

## ADVANCED NURSING PRACTICE IN BURNS MANAGEMENT

*“Pain after burn injury is preventable, and nurses are central to Achieve that goal”*

Renuka.K, Kripa Angeline. A, Sangeetha.M. A \*

---

### Abstract

Burns are the most intensely painful injuries. All patients will experience pain, regardless of the cause, size, or depth of the burn. In spite of advances in topical wound care and pharmacological management and palliative care, wound care is the main source of the pain associated with burn injury. A deeper understanding of the many aspects of treating burns and their associated pain can help nurses to provide more effective analgesia. Nurses play a vital role in understanding the management of burn wound, prevention of infection and pain management .

*Key Words : Burns, Fluid management, Wound care, Rehabilitation, Skin Grafting*

---

### Introduction

Recent discoveries and new therapies resulting from clinical and basic research are continually being incorporated into burn care worldwide. As a result, the mortality of burned children and length of the hospital stay have been greatly reduced over the last 25 years. Advances in the last 25 years have not only improved the length of hospital stays and survival rates, but also tremendously improved the long-term outcomes of severely burned patients. These patients have skills and developmental improvements that are truly outstanding, making them effective, productive and thoughtful members of society<sup>1</sup>. This review will summaries some of the more significant changes that have occurred in the field of burn care. These have resulted in improved survival and functional status. It highlights innovative fields of research which may be responsible for further improvement in outcome.

---

### Phases of Burns Management

Burn injury can be divided into three phases: emergent, acute and rehabilitative.

- ❖ The emergent phase occurs from the time of injury through the first 72 hours of treatment. Care during this period focuses on stabilization and transport. The first 24 hours are the most critical<sup>2</sup>.
- ❖ The acute phase of injury is the majority of the patient's time in the hospital. The focus during this time is infection control, wound care,



*Emergency management of Burns*

---

\* Prof. Dr. Renuka.K, Kripa Angeline. A, Assoc. Prof, Sangeetha.M. A, Asst Lecturer, Dept of Medical Surgical Nursing, KGNC, Puducherry 607402, India.

pain control, nutritional support (as much as 10,000 calories a day may be required), surgical intervention, physical and occupational therapy, and psychosocial support<sup>2</sup>

- ❖ The rehabilitative phase lasts from complete wound closure through the active scar maturation process and its average is 1-2 years. Complete rehabilitation may be lifelong, involving reconstructive procedures and contracture releases.<sup>2</sup>

---

## Management of burns patient

---

### Emergent Phase

During the emergent phase, rapid assessment and intervention are essential, the nursing care is prioritized as follows:

Initial assessment by primary survey includes a rapid examination of the ABCs: airway stabilization and C-spine immobilization (if needed), breathing and circulation (check status and start IV lines and fluid).

History taking based on **AMPLE** (Allergies, Medications, Past Medical History, Last Meal and Events Preceding Injury).

- Accurate burn size estimation using Rule of nine<sup>35</sup>. The fluid resuscitation needs within the first 24 hours after burn injury, is calculated using the following formulae
- Parkland formula
- Modified Brooke formula
- Consensus formula

All pain medications should be given intravenously, tetanus status should be checked and baseline laboratory studies obtained.<sup>2</sup>

### Acute Phase

Infection control and wound care constitute the primary focus during the acute phase.<sup>3</sup>

### Wound care

The overall goals of wound care for burn patients are universally accepted and seek to:

- Eliminate media for bacterial growth; promote healing of partial-thickness wounds ; prevent conversion of burn wounds
- Promote patient comfort and
- Minimize scarring and contracture<sup>5</sup>.

Wound care procedures such as wound cleansing, debridement, skin grafting (including donor site care and the removal of surgical staples anchoring skin grafts into place), dressing removal, insertion and inflation of tissue expanders, passive range of motion exercises in affected joints, and splint application helps to achieve these goals.<sup>4</sup>

---

## Recent Advancement in Burns Management

---

### Hydrotherapy

Hydrotherapy is used to vigorously flush the burn wound, cleaning the wound and removing loose, nonviable tissue. Most often, a shower gurney is used for this purpose. Because this method reduces the risk of infection, it is preferable to another form of hydrotherapy known as **Tanking**, in which the patient is immersed into a tank of turbulent warm water. An antimicrobial soap such as Dial liquid soap or Hibiclens should be used, with water, to wash the burn wound before the application of any antimicrobial ointment. Followed by hydrotherapy **Manual debridement** is often done by nurses after wound cleansing. It involves the scraping or pulling off of loose nonviable skin.<sup>34</sup> **Deep surgical debridement** is also done to remove adherent eschar under general anesthesia within three to five days after injury. Moistening the adherent dressings prior to removal will minimize patient discomfort.<sup>5</sup>



*Wound Cleansing and dressing.*

## Collagen dressing

Collagen dressings are dressings that are derived from animal sources, such as bovine (cattle), equine (horse) or porcine (pig) sources. The collagen helps to promote the growth of new collagen at the wound site, prompting an often speedier recovery period. Collagen dressings can also help with fibroblast production and according to, some dressings may also help maintain the appropriate temperature of the wound site's microenvironment.<sup>6</sup>

There are different types of collagen dressing

### *Hydrocolloid:*

Hydrocolloid dressings are used on burns, light to moderately draining wounds, necrotic wounds, under compression wraps, pressure ulcers and venous ulcers.<sup>6</sup>

### *Hydrogel:*

This type of dressing is for wounds with little to no excess fluid, painful wounds, necrotic wounds, pressure ulcers, donor sites, second degree or higher burns and infected wounds.<sup>6</sup>

### *Alginate:*

Alginate dressings are used for moderate to high amounts of wound drainage, venous ulcers, packing wounds and pressure ulcers in stage III or IV.

### *Collagen:*

A collagen dressing can be used for chronic or stalled wounds, ulcers, bed sores, transplant sites, surgical wounds, second degree or higher burns and wounds with large surface areas.<sup>33,34</sup>

## Banana leaf dressing

It is the less expensive and widely used dressing for burns. Banana leaves are a cheap and effective alternative to traditional medical wound dressings. Wounds treated with banana leaves heal in the same period of time as wounds treated with Vaseline gauze dressings.

## Aquacel foam dressing

The only silver foam dressing that offers the healing benefits is AQUACEL Combining hydrocolloid technology with Hydrofiber Technology and ionic silver, AQUACEL Ag Surgical dressing provides the following benefits:

- ❖ **Waterproof:** Provides excellent absorption and retention capabilities for moderate to highly exuding wounds.<sup>2</sup>
- ❖ **Antimicrobial Protection**<sup>1-3</sup>
- ❖ **Comfortable and Flexible:** Comforts to the wound surface to form an intimate contact,<sup>3</sup>
- ❖ **Skin Friendly:** Helps reduce wound pain while the dressing is in situ and upon removal.<sup>4-7</sup> Supports wound healing by providing a moist wound healing environment.

## Skin grafting Substitutes

There are various ways to classify the skin substitutes. A classification was proposed based on composition as follows<sup>4</sup>



*Skin Grafting*

## Class I: Temporary impervious dressing materials

### a) Single layer materials

- Naturally occurring or biological dressing substitute, e.g. amniotic membrane, potato peel
- Synthetic dressing substitute, e.g. synthetic polymer sheet (Tegaderm, Opsite), polymer foam or spray

### b) Bi-layered tissue engineered materials, e.g. TransCyte

## Class II: Single layer durable skin substitutes

- a. Epidermal substitutes, e.g. cultured epithelial autograft (CEA), Apligraf
- b. Dermal substitutes
  - bovine collagen sheet, e.g. Kollagen
  - porcine collagen sheet
  - bovine dermal matrix, e.g. Matriderm
  - human dermal matrix, e.g. Alloderm

## Class III: Composite skin substitutes

- a) Skin graft
  - Allograft
  - Xenograft
- b) Tissue engineered skin
  - Dermal regeneration template, e.g. Integra
  - Biobrane

From the practical point of view, the skin substitutes are best classified as temporary or permanent and synthetic or biological.

### Biological Skin substitutes

- **Amnion**

The amnion is a thin semi-transparent tissue forming the innermost layer of the foetal membrane. The amnion has been used as biological dressings for burns.<sup>19-20</sup> As fresh amnion carries risk contaminations and disease transmission, amnion is collected from placentae of selected and screened donors. Various preservation methods have been introduced, including cryopreservation in liquid nitrogen, preservation in silver nitrate, storage in antibiotics solution, glycerol-preserved sheets, dried sheets and gamma-irradiated sheets.<sup>6</sup> It has been claimed to be one of the most effective biological skin substitutes used in burn wounds, with efficiency of maintaining low bacteria count. It also has advantages of reducing loss of protein, electrolytes and fluids, decreasing the risk infection, minimising pain, acceleration of wound healing and good handling properties. Amnion is primarily used for covering partial-thickness burns until complete healing. It is particularly useful for superficial partial-thickness facial burns<sup>6</sup>. When used in facial burns, it is noted to be adhesive, conformable and easily removable. It is also used for temporary coverage

in wound bed preparation and sandwich grafting technique.

### Cultured epithelial autografts

The culture of keratinocytes is an important advance in the burn care. CEA was first reported in the clinical use in 1981 in extensive full thickness burns. A large surface area of keratinocytes can be obtained from the relatively small biopsy of healthy skin from the patient. The autologous keratinocytes are isolated, cultured and expanded into sheets over periods of 3–5 weeks. The technique of suspension in fibrin glue has reduced the time for clinical use to 2 weeks<sup>7</sup>.

### Synthetic skin substitutes

Synthetic skin substitutes are constructed out of non-biological molecules and polymers that are not present in normal skin.<sup>8</sup> These constructs should be stable, biodegradable and provide an adequate environment for the regeneration of tissue. It should maintain its three-dimensional structure for at least 3 weeks to allow ingrowths of blood vessels, fibroblast and coverage by epithelial cells. Biodegradation should preferably take place after this period. This process should occur without massive foreign body reaction as this process would increase the inflammatory response, which may be associated with profound scarring. It should also be composed of immunocompatible materials to avoid immunoreactive processes.

The artificial nature of these skin substitutes has some distinct advantages and disadvantages when compared to natural biological structures. The composition and properties of the product can be much more precisely controlled. Various additives such as growth factors and matrix components can be added to enhance the effect. These products could also avoid complications due to potential disease transmission. However, these synthetic skin substitutes generally lack basement membrane and their architecture do not resemble native skin. The use of non-biological components can be problematic when trying to produce a biologically compatible material.<sup>8</sup>

There are several synthetic skin substitutes that are available for wound coverage. However, there are also substantial number of synthetic substitutes undergoing in vitro or animal testing.<sup>9-11</sup> Amongst

the synthetic skin substitutes available in the market are Biobrane, Dermagraft, Integra, Apligraf, Matriderm, Orcel, Hyalomatrix and Renoskin.

- **Biobrane**

Biobrane consists of an inner layer of nylon mesh that allows fibrovascular ingrowth and an outer layer of silastic that serves as a vapour and bacterial barrier.<sup>12</sup> It has been used to give a good effect in clean superficial burns and in donor sites. When used to cover partial-thickness wounds, the mesh adheres to the wound until healing occurs beneath. Biobrane should be removed from any full-thickness wound prior to skin grafting.

Biobrane is an established synthetic dressing for burn wounds, particularly in the paediatric population. Whitaker et al. published a critical evaluation of the evidence base for the varied uses of Biobrane within the field of plastic and reconstructive surgery.<sup>13</sup> They concluded that there is good evidence (Grade A) to support the use of Biobrane in the management of burns, particularly in partial-thickness burns in children. When dressed with Biobrane, patients with superficial partial-thickness burns experience less pain as compared to gauze and silver sulfadiazine dressing.<sup>14</sup> Biobrane also significantly reduces hospital stay, wound healing time and requirements of pain medications.<sup>15</sup> There are reported applications in patients with toxic epidermal necrosis, chronic wounds, or following skin resurfacing.<sup>13,16</sup>

- **Dermagraft**

Dermagraft is a bioabsorbable polyglactin mesh seeded with allogenic neonatal fibroblast.<sup>17</sup> Indications for the usage of Dermagraft are in burn wounds, chronic wounds and diabetic ulcers.<sup>8</sup> It can be used as a temporary or permanent covering to support the take of meshed split-thickness skin grafts on excised burn wounds.<sup>17,18</sup>

Dermagraft appears to produce results as good as allograft with regard to wound infection, wound exudate, wound healing time, wound closure and graft take. It was also reported to be removed easier than allograft, with significantly higher level of patient satisfaction.<sup>8,19</sup> There has been no adverse reactions to Dermagraft, with no evidence of rejection, early deterioration or separation from wound.<sup>18</sup> There has so far been no safety issues regarding Dermagraft.<sup>19</sup>

- **Integra**

Integra is a dermal regeneration template consisting of bovine collagen, chondroitin-6-sulphate and a silastic membrane. This product has gained widespread use in the clinical treatment of deep partial-thickness and full-thickness burn wounds, full-thickness skin defects of different aetiologies, chronic wounds and in soft tissue defects.<sup>8,17,20,21</sup> The bovine collagen dermal analogue integrates with the patient's own cells and the temporary epidermal silicone is peeled away as the dermis regenerates. A very thin autograft is then grafted onto the neodermis.<sup>17,22</sup> Heimbach et al. showed that Integra was superior to autograft, allograft or xenograft in terms of wound healing time.<sup>21,23</sup>

- **Apligraf**

Apligraf is a bilayered living skin equivalent. It is composed of type I bovine collagen and allogenic keratinocyte and neonatal fibroblast.<sup>17,22</sup> It is indicated in partial to full thickness burns, skin graft donor sites, chronic wounds, diabetic ulcers and Epidermolysis Bullosa.<sup>8</sup> It has to be applied "fresh" as it has a shelf-life of 5 days at room temperature.<sup>17</sup> Apligraf has been shown to accelerate wound closure. Apligraf when combined with autograft has produced more favourable results than autograft only. Scar tissue, pigmentation, pliability and smoothness were significantly closer to normal with Apligraf.<sup>24</sup>

- **Matriderm**

Matriderm is a structurally intact matrix of bovine type I collagen with elastin. It is utilised for dermal regeneration. Its indications are full thickness or deep dermal burn wounds and chronic wounds. The matrix serves as a support structure for the ingrowth of cells and vessels. Its elastin component improves the stability and elasticity of the regenerating tissue. As the healing process advances, fibroblast lays down the extracellular matrix and the Matriderm reabsorbs.<sup>25</sup> Its indications seem to be similar to Integra. Schneider et al. compared the engraftment rate and rate of vascularisation of Matriderm and Integra in a rat model. They revealed no major differences in engraftment rates or vascularisation.<sup>26</sup> However, unlike Integra, Matriderm has been shown to be able to accommodate immediate split thickness skin grafting with no diminished take.<sup>27</sup> In experimental models, the matrix reduces wound contracture, and histologically collagen bundles in

the scar are more randomly orientated. Clinical trials with a long-term clinical evaluation showed no difference in scar elasticity between the described dermal substitute and split thickness grafts alone.<sup>27</sup>

- **OrCel**

OrCel is a bilayered cellular matrix in which normal human allogeneic skin cells (epidermal keratinocytes and dermal fibroblasts) are cultured in two separate layers into a type I bovine collagen sponge. OrCel is a bilayer dressing resembling normal skin and was developed as a tissue-engineered biological dressing. It is indicated in the treatment of chronic wounds and skin graft donor sites. OrCel has also been used as an overlay dressing on split-thickness skin grafts to improve function and cosmesis.<sup>8,28,29</sup>

- **Hyalomatrix**

Hyalomatrix is a bilayer hyaluronan base scaffold with autologous fibroblast. It has an outer silicone membrane. The scaffold delivers hyaluronan to the wound bed, and the silicone membrane acts as a temporary epidermal barrier.<sup>30</sup> It is indicated in burn wounds and chronic wounds.<sup>8</sup>

## Skin Grafting

Surgical debridement under anesthesia can facilitate the removal of nonviable tissue. There are two basic types of skin grafts: split-level thickness and full thickness. Split-Level Thickness Grafts involves removing only the top two levels of the skin the epidermis and the dermis from the donor site. These grafts are used to cover large areas. A full thickness graft involves removing the muscles and blood vessels as well as the top layers of skin from the donor site.

---

## Pain management

---

### Pharmacologic therapies

- **Morphine** remains the gold standard in the treatment of moderate-to-severe acute pain. Hospitalized burn patients require three types of pain medication: **background, procedural and breakthrough**.<sup>13</sup>
- Severe **background pain** can be managed with morphine through continuous IV infusion or patient-controlled analgesia (PCA). Mild-to-

moderate background pain can be managed with short-acting, orally administered opioids, such as oxycodone 5 mg - acetaminophen 325 mg (Percocet). Regularly scheduled long-acting morphine can be used to treat chronic pain. If used, the dose must be adjusted as needed and should be tapered over time.

- **Intravenous fentanyl** (Sublimaze), another opioid, is more effective in the control of severe burn pain.<sup>8</sup> Fentanyl is often combined with the benzodiazepine midazolam (Versed) to induce conscious sedation with analgesia. The success of efforts with fentanyl has led to research on alternative routes of administration. Sharar and colleagues compared the use of oral transmucosal fentanyl citrate delivered in a raspberry-flavored lozenge with oral oxycodone before outpatient pediatric burn wound care and documented similar outcomes in pain and anxiety levels. The patients also preferred the taste of the fentanyl preparation.<sup>10</sup>
- **Ketamine** (Ketalar), a dissociative drug used in general anesthesia, has been described as effective in controlling procedural burn pain in children.<sup>12</sup>
- **Procedural pain** is more severe than background pain and can be excruciating without adequate analgesia so that **Procedural medication** is usually ordered before dressing changes. The dose is dependent on the extent and severity of injury. Morphine is the preferred drug and can be administered in an IV, oral instant-release or elixir form. Propofol (Diprivan) is another general anesthetic used for procedural burn wound care. Propofol is preferred over ketamine for procedural burn pain in adults.
- **Breakthrough pain** medications are added as needed. Narcotics should be administered based on objective pain scores. Titrating according to response and weaning when appropriate helps decrease untoward side effects.<sup>14]</sup>
- **Gabapentin** (Neurontin) and **methadone hydrochloride** (Methadone) can prove helpful in controlling chronic burn pain. Methadone can also be used to help wean off patients from opioids after long-term use.

## Nonpharmacologic modalities

Nonpharmacological therapy includes relaxation techniques (for example, focused deep breathing and hypnosis), cognitive strategies (such as distraction, reappraisal, guided imagery, and visualization), biofeedback, music therapy, therapeutic touch, and the presence of significant others for emotional support, have been studied by researchers. Many of these have proven to be beneficial, but such modalities are adjuncts to, not substitutes for, narcotic analgesia during painful wound care.<sup>3,18</sup> Prensner and colleagues found music to have a distracting benefit when used as an adjunctive therapy to reduce pain and anxiety during burn wound care.<sup>19</sup> Transcutaneous electrical nerve stimulation (TENS) has also been used successfully in burn pain management.

### Topical selection is based on established criteria:

These medications can be applied directly. It is messy and may be indicated for more superficial wounds or in areas where pressure from a secondary dressing is contraindicated.

The closed method is more common. In this method, topicals are applied directly to a wound and a bandage covers the topical, or the topical agent may be impregnated into the gauze to avoid desiccation. Control of drainage, ease of use and cost are important features. Always wrap digits separately, minimize for function, avoid pressure over the ears and wrap to minimize edema.<sup>14</sup>

- **Silver sulfadiazine (Silvadene)** cream is effective against all organisms commonly associated with burn wound infection.
- **Mafenide acetate (Sulfamylon)** is a thick, white cream with antimicrobial properties, is often used on burned ears and noses, (the drug's nickname, "white lightning"). It is more effective than silver sulfadiazine at penetrating eschar.
- **PluroGel** is a topical antimicrobial agent developed at the University of Virginia Medical Center that has properties similar to those of Silvadene and is effective against all organisms commonly associated with burn wound infection.

Innovative **silver-coated dressings** such as Acticoat and Aquacel Ag are the most recent antimicrobial alternatives for topical burn wound care.<sup>34</sup>

## Rehabilitative Phase

During the rehabilitative phase, significant lifestyle changes become more evident to patients. Prurities can be problematic, caused by a combination of dry skin and the release of histamine during scar remodeling. The relief strategies include cool or tepid baths, pressure garments, massage, avoidance of caffeine and the application of ice<sup>37</sup>.

Sensitivity to heat and cold is a problem for many patients with a high TBSA. These patients should avoid extremes in temperature, especially in the first year post-injury. They should dress appropriately for the weather, with an emphasis on layers of clothing that can be removed as needed.

Grafted areas have decreased sensation and require visual inspection for open areas, Scar and discoloration are topics of great discussion and controversy. Some agents may minimize hypertrophic scarring: pressure garments, silicon gel sheets (Silon, Cica-Care, Avogel), steroid injections and creams (Kenalog, Aristocort, Triderm), and Uvex face masks. Camouflage makeup may help with hypo- or hyperpigmentation<sup>35</sup>.

Reintegration into society is difficult due to the disfigurement associated with burn injury. Support is available through various groups typically based at burn centers. School re-entry programs are available to help children with the transition back to school. A peer support counseling network, Survivors Offering Assistance in Recovery, is available throughout many areas of the country.<sup>15</sup> A burn injury is challenging and requires specialized care across the continuum. Nurses are ideally suited to facilitate this process.

---

## Conclusion

---

Nurses spend their majority of time in direct patient care that affords them the opportunity to establish meaningful therapeutic relationship with burned patients and their families. Therefore, it is vital that nurses should update their knowledge on advanced practice for burns wound care to establish a standard and quality in nursing practice.

## References

1. Thomas J. The Cocoanut Grove inferno. 50 years ago this week, 492 died in a tragedy for the ages. *Boston Globe* 1992 Nov 22
2. Cope, O., Laugohr, H., Moore, F.D., Webster, R. Expeditious care of full-thickness burn wounds by surgical excision and grafting. *Annals of Surgery* 125: 1- 22, 1947.
3. Sheridan R, et al. Management of background pain and anxiety in critically burned children requiring protracted mechanical ventilation. *J Burn Care Rehabil* 2001;22(2):150-3
4. Choiniere M, et al. Patient-controlled analgesia: a double-blind study in burn patients. *Anaesthesia* 1992;47(6):467-72.
5. Meyer WJ, 3rd, et al. Acetaminophen in the management of background pain in children post-burn. *J Pain Symptom Manage* 1997;13(1):50-5.
6. Long TD, et al. Morphine-infused silver sulfadiazine (MISS) cream for burn analgesia: a pilot study. *J Burn Care Rehabil* 2001;22(2):118-23.
7. Horch RE, Stark GB. Comparison of the effect of a collagen dressing and polyurethane dressing on healing of split thickness skin graft donor sites. *Scand J Plast Reconst Surg Hand Surg*. 1998;32:407-13.
8. Nataraj C, Ritter G, Dumas S, Helfer FD, Brunelle J, Sander TW. Extra cellular wound matrices: Novel stabilization and sterilization method for collagen-based biologic wound dressings. *Wounds*. 2007;19:148-56.
9. Gruss JS, Jirsch DW. Human amniotic membrane: A versatile wound dressing. *Can Med Assoc J*. 1978;118:1237-46.
10. Hadjiiski O, Anatasov N. Amniotic membranes for temporary burn coverage. *Ann Burns Fire Disasters*. 1996;9:88-92.
11. Linneman PK, et al. The efficacy and safety of fentanyl for the management of severe procedural pain in patients with burn injuries. *J Burn Care Rehabil* 2000;21(6):519-22.
12. Prakash S, et al. Patient-controlled analgesia with fentanyl for burn dressing changes. *Anesth Analg* 2004;99(2):552-5.
13. Sharar SR, et al. A comparison of oral transmucosal fentanyl citrate and oral oxycodone for pediatric outpatient wound care. *J Burn Care Rehabil* 2002;23(1):27-31.
14. Finn J, et al. A randomised crossover trial of patient controlled intranasal fentanyl and oral morphine for procedural wound care in adult patients with burns. *Burns* 2004;30(3):262-8.
15. Groeneveld A, Inkson T. Ketamine. A solution to procedural pain in burned children. *Can Nurse* 1992;88(8):28-31.
16. Humphries Y, et al. Superiority of oral ketamine as an analgesic and sedative for wound care procedures in the pediatric patient with burns. *J Burn Care Rehabil* 1997; 18(1 Pt 1):34-6.
17. Powers PS, et al. Safety and efficacy of debridement under anesthesia in patients with burns. *J Burn Care Rehabil* 1993;14(2 Pt 1):176-80.
18. Raymond I, et al. Sleep disturbances, pain and analgesia in adults hospitalized for burn injuries. *Sleep Med* 2004;5(6):551-9.
19. Raymond I, et al. Incorporation of pain in dreams of hospitalized burn victims. *Sleep* 2002;25(7):765-70.
20. Raymond I, et al. Quality of sleep and its daily relationship to pain intensity in hospitalized adult burn patients. *Pain* 2001;92(3):381-8.
21. Ashburn MA. Burn pain: the management of procedure-related pain. *J Burn Care Rehabil* 1995;16(3 Pt 2):365-71.
22. Hoffman HG, et al. Use of virtual reality for adjunctive treatment of adult burn pain during physical therapy: a controlled study. *Clin J Pain* 2000;16(3):244-50.
23. Powers PS, et al. Interrupted debridement. *J Burn Care Rehabil* 1985;6(5):398-401
24. Elliott CH, Olson RA. The management of children's distress in response to painful medical treatment for burn injuries. *Behav Res Ther* 1983;21(6):675-83.
25. Kelley ML, et al. Decreasing burned children's pain behavior: impacting the trauma of hydrotherapy. *J Appl Behav Anal* 1984;17(2):147-58.
26. Nover RA. Pain and the burned child. *J Am Acad Child Psychiatry* 1973;12(3):499-505
27. Ptacek JT, et al. Pain, coping, and adjustment in patients with burns: preliminary findings from a prospective study. *J Pain Symptom Manage* 1995;10(6):446-55.
28. Perry S, Heidrich G. Management of pain during debridement: a survey of U.S. burn units. *Pain* 1982;13(3):267-80.
29. Wiechman SA, Patterson DR. ABC of burns. Psychosocial aspects of burn injuries. *BMJ* 2004;329(7462):391-3.
30. Saxe G, et al. Relationship between acute morphine and the course of PTSD in children with burns. *J Am Acad Child Adolesc Psychiatry* 2001;40(8):915-21.
31. Trop M, et al. Silver-coated dressing Acticoat caused raised liver enzymes and argyria-like symptoms in burn patient. *J Trauma* 2006;60(3):648-52.
32. By Patricia A. Connor-Ballard, *AJN* t April 2009 , Vol. 109, No. 4
33. Park SN, Lee HJ, Lee KH, Suh H. Biological characterization of EDC-crosslinked collagen-hyaluronic acid matrix in dermal tissue restoration. *Biomaterials*. 2003;24:1631-41.
34. Lazovic G, Colic M, Grubor M, Jovanovic M. The application of collagen sheet in open wound healing. *Ann Burns Fire Disasters*. 2005;18:151-6.
35. Veves A, Sheehan P, Pham HT. A randomized, controlled trial of promogran (a collagen/oxidized regenerated cellulose dressing) vs standard treatment in the management of diabetic foot ulcers. *Arch Surg*. 2002;137:822-7.
36. Nagata H, Ueki H, Moriguchi T. Fibronectin: Localization in normal human skin, granulation tissue, hypertrophic scar, mature scar, progressive systemic sclerotic skin, and other fibrosing dermatoses. *Arch Dermatol*. 1985;121:995-9.
37. Motta G, Ratto GB, De Barbieri A, Corte G, Zardi L, Sacco A, et al. Can heterologous collagen enhance the granulation tissue growth? An experimental study. *Ital J Surg Sci*. 1983;13:101-8.