

## FLUID THERAPY BEFORE AND AFTER OPERATION \*

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THE administration of parenteral fluids to patients undergoing surgical procedures has all too frequently been used in an empiric manner without due regard as to the amount or type of fluid indicated. The purposes of this paper are to call attention to some simple fundamental principles which should be kept in mind when using parenteral fluids, and to discuss the aid we have obtained in controlling fluid therapy by determining the hematocrit and specific gravities of whole blood and plasma.

The properly hydrated patient with a normal amount of hemoglobin is a better anesthetic risk than is the patient who is anemic, dehydrated, or hydrated to excess. It may be considered the duty of the anesthetist in certain situations that he recommend the amount and type of fluid to be administered to each patient. Frequently, the surgeon is unable to supervise this therapy as closely as he would like. Patients are benefited by this vigilance. The anesthetist acts as a "hold over" during the change of intern and resident staffs, and valuable time need not be lost or anxious moments experienced by surgeons because of a lack of trained personnel.

It has been long recognized that in most patients the need for administration of fluids can be determined by means of their urinary output. Normally, the kidneys excrete approximately 1500 cc. of urine daily, containing 35 grams of tissue waste. From 150 to 200 cc. of water is lost in the feces, 300 cc. in the expired air, and up to 1500 cc. from cutaneous surfaces. In all, the normal individual requires a total intake of 3000 to 3500 cc. daily. There are certain factors which will increase this basal requirement, such as an increase in internal or external heat. In the surgical patient a urinary output of from 1200 to 1500 cc. with a specific gravity of 1.010 indicates adequate fluid intake (1, 2, 3, 4, 5, 6, 7, 8). An output of from 600 to 1000 cc. with a specific gravity of 1.020 to 1.030 does not necessarily indicate the occurrence of dehydration since under these conditions the normal amount of tissue waste is excreted (9). If it is also kept in mind that the maximal daily requirement of sodium chloride is 10 grams, which is equivalent to 1200 cc. of normal saline, one will have a reasonably simple method for esti-

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inating the desirable amount or type of fluid intake (10). This method requires frequent determinations of the concentration of hemoglobin and the number of red blood cells to detect the presence of anemia. Unfortunately, these criteria are not sufficiently accurate to be a guide for therapy, nor are changing internal conditions sufficiently recognizable in patients who have suffered loss of blood or whose postoperative course is complicated by excessive vomiting, diarrhea, or loss of fluids from intestinal fistulae. In the presence of cardiorenal disease, a more accurate control of fluid therapy than can be obtained by following the methods described above is necessary. The fear of producing pulmonary edema often results in serious dehydration of the cardiac pa-

CHART 1  
NAME P. R. AGE 12. HOSPITAL No. E-5949

Date	Diagnosis	Duration of Illness	Pre-op. Fluids	Operation	Blood Studies	Interpretation	Post-op. Fluids	Result
12 29/40	Acute intestinal obstruction due to volvulus	4 hours	2000 cc. 5 per cent glucose in saline		10 a.m. 1.0638 Bl. 1.030 Pl. 7.86 T. P. 50% H	Marked dehydration		Patient very ill; toxic looking
				Reduction of volvulus	12 p.m. 7.6 T. P. 47% H			
					3 p.m. 1.0391 Bl. 1.0275 Pl. 7.01 T. P. 43% H	Excellent result from fluids. Patient in very much better condition for operation		Patient shows marked clinical improvement
12 31 40					8 a.m. 1.0506 Bl. 1.0255 Pl. 6.32 T. P. 33% H	Blood dilution. Fluids should not be forced		Clinically markedly improved  Patient maintained with fluids by mouth very satisfactorily

Dehydration accompanying acute intestinal obstruction and result of fluid therapy. Bl.—Blood specific gravity. Pl.—Plasma specific gravity. T. P.—Total protein. H.—Hematocrit.

tient. In some instances where there is an increased nitrogenous content of the blood and a decreased urinary output of low specific gravity, the question arises whether simple dehydration or renal insufficiency exists (11).

Scudder (12, 13, 14) has described a method for the control of fluid therapy which is simple, rapid, and accurate. We have adopted this method at the Beverly Hospital. The specific gravity of whole blood and of plasma is determined (15, 16, 17) and a hematocrit reading is obtained before or after surgical procedures in patients who are seriously ill, and in patients who are to undergo such procedures as resection of the stomach or bowel. By performing preoperative studies, it is frequently possible to choose the optimal time for operation.

Many investigators have determined the weight of blood (18, 19, 20, 21, 22) but it was not until 1924 that Barbour and Hamilton (15) presented a practical means of determining the specific gravity of whole blood by means of a simple laboratory test. The principle is based on Stokes' law, which states that the time required for a drop of known volume to fall a given distance through an immiscible fluid depends on the size and density of the drop and the viscosity and density of the fluid.

The apparatus used clinically (12, 15, 23) consists of a graduated pipette with a Guthrie holder which delivers a .01 ml. drop, and four tubes with two marks 30 cm. apart. These tubes are immersed in a water bath, and are filled with mixtures of xylene bromobenzene. A stop watch calibrated in one-tenth second determines the rate at which

CHART 2  
NAME L. A. AGE 28. HOSPITAL NO. E-2930

Date	Diagnosis	Duration of Illness	Pre-op. Fluids	Operation	Blood Studies	Interpretation	Post-op. Fluids	Result
7-4-40	Shock, post-traumatic. Fracture, compound, comminuted, of tibia and fibula. Fracture of tibia and fibula, right. Wounds of scalp and face			Low thigh amputation	Bl. Sp. Gr. 1.0446 Hematocrit 20%	Severe blood loss and obvious shock. Blood needed badly	Eachatin, 10 cc.  5 a.m. 400 cc. blood in 30 minutes 6 a.m. 500 cc. blood	
7-6-40					Bl. Sp. Gr. 1.0486 Hematocrit 25%	Persisting anemia		
7-7-40					Bl. Sp. Gr. 1.0501 Hematocrit 25%	Persisting anemia. Blood indicated		
7-8-40					Bl. Sp. Gr. 1.0442 26%	Persisting anemia. Blood indicated	500 cc. blood	
7-10-40					Bl. Sp. Gr. 1.0510 25%	Much improved	500 cc. blood	Patient considerably improved

Acute blood loss and shock. Blood specific gravities and hematocrits reveal good response to whole blood therapy.

the drop falls through the distance between the marks on the tubes. If the blood is believed to be normal or heavier than normal, a drop of it is allowed to fall in tube B<sub>1</sub> (specific gravity 1.0530). If the blood is anemic, a drop is allowed to fall in B<sub>2</sub> (specific gravity 1.0430). By means of a nomogram, the apparent difference in density between the unknown drop and the xylene bromobenzene is determined. The procedure is repeated with a standard of known specific gravity. The true difference in density between the unknown drop and the standard is then found by subtracting the lesser difference in density from the greater. The specific gravity of the standard is corrected for the temperature of the water bath by subtracting .0001 for each two degrees below 20 C. If the drop falls faster than the standard, it is heavier, and the true dif-

ference in density is added to the corrected specific gravity of the standard. If the blood falls more slowly than the standard, it is lighter, and the true difference in density is subtracted from the corrected specific gravity of the standard. In about two or three minutes the specific gravity of whole blood can be determined accurately to the fourth decimal place.

CHART 3  
NAME D. R. R. AGE 10. HOSPITAL NO. F-309

Date	Diagnosis	Duration of Illness	Pre-op. Fluids	Operation	Blood Studies	Interpretation	Post-op. Fluids	Result
1/20/41	Acute zosterous appendicitis with perforation	222 hours	1200 cc. 5% glucose in saline (none at home)	Appendectomy with drainage and oohemorrhization	RBC 4,500,000 WBC 17,000 Hemoglobin 85%			
1/21/41					Bl. Sp. Gr. 1.0513 Pl. Sp. Gr. 1.0302 Total Protein 8.27 Hematoerit 36%	(1) Anemia Hematoerit, Bl. Sp. Gr. (2) Dehydrated Total Protein. Advise fluids	I. 1760 Sal. and Glucose O 815 cc.	Clinically patient toxic but holding his own. T-101. P-120. R-24
1/22/41				Wound draining very slightly			I. 2280 G & H-O G & Sal. O 705 cc.	Patient restless. Abdominal discomfort. Sulfanilamide being given. Blood picture unchanged. RBC and WBC
1/23/41				Some evidence of pelvic abscess formation. Wound healing well. Moderate amount drainage	a. m. Bl. Sp. Gr. 1.0470 Pl. Sp. Gr. 1.0218 Total Protein 5.07 Hematoerit 34% (following saline glucose)	Fluids have been pushed so that patient's blood has been diluted. Total protein approaching edema level. Protein being lost into abscess. Hematoerit reveals anemia. Strong indication for blood transfusion	1500 cc. 5% glucose given. Blood studies done after	Clinical appearance of patient relatively unchanged
1/24/41					a. m. Bl. Sp. Gr. 1.0480 Pl. Sp. Gr. 1.0214 Total Protein 4.93 Hematoerit 34% immediately before blood		350 cc. blood	
1/24/41					a. m. Bl. Sp. Gr. 1.0560 Pl. Sp. Gr. 1.0240 Total Protein 5.81 Hematoerit 40%			Excellent result. Blood shows practically normal values. Clinically patient appears very much improved

Falling total protein and blood dilution. Danger of producing edema averted by stopping intravenous fluids and administering whole blood.

The specific gravity of the plasma is determined in the same manner, using the tubes marked P<sub>1</sub> or P<sub>2</sub>. If the plasma is likely to be normal or heavier, two drops of the sample are allowed to fall in tube P<sub>1</sub> (specific gravity 1.0230). If the plasma is lighter than normal, tube P<sub>2</sub> is used (specific gravity 1.0130). It is known that there is a constant relationship between the specific gravity of plasma and its protein content. Knowing the weight of the plasma and substituting in the formula  $P = 340.1 (G - 1.00687) \pm 0.103$ , the protein content can be easily deter-

mined (24). In order to eliminate this calculation, there is supplied a series of tables from which the protein content may be read following the determination of the specific gravity of the plasma. The accuracy of the test is doubtful, so far as protein is concerned, in the presence of severe diabetes, hypercholesterolemia, gross lipemia, and excessive bilirubinemia. The time required for this determination is two or three minutes.

To complete the laboratory procedure a hematocrit reading is obtained. Oxalated blood is placed in a Sanford hematocrit tube and centrifuged for thirty minutes. If an emergency exists, centrifuging for fifteen minutes will be sufficient. The hematocrit is read directly from the tube.

A hematocrit reading and specific gravity of blood and plasma increased above normal suggest a diagnosis of simple dehydration or early shock, without hemorrhage. One cannot stress too strongly the necessity of knowing the patient's clinical condition as regards the existence of diarrhea, vomiting, intestinal fistulae, and type of operative procedure performed, as well as its duration. The treatment for dehydration is simple, and requires only the administration of fluids until the values return to normal. In shock, the treatment is somewhat more complicated and may require hypertonic salt solution to recall fluid from the tissues (12). The administration of adrenal cortical extract may be beneficial in restoring capillary tone and redistributing electrolytes (12). Plasma transfusions are of special benefit. By the falling drop method, shock may sometimes be detected as much as twelve or fourteen hours before clinical manifestations are evident. The presence of anemia alters the values to the extent that the hematocrit and specific gravity of whole blood is decreased, but the plasma protein is increased.

If, in the presence of an immediate drop in hematocrit reading and in the specific gravity of whole blood with little change in the plasma protein content, hemorrhage, either visible or concealed, should be suspected, whole blood transfusions should be done, and the bleeding point should be sought.

Impending edema will reveal itself by a slowly falling value for plasma protein. This may be found as long as twenty-four hours before clinical edema is seen. If the value for total protein should be unusually low, a determination of the plasma albumin should be made. If the albumin is below 2.5 grams per cent in adults or 1.5 grams per cent in children, diuretics will have little or no effect. Plasma transfusions must be given.

#### SUMMARY

The clinical use of a method for the control of fluid therapy has been outlined. We have found the method extremely helpful, particularly for patients seriously ill before or following a surgical procedure. Our results corroborate those of Seudder.

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## COMING EXAMINATION

The November 1st written, Part I examination of the American Board of Anesthesiology, Inc., has been cancelled. The next written examination will be held on March 31, 1942. Applications must be in the headquarters' office on or before December 31, 1941. Sec., Paul M. Wood, M.D., 745 Fifth Avenue, New York City.