

Hypervolemia after Modified Parkland Formula in Children Scald Burns

HAMDY BASHA, M.D.; MAURICE FEKRY, M.D.; AMIR ABDELKARIM, M.D.;
SHERIF ABDELRAHMAN, M.D. and HAITHAM M. SALAH, M.Sc.

The Department of Plastic Surgery & Burn Unit, Matareya Teaching Hospital, Cairo, Egypt

ABSTRACT

From January 2012 till November 2014, 60 cases of scald burn had been managed in the burn unit, Plastic Surgery Department at Matareya Teaching Hospital. Their age ranged from 2 months to 12 years with an average of 3.5 years. Male to female ratio was 1: 1. Their burn wounds were diagnosed as 10 to 45% of their total body surface area (TBSA) and were superficial to deep second degree burns. Thirty five children had burns below 20% TBSA and 54 children had their burns superficial second degree.

Patients were on arrival resuscitated and managed by the modified Parkland formula (2ml/kg/burn surface area as crystalloid fluid) without restricting their oral intake. Signs of hypervolemia were obvious from the second to the fifth post-burn day in 10 cases. Although fluid resuscitation regimen was on the 3rd day shifted to a more fluid-restricting policy (The Clinical Formula) for management of scald burn in children (intravenous fluid equal to the normal urine output for certain age + normal oral feeding and fluid) is a safe, easy and competent procedure.

The 10 cases developed pulmonary oedema and 4 of them showed signs and symptoms of brain oedema. Two of them died.

In conclusion, the modified Parkland formula without restricting oral intake puts infants and children below the age of 4 years with scald burns at high risk of developing hypervolemia.

INTRODUCTION

Hypervolemia (fluid overload) is not infrequent during fluid resuscitation in childhood age group. Complications of this volume overload are almost presented as pulmonary and/or brain oedema. The intravascular volume in this age could not compensate any excess fluid, as well as the kidney function could not eliminate this excess volume. Literature shows that these complications are not rare with the use of the modified Parkland formula (2ml/kg/burn surface area) [8,9]. Fluid resuscitation using the previously published clinical formula [1,4,5] in such injuries helps to eliminate the risk of pulmonary and brain oedema in children.

MATERIAL AND METHODS

Sixty cases of scald burn had been managed in the Burn Unit, Plastic Surgery Department, Matareya Teaching Hospital in the period from January 2012 till November 2014. Their scald burn was due to boiled water, tea, or soup. Male to female ratio was 1: 1 and their age ranged between 2 months and 12 years with an average of 3.5 years (Tabel 1). These patients suffered from fresh major burn, second degree in depth, and 10-45% of TBSA. Thirty five children had burns below 20% TBSA and 54 children had their burns superficial second degree (Tabel 2). The most commonly affected areas were chest, face, upper limbs and abdomen. The lower limbs and back were rarely affected but when injured they presented as small patches.

In the first 24 hours after hospital admission: Mild analgesic was used, blood sample for laboratory investigations was taken, urinary catheter was inserted and plain chest X-ray was done for every child. We used the modified Parkland formula, 2ml/kg/burn surface area in the form of Ringer's lactate (RL), half of it in the first 8 hours and the second half in the next 16 hours. Oral feeding and fluid intake were allowed. In all cases positive balance was noted as 25% more than it should be.

In the second 24 hours: Half of the first-day calculated amount of crystalloid was infused and colloids were given to expand plasma volume to maintain a urinary output of 1 ml/kg/hour in infants. The fluid balance chart showed excess positive balance with above 25%. The urine flow was increased in the range of 1.5-2ml/kg/hr. By the end of this day, 10 cases with age below 4 years started to show tachypnea, tachycardia and low grade fever by the end of this day.

On the third day: The 10 patients developed signs of hypervolemia and chest infection. Signs

of hypervolemia and/or infection in the form of tachypnea (40/min) and tachycardia (140-160/min) developed. Polyuria and positive fluid balance with more than 25% above the expected amounts were noted. Chest X-ray showed hilar congestion. Four children with hypervolemia presented apathy, decrease appetite and reversed sleep rhythm. The condition was rapidly diagnosed as pulmonary oedema and chest infection. Intravenous fluid restriction was immediately considered and proper antibiotics were given. Fluid resuscitation regimen was shifted from the modified Parkland formula to the Clinical Formula (oral feeding + equivalent fluid to the normal urine output) [1].

Investigations on day 2 to day 4 included complete blood picture, arterial blood gases, total protein, serum albumin, serum electrolytes, renal and liver function tests. Plain X-ray was done when respiratory rate showed any abnormality, or temperature showed hyperpyrexia and the temperature curve showed many peaks. After the patient bypass the shock phase and when the hematocrit value was less than 32%, a blood unit or plasma was supplied. A prophylactic antibiotic was used as well as an analgesic. Multivitamins and adjuvant oral high protein products were used also. Daily weight recording was a routine measure. Cases who suffered bronchopneumonia were managed by the powerful broad spectrum antibiotic in the form of Imipenem (Tienam).

Investigations from the second, third and fourth days showed increased WBCs, decreased hematocrit value (28-32%), decreased HB (less than 10gm), hyponatremia, hypokalemia and chest X-ray showed increase cardiac shadow, hilar congestion and opacity in the abdomen with elevated copula of the diaphragm. Positive fluid balance more than 25% was present in the complicated cases (10 cases) and their age ranged from 2 months-4 years.

Table (2): Results.

Fluid balance		Local wound				End results		
Overload	Normal balance	Depth (2 nd degree)		TBSA		Death	Healing	
		Sup.	Deep	<20%	>20%		Conserve	STSG
10 (16%)	50 (84%)	54 (90%)	6 (10%)	35 (58%)	25 (42%)	2 (3%)	52 (87%)	6 (10%)

Table (3): Complications of fluid overload.

Pulmonary oedema	Pulmonary congestion	Brain oedema	Chest infection	Fluid balance
10 (16%)	10 (16%)	4 (6.7%)	10 (16%)	>25% of expected

Wound care was performed daily by local anti-septics and Vaseline gauze. Six cases showing deep ulcers with retarded healing were managed by split thickness skin graft.

RESULTS

Ten cases out of 60 suffered from pulmonary oedema, four of them showed signs and symptoms of brain oedema and an accompanied event with these complications was chest infection as lower respiratory infection. Two cases died due to uncontrolled pulmonary oedema and severe bronchopneumonia ending by septic shock; one at the age of 1.5 years with scald 45% TBSA and another at the age of 4 years with scald 20% TBSA. Afromasigning mortality rate at 3.3%. Death occurred in these two cases on the 10th and 27th day post management respectively. The remaining 58 cases healed in 15-30 days, with 6 cases needed debridement and skin grafting. Volume overload occurred in 10 cases initially managed by modified Parkland formula, the fluid balance charts were always showing positive balance more than 25% than it should be and the urine output was 1.5-2 ml/kg/hour (Table 3). Hyponatremia and hypokalemia were presented in the associated investigations. Plain chest X-ray showed always hilar congestion, patchy opacities in lungs, elevated copula of the diaphragm and concealed colonic gases by opacity in the abdomen. Blood picture always showed decreased hemoglobin content, leukocytosis, haemodilution, hyponatremia and hypokalemia. The hospitalization time was 15-30 days with an average of 20 days. Neither a dynamic intestinal obstruction nor stomach stress ulcers occurred.

Table (1): Age and sex distribution among burned children.

Age		Percentage	
		Male	Female
2 months-1 year	10	4	6
1-4 years	31	17	14
4-12 years	19	9	10

DISCUSSION

The reported morbidity and mortality rate induced with large fluid volume resuscitation usually occur in the extremes of age especially in childhood. Studies have supported that patients who received large volumes of resuscitating fluids were at higher risk for complications and death [7,8]. Three important items present in the management of scald burn in children namely the marked physiological variation in this age group, the intensity of injury in scalding versus direct flame and the complications present with the modified Parkland formula (2ml/kg/burn surface area). The intravascular volume in this age could not compensate any overload, as well as the kidney function could not eliminate this excess volume. The reports which discussed the complications present with modified Parkland or any other formulas using constant multiplied by body weight and burn surface area, pointed out to these dangerous complications in the form of pulmonary oedema, brain oedema and multiple organ dysfunctions [4-6]. Some reports found that these formulas could not overcome the marked variation in the physiological and actual demands aspect in this age group [3,4]. A process of fluid resuscitation in the form of urine output/kg/hour, could help to solve the problem as oral feeding and fluid intake are not restricted in infancy and children up to the age of 4 years [1]. The modified Parkland formula (2ml/kg/burn surface area) assumes nothing should be received by mouth (NPO). Infants and children below the age of 4 years do not tolerate NPO and NPO especially in this age group is hazardous. Combining the 2ml/kg/burn surface area with free oral intake in scald burns in children below the age of 4 years puts them at high risk of developing hypervolemia. The restriction of oral feeding and fluid intake for 48 hours in infants and children have metabolic disturbances in the form of severe hypoglycemia and weight loss, a condition may be aggravated by the hormonal, fluid and electrolyte response to the injury. For fear of these facts when associated with malnourishment and underweight in scalded infants and children, an increase in the morbidity and mortality rates might occur. The thermal wave propagation to the deep structures due to scald produces less damage as compared with the direct flame burn which may be reflected on the amount of fluid evaporated from the injured tissues.

To overcome these three components, we managed these cases using a variable which is the

intravenous fluid equivalent to the urinary output/day according to the age and weight of the child, with immediate oral feeding and fluids. We gave ourselves the right to call it The Clinical Formula for management of scald burn in children [1]. Since we started its adoption during 2014, pulmonary oedema, brain oedema, multiple organ dysfunctions and death have not occurred. The healing process has been relatively rapid and the hospitalization time has been minimized [1,2].

Conclusion:

The modified Parkland formula (2ml/kg/burn surface area) entailing nothing should be received by mouth (NPO) puts infants & children below the age of 4 years with scald burns at high risk of developing hypervolemia. The Clinical Formula for management of scald burn in children (intravenous fluid equal to the normal urine output for certain age +normal oral feeding and fluid) is a safe, easy and competent procedure.

Community and health programs must take place to inform the mothers about the hazards of scald burn in infancy and childhood.

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