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Case Report

Management of second-degree burn in child: A case report

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Abstract

Background Burns are a common occurrence in children and are generally caused by scald. Burns can affect the socio-economic life and quality of life of the sufferer due to the disability that results in death. Second-degree burns have high enough morbidity and mortality that require adequate management. Management of burns in children includes assessment of the degree of burn, pain control, wound cleansing, debridement, appropriate dressing and wound evaluation.

Method A 5-year-old boy with the chief complaint of sores caused by scald on his chest, hands and feet. The area that was scalded with hot water immediately turned red, then blisters and accompanied by pain and chills. Examination of the dermatological status showed that the anterior trunk region showed hyperpigmented patches with multiple bullae with erosions in several parts. In the region of the antebrachialis et manus dextra et femoralis dextra, hyperpigmented patches appear with erosions. The patient was diagnosed with second-degree burns and received initial management in the form of fluid resuscitation, antibiotics and painkillers. Subsequent management with wound debridement in 3 sessions every 5 days, post-debridement silver sulfadiazine ointment, PRF in the 2nd and 3rd debridement sessions, mupirocin ointment post-debridement for deep erosions, 10% vitamin C solution in post-debridement medication, tretinoin 0.05% cream once a day at night, doxepin hydrogen chloride 5% cream applied twice a day, day and night, vaseline album is applied 2 times a day morning and evening as a home treatment.

Result The presence of bullae, lesions that appear wet and erythematous and also a history of contact with hot water, supports the diagnosis of second-degree burns. Initial management in this case aims to maintain hemostasis, namely by resuscitation of body fluids and control of pain and infection. Follow-up wound care consisted of wound cleansing, debridement, administration of topical agents to prevent infection and scarring and accelerate wound healing which included PRF, silver sulfadiazine ointment, 10% vitamin C solution, 0.05% tretinoin cream, 5% doxepin hydrogen chloride cream and vaseline album. The results after 8 weeks follow up showed improvement.

Conclusion Combination therapy of debridement, PRF, topical antibiotic, vitamin C solution, tretinoin cream, topical antihistamine, and vaseline album has been shown to improve second degree burn with minimal scarring.

Key words
Child; Debridement; Burn injury; Wound care.

Introduction

Burns are lesions appearing due to contact with heat source such as exposure to fire, high-temperature object, electricity, and chemicals.[1,2] The primary etiology of burns in children is contact with hot liquids.[3] Burns can affect the patients' social-economic life and quality of life due to disability leading to death.[4] Morbidity

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and mortality of burns are affected by severity. Some factors affect the severity of burns: location, exposure temperature, and heat exposure duration.[5]

James *et al*; reported 8,991,468 burn incidences with 120,632 deaths in 2017.[6] Riskesdas (Primary Health Research) 2013 shows that 0.7% burn incidence occurs in Indonesia. The highest incidence rate occurs in Papua region (2%), while 0.6% occurs in Central Java.[7] The etiology of burns is 86% caused by thermal trauma. Burns are the second leading cause of death from accidents in children aged 1-4 years and the fourth leading cause of death in adults and children.[3]

Burns are classified by wound depth and width. By depth, burns are classified into some degrees: I, IIa, IIb and III. Second-degree burns are the ones involving superficial dermis while second b (IIb)-degree involves deeper dermis part. The third-degree burns involves epidermis, dermis, subcutaneous, and deeper structure.[5] By the extent of involvement, burns are divided into minor and major burns. Minor burns are those with lesion <10% of total *body surface area* (BSA) while major burns involve >30% of total BSA in children.[4]

The management of burns involves assessment on the degree of burns, pain control, wound cleansing, debridement, appropriate dressing and wound evaluation.[8] Acute burns need adequate resuscitation, management of hypermetabolism occurring due to burns, and infection control. Therapy for the second degree burns includes debridement on intact bullous having the risk of rupture and removing bullous liquid containing high-concentration thromboxane, and applying topical antibiotics or covering the wound using synthetic wound dressing.[9] *Platelet rich fibrin* (PRF) and vitamin C can cure the wound more quickly.[10,11] Silver sulfadiazine and vaseline album have protective effect on bacteria.[12,13] Tretinoin can trigger the growth of first- and third- type collagen.[14] Doxepin is an antihistamine that can be used to reduce itchiness in burn healing.[15]

Thermal trauma can result in burns in which the barrier function of normal skin is lost. This condition results in some complications like infection, hypothermia, increased trans *epidermal water loss* (TEWL) and lost tactual and esthetical functions.[16] Either localized or systemic complication of infection may occur, involving blood flow infection and pneumonia that can evolve into sepsis, multisystem organ failure and death. Esthetically poor appearance due to burns can trigger anxiety and depression.[17] This article writing aims to find out the appropriate management of burns in children to result in good wound healing and to prevent complication.

Case

A five year old boy came to Emergency Unit of Universitas Sebelas Maret Hospital of Surakarta with wound induced by hot water flush on breast, hand, and leg. One and a half of hours before coming to the hospital, the patients was accidentally flushed with hot water on breast, arm, and thigh areas when his mother was preparing hot tea. The area flushed with hot water turns red, and then scald and sore appeared along with pain. The patient's mother then flushed the patient's body entirely using water in the bathroom as the first aid but no improvement occurred. The patient complained of severer pain on the wound with chills. The patient was then brought to Emergency Unit of a Private Hospital in Kartasura and then referred to the Emergency Unit of Universitas Sebelas Maret Hospital of Surakarta. Neither drug nor ointment was given to relieve the complaint.

From physical examination, the general condition of patient includes moderate sickness,

Figure 1 (A). Hyperpigmented patch appear on anterior trunk region along with multiple bullous and erosion in some parts (red arrow). (B) Hyperpigmented patch appearson antebrachialis et manus dextra region along with erosion (yellow arrow). (C) hyperpigmented patch appears on femoralis dextra along with erosion (green arrow).

compos mentis, pain score 3-4. The examination of vital signs found pulse 127 x/minute, respiration rate 21x/minutes, temperature 36.2°C. The patient is 90 cm tall and 13 kg weigh, with good nutrition status. Laboratory test found Hb 10.7 g/dl (N= 11.5-13.5 g/dl); hematocrit 31% (N= 34-40%); thrombocyte 407,000/µl (N= 150,000-450,000/µl); 16,440/µl (N= 4,500-l4,500/µl); erythrocyte $4.48x10^6$/µl (N= $3.9-5.3x10^6$/µl); potassium 3.06 mmol/l (N= 3.5-5.5 mmol/l); natrium 132.43 mmol/l (N= 135-145 mmol/l); chloride 96.99 mmol/l (N= 96-106 mmol/l); calcium 0.75 mmol/l (N= 1.1-1.35 mmol/l). Dermatological status test shows that hyperpigmented patch appear on anterior trunk region along with multiple bullae and erosion on some parts. Hyperpigmented patch appears on antebrachialis *et* manus dextra *et* femoralis dextra region along with erosion. BSA involvement is 25%.

We diagnosed this patient with second-degree burn. The early management for the patient was conducted by pediatric department by oxygenation, asering 300 cc *loading* intravenous infusion, intravenous infusion of D5 ¼ NS 52 ml/hours, azithromycin injection 150 mg/day, and natrium metamizole injection 150 mg/8 hour. Debridement was done to the patient on supination position under *Laryngeal Mask Airway* (LMA) general anesthesia. Debridement procedure started with washing the skin lesion area using chlorhexidine and then rinsing it with aqueduct and drying the lesion using sterile duct. Skin lesion was then washed using povidone iodine liquid disinfectant and rinsed with NaCl 0.9% solution and dried again using sterile duct. Debridement is then done to the skin lesion that washed again using chlorhexidine and rinsed using NaCl 0.9% and dried later using sterile duct.

Figure 2 (A). Wound washing before debridement treatment. (B) Debridement. (C) The application of topical therapy post-debridement. (D-F) Sofra tulle® application (E) Bandage the wound with sterile gauze (F) Wrap the wound with gauze roll. (G) Wound wrapping using elastic bandage.

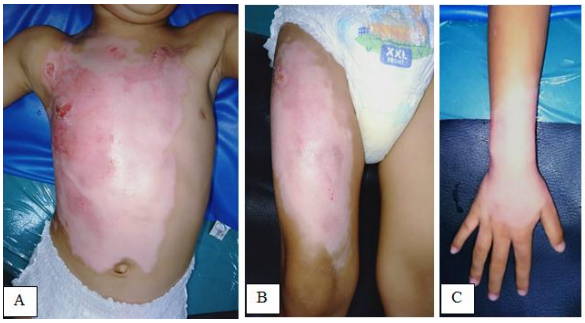

Figure 3 Follow-up Photograph of patient 2 (two) weeks post-debridement (A-B). Erosion appears on anterior trunk et femoralis dextra region with erithematous base and crust on some elements (C) Erosion appears on antebrachialis et manus dextra region with erithematous base. Some wound areas still seem to be wet.

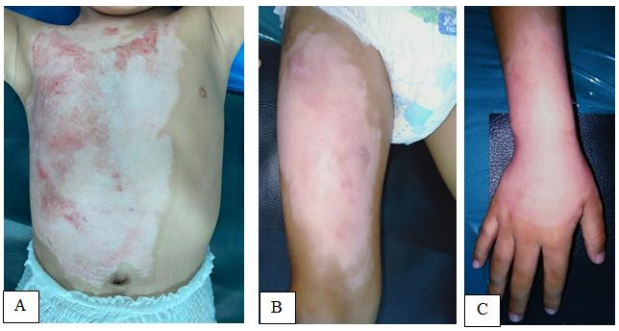

Figure 4 Follow up photograph of patient 4 weeks post-debridement (A-B). Erosion apperas on anterior trunk et femoralis dextra with erythematous base and crust at least on some parts (improvement). (C). Erosion appears on antebrachialis et manus dextra region with erythematous base. Some wounds still seem to be wet. Reepitheliation occurs in the wound edge.

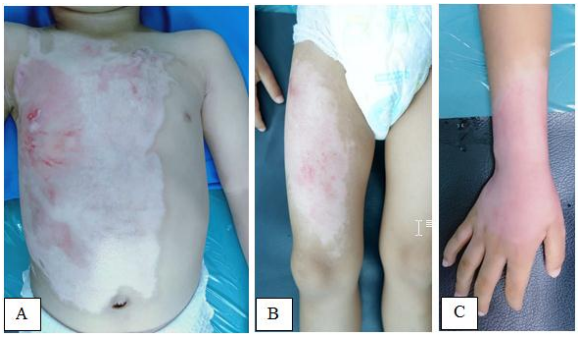

Figure 5 Follow-up Photograph of patient 8 (eight) weeks post-debridement (A-B) Erosion appears on anterior trunk et femoralis dextra region with erythematous base along with crust at least on some parts (improvement) (C). Erosion appears on antebrachialis et manus dextra region with erythematous base. The wound area seems to be dry. Reepitheliation occurs in the wound edge (improvement).

The wound area was silver sulfadiazine cream was applied on the wound area and mupirocin 2% ointment was applied to the deeper erosion wound. *Sofra tulle*® was then applied to the wound that is then covered with thick gauze, thin gauze roll, and elastic bandage. Debridement was done three times in 5 days. *Platelet rich fibrin* (PRF) was administered in the 2nd- and 3rd- session debridement before the application of silver sulfadiazine 1% cream. The medication was done on days-1, -3, -7, and -14 post debridement. Medication started with compressing the wound using gauze moistened with NaCl 0.9% for 10-15 minutes and then applying vitamin C 10% solution to the wound area other than area with deep erosion. Mupirocin 2% ointment was applied to the wound with deep erosion. The wound was covered with *sofra tulle*®, sterile gauze, gauze roll, and elastic bandage. Tretinoin 0.05% cream was applied once a day at night to the drying wound area, hydrogen chloride doxepin 5% cream was applied twice a day at day and night, vaseline album was applied twice a day in the morning and evening as maintenance therapy at home. The patient was recommended not to scratch the wound, to consume food containing high protein and to maintain wound cleaning.

Discussion

Burns are an incidence often occurring in children and generally due to hot water flush. In addition, it can be caused by contact with fire, electricity, chemicals, and radiation. Burn incidence rate in children is higher than that in adult. Burns lead to the lost protecting function of skin and can result in other complications such hypothermia and infection.[18]

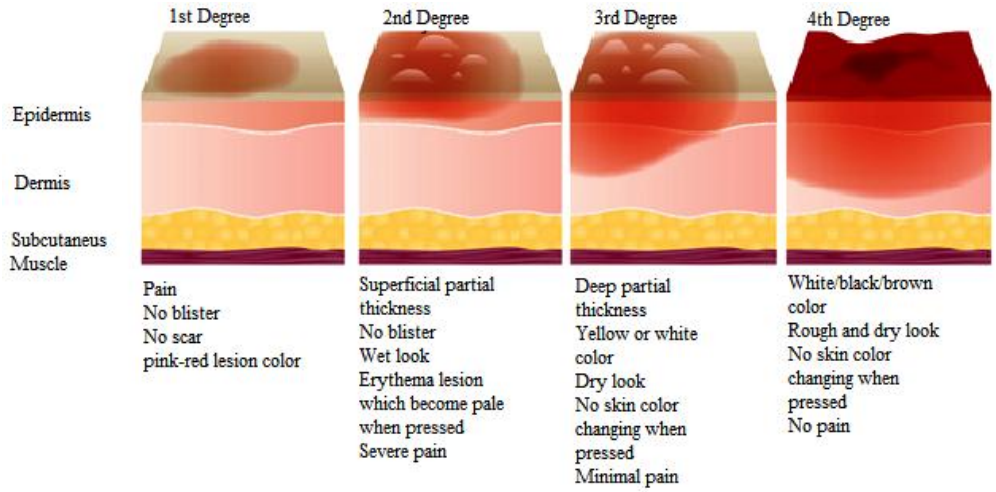

Figure 6 The classification of burn degrees by depth.[4,5]

Babies and children's skin is thinner and not heat resistant, compared with the adult's and thereby, special attention should be paid to early evaluation, management, resuscitation, and pain control.[18,19]

Thermal trauma at cellular level will lead to protein denaturation and lost plasma membrane integrity.[16] Membrane cell damage results in dynamic cascade of inflammation mediator in which inflammation phase starts so that neutrophil and monocyte will reach the next trauma area leading to liquid vasodilation and extravasation.[16,20] This immune response that has been begun is followed with macrophage activation by chemokine.[20] This cascade can worsen intercellular permeability that has been impaired, worsen the liquid regulation, and result in systemic inflammatory response. Thermal trauma induces the lost gradient of hydrostatic and osmotic pressures so that edema and large-scale liquid transfer occur. Complement activation and intravascular stimulation against neutrophil triggers the production of cytotoxic oxygen free-radical. The improvement of histamine activity, the improvement of *xanthine oxidase* catalytic agent leads to the increase in local vascular permeability progressively. The toxin produced by *xanthine oxidase*, hydrogen peroxide and hydroxyl radical will appear on the impaired dermal structure. Oxidant and protease will damage skin and capillary endothelial cell and thereby potentially results in necrosis in ischemic tissue.[16,21]

Burns are classified by wound depth. 1st-degree burns are superficial ones involving epidermis only. The representation of wound is bright red to red, looks dry with medium-degree pain, and no bullae. 2nd-degree burns are divided into two: superficial (IIa) and deep (IIb). The superficial 2nd- degree burn involves superficial dermis with reddish lesion and bullae, looks wet and shows a pale color change when erythematous lesion is pressed, and severe pain occurs. The deep 2nd-degree burns involve deeper dermis with yellow or white lesion, look dry and show no pale color change when pressed. Minimum pain occurring in this degree is due to the degraded sensation. 3rd-degree burns involves epidermis, dermis, subcutaneous or deeper structure with white or black or brown lesion, looks rough and dry, and shows no pale color change when pressed and no pain.[5] In this patient, the ruptured bullae creating erosion with reddish base is found, and thereby supporting the diagnosis of 2nd-degree burn. The 2nd-degree burn leads to superficial edema deposition between the healthy tissue and the injured one, and thereby results in bullae

with varying rupture degrees.[9]

1st- Degree: pain, no bullae, no scar, bright red-red lesion.

2nd- Degree: superficial partial thickness, bullae, wet, pale erythematous lesion when pressed, severe pain.

3rd- Degree: deep partial thickness, yellow or white, dry, no pale color change when pressed, minimum pain.

4th- Degree: white/black/brown, rough and dry, no pale color change when pressed, no pain.

The management of burns generally involves wound assessment or early evaluation, resuscitation, pain control, and wound treatment. The management of burns in children should get more special attention than that in adults.[18,19] Burns in children involving BSA >10% should get parenteral liquid resuscitation. Children have high hypoglycemic and hypothermic risks and therefore, body temperature should be checked more routinely and intravenous isotonic liquid combined with dextrose 5% as the treatment. The burn patient with lesion on face area should get intubation related to respiratory tract edema potentially developing into respiratory tract obstruction. Intubation attached to children is often released easily, it will worsen the respiratory tract edema and thus, it will require stronger intubation fixation.[13] The principle of burn treatment in children is generally as same as that in adult, involving some stages: lesion washing, debridement, antimicrobial agent use and other supporting topical agent as well as bandage. Attention should be paid to children to avoid the application of silver sulfadiazine ointment to central face area to prevent it from entering unintentionally into eyes and causing severe eye iritation.[18,19]

Debridement of burns in children starts with cleaning the wound using light antimicrobial detergent (e.g. chlorhexidine).[8] Povidone iodine is an antiseptic agent other than chlorhexidine used as well to clean the wound followed with washing using normal saline.[22] This process can remove slough, exudate, and debris so that the assessment on body surface area involved and wound depth can be done better. All roofs of bullae are removed but the one on palm and sole and the small-sized one. This process can prevent the formation of crust and slough due to the rupture of bullae that can disturb wound healing. Antibiotic ointment is then applied to the cleaned wound to protect it from bacteria and debris.[8] The wound cleaning in this case is done using chlorhexidine and then aqueduct to be dried and washed later using povidone iodine, flushed using NaCl 0.9% solution and dried again. Debridement is then done and followed with wound washing using chlorhexidine, flushing using NaCl 0.9% solution, drying, and silver sulfadiazine cream application.

Silver sulfadiazine is a topical antibiotic cream often used as the therapy of burns. The component of sulfadiazine has bacteriostatic effect. Silver sulfadiazine effectively fight against a variety of bacteria often found in burns, either gram positive like *Staphylococcus aureus, Streptococcus pyogenes, Corynebacterium diphtheriae,* and *Clostridium perfringens* or gram negative like *Pseudomonas aeruginosa, Klebsiella species, Enterobacter species, Proteus species, Citrobacter,* and *Escherichia coli*. This agent can repair epithelialization and wound healing due to the cytotoxic effect of fibroblast and keratinocyte.[23] Ostlie *et al;* conducted a study on 50 children with second-degree burns in United States of America treated with collagenase therapy. Infection incidence rate in the group treated with silver sulfadiazine is smaller (1 patient) than that in the group treated with collagenase (7 patients).[24] In this case, silver sulfadiazine cream

was administered to our patient aiming to prevent the infection of wound.

Platelet rich fibrin (PRF) is the concentrate protein of whole blood-derived *platelet rich plasma* (PRP). Erythrocyte is removed from PRF through centrifugation. Platelet and leukocyte autologous contained in complex fibrin matrix functions to accelerate the wound healing in the tissue. Collagen and thrombin are molecules also contained in platelet membrane. The main function of platelet is to create hemostasis condition through coagulation cascade activation when platelet plug is created. Various growth factors such as cytokine and chemokine are released when platelet is activated. It is followed with angiogenesis, tissue regeneration and bacterial elimination leading to long term wound healing.[25-28] Schulz *et al;* reported the decrease in wound healing time in 10 patients with second-degree burns who were treated with PRF following debridement in Germany in 2021.[11] In this case, the patients were treated with PRF therapy in the 2nd- and 3rd- session debridement aiming to heal the wound more quickly.

Vitamin C is an agent that can reduce free radicals and induce good development in burns. The basic function of vitamin C is to produce collagen synthesis in skin tissue. Collagen synthesis is the process very important in thermal trauma.[29] Haddadi *et al*. (2021) reported the improved wound score in the patient with 2nd-degree burns treated with Vitamin C 10% solution estimated using *Bates-Jensen Wound Assessment Tool* and score improvement was found in the days-3, -7, and -14 with $p < 0.001$.[10] The administration of topical Vitamin C can increase Vitamin C level in the skin and thereby reduce inflammation and trigger the formation of new granulation tissue in large quantity. The smaller number of macrophage and the formation of new blood vessels are found more in the administration of vitamin C.[29,30] The development of granulation tissue has been begun about 1 week following the therapy and resulting in the wound healing process. Vitamin C can also reduce free radicals and induce the burns repairing due to its contribution to collagen formation. Collagen synthesis is an important and desirable process in burns.[29] In this case, the vitamin C 10% topical solution is applied to the patient on days- 1, -3, -7, and -14.

Tretinoin belongs to retinoid-derived vitamin A used widely in scars. The work mechanism of topical tretinoin is putatively through the bond between alpha-, beta-, and gamma *retinoic acid receptors* (RARs) and *retinoid X receptor* (RXR) by inhibiting inflammation mediator, so that the procollagen production increases and triggers the creation of first- and third-type collagen.[14] Dematte *et al*. (2011) conducted a study on 15 post-burn patients treated with tretinoin 0.05% cream and found the increased distensibility in scars that was estimated from the decreased skin resistance and elasticity.[31] Tretinoin 0.05% cream was administered to the patient once a day at night.

Vaseline album or petroleum jelly is a moisturizer containing long-chain aliphatic hydrocarbon. This agent is occlusive and can protect the skin from infection following minor surgery. This protective effect is obtained through improving the expression of *antimicrobial peptide* (AMP). Vaseline album can improve epidermis differentiation in which granular layer is created continuously and orthokeratosis restoration occurs. Genuino *et al*. (2014) reported the shorter mean time of re-epithelialization by administering petrolatum to 26 patients with 2nd-degree burns, compared with control group without side effect and infection.[32] Vaseline album is applied to the patient twice a day in the morning and evening for protecting purpose during wound healing and re-epithelialization acceleration.

The very annoying pruritus often occurs in the burn healing process. It is because of increased histamine in the wound healing process. Doxepin 5% cream is an antihistamine belonging to tricyclic antidepressant class often used to reduce pruritus complaint in burn healing. This agent's mechanism is to inhibit histamine H1 and H2 receptors and it has potential strong antihistamine. Kwa *et al* (2019) reported the significant decrease of pruritus score in 13 burn patients treated with 5% doxepin cream for 12 (twelve) weeks assessed based on *Visual Analogue Scale*.[15] In this case, doxepin hydrogen chloride 5% cream was applied to the patients 2 times a day at day and night.

The IIa-degree burn can be healed within 3 weeks with minimum scars while the IIb-degree burn can be healed within 3-8 weeks followed with scars.[33] The second-degree burns have high morbidity and mortality. The prognosis of patients with burn is dependent on age, other comorbidity suffered from, treatment by experienced medical workers, wound area, infection, high calorie and protein intake, and inhalation injury in patients.[3]

Conclusion

A case of IIa-degree burn has been reported in a 5 (five) year old boy due to contact with hot water. The burn was found on anterior trunk region in the form of hyperpigmented patch and multiple bullae with erosion in some areas. Hyperpigmented patch and erosion were found on antebrachialis *et* manus dextra *et* femoralis dextra region. The patient was treated early with liquid resuscitation, antibiotics, and pain killer. The next treatment was done with wound debridement in 3 sessions once in 5 days, silver sulfadiazine cream post debridement, PRF in the 2^{nd}- and -3^{rd} session debridement, mupirocin ointment post-debridement and during medication post-debridement in the deep erosion, vitamin C 10% solution in medication post-debridement, tretinoin 0.05% cream once a day at night, application of doxepin hydrogen chloride 5% cream twice a day at day and night, and vaseline album application twice a day in the morning and evening as the maintenance therapy at home. Education is given to the patient to make him not scratching the wound, to consume high-protein food and to keep the wound clean.

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