

## Original Article

# The effect of Huhuang burn liniment combined with mupirocin on treating *Staphylococcus aureus* infections in patients with small- and medium-sized burns

Qiankun Sha<sup>1\*</sup>, Mo Cheng<sup>2\*</sup>, Faying Zhou<sup>3</sup>, Yong Wang<sup>4</sup>, Dong Zhao<sup>1</sup>, Yan Huang<sup>5</sup>, Wei Fang<sup>6</sup>

<sup>1</sup>Department of Pharmacy, Chongqing Yangdu Biology Institute, Chongqing City, China; <sup>2</sup>Department of Pharmacy, People's Hospital of Dianjiang County of Chongqing, Chongqing City, China; <sup>3</sup>Department of General Surgery, Qianjiang Central Hospital of Chongqing, Chongqing City, China; <sup>4</sup>Department of Dermatology, Qijiang District Traditional Chinese Medicine Hospital of Chongqing, Chongqing City, China; <sup>5</sup>Department of Pharmacy, The People's Hospital of Nanchuan, Chongqing City, China; <sup>6</sup>Department of Pharmacy, Chongqing Sanxia Central Hospital, Chongqing City, China. \*Equal contributors and co-first authors.

Received August 22, 2020; Accepted September 16, 2020; Epub February 15, 2021; Published February 28, 2021

**Abstract:** Objective: To explore the effect of Huhuang burn liniment in the treatment of patients with small- and medium-sized burns and its inhibitory effect on *Staphylococcus aureus* infections on wounds. Methods: A total of 94 patients with small- and medium-sized burns were recruited as the cohort for this prospective study and were randomly divided into the control group and the research group, with 47 cases in each group. In the control group, we applied mupirocin ointment to the wounds, and in the research group, we applied mupirocin ointment and Huhuang burn liniment to the wounds. The total clinical effective rate and the negative conversion ratio of *Staphylococcus aureus*, the wound healing times, the degrees of pain (using the Visual Analog Pain Scale score), and the incidences of adverse reactions were compared. The interleukin-6, interleukin-8, hypersensitive C-reactive protein, and tumor necrosis factor- $\alpha$  expressions were measured using immune transmission turbidimetry or enzyme-linked immunosorbent assays, and the incidences of adverse reactions were compared. Results: The research group had a significantly higher total effective rate (93.62% vs. 76.60%), and the negative conversion ratio of *Staphylococcus aureus* in the research group was significantly higher than it was in the control group (93.62% vs. 76.60%) (both  $P < 0.05$ ). The wound healing times in the research group were significantly shorter than they were in the control group ( $P < 0.05$ ). After the treatment, the VAS scores, the serum IL-6, IL-8, hs-CRP, and TNF- $\alpha$  levels in the research group were significantly lower than they were in the control group ( $P < 0.05$ ). There was no significant difference in the incidences of adverse reactions between the two groups ( $P > 0.05$ ). Conclusion: In the treatment of small- and medium-sized burn wounds, mupirocin combined with Huhuang burn liniment can effectively inhibit *Staphylococcus aureus* infections, accelerate wound healing, eliminate *Staphylococcus aureus*, reduce pain, and not increase the adverse reactions. The combination may work by reducing the inflammatory reactions.

**Keywords:** Huhuang burn liniment, small- and medium-sized burns, *Staphylococcus aureus* infections, inflammatory reactions, adverse reactions

## Introduction

A burn is an injury of the skin or the mucous membrane tissue induced by thermal factors such as flame, hydrothermal solutions, high temperature gas, and the like. When severely burned, subcutaneous muscles and fat are injured, and in critical cases, internal organs and bone tissues are also affected, reducing patients' quality of life [1]. Small- and medium-

sized burns are a common type of burn. In the clinical treatment of burns, if the wound is not properly handled, the difficulty of wound healing increases, often leaving scars and affecting the appearance and function of the skin [2, 3]. *Staphylococcus aureus* infections are a common problem in the burn treatment process. About 80% of all small- and medium-sized burn wounds appear with *Staphylococcus aureus* infections. The *Staphylococcus aureus* occur-

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

rence rate is second only to *Pseudomonas aeruginosa* among bacterial infections in outpatients and inpatients with small- and medium-sized burns. These patients experience slow wound healing, a low skin graft success rate, and a poor treatment effect [4]. Therefore, effectively treating *Staphylococcus aureus* infections in patients with small- and medium-sized burns is a difficult problem in clinical work.

Currently, antibacterial drugs are often used to clinically treat small- and medium-sized burn wounds in patients, wounds that can often have *Staphylococcus aureus* infections, but the treatment is often unsatisfactory. A possible reason for this is that *Staphylococcus aureus* is easily resistant to antibiotics. Meng et al. showed that the resistance rates of *Staphylococcus aureus* to erythromycin and levofloxacin in burn patients were 75.4% and 64.2% [5].

In recent years, traditional Chinese medicine (TCM) has been increasingly applied to the clinical treatment of burn wounds with significant success, and *Staphylococcus aureus* has a low resistance to some Chinese medicine ingredients. Huhuang burn liniment is a traditional Chinese medicine preparation. It can purify fire and detoxify, cool the blood, promote blood circulation, reduce swelling and pain, dry dampness and astringe aphtha, and some of the Chinese medicine ingredients in Huhuang liniment have antibacterial effects. Research by Wang et al. showed that Huhuang burn liniment has a good effect on third-degree radiation skin injuries in the treatment of nasopharyngeal carcinoma, so it can shorten treatment times and reduce infections and inflammatory reactions [6]. An experiment by Zhao et al. used Huhuang burn liniment to treat superficial or deep second-degree small- and medium-sized burns caused by hot water or fire, and the results showed that superficial second-degree burns were cured in one week on average without leaving scars. Deep second-degree burns were cured within 15-21 days, with pigmentation and shallow scarring [7]. However, its specific mechanism is still unclear.

Based on these findings, this study used mupirocin and Huhuang burn liniment to treat 94 patients with small- and medium-sized burns, and then we observed the effects of the treat-

ment on the *Staphylococcus aureus* infections and the serum inflammatory factors.

### Materials and methods

#### General information

A total of 94 patients with small- and medium-sized burns treated in The People's Hospital of Nanchuan from March 2018 to January 2020 were recruited for this prospective study. They were randomly divided into the control group and the research group, with 47 patients in each group. The control group was treated with mupirocin ointment, and the research group was treated with mupirocin ointment combined with Huhuang burn liniment. This study was approved by the Ethics Committee of The People's Hospital of Nanchuan.

Inclusion criteria: Patients who met the diagnostic criteria for burns in western medicine published in *Surgery* edited by Chen Xiaoping, and in whom *Staphylococcus aureus* infections were confirmed through a burn wound secretion culture or a drug sensitivity test show that it is a *Staphylococcus aureus* infection [8]; patients who met the diagnostic criteria of burning sore in Chinese medicine published in the *Guiding Principles for Clinical Research of New Chinese Medicines* edited by Zheng Xiaoyou, with the primary symptoms including local edema, wound erythema, and burning pain, and the secondary symptoms including thirst, fever, short yellow urine sections, and the tongue and pulse as a red tongue with a yellow tongue coating, and a rapid pulse [9]; patients who provided a signed, informed consent, patients between 18-60 years old, patients with a burn injury area  $\leq 15\%$ .

Exclusion criteria: Patients allergic to mupirocin ointment or Huhuang burn liniment, patients with radioactive or chemical burns, patients with burn wounds contaminated with or stained by foreign bodies that cannot be removed, making it difficult to judge the depth of the wound, patients with wounds with infections caused by bacteria other than *Staphylococcus aureus*, patients with poor compliance and unable to cooperate with the treatment protocol.

#### Treatment methods

The patients in both groups were administered routine treatment, including pain relief with

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

**Table 1.** Comparison of the general patient data (( $x \pm sd$ )/n (%))

	Control group (n = 47)	Research group (n = 47)	$\chi^2/t$	P
Gender (case)			0.172	0.678
Male	25 (53.19)	27 (57.45)		
Female	22 (46.81)	20 (42.55)		
Age (years)	42.1 $\pm$ 3.5	41.5 $\pm$ 3.9	0.785	0.435
Burn area (cases)			0.171	0.679
< 10%	23 (48.94)	21 (44.68)		
10%-15%	24 (51.06)	26 (55.32)		
Burn site (cases)			0.044	0.834
Trunk	20 (42.55)	19 (40.43)		
Limbs	27 (57.45)	28 (59.57)		

ibuprofen and codeine, tetanus shots, and flucloxacillin.

In the control group, mupirocin ointment (Sino-American Tianjin SmithKline Pharmaceutical Co., Ltd.) was evenly applied to the wound once a day. If the wound was not relieved, the application frequency was increased to twice a day. The research group was treated with mupirocin ointment combined with Huhuang burn liniment. The mupirocin ointment was used in the same way it was in the control group, and the Huhuang burn liniment was applied to the wound surface using exposure or semi-exposure therapy, 1-3 times a day. Both groups were treated continuously for 2 weeks.

### Outcome measures

We then compared the total clinical efficacy rates in the two groups. Evaluation criteria: if the wound healing rate is > 70% and the *Staphylococcus aureus* test becomes negative, the treatment is considered significantly effective. If the wound healing rate is  $\leq$ 70% but > 30%, and the *Staphylococcus aureus* test becomes negative, or if the wound healing rate is  $\leq$ 30% and the *Staphylococcus aureus* test becomes negative, as the treatment is considered effective. If the wound healing rate is less than 30%, and the *Staphylococcus aureus* test is positive, the treatment is considered invalid. The total effective rate = significantly effective rate + effective rate.

The negative conversion ratios of *Staphylococcus aureus* and the wound healing times in the two groups were compared. Prior to and

after the treatment, an appropriate volume of secretions was scraped from the patients' burn wounds and tested using sputum cultures or drug sensitivity tests. The negative conversion ratio of *Staphylococcus aureus* (%) = the case number of negative conversion/total number of cases \* 100. The wound healing time was the time from injury to wound disappearance (when the wounds were completely covered by normal skin tissue).

The patients' degrees of pain were evaluated using the Visual Analog Pain Scale (VAS). The highest possible VAS score is 10. Higher scores indicated more severe pain in the patients [10].

The inflammatory factor levels in the two groups were compared. Before and after the treatment, 5 ml of fasting venous blood was extracted from the two groups of patients, and the interleukin-6 (IL-6), interleukin-8 (IL-8), hypersensitive C-reactive protein (hs-CRP), and tumor necrosis factor- $\alpha$  (TNF- $\alpha$ ) levels were measured using immunoturbidimetry or enzyme-linked immunosorbent assays. The experimental process was carried out according to the kit's instructions as provided by the Nanjing Sembejia Biotechnology Co., Ltd.

The incidences of adverse reactions, such as rash, itching, and a local burning sensation, was compared between the two groups. Incidence of adverse reactions (%) = number of cases of adverse reactions/total number of cases \* 100.

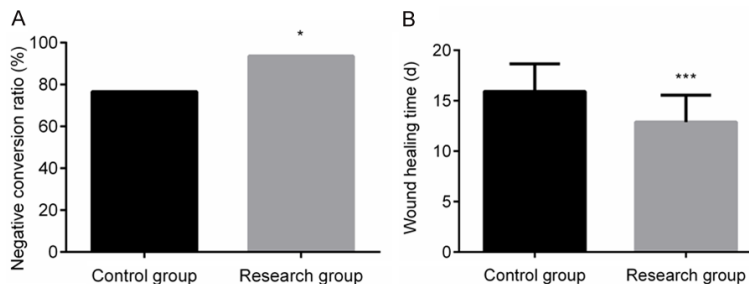
### Statistical methods

SPSS 23.0 was used to analyze the data. All the data was tested using a normal distribution test. The measurement data were expressed as the mean  $\pm$  standard deviation ( $x \pm sd$ ), and independent sample t tests were used for the comparison between two groups. Paired sample t tests were used for the comparisons at different time points within a group. The count data were expressed as the number of cases/percentage (n/%), and the comparisons between two groups used Fisher's exact tests or  $\chi^2$  tests. The rank data were tested using

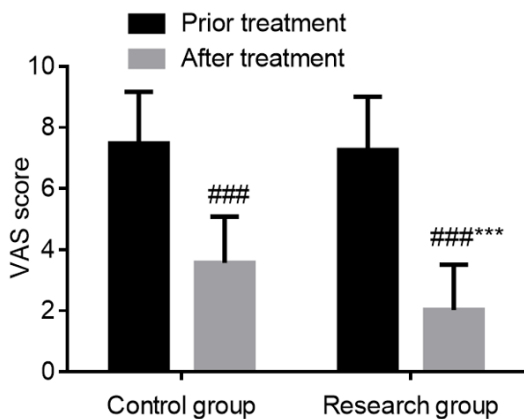
# Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

**Table 2.** Comparison of the total clinical effective rates (n, %)

Group	Control group (n = 47)	Research group (n = 47)	Z	P
Significantly effective	20 (52.55)	27 (57.45)	2.296	0.022
Effective	16 (34.04)	17 (36.17)		
Invalid	11 (23.40)	3 (6.38)		



**Figure 1.** Comparison of the negative conversion ratio and the wound healing time of *Staphylococcus aureus*. A. Negative conversion ratio of *Staphylococcus aureus*; B. Wound healing times. Compared with the control group, \*P < 0.05, \*\*\*P < 0.001.



**Figure 2.** Comparison of the VAS scores. Compared with the same group prior to the treatment, ###P < 0.001; compared with the control group after the treatment, \*\*\*P < 0.001. VAS: Visual Analog Pain Scale.

rank sum tests. P < 0.05 indicated that a difference was statistically significant.

## Results

### Comparison of the general patient data

There were no significant differences in the general data, including gender, age, burn area, or burn location between the two groups (all P > 0.05). See **Table 1**.

### Comparison of the total clinical effective rates

The total effective rate in the research group was significantly higher than the rate in the control group (93.62% vs. 76.60%, P < 0.05), suggesting that used jointly with the mupirocin ointment, the Huhuang burn liniment can effectively improve the total clinical treatment efficacy in patients with small- and medium-sized burns. See **Table 2**.

### Comparison of the negative conversion ratios of *Staphylococcus aureus* and the wound healing times

The negative conversion ratio of *Staphylococcus aureus* in the research group was significantly higher than it was in the control group (93.62% vs. 76.60%, P < 0.05). The wound healing times in the research group were shorter than they were in the control group (P < 0.001). The above results suggest that used jointly with the mupirocin ointment, Huhuang burn liniment significantly reduces the incidences of *Staphylococcus aureus* infection and shorten the wound healing times in patients with small- and medium-sized burns. See **Figure 1**.

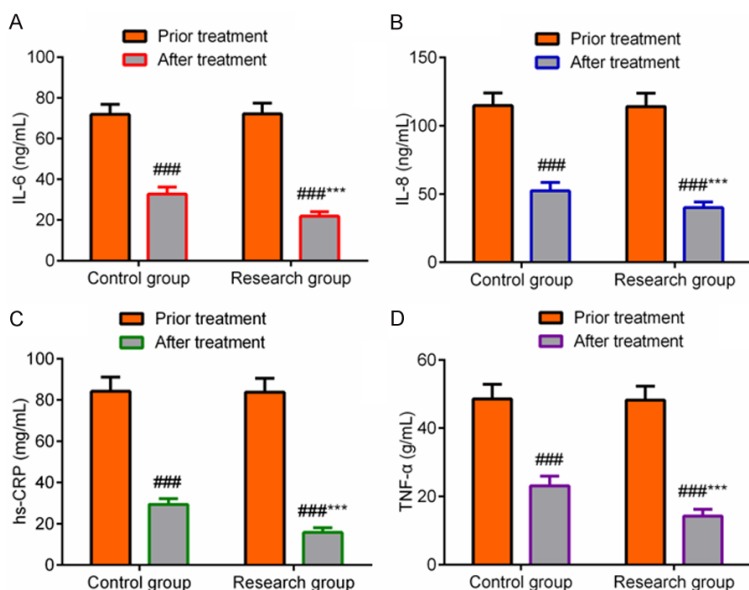
### Comparison of the pain scores

Compared with before the treatment, the VAS scores in the two groups were lower after the treatment (P < 0.001). The VAS scores in the research group were lower than the VAS scores in the control group after the treatment (P < 0.001). The above results suggest that Huhuang burn liniment can effectively relieve pain in the treatment of *Staphylococcus aureus* infections in patients with small- and medium-sized burns. See **Figure 2**.

### Comparison of the inflammatory factor levels

Compared with the prior treatment, the serum IL-6, IL-8, hs-CRP, and TNF- $\alpha$  levels in the two groups decreased after treatment (all P <

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection



**Figure 3.** Comparison of the serum IL-6, IL-8, hs-CRP, and TNF- $\alpha$  levels. A. IL-6; B. IL-8; C. hs-CRP; D. TNF- $\alpha$ . Compared with the same group prior to the treatment, ###P < 0.001; compared with the control group after the treatment, \*\*\*P < 0.001. IL: interleukin; hs-CRP: hypersensitive C-reactive protein; TNF- $\alpha$ : tumor necrosis factor- $\alpha$ .

**Table 3.** Comparison of the incidences of adverse reactions (n, %)

Group	Control group (n = 47)	Research group (n = 47)	$\chi^2$	P
Rash	1 (2.13)	0 (0.00)		1.000
Itching	0 (0.00)	2 (4.26)	0.511	0.475
Local burning sensation	1 (2.13)	1 (2.13)	0.000	1.000
Total	2 (4.26)	3 (6.38)	0.000	1.000

0.001). The serum levels of the above inflammatory factors in the research group were lower than they were in the control group after the treatment (all P < 0.001). The results showed that Huhuang burn liniment can effectively reduce inflammatory reactions in the treatment of *Staphylococcus aureus* infections in patients with small- and medium-sized burns. See **Figure 3**.

### Comparison of the incidences of adverse reactions

There were no significant differences in the incidences of adverse reactions between the two groups (P > 0.05), suggesting that Huhuang burn liniment does not increase the adverse reactions in the treatment of small- and medium-sized burn patients with *Staphylococcus aureus* infections. See **Table 3**.

## Discussion

The loss of skin barrier function and local tissue necrosis in burn wounds provides a powerful environment for bacterial infection [11, 12]. The effect of the routine use of antibiotics in the treatment of small- and medium-sized burn patients is not good [13, 14]. In our study, mupirocin combined with Huhuang burn liniment was used to treat *Staphylococcus aureus* infections in patients with small- and medium-sized burns. We found that the total effective rate and the negative conversion ratio of *Staphylococcus aureus* in the research group were higher than they were in the control group, and the wound healing times were shorter than they were in the control group. Chang et al. found that the total effective rate of Huhuang burn liniment in the treatment of second-degree burns was 97.5%, significantly higher than the total effective rate using conventional western medicine (87.0%), and this was basically consistent with the results of our study [15, 16].

All these results suggest that Huhuang burn liniment is effective in the treatment of *Staphylococcus aureus* infections in patients with small- and medium-sized burns, so it can effectively inhibit *Staphylococcus aureus* and accelerate wound healing.

Mupirocin ointment can inhibit the synthesis of *Staphylococcus aureus* proteins by synthesizing proteolytic enzymes to produce an antibacterial effect, and it can effectively penetrate necrotic tissue, so it is convenient to use [17]. Although mupirocin ointment has a certain curative effect in the treatment of *Staphylococcus aureus* infections, there are adverse reactions such as rash, itching, a local burning sensation and on the like in the treatment process, reducing the patients' treatment compliance, affecting the treatment efficacy and easily causing bacterial drug resistance

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

[18]. Therefore, effectively treating small- and medium-sized burns and reducing the occurrence of bacterial drug resistance is the focus of our current research.

In recent years, studies have found that Huhuang burn liniment can reduce the incidence of drug resistance [19]. TCM defines burns as sores or burning sores. The pathogenesis of burns lies in the damage to the skin caused by heat toxin and fire toxin, so heat-clearing and detoxification are the main treatments. Huhuang burn liniment is composed of *Polygonum cuspidatum*, *Phellodendron chinense*, safflower, *Coptis chinensis*, buffalo horn, *Angelica dahurica*, groundsel, and borneol. Among them, *Polygonum cuspidatum* has the effect of dispersing blood stasis and analgesia, heat-clearing and detoxification. *Phellodendron chinense* and *Coptis chinensis* have the effect of purging fire, removing toxins, heat-clearing, and drying dampness. Safflower has the effect of promoting blood circulation and removing blood stasis. Buffalo horn has the effect of clearing heat and cooling the blood. *Angelica dahurica* has the effect of dispelling wind and drying dampness, detumescence and analgesia. Groundsel has the effect of clearing heat and removing toxins, and borneol has detumescence and analgesic effects. The combination of above drugs has the effect of cooling the blood and promoting blood circulation, purging fire and removing toxins, reducing detumescence and analgesia, drying dampness and furuncles, so it can effectively promote wound healing. Modern pharmacological studies have shown that the main active components of *Phellodendron chinense* and *Coptis chinensis* are magnolia alkaloid, phellodendrine and berberine, which have inhibitory effects on bacteria, fungi, and ulcers, and polydatin has an inhibitory effect on *Staphylococcus aureus* and typhoid bacilli [20-22].

In our study, we found that the VAS scores in the research group were lower than they were in the control group after the treatment and there were no significant differences in the incidences of adverse reactions in the two groups. These results suggest that Huhuang burn liniment can effectively reduce patients' pain without increasing their adverse reactions in the treatment of *Staphylococcus aureus* infections in patients with small- and medium-

sized burns. The possible reason may be the analgesic effect of *Angelica dahurica* and safflower yellow pigment, which can effectively relieve wound pain. Previous clinical findings have shown that the pathogenic process of burns and other acute trauma are accompanied by the release of a large number of inflammatory cytokines, such as IL-6, IL-8, hs-CRP, TNF- $\alpha$ , and the like, which cause inflammatory reactions, affect wound tissue repair, increase the treatment difficulty, and prolong the wound healing time. Therefore, reducing inflammatory reactions is of great significance to accelerating wound healing and promoting patients' rehabilitation [23, 24]. In our study, the serum IL-6, IL-8, hs-CRP, and TNF- $\alpha$  levels in the research group were lower than they were in the control group after the treatment, which suggests that Huhuang burn liniment can significantly reduce inflammatory reactions in the treatment of *Staphylococcus aureus* infections in patients with small- and medium-sized burns. The possible reason may be the anti-inflammatory effects of the polydatin in *Polygonum cuspidatum* and the *radix angelicae dahuricae* in *Angelica dahurica* [25].

However, there are some limitations to our study. For example, this study was a single-center study, and the study interval was short. In addition, the long-term efficacy has not been evaluated. Therefore, a further multi-center study with a large study cohort will be needed for further investigation [26].

In conclusion, Huhuang burn liniment can effectively promote wound healing, eliminate *Staphylococcus aureus* infections, reduce patients' pain without increasing the adverse reactions in patients with small- and medium-sized burns. The possible mechanism may be that Huhuang burn liniment can inhibit inflammatory reactions.

### Disclosure of conflict of interest

None.

**Address correspondence to:** Wei Fang, Department of Pharmacy, Chongqing Sanxia Central Hospital, No. 165 Xincheng Road, Wanzhou District, Chongqing 404100, China. Tel: +86-023-58103181; E-mail: fangweix1c@163.com; Yan Huang, Department of Pharmacy, The People's Hospital of Nanchuan, No. 16 South Street, Nanchuan District,

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

Chongqing City 408499, China. Tel: +86-023-71419120; E-mail: 379754164@qq.com

### References

- [1] Shek K, Patidar R, Kohja Z, Liu S, Gawaziuk JP, Gawthrop M, Kumar A and Logsetty S. Rate of contamination of hospital privacy curtains on a burns and plastic surgery ward: a cross-sectional study. *J Hosp Infect* 2017; 96: 54-58.
- [2] Zhu Z, Cao GW, Bao JJ, Hu ZH, Shen Z, Tao H, Cao B and Xu F. Effects of application of vancomycin in the early stage of patients with extremely severe burn. *Zhonghua Shao Shang Za Zhi* 2017; 33: 206-210.
- [3] Tejiram S, Johnson LS, Mete M, Desale S, Johnson K, Zhang J, Moffatt LT and Shupp JW. Screening nasal swabs for methicillin resistant *Staphylococcus aureus*: a regional burn center's experience. *Burns* 2017; 43: 771-779.
- [4] Zhou B, Tu HL, Ba T, Wang LF, Wang SJ and Nie SY. Effects of combined application of culture supernatant of human umbilical cord mesenchymal stem cells and ciprofloxacin on *Staphylococcus aureus* in vitro. *Zhonghua Shao Shang Za Zhi* 2017; 33: 355-360.
- [5] Meng ZH, Qian XM and Wang YL. Drug resistance analysis of *Staphylococcus aureus* infection in severe burn wounds. *Zhonghua Yi Yuan Gan Ran Xue Za Zhi* 2014; 24: 1572-1573+1579.
- [6] Wang CG. Clinical study of Huhuang burn liniment in the treatment of third-degree radiation skin injury of nasopharyngeal carcinoma. *Xian Dai Yao Wu Yu Lin Chuang* 2019; 34: 2794-2798.
- [7] Zhao CL, Xie WG, Wan SY, Yu RH, Liu LP and Mei GQ. Treatment of II water and fire scald by Huhuang burn liniment. *Hubei Zhong Yi Za Zhi* 1999; 21: 364-365.
- [8] Chen XP, Wang JP and Zhao JZ. Surgery (9th Edition). In: Chen XP, Wang JP, Zhao JZ, editors. Beijing: People's Medical Publishing House; 2018.
- [9] Zheng XY. Clinical research of new Chinese medicines. In: Zheng XY, editor. Beijing: China Medical Science Press; 2002.
- [10] Saeidinia A, Keihanian F, Lashkari AP, Lahiji HG, Mobayyen M, Heidarzade A and Golchai J. Partial-thickness burn wounds healing by topical treatment: a randomized controlled comparison between silver sulfadiazine and centiderm. *Medicine (Baltimore)* 2017; 96: e6168.
- [11] Gottlieb M, Long B and Koefman A. The evaluation and management of toxic shock syndrome in the emergency department: a review of the literature. *J Emerg Med* 2018; 54: 807-814.
- [12] Garvey MI, Pichon B, Bradley CW, Moiemens NS, Oppenheim B and Kearns AM. Improved understanding of an outbreak of methicillin-resistant *Staphylococcus aureus* in a regional burns centre via whole-genome sequencing. *J Hosp Infect* 2016; 94: 401-404.
- [13] Fratini F, Cilia G, Turchi B and Felicioli A. Beeswax: a minireview of its antimicrobial activity and its application in medicine. *Asian Pac J Trop Med* 2016; 9: 839-843.
- [14] Gitau W, Masika M, Musyoki M, Museve B and Mutwiri T. Antimicrobial susceptibility pattern of *Staphylococcus aureus* isolates from clinical specimens at Kenyatta National Hospital. *BMC Res Notes* 2018; 11: 226.
- [15] Chang DF, Qiu L, Zhang HS and Yang DQ. Clinical study of Huhuang burn liniment in treating second degree burn. *Chongqing Yi Xue* 2017; 46: 1482-1483, 1486.
- [16] Jayaraman SP, Jiang Y, Resch S, Askari R and Klompas M. Cost-effectiveness of a model infection control program for preventing multi-drug-resistant organism infections in critically ill surgical patients. *Surg Infect (Larchmt)* 2016; 17: 589-595.
- [17] Zorgani AA, Elahmer O, Abaid A, Elaref A, Elamri S, Aghila E and Tubbal A. Vancomycin susceptibility trends of methicillin-resistant *Staphylococcus aureus* isolated from burn wounds: a time for action. *J Infect Dev Ctries* 2015; 9: 1284-1288.
- [18] Lee MA and Cohen PR. Zoon balanitis revisited: report of balanitis circumscripta plasmacellularis resolving with topical mupirocin ointment monotherapy. *J Drugs Dermatol* 2017; 16: 285.
- [19] Chang R, Zeng XC and Pan Y. Therapeutic evaluation of Huhuang burn liniment combined with antibiotics in the treatment of deep II degree burns. *Journal of Practical Traditional Chinese Medicine* 2020; 36: 254-256.
- [20] Maxwell RA, Croft CA, Creech CB, Thomsen I, Soper N, Brown LE, Mejia VA, Dart BW 4th and Barker DE. Methicillin-resistant *Staphylococcus aureus* in a trauma population: does decolonization prevent infection? *Am Surg* 2017; 83: 1407-1412.
- [21] Liu H, Gu LB, Tu Y, Hu H, Huang YR and Sun W. Emodin ameliorates cisplatin-induced apoptosis of rat renal tubular cells in vitro by activating autophagy. *Acta Pharmacol Sin* 2016; 37: 235-245.
- [22] Lu JJ, Hu XW, Li P and Chen J. Global identification of chemical constituents and rat metabolites of Si-Miao-Wan by liquid chromatography-electrospray ionization/quadrupole time-of-flight mass spectrometry. *Chin J Nat Med* 2017; 15: 550-560.
- [23] Li D, Wang JH, Jiang H, Chen GP, Yang X and Liu DL. Research on transforming growth factor- $\beta$  in the repair process of skin burn patients. *Int J Clin Exp Med* 2018; 11: 9662-9669.

## Effect of Huhuang burn liniment in treating on *Staphylococcus aureus* infection

- [24] Banothu V, Neelagiri C, Adepally U, Lingam J and Bommareddy K. Phytochemical screening and evaluation of in vitro antioxidant and antimicrobial activities of the indigenous medicinal plant *Albizia odoratissima*. *Pharm Biol* 2017; 55: 1155-1161.
- [25] Zan Y, Kuai CX, Qiu ZX and Huang F. Berberine ameliorates diabetic neuropathy: TRPV1 modulation by PKC pathway. *Am J Chin Med* 2017; 45: 1709-1723.
- [26] Zho J, Zhou F, Chen L, Shu B, Zhai Q, Wu J, Liu X, Qi S and Xu Y. Negatively-charged aerosol improves burn wound healing by promoting eNOS-dependent angiogenesis. *Am J Transl Res* 2018; 10: 246-255.