AUTOTRANSFUSION :

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Blumdell was the first to report the use of autotransfusion. In 1818, he used vaginal blood in 10 cases of severe postpartum hemorrhage with a resulting mortality of 50%[1]. Brainard, in 1860, autotransfused blood collected from a leg amputation[2]. In 1874, Dr. William Highmore suggested the use of autotransfusion after the unsuccessful treatment of a case of postpartum hemorrhage[3]. The same year, Hueter autotransfused 350cc of blood into the left posterior tribial artery in a case of frost-gangrene and attributes the survival of the foot to this procedure[4]. In 1883, William Halsted reported an interesting concept of autotransfusion as treatment of carbon monoxide poisoning[5]. In 1886, John Duncan and A.G. Miller published separate papers on autotransfusion during amputation procedures[6,7].

Additional cases were not reported until Theis, in 1914, successfully used autotransfusion in cases of ruptured ectopic pregnancy[8]. In 1917, almost 100 years after Blumdell's first report, Lockwood autotransfused blood obtained from the spleen of a patient with Banti's Syndrome, the same year Elmendorf became the first surgeon to use autotransfusion in a case of hemothorax[9,10]. In 1925, the classical paper by Harvey Cushing employing autotransfusion in 23 major intracranial operations was published[11].

Since that time, periodic examples of autotranfusion have appeared in the literature. In 1929, Butler reported on its use in two cases of ruptured tubal pregnancy[12]. In 1931, Ricci and DiPalma reported a summary of 282 cases in ruptured ectopic pregnancies collected mostly from German literature and disclosed that the mortality rate was the same as that of 869 cases which were not treated with autotransfusion[13]. In 1934, Tiber reported its use in 373 cases of ruptured ectopic pregnancies[14]. Watson and Watson, in 1936, reviewed the American literature and added two cases of their own[15]. In 1943, Negovski reviewed the Russian literature and in 1946,

NEW OR USED ?

Lefebure published on autotransfusion in the treatment of asphyxia, electrocution, drowning and carbon monoxide poisoning[16 17]. Since that time, autotransfusion has been reported by various authors in various surgical situations. One last report should be included. In 1956, Eteuati Leiato, a Samoan medical practitioner on the island of Manua autotransfused 1,000 to 1,500 cc of the patient's blood in a case of placenta previa. The patient and child survived[18].

This brief historical review points out the fact, indeed, that autotransfusion is not a new or novel technique. It indicates also that sophisticated technology is not necessary for the employment of the technique. One might wonder why autotransfusion has been in the literature for 150 years, but has never gained general acceptance or popularity.

Autotransfusion has been employed at the Texas Heart Institute for the past year on an emergency and elective basis. Unusual occurrences in January, 1973, gave us cause to question the procedure and to evaluate its usefulness.

Materials and Methods

In the autotransfusion system used, two Sarns roller pumps were employed. One pump had been modified so as to have 60% faster rpm. The faster pump was used for the suction and the normal pump used to re-infuse blood. Blood was suctioned through a dacron wool filter into a cardiotomy reservoir and from the reservoir the blood was pumped into a vein.

In this initial investigation, ten patients were selected who were to undergo surgical correction of distal aorto-occlusive disease. Seven patients underwent resection of aortic abdominal aneurysm and graft replacement and three patients had femoral bifurcation grafts. The patients ranged in age from 54 to 73 years, and the mean age was 64 years. Their weights ranged between 67 and 100 kilograms, the mean being 79 kilograms. The amount of blood suctioned during the procedure ranged from 30cc to 1800cc. The average volume of blood salvaged was 570cc. The patients were heparinized with 200 units of heparin per kilogram. Control blood samples were drawn just after heparinization (Fig. 1).

Figure 1. The patient distribution.

AGE	63.9 (54-73)	WEIGHT (kg)	79.3 (67-100)

ABDOMINAL AORTIC ANEURYSM	7
AORTO-FEMORAL BYPASS GRAFT	3

SALVAGED BLOOD (ml) (Range)	670 (30-1800)

The following laboratory determinations were made on the control blood samples and on the salvaged blood: plasma hemoglobin, serum haptoglobin, euglobulin lysis time, fibrin split products, fibrinogen, hemoglobin, hematocrit, white blood count, mean corpuscular volume, platelet count and reptilase times.

Autotransfusion: New or Used?

Results

The mean patient white count was 8,660 and of the salvaged blood, 3,650. The platelet count averaged 213,900 and of the salvaged blood, 95,140. Mean plasm hemoglobin rose from 5.3 mg% to 633 mg%, while serum haptoglobin mean value decreased from 158 to 35. These results are what one would anticipate from red cell damage and hemolysis. A small percentage of the decrease in leukocytes and platelets can be attributed to the use of a dacron wool filter. The serum free haptoglobin, of course, is in direct relationship to the free plasma hemoglobin. One would expect a low to absent serum haptoglobin level with increasing plasma hemoglobin (Fig. 2).

The patients' hemoglobin decreased from a mean value of 12 gm to 6.6 gm in the salvaged blood. The mean hematocrit decreased from 35% to 19% and the mean corpuscular volume increased from 87.9 to 94 (Fig. 3). During surgery, an average of 570cc of blood was salvaged, representing 37.6 gm of hemoglobin salvaged. Compared to a mean expected total circulating hemoglobin value of 627 gm for the group, only 5.9% of the patients' total hemoglobin was salvaged. The serum haptoglobin and plasma hemoglobin values reflect significant hemolysis which we feel is due to red cell damage secondary to extravasation, suction, and pumping through the extracorporeal circuit.

Fibrinogen decreased from 647 mg to 138 ml/100 ml. Reptilase increased from 3.9 to 59.1 seconds. Platelet count was reduced from 213,000 to 95,140. These values reflect loss of coagulation factors and platelets which in all probability is due to coagulation. This may be in the form of microthrombi or gross clot formation (Fig. 4).

Euglobulin lysis time decreased from a mean time of 117 minutes to 11 minutes. The mean titer of fibrin split products in salvaged blood determined by the TRCHII method was 86, whereas the mean titer was 11.8 when employing the staphyloccal clumping test. Pre-operative samples were not obtained. Analysis of the values reveals evidence of minimal fibrinolysin production as there is a borderline euglobulin lysis time and evidence of abnormal amount of fibrin split products, which are regarded as secondary to plasminogen activation with plasmin acting on fibrinogen and possibly fibrin (Fig. 5).

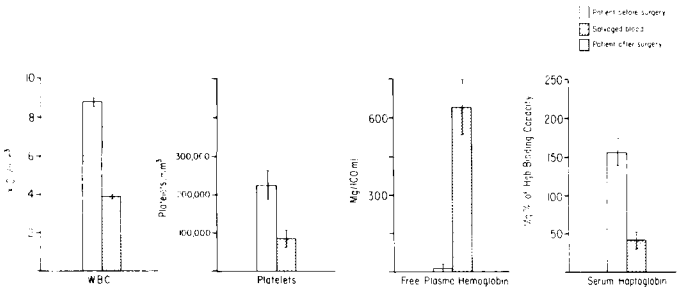


Figure 2. Changes of the white count, platelet count, free plasma hemoglobin level, and free serum haptoglobin levels.

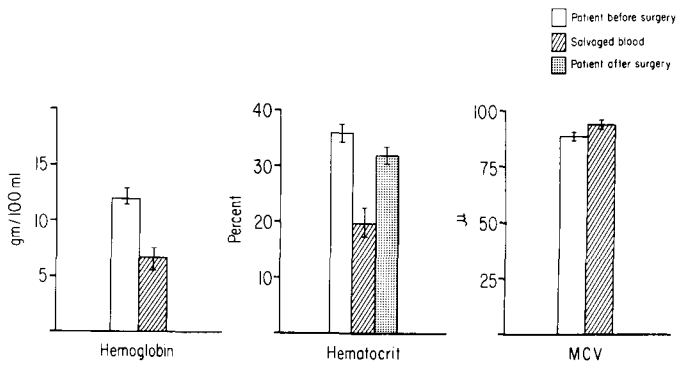


Figure 3. Changes in the total hemoglobin, the hematocrit, and the mean corpuscular volume.

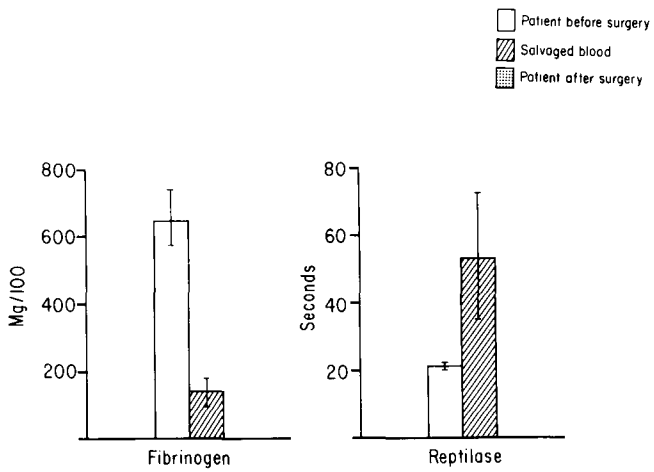


Figure 4. Changes in fibrinogen and reptilase.

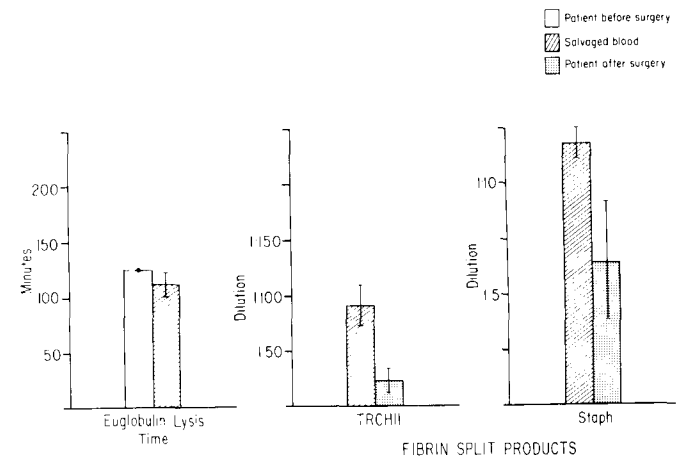
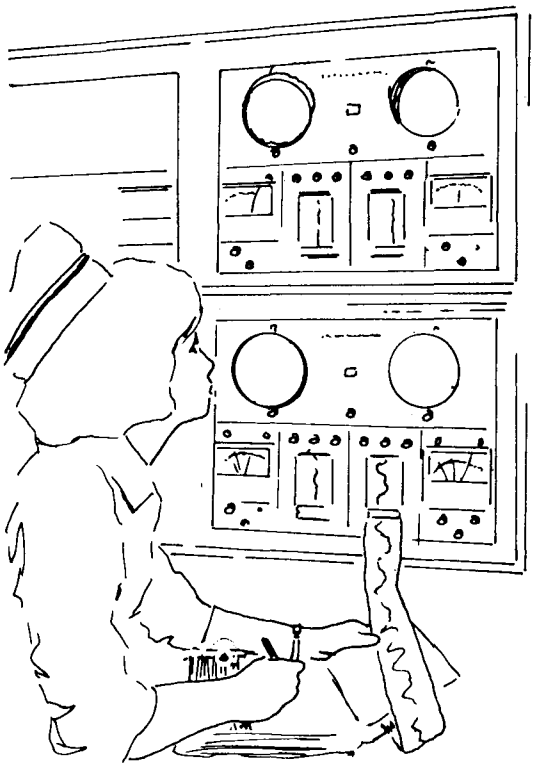


Figure 5. Changes in euglobulin lysis time and fibrin split products by tanned red cell hemaglutination inhibition immunoassay and staphylococcal clumping methods.

Autotransfusion: New or Used?



Discussion

The laboratory studies indicate that the administration of the blood salvaged in these cases would have been of very little benefit. From limited clinical experience performed during this initial investigation of autotransfusion, we must conclude as did Watson and Watson in 1936, that "In spite of the excellent results obtained in the majority of cases, the occurrence of reactions, some of which may prove fatal, should limit the use of autotransfusion to those cases in which the demand for blood is urgent and in which there are no contraindications imposed by the age or the source of the blood"[15].

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