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Research article

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Fluid resuscitation data in adults and children

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Abstract

Introduction: *The Advanced Burn Life Support (ABLS) guidelines established from the American Burn Association accepted the Parkland formula(PF) as well the Modified Brooke formula and recommend a 2 to 4 ml/kg/% of Total Body Surface Area in the first 24 hours after burn injury.*

Objectives: *The purpose of this study is to evaluate the relationship between age and resuscitation parameters (fluids/urine output) making the comparison of patients resuscitated with less than or equal to the PF with patients resuscitated more than PF. The study takes into account the first 24 hour resuscitation period for adults and children in terms of the Parkland formula. Patients And Methods: A prospective observational study was performed on 50 patients admitted in the Intensive Care (ICU) of the Service of Burns in the University Hospital Center (UHC) "Mother Teresa" in Tirana, Albania in the period January to December 2016.*

Results: *Patients who have received more than formula were with burn size 11-30% BSA Partial-Thickness burns, from scalds as causative agent mainly children ($p<0.0001$). On the contrary, patients who have received less and equal than formula were with burn size more than 30% BSA, Full-thickness burns, from flame, electrical and chemical as causative agent mainly adults($p<0.0001$).*

Conclusion: *The groupage most affected from burn injury was young children. Scalds account for 89% of burns in children while flame accounts for 59% of burns in the adults' group. We commenced resuscitation at burn size 12% for children and 20% for adults. The ROC curve tested that the cut-off is 8 years old and greater ages from 8 years old are associated with equal or less than formula resuscitation and 40% of the variance of fluid administration is explained by age.*

Keywords: Burns, Resuscitation, Children.

Introduction

The burn-injured patient has unique resuscitation requirements because of metabolic stress and specific features when compared with other forms of trauma [1]. Although fluid requirement calculations based on Parkland's formula (PF) and monitoring with simple data, such as hourly urine output (UO), mean arterial blood pressure (MAP), and heart rate (HR), are the most widespread approaches for resuscitation, it is controversial whether these parameters are sufficient in the monitoring of resuscitation [2-4].

The Advanced Burn Life Support (ABLS) guidelines established from the American Burn Association accepted the Parkland formula as well the Modified Brooke formula and recommend a 2 to 4 ml/kg/% of Total Body Surface Area (TBSA) burn range of total fluid volumes for the first 24 hours with the infusion rate adjusted to maintain a UO of 0,5 to 1,0 ml/kg/h or 30 to 50 ml/h. According to experts' recommendations, pediatric patients often require larger volumes due to a greater surface area to weight ratio and may have a higher target UO of 1.0 to 2.0 ml/kg/h [5-7]. There are studies when resuscitation in children is expressed in terms of the Parkland formula [8-10].

The purpose of this study is to evaluate the relationship between age and resuscitation parameters (fluids/urine output) making the comparison of patients resuscitated with less than or equal to the PF with patients resuscitated more than PF. The study takes into account the first 24 hour resuscitation period for adults and children in terms of the Parkland formula.

Material and Methods

A prospective observational study was performed on 150 patients admitted in the Intensive Care (ICU) of the Service of Burns in the University Hospital Center (UHC) "Mother Teresa" in Tirana, Albania in the period January to December 2016. Of these, 50

patients were critically burned and thus fulfilled inclusion criteria in our study. This encompasses patients with Body Surface Area (BSA) burned ≥20 %; patients with BSA≤ 20%BSA in burn shock but who need resuscitation; children; adults and elderly with thermal, chemical, and electrical burns, with involvement of the critical regions. Exclusion criteria were the presence of inhalation injury, trauma, pregnancy, discharge from ICU during the first 48 hours, and death within 24 hours. Patients which have had unstable clinical signs and are considered for further invasive monitoring are not included here

The % BSA burned was determined using the Lund and Browder chart. Adult patients were resuscitated with Parkland formula. In the first 24 hours fluid resuscitation was done with Lactate Ringer (LR) calculated 4 ml x weight (kg) x % of total burn surface area (TBSA) burn in %= ml/24 hours. The formula is used for initial resuscitation. The amount of calculated fluid is given in 2 stages: half of the calculated volume is administered in the first 8 hours and the other half in the next 16 hours. The initial rate of fluid administration was determined by Parkland formula, afterwards, it is titrated by the attending physicians to maintain urine output between 0.5-1.0 ml/kg/h [11].

Children were resuscitated according to the Shriner-Galveston formula which in the first 24 hours provides 5000 ml/m2 burned BSA as a resuscitation fluid and 2000 ml/m2 total BSA as a maintenance fluid. As with the adult formulas, half is given over the first 8h and the remainder is given over the next 16h. The fluid utilized in this formula is Lactated Ringer's solution with 12.5 g of 25% albumin per liter plus 5% dextrose as needed.

The baseline data are age, gender (male; female), TBSA(%), depth of burn: partial-thickness burns (PTB)% and full-thickness burns (FTB)%, etiology of burn (scalds, flame, electrical, chemical), time of hospitalization (immediately;0-3 hours;3-6 hours,6-8 hours) , mortality, LOS in ICU and in hospital. Depending on the burnt BSA we classified the patients in:11-20% BSA; 21-30% BSA; 31-50% BSA; 51-60% BSA; 61-70% BSA; 71-80% BSA and 81-100% BSA.

Fluid resuscitation was evaluated as:

- Total volume (ml) during the first and second day taking into consideration also pre-hospital volumes,
- Water load (ml/kg/%),
- Urine output (ml/kg/h)
- Patients with a fluid resuscitation of 3.7-4.3 ml/kg/% burned BSA(%) in the first 24 hours was defined to have met the calculations of Parkland Formula (PF) those who have received less and more fluids are grouped into separate groups: equal with PF, less than PF and more than PF [11].

Statistical Method

IBM SPSS statistic Software 23 program was used for the statistical analysis. The continuous data are presented by mean and SDs and were examined with Independent samples t-tests whereas the discrete variables are presented by the absolute value and percentage and the Fischer exact test is used for comparison of proportions. Linear regression models were used to study the relationship between variables. Area Under ROC was used to compare the diagnostic performance of the condition variable and criterion variables. Statistically, P values of 0.05 or less are considered with a significant difference.

Results

The cohort baseline characteristics are summarized in table 1. The average patient age was 22.0 ± 23.7 (range 1-80 years, median 5). 28 of the 50 (56%) patients were children (0-15.9 years) while adults were 22 or 44% of the total. The mean age in the children's group was 2.8 ± 2.6 years and in the adults' group was 46.4 ± 13.9 years. Approximately 60% of the population was male with a male to female ratio of 1.5:1.

Mean BSA (%) burned for all patients was 30.56 ± 16.1%, minimum 12%, maximum 80%, median 25. We have commenced resuscitation at burn size 12% for children and 20% for adults. Mean BSA (%) burned for children was 27.4 ± 17.1 %, while for adults was 34.5 ± 14.1%. There were 9 children with burns less than 20% which needs resuscitation. In the children group, 25 of 28 patients have burns up to 40% BSA where burns 11-20% are predominant (15 patients or 53.6% of children) and 10% are presented with burns from 40% to 80%BSA. In the adults group, there were 6 patients (27.3%) with burns 20% BSA, and 18 patients (72.7%) were with burns up to 60% BSA.

FTB was present in 13 patients or 26% of the total number while within groups they accounted for 14% of children (4 of 28 patients) and 41% of the adults' group (9 of 22 patients). The major part of burns was caused by scalds 27 patients (54% of the total) out of which 25 were children. Scalds account for 89% of burns in children. The flame was the cause of the burns in 16 patients or 32% of the total out of which the major part, 13 patients, were adults. Flame accounts for 59% of burns in the adult group. Electrical burns represented 10% of all burns and all patients were adults ranging from 40 to 59.9 years. Finally, chemical burns were present only in adults: 2 patients or 4% of all patients.

Table 1: Cohort Baselines Characteristics.

		ALL PATIENTS	GROUP-AGES	
		(n=50)	Children (n=28)	Adults (n=22)
Age, mean ± sd		22.0 ± 23.7	2.8 ± 2.6	46.4 ± 13.9
Gender	Male, n (%)	30(60)	17(61)	13(59)
BSA(%)burned, Mean ± SD		30.56 ± 16.1	27.4 ± 17.0	34.5 ± 14.1
Grouping according BSA(%)burned, n(%)	10-20	21(42)	15(53.6)	6(27.3)
	21-30	10(20)	6(21.4)	4(18.2)
	31-40	10(20)	4(14.3)	6(27.3)
	41-50	4(8)	1(3.6)	3(13.6)
	51-60	3(6)	0(0)	3(13.6)
	61-70	1(2)	1(3.6)	0(0)
	71-80	1(2)	1(3.6)	0(0)
Cause of burn	Scalds, n(%)	27(54)	25(89)	2(9)
	FLAME, n(%)	16(32)	3(11)	13(59)
	ELECTRICAL, n(%)	5(10)	0(0)	5(22)
	CHEMICAL, n(%)	2(4)	0(0)	2(9)
Depth of burn	Partial thickness, n(%)	37(74)	24(86)	13(59)
	FULL THICKNESS,N(%)	13(26)	4(14)	9(41)
Time of hospitalization	Immediately, n(%)	20(40)	14(50)	6(27)
	0-3 hours, n(%)	20(40)	8(29)	12(55)
	3-6 hours ,n(%)	9(18)	5(18)	4(18)
	6- 8 hours,n(%)	1(2)	1(3)	0(0)
MORTALITY,n(%)	-	1(2)	1(4)	0(0)
Icu los ,mean ± sd	-	11.54 ± 9.2	9.6 ± 7.6	14 ± 10.5
Hospital Los, mean ± sd	-	12.7 ± 7.8	10.1 ± 6.3	16.1 ± 8.2

Patients were admitted to the burn center 2.4 ± 1.6 hours after injury (range 1-7 hours) where 80% of them were presented immediately up to three hours after burn and 20% after 3 hours of injury. 42-% of patients were treated with fluid therapy in regional hospitals and 58% were presented directly in our service. First aid was given before hospitalization in 36 patients or 72% and only 14 patients or 28% presented to our service without first aid.

Outcome data are as follows: 46 or 92% were survivors. Mortality was 2%, while 3 patients or 6% were transferred abroad for completing the treatment. LOS was 11.5 ± 9.2 days in the intensive care unit (ICU) and 12.7 ± 7.8 days in the hospital.

Table 2: General characteristics of patients according to resuscitation in the first 24 hours.

	Equal with Parkland Formula(n=8)	Less than Parkland Formula(n=24)	More than Parkland Formula (n=18)	Significance p
Age(years),mean ± SD	34.25 ± 22	32.9 ± 24.4	2(1.7)	<0.0001
BSA burn(%),mean ± SD	33.12 ± 14.71	37 ± 16.27	22.05 ± 23.46	0.04
BSA groups,n(%)				
11-20%	4(50)	4(16.7)	13(72.2)	0.06
21-30%	0(0)	6(25)	4(22.2)	0.39
31-40%	1(12.5)	9(37.5)	0(0)	0.03
41-50%	2(25)	2(8.3)	0(0)	0.15
51-60%	1(12.5)	2(8.3)	0(0)	0.41

61-70%	0(0)	1(4.2)	0(0)	0.5
71-80%	0(0)	0(0)	1(5.6)	0.42
Full-Thickness,n(%)	3(37.5)	10(41.7)	0(0)	0.03
Partial-Thickness,n(%)	5(62.5)	14(58.3)	18(100)	0.4
BSA(%) Full-Thickness,mean ± SD	26.6 ± 11.54	39 ± 13.49	0 ± 0	<0.0001
BSA(%) Partial-Thickness,mean ± SD	37 ± 16.04	35.5 ± 13.81	22.0 ± 15.3	0.009
Cause of burn, n(%)				
Scalds	2(25)	8(33)	17(94.4)	0.07
Flame	4(50)	11(45.8)	1(5.6)	0.07
Electrical	2(25)	3(12.5)	0(0)	0.18
Chemical	0(0)	2(8.3)	0(0)	0.35
Water load (ml/kg/%),mean ± SD	3.97 ± 0.28	2.88 ± 0.53	5.44 ± 0.99	<0.0001
Urine Output(ml/kg/h),mean ± SD	1.58 ± 0.51	1.29 ± 0.35	1.79 ± 0.33	<0.0001
Children,n(%)	2(7.1)	8(28.6)	18(64.3)	0.05
Adults,n(%)	6(27.3)	16(72.7)	0(0)	0.005
Survival,n(%)	8(100)	23(95.8)	18(100)	0.9
ICU Length of Hospital Stay(days),mean(SD)	10.75 ± 6.59	14.9 ± 12.4	7.33 ± 3.55	0.04

In table 2 we present resuscitation characteristics for water load (ml/kg/%) and urine output (ml/kg/h) of patients in different groups (children and adults) resuscitated equal with PF (8 patients or 16%), less than PF (24 patients or 48%) and more than PF (18 patients or 36%).

All of the patients of the adult group (100% of adult patients) were resuscitated with volumes equal and less than PF: 6 or 27.3% and 16 or 72.7% respectively and no adult patient required more than 4.3 ml/kg/% of LR. Of 32 patients 10 were children which in terms of PF were resuscitated equal or less than PF.

The presence of FTB was approximately 40% in the first two groups (3 patients from 8 in group equal with PF and 10 patients from 24 in the group resuscitated with less than PF) while all patients in the group more than PF have PTB (n=18). All the patients in the group resuscitated more than PF were children with a mean age of 2 ± 1.7 years, in 13 patients (72.2%) burn size was in the range 11-20%, scalds were the etiologic factor in 17 patients (94.4%) while flame in only 1 patient. The water load in this group was 5.44 ± 0.99 ml/kg/% while the urine output was 1.79 ± 0.33 ml/kg/h.

In children, UO amounts to the same values as the UO of the group resuscitated with more than PF while there is a reduction of UO values in adults in the group resuscitated with less than PF (1.17 ± 0.34 vs 1.53 ± 0.43 ml/kg/h, p=0.05). There is also a statistical difference regarding UO between groups, tested by ANOVA, concerning flame burns, PTB, and burns 21-30% BSA.

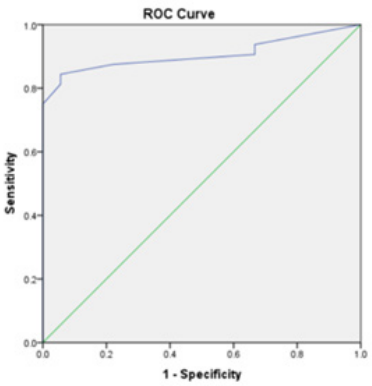
Table 3: Resuscitation characteristics in different groups according to parkland formula.

BSA groups	Equal with Parkland Formula (n=8)	Less than Parkland Formula (n=24)	More than Parkland Formula (n=18)	p	Equal with Parkland Formula (n=8)	Less than Parkland Formula (n=24)	More than Parkland Formula (n=18)	p
	Water load (ml/kg/%),mean ± SD				Urine Output(ml/kg/h),mean ± SD			
11-20%	4.09 ± 0.24 (n=4)	2.43 ± 0.34 (n=4)	5.77 ± 0.82 (n=13)	<0.0001	1.88 ± 0.55(n=4)	1.42 ± 0.19 (n=4)	1.69 ± 0.32 (n=13)	0.26
21-30%	0 ± 0 (n=0)	3.28 ± 0.17 (n=6)	4.95 ± 0.52 (n=4)	<0.0001	0 ± 0 (n=0)	1.31 ± 0.40 (n=6)	2.08 ± 0.20 (n=4)	0.008
31-40%	3.64 ± 0.00(n=1)	2.77 ± 0.66 (n=9)	0 ± 0 (n=0)	0.24	1.08 ± 0.00(n=1)	1.09 ± 0.27 (n=9)	0 ± 0 (n=0)	0.97
41-50%	3.75 ± 0.06(n=2)	3.01 ± 0.67 (n=2)	0 ± 0 (n=0)	0.26	1.35 ± 0.13(n=2)	1.77 ± 0.54 (n=2)	0 ± 0 (n=0)	0.39
51-60%	4.30 ± 0.00(n=1)	2.97 ± 0.04 (n=2)	0 ± 0 (n=0)	0.02	1.31 ± 0.00(n=1)	1.18 ± 0.31 (n=2)	0 ± 0 (n=0)	0.79

61-70%	0 ± 0 (n=0)	2.73 ± 0.00 (n=1)	0 ± 0 (n=0)	NA	0 ± 0 (n=0)	1.81 ± 0.00 (n=1)	0 ± 0 (n=0)	NA
71-80%	0 ± 0 (n=0)	0 ± 0 (n=0)	3.09 ± 0.00 (n=1)	NA	0 ± 0 (n=0)	0 ± 0 (n=0)	1.78 ± 0.00 (n=1)	NA
Degree								
Full-Thickness	3.99 ± 0.31(n=3)	3.07 ± 0.40 (n=10)	0 ± 0 (n=0)	0.004	1.36 ± 0.53(n=3)	1.16 ± 0.27 (n=10)	0 ± 0 (n=0)	0.38
Partial-Thickness	3.96 ± 0.30(n=5)	2.73 ± 0.58 (n=14)	5.44 ± 0.99 (n=18)	<0.0001	1.70 ± 0.51(n=5)	1.39 ± 0.37 (n=14)	1.79 ± 0.33 (n=18)	0.01
Cause of burn								
Scalds	3.69 ± 0.07(n=2)	2.94 ± 0.53 (n=8)	5.43 ± 1.0 (n=17)	<0.0001	1.73 ± 0.91(n=2)	1.42 ± 0.40 (n=8)	1.78 ± 0.33 (n=17)	0.12
Flame	4.02 ± 0.31(n=4)	2.77 ± 0.60 (n=11)	5.66 ± 0.00 (n=1)	<0.0001	1.54 ± 0.40(n=4)	1.09 ± 0.26 (n=11)	1.87 ± 0.00 (n=1)	0.01
Electrical	4.16 ± 0.14(n=2)	3.13 ± 0.52 (n=3)	0 ± 0 (n=0)	0.08	1.51 ± 0.66(n=2)	1.58 ± 0.22 (n=3)	0 ± 0 (n=0)	0.86
Chemical	0 ± 0 (n=0)	2.81 ± 1.87 (n=2)	0 ± 0 (n=0)	NA	0 ± 0 (n=0)	1.44 ± 0.57 (n=2)	0 ± 0 (n=0)	NA
Children	3.69 ± 0.07(n=2)	2.98 ± 0.45 (n=8)	5.44 ± 0.99 (n=18)	<0.0001	1.73 ± 0.91(n=2)	1.53 ± 0.23 (n=8)	1.79 ± 0.33 (n=18)	0.23
Adults	4.07 ± 0.26(n=6)	2.82 ± 0.57 (n=16)	0 ± 0 (n=0)	<0.0001	1.53 ± 0.43(n=6)	1.17 ± 0.34 (n=16)	0 ± 0 (n=0)	0.05

In table 3 we have given the data for water load (ml/kg/%) and Urine output (ml/kg/h) in three groups of patients regarding BSA%, Degree, and cause of burns. Patients who have received more than formula were with burn size 11-30% BSA Partial-Thickness burns, from scalds as causative agent mainly children (p<0.0001). On the contrary, patients who have received less and equal than formula were with burn size more than 30% BSA, Full-thickness burns, from flame, electrical and chemical as causative agent mainly adults(p<0.0001). Patients who have urine output greater than normal values were children, burns from scalds, and partial-thickness burns.

We want to set the threshold for fluid administration (ml/kg/%) or water load in the 1st 24 hours and age classification positive state (fluid load less and equal Parkland formula) and negative state (fluid load more than Parkland formula). In figure 1 the ROC curve tested that the cut-off is 8 years old and greater ages from 8 years old are associated with equal or less than formula resuscitation



Diagonal segments are produced by ties.

Area Under the Curve

Test Result Variable(s): AGE

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.905	.044	.000	.819	.992

The test result variable(s): AGE has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

Coordinates of the Curve

Test Result Variable(s): AGE

Positive if Greater Than or Equal To[a]	Sensitivity	1 - Specificity
.000	1.000	1.000
1.250	.938	.667
1.750	.906	.667
2.500	.875	.222
3.500	.844	.056
4.500	.813	.056
8.000	.750	.000
18.500	.688	.000
26.500	.656	.000
27.500	.625	.000
30.000	.594	.000
33.500	.531	.000
36.000	.500	.000
39.500	.469	.000
44.000	.406	.000
46.500	.375	.000
47.500	.313	.000
48.500	.250	.000
51.000	.219	.000
53.500	.188	.000
55.000	.156	.000
57.500	.125	.000
62.000	.094	.000
66.500	.063	.000
74.000	.031	.000
81.000	.000	.000

The test result variable(s): AGE has at least one tie between the positive actual state group and the negative actual state group.

Figure 1: ROC curve for testing age threshold for water load (More, less, or equal with Parkland formula).

We performed Linear regression with the dependent variable fluid volume and age as requested variables. The adjusted R square is .40 which means that 40% of the variance of fluid administration is explained by age (Figure 2).

Regression

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	AGE[b]	.	Enter

a. Dependent Variable: volume resuscitation 24 h

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.639[a]	.408	.396	.377

a. Predictors: (Constant), AGE

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.703	1	4.703	33.110	.000[b]
	Residual	6.817	48	.142		
	Total	11.520	49			

a. Dependent Variable: volume resuscitation 24 h

b. Predictors: (Constant), AGE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.647	.073		8.863	.000
	AGE	-.013	.002	-.639	-5.754	.000

a. Dependent Variable: volume resuscitation 24 h

Figure 2: Linear regression of volume resuscitation and age.

Discussion

Firstly, we will focus on the description of the patients included in the study (28 children and 22 adults) who were admitted to the burn center 2.4 ± 1.6 hours after injury (range 1-7 hours). This is a similar timeline to the one suggested by other studies [12]. The criteria for admission to the ICU cannot be strict considering that every burned patient presents his individuality in response to the burn trauma. Concretely, we noticed that 9 children (18% of the total) with less than 20% BSA burns were admitted to the ICU starting from the 12% BSA surface. 6 adults (12% of the total) were also admitted with 20% BSA burns. Although in most cases children were hospitalized with burns of 12-20%, there were also children with a large burn area of up to 60% BSA. From our data, we notice that burns in children were PTB in 24 out of 28 cases (86%) while in adults there was an equal distribution of FTB and PTB. Scalds caused the major part of burns for 27 patients (54% of the total), of which 25 patients were children. While the main causative agent in the adult group was flame which is the same as the cause mainly reported by other authors as well [12,13].

Secondly, we will discuss our data regarding the principal exposure of interest fluid resuscitation. Charles Baxter and G. Tom Shires have stated that the majority of burn patients (70% of adults) will be adequately resuscitated if they receive 3,7 to 4,3 ml/kg/% of

Total Body Surface Area (TBSA) burn of Ringer's lactate in the first 24 hours following injury and only 12% require more than 4,3 ml/kg/% TBSA. The actual endpoint of resuscitation that was achieved with this regimen was suggested to be a urine output of more than 40 ml/h on average. The Parkland Formula suggests that during the 4th 8 hour period post-burn, plasma should be administered at 0.3 to 0.5 ml per weight in kilograms per total body surface area burned and that during the second 24 hour period the electrolyte solution should be titrated to maintain urine output at 50ml/hr. Additionally, Baxter and Shires placed the maximum size of the burn for calculation purposes at 50% [11,14-16].

In our study patients' ages ranged from 1 to 80 years. 28 children ranging between 1-15.9 years (mean 2.8 ± 2.6 years) with BSA burned 12 to 80% (mean 27.4 ± 17.0%) met the inclusion criteria. The average total volume of fluid received during the first 24 hours in terms of PF was 4.6 ± 1.4 ml/kg/% ranging from 2.5 to 7.2 ml/kg/%. It has been suggested that pediatric patients require approximately 6 to 8 ml/kg/% BSA burned [8-10]. 22 adults ranging between 26 -80 years (mean 46.4 ± 13.9 years) with BSA (%)burned 20-60% (mean 34.5 ± 14.1%) met the inclusion criteria. The average fluid received during the first 24h was 3.1 ± 0.75 ml/kg/%, median 3.2, minimum 1.6, and maximum 4.3 ml/kg/% so all the adults were resuscitated less or equal with PF.

As we have demonstrated the majority of patients are clustered in the range 2-4 ml/kg/%. We have no adult patient resuscitated with more fluid than according to PF. From our study 24 patients or 48% of which 16 adults and 8 children received less than PF volumes,8 patients or 16% received standard resuscitation volumes (6 adults and 2 children) and 18 patients or 36% received more than PF volumes (all were children). Considering adult patients only, we find 16 patients (73% of the adults) who received restricted volumes and only 6(27%) who received standard resuscitation volumes. Some studies have noticed a considerable number of patients receiving more than PF from 58% to 86.2% of their total number. However, though, there are studies with similar numbers to ours where the percentage of patients resuscitated with volumes equal to PF range from 13% to 13.8% of the total number [2,3,17].

Greenhalgh recently published findings from a survey of American Burn Association (ABA) and International Society for Burn Injuries (ISBI) members regarding various topics in resuscitation. According to Greenhalgh, 94.9% of responders used urine output as a major index of successful resuscitation [18].

Our data showed that the 1st 24h mean UO for all patients was 1.5 ± 41.6 ml/h. These UO values are higher than the ideal values of 0.5-1.0 ml/kg/h in 77.3% of adults, with an average of 1.2 ± 0.3 ml/kg/h or 95.1 ± 31 ml/h, and only 5 patients had ideal values. The latter is part of the group resuscitated with less than PF and, interestingly, UO remains in higher values also in the group resuscitated equal to PF. These data are consistent with many authors [4,7]. Children had UO values 1.7 ± 0.35 ml/kg/h or 23.9 ± 9.1 ml/h in a range of 1.0-2.0 ml/kg/h where only 8 patients in the group having resuscitated with less than PF had values of up to 1.5 ml/kg/h while all others had values more than 1.5 ml/kg/h. Our opinion is that fluids given even equal with PF or more than PF are accompanied by higher UO and the theoretical values of this parameter can be achieved only with strict monitoring.

Conclusion

The groupage most affected from burn injury was young children. Scalds account for 89% of burns in children while flame accounts for 59% of burns in the adults' group. We commenced resuscitation at burn size 12% for children and 20% for adults.

Patients who have received more than formula were with burn size 11-30% BSA Partial-Thickness burns, from scalds as causative agent mainly children ($p<0.0001$). On the contrary, patients who have received less and equal than formula were with burn size more than 30% BSA, Full-thickness burns, from flame, electrical and chemical as causative agent mainly adults ($p<0.0001$). The ROC curve tested that the cut-off is 8 years old and greater ages from 8 years old are associated with equal or less than formula resuscitation and 40% of the variance of fluid administration is explained by age.

References

1. Dries DJ, Waxman K (1991) Adequate resuscitation of burn patients may not be measured by urine output and vital signs. Crit Care Med 19:327-329.
2. Cartotto RC, Innes M, Musgrave MA, Gomez M, Cooper AB (2002) How well does the Parkland formula estimate actual fluid resuscitation volumes? J Burn Care Rehabil23:258-265.
3. Blumetti J, Hunt JL, Arnoldo BD, Parks JK, Purdue GF (2008) The Parkland formula under fire: Is the criticism justified? J Burn Care Res 29:180-186.
4. Friedrich JB, Sullivan SR, Engrav LH, Round KA, Blayney CB, Carrougher GJ, et al. (2004) Is supra-Baxter resuscitation in burn patients a new phenomenon? Burns 30:464-466.
5. https://evidencebasedpractice.osumc.edu/Documents/Guidelines/ABLSProviderManual_20101018.pdf
6. Warden GD (2007) Fluid resuscitation and early management. In: Herndon DN, ed.Total Burn Care.2nd ed. London, U.K.: Saunders 2007:107-118
7. Sheridan R, Remensnyder J, Prelack K, Petras L, Lydon M (1998) Treatment of the seriously burned infant. J Burn Care Rehabil 19(2):115-118.
8. Graves TA, Cioffi WG, McManus WF, Mason AD Jr, Pruitt BA Jr (1988) Fluid resuscitation of infants and children with massive thermal injury. J Trauma 28(12):1656-1659.
9. Merrell SW, Saffle JR, Sullivan JJ, Navar PD, Kravitz M, Warden GD (1986) Fluid resuscitation in thermally injured children Am J Surg 152(6):664-669.
10. Dittrich MHM, Hosni ND, de Carvalho WB (2019) Resuscitation in Extensive Burn in Pediatrics and Fluid Creep: An Update. Curr Treat Options Peds 5:448-457.
11. Baxter CR, Shires T (1968) Physiologic response to crystalloid resuscitation of severe burns. Ann NY Acad Sci 150:874-893.

12. Mitchell KB, Khalil E, Brennan A, Shao H, Leah ARNE, Yurt RW, et al. (2013) New management strategy for fluid resuscitation: quantifying volume in the first 48 hours after burn injury. J Burn Care Res 34:196-202.
13. Salinas J, Drew G, Gallagher J, Cancio LC, Wolf SE, Wade CE, et al. (2008) Closed-loop and decision assist resuscitation of burn patients. J Trauma 64(suppl 4): S321-332
14. Elgjo GI, Traber DL, Hawkins HK, Kramer GC (2000) Burn resuscitation with two doses of 4 ml/kg hypertonic saline dextran provides sustained fluid sparing: a 48 hours prospective study in conscious sheep. J Trauma 49:251-265.
15. Baxter CR (1978) Problems and complications of burn shock resuscitation. Surg Clin North America 58:1313-1322.
16. Baxter CR (1979) Fluid resuscitation, burn %, and physiologic age. J Trauma 19:864-865.
17. Engrav LH, Colescott PL, Kemalyan N (2000) A biopsy of the use of the Baxter formula to resuscitate burns or do we do it as Charlie did it? J Burn Care Rehabil 21:91-95.
18. Greenhalgh DG (2010) Burn resuscitation: the results of the ISBI/ABA survey Burns 36(2):176-182.