Letters to the Editor

JAMES BARRY: INSPECTOR GENERAL OF ARMY HOSPITALS

From Col. E E Vella, L/RAMC

Sir,

The incidental facts surrounding this extraordinary female Medical Officer never fail to surprise.

In 1815, when serving in South Africa, it appears she performed with neat surgical skill, a caesarean section on a patient who was delivered successfully of a male infant.

The baby was duly christened, not unexpectedly, James Barry Munnik.

The boy grew up into adulthood, married and in due course became the grandfather of the well-known James Barry Munnik Hertzog – the Prime Minister of South Africa.

I am etc.

E E Vella

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HYPERTONIC ELECTROLYTE SOLUTIONS AND RESUSCITATION

From Prof/Dr Hans Heugh Wandall
Surgical Adviser, Directorate of Medical Services, Danish Armed Forces; Formerly Director; Institute for Experimental Research in Surgery, University of Copenhagen.

SIR – The manuscript by Colonel P. J. N. Howorth on The Role of Isotonic and Hypertonic Solutions in the Resuscitation of Shocked Patients reviews the history of resuscitation and treatment of shocked patients. The author concludes that resuscitation with isotonic solutions is feasible provided sufficient red cells are in the circulation and that the patient is not badly shocked. Recognizing the need for simple IV resuscitation under field conditions the author finds that the literature indicates that hypertonic solutions might be of help in the case of casualties developing profound shock when there is delay in the initiation of resuscitation.

Of the cited articles, three deal with clinical observations, quoting the use of glucose/water 50% on Vietnam War casualties, describing the use of hypertonic salt solution in a civilian hospital, and studying the effect of hypertonic solution with and without 12.5% albumin compared with the effect of Ringer’s solution in burns also in a civilian hospital. In an article by McNamara et al, the use of 3% sodium chloride solution, 50% glucose/water, and 25% mannitol was examined in a randomly selected group of patients, severely wounded and having already been resuscitated by a standard regime of electrolyte solutions, massive transfusion, infusion of bicarbonate and calcium solutions, and in most cases requiring immediate operation as part of resuscitative treatment. No details are given concerning the patients’ clinical conditions, or the types and extent of injury. Only blood pressures and metabolic parameters are presented in the Tables. The glucose solution was found to have an effect on the haemodynamic parameters which was better than that of mannitol and hypertonic saline. No differences were found in the metabolic parameters. Some speculative comments are given concerning the possible benefit of the glucose being that of providing nutrition to an anoxic myocardium. The authors conclude that further clinical studies are needed, but suggest that the preliminary results indicate that hypertonic glucose may be a valuable resuscitative adjunct during the period while blood volume is being restored.

De Felippe et al report reversal of terminal haemorrhagic shock in eleven out of twelve patients who had not responded to vigorous fluid volume replacement, corticosteroids and dopamine. Infusion of 7.5% sodium chloride solution achieved an immediate moderate rise in arterial pressure, restored urinary production and consciousness. Nine of the patients could later be discharged from hospital. The disease conditions included three with chronic alcoholism, four with hepatic fibrosis complicated by oesophageal bleeding, one with iliac arterial thrombosis, and one with diabetes and hypertension. The diagnoses in the cases of the three who died are listed as follows: one traumatic hepatic rupture associated with a fractured femur, one with adenocarcinoma of prostate, and one with hypertension and diabetes.

The authors conclude that “hypertonic infusions should be useful in the treatment of refractory hypovolemic shock”.

In the third paper, Jelenko et al report a detailed clinical study of ninety patients with burns ranging in extent from 20% to 98%. Several regimes are compared, including the use of Ringer’s solution, hypertonic sodium lactate, and hypertonic sodium lactate with 12.5% alubumin. Patients on the last of these regimes required the lowest fluid volume replacement to achieve stabilisation within the first 72 hours following injury. These patients were resuscitated in a shorter period of time, and were able to maintain fluid requirement by mouth more quickly. The article, however, presents very little information regarding the clinical course in the various groups.

The conclusions are that appropriate resuscitation in burns requires the infusion of fluid at a specific rate, and that salt, fluid and colloid loss into the interstitium during resuscitation is related to the rate of delivery, and/or the physical nature of the fluid used, and not to capillary bed damage away from burned areas.
Later in his discussion of the mechanisms whereby hypertonic solutions produce their effects in shock, Colonel Howorth refers to the works of Shires and co-workers who demonstrated a reduction in extracellular compartment volume greater than can be accounted for by the blood volume lost from the circulation, and to an article by Carrico et al in which is reported experiments showing a fall in cell membrane potential related to the fall in blood pressure and the rise in extracellular potassium concentration in haemorrhagic shock. It is concluded that the rise of plasma osmolality may help to correct ionic shifts in “sick cells” and their surroundings, as it is known that hypoxia leads to impaired function of the Na/K-activated AMP-ase which controls Na transport across membranes.

In my opinion, it is questionable whether such speculation on the details of cellular and subcellular activity permits deductions concerning trends in the development of the clinical syndrome of shock. Only a few years ago, similar considerations and experimental observations formed the basis for the infusion of adenosine triphosphate (ATP). Current studies, however, show that in the clinical management of shock, the use of ATP is not only not beneficial, but that its administration has significant adverse haemodynamic effects.

But to return to the article by Carrico et al, they only used the demonstrated relationship of lowered cell membrane potential and hypotension as a guideline when recommending a standard regime of resuscitation using initially balanced Ringer’s lactate solution supplemented by whole blood. They state: “Adequate resuscitation returned the membrane potential to normal levels”. Their recommended resuscitation regime consists of 1-2 litres of balanced Ringer’s lactate solution infused within 45 minutes. The patient’s response provided a rough estimate of the severity of blood loss. If the haemodynamic response is not satisfactory, other measures such as whole blood transfusion or surgery to stop haemorrhage are to be added to the resuscitative efforts.

The following quotation is from a paper by Trunkey et al. “There was no significant change in total water content of muscle biopsies in the preshock and shock states. The major point to note is that the internal redistribution of ions following prolonged shock was not accompanied by a change in the total electrolyte content of skeletal muscle”. In their paper, Carrico and his co-workers conclude that “a significant disparate reduction in ECF occurs with haemorrhagic shock and increased survival can be obtained by the adjunctive use of a balanced salt solution in addition to whole blood in the treatment of patients in haemorrhagic shock”.

The work of Shires and his group can only be understood if the role of lymphatics in the exchange process between the vascular and interstitial spaces is included in our speculations.

All distributional shifts within the circulation are rather swift, whilst movements in the interstitial space and the lymphatics are comparatively slow. Water, ions, as well as proteins can leave the vascular space through the arterial side of the capillary network. Water and ions may re-enter the blood stream at the venous end of the capillaries. Proteins on the other hand can only return through the lymphatics. The route by which water and salts are returned to the vascular compartment from the interstitium is in part governed by its macromolecular composition and concentration. Shires used isotope equilibration curves, and as they require steady states for proper evaluation, the interpretation during a period of shock when the circulation is unstable is no reason for not assuming that the demonstrated reductions are due to what has entered the slow lymphatic drainage. Loss from the circulation – by haemorrhage or by exudation into an inflamed peritoneal or pleural cavity – is compensated by an increase in lymphatic drainage of protein-rich fluid from other body areas, and as long as this supply is sufficient, the patient remains in “latent shock”. The effect of hypertonic solutions may be mobilization of water via venous capillaries, but this diverts water from the mobilization of proteins to the lymphatic capillaries. The use of plasma-expanders with molecules the size of albumin may similarly be considered undesirable because of their interference with the concentration and composition of the macromolecules in the extravascular space.

It is unquestionable that infusion of hypertonic solutions affects the circulation, increasing blood pressure and decreasing peripheral resistance. In experiments on dogs it was shown that hypertonic sodium chloride solutions increase adrenergic activity by catecholamine release. Mean systemic and pulmonary arterial pressures rose slightly, and the peripheral resistance within both circulations was calculated to be lower (Chang-Seng Liang et al). The observed effect was found to be unrelated to hypertonicity as hypertonic TRIS HCl solution had no effect on the haemodynamic parameters. As the experiments were performed on healthy dogs, one must ask what the findings would have been in dogs with reduced blood volume and pre-existing adrenergic activation.

In summary, the circulatory effect of hypertonic solutions is unrelated to their content. Clinically, 50% glucose was more effective than sodium chloride solution in raising blood pressure and this was ascribed to the effect on myocardial metabolism. Experimentally, it was shown that sodium chloride exerted its effects through catecholamine activity. Sodium bicarbonate similarly exerts a vascular effect by altering the pressure receptor sensitivity to catecholamines by raising the blood pH. From this it may be deduced that hypertonic solutions do not have a place in a primary resuscitation regime aimed at the restoration of volume of the extracellular space.

Although I appreciate Colonel Howorth’s expressed intention of examining possibilities for improving the
care of severely wounded personnel coming late to resuscitation, I must draw the following conclusions: (a) The effect of hypertonic solutions on the circulation appears to be ill-defined and to be produced by uncontrollable neurogenic and endocrine mechanisms; (b) As hypertonic solutions damage the intimal linings in veins and interfere with blood coagulation, they should not be used outside hospitals containing experienced intensive care facilities; (c) No evidence is presented in Colonel Howorth's paper that could justify changing the established standard regime for resuscitation which is based on the use of balanced and isotonic electrolyte solutions supplemented by whole blood when an undesirable degree of haemodilution is produced.

I am etc.,

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REFERENCES


Prof/Dr Wandall’s letter was sent to Colonel Howorth for comment. The following is his reply:

SIR—Whilst I welcome Professor Wandall’s contribution to the debate I think that some of his remarks are irrelevant. I was not proposing that hypertonic solutions might be used in the primary resuscitation regime, but was only suggesting that in times of surgical overload in adverse field conditions, time would be bought for patients and lives possibly saved by their use. I realise that the mechanism about how they raise blood pressure and decrease peripheral resistance is unclear. The risks of tissue necrosis using hypertonic solutions is well-known1 and would be largely overcome by adding hypertonic solutions to an existing IV line. The Professor’s final conclusion is a counsel of perfection which no-one would disagree with except in the circumstances I have alluded to.

I am etc.,

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REFERENCE
James Barry: Inspector General of Army Hospitals

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