AUTO BLOOD TRANSFUSION IN GYNECOLOGY

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IN THE literature of blood transfusion I have found several references to the replacement of blood by British surgeons in India some fifty years ago in a case of ruptured spleen. I have not been able to find the name of the surgeon or surgeons, and I do not know whether this measure was employed in more than one instance. It would seem probable that the conception of reinfusing blood lost by hemorrhage was known in England at that time, for there is an article in the *London Lancet* in 1874, by Mr. William Highmore, F.R.C.S., Senior Surgeon to the Yeatman Hospital in Sherborne, suggesting that blood might be reinjected after hemorrhage, and saying that he had lost an obstetric case by hemorrhage and in a similar case that he would collect the hemorrhagic blood of the woman and "after it was defibrinated and warmed to the proper temperature by a clinical thermometer over a hot water-bath that he would inject it with a Higginson syringe and transfusion pipe."

Kubányi of Budapest says that the idea of auto blood transfusion originated with William Highmore. The practical application of this suggestion must have taken place not long after for in the *Edinburgh Medical Journal* in 1885-86, A. G. Miller, F.R.C.S., Surgeon to the Royal Infirmary and Lecturer on Surgery in Edinburgh reports a "case of amputation at hip joint in which reinjection of blood was performed and rapid recovery took place." Eleven ounces of blood was reinjected by Dr. Duncan. Two extremely interesting articles by Dr. Duncan on auto blood transfusion in amputations are in the British Medical Journals of 1885 and 1886. Dr. Duncan in his first report says that "The importance of a few ounces of blood in cases of collapse can hardly be overestimated." He added 5 per cent of phosphate of soda, 1 part to 3 of blood, which he said was first done by Braxton Hicks on the recommendation of Dr. Pary. In the second paper is a word of caution not to "neglect stringent precautions needful to avoid the contingencies of septicity and embolism and lest it should fall into discredit from too wide an application." He adds "I advocate it as perfectly sane and capable of saving many lives in the major operations of surgery. I make it a routine practice in all the larger amputations because there is no risk and every ounce of blood is serviceable, to my own mind the principle of reinfusing the patient is now definitely established." In spite of the favorable results obtained the "reinfusion" of blood seems not to have been widely practiced in England as few references to it occur later.

The recent use of a patient's own blood for an infusion dates from 1914 when Johannes Thies of Leipsic reinjected the blood in three patients each one of whom had had a severe abdominal hemorrhage following a ruptured tubal pregnancy, and each patient made a good recovery. Thies had previously examined bacteriologically several specimens of blood taken from the abdominal cavity in similar cases of hemorrhage, and found the blood to be sterile and the red cells uninjured. In the

first case salt solution was mixed with the blood in the proportion of 3:2 and the solution was given in the thigh. In the second case it was given in a vein in the arm, and in the third case in a vein in the omentum. Thies reports these three cases in Zentralbl. f. Gynäk., 1914, but was unable to continue as he was soon called to the front where he remained as assistant surgeon throughout the war. Auto blood transfusions were performed, however, in the Leipsic clinic by Lichtenstein who reported in 1915 that eight more patients had had auto blood transfusions for hemorrhage in ruptured tubal pregnancy with excellent result in each case. In 1918 and 1919 Lichtenstein described the technic, which he had now used successfully for 39 cases, and said that now "no woman operated upon because of tubal ruptured ought to die from hemorrhage without an auto blood transfusion." The method was now being used in several "frauen" clinics in Germany with nearly universal approval. In 1920 Döderlein wrote enthusiastically of the result in 5 cases of his, giving to Thies the credit for the discovery of the method which he says is so strikingly simple, and so wonderful in its results. Goder quotes Döderlein as saying that "many certainly hopeless cases had been completely restored to life by auto blood transfusion." From now on there were frequent reports in German literature of transfusing a patient with her own blood following an abdominal hemorrhage from tubal pregnancy.

Writers differ, however, as to the term to use to describe this measure. In 50 reports 32 of the writers employ the words "auto blood transfusion," 9 use the term "auto blood infusion" and the other 9 call the practice a "reinfusion," "injection," "reinjection," "retransfusion," "replacement." This seems a needless confusion of terms. Webster defines the term transfusion as follows: "To pour out of one vessel into another." If to transfusion we apply the prefix auto blood (meaning a patient's own blood returned to his circulation after a hemorrhage) we have a term that describes the transfusion and also differentiates it from the donor blood transfusion.

The first account that I have found of auto blood transfusion in this country was made by White Nov. 29, 1920 and reported in *Surgery, Gynecology and Obstetrics*, March, 1923. This patient had a rupture of the liver and was given 500 c.c. of his own blood (citrated) and made a good recovery. White used a Balfour aspirator to collect the blood and states that he had only 2 reactions in this and the 5 transfusions made subsequently.

Davis in 1922-23 reports a case of punctured wound of the spleen given 600 c.c. of his own blood in September, 1922. The next report is in *Surgery, Gynecology and Obstetrics* in 1923 by Burch, who made an auto blood transfusion in 1922 after removing a spleen, and states he has used this measure in 3 other cases (2 ruptured tubal pregnancies and 1 nephrectomy) successfully. Burch gives a bibliography and résumé of many of the early cases. He says that since 1914 there have been 164 cases of auto blood transfusion reported in European literature but only 4 were reported from outside Germany. Two deaths occurred, "one resulted from a technical error, one from hemoglobinuria." In conclusion Burch says that he believes auto transfusion a most valuable procedure in certain cases. This same year and also in *Surgery, Gynecology and Obstetrics*, Sir William Taylor, the regius professor of Surgery in the University of Dublin, describes on the editorial page of the September number his "*Auto Infusion of Blood from the Spleen in Cases of Splenectomy*," and Dr. William J. Mayo in another editorial that month, in writing of a visit to Dublin, says that Sir William immediately transfuses the free blood in the spleen to the patient. The next report of the use of a patient's own blood for transfusion is the extremely interesting account by Dr. Harvey Cushing at the Peter Bent Brigham Hospital and Dr. Loyal E. Davis, formerly Fellow of the National Research Council. Out of 285 major neurologic operations in the

clinic blood replacement was carried out 23 times. Briefly stated, the blood was collected by a water suction apparatus, filtered through gauze and then allowed to flow by gravitation into the basilic vein in the arm. In commenting the writers say "There can be no question, however, but that the proportion of these admittedly formidable operations which have required more than one stage for their completion has been considerably cut down by the judicious use of this procedure"—and to quote again, "It is a source of comfort to a surgeon, in the emergencies which may arise from an undue lowering of pressures, to know that there is ready at hand an infusion fluid which is fairly rich in the more essential blood elements, a fluid which requires no grouping," etc.

The technic now to be described of collecting a patient's own blood lost during an operation and later returning it to her veins was developed with the idea of salvaging the large amount of fluid blood found in the abdomen at the time of an operation for a ruptured tubal pregnancy. It has always seemed illogical to throw away a patient's blood, and then institute a frantic search for a donor to supply blood, for even though the blood is of the same type and is compatible, still we know that a severe reaction sometimes follows. A distinguished pathologist of this city exclaimed, "That is not surgery!" when he saw an operator throw away the specimen he had just removed from an abdomen. Perhaps we may say to throw away good blood is not surgery. It seemed that if we had a way to quickly collect and return the blood to the patient's veins that we might not need to make the more difficult blood transfusion and so avoid a reaction that is more apt to follow the injection of a donor's blood than the patient's own blood. The work of Levine and Segall at the Royal Victoria Hospital in Montreal has proved that reactions more often occur after a blood transfusion which has been given to a patient in the first twenty-four hours following an operation, owing to the changes produced in the blood by the anesthetic.

For a year I kept in the operating room sealed sterile ampoules of 2 per cent sodium citrate solution ready for an auto blood transfusion in ruptured tubal pregnancy, but the frequent change of personnel in the intern and nursing staffs made it impossible to secure all the help needed for the transfusion, when the operation itself demanded my entire attention. I concluded that teamwork could be attained only by frequent practice of the technic on the simpler cases and arranged to try this measure in clean hysterectomies for myoma uteri. It was a surprise to me to find the transfusion so valuable. I had decided that the suction method we use to collect fluids from the abdomen was the best way to collect the blood flowing into the pelvis, as the ladle or cup which is used for large amounts of blood would be in the way here and sponges should never be used as the squeezing out of the blood injures the red cells. Ten c.c. of sterile 2 per cent sodium citrate solution were placed in the sterile graduated suction bottle and blood drawn to the 100 c.c. mark. (This is the amount [2

per cent] used by Lichtenstein who has shown by experiment that 5 gr. of sodium citrate may be given safely to a patient, even though one returned 1000 c.c. of blood to a patient the amount of a 2 per cent solution would be only 2 gr.) The bottle was then removed and a similar bottle containing the same amount of sterile sodium citrate solution was connected and suction begun again. The 100 c.c. of citrate blood was then poured through 20 thicknesses of gauze wet with sterile normal salt solution. The gauze lay on the top of a sterile funnel which was in a sterile flask standing in a bowl of hot water. Five times as much sterile normal salt solution (105° F.) as sodium citrate solution (i.e., 50 c.c.) was poured over the blood which was then covered to prevent aeration and allowed to filter. Care was taken not to stir nor shake the blood to avoid injury to the red cells. The blood thus collected was then given by gravity method into the median basilic vein in the arm. (In cases of shock if the veins in the arm are collapsed the blood may be given with a syringe into a vein in the omentum or into the deep epigastric vein in the abdominal wall.) I did not know, until I had given blood to several patients by this method, that Dr. Harvey Cushing had collected blood by suction and given it by this same gravity method. In the first cases transfused a specimen of the blood collected by suction was sent at once to the pathologist, who reported in each instance that the erythrocytes had not been injured by the suction method of collecting the blood. The first ten consecutive cases will be reported in the order in which they were operated upon. Auto blood transfusion was planned only for clean cases that had very large myomata uteri, and when a difficult operation was anticipated either because of the size or the location of the tumor, or some condition of the patient, such as obesity or anemia. Gum glucose solution was given in nearly every case as has been my practice for several years, when it was especially desirable to maintain blood pressure, as in a poor risk patient or in a long operation. Two hundred and fifty to 300 c.c. of the gum glucose solution were usually given and the blood pressure readings were taken just before the patient left the operating room, and after the blood had been injected into a vein. As it happened the first case needed the blood transfusion more than I had anticipated.

Case 1.—Mrs. R., No. 42017. Operation Nov. 23, 1928 for a large blood cyst. Numerous coils of intestine were firmly adherent over the tumor. There were 250 c.c. of blood collected in 25 c.c. of 2 per cent sodium citrate solution and 125 c.c. of normal salt solution were added. The patient left the operating room with blood pressure 124/70. Pulse 96, respiration 36. There was no reaction of any kind and the convalescence was absolutely normal. It was a great comfort to know while operating that the blood would be replaced at once and this permitted slower, more careful dissection of the intestines from the tumor, than would have been justifiable if blood had not been available.

CASE 2.—Mrs. W., No. 42110. Operation December 10, 1928. Hysterectomy for myoma uteri the size of a three and one-half months' pregnancy. As the clotting time was seven minutes, forty-five seconds, it seemed that an auto blood transfusion might be of help. But the bleeding was slight and only 25 c.c. of blood were collected, but this was given together with 50 c.c. of sodium citrate solution. This excess amount of sodium citrate was given by an assistant through a misunderstanding of the technic. The patient left the operating room with blood pressure 122/68, pulse 88, respiration 28. One hour after returning to her room the patient had a slight general tremor and dusky color, due, I believe, to the excess of sodium citrate solution. A hypodermoclysis of 1000 c.c. of normal salt solution was at once given. The tremor had subsided before the needles were introduced and the color promptly returned to normal in a few minutes. This was the only case that had any reaction whatsoever following auto blood transfusion.

CASE 3.—Mrs. M., No. 40643. Operation Jan. 15, 1929. Hysterectomy for vascular myoma uteri size of five months' pregnancy. This patient had been transfused several days before the operation because of secondary anemia, and as often happens after a recent transfusion she bled freely. There were 200 c.c. of blood collected, 20 c.c. of sodium citrate solution, 100 normal salt solution. The patient left the operating room with blood pressure 132/68, pulse 96, resp. 28. The blood count is of interest as it shows no secondary fall in the number of erythrocytes but an appreciable gain a few days after the auto blood transfusion which is contrary to the usual drop seen after donor's blood has been given. The preoperative count taken Jan. 12, 1929 (three days before operation) was 4 600,000 and 76 per cent hemoglobin; Jan. 16, 1929 (one day postoperative), 3,550,000, 74 per cent hemoglobin; Jan. 21, 1929 (six days postoperative), 4,000,000, 72 per cent hemoglobin.

CASE 4.—Mrs. R., No. 42255. Patient forty-six years, frail type, hemoglobin 40 per cent on entrance to the hospital (after blood transfusions 82 per cent). Operation Jan. 21, 1929, hysterectomy for myoma uteri extending 3 inches above the umbilicus. There were 175 c.c. of blood, 20 c.c. of sodium citrate solution, 100 c.c. normal salt solution. The patient left the operating room with blood pressure 150/72, pulse 100, resp. 28. The convalescence in this case was remarkably smooth for such a frail patient and showed not only a maintenance of the blood but some increase four days postoperative. The blood count was as follows: Jan. 17, 1929 (four days before operation) 4,450,000, 82 per cent hemoglobin; Jan. 25, 1929 (four days postoperative), 4,460,000, 80 per cent hemoglobin.

CASE 5.—Mrs. B., No. 42320. This patient was fifty years of age and had a large myoma above the umbilicus, a cystocele and rectocele. As the plastic operation as well as the hysterectomy was necessary it was thought best to save as much blood as possible. The hysterectomy proved to be a simple one, however, and only 30 c.c. of blood were collected; blood 30 c.c., sodium citrate 10 c.c., saline 150 c.c. The blood pressure after operation was 110/76, pulse 98, resp. 38.

CASE 6.—Mrs. M., No. 33476. Operation Feb. 28, 1929. Hysterectomy for an extremely vascular myoma the size of a five months' pregnancy. There were 175 c.c. of blood collected, 20 c.c. of sodium citrate solution, and 100 c.c. of normal salt solution. The patient left the operating room with blood pressure of 128/72, pulse 120, resp. 28. Absolutely no reaction and a smooth convalescence except for a mild pyelitis which the patient had had a year previous to the operation. The blood count was as follows: Feb. 27, 1929 (day before operation) 4,840,000, hemoglobin 88 per cent; March 6, 1929 (seven days postoperative) 4,480,000, hemoglobin 85 per cent.

CASE 7.—Mrs. R., No. 42517. This patient was forty-seven years of age, hemoglobin 43 per cent from repeated hemorrhages. She was transfused twice before operation. Operation Feb. 2, 1929. Hysterectomy for hyperemic myoma extending nearly to the umbilicus and into both broad ligaments. The rectum and sigmoid were densely adherent posteriorly and the bladder high on the anterior wall. It was necessary to split the capsule and shell the tumor out. The abdominal wall was unusually fat. The difficulties of this operation and the vascularity of the tumor made the auto blood transfusion of real value. There were 275 c.c. of blood collected, 30 c.c. of sodium citrate solution, and 200 c.c. of normal salt solution. The patient left the operating room with blood pressure 150/88, pulse 94, resp. 38. The blood count was as follows: Jan. 28, 1929 (five days before operation) 4,200,000, 70 per cent hemoglobin; Feb. 7, 1929 (five days after operation) 4,150,000, 65 per cent hemoglobin.

CASE 8.—Mrs. K., No. 42852. Operation March 28, 1929. Hysterectomy for myoma. The rectum was densely adherent to the tumor. Hemorrhagic cyst the size of an orange in the broad ligament; blood 120 c.c., 2 per cent of sodium citrate 40 c.c., saline 200 c.c. Postoperative blood pressure 135/25. March 25, 1929, 4,050,000, 72 per cent hemoglobin (three days before operation). March 30, 1929, 3,580,000, 70 per cent hemoglobin (two days after operation).

CASE 9.—Mrs. Y., No. 42682. Operation March 15, 1929. Hysterectomy for myoma uteri the size of a four months' pregnancy with left broad ligament myoma the size of a golf ball. There were 135 c.c. of blood collected, 2 per cent sodium citrate solution 15 c.c., normal salt solution 140 c.c. Patient left the operating room with a blood pressure of 122/86. The blood count was as follows: March 11, 1929, 4,850,000, 85 per cent hemoglobin (four days before operation); March 16, 1929, 4,200,000, 80 per cent hemoglobin (one day postoperative); March 18, 1929, 3,590,000, 75 per cent hemoglobin; March 20, 1929, 3,890,000, 75 per cent hemoglobin.

CASE 10.—Mrs. C., No. 42740. Operation March 26, 1929. Hysterectomy for myoma the size of a four months' pregnancy with a myoma filling Douglas' culdesac and a parovarian cyst the size of a grapefruit. There was very little bleeding and only 15 c.c. of blood were collected, 10 c.c. of 2 per cent sodium citrate, 100 c.c. saline. Blood pressure 144/96. Blood count March 18, 1929, 4,200,000, hemoglobin 82 per cent.

Of these first 10 cases to whom auto blood transfusion was given because of anticipated bleeding there were 3 who lost only a negligible amount of blood (15 to 30 c.c.), 4 lost from 120 c.c. to 175 c.c. and 3 lost from 200 c.c. to 275 c.c. It is not in the least likely that any one of the patients would have died without this transfusion but for Cases 1 and 3 I might have ordered a donor blood transfusion and I certainly would have for Case 7. The convalescence was so smooth for every patient it was a pleasure to see the result. It is of interest to note that 3 patients receiving 175 to 275 c.c. of blood had no secondary fall in red cells as commonly occurs after a donor blood transfusion. The first and sixth patients unfortunately did not have a count made early enough to show whether this would have been so or not.

CASE 11.—Mrs. P., No. 42768. Reported through the kindness of Dr. Ward. This was a diabetic patient who had a fibroid extending to the umbilicus and pressure symptoms necessitating its removal, and mild anemia. Operation March 22, 1929. Hysterectomy. There were 140 c.c. of blood collected, 2 per cent sodium citrate 20 c.c., normal saline 300 c.c. The patient was in such an absolutely satisfactory condition at the end of operation that the donor blood transfusion, which had been ordered, was deferred until twenty-four hours later, to avoid a possible reaction due to changes in the blood produced by the anesthetic. The blood count

was as follows: March 19, 1929, 3,850,000, 65 per cent hemoglobin; March 21, 1929, blood transfusion, 500 c.c., donor blood; March 25, 1929, 4,600,000, 86 per cent hemoglobin.

CASE 12.—Mrs. K., No. 42694. I am reporting this case with the kind permission of the surgeon who is on the courtesy staff of the hospital. The patient was taken to the operating room because of a secondary hemorrhage. It was impossible to get the blood pressure when she arrived there. "The abdomen was tensely distended with large amount of fluid blood and clots. The fluid blood (400 c.c.) was aspirated from the abdomen, citrated, filtered and mixed with gum glucose solution and preparation made for infusion into a vein in the arm. As the patient's veins were completely collapsed it was necessary to cut down on the vein before the needle could be introduced. The bleeding point was clamped and at the same moment the patient ceased breathing and was pulseless. Adrenalin was immediately administered and artificial respiration begun; by this time the infusion started, and as the infusion solution entered the circulation the pulse promptly responded. The wound was closed and on the arrival of the donor 500 c.c. of blood were given to the patient in the other arm." She left the operating room with a blood pressure of 126/70 and made an excellent convalescence. There were 400 c.c. auto blood and 225 c.c. gum glucose solution. The blood count was as follows: March 11, 1929 (day before the first operation), 4,650,000, 85 per cent; March 13, 1929 after 400 c.c. auto blood transfusion, 500 c.c. donor blood transfusion, 4,000,000, 70 per cent hemoglobin.

The surgeon told me that "there was absolutely no pulsation in the abdomen when the infusion started" and that he believed "the patient never would have recovered without the gum glucose solution and auto blood transfusion." The technic could not have been carried out in such a grave emergency if the staff had not been trained to teamwork in the simpler cases. One such patient saved would be well worth the time and effort spent to train the interne and nursing staff.

There is very little equipment needed. Every operating room should have a suction apparatus to collect fluid. It need not be an expensive electric driven motor, as tubing connected to a double faucet produces sufficient suction by running water. Sealed sterile ampoules of 2 per cent sodium citrate solution are not expensive and keep indefinitely. *Teamwork is essential.* It is necessary not only to explain the technic to the staff but they must practice it often enough on simpler cases so that in an emergency operation they are competent to make the transfusion without instruction from the operator. The order "Auto Blood Transfusion" ought to mean the suction tube in the abdomen, and citrate solution in the graduated bottle ready to begin suction two minutes after the order is given. An auto blood transfusion does not interfere in the least with the operation. The sterile suture nurse changes the bottles and filters the citrated blood. The second assistant manages the suction tube and can drop out at the end of the operation and inject the blood, or a third assistant can give the blood during the operation if desired. If he has been giving gum glucose solution the blood is simply poured into this. In teaching the staff one should caution them. (1) *Never to use stagnant nor clotted blood nor blood if there is any suspicion of infection in the pelvis or abdomen.* (2) Ten c.c. *of a sterile 2 per cent* sodium citrate *solution*

should be used with *each 90 c.c. of blood* to prevent *coagulation,* and 5 times as *much sterile normal* salt solution should be used as *sodium citrate solution,* more salt solution may be added if desired to offset the loss of body fluids.

The advantages of an auto blood transfusion are:

1. It lessens or prevents shock by supplying immediately blood to the circulation at a time when every ounce of blood counts.

2. It obviates the delay necessary to find a donor and type and match the blood.

3. It supplies a compatible blood and thus avoids a reaction due to the incompatibility of the donor's blood with the recipient resulting from changes in the recipient's blood produced by the anesthetic.

4. The ease and simplicity of this method make it possible to give it to patients for whom one would hesitate to order a donor blood transfusion.

CONCLUSIONS

1. Auto blood transfusion may be a valuable aid in difficult clean pelvic operations accompanied by hemorrhage.

2. Auto blood transfusion may be a life saving measure in emergencies if the intern and nursing staff are thoroughly trained to carry out this technic in the simpler cases.

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DISCUSSION

DR. A. M. CAMPBELL, Grand Rapids, Mich.—The patient who is markedly anemic before the operation, the patient who loses a considerable amount of blood during the operation and the one who is unfortunate enough to suffer from postoperative hemorrhage should be transfused.

The method of giving this transfusion as presented here appeals to me because it can be carried on without interfering with the surgeon's major task.

Dr. Farrar's case reports refer generally to the use of autotransfusion in hysterectomy for fibroids. While it is undoubtedly of use in these cases, it seems to me that it achieves its greatest triumph in intraperitoneal hemorrhage which has occurred before the patient comes to operation and notably so in ectopic pregnancy with rupture. My own experience with autotransfusion was in a case of ectopic pregnancy which was not diagnosed until the tenth day. The transfusion was without incident and, inasmuch as some of the blood must have been in the free peritoneal cavity for at least ten days, I think it bears out the fact that the length of time that the blood remains in the peritoneal cavity before the transfusion is not an extremely important factor.

DR. GEORGE GRAY WARD, New York, N. Y.—It has been with a great deal of satisfaction that the staff of the Woman's Hospital has seen this work of Dr. Farrar perfected in the development of the technic and training of the personnel, and in several instances it has undoubtedly proved life saving. The whole crux of the thing as I see it is that while we may say we intend to use auto blood transfusion when we have a case that needs it, unless we have made preliminary preparations not only with regard to the apparatus but also the constant training of the staff in the use of it, we will fail in getting the full benefits that should come from it through delay and confusion when minutes are precious.

In our operating rooms we have always set up for every operation the infusion apparatus because we use intravenous infusions of gum-glucose very frequently in cases where we expect difficulty or cases that show a tendency to shock, very often as a preliminary to later blood transfusion so that this apparatus is always available and ready for immediate use, and all our interns are experts in putting a needle in a vein, and can use this apparatus without any trouble.

In the case of a large vascular fibroid there may be a large amount of blood lost in removing the growth, although you may be very skillful; and if the apparatus is ready for instant use, this can be returned to the circulation with marked benefit. This means that the staff must be quite accustomed to the technic so that they can do it without delay, and this requires preliminary practice in the simple cases. In other words, it means constant practice on the part of the staff and the nurses to be ready for the serious case.

DR. LILIAN K. P. FARRAR (closing).—I would like to speak of just one thing and that is of training the intern staff. It has been Dr. Ward's practice to use blood transfusions before operation and especially for the large number of debilitated cancer patients. The interns have become very expert. In auto blood transfusion, enthusiastic young interns trained in the procedure are a tremendous help. Several of our ex-interns are now giving blood transfusions in other cities and are able to do so because of the training they received and the keenness and interest they developed.