



FLUID RESUSCITATION FOR MAINTENANCE OF INTRAVASCULAR COMPARTMENT IN PATIENTS WITH THERMAL BURN.

General Surgery

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ABSTRACT

Background: Managing and treating patients with burn is a complex process. Various factors determine therapeutic outcome in burn patients. Fluid resuscitation is very essential in burn patients during acute phase. There are significant controversies regarding the best type of fluid resuscitation to be during the acute phase following a major burn. In the present study, the outcome of Parkland and Brooke formulae for fluid resuscitation was assessed in terms of adequacy, complication and cost effectiveness in patients with thermal burns. **Methods:** In Parkland group fluid used was crystalloid (RL), whereas in Brooke group fluids used were crystalloid (RL and 5% Dextrose water) and colloid (5% Albumin). Patients were randomized and selected as per inclusion and exclusion criteria. Both group patients were resuscitated using urine output of 0.5 - 1.0 ml/kg/hour as end point of resuscitation. **Results:** As per Brooke formula, use of colloid solution (5% albumin) in early part of resuscitation can reduce volume requirements to adequately resuscitate acute thermal burn patients. Abdominal pressure, the precursor to abdominal compartment syndrome, can be kept low by using albumin. Albumin use in early part of resuscitation reduces 'fluid creep'. However there was no significant difference between final outcome with respect to mortality or duration of hospital stay in Parkland and Brooke group. **Conclusion:** Complications of over resuscitation can be reduced by using Brooke formula in majority of burn patients. As burn resuscitation is a complex process and number of factors plays a role in treatment outcome, we recommend using Parkland formula for initial resuscitation and use of 5% albumin in later part of resuscitation in selected patients who show increased requirement of crystalloid to maintain intravascular compartment.

KEYWORDS

Fluid resuscitation, Brooke formula, Parkland formula, thermal burn.

INTRODUCTION.

Skin, the largest organ of the body has several vital functions like protection from microbes and environment, sheathing internal organs and preventing dehydration. Burn is the most important threat to dermal integrity. Globally, the incidence of burn injuries has increased primarily due to rapid industrialization.¹ Burn injuries negatively impact's the physical and psychological state of an individual.²

Thermal burns are commonest among various types of burn injuries. It results from contact with hot surfaces, liquids, steam or flame.³ Thermal burn injuries may be sustained by patient while attempting suicide or homicide.⁴ It is estimated that 2,65,000 deaths per annum are related to burns related injuries and the vast majority of them are reported from low- and middle-income countries like India.⁵

In burn patients, leakage of intravascular component into the extravascular space significantly contributes to fluid depletion. Additionally deranging of cell membrane also produces alteration of electrolytes, with intracellular sodium accumulation and consequent cellular swelling.⁶

As mediators like histamine, prostaglandins and leukotrienes, coupled with complement activation in general and histamines in particular, seems to play an important role in permeability changes causing hypervolemia and shock, fluid resuscitation is very essential in burn patients during acute phase.⁶

Globally, there is a vast experience regarding management of burn patients. However, there significant controversies still exist regarding the best type of fluid resuscitation during the acute phase following a major burn.⁶ Several resuscitation formulae are used for calculation of the fluid management in burn patients. These include Vans, Brooke, modified Brooke, Monaf, Parkland and modified Parkland formulae and based on the body surface and surface of area affected by burn.⁶ In the present study, the outcome of Parkland and Brooke formulae for fluid resuscitation was assessed in terms of adequacy, complication and cost effectiveness in patients with thermal burns.

MATERIAL AND METHODS.

The present study was conducted in the Burn Unit of Department of

General Surgery, of a tertiary care hospital of Maharashtra for a period of two years. A total of 100 patients (age >20 and <80 years) with acute thermal burns >20% but <80% of total body surface (TBSA) were included in the study. These patients were divided into two groups: Group 1 (Parkland group) and Group 2 (Brooke group). Each group contained 50 participants.

On admission, the demographic features (age, sex, body weight) and history of burn injury of the patients included the study were recorded and study protocol were explained to the patients. A written informed consent was obtained from all patients included in the study.

Estimation of burn size was done by using 'rule of 9'. Patients were catheterized at admission. Central intravenous access was taken for fluid administration. (Internal jugular or Femoral vein). Bladder pressure was monitored using transurethral catheter. Increased abdominal pressure was taken as 25 cm of H₂O during the course of patient's hospital stay.⁷

Patients with respiratory compromise were intubated secure airway. Nasogastric tube was inserted for decompressing stomach. Nutritional support was given by calculating the energy needs as per Curreri formula as 25 Kcal/kg/day plus 40 Kcal/% TBSA burned/day.

For pain management injection Tramadol at 15mg q8h intravenously (IV) was given along with injection Rabeprazole 20mg q 12h IV. For toileting of wound low concentration of sodium hypochlorite (0.025%) was used whereas wound dressing was done using 1% Silver Sulfadiazine topical ointment. Collagen dressing was used in patients as required. Wound debridement and skin grafting was done if necessary.

As discussed above the patients were assigned to two different groups having 50 participants each.

Study group I (Parkland group):

Patients were resuscitated using Parkland formula (4 ml/Kg/% of TBSA of Lactated Ringer's solution). Half of estimated fluid was given within 8 hours of time of injury and half in later 16 hours. Rate of fluid administration was controlled while monitoring urine output hourly

basis. Adequate urine output will be taken as 0.5-1.0 ml/hour/kg. Total quantity of fluid given after resuscitation for 24 hours was noted.

Study group II (Brooke group):

Patients were resuscitated using Brooke's formula (1.5 ml/Kg/% TBSA of Lactated Ringer's solution + 0.5 ml/Kg/% TBSA of 5% Albumin solution + 2000ml of 5% Dextrose solution). Total quantity of fluid required to be given was calculated and half of which given in first 8 hours and other half in next 16 hours. Rate of fluid administration was controlled while monitoring urine output hourly basis. Urine output was recorded 24 hours of time of injury.

Comparison between two groups was done of parameters urine total quantity of fluid used in first 24 hours of resuscitation, total number of days of hospital stay, mortality outcome and complication as increased abdominal pressure and fluid creep phenomenon noted. Fluid creep the phenomenon defined as the excess of fluid volumes given as compared to original estimation of the required fluid by both formulas.

RESULTS.

The mean age of patients in Parkland group was 38.1 ± 13.71 years whereas in Brooke group it was 37.6 ± 14.62 years (Figure 1). However this difference was not statistically significant (Student t-test, $P > 0.05$).

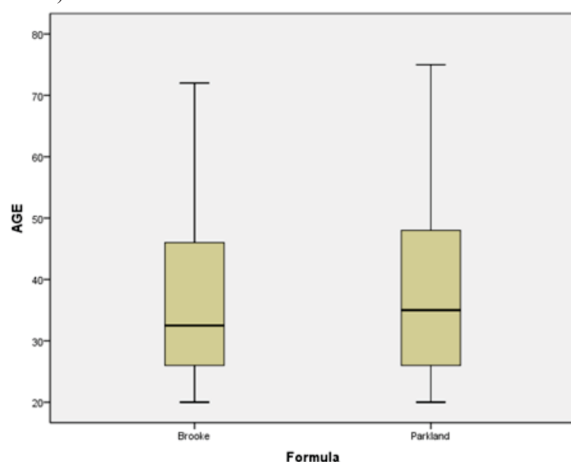


Figure 1: Age Wise Distribution Of Patients In Two Groups

Table 1: Sex Wise Distribution Of Patients In Two Groups.

SEX	Formula		Parkland		Total		Student T test, P value
	Brooke		Parkland		Count	%	
FEMALE	27	54.0	33	66.0	60	60.0	0.307
MALE	23	46.0	17	34.0	40	40.0	
Total	50	100.0	50	100.0	100	100.0	

The sex wise distribution of patients in both groups is shown in table 1; the Incidence of burn injury is more in females than males in this study. The mean weight in Parkland group and Brooke group was 58.5 ± 8.7 and 57.9 ± 7.86 respectively. The weight of patients in both the groups was comparable (Student t-test, $P > 0.05$).

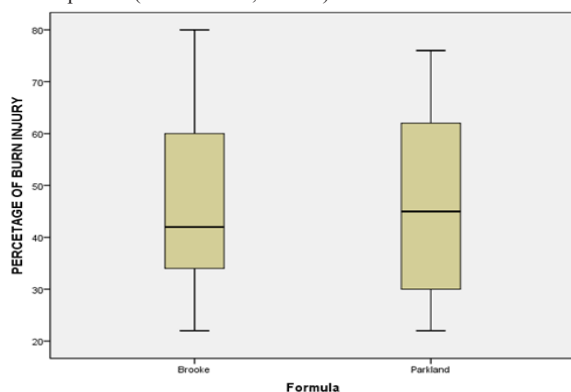


Figure 2: Percentage Of Burn Injury Distribution In Parkland And Brooke Group.

The mean percentage of burn injury in Parkland and Brooke group are $46.1 (\pm 17.96) \%$ and $47.3 (\pm 17.65) \%$, respectively. The difference between mean % of burn injuries in both groups was statistically non significant (Student t-test, $P > 0.05$).

As shown in table 2, when Volume of crystalloid required resuscitating thermal burn patient were compared. It was significantly high in Parkland formula compared to that used in Brooke formula. Similarly total volume used was also in the Parkland group. Mean urine output at 24 hour of resuscitation was significantly high in Parkland group (1222 ± 197.99 ml) compared to. In Brooke group (1109.0 ± 242.79).

Table 2: Volume Of Fluid Given And Urine Output At 24 Hour In Parkland And Brooke Group.

	Formula						t	df	Chi square test P value
	Parkland			Brooke					
	N	Mean	± S D	N	Mean	± S D			
Volume of Crystalloids	50	8480.0	2693.45	50	3090.0	799.81	13.56	98	< 0.001*
TOTAL VOLUME GIVEN	50	8400.0	2706.76	50	5832.0	894.30	6.37	98	< 0.001*
U.O. at 24 hour	50	1222.0	197.99	50	1109.0	242.79	2.55	98	0.012*

* statistically significant

The proportional distribution of fluid Creep in both the groups is shown figure 3, Fluid creep was present in 50% patients in Parkland group and in 24% patients Brooke group. In 2 patient it could not be observed due to early death. Resulted 'P' value is 0.014 which was statistically significant.

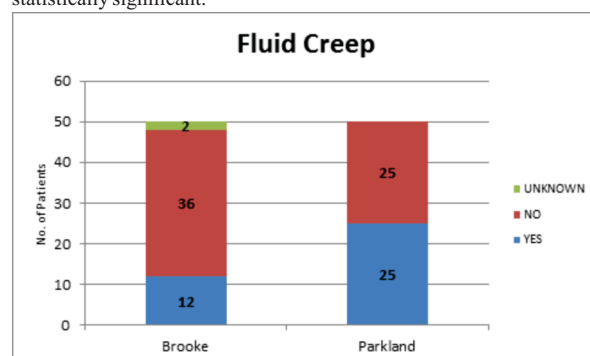


Figure 3: the Proportional Distribution Of Fluid Creep In Both The Groups.

As shown in figure 4, increased abdominal pressure (IAP) was observed in 21 patients of Parkland group (42%), compared with Brooke's group, where it was present in 5 patient's (10%). Resulted P value was < 0.01 , which was statistically significant. Result is unknown in 8 patients.

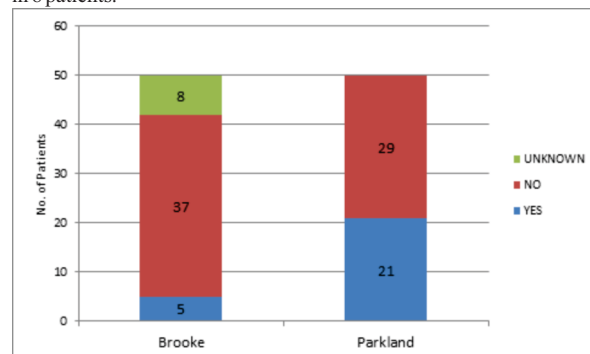


Figure 4: IAP distribution in both group.

The Mean duration of stay in Parkland group was 30.9 days whereas in Brooke group it was 30.7 days. This difference was not statistically significant (Student t test $P > 0.05$). In the present study, 35 deaths occurred. Death percentage in Parkland group is 32 (N=16) while in

Brooke group it is 38 (N=19). This difference was statistically insignificant (Student t test $P > 0.05$). Brooke group has comparatively higher cost.

DISCUSSION.

Various international and national studies have reported increase in the incidence of burn injury. In India over 1,000,000 people sustain moderate or severe burn every year.⁸ Similar to observation noted in many Indian studies and to that the World Health Organisation (WHO), the incidence of burns was high in females compared to males. In low and middle income countries (LMICs) women are at high risk of burn injuries due to exposures in and around household and are related to high risk cooking arrangements, use of unsafe fuel for cooking and type of clothing.⁹

Managing and treating patients with burn present as a challenge to surgeon. Fluid resuscitation is of the most important management strategy in patients with major burns. The Parkland formula and its modifications are popular for resuscitating the burned patient.⁶ However the Parkland formula may result in unnecessarily large fluid loads.

As per Brooke formula, the use of colloid solutions in the fluid resuscitation of burns could effectively reduce the edema formation and amount of fluid required. Patients with severe burns, pre-existing heart disease, and inhalation injuries may benefit the most from lower-volume resuscitations aided by colloid. Colloids used in burn resuscitation have included dextran, albumin and plasma.¹⁰

Multitudes of formulae for fluid resuscitation in burn patients have been recommended, although all uniformly emphasize that adequate resuscitation is evidenced by a normal urinary output (1 mL/kg/h in children 0.5 mL/kg/h or at least 30-40 mL/h in adults), a normal sensorium, and stable vital signs.⁶

In this Parkland and Brook formulae were evaluated for fluid resuscitation for maintenance of intravascular compartment in patients with thermal burn. Mean total volume of fluid used in Parkland group was 8400 ± 2706.76 ml whilst in Brooke group it was 5832 ± 894.30 . This shows that burn patients can be resuscitated with less volume of fluid if colloid as albumin is used in early 24-hour period of burn resuscitation. Similar observation was reported by Cartotto *et al*, where immediate use of albumin during early burn resuscitation achieved adequate resuscitation using lower fluid volumes.¹¹

In this study fluid creep was present more in Parkland group (50%) than Brooke group (24%). This was in accordance to Lawrence *et al* who concluded that colloid administration normalizes resuscitation ratio and ameliorates fluid creep. They administered albumin as a colloid after initial use of crystalloid in those patients who require more volume of crystalloids for the urinary output.¹²

Similar to the observation of Lawrence *et al*,¹² it was observed in present study that albumin use was more expensive as median cost of treatment is INR 74000 in Brooke group and INR 58500 in Parkland group. Albumin use does not affect duration of hospital stay and mortality.¹² In the current study mean duration of hospital stay in Parkland group is 30.9 days and Brooke group is 30.7. Total hospital stay does not solely depends on fluid resuscitation but there are other factors present which can influence the final outcome which are not considered in our study.

Mortality rate in Parkland group is 38% and in Brooke group it is 32%. Lower mortality rate in Brooke group may be explained by lower incidence of increased abdominal pressure due to less volume requirement for resuscitation in early part of thermal burn injury. However these values are not statistically significant.

CONCLUSION.

To conclude, use of albumin in early period of acute thermal burn resuscitation achieves adequate resuscitation with lower fluid volumes and avoids 'fluid creep'. As noted in this study, albumin use further helps to reduce the complications due to increased abdominal pressure. Mortality although less in Brooke group (32%, n=16/50) compared with Parkland group (38%, 19/50), is more than expected and may be attributable to other aspects of albumin properties and needs to be researched further. Albumin use increases the cost of treatment and does not affect the duration of hospital stay. Parkland formula is easier

to use and is cost effective. Complications of over resuscitation can be reduced by using Brooke formula in majority of burn patients. As burn resuscitation is a complex process and number of factors plays a role in treatment outcome, we recommend using Parkland formula for initial resuscitation and use of 5% albumin in later part of resuscitation in selected patients who show increased requirement of crystalloid to maintain intravascular compartment.

Conflict of interest: Nil

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