dosage in old, very young, or badly shocked casualties. 6. Shock position. 7. Drugs: If adrenal cortex available, 5 cc. may be given intravenously or subcutaneously at the start, followed by 2 cc. at intervals of from four to six hours. Adrenal cortex, readily carried in the first aid kit, might often be indicated at the site of the casualty, with blood or plasma given at the hospital. 8. Administer oxygen. 9. Fluid therapy: Cannulate accessible vein. Start full-strength plasma intravenously at the rate of 200 cc. plus per hour or more rapidly if the blood pressure is falling. Continue eighteen hours if hemoglobin percentage is tending to increase. During second twenty-four hours combat hemoglobin concentration with half-strength plasma as indicated. If burn exceeds 15 per cent of the body surface, begin full-strength plasma injection, whether or not patient shows signs of shock during the early treatment. 10. Do not begin local burn treatment until blood pressure is stabilized. 11. During the second twenty-four hours maintain near normal hemoglobin or hematocrit level by: (a) fluids by mouth; (b) equal parts of plasma with normal saline intravenously as indicated."

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"The human body is a complex mixture of water, salts and organic substances maintained in form by rigid structural units and covered with a relatively waterproof coating. In the presence of a variable environment . . . the maintenance of fluid and electrolyte balance within the normal limits of health is a remarkable process. Fortunately the body possesses many physiological mechanisms for the maintenance of this balance and only rarely is medical aid necessary as a supplement. Like all medical treatment, replacement therapy must be on a sound physiological basis or definite harm will result. . . . Body tissues vary from 20% water in fat to 99% in spinal fluid. Blood plasma has 92% water and whole blood about 80%. . . . A rough average is that three-quarters of body weight is water. . . . This water is divided in two phases generally spoken of as intracellular water (75%) and extracellular water (25%). The latter may be again divided into intercellular water of the tissues (17%) and intravascular water of the blood (8%). Thus our average normal man will have about 35 liters of intracellular water, 10 liters of intercellular water and about 5 liters in his vascular system. . . . Normally about 2500 cc. of water are added to and the same amount lost from the body in each 24 hours. . . . During growth there is water retention in the body. . . . Water can be withdrawn from cells for vital processes, but a total loss of about ¼ of the body water is inconsistent with life. . . .

"Water acts not only as the fluid medium for transport of foods and waste products, but because of its high latent heat of vaporization, it plays an important role in heat regulation of the body. . . . With a fever of 105° F. the body may secrete 5 liters of sweat in 24 hours instead of the 1 liter of normal insensible perspiration. . . . The walls of the capillaries are permeable to salts, glucose and water but not to the larger molecules of serum proteins. The latter exert an osmotic pressure and so tend to draw water into the capillaries. Blood pressure within the capillaries tends to shove water out through the vessel wall. At the arterial end of the capillary water and salts are going out into the tissue spaces, but at the venous end where hydrostatic pressure is less than the osmotic pressure, water and salts are entering the capillary. . . . Normally this loss and gain balances. With a fall in serum protein and the same blood pressure more water is lost than regained and edema results. The picture is further complicated by changes in permeability brought about by tissue damage, tissue anoxia, and histamine, when the capillary may be permeable to protein and lose its ability to take on water because osmotic pressure of the proteins no longer exists. Cell membranes of man, like the capillaries, are impermeable to proteins, permeable to most ions and small molecules, but they are in general not permeable to sodium and potassium. Thus sodium is found almost entirely outside cells and potassium almost entirely inside cells. For this reason sodium salts given by mouth tend to stay extracellular and attract water out of the cells, producing or aggravating edema, and any degree of loss of sodium from the body will cause a similar loss of extracellular fluid. . . .

"Blood is the only phase of body water which can be used to study water balance, unless the impractical long-term balance studies of intake and excretion are used. . . . When fluid is injected and blood volume raised, the disturbance is countered by an increase in excretion and passage of fluid into tissue spaces. Intravenous injection of a crystalloid isotonic solution changes normal blood volume only for a short while and restoration is complete in about half an hour. Loss of blood volume as in hemorrhage is also balanced by withdrawal of fluid from tissue spaces after an interval of a few hours. Other measures of changes in intravascular fluid which are of use are red blood count, hemoglobin, serum proteins and the volume of packed red cells (hematocrit). Unlike the determination of blood volume these values are relative and not absolute. Just after hemorrhage the values for the above are normal though total blood volume is reduced. Later the hemoglobin, hematocrit and protein will be reduced when the loss is replaced by tissue fluids. In shock there is a loss of plasma into tissue spaces. Blood will then show increased hemoglobin, red count and hematocrit while protein will be unchanged. In dehydration due to water loss all four will be increased. One must remember that values so obtained are only relative and must be interpreted against an often unknown value before the event in question. If run at intervals they are of great help in following and treating disturbances of water balance. . . .

"Body energy is derived primarily from oxidation of food stuffs. Oxidation yields a host of acidic substances yet the chemistry of cells and fluids is such that only the most minute changes in acidity take place. There are several mechanisms for combatting acidity. . . . The base of the extracellular fluids is mainly sodium, and normally the amount of this varies only slightly in blood. It is combined mainly with bicarbonate and chloride, having small amounts combined with phosphate, sulfate, organic acids and proteins. If less than the normal amount of base is received by the body the kidney saves it and excretes ammonia instead, if more is received it is selectively excreted. Only when changes are very large are the mechanisms inadequate and alkalosis or acidosis result. For convenience chemists designate the degree of acidity of a fluid as its pH, which is a simple figure, say 7.3, the negative logarithm of the hydrogen ion concentration. . . . An absolutely neutral solution has a pH of 7.0, those with a pH less than 7.0 are acid, and those with a pH greater than 7.0 are alkaline. Blood is always slightly alkaline; even in severe states of acidosis the pH is greater than 7.0.

"An example of a buffer system which occurs in blood is $NaHCO_3$ and H_2CO_3. Chemistry teaches us that pH will vary as the ratio of the concentrations of the constituents of a buffer. . . . If we feed $NaHCO_3$ by mouth a change to an alkalosis should result. Actually the body compensates slight changes by excretion of extra alkali through the kidney and by retaining CO_2 (H_2CO_3) so that the ratio is not changed and pH stays normal. In this instance we could have a high CO_2 combining power, yet a normal pH and a compensated alkalosis. . . . If kidney function should be failing, the result would be a higher CO_2 combining power, a raised pH and an uncompensated alkalosis. . . . Since blood base (Na) is combined with HCO_3^- and Cl^-, vomiting, by a loss of free HCl, would increase combined CO_2 and give rise to an alkalosis at first compensated by increased dissolved CO_2, later uncompensated when chloride is markedly depleted. We can have an alkalosis also by a respiratory loss of dissolved CO_2 as in hyperventilation. . . . In the latter instance we can have a low CO_2 combining power and an increased pH or alkalosis. Suppose we add acids to blood as the diabetic does when fat oxidation fails in the absence of insulin. These acids will require some base for neutralization. Less will be left for HCO_3^- and Cl^-. $NaHCO_3$ will tend to be lowered. If CO_2 combining power is lowered but the respiration decreases H_2CO_3 proportionately, pH will be normal and we have a compensated acidosis. . . . Kidney excretion of the acids as ammonium salts will also tend to conserve base and prevent acidosis. When the reserves are exhausted, CO_2 combining power will be low and pH low in an uncompensated acidosis. . . . Loss of base also causes dehydration.

"In kidney diseases with marked nitrogen retention, the inability to excrete ammonium salts to conserve base, and the inability to excrete phosphates and sulfates, result in a loss of base and also less base from the lowered total to form $NaHCO_3$. Respiratory decrease of H_2CO_3 can compensate for a while but finally the ratio is decreased, pH and CO_2 combining power are low, and acidosis is present. Respiratory acidosis may also occur as in emphysema or rebreathing. Here CO_2 piles up in the alveolar spaces. . . . It should be noted that in the respiratory acidosis and alkalosis, the CO_2 combining power varies in the opposite direction to pH changes. Only in conditions where the fixed base (Na) is changed can CO_2 combining power be used as a measure of acidosis or alkalosis. Fortunately these are the ones most frequently encountered clinically. . . . Man was intended to have fluid administered only by mouth. When possible this route should be used, and there seems little if any excuse for giving fluids by other routes when the oral route will suffice. Water taken by mouth is absorbed within an hour into the blood stream. . . . The intestinal epithelium will not pass unwanted materials such as sulfates and leaves unabsorbed excess materials of the diet such as calcium. It seems self-evident that such things as serum proteins and red blood cells can be of little value given by mouth since they would be digested before absorption. The building materials for them (protein and iron) can be given instead with as good effect, but they have no value for emergency treatment. . . . Administration of fluid per rectum is a route which has been neglected. Water, small molecules and salts are well absorbed, though protein, starch and complex molecules are not. Because of difficulties with retention the amounts which can be given are limited. All food and water have been supplied for as long as two months by rectum, and nitrogen balance maintained. . . .

"The intramuscular route limits the amount of fluid given because of the relatively small amount of intracellular space in muscle. Absorption is fairly rapid for diffusible substances with small molecules. Only isotonic solutions should be given to avoid killing of the tissues. Intraperitoneally considerably larger volumes may be given. Absorption is still good for diffusible molecules. Fluids given this way must also be isotonic or nearly so, to avoid damage to tissues, and the technique of administration may at times cause danger by puncture of a viscus. The subcutaneous route was popular several years ago and is still used extensively in many hospitals. It is somewhat more painful than the venous route, and once again the fluids given must be nearly isotonic to avoid killing of tissue and sloughing. Absorption from the muscles, abdominal cavity or subcutaneous tissues depends on circulation and is only slightly faster than from the gastro-intestinal tract when circulation is adequate. Reactions are much less apt to occur than by the intravenous route, and for routine fluid administration, where time is not an important factor, the subcutaneous route is probably a second choice to oral therapy. In some cases where time is an important factor, where non-diffusible substances are to be administered, or where non-isotonic solutions are needed, the intravenous route must be used. . . . The dangers of intravenous fluid therapy are few but not unimportant, the chief ones being the kind of fluid to give and the amount to give. . . . Recently Tocantins and others at Jefferson Medical College have advocated infusions via the bone marrow, using the sternum in adults and the tibia or femur in children. When venipuncture is difficult this route may have an important place. Non-diffusible constituents such as red cells or plasma proteins can be given. Aphysiological variations in concentrations of crystalloids or in pH should be avoided by this route. . . .

"Water . . . can be used as distilled water or as tap water. Either may be given orally or rectally but should not be used by other routes. Beverages . . . include tea, coffee, milk, fruit juices, beer, wines and distilled liquors. The last, though sometimes low in actual water content, will supply more than their original volume of water when oxidized. The use of this group is almost exclusively oral, though some of them can be given rectally. . . . The various strengths of salt and of sugar solutions are made particularly for parenteral administration. Such salt solutions as sodium and magnesium sulfates are used orally. Sulfates do not pass the intestinal epithelium and so attract water into the intestine and act as cathartics, with resultant dehydration of the body. Sodium chloride solutions can be given by mouth with good absorption but they are usually made for injection. . . . Concentrations of NaCl as low as 0.3% may be given by vein. . . . Concentrations as high as 25% are also given. These are hypertonic solutions. In the veins they tend to draw water into the blood, until diffusion lowers the salt concentration, and thus they dehydrate tissues and stimulate kidney excretion. Both effects are temporary and eventually the salt diffuses into interstitial spaces where it withdraws water from the cells which it cannot enter. Various modifications of the isotonic sodium chloride solution have been made to include other salts present in the body. . . . Sugar solutions are the second example of crystalloids in water. Five per cent dextrose is isotonic with blood and tissue fluid, and is the most commonly used of this class. . . .

"Mixtures of saline and dextrose act as each would separately. . . . Non-crystalloid substances in water . . . are administered almost exclusively by vein, and help to draw water into the blood, or supply a lack of some intravascular constituent such as red blood cells. . . .

"Solutions of gelatin and of acacia in saline exert an osmotic pressure on capillary walls and have been used to restore water to the vascular tree from tissue spaces. Both of these have been developed to the stage where the former troublesome toxicities have been avoided and they have a place in therapy. The ideal substance to use is human plasma which is non-toxic if properly prepared, and will draw water into the blood stream by increasing the osmotic pressure of the blood. Both citrated plasma and serum from clotted blood are in general use today. Plasma diluted with saline, when injected will not raise osmotic pressure unless it is extremely low, and the saline will tend to pass into tissue spaces. It could be used to supply protein for replacement, but would only aggravate edema. Concentrated plasmas, developed by the dehydration of plasma to a powder, and resolution in less than the original volume of water, act best to raise osmotic pressure of the blood and withdraw water into the vascular tree. Bovine plasma has been tried intravenously on animals but it is quite toxic and as such cannot be used for humans. . . . Serum or plasma proteins are of two general classes, albumins and globulins. The albumins have smaller molecules and therefore exert greater osmotic pressures per unit of weight than the large molecules of globulins. Preliminary experiments show that the globulins are the cause of all anaphylactoid reactions to serum of other species, while the albumins are non-toxic. Methods of separation are difficult but not impossible. . . .

"Transfusions of whole blood must be mentioned to complete our examples of parenteral fluids. Here we give the cellular elements of the blood as well as the proteins, and so are able to combat hemorrhagic tendencies, treat anemias and leukopenias when they are present, as well as treat disturbances of water balance when plasma is not available. . . . The uncomplicated case requires at least 2500 cc. of fluid per day for water balance. If given parenterally this should be 1000 cc. of isotonic saline and 1500 cc. of isotonic dextrose in water. After fever or profuse sweating this should be increased at least another 1000 cc., preferably of the sugar solution. After vomiting or gastric drainage the excess volume lost should be replaced by an equivalent volume of isotonic saline. After diarrhea the excess volume excreted should be compensated by 1000 cc. or more of isotonic saline or 500 cc. of an alkaline solution and the balance of saline. Hypertonic solutions should be used exclusively to relieve cerebral or pulmonary edema. They have no place in the treatment of dehydration. Whole blood should be given only when extra red blood cells and hemoglobin, antibodies or platelets which disappear in stored plasma, or fibrinogen for clotting, are needed. For the prevention of shock concentrated plasma or plasma should be given in amounts sufficient to keep hemoglobin or red count from rising. If plasma is not available hypertonic solutions of dextrose or sodium chloride are of some help, dextrose being somewhat better than saline. When shock is present large amounts of concentrated plasma or plasma are needed to restore blood volume. Crystalloid solutions are of little value in shock once it has developed. Give fluids by mouth, by rectum and by clysis whenever this can be done. More important than the decision to give fluids, is the decision of what kind of fluid and how much to give." 12 references.

J. C. M. C.

BETLACH, C. J.: *Selective Anesthesia.* California & West. Med. **58**: 16–18 (Jan.) 1943.

"Some of the factors which make selective anesthesia safer than large doses