Outcome of Heliotherapy and Modified Parkland’s Formula for Fluid Resuscitation in Management of Moderate Degree of Burns: A Single Centre Observational Study

Mahesh Pukar¹, Aakash Rajshakha², Sohank Mewada³, Dhairya Lakhani⁴

¹Professor, Department of Surgery, Smt. B.K. Shah Medical Institute & Research Centre, Sumandeep Vidyapeeth University, Vadodara, Gujarat, India, ²Resident, Department of Surgery, Smt. B.K. Shah Medical Institute & Research Centre, Sumandeep Vidyapeeth University, Vadodara, Gujarat, India, ³Intern, Department of Surgery, Dr. Ulhas Patil Medical College & Hospital, Maharashtra, India, ⁴Intern, Department of Surgery, Dhiraj General Hospital, Vadodara, Gujarat, India

Abstract

Background: Acute resuscitation is one of the most challenging aspects of caring for burned patients. Although the Parkland formula is still the most common employed resuscitation formula worldwide, it is far from a perfect solution.

Materials and Methods: This is a prospective observational study, which was carried out over a period of 3 years. A total of 50 patients were enrolled. Modified Parkland formula and heliotherapy were used in the management of moderate degree burns.

Result: Out of 50 patients with Moderate degree of burns 47 survived (mortality rate: 6%). One of the deaths in occurred during the period of resuscitation (day 2). While the other two deaths were related to septic shock. Urine Output (ml/kg/h) of 0.72 ± 0.06 and 0.92 ± 0.05 was noted on day 1 and 2, respectively.

Conclusion: Modified Parkland formula and heliotherapy proved to be effective in our set-up in comparison to the conventional Parkland formula and protocol for management of burns, as reflected in the published literature, thus, we recommend multicentric trials to test the efficacy of this technique, in management of burns.

Keywords: Burn, Heliotherapy, Injury

INTRODUCTION

A cute resuscitation is one of the most challenging aspects of caring for burned patients. There is a large and ever-increasing body of research devoted to refining strategies for acute burn resuscitation. Parkland formula is still the most widely employed resuscitation technique worldwide; still it is far from a perfect cure.

Ongoing studies focuses on refining existing formulas to prevent complications of over-resuscitation. This includes devising novel means for titrating resuscitation, such as nurse-driven or computer-driven protocols. The Parkland formula is easy to calculate and has a long history of use in the burn resuscitation. Nevertheless, researchers have not stopped from examining its efficacy, and also determining whether practitioners of this resuscitation formula are using it correctly.¹

Moreover, open burn wounds are an excellent culture medium for microorganisms; their presence contributes to both deepening of the burn and emergence of septic complications.² The ideal wound dressing, therefore, must have strong antibacterial properties, coupled with a weak clinically negligible cytostatic effect on the regenerating tissues. Also, an adjunct heliotherapy has proved fruitful to meet these demands of burn wound care.³

In our center, Dhiraj General Hospital which is a 1,200 bedded hospital catering to rural population...
of Vadodara and Waghodiya of Gujarat state, most teams in the department undertake management for moderate degree of burns with the modified parkland regimen along with heliotherapy wherever required. In the present study, we sought to report our experience in management of moderate degree burn by using modified formula and honey therapy over a 3 years period.

MATERIALS AND METHODS

The Study Setting
This is a prospective observational study, which was carried out over a period of 3 years (June 01, 2011 to May 31, 2013) in the Department of Burns and Trauma of Dhiraj General Hospital, which is a 1200-bedded multispeciality hospital that caters to the rural population of Vadodara and Waghodia.

All the patients with burns, admitted to our unit during June 01, 2011 to May 31, 2013 that fitted in the inclusion criteria, and were willing to participate, were enrolled for the study.

Before their enrolment, all the participants were explained about the nature and the purpose of the study. Consents were obtained from the patients.

The Study Subjects
A total of 50 patients who fulfilled the below-mentioned criteria were enrolled in the study. A total of 75 patients were admitted with burns during the study period, out of which 9 were severe, 50 were moderate, and 16 were mild degree of burns.

All the patients above 20 years of age with moderate degree of burn according to Browder chart, with or without inhalation injury were willing to give informed consent were included in the study.

While the patients who were not willing to give informed consent for study group, patients with mild and severe degree of burns according to Browder chart, those who were suffering from critical or terminal illness, those admitted 24 h post-burn, and the patients with immune-compromised statuses were excluded from the study.

The Study Design
All the patients (n = 50) with moderate degree of burns according to Browder’s chart were enrolled in the study. The demographic profile, complete histories, information on the vitals and relevant systemic examinations of all the patients including Browder charts were recorded in a proforma, and their urine output were monitored periodically.

The Study of Management
All the subjects were examined, to confirm the diagnosis of moderate burns, then every hourly TPR charting along with resuscitation using combination of ringer lactate (RL) 3 ml and 0.5 ml dextrose normal saline (DNS) per percentage of burns (according to Brodie's chart) per weight (in kg) was done, securing central line. Then, subjects were catheterized to monitor urine output. Tetanus toxoid along with broad-spectrum antibiotics was administered. Blood and urine samples are sent for appropriate investigations. Followed by, wound cleaning with normal saline, then honey application and closed dressing with antibiotic impregnated gauze piece. After that, oxygen therapy at minimum 4 l/min was administered.

Fluid resuscitation was done by infusing 30%, 25%, 20%, 15%, and 10% of calculated total fluid to be replaced, every 5 h; hence almost 100% of fluid replacement is done in first 24 h. In next 24 h, 50% of the total calculated fluid is given. Fluid to be replaced is calculated by Brodie’s chart, 3.5 ml per percentage burns per body weight in kg. After 48 h blood and albumin replacement is done.

Once patient is resuscitated, he is passed through following protocol on daily basis; in morning after burn bath, sun exposure is given by exposing full body for 45-60 min, then honey application is done, followed by closed dressing, this was continued till the healing is achieved.

Every 5th day sample is sent for culture and sensitivity and from 7th day we would change antibiotic according to sensitivity report.

Statistical Analysis
It was carried out by using mean, standard deviation, incidence rate and percentage of the test.

OBSERVATION AND RESULTS
A total of 50 patients with moderate degree of burns and fitting the inclusion criteria were included in the study. The baseline demographic and total body surface area (TBSA) are presented in Table 1. 47 surviving patients and 3 deaths (mortality, 16%). One of the deaths in occurred during the period of resuscitation (day 2), While the other two deaths were related to septic shock.

The interpretation of the study result and its comparison with the published data, it indicates a significant difference between mortality and morbidity parameters with the use of modified parkland’s regimen and honey therapy as compared to the original formula. A summary
of fluid administered and urine output over the first and second day following injury is shown in Table 2.

**DISCUSSION**

Preventive measures have advanced over recent years; still burns continue to be a common source of injury. Burn injuries overall account for a small proportion of all emergencies reported to a tertiary care center. But aggressive and effective management reduce the morbidity and mortality of burn injuries. Burn management consists of complex modalities of treatment.

Management of burn injury, as any case, consists of progressive events and steps. As with any trauma patient, the initial assessment of a burned patient is divided into a primary and secondary survey. The primary survey consists of identification and treatment of immediately life-threatening conditions. In the secondary survey, a more thorough head-to-toe evaluation of the patient is undertaken. A primary survey should be conducted in accordance with advanced trauma life support guidelines.

Initial evaluation of the burn patient involves four crucial assessments: Airway management, evaluation of other injuries over the body, estimation of the burn area, and diagnosis of carbon monoxide (CO) and cyanide poisoning. The second cause of injury is searched for. The cause may be due to thermal - kerosene, gas or other petrochemicals, blast injuries; chemical; etc. Tachypnea, The cause may be due to thermal - kerosene, gas or other petrochemicals, blast injuries; chemical; etc. Tachypnea, facial burns, signed nasal vibrissae, soot containing petrochemicals, blast injuries; chemical; etc.

**Table 1: Characteristic of study participants**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (year) ± SD</td>
<td>33.29±8.41</td>
</tr>
<tr>
<td>Mean weight (kg) ± SD</td>
<td>62.56±7.60</td>
</tr>
<tr>
<td>Gender</td>
<td>Male: 27</td>
</tr>
<tr>
<td></td>
<td>Female: 23</td>
</tr>
<tr>
<td>TBSA (percentage) ± SD</td>
<td>46.2±7.79</td>
</tr>
<tr>
<td>Presence of inhalation injury</td>
<td>2</td>
</tr>
<tr>
<td>Hours after burn ± SD</td>
<td>2.1±0.74</td>
</tr>
<tr>
<td>Mean hospitalization stay (days) ± SD</td>
<td>39.2±9.61</td>
</tr>
<tr>
<td>Mortality</td>
<td>3</td>
</tr>
</tbody>
</table>

SD: Standard deviation, TBSA: Total body surface area

**Table 2: Fluid vitals in study subjects**

<table>
<thead>
<tr>
<th>Vitals</th>
<th>Day 1</th>
<th>Day 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVF (ml)</td>
<td>10030±2181.58</td>
<td>5135±1072.87</td>
</tr>
<tr>
<td>IVF (ml/kg/h)</td>
<td>6.66±1.15</td>
<td>3.41±0.56</td>
</tr>
<tr>
<td>Cumulative IVF (ml/kg)</td>
<td>159.96±27.53</td>
<td>81.95±13.53</td>
</tr>
<tr>
<td>Urine output (ml)</td>
<td>1086.8±139.36</td>
<td>1381.1±134.59</td>
</tr>
<tr>
<td>Urine output (ml/kg/h)</td>
<td>0.72±0.06</td>
<td>0.92±0.05</td>
</tr>
<tr>
<td>Cumulative urine output (ml/kg)</td>
<td>17.42±1.58</td>
<td>22.16±1.18</td>
</tr>
</tbody>
</table>

IVF: Intra-Urine Fluid

We followed the following set of steps in managing patients with moderate burns,

A: Assessment, B: Breathing management, C: Consent, D: Dressing.

Treatment depends on the characteristics and size of the wound. Current therapy directed specifically toward burn wounds can be divided into three stages: Assessment, management, and rehabilitation. The choice of dressing is based on the characteristics of the treated wound. There are multitudes of topical therapies for the treatment of burn wounds. Of these, silver sulfadiazine is the most widely used in clinical practice. Silver sulfadiazine has a wide range of antimicrobial activity, primarily as prophylaxis against burn wound infections rather than treatment of existing infections. Added benefits of honey include being inexpensive and easily applicable, and has some soothing qualities. It is not significantly absorbed systemically and; thus has minimal metabolic derangements. Silver sulfadiazine has a reputation for causing neutropenia, but this association is more likely to be a result of neutrophil margination due to the inflammatory response to the burn injury.

Compressive dressing should be given to the crape bandage rolling half way on the previous. Over the joints, it should be applied as figure of eight bandage, which helps in reduction of edema.

**E: Emergency Care (Central Venous [CV] Line Access and Management of Shock)**

On emergency basis secure intravenous (IV) access line by central line either subclavian or internal jugular vein. Urinary catheterization should be done to monitor the urinary output. Early, aggressive resuscitation regimens have improved survival rates dramatically. Burn-related...
shock has been replaced by sepsis and subsequent multi-organ failure as the leading cause of death associated with burns due to the advent of fluid resuscitation measures. Vigorous fluid resuscitation should be carried out in case of hypovolemic shock.

**F: Fluid Resuscitation (as per new Modified Formula)**

Most burn resuscitation formulas estimate fluid requirements using the burn size as a percent of TBSA burned. The “rule of nines” is a crude but quick and effective method of estimating burn size. Adequate resuscitation of a burned patient depends on establishment and maintenance of reliable IV access. Concurrently with the primary survey, large-bore peripheral IV catheters should be placed, and fluid resuscitation should be initiated; for a burn larger than 40% TBSA, two large-bore IVs are ideal. CV access may be required in the severely burned patient, and provides useful information as to volume status in the intensive care unit.

A myriad of formulas exist for calculating fluid to be repeted, the concept behind the continuous fluid needs is simple. Baxter\(^4\) and others established the basis for modern fluid resuscitation protocols. They showed that edema fluid in burn wounds is isotonic and contains the same amount of protein as plasma does and that the greatest loss of fluid is into the interstitium they concluded that in the first 24 h until capillary permeability returned closer to normal, colloid solutions should not be used. In fact, recent data show that the Parkland formula often underestimates the volume of crystalloid received in the first 24 h after a severe burn; this phenomenon has been termed fluid creep by Pruitt.\(^4\)

Increased times to initiating resuscitation of burned patients result in poorer outcomes, and delays must be minimized. Continuation of fluid volumes should depend on the time since injury, urine output, and, mean arterial pressure (MAP); as the leak closes, the patient will require less volume to maintain these two resuscitation endpoints.

Any formula for burn resuscitation is merely a guideline, and fluid must be titrated based on appropriate measures of adequate resuscitation. A number of parameters are widely used to gauge burn resuscitation, but the most common remain the simple outcomes of blood pressure and urine output. As in any critically ill patient, the target MAP is 60 mmHg to ensure optimal end-organ perfusion. Goals for urine output should be 30 mL/h (0.5 mL/kg/h) in adults and 1-1.5 mL/kg per hour in pediatric patients. Blood pressure may be difficult to measure in burned patients with edematous or charred extremities. Some studies have found serum lactate as a better predictor of mortality in severe burns; while some studies show that base deficit could be a better predictor of eventual organ dysfunction and mortality.\(^5\)

Actual administrated fluid volumes typically exceed volumes predicted by standard formulas. One survey of burn centers showed that 58% of patients receive more fluids than would be predicted by Baxter’s formula.\(^6\) A comparison of modern-day patients with historical controls shows that this over-resuscitation may be a relatively recent trend. Those patients receiving higher fluid volumes were at increased risk of complications and death. Common complications include abdominal compartment syndrome, extremity compartment syndrome, intraocular compartment syndrome, and pleural effusions.

In our protocol, we suggest fluid resuscitation using 3 ml RL + 0.5 ml DNS per kg body weight per % of TBSA in first 24 h fluid should be administered to maintain urinary output should be 0.5-1 ml/kg/hour. We emphasize on considering urine output as a monitoring parameter to change fluid resuscitation accordingly. If urinary output is <0.5 ml/kg/hour then fluid administration should be increased by 25%, and if it is more than 1 ml/kg/hour then fluid administration should be reduced by 25% of total calculated volume of 24 h. Urinary output is important as decreased output indicates de/hypohydration suggestive of the patient going in acute renal injury n if output increases it indicates over-hydration predisposing to respiratory complications like pulmonary edema. To prevent these complications, we suggest use of modified resuscitation formula - 3.5 ml RL + ml DNS per kg body weight per % TBSA, along with strict monitoring of 5-h duration each. Shorter duration of 5 h in intensive phase than the traditional 8-h intensive phase is more efficient in combating these complications.

**G: Gastric Decompression along with NBM**

Nasogastric tube is passed to decompress the stomach to prevent the complications such as acute gastric dilatation of stomach and stress ulcers. To combat any regurgitation in patients with intestinal ileus, a nasogastric tube is inserted in all patients with major burns to decompress the stomach. Enteral feeding should be started after 48 h if the patient cannot able to take orally then it should be given through nasogastric tube.

**H: Heliotherapy, Honey Application**

Burn bath should be given before the dressing with salvon or soap water. This step helps us to remove burn necrotic tissue remnants thus preventing, microorganism colonization. Exposure to ultraviolet rays from the sun directly and also vitamin D3, i.e., heliotherapy is effective for reducing the infection rate, reducing incidence of keloid formation, it promotes faster granulation and healing. It also helps to prevent
depigmentation of the skin by increasing melanin pigment which tries to maintain near normal skin color. With these therapy chances of skin grafting reduces and there is less contracture development. It is possible however that the currently accepted practice of near continuous ultraviolet (UV) protection abrogates the normal cutaneous response to injury, with melanocyte redistribution and pigmentation creating hypopigmented scars. Use of monochromatic sources, polarized light have been proven effective in the treatment of burn injury. But, the light sources have disadvantages of radiation-induced dermatitis, radiation keratitis, increased cost, sophisticated machine requirement, show a high incidence of cancer. In our study, we propose the judicious use of (heliotherapy) sunlight available from natural sources without any cost, with the appropriate required amount of UV rays. The judicious UV exposure heliotherapy might, in fact, be beneficial for wound healing and skin homeostasis.

Use of honey has been mentioned in various Indian literatures dating to around 200 BC. Recently the chemical nature of honey responsible for antiseptic and antibacterial properties has been explained. The antibacterial activity of the honey has been accredited to the presence of inhibit, which consist of hydrogen peroxide, phenolic acid, flavonoids along with other chemical constituents. Also high acidic pH and low water activity induced osmosis. Topical use of honey reduces swelling, bad odour, sticking of dressing to wound and scarring.6

Burn wound site infection may be attributed to the presence of burn necrotic tissue, delayed reporting and inadequate fluid resuscitation. Infection is responsible for considerable morbidity and patient discomfort; prolonged hospitalization is better countered with the help of application of honey. Honey promotes wound healing and decreases the average duration of wound healing. Sample serous ooze is observed in burn wound but with the honey application there is very minimal ooze is seen from the wound. It reduces edema and exudation, by absorbing fluid from the wound. Its antimicrobial properties prevent microbial growth in the moist healing environment that it creates.

Honey causes no pain on dressing; it is non-irritating, causes no allergic reaction and have no harmful effects on tissues. Dressing should be done daily. Proper wound care should be taken to prevent burn wound infection.7,8

I Investigation
During management certain investigations should be done: After 24 h complete blood count, blood sugar, kidney function test, and electrolyte. According to serum sodium level fluid administration should be managed; Pus swab from the wound should be taken on the 5th day for Scandinavian candesartan acute stroke trial.

I: Immunization, IV Antibiotics
Choice of tetanus prophylaxis were based on the condition of wound and patient’s immunization status. All patients with burns of >10% TBSA receive 0.5 mL of tetanus toxoid. Immunization for prophylaxis against tetanus toxoid should be done. H2 receptor blocker should be started to prevent stress ulcers. Albumin and blood transfusion should be given after 48 h.

Limb Movement to Give Physiotherapy
As burn surgery continues to be a largely neglected area of plastic surgery in both the public and the private sector hospitals in our country, we strongly recommend establishing improved facilities for acute burn management and for rehabilitation throughout the country. Dedicated and well-trained professionals are needed to ensure proper surgical management of burns in our country. We also (there is a strong) need to develop international guidelines that are consistent with our local circumstances.

CONCLUSION
Modified Parkland formula and heliotherapy proved to be effective in our set-up in comparison to the conventional Parkland Formula and protocol for management of burns, as reflected in the published literature, thus, we recommend multi-centric trials to test the efficacy of this technique, in management of burns.

Limitations
This was a small-scale study and hence, similar large-scale studies should be done at various centers of the country, to establish a cost effective, gold standard technique for management of Burns.

ACKNOWLEDGMENT
We are thankful to Dr. PravinKharod, Past Trustee - C.U. Shah Charitable Trust & Director, Kharod Surgical Hospital; Dr. BalilKharod, Professor, Department of Surgery, C.U. Shah Medical College, Surendranagar, Gujarat; Dr. O.D. Mangukia, Magukiya Surgical Hospital & Dr. DhimantBhavsar, Bhavsar Surgical Hospital for reviewing the manuscript and helping us improve the quality of the manuscript.

REFERENCES


Source of Support: Nil, Conflict of Interest: None declared.