IMPROVED SURVIVAL WITH AN INNOVATIVE APPROACH TO THE TREATMENT OF SEVERELY BURNED PATIENTS: DEVELOPMENT OF A BURN TREATMENT MANUAL

AMELIORATION DE LA SURVIE DES PATIENTS GRAVEMENT BRULÉS GRACE AU DÉVELOPPEMENT D'UN MANUEL DE TRAITEMENT DES BRULES

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SUMMARY. The management of severely burned patients remains a major issue worldwide as indicated by the high incidence of permanent debilitating complications and poor survival rates. In April 2012, the Advanced Emergency & Critical Care Medical Center of the Okayama University Hospital began implementing guidelines for severely burned patients, distributed as a standard burn treatment manual. The protocol, developed in-house, was validated by comparing the outcomes of patients with severe extensive burns (SEB) treated before and after implementation of these new guidelines at this institution. The patients included in this study had a burn index (BI) ≥30 or a prognostic burn index (PBI = BI + patient's age) ≥100. The survival rate of the patients with BI ≥30 was 65.2% with the traditional treatment and 100% with the new guidelines. Likewise, the survival rate of the patients with PBI ≥100 was 61.1% with the traditional treatment compared to 100% with the new guidelines. Together, these data demonstrate that the new treatment guidelines dramatically improved the treatment outcome and survival of SEB patients.

Keywords: severe extensive burns, burn wound sepsis, survival

RÉSUMÉ. *La prise en charge des patients gravement brûlés est toujours un problème majeur dans le monde, avec une mortalité élevée et de lourdes séquelles chez les survivants. En Avril 2012, le Centre de l'Hôpital de l'Université d'Okayama a commencé à distribuer un manuel pour le traitement des patients gravement brûlés. Notre protocole a été validé en comparant les résultats des patients souffrant de brûlures étendues traités avant et après la mise en œuvre de ces nouvelles lignes directrices. Les patients inclus dans cette étude avaient une surface brûlée (SB) ≥30% ou un index de Baux (IBx= SB + âge du patient) ≥100. Le taux de survie chez les patients atteints sur ≥30% SB était de 65.2% avant et 100% après. Le taux de survie chez les patients avec un IBx ≥100 était de 61.1% avant et 100% après. Ces données démontrent que les nouvelles lignes directrices de traitement ont amélioré considérablement la survie chez ces patients.*

Mots-clés: *brûlures étendues, protocole de traitement, infections, survie*

Introduction

Treatment of patients with severe extensive burns (SEB) is a primary concern in intensive care units (ICUs) because of the need for long-term intensive care, multiple surgical procedures, strict control of water balance, intravascular catheterization, and nutritional control. Therefore, new treatment guidelines are urgently needed to address the shortcomings of current practice.

The Advanced Emergency & Critical Care Medical Center at Okayama University Hospital began accepting patients with SEB and developed new treatment guidelines for these patients,[1] which included the following four steps: early surgery; transfusion management using a peripheral vein, which reduced the need for central venous catheterization; local treatment with a silver-containing wound

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Manuscript: submitted 08/12/2014, accepted 23/03/2015.

dressing; and establishment of early enteral alimentation.

Herein we describe the treatment strategy for SEB patients in our hospital and report the treatment outcomes before and after introduction of the new guidelines.

Patients and methods

Of the patients hospitalized for treatment at the Advanced Emergency & Critical Care Medical Center, Okayama University Hospital after July 1, 2003, patients with SEB and a burn index (BI = Third or Fourth degree burns+1/2 Second degree burns of the body surface area) ≥30 or prognostic burn index (PBI = BI + patient's age) ≥100[2] were included. The exclusion criteria were any condition that could interfere with the treatment outcome, namely skin-related or severe cardiovascular diseases. This study was approved by the Okayama University Hospital Ethics Committee, posted on the homepage of our laboratory on the hospital website, and conducted with consent from the patients.

Burn treatment protocols

Treatment outcomes were compared between the traditional treatment protocol (TraP) and the new treatment protocol (NewP) that was based on the new burn treatment guidelines implemented by the Advanced Emergency & Critical Care Medical Center in April 2012.

TraP involved four steps: surgical intervention planning, transfusion management, local treatment, and establishment of enteral alimentation. The first operation was planned for two weeks after the injury, which is considered late surgery. Transfusion management involved central venous catheterization for almost all burned patients to control water balance and provide total parenteral nutrition. Local treatment consisted of daily water therapy with or without surgical debridement. Enteral alimentation usually commenced 1 week after the injury.

NewP also involved these four steps, but with modifications, which are briefly described here and in more detail in the subsequent paragraphs. First, the late surgery was replaced by an early surgery performed within 24 h of admission. Second, the water therapy was replaced with peripheral venous lines. Third, local infection control involved silver-containing dressings. Finally, enteral feeding was initiated earlier, immediately after admission.

Early surgery

In our hospital, we currently perform early total escharectomy in which all eschars are resected within a week after injury. Although studies have demonstrated the efficacy of early surgery for SEB patients,[3-7] early surgeries are performed in relatively few facilities in Japan. Given that our facility is a university hospital, it is difficult to frequently perform surgeries for SEB patients in the operating theater. We therefore perform bedside debridement for limbs and the trunk starting 24 h after admission. The use of an Esmarch bandage allows for debridement with minor bleeding in limbs. We control local infections by covering the wounds after debridement with silver-containing wound dressings. For the front of the body, when possible, we perform surgery in the operating room due to the wide debridement range. For the back of the body, when the operating room is available, we perform debridement and skin grafting. Otherwise, we perform debridement alone as this can be completed at the bedside. We fix grafted skins using silver-containing AQUACEL® Ag Hydrofiber® (Convatec, Greensboro, NC, USA) wound dressings, but do not use tie-over dressing at any of the skin grafting sites, except at special sites such as the fingers. At the time of surgery, the surgeon in charge and attending burn surgeon(s) consult regarding the surgery plan, in minute increments, and proactively stipulate the intraoperative bleeding volume and body temperature at surgery completion, based on the fact that burn surgeries are conducted for damage control. This plan is shared with the anesthesiologist and operating room nurses. These plans have allowed us to perform multiple surgeries without significant decrease in vital signs even in the acute phase of burns.

Transfusion management using peripheral venous lines

The criteria for the insertion of a central venous catheter (CVC) include a 7-day period after entry during which frequent debridement is required, need for extracorporeal circulation such as continuous hemodialysis and filtration, and an inability to secure a peripheral venous line for ≥16 hours (an employee's work shift is 8 hours in our hospital). Otherwise, the line is changed to a peripheral venous line within 72 h. Long-term CVC use increases the risk of a catheter-related blood stream infection (CRBSI).[8] Therefore, this strict line control led to only one case of arterial line infection over a 2-year period.

Because multiple drug administration lines are required for SEB patients, we manage transfusions by inserting a CVC intended for children (15-G triple lumen) into a peripheral vein guided by ultrasound in our hospital. This method is very useful because it allows us to secure transfusion lines easily, even in patients with severe edema, and secure multiple lines simultaneously. In addition, ultrasound guidance allows us to secure a transfusion line not only in peripheral veins in the limbs but also in veins in all regions of the body, including the superficial inferior epigastric and superficial/deep temporal veins.

Local infection control with a silver-containing wound dressing

Silver sulfadiazine creams have primarily been used for conventional wound treatments for third-degree burns; this was also true in our hospital in addition to daily shower cleaning before the introduction of the new guidelines. However, care must be taken with hydrotherapy for burn patients because of the risk of infection.[9] In addition, shower cleaning imposes a very high burden on medical staff in terms of personnel and time. In our facility, basic fibroblast growth factor preparation spray and the silver-containing AQUACEL® Ag (Convatec, Greensboro, NC, USA) wound dressing are used at the bedside approximately 1–2 times/week following cleaning of the wound

sites after completion of debridement.[10,11] During the 2 years after the introduction of the silver-containing wound dressing and early total escharotomy, burn wound sepsis (BWS) developed in only one patient. The silver-containing wound dressing is also very useful in skin grafting.

Establishment of early enteral alimentation

Nutritional control is an important goal in SEB patients. Our department does not use high calorie transfusion except in patients with evident intestinal damage because of the strict restriction of CVC use. Instead, nutritional control by enteral alimentation should be considered when the intestinal tract is available, even in patients who cannot ingest nutrition orally.[12]

We commence enteral alimentation immediately on the day of hospitalization using a nasogastric tube to reduce the pressure in the digestive tracts and an elemental diet tube to provide the enteral nutrition. It is usually possible to establish the desired nutritional level using only enteral alimentation approximately a week after the injury.

Because the exclusive use of conventional calculations for dietary requirements is likely to lead to improper alimentation, we use an indirect calorimeter[13] and rapid turnover proteins at least once a week to determine nutrient requirements. This is also useful for monitoring the progress of burns treatment because energy expenditure, as measured by the indirect calorimeter, gradually decreases, and rapid turnover proteins tend to increase as the overall status of the patient improves during treatment.

Statistical analysis of treatment response

The patients were placed into one or both of two groups: BI ≥30 and PBI ≥100. We chose these groups because the mean LD in the Burn Unit of Tokyo, Japan, is approximately 50%.[14] The impact of TraP or NewP on survival six months after discharge was analyzed for each group.

The mean age, mean BI, and mean PBI were compared between TraP and NewP within each group using Wilcoxon signed-rank tests, and the survival rate was compared using Fisher's exact tests (IBM SPSS Statistics). Burn-related complications, namely infections (i.e., BWS, CRBSI), were also compared between TraP and NewP using χ^2 test (IBM SPSS Statistics).

Results

Baseline Characteristics

Between July 1, 2003 and March 31, 2014, 31 SEB patients with BI ≥30 and 27 SEB patients with PBI ≥100 were hospitalized for treatment at the Advanced Emergency & Critical Care Medical Center. Of these, 3 patients were excluded because consent could not be obtained: two patients who experienced cardio-pulmonary arrest on arrival and one patient with extensive flame burns due to a suicide attempt. Accordingly, the analysis included 28 patients with BI ≥30 (17 men; mean age, 54.96 ± 25.78 years) and 24 patients with PBI ≥100 (11 men; mean age, 73.94 ± 12.36 years). There were no significant differences between TraP and NewP in mean age, BI, PBI, and survival within each group (P > 0.05) (*Tables I and II*). This analysis was done retrospectively, and we obtained all data about burn patients from the medical records of our hospital.

Table I - Treatment outcomes in patients with a burn index ≥30

Treatment period	n	Average age (years) (median)	Mean BI (median)	Survival rate (%)
July 2003–March 2012 (TraP)	23	51.7 (61)	49.8 (47)	65.2
April 2012–March 2014 (NewP)	5	51.7 (53)	51.2 (55)	100
p-value		0.0988	0.32	0.2808

BI, burn index; TraP, traditional treatment protocol for burns; NewP, new treatment protocol for burns
Survival was determined at 6 months after discharge.

Table II - Treatment outcomes in patients with a prognostic burn index ≥100

	n	Average age (years) (median)	Mean BI (median)	Mean PBI (median)	Survival rate (%)
July 2003 March 2012 (TraP)	14	71.7 (75)	46.32 (48.5)	119.2 (114.7)	61.1
April 2012 March 2014 (NewP)	5	70 (81)	39 (30)	110 (106)	100
p-value		0.889	0.8522	0.2275	0.2565

BI, burn index; PBI, prognostic burn index; TraP, traditional treatment protocol for burns; NewP, new treatment protocol for burns
Survival was determined at 6 months after discharge.

Impact of treatment type on patient survival

Of the 28 SEB patients with BI ≥30, the survival rate of the 23 patients who received TraP was 65.2%, while all five patients who received NewP survived (*Table I*). Similarly, of the 19 patients with PBI ≥100, the survival rate of the patients who received TraP was 61.1%, while all patients who received NewP were discharged from the hospital (*Table II*).

Impact of the treatment on burn-related complications

There were no deaths from infectious complications with NewP in either group (*Tables III and IV*). With TraP, deaths from BWS, CRBSI-related sepsis, and burn-related shock occurred in both groups; however, there were no statistically significant differences between NewP and TraP (P < 0.05).

Discussion

Severe burns are often associated with life-threatening or debilitating complications; however, after the introduc-

Table III - Major infectious complications resulting in death in patients with a burn index ≥30

Major infectious complications of death (BI>30)				
	n	**BWS**	**CRBSI**	**Rate (%)**
July 2003 - March 2012 (TraP)	23	3	2	21.7
April 2012 - March 2014 (NewP)	5	0	0	0
p-value	*	0.39	0.49	0.25
BWS, burn wound sepsis; CRBSI, catheter-related blood stream infection				

Table IV - Major infectious complications resulting in death in patients with a prognostic burn index ≥100

Major infectious complications of death (PBI > 100)				
	n	**BWS**	**CRBSI**	**Rate (%)**
July 2003 - March 2012 (TraP)	14	2	2	28.5
April 2012 - March 2014 (NewP)	5	0	0	0
p-value	*	0.37	0.37	0.17
BWS, burn wound sepsis; CRBSI, catheter-related blood stream infection				

tion of the new manual for burns treatment, none of the patients with SEB in our hospital died of their burns or burn-related infectious complications. Because severe infections, such as BWS, CRBSI, and bacterial translocation tend to result in death of patients with SEB, surgical interventions are delayed, resulting in late surgical interventions. This could create a vicious cycle, from which it would be difficult to remove SEB patients. Therefore, we believe that the first week after the injury is the most opportune time to perform early surgery, conduct strict water management, and establish early enteral alimentation. Transfusion management using peripheral venous lines is very important to prevent CRBSI during the entire treatment cycle of SEB patients.

In the treatment of SEB patients, early wound healing is very important in surviving SEB.[15] In our new protocol, we think that early surgery is the most important step in SEB patient therapy. In other words, if early surgery cannot be performed, then it is very difficult to save the life of the SEB patients. Furthermore, there are presently few reports on the survival rate of SEB (BI>30 or PBI>100) patients.[16,17] These reports do not mention specific survival rate of SEB patients. Here, we report the survival rate of SEB patients in Japan, and our study shows excellent results compared to the other reports. Our study findings indicate that the new treatment protocol, which emphasizes burn wound management by preventing BWS and strict line control, results in better prognosis in SEB patients.

Conclusion

Following the introduction of the burn treatment manual developed in the Advanced Emergency & Critical Care Medical Center at Okayama University Hospital, all patients with SEB survived. This manual advocates early surgery, transfusion management using peripheral venous lines, local infection control using a silver-containing wound dressing, and establishment of early enteral alimentation. Large cohort studies in independent hospitals should be conducted to further validate the applicability and performance of the treatment manual.

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