary factor, but there had also been a moderate loss of blood. The successful result in this case was due to the fact that the shock, although extreme, had lasted only a few hours, and that the blood-pressure was satisfactorily raised and maintained by the transfusion. In certain of my cases, transfusion would have been of even greater value if performed earlier. Delay was frequently due to difficulty in getting a suitable donor.

Shock was the outstanding feature of Case XII.

Case XII.—In this case the patient suffered from intractable vomiting due to vicious circle following gastro-enterostomy. Ten days after the original operation a lateral anastomosis between the two limbs of the loop was made. The results of this operation were, however, disappointing and the vomiting continued. In spite of rectal alimentation the patient rapidly became collapsed and he himself believed his condition to be hopeless. It was finally decided to give him the chance of a further operation and to replace the posterior by an anterior gastro-enterostomy. At the request of the surgeon in charge of the case preparations were made to perform transfusion during the operation. The appearance of the tissues was typical of deep shock. There was no arterial bleeding; the blood appeared in the form of a venous ooze, more from capillaries than individual vessels. A transitory improvement followed transfusion. Bleeding became slightly more active and the pulse at the wrist was palpable; but there was no spouting of arteries, and towards the close of the operation the patient was even more collapsed than at the commencement. Half a pint of gum solution (6 per cent.) infused intravenously produced no response. The patient died two hours after the completion of the operation. The case demonstrated that a degree of exhaustion, combined with severe shock, can be reached which will not respond favourably to attempts to raise the blood-pressure or to maintain it by intravenous injections of fluids or of blood.
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I have seen cases of recent acute hæmorrhage, in which the patient's condition was even more urgent than in the above case, revived by transfusion of blood, and I agree with other observers with more experience, that transfusion is not so successful in relieving patients suffering from shock as in cases of collapse from hæmorrhage, or in cases of hæmorrhage combined with a moderate degree of shock.

Although in cases of pure shock there is no loss of corpuscles, the volume of circulating blood is reduced, and there is deficient oxidation of the tissues. It is reasonable to believe that the intravenous injections of fluids which can raise and maintain the blood-pressure would be almost as efficient as blood for the purpose. On the relative merits of gum or gelatine solutions when injected intravenously for the treatment of shock, I am not in a position to speak; but I think there is no doubt that the transfusion of blood is more efficacious than infusion of saline in cases of shock, and, further, that when shock is combined with loss of a considerable amount of blood, transfusion is indicated, and is the most certain means of saving life.

Apart from shock, patients suffering from sepsis are less likely to recover quickly from loss of blood than when the effects of septic poisoning are absent. Repeated hæmorrhages are liable to hasten the patient's death. Lowered vitality from loss of blood prevents the sepsis from being overcome, and the toxic condition maintains the anæmia. Such patients often require operation, and, therefore, occasions must frequently arise when transfusion of blood is called for. In reanimating patients suffering from secondary hæmorrhage, transfusion yields as striking results as in cases of primary hæmorrhage. My cases of secondary hæmorrhage are too few to permit of exact deductions being drawn as to the effects of transfusion on the condition of the wounds. I believe that, in certain of the cases, transfusion did raise the patient's resistance to the infection; but there was no evidence that the improvement was specific in nature, or due to the protective qualities of the serum of the transfused blood. It is possible that transfusion may favourably influence the septic process in wounds in three ways:—1. By diminishing anæmia, and by improving the patient's general condition and vitality; 2. By stimulating the hæmopoietic organs; 3. By the introduction of fresh antibacterial or antitoxic substances.

The practicability of treating a patient by injection of blood
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from an immune donor, who has recovered from a similar infection or has been immunised against it, has already been demonstrated by several observers, and there is every reason to think that work along these lines will yield useful results in the future.

**Effects of Transfusion on Arrest of Hæmorrhage.**

As far as my observations go, transfusion of fresh blood does in certain cases aid the spontaneous arrest of hæmorrhage. This appears to be the case particularly when the continuance of the hæmorrhage is due to conditions, such as hæmorrhagic disease of the new-born or hæmophilia, in which the coagulation time of the blood is prolonged. I have had no opportunity of treating a case of hæmophilia, but the results of the cases recorded in literature show that transfusion of healthy blood has a specific action in arresting the bleeding in this disease.

Unger\(^7\) has recorded seven cases of hæmophilia in which the bleeding was arrested by a single transfusion of whole blood; in one case, however, two additional transfusions were necessary before the hæmorrhage was controlled, and in this case it was found that citrated blood was not so effective as whole blood. In five of the cases the patient's life was saved by the transfusion, after almost every possible means had been tried, without success, to stop the bleeding.

According to Bernheim, as a rule 100 or 200 c.c. of blood are sufficient to arrest bleeding, but in cases of exsanguination large amounts can be given with advantage. Ottenberg and Libman,\(^8\) Petersen and others, have had equally good results in hæmophilia. The alarming symptoms are controlled, and although the patient is not cured, immunity against recurrence of bleeding is conferred for a variable time. These observers have therefore suggested that small quantities of blood should be injected intravenously at intervals of one to three months. As age advances the tendency to bleed diminishes, and therefore it might be possible to tide over the dangerous period by prophylactic treatment.

Ottenberg and Libman found that fresh serum or defibrinated blood applied to the bleeding point had an undoubted effect in some cases, but that serum introduced subcutaneously or intravenously had no effect on hæmorrhage, and did not alter the coagulation time of the hæmophilic's blood. Serum treatment
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had been tried without avail in practically all of their cases of haemophilia in which the bleeding was arrested later by transfusion of blood.

These facts, therefore, demonstrate that transfusion of blood is the method of choice in cases of haemophilia if the symptoms are alarming, or if the bleeding continues in spite of other methods of treatment.

The advantage of transfusion is that it not only controls bleeding, but replaces the blood which has been lost, and therefore improves immediately the patient's general condition.

The effect of transfusion in arresting bleeding in the case of haemorrhagic disease of the new-born is as striking as that which follows transfusion in haemophilia. The mortality from melæna neonatorum and other forms of bleeding in the new-born is, unfortunately, high; and in these conditions there is, apparently, delay in coagulation.

The value of transfusion was clearly shown in Case I., in which the patient, an infant aged ten hours, was suffering from melæna neonatorum. As a result of intestinal hemorrhage, the child was profoundly anæmic, and was reduced to a moribund condition; and, while in this critical state, blood was transfused from the father. Transfusion promptly restored the child to a vigorous condition, and no further bleeding occurred. This operation was done six years ago, and the child is reported to have remained well ever since. The only alternative to transfusion of blood in these cases appears to be the subcutaneous injection of serum or of blood; and there is no doubt that this treatment, introduced by Welch in 1910, has greatly reduced the mortality. Robert Hutchison has recently recorded three cases of haemorrhagic disease of the newly-born successfully treated by the subcutaneous injection of whole blood, or blood serum in amounts of from 5 to 8 c.c.; but, although the patients recovered, there was a further haemorrhage in each case.

According to Hutchison, it is impossible to say with certainty how serum acts, but it is probable that it supplies some constituent, lacking in the infant’s blood, which is necessary for clotting. Hutchison further suggests that normal horse serum or anti-diphtheritic serum would act as well as human serum.

If, as Hutchison suggests, the effect of serum is to raise the coagulability of the blood, it is obvious that the desired effect could be better obtained by intravenous injection of whole blood.
Little notice seems to have been taken in this country of the advantages of transfusion for this condition. As the case recorded here shows, a moribund infant may be almost immediately restored to a healthy condition by transfusion of blood. The value of transfusion in such cases lies not only in the arrest of the haemorrhage, but in the replacement of the blood which has been lost. It is perfectly obvious, therefore, that transfusion can restore patients reduced to a stage of collapse, which could not be expected to yield to the subcutaneous injection of small amounts of serum or of blood. This statement is supported by the experience of Unger, who found that, as in haemophilia, transfusion will save life in cases not helped by subcutaneous injections of serum or of blood.

The intravenous injection of 50 to 100 c.c. of whole blood by means of syringes is so simple in infants that there is no object in delaying transfusion in critical cases, which will include the majority, once the diagnosis has been established. In less serious cases transfusion should not be delayed for more than an hour or two, if it is evident that subcutaneous injection of blood or of serum has failed to arrest the bleeding.

A sufficient number of cases of purpura haemorrhagica, treated by transfusion on account of the anaemia, have been recorded to show that in a considerable proportion the tendency to haemorrhage is arrested at least temporarily. My own experience of transfusion in this disease is limited to two cases, one of which was not benefited. In the second case the patient was improved for a few weeks, but the symptoms soon relapsed and caused the patient's death. After the exposure of the patient's vein there was excessive and continued oozing of blood from the tissues of the wound, and the interesting observation was made that the capillary bleeding was arrested by the transfusion. As the coagulation time of the blood in purpura is little altered, it has been suggested that the haemostatic effect of transfusion may be due to the introduction of fresh blood platelets which are known to be reduced, especially during or after a period when haemorrhages have occurred. It is obvious that the continued freedom from recurrence of haemorrhage, which is occasionally observed, is not sufficiently explained by this theory, as the normal duration of blood-platelets in the circulation is known to be short. Further observations are required before any expression of opinion regarding the value of transfusion in this disease would be justified.
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I believe that transfusion of blood will sometimes favour the arrest of hæmorrhage in cases where the coagulation time of the blood is normal, or at least not materially altered as it is in hæmophilia or in infants with hæmorrhagic diathesis. In some cases of repeated bleedings, with the patient becoming progressively more anæmic, there seems to be little tendency for spontaneous clotting to occur even when the coagulation time of the blood is not lengthened. Any clots which form are apt to be soft and non-adherent, and it seems likely that, without altering the coagulability of the blood, transfusion can favour natural arrest by providing a firmer clot.

This result was noted in one of my cases of secondary anæmia. The patient was reduced to a profound degree of anæmia by repeated hæmorrhages from the hæmorrhoidal veins, and he was transfused in order to improve his condition preparatory to operation for an enlarged prostate. The patient's condition was improved by the transfusion as regards his anæmia, and no fresh bleeding occurred in the interval after transfusion till the patient's death, some weeks later, from surgical kidney.

In cases of internal hæmorrhage where the bleeding point is not controlled, as in hæmorrhage from the stomach or duodenum, it would naturally be concluded that the effect of raising the blood-pressure by transfusion would be to increase the hæmorrhage, and that the blood which was introduced would quickly be lost again. There is a good deal of clinical evidence to prove that this effect of transfusion need not be greatly feared. It is always a difficult point, in cases of prolonged bleeding from a gastric or duodenal ulcer, to decide whether to keep the patient quiet and to wait for the hæmorrhage to cease, or to operate. Against operation, there is the fact that in most of these cases the bleeding stops spontaneously, and the patient finally recovers; there is also the possibility that, when the abdomen is opened, the bleeding point cannot be found or satisfactorily secured. If, after hesitating to operate in a case of gastric bleeding, whether from an ulcer or after an operation on the stomach, it is apparent that the bleeding shows no signs of ceasing, and the patient's condition is becoming critical, the risks of operation will be considerable, and such cases will not infrequently die, if operated on, from the combined effects of loss of blood and shock. It is obvious that when the patient is profoundly anæmic his condition could be
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improved whether an operation has to be performed or not, provided that transfusion does not increase the amount of bleeding. Cases II. and III. may be referred to in this connection, as in both of these cases transfusion produced a favourable turn at a period when the patient was becoming progressively more collapsed, and in imminent danger of death from hæmatemesis.

Case II. was transfused as an urgent procedure because of collapse from gastric hæmorrhage. At the time of the transfusion the exact cause of the hæmorrhage was not determined, the provisional diagnosis being hæmorrhage from a gastric vein in relation to cirrhosis of the liver. The patient was pulseless, cold and restless, and gasping for air. 700 c.c. of citrated blood were injected with satisfactory result, the patient's symptoms being immediately relieved. The increasing collapse and respiratory embarrassment suggested that the bleeding had continued up to the time of the transfusion, after which no further hæmorrhage occurred. Although it cannot be definitely stated that the arrest of the hæmorrhage was due to the transfusion, it was at least certain that the improvement in the patient's general condition and the increase of blood-pressure neither prolonged the hæmorrhage nor caused it to start afresh.

Case III. was another example of a case in which it was considered doubtful at the time what the effects of transfusion would be on an uncontrolled bleeding point. Gastro-enterostomy had been performed thirty-six hours previously for duodenal ulcer. Hæmatemesis commenced soon after the operation, and continued during the period stated. The stitching had been done with great care, and there was some doubt whether the bleeding was from the ulcer, as in a previous case, or from the gastro-enterostomy opening. Three hours before the transfusion the stomach was washed out, and the reddish tinge of the contents showed that there was fresh bleeding at the time. Subsequent to the lavage there was no more sickness, but the patient became steadily more collapsed, and finally was cold, clammy, and pulseless. It was difficult to say if the bleeding had been arrested by the washing out of the stomach, but the fact that he became restless from air hunger, and semi-conscious, pointed to its continuance. In any case the effect of the transfusion was immediate, restoring the patient to complete consciousness and improving his pulse
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and colour, and the improvement in the circulation continued without any recurrence of hæmorrhage.

The amount of blood in this case was limited to 500 c.c. because sufficient improvement followed injection of that amount, and it was considered inadvisable to raise the blood-pressure too much in case of exciting fresh hæmorrhage.

Although it cannot be proved that in either of the above cases the hæmorrhage was arrested by transfusion, the fact is established that transfusion can be done in certain cases of uncontrolled hæmorrhage from the stomach with immediate benefit to the patient, and without causing fresh bleeding. In comparison with transfusion the intravenous injection of saline is less efficacious in cases of exsanguination, and it has the further disadvantage of lessening the coagulating power of the blood, a point of importance where the bleeding is not controlled. Transfusion can be relied upon to improve the patient's condition, at least temporarily, and the evidence shows that when a moderate amount of blood is transfused, coagulation is favoured. Naturally, if the vessel at fault is a large one, transfusion will fail to arrest the bleeding and nothing is likely to save the patient except operation, the risks attendant to which may be very great indeed. Transfusion of blood, therefore, might conceivably be the only means of rallying the patient sufficiently to enable the operation to be successfully performed. I have observed several patients who have died from continuance of hæmorrhage from gastric or duodenal ulcers, or after operations on the stomach, in spite of the usual treatment, whose lives I now think might conceivably have been saved if transfusion had been tried.

The value of transfusion in cases of gastric and duodenal hæmorrhage does not appear to have been sufficiently recognised, and, in this connection, I should like to quote the results obtained by Ottenberg and Libman, who record fourteen cases of gastric and duodenal ulcer, all of which were in desperate condition from severe anaemia and progressive hæmorrhage at the time of the transfusion. Twelve of the fourteen cases recovered, the remaining two cases dying from peritonitis or complications of laparotomy. These observers were struck by the fact that in almost all of the cases the hæmorrhage stopped after the transfusion.

As regards the relation of transfusion to the recurrence of secondary hæmorrhage in septic cases, my impression is that,
when large arterial trunks are involved, the subsequent immunity of the patient from fresh hæmorrhages depends almost entirely on the elimination of the local sepsis. If the septic condition of the wound does not rapidly yield to antiseptic treatment, fresh hæmorrhages may occur, possibly hastened by the increased arterial pressure and improvement in the health following transfusion. Other things being equal, the transfusion undoubtedly will speed up the reparative process, which unfortunately is slower in the coats of the infected artery than in the surrounding tissues. Frequently in these cases the artery may be found buried in healthy granulation tissue, and yet, when it is ligated for a secondary hæmorrhage, the vessel wall is still soft and friable. The infection seems to cling to the stumps both of ligated arteries and of nerve trunks after the surrounding parts have become clean and healthy.

In chronic cases of sepsis, associated with repeated small hæmorrhages, transfusion may stimulate the patient's power of resistance, and indirectly prevent subsequent bleedings; but, as far as I have seen, the local treatment is the important factor in the prevention and arrest of hæmorrhage due to sepsis.

CONCLUSIONS REGARDING THE VALUE OF TRANSFUSION OF BLOOD IN CASES OF PRIMARY AND SECONDARY HÆMORRHAGE.

1. Transfusion is frequently life-saving, when other treatment for the constitutional effects of hæmorrhage has failed.
2. It diminishes the amount of shock during operations on exsanguinated cases.
3. It has a restorative effect in cases suffering from the combined effects of hæmorrhage and shock, either traumatic or operative, when other treatment has failed.
4. It can raise and maintain the blood-pressure, and restore patients suffering from severe shock, when other treatment for shock has failed.
5. It is less effective in cases of pure shock than in cases of hæmorrhage.
6. The immediate response to transfusion is as pronounced in cases of secondary hæmorrhage as in primary hæmorrhage.
7. Transfusion may improve the patient's resistance to infection, and indirectly hasten healing of septic wounds.

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8. Transfusion has a specific action in hæmorrhagic disease of the newly-born, arresting the hæmorrhage, and permanently restoring the patient to health.

9. Transfusion has a specific action in hæmophilia, and is the most certain means of arresting bleeding in this disease. Immunity against recurrence of hæmorrhage is conferred for a variable time.

10. Transfusion may temporarily diminish the tendency to hæmorrhage in cases of purpura hæmorrhagica, but there is little evidence that it can materially alter the course of the disease.

11. Transfusion will, in certain cases of secondary anæmia, associated with repeated small bleedings, favour the natural arrest of hæmorrhage.

12. Transfusion may save life in cases of uncontrolled gastric or duodenal hæmorrhage, and in such cases encourages the arrest of bleeding by improving the quality of the clot.

13. When the bleeding has ceased spontaneously, the transfusion of a moderate amount of blood is unlikely to excite fresh hæmorrhage.

14. The local treatment of septic wounds is the most important factor in preventing a recurrence of secondary hæmorrhage, and transfusion can only indirectly diminish the risk of bleeding.

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