Al-Azhar International Medical Journal

Volume 4 | Issue 1 Article 33

1-2023

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How to Cite This Article

El- mofty, Ahmed Maged; Nasef, Mahmoud Abdelfatah; Ibrahim, Ahmed Fathy Abd Elaziz; and Mahmoud, Ahmed Elsayed Abd Elhameed (2023) "Evaluation of Enteral Fluid Resuscitation in Burned Patients," *Al-Azhar International Medical Journal*: Vol. 4: Iss. 1, Article 33.
DOI: https://doi.org/10.58675/2682-339X.1634

CASE SERIES

Evaluation of Enteral Fluid Resuscitation in Burned Patients

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Abstract

Background: **Burn injuries are among the most devastating of all injuries and a major global crisis of public health concern.**

Aim and objectives: **The study's objective was to assess how enteral fluid resuscitation affects burned patients.**

Patients and methods: **A randomized controlled clinical trial was performed in this study. This study was done at the burn unit of the Department of Plastic and Burn Surgery at Al-Azhar University Hospitals (Alhussien and Said Galal hospitals) and Hehia Burn Center (El-Sharkia Governorate).**

Results: **Regarding studied electrolytes among the three groups (control group A, with parenteral burn resuscitation, and two studied groups B and C, with enteral burn resuscitation), there was a significant difference in Na levels in first 36 h only. However, there was no significant difference regarding K. There was no significant difference regarding hematocrit except at the last result at 48 h. Moreover, there was a notable difference among groups regarding mean urine output and pulse.**

Conclusion: **It is safe to say that oral rehydration therapy was successful in the resuscitation of moderately burned patients (Total Burn Surface Area (TBSA) 15–35% and age between 14 and 45 years) with the following benefits: ease of use, low cost, possible for use as first aid until the patient is transported to a hospital, no risk of fluid overload, and avoidance of all the difficulties and dangers associated with intravenous infusions.**

Keywords: Burn injuries, Enteral fluid resuscitation, First aid treatment, Oral rehydration therapy

1. Introduction

Burn injuries have a high morbidity and fatality rate yet are underappreciated injuries. Burn injuries, especially severe burns, are complicated with inflammatory and immunological response, metabolism abnormalities, and distributive shock that can cause multiple organ failure and be difficult to manage. As a result, burn injury patients cannot be deemed recovered once their wounds have healed because burn injury causes profound long-term changes that must be addressed to maximize quality of life. Therefore, providers of burn care are faced with a plethora of difficulties, such as managing critical and acute care, long-term care, and rehabilitation.[1]

One of the most severe types of injuries, burns represent a serious public health issue on a global scale.[2] Burns are a trauma associated with poverty; almost 90% of burns happen in low-income and middle-income country as well as the poorer regions of high-income countries.[3]

Worldwide, intravenous (IV) routes are used to administer all burn resuscitation formulas; these formulas vary in volume, sodium (NA) content, and colloid content. Chemical and mechanical irritability, circulatory overload resulting in fluid creep, infection at the cannula site resulting in thrombophlebitis/phlebitis, sepsis, and even septic shock are all limitation of IV resuscitation. Additionally, it is not convenient in disaster and mass casualties.[4] Burns of 20%

Received 9 July 2022; accepted 24 August 2022.
Available online 22 January 2024

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https://doi.org/10.58675/2682-339X.1634

TBSA can be resuscitated and burns up to 40% TBSA can most likely be resuscitated using oral resuscitation solutions (ORS).[5] The goal of the study was to assess how enteral fluid resuscitation affects burned people.

2. Patients and methods

A randomized controlled clinical trial was used in this study. This study was done at the Burn Unit of the Department of Plastic and Burn Surgery at Al-Azhar University Hospitals (Alhussien and Said Galal hospitals) and Hehia Burn Center.

2.1. Inclusion criteria

All patients included in this study met the following criteria: age from 14 to 45 years; both sexes; fresh burns (flame and scald burn), that is, thermal burns that appear within 8 h of the injury; and total burn surface area of 15–35%.

2.2. Exclusion criteria

Patients with respiratory damage, associated injuries (multiple traumas, internal hemorrhage, etc.), co-morbidities (diabetes mellitus, hypertension, renal failure, ischemic heart disease, and chronic liver disease), pregnancy and breastfeeding, and any medical or surgical gastrointestinal diseases were the exclusion criteria.

2.3. Study design

A total of 60 consecutive patients with burns were selected during the period from June 2018 to June 2021 based on inclusion and exclusion criteria. They were prospectively randomized into three groups of 20 patients each.

Group A (control group): parenterally resuscitated using the Parkland technique, that is, 4 ml/kg/% burn for the first 24 h using Ringer lactate (RL) solution, and after 24 h, 1 ml/kg/% burn RL solution for crystalloid.

Group B: resuscitated enterally according to the Sorensen's formula using WHO-ORS sachets, that is, 150–200 ml/kg for the first 24 h, and 100–150 ml/kg for the second 24 h. One liter of water is mixed with five WHO-ORS sachets and delivered through a nasogastric tube.

Group C: resuscitated enterally according to the Parkland formula by RL solution through nasogastric tube (4 ml/kg/TBSA%).

Patients were subjected to standard local and general burn management including weighing the patient, insertion of a urinary catheter, and nasogastric tube. They also underwent clinical examination, assessment of the burn wound, recording of their medical history, and laboratory analysis such as whole blood picture, Na, potassium (K), arterial blood gases, blood urea, and serum creatinine at admission and at the end of resuscitation period.

2.3.1. Patient monitoring

In all groups, each patient's condition was similarly observed to ensure that resuscitation was both sufficient and successful and that their overall health was stable. The monitoring system used in the burn unit was as follows: clinical monitoring [mainly heart rate and blood pressure (BP)] with detection of signs and symptoms of shock, urine output, hematocrit value, and Na and K.

2.3.2. End point of oral resuscitation

To ensure the safety of the study groups B and C, clinical monitoring of the patients; if there was any deterioration, patient were excluded from this group and managed parenterally according to the Parkland formula.

Each patient was subjected to the criteria of admission, that is, burns that affect the face, hands, feet, genitalia, perineum, or major joints, as well as partial-thickness burns greater than 10% TBSA. Patients with full-thickness and deep partial-thickness burns in any age group; patients with burns caused by electricity, chemicals, or suspicion of an inhalation injury were admitted and resuscitated. Then, history taking and general examination were performed:

Vital signs at the time of admission such as BP, pulse, and temperature were assessed. Associated injuries were recorded, as some of patients may have associated injury with the burn such as head trauma and fracture lower limb. Then, local examination was performed, including type of burn (thermal, chemical, or electrical burn), size (estimation of burn percentage), total body surface area depending on Lund and Browder chart, site of burn (either it is a special area or not, whether the limbs or chest – if affected – circumferential or not, and if the face is burned, we asked about signs of inhalation), and depth of burn by clinical evaluation, whether it was superficial dermal, deep dermal, or full-thickness burn.

2.3.3. Laboratory investigations

Routine laboratory investigation included complete blood count, coagulation profile, liver function

test, kidney function test, arterial blood gases, electrolytes (Na and K), serum albumin, total protein, random blood sugar, and viral markers (hepatitis B surface antigen and antibody, hepatitis C antibody, and HIV screen). All tests were done on admission to assess general health condition of the patient, correct any present disturbances, and begin case management.

This study was carried out on 60 burned patients admitted to the Burn Unit of Al-Azhar University Hospital and Hehia Burn Center. Their burns ranged from 15 to 35% TBSA. All patient received the general care for burn according to the protocol of treatment in burn units.

These burned patients were either given IV fluid therapy or oral rehydration therapy to resuscitate them. Rehydration methods were chosen at random, with one patient receiving IV fluid, the next receiving oral fluid, and so on.

The first group (A) included 20 burn patients who were regarded as the control group. They were between the ages of 15 and 43 years. There were 12 men and 8 women. Their mean burn severity was 24.40 ± 5.87% TBSA. A total of 13 patients had burns from fires, and the remaining 7 had scalds. The Parkland formula was used as a guide to administer IV fluid therapy to the patients in this group to resuscitate them.

The second group (B) included 20 patients with burns. Their ages ranged from 16 years to 42 years. There were 15 males and 5 females, and the mean extent of their burns was 27.00 ± 4.81% TBSA. The cause of the burn was flames in 15 patient and scalds in 5 (Table 2). ORS was used to resuscitate this particular set of patients, considering that all fluids delivered orally will be fully absorbed by the gastrointestinal tract and considering that the weight of the patient and the severity of the burn would determine the amount of fluids needed for resuscitation. The ORS must be dissolved in 200 ml of water each packet. By dividing the total amount of fluids by 200, we can determine how many packets will be necessary to provide half the solution during the first 8 h and the other half during the following 16 h. On the second postburn day, in addition to other nutritional materials as needed, this solution is also administered.

The third group (group C) included 20 patients with burns. Their ages ranged from 16 to 43 years. There were 14 males and 6 females, and the mean extent of their burns was 25.55 ± 5.40% TBSA. The cause of the burn was flames in 16 patient and scalds in 4 (Table 2). This group was resuscitated enterally by lactated ringer through nasogastric tube according to the Parkland formula (4 ml/kg/TBSA%).

All the patients under study were monitored for vital signs and urine output every 8 h. Blood samples were taken every 12 h to evaluate the efficacy of resuscitation, by determination of serum Na, K, and hematocrit.

3. Results

Regarding the demographic data among the studied groups as demonstrated in (Tables 1–5), we found that there was no statistically significant difference regarding age, sex, and weight. Table 1 shows that regarding burn details, our study showed that in group A, majority of the patients (30%) had TSBA of 20–24%, whereas in group B, majority of the patients (40%) had TSBA of 30–35%, and in group C, majority of the patients (35%) had TSBA of 25–29%, without statistically significant difference. The three studied groups were comparable in percentages of burn degree and etiology also, without statistically significant difference.

To our knowledge, there are very limited comparative-controlled studies in the literature on this topic, and this is the first study that compared cases resuscitated parenterally according to the Parkland formula, resuscitated enterally according to the Sorensen's formula by WHO-ORS and those resuscitated enterally according to the Parkland formula by RL solution.

Tables 1 and 2 show that the three studied groups were comparable regarding basic characteristics, without statistically significant difference.

3.1. Clinical outcome of different groups

The patient's BP was recorded every 8 h in all groups, and the results showed no statistically significant difference among groups.

The patients' pulse was recorded every 8 h in all groups, and the results showed statistically significant difference among groups, especially between group A and group B and between group A and group C, as shown from post-hoc analysis.

3.2. Urine output

The patient's urine output was recorded every 8 h in all groups, and the results showed statistically significant difference among groups, especially between group A and group C and between group B and group C, as shown from post-hoc analysis.

Table 1. Descriptive for demographic data and characteristics of burn of the studied patients.

	$N = 60$ [n (%)]
Sex	
Female	19 (31.7)
Male	41 (68.3)
Age	
Mean ± SD	29.47 ± 7.05
Range	15–43
Weight	
Mean ± SD	83.12 ± 9.48
Range	62–102
Cause	
Flame	44 (73.3)
Scaled	16 (26.7)
Degree	
Deep Dermal	34 (56.7)
Superficial Dermal	16 (26.7)
Deep	10 (16.7)
TBSA%	
Mean ± SD	25.65 ± 5.40
Range	15–35
Percentage	
15–19	8 (13.3)
20–24	15 (25.0)
25–29	19 (31.7)
30–35	18 (30.0)

3.3. Laboratory

3.3.1. Na level

The patient's Na level was recorded every 12 h in all groups, and the results showed statistically significant difference among groups in the first 36 h, especially between group A and group B and between group B and group C, as shown from post-hoc analysis (Table 6).

3.3.2. K

The patient's K level was recorded every 12 h in all groups, and the results showed no statistically significant difference (Table 7).

3.4. Hematocrit level

The patient's hematocrit levels were recorded every 12 h in all groups, and the results showed no statistically significant difference among groups, except at the last result at 48 h, especially between group A and group B (Table 8).

Table 2. Comparison among group A, group B, and group C based on demographic data and characteristics of the burn.

	Group A ($N = 20$) [n (%)]	Group B ($N = 20$) [n (%)]	Group C ($N = 20$) [n (%)]	Test value	P value	Significance
Sex						
Female	8 (40.0)	5 (25.0)	6 (30.0)	1.078[a]	0.583	NS
Male	12 (60.0)	15 (75.0)	14 (70.0)			
Age						
Mean ± SD	30.00 ± 7.74	29.55 ± 6.38	28.85 ± 7.27	0.131[b]	0.877	NS
Range	15–43	16–42	16–43			
Weight						
Mean ± SD	84.10 ± 10.37	81.80 ± 10.79	83.45 ± 7.20	0.306[b]	0.738	NS
Range	62–102	65–99	73–97			
Cause						
Flame	13 (65.0)	15 (75.0)	16 (80.0)	1.193[a]	0.551	NS
Scaled	7 (35.0)	5 (25.0)	4 (20.0)			
Degree						
DD	10 (50.0)	12 (60.0)	12 (60.0)	1.535[a]	0.820	NS
SD	6 (30.0)	6 (30.0)	4 (20.0)			
Deep	4 (20.0)	2 (10.0)	4 (20.0)			
TBSA						
Mean ± SD	24.40 ± 5.87	27.00 ± 4.81	25.55 ± 5.40	1.173[b]	0.317	NS
Range	15–35	18–34	17–35			
Percentage						
15–19	4 (20.0)	1 (5.0)	3 (15.0)	3.571[a]	0.734	NS
20–24	6 (30.0)	4 (20.0)	5 (25.0)			
25–29	5 (25.0)	7 (35.0)	7 (35.0)			
30–35	5 (25.0)	8 (40.0)	5 (25.0)			

$P > 0.05$: nonsignificant.
$P < 0.05$: significant.
$P < 0.01$: highly significant.
[a] χ^2-test.
[b] One-way analysis of variance test.

Table 3. Comparison among group A, group B, and group C regarding BP.

BP	Group A ($N = 20$)	Group B ($N = 20$)	Group C ($N = 20$)	Test value[a]	P value	Significance
1–8 h						
Mean ± SD	106.50 ± 6.78	106.50 ± 6.12	104.75 ± 5.34	0.547	0.581	NS
Range	96–116	96–115	96–112			
8–16 h						
Mean ± SD	108.65 ± 4.85	107.50 ± 3.69	106.65 ± 3.92	1.151	0.324	NS
Range	100–118	101–115	99–113			
16–24 h						
Mean ± SD	110.45 ± 5.70	110.25 ± 3.61	108.80 ± 3.74	0.818	0.446	NS
Range	100–119	103–117	102–114			
24–32 h						
Mean ± SD	112.25 ± 4.94	112.55 ± 3.65	111.90 ± 3.65	0.124	0.883	NS
Range	102–119	106–120	105–117			
36–40 h						
Mean ± SD	114.20 ± 3.94	114.70 ± 3.60	113.90 ± 3.64	0.235	0.792	NS
Range	106–120	108–122	108–119			
41–48 h						
Mean ± SD	116.65 ± 3.59	117.45 ± 3.33	117.05 ± 3.78	0.251	0.779	NS
Range	109–122	112–124	112–123			

BP, blood pressure.
$P > 0.05$: nonsignificant.
$P < 0.05$: significant.
$P < 0.01$: highly significant.
[a] One-way analysis of variance test.

Table 4. Comparison among group A, group B, and group C regarding pulse.

Pulse	Group A ($N = 20$)	Group B ($N = 20$)	Group C ($N = 20$)	Test value[a]	P value	Significance
1–8 h						
Mean ± SD	88.05 ± 5.92	92.15 ± 3.51	93.35 ± 3.05	8.182	0.001	HS
Range	75–96	86–98	87–99			
8–16 h						
Mean ± SD	84.80 ± 6.14	88.30 ± 3.99	88.50 ± 4.21	3.639	0.033	S
Range	73–93	81–95	81–98			
16–24 h						
Mean ± SD	81.35 ± 5.95	85.35 ± 3.69	86.10 ± 3.84	6.139	0.004	HS
Range	70–89	78–92	79–92			
24–32 h						
Mean ± SD	79.10 ± 5.92	82.25 ± 4.06	83.15 ± 3.77	4.124	0.021	S
Range	68–87	74–89	75–89			
36–40 h						
Mean ± SD	76.00 ± 7.22	80.10 ± 4.62	81.05 ± 3.85	4.897	0.011	HS
Range	65–87	73–89	73–87			
41–48 h						
Mean ± SD	72.60 ± 7.95	77.45 ± 4.80	78.70 ± 4.47	5.865	0.005	HS
Range	60–84	69–87	71–89			

Post-hoc analysis

	Group A vs. group B	Group A vs. group C	Group B vs. group C
1–8 h	**0.004**	**0.000**	0.386
8–16 h	**0.027**	**0.020**	0.897
16–24 h	**0.008**	**0.002**	0.609
24–32 h	**0.038**	**0.008**	0.546
36–40 h	**0.020**	**0.005**	0.582
41–48 h	**0.013**	**0.002**	0.509

HS, highly significance; S, significance.
$P > 0.05$: nonsignificant.
$P < 0.05$: significant.
$P < 0.01$: highly significant.
[a] One-way analysis of variance test.

Table 5. Comparison among group A, group B, and group C regarding urine output.

Urine output	Group A (N = 20)	Group B (*N* = 20)	Group C (*N* = 20)	Test value[a]	*P* value	Significance
1–8 h						
Mean ± SD	0.47 ± 0.04	0.46 ± 0.06	0.42 ± 0.04	8.241	0.001	HS
Range	0.4–0.6	0.35–0.53	0.35–0.51			
8–16 h						
Mean ± SD	0.48 ± 0.04	0.49 ± 0.05	0.43 ± 0.04	10.053	0.000	HS
Range	0.4–0.6	0.4–0.56	0.37–0.49			
16–24 h						
Mean ± SD	0.52 ± 0.04	0.50 ± 0.05	0.45 ± 0.03	13.290	0.000	HS
Range	0.45–0.61	0.4–0.56	0.39–0.51			
24–32 h						
Mean ± SD	0.54 ± 0.05	0.53 ± 0.05	0.49 ± 0.04	7.407	0.001	HS
Range	0.46–0.63	0.45–0.6	0.4–0.54			
36–40 h						
Mean ± SD	0.57 ± 0.04	0.54 ± 0.05	0.50 ± 0.03	14.396	0.000	HS
Range	0.49–0.65	0.45–0.61	0.42–0.54			
41–48 h						
Mean ± SD	0.60 ± 0.04	0.56 ± 0.05	0.52 ± 0.04	15.354	0.000	HS
Range	0.51–0.65	0.5–0.63	0.4–0.57			

Post-hoc analysis	Group A vs. group B	Group A vs. group C	Group B vs. group C
1–8 h	0.446	**0.000**	**0.003**
8–16 h	0.747	**0.000**	**0.000**
16–24 h	0.268	**0.000**	**0.000**
24–32 h	0.781	**0.001**	**0.002**
36–40 h	0.051	**0.000**	**0.002**
41–48 h	0.021	**0.000**	**0.003**

HS, highly significance; S, significance.
P > 0.05: nonsignificant.
P < 0.05: significant.
P < 0.01: highly significant.
[a] One-way analysis of variance test.

Table 6. Comparison among group A, group B, and group C regarding Na level.

Laboratory	Group A (*N* = 20)	Group B (*N* = 20)	Group C (*N* = 20)	Test value[a]	*P* value	Significance
Na						
First 12 h						
Mean ± SD	137.75 ± 3.57	140.85 ± 2.80	139.20 ± 2.88	5.009	0.010	S
Range	130–148	137–146	134–145			
Second 12 h						
Mean ± SD	137.00 ± 2.29	139.35 ± 2.39	137.60 ± 2.19	5.677	0.006	HS
Range	132–142	135–143	134–142			
Third 12 h						
Mean ± SD	135.35 ± 1.87	136.80 ± 1.88	135.05 ± 2.93	3.365	0.042	S
Range	133–140	134–140	129–140			
Fourth 12 h						
Mean ± SD	135.60 ± 2.09	135.70 ± 1.66	135.40 ± 2.01	0.126	0.882	NS
Range	132–141	132–139	131–138			

Post-hoc analysis	Group A vs. group B	Group A vs. group C	Group B vs. group C
First 12 h	0.003	0.145	0.098
Second 12 h	0.002	0.411	0.019
Third 12 h	0.049	0.679	0.018

HS, highly significance; S, significance.
P > 0.05: nonsignificant.
P < 0.05: significant.
P < 0.01: highly significant.
[a] One-way analysis of variance test.

Table 7. Comparison among group A, group B, and group C regarding K level.

K	Group A ($N = 20$)	Group B ($N = 20$)	Group C ($N = 20$)	Test value[a]	P value	Significance
First 12 h						
Mean ± SD	4.09 ± 0.18	4.05 ± 0.21	4.05 ± 0.20	0.255	0.776	NS
Range	3.7–4.3	3.6–4.3	3.7–4.3			
Second 12 h						
Mean ± SD	3.95 ± 0.14	3.94 ± 0.14	3.89 ± 0.20	0.696	0.503	NS
Range	3.6–4.2	3.5–4.1	3.5–4.3			
Third 12 h						
Mean ± SD	3.74 ± 0.16	3.66 ± 0.13	3.62 ± 0.24	2.429	0.097	NS
Range	3.3–3.9	3.4–3.9	3.3–4			
Fourth 12 h						
Mean ± SD	3.66 ± 0.12	3.65 ± 0.11	3.62 ± 0.09	0.791	0.459	NS
Range	3.4–3.9	3.4–3.9	3.5–3.8			

$P > 0.05$: nonsignificant.
$P < 0.05$: significant.
$P < 0.01$: highly significant.
[a] One-way analysis of variance test.

Table 8. Comparison among group A, group B, and group C regarding hematocrit level.

Hematocrite	Group A ($N = 20$)	Group B ($N = 20$)	Group C ($N = 20$)	Test value[a]	P value	Significance
First 12 h						
Mean ± SD	47.50 ± 2.78	49.45 ± 2.16	48.95 ± 3.27	2.665	0.078	NS
Range	42–53	45–54	41–53			
Second 12 h						
Mean ± SD	42.30 ± 2.08	42.85 ± 2.30	42.00 ± 2.55	0.691	0.505	NS
Range	39–47	40–48	36–47			
Third 12 h						
Mean ± SD	36.35 ± 2.08	35.65 ± 2.28	35.50 ± 1.82	0.961	0.389	NS
Range	32–41	31–39	32–38			
Fourth 12 h						
Mean ± SD	33.00 ± 1.69	34.55 ± 2.01	33.70 ± 1.69	3.710	0.031	S
Range	30–36	31–38	31–36			

Post-hoc analysis	Group A vs. group B	Group A vs. group C	Group B vs. group C
Fourth 12 h	0.009	0.224	0.141

S, significance.
$P > 0.05$: nonsignificant.
$P < 0.05$: significant.
$P < 0.01$: highly significant.
[a] One-way analysis of variance test.

4. Discussion

Burns are among the most difficult and physiologically complex injuries, and they can lead to the emergence of shock and hemodynamic collapse early.[6] Owing to the concurrent local and systemic inflammatory response to injury, which most closely resembles hypovolemic shock, patients who have sustained significant burns are at risk of developing 'burn shock' quickly.[7]

For the first 48 h following the time of burn injury, rapid initiation of treatment tailored to each burn patient is essential for minimizing burn shock, secondary injuries, and other downstream sequelae.[8]

Oral rehydration treatment (ORT) is an established method for reducing dehydration brought by diarrhea. Basically, ORT is a procedure that involves giving patients enough of an oral glucose and electrolyte solution. Local health care providers or family members can provide ORT at a minimal cost.[5]

The major goal of this study was to evaluate the outcome of enteral fluid resuscitation in burned patients.

This prospective randomized clinical trial was conducted in Al-Azhar University Hospitals (Alhussien and Said Galal Hospitals) and Hehia Burn Center (El-Sharkia governorate). This study was conducted on 60 patients, who were divided into three groups. E ach group included 20 candidates. Group A (control group) underwent resuscitated parenterally according to the Parkland formula, group B underwent resuscitated enterally

according to the Sorensen's formula by WHO-ORS, and group C underwent resuscitated enterally according to the Parkland formula by RL solution.

Regarding demographic data among the studied groups, we found that there was no statistically significant difference among the studied groups regarding age, sex, and weight. Meanwhile, the three studied groups were comparable in percentages of burn degree and etiology also, without statistically significant difference.

To our knowledge, there were very limited comparative-controlled studies in literature on this topic, and this is the first study to compared cases resuscitated parenterally according to the Parkland formula, resuscitated enterally according to the Sorensen's formula by WHO-ORS, and those resuscitated enterally according to the Parkland formula by RL solution.

The current study was supported by a randomized controlled clinical trial by Moghazy *et al.*[9] which aimed to assess the limitations and complications of burn resuscitation using WHO-ORS and salt pills, as well as the efficacy and safety of the acute phase. According to the Sorensen's formula, the study group ($n = 10$) received WHO-ORS (15% of body weight/day) and one salt tablet (5 g) per liter. The Parkland formula was used to administer IV fluids to the control group ($n = 20$). According to their findings, there was no significant difference in the age, sex, or weight of the patients in the two groups. Similarly, they found that both groups were comparable in burn injury parameters regarding percentage, etiology, and degree. Regarding degree, all the patients had mixed burns; they were classed either second degree or third degree depending on the prevalent degree.

Regarding the mean systolic blood pressure (SBP) in all groups, our results revealed that there was no statistically significant difference between the groups regarding mean SBP.

Our results were supported by Moghazy *et al.*[9] who reported that there were significant lower values of mean SBP in the study group than the control group in the first, seventh, and 19th hour. The only time that SBP fell below the critical limit of 100 mm Hg occurred within the first hour. Although there was a considerably reduced mean SBP value in one reading on the second and third days, the value of the study group did not drop below the critical limit.

A prospective randomized study by Guinot et al.[10] aimed to investigate the use of oral water ingestion in the treatment of patients with shock. Patients were randomized 1 : 1 to an intervention (500 ml via nasogastric tube over 15 min of water) or standard care group (500 ml of IV saline solution over 15 min). The study revealed that both water and saline significantly improve the BP with no significant difference between the studied groups.

Regarding the mean pulse between the study groups, we found that there was a statistically significant difference among the groups.

However, the study by Moghazy et al.[9] reported only a few sporadic significant lower values for mean pulse in the study group. On the contrary, no value went above the threshold of 100/min. There was no statistically significant difference between the groups regarding mean pulse in first, second, and third days.

Furthermore, the study by Guinot et al.[10] revealed that both water and saline significantly improve the heart rate, with no significant difference among the studied groups.

Regarding mean urine output in the studied groups, our results showed that there was a significant difference between the groups regarding mean urine output.

However, the study by Moghazy et al.[9] found that on the first day, just 2 readings – the third and ninth hours – had values over the critical value, indicating that urine output in the study group was much lower. In comparison with the control group on the second day, the study group displayed three considerably higher values and two significantly lower values; both lower values in both groups were above the critical value.

Moreover, the study by Dittrich et al.[11] reported that the median urine output showed no difference between intervention and control groups (2.1 vs. 2.0 ml/kg/h; $P = 0.152$ on day 1; 2.58 vs. 2.54 ml/kg/h; $P = 0.482$ on day 2; and 2.9 vs. 3.0 ml/kg/h; $P = 0.093$ on day 3).

The study by Jackson et al.[12] treated 113 children and 49 adults of 162 burn cases with 10–35% TBSA injuries using enteral administration of Meyer's solution, and 75% of those cases were effectively treated with oral resuscitation. Nevertheless, for the first 48 h following the burn, mean urine output was noted to be lower than usual. Vomiting was not always a requirement to begin IV therapy, although how frequently it occurred was.

Regarding the laboratory data of the burned patients, our results revealed that for studied electrolytes, there was a significant difference among the three groups in Na levels in first 36 h only. However, there was no significant difference regarding K. Moreover, there was no significant difference regarding hematocrit, except the last result at 48 h.

Our study reported that there was no case of mortality among the patients in all groups.

The study by Guinot et al.[10] revealed that in saline group the Na^+ levels were nonsignificantly different, whereas the Cl^- levels were significantly increased, and in the water group, the Cl^- levels were nonsignificantly different, whereas the Na^+ levels were significantly increased.

Furthermore, Shahidul et al.[13] reported 139.45, 134.96, 136.18, 136.87, and 137.34 mmol/l as the normal plasma Na^+ levels, whereas 4.17, 3.86, 3.76, 3.76, and 3.89 mmol/l were the normal plasma K^+ levels on PBD 1, 2, 3, 4, and 5, respectively. Throughout treatment with this fluid therapy, serum electrolytes were within the normal range. When resuscitation is effective, this is preferred. According to the paired *t*-test, the plasma Na^+ and K^+ levels were just statistically significant ($Na^+ = 0.001$ and $K^+ = 0.001$).

Our study reported that there was no case of mortality among the patients in all groups.

In agreement with our results, the study by Ete et al.[14] aimed to assess the effects of albumin and nonalbumin solutions on mortality in burn injury patients during the fluid resuscitation phase; the study enrolled four trials involving 140 patients and concluded that there was a neutral effect on mortality in burn patients resuscitated acutely with albumin solutions.

4.1. Conclusion

We can state that the use of oral rehydration therapy showed encouraging results in the resuscitation of moderately burned patients with the following benefits: ease of use, low cost, potential for use as first aid until the patient reaches a hospital, no risk of fluid overload, and avoidance of all the challenges and complications of IV infusions.

Conflict of interest

There are no conflicts of interest.

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