SAJS
General Surgery

A review of burn care at an emerging centralised burns unit

H. J. KINGU, M.D., M.MED. (SURG.)
E. L. MAZWAI, M.B. CH.B., F.R.C.S. (ED.)
Department of Surgery, Walter Sisulu University, Mthatha, Eastern Cape

Summary

Background. The aim of the study was to investigate the demographics, aetiological factors, anatomical lesions, biological features, management protocol and outcomes of patients admitted with major burn injuries to the Nelson Mandela Academic Hospital (NMAH), which is one of only three tertiary hospitals in the Eastern Cape and is in the process of establishing a designated burns unit.

Methods. All burns patients admitted to the burns ward from January 2006 to July 2008 were included in the study. All were treated using multidisciplinary team care, a high index of suspicion for inhalation injuries, followed by prompt treatment, accurate burn extent and depth assessment, fluid therapy, patient-controlled analgesia, strict aseptic wound care, and early enteral feeding. Data collected included gender, age, residential address, cause and extent and depth of burns, serum albumin, whether any skin graft was done, hospital stay, complications and mortality.

Results. The sample comprised 66 patients; 59 were children <14 years old, and 38 were <4 years. There were 34 males and 32 females; scalds and flame injuries accounted for 68% and 17% of cases respectively. The majority (85%) sustained burns ranging from 11% to 40% total body surface area (TBSA). The body areas injured were the left upper limb (60%), chest (58%), abdomen (49%) and right upper limb (48%). All sustained major burns, and skin grafts were performed on 39%. Complications included respiratory distress syndrome, fluid and electrolyte imbalances, protein energy malnutrition, infection and contracture deformities. The mean hospital stay was 3.7 days/% TBSA burn, and the overall mortality rate was 17%.

Conclusion. Mortality was unacceptably high. The strain of aggressive management to reduce mortality and morbidity would be alleviated by measures such as community health education, raised socio-economic status, and safety legislation. Establishing a well-staffed and well-equipped burns unit would greatly improve patient care.

Burns affect 3.2% of the South African population annually.[1] Scalds are by far the most common cause, accounting for 52 - 78% of patients,[2-4] and are the main cause of death in children <4 years old and the third most common external cause of fatal injuries in persons up to 18 years old.[1,5] Factors contributing to this high incidence are low socio-economic status, lack of infrastructure and education, traditional beliefs, and diseases such as epilepsy.[5] In the USA, about 1.2 million people a year sustain burns; 45 000 are hospitalised and 4 500 die of burn-related injuries. A third of burns unit admissions and deaths involve children.[2] Infections predominate (75%)[6] as a cause of morbidity and mortality in patients with extensive burns, and can convert partial-thickness to full-thickness wounds.

Early excision and grafting is best done within the first week in full-thickness and deep dermal burns in a stable patient.[1,5,7] Early excision is a highly invasive procedure involving great blood losses, major fluid shifts, critical care cardiopulmonary support and monitoring, and has potential for significant procedure-related morbidity and mortality.[7] It has been advised that where facilities are limited, the slough should be allowed to separate spontaneously, using enzymatic creams or surgical debridement after day 10 post-burn, before grafts are done. This process expedites control of metabolic, haematological and septic wound complications, fewer operative procedures are necessary, and there is less metabolic disturbance.[1,8] The present study aims to investigate the demographics, aetiological factors, anatomical lesions, biological features, management protocol and outcomes of patients admitted with major burns. The information will aid in establishing a burns unit in the Eastern Cape.

Patients and methods

Nelson Mandela Academic Hospital (NMAH) is a provincial and tertiary academic hospital affiliated to the Faculty of Health Sciences at Walter Sisulu University in Mthatha, Eastern Cape. It is the teaching and research centre for both undergraduate and postgraduate students, also offers secondary and tertiary medical services, and is intended to be the referral hospital for tertiary and specialised hospital care for the 2.6 million people in the Transkei region. The study was retrospective, and included all patients with major burns who were admitted to NMAH during the study period (January 2006 - July 2008). Data collected from patients' files included age, address, gender, when and how the burn was sustained, pre-existing medical conditions, referring unit, patient's weight, and extent, location and depth of burns and other associated injuries. All investigations including full blood count, urea, creatinine, electrolytes, albumin and

wound swabs for bacterial culture were recorded. Early (<12 hours) supplemental feeding through a nasogastric tube was instituted whenever oral intake was inadequate. Systemic antibiotics were administered only according to sensitivity results.

Patients had showers; the burn site was isolated by occlusive topical antiseptic dressings. Wounds were conservatively managed until healed, or until there was spontaneous slough separation. If slough had not separated within the first 10 days, delayed escharectomy under anaesthesia was done. During hospitalisation, correction of hypo-albuminaemia and anaemia by nutritional supplementation and blood transfusions was done, aiming at pre-operative serum albumin of 30 - 35 g/l and haemoglobin >10 g/dl. In burns involving >30% TBSA, 4 units of cross-matched blood were available for intra-operative use.

Split-thickness skin grafting was indicated when wounds became uniformly pinkish-red without slough or evidence of infection. Burns <40% TBSA with adequate donor skin underwent a single autograft procedure, while those covering >40% TBSA were grafted in stages depending on availability of autografts. No skin substitutes were available.

Donor skin was harvested using a Humby knife. Tangential debridement was done until a viable bed was encountered; excision was limited to 20 - 25 cm^2 areas, bleeding was controlled, then further excision was done until completion. Brisk and substantial bleeding from both donor and recipient sites was meticulously controlled by local pressure, compressive hydrogen peroxide-soaked mops, dressing changes, elevation, patience (to allow normal haemostasis) and electro-coagulation. Sheet grafts were applied whenever donor skin was adequate. When inadequate, meshed grafts of 1.5:1 ratio were used; sheets were always used on the face and hands. Occlusive Vaseline-gauze dressings were placed on both donor and recipient sites; grafts were kept in place by bolster dressings or, in extremities, splinting till inspection on the 5th postoperative day. Follow-up was until death or up to 3 months after discharge.

Results

Demographic characteristics

Of the 66 patients, 34 were male and 32 female (M:F 1:1). Fig. 1 shows the percentage distribution according to age groups; 82% were <10 years old, 14% were 10 - 40 years old, and 4% were >40 years old. Most (47%) were toddlers; younger children and infants made up 23% and 9% of the group, respectively. Twenty-four (36%) were Mthatha residents who came directly from home; the rest were referred from district hospitals: 18% from Mqanduli, 11% from Libode, and 7% from other areas of the Eastern Cape. Locations around Mthatha (e.g. Waterfall Park, Mqanduli, Gengqe and Libode) were most represented – almost two-thirds of the patients came from these areas (Table I).

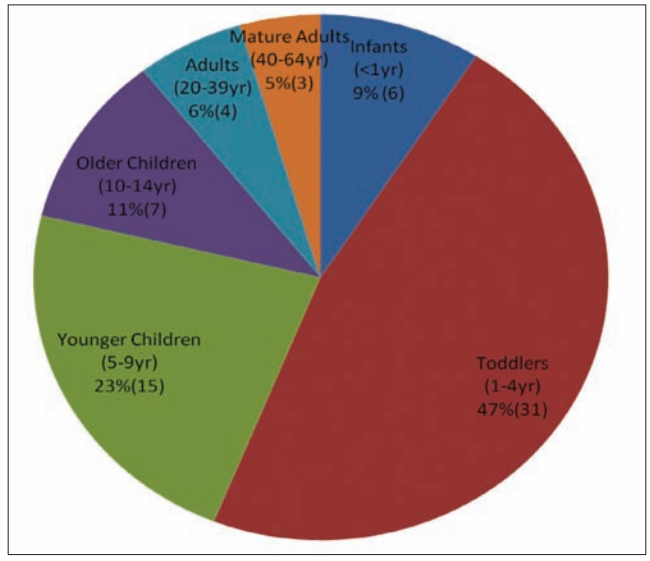

Fig. 1. Age distribution of patients admitted with burns.

Aetiology

Fig. 2 shows the causes of the burns and the percentage of total patients injured. The age group with the highest risk is shown in white text, with the percentage of patients within that age group shown in parentheses. The most common cause was scalds (68%). All infants and 87% of toddlers were injured this way; combined, 89% of children ≤4 years old sustained scalds. Hot porridge and forced immersion in hot water was responsible in 2 cases each. Open flame accounted for 17% of cases; all except one occurred in residential areas. In all but 3 of the residential accidents, the children sat next to an open flame and their clothing caught fire. Of the

TABLE I. RESIDENTIAL ADDRESSES OF THE 66 ADMITTED PATIENTS

Residence	Distance from Mthatha (km)	No. of patients	Percentage
Mthatha	**0**	**24**	**36**
Libode	**36**	**7**	**11**
Mqanduli	**41**	**12**	**18**
Elliotdale	**72**	**4**	**6**
Engcobo	**80**	**4**	**6**
Port St Johns	**105**	**2**	**3**
Mt Fletcher	**155**	**2**	**3**
Other*	**-**	**11**	**17**
All areas	**61 (average distance)**	**66**	**100**

*These patients lived elsewhere than in the places listed in the table.

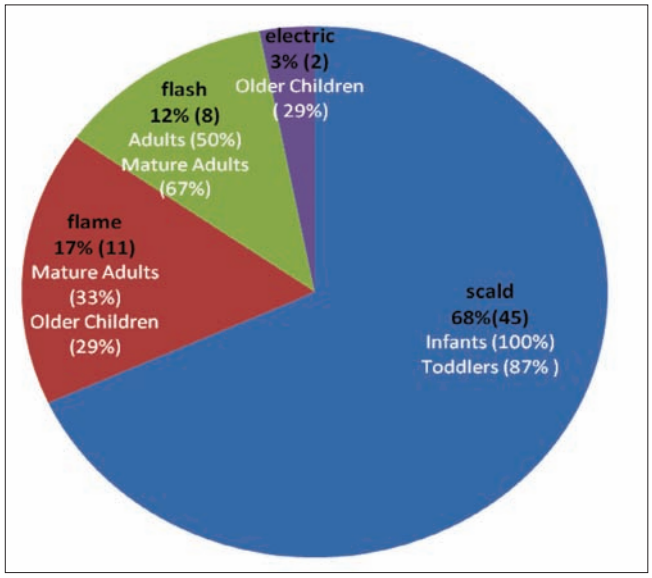

Fig. 2. Causes of thermal injuries and predominant age groups injured.

remaining 3, one was an epileptic burnt during convulsions, one was burning refuse, and one was caught in a veld fire.

Flash injuries (8 cases) ranked third. Paraffin stove explosions occurred in 6 of these; 5 were kitchen accidents, and in one case the stove had been used as a means of suicide. Petrol bombs were the cause in the case of 2 patients. In both flame and flash injuries, ignition of clothing occurred. Electrical injury accounted for 2 of the burns patients: a 12-year-old boy used a metal rod to touch live high-voltage cables, and the other was an 8-year-old who was struck by lightning.

Burn size and anatomical areas involved

The distribution of injuries according to anatomical area is summarised in Table II. Fig. 3 shows the relationship between percentage TBSA burnt and mortality rate. The majority (52%) of patients sustained burns of 10 - 20% TBSA. All 3 individuals who sustained burns >60% TBSA died.

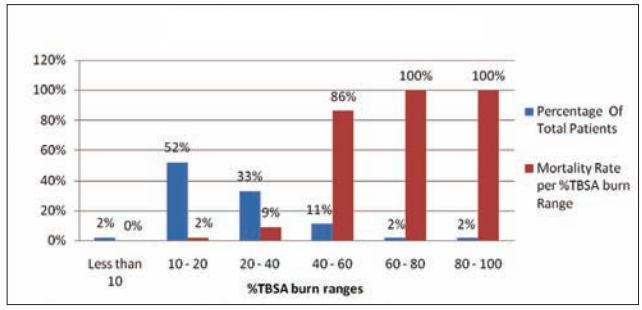

Fig. 3. Percentage TBSA burned and mortality.

Burn depth and surgical management

Twenty-eight patients sustained superficial dermal burns. The remaining 38 had deep dermal or full-thickness burns. One self-referred elsewhere and 11 died. Twenty-six underwent tangential debridement followed by split-thickness skin graft. Graft take was >95% requiring no further surgical procedures. Two patients required 2 procedures, while one had 3 staged operations owing to inadequate donor skin.

Respiratory complications. Clinical evidence of inhalation injury (e.g. stridor, dysphonia, singed hair, carbonaceous sputum) was observed in 30 patients; intubation was necessary in 2. Five children developed otitis media. Two patients developed bronchopneumonia.

Fluid and electrolyte complications. Renal failure occurred in 3 female patients aged 37, 45 and 59 years with burns of 90%, 60% and 60% TBSA respectively. One 3-year-old boy with inhalation injury and 17% TBSA deep flame burns involving the head, neck and chest developed convulsions, diarrhoea and vomiting 5 days after the injury. He died despite fluid resuscitation. Laboratory results confirmed hyponatraemia.

Nutritional complications. Serum albumin taken on admission before fluid resuscitation or after burn oedema had settled (5 - 7 days post burn) was for the purpose of this study termed 'pre-burn albumin'. Pre-burn albumin results are shown in Fig. 4; 8 patients were severely, 32 moderately and 13 mildly malnourished before injury. Post-burn albumin levels were regarded as the lowest albumin levels recorded (several days after completion of resuscitation)

TABLE II. ANATOMICAL AREAS AFFECTED BY BURN INJURY IN THIS STUDY

Anterior			Posterior		
Anatomical part*	*N*	%	Anatomical part *	*N*	%
Upper limb (L)	**40**	**60**	**Back**	**20**	**30**
Chest	**39**	**58**	**Scalp**	**9**	**13**
Abdomen	**33**	**49**	**Buttocks**	**8**	**12**
Upper limb (R)	**32**	**48**	**Upper limb (L)**	**4**	**6**
Lower limb (L)	**30**	**45**	**Upper limb (R)**	**3**	**4**
Lower limb (R)	**30**	**45**	**Lower limb (L)**	**1**	**1**
Face	**23**	**34**	**Lower limb (R)**	**1**	**1**
Perineum	**9**	**13**			
Neck	**7**	**10**			

*Some patients had more than one anatomical part injured.

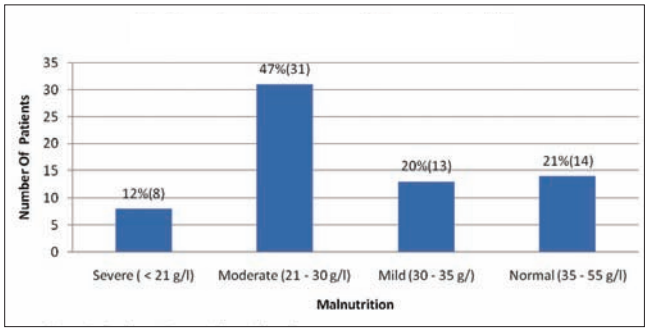

Fig. 4. Pre-burn serum albumin levels.

during the hospital stay (Fig. 5). After burns, 21 patients became severely malnourished, 28 moderately, and 12 mildly malnourished.

Infections. Twenty-nine patients had positive wound swab cultures (Fig. 6). *Klebsiella pneumoniae* was the most common, closely followed by *Staphylococcus aureus,* and *Proteus mirabilis* ranked third. Seven patients had clinical septicaemia; 4 had positive blood cultures. *S. aureus* and *Pseudomonas aeruginosa* were isolated in 3 and 2 patients, respectively.

Post-burn contractures. Seven patients developed post-burn contractures needing surgical release. The knee was involved in 3, the elbow in 2, and the axilla, ankle and wrist joints in one patient each.

Hospital admission

The mean hospital stay in this series was 3.7 days/% TBSA burn (Table III).

Overall mortality

The relationship between age and mortality is shown in Fig. 7. Mortality was highest (100%) among patients aged 40 - 64 years, and lowest (0%) among those aged 10 - 14 years. Toddlers, who formed the majority of cases, had a mortality of 10%. Overall, 11 patients died. Death was due to septicaemia (7), renal failure (3) and hyponatraemia (1). The mean survival from time of injury to death was 15 days (range 5 - 29 days).

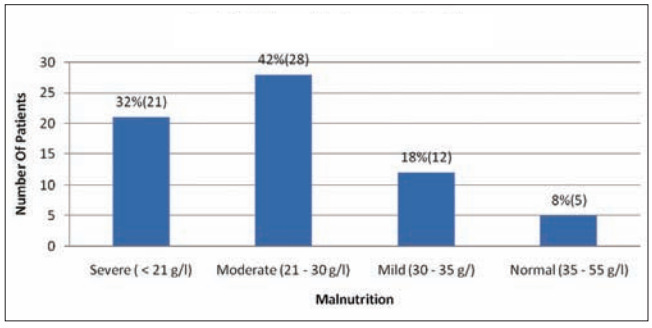

Fig. 5. Post-burn serum albumin levels.

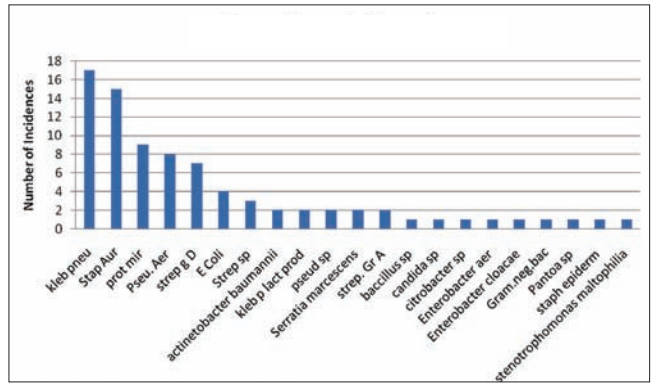

Fig. 6. Incidences of organisms cultured.

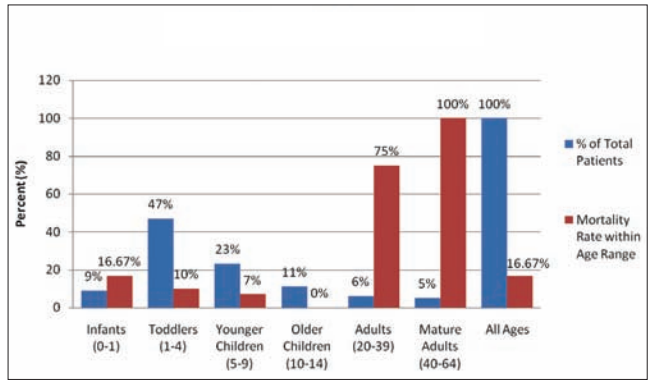

Fig. 7. Patients' ages in relation to mortality.

Discussion

In this series, 40/66 patients were ≤4 years old and 22 >4 years old. Clearly, children ≤4 years are at the greatest risk, which is explained by the increased inquisitiveness and activity characteristic of this age group. Other studies similarly showed a doubled risk when these two age groups were compared.[2] The M:F ratio was 1:1. Similar results were reported from Malawi[9] and Lesotho.[8] Nearly two-thirds of the patients lived in and around Mthatha, Mqanduli and Libode, which typically have minimal infrastructure and uneducated and poverty-ridden populations, in consequence greatly contributing to burn causation. Other authors report similar conditions.[5,10] There was no significant difference in outcome in patients arriving directly from home and those referred from peripheral hospitals.

The most common cause of burns in this study was scalding due to accidental spilling of hot liquids and immersion in hot bathwater at home. Scalding caused burns in 89% of cases among children ≤4 years old. This figure is higher than reported in other series,[2-4] stressing the need for preventive action. Child abuse by deliberate immersion in hot water was noted in 2 cases. A higher proportion of children

TABLE III. HOSPITAL STAY OF SURVIVORS IN DAYS/% BURN

% TBSA burn	*N*	Days/% burn	Range of days/% burn
0 - 20	**34**	**4.68**	**0.5 - 26**
21 - 40	**19**	**2.19**	**0.318 - 7.5**
41 - 60	**2**	**1.30**	**1.25 - 1.35**
61 - 100	**0**	**0**	**0**

are probably abused in this way and often not brought to hospital. It has been reported that 5% of child abuse injuries manifest as scalds.[11]

The second most common cause was flame and flash burns which, combined, affected 19/66 patients. Paraffin stove explosions and clothing ignition were responsible for the most severe morbidity and mortality. Half the patients sustaining these injuries had ≥40% TBSA full-thickness burns. Other workers have reported similar findings.[4,10] In Nigeria, flame and flash injuries caused 27.4% of burns, mainly owing to careless storage of petroleum products.[4] In South Africa, urban population growth, informal settlements, lack of electrification, and drug and alcohol abuse contribute greatly to this high prevalence, which may be preventable by health education and socio-economic improvements.

In our series, 28/66 patients had superficial burns, 38/66 deep-dermal or full-thickness burns, 11 died before grafting, and 26/66 had skin grafts. Our results differ from those of Komolofe *et al.* in Malawi, who had 71% superficial burns and only 22% deep-dermal or full-thickness burns requiring skin grafting.[9] This discrepancy may be due to the fact that NMAH treats mainly severely burnt patients while moderate and minor injuries were managed in peripheral hospitals.

Nutrition assessment, monitoring and response to feeding are complicated and fraught with error. In our setting, the best option for determining pre-injury nutritional status was using serum albumin combined with clinical assessment.[12] Serum albumin is lowered by dilution during major resuscitation. Albumin is influenced by the metabolic response and is therefore a compromised measure of nutrition.[12] Low serum albumin is a common finding in marasmus and kwashiorkor.[13] Using serum albumin for nutritional assessment, our findings indicate moderate to severe malnutrition before (61%) and after (76%) sustaining burns. As concluded by other researchers,[14] malnutrition contributed to increased mortality in our study.

Our incidence of wound infection (44%) was high compared with the 24% recorded by Adesunkanmi and Oyelami in their review of 156 burn injuries seen in Nigeria.[15] The most frequently isolated organisms in burn units are *S. aureus* and *P. aeruginosa*, which are typically associated with delays in wound closure.[6] While the same organisms were isolated by authors in Lesotho and Nigeria,[8,10] *K. pneumoniae* was most common in our study. We practised delayed wound closure. Burn wound infection is prevented by early (within the first 3 days post-burn) surgical debridement and skin closure. Lacking a committed burns theatre, skin substitutes and specialised critical care in our hospital,[16] this was unpractical.

The 4.7 days/% burn hospital stay among our survivors is long compared with the results of other workers,[17] who achieved 0.5 - 0.6 days/% burn. Our results are comparable to those prior to modern practice. Early excision and grafting results in increased survival, decreased infection rates and decreased hospital stay.[18] A hospital stay of 1.87 days/% burn can be expected in children with inhalation injury, flame burns >30%TBSA and age <48 months when managed in well-equipped and -staffed burns units.[19]

The 1 in 6 mortality rate is high, compared with studies from other developing countries which ranged from 6.5% to 12%.[3,8,9,15] The mean survival of 15 days from time of injury to death is short compared with other studies,[5] highlighting the severity of injury encountered in our patients. Inhalation injury; fluid, electrolyte and renal dysfunction; malnutrition; and septic complications were the main contributors to this high mortality. Allowing spontaneous eschar separation did not improve survival in patients with >40% TBSA burns.[20]

All moderate to severe burn patients – especially with inhalation injury – require critical care; this is necessary for intensive monitoring and life-sustaining organ support until wound cover is achieved. The average stay in a burns ICU is approximately 1 day/%TBSA burn.[16] Establishment of a specialised burns unit with intensive care facilities, early nutritional support, committed burns theatre and skin substitutes will improve future results.

Conclusions

Burns occur among all categories of people in the Eastern Cape – mostly disadvantaged communities. Children <4 years old are at greatest risk. Though the study was limited to 66 patients over a 2-year period, it reflects the epidemiology in the area.

Preventive strategies to reduce burns incidence in the most affected areas include training in primary schools about burn awareness and prevention, child safety in the home, safe use of paraffin stoves, and first aid education. Improved nutrition, housing and socio-economic status and the enacting of legislation aimed at reducing scald risk by keeping home and public water heater temperatures to 55°C may go a long way in reducing burn accidents and morbidity.

Once the burn has occurred, depth is reduced by cooling burns <3 hours old using tap water for at least 30 minutes. Burnshield can also be used to cool and dress wounds in the first 24 hours. Early referral of well-evaluated and well-resuscitated patients will greatly reduce inhalation injury and shock complications.

To prevent the hypermetabolic state, a well-established burns unit should have facilities for controlling ambient temperature and humidity, intensive care, barrier nursing and a dedicated theatre for early excision and skin grafting or application of skin substitutes when there is inadequacy of donor tissue.

We express special thanks to the Chief Executive Officer and administrative staff of NMAH for allowing access to patient records, to the Paediatric Burns Unit nursing staff who diligently took care of the patients included, and to Dr Julius Wandabwa and Blandina Kingu for their contribution in epidemiological and statistical analysis, respectively. We also thank Professor Longo-Mbenza Benjamin (Walter Sisulu University Research Champion) for reviewing this paper.

REFERENCES

1. Karpelowsky JS, Rode H. Basic principles in the management of thermal injuries. *SA Fam Pract* 2008; 50(3): 24-31.
2. Duffy BJ, McLaughlin PM, Eichelberger MR. Assessment, triage, and early management of burns in children. *Clin Ped Emerg Med* 2006; 7: 82-93.
3. Mungadi IA. Childhood burn injuries in northwestern Nigeria. *Niger J Med* 2002; 11(1): 30-32.
4. Gali BM, Madziga AG, Naaya HU. Epidemiology of childhood burns in Maiduguri, north-eastern Nigeria. *Niger J Med* 2004; 13(2): 144-147.
5. Rode H. Burn research and clinical practice. *S Afr J Surg* 2007; 45: 4-10.
6. Sharma BR. Infection in patients with severe burns: Causes and prevention thereof. *Infect Dis Clin N Am* 2007; 21: 745-759.
7. Pham TN, Gibran NS. Thermal and electrical injuries. *Surg Clin North Am* 2007; 87(1): 185-206.
8. Shonubi AMO, Akiode O, Musa AA, Salami BA, Kingu HJ, Mohaleroe P. Thermal injuries in under-4-year-old children: the Lesotho experience. *Afr J Med Sci* 2005; 34: 77-80.

9. Komolofe OO, James J, Maloka M, Kalongeolera L. Epidemiology and mortality of burns at the Queen Elizabeth Central Hospital Blantyre, Malawi. *Cent Afr J Med* 2003; 49: 130-134.
10. Kalayi GD. Burn injuries in Zaria: A one-year prospective study. *East Afr Med J* 1994; 71(5): 317-322.
11. Holmes JH, Heimbach DM. Burns. In: *Schwartz's Principles of Surgery.* 8th ed. New York: McGraw-Hill, 2005: 187-221.
12. Prins A. Nutritional management of the burn patient. *Continuing Medical Education* 2008; 26(9): 432-435.
13. Heird WC. Food insecurity, hunger and undernutrition. In: *Nelson Textbook of Pediatrics.* 18th ed. Philadelphia, USA: Saunders-Elsevier, 2007: 225-232.
14. Briassoulis G, Zavras N, Hatzis T. Malnutrition, nutritional indices, and early enteral feeding in critically ill children. *Nutrition* 2001; 17: 548-557.
15. Adesunkanmi K, Oyelami OA. The pattern and outcome of burn injuries at Wesley Guild Hospital, Ilesha, Nigeria: a review of 156 cases. *J Trop Med Hyg* 1994; 97(2): 108-112.
16. Van der Merwe E. Critical care of burn patients in developing countries: cost versus need. *Continuing Medical Education* 2008; 26(9): 428-430.
17. Pereira CT, Barrow RE, Sterns AM, *et al*. Age-dependent differences in survival after severe burns: a unicentric review of 1,674 patients and 179 autopsies over 15 years. *J Am Coll Surg* 2006; 202: 536-548.
18. Heimbach D. Early burn excision and grafting. *Surg Clin North Am* 1987; 67: 93.
19. Sheridan RL, Schnitzer JJ. Management of the high-risk pediatric burn patient. *J Ped Surg* 2001; 36(8): 1308-1312.
20. Steenkamp WC, Albertyn R. Psychosocial factors that influence the outcome of burn treatment. *Continuing Medical Education* 2008; 26(9): 424-426.