PROFILE OF BURN SEPSIS CHALLENGES AND OUTCOME IN AN EXCLUSIVE CHILDREN'S HOSPITAL IN CHENNAI, INDIA

Ramakrishnan K.M., Jayaraman V., Mathivanan T., Babu M., Ramachandran B., Sankar J.*

Childs Trust Medical Research Foundation and Kanchi Kamakoti Childs Trust Hospital, 12-A Nageswara Road, Chennai, India

SUMMARY. A group of 273 paediatric patients admitted to Kanchi Kamakoti Childs Trust Hospital Burn Unit, Chennai, India between the years 2004 to 2010 were analysed retrospectively. Of these, 89 were suffering from sepsis and septic shock and 15 died. Strict adherence to antibiotic administration and to the Paediatric Intensive Care Unit (PICU) and management protocol improved the outcome, especially in 2009 and 2010.

Keywords: paediatric burns, sepsis, PICU care

Introduction

Burns are the most devastating form of trauma. Though survival has improved over the years in major burns all over the world, the situation in India is different. Delay in arrival in/// a burn facility from remote villages, lack of early coverage of the wound and sepsis are the most important factors dictating the patient outcome in our country. Burn wound infection and sepsis are still the most important causative factors of mortality as reported by many burn surgeons.[1] Successful management of a major burn in India is entirely dependent upon the occurrence of infection or not.

The present study

This is a retrospective analysis of 273 children with burns admitted to the Kanchi Kamakoti Childs Trust Hospital Burns Unit, Chennai, between 2004 and 2010. A similar study for the period 2000 to 2006 has already been published.[2] Adoption of new guidelines for the definition of sepsis, as formulated by the American Burns Association in 2007 and the Society for Critical Care Medicine in 2005[3,4] with clear delineation and categorization of infected cases, and the strict adoption of antibiotic policy on infection, treatment protocol and PICU care all were instrumental to reduce mortality rate among our burn patients.

Epidemiology

Burned tissue is a major source of infection. This is one of the most important and potentially serious complications that may occur in the acute period following burn injury. Epidemiology has changed thanks to infection control measures, the adoption of strict policy on antibiotic administration, identification of newly emerging resistant strains of bacteria (extended spectrum beta lactamase [ESBL]) producing Gram-negative *Pseudomonas*, *Acinetobacter* and Biofilm formation from Gram-positive staphylococci, methicillin-resistant *Staphylococcus aureus* (MRSA), and methicillin-sensitive *Staphylococcus aureus*. AIDS and its survivors have also come into the epidemiological scenario. Multi-drug resistant organisms have likewise made their contribution to epidemiology.

Microbiology of the burn wound

Initially burn wounds are sterile[3] but very quickly they become colonized. Subsequently non-invasive wound infection develops and may progress into invasive sepsis. Limited infection with purulent discharge underneath a burn eschar invades the surrounding normal tissues. Bacteraemia causes sepsis and ultimately damage to several organ systems.

Bacteria causing sepsis

The prevalence of bacteria differs between burn units.

The organisms we observed in our Centre are summarized in *Table I*.

* Corresponding author: Dr Janani Sankar, Senior Consultant Paediatric Medicine, Kanchi Kamakoti Childs Trust Hospital, 12a,Nageswara Road, Nungambakkam Chennai 600034, India

Table I - Micro-organism cultures from burn wounds

Gram negative	*Pseudomonas aeruginosa*, *Klebsiella, E. coli, Acinetobacter*
Gram positive	*Staphylococcus aureus*
Fungus	*Candida* sp.

The types of organisms and the seasonal variation are all dictated by the location of the burn unit, city and country. In Chennai, the most prevalent micro-organism was *Pseudomonas*. Some cultures were found to be ESBL-producing types, which are difficult to treat. In spite of adequate treatment, resistant strains do develop.

Clinical staging of burn wound infection

Regular monitoring of burn wounds allows early recognition of infection.[5] The American Burn Association (ABA) recently published criteria for the diagnosis of sepsis and wound infections. Local signs include conversion of a partial-thickness injury to full-thickness wound, worsening cellulitis of surrounding normal tissues, eschar separation, and tissue necrosis.

The various stages of burn wound infection include wound colonization, wound infection, invasive infection, cellulitis, and necrotizing infection/fasciitis.[3]

Burn wound colonization

Wound colonization is characterized by the presence of low concentrations of bacteria on the surface without invasion or systemic signs or symptoms of infection. Tissue biopsies obtained from colonized but not infected skin usually reveal less than 10^5 bacteria per g of tissue.

Non-invasive infection

Wound infection is associated with higher concentration of bacteria (>10^5 bacteria per gram of tissue) within the wound or wound eschar.

Invasive sepsis

An invasive infection includes concentrations of bacteria (frequently >10^5 bacteria per gram of tissue) at an appropriate depth of the burn wound to cause suppurative separation of the eschar or graft loss with involvement of unburned tissue or the presence of a systemic response consistent with sepsis.

Current definition of sepsis used in this study

Current definitions adopted are the result of the ABA consensus meetings held at Tucson-Arizona in 2007. The stages of infection have been adopted with minor modification.[6,7]

Staging of sepsis

The word "sepsis" used in association with burn wounds indicates burn wound infection. An exaggeration of this status defines "severe sepsis", which is indicative of deep invasion that can rapidly progress into septic shock and has traditionally been defined as sepsis plus Multiple Organ Dysfunction Syndrome (MODS). Systemic manifestations of sepsis are the same as those for systemic inflammatory response syndrome (SIRS).

In children the transition from sepsis to severe sepsis is brisk and very difficult to identify. Following careful and rapid assessment, we have included both stages into one and children were managed aggressively whenever the early signs of wound sepsis were identified.

Sepsis is a presumptive diagnosis. Antibiotics are usually started and a search for the cause of infection is initiated. Pathognomonic signs and symptoms include at least three of the following:

1. Temperature > 39^0 C or < 36.5 ^{0}C
2. Progressive tachycardia: in children >2 SD above age-specific norms
3. Progressive tachypnoea: in children > 2 SD above age-specific norms
4. Thrombocytopenia: in children < 2 SD below age-specific norms
5. Hyperglycaemia
6. Inability to continue enteral feedings > 24 h

To confirm the diagnosis a documented infection must be identified:

A. Culture positive infection
B. Pathological tissue source identified
C. Clinical response to antimicrobials

Septic shock

Rapid systemic spread of infection will lead the child to the next phase of septic shock.

The child appears very sick with high temperature and MODS, ARDS, pneumonia, and reduced urinary output necessitating PICU care.

Indicated investigations include complete blood count, serum proteins, wound culture (surface swab, tissue biopsy), blood culture, and serum procalcitonin level. Samples for culture are taken on admission, at 7 days, and at weekly intervals thereafter.

In the presence of sepsis and septic shock, if blood cultures are positive, repeat cultures are done after the antibiotic regimen is completed.

Analysis of cases

A total number of 273 burned children were analysed in the years 2004-2010:

- Years 2009 and 2010 had a higher incidence of burns with an increasing number of admissions to Kanchi Kamakoti Childs Trust Hospital.
- The incidence in male children continues to be higher than in female children.

- The age group 1-5 yr is most vulnerable.
- More children had less than 30%TBSA burn.
- Out of 273 cases 89 developed wound infection.
- 39 of the 89 cases infected had over 30% TBSA burns.
- 41 patients developed systemic sepsis and septic shock.
- 15 patients died, all infected.
- 11 of the 15 deceased patients had burns in over 30% TBSA.

Present treatment protocol

Check on antibiotic administration

As soon as a child with more than 10% TBSA burn is admitted, an immediate surface swab is taken for Gram stain. If positive, culture and antibiogram are performed.

In cases of clinical wound sepsis the swab is subjected directly to culture and antibiogram. As stated earlier, aggressive therapy is initiated whenever early signs of wound sepsis are identified. Initial choice of antibiotics is based on the Gram stain and the known sensitivity of the local microbial flora. Subsequently, antibiotic therapy is adjusted according to the culture results.

The initial antibiotic administration for children with sepsis usually includes Meropenam (Meronem, Astra Zeneca, Bangalore, India) and Vancomycin (Vancocin CP, Astra Zeneca, Bangalore, India).

Subsequently, at the conclusion of each antibiotic regimen, repeat cultures, either burn wound surface swab or blood, are done. For children in ICU for five weeks, surveillance for fungal infection is performed both with blood and catheter tip cultures. If fungal infection is proven, anti fungal therapy is also administered.

Local wound management

Superficial partial thickness burns are covered with collagen membrane (Kollagen, Eucare Pharmaceuticals Ltd, Chennai, India). Children with 15% or more deep partial thickness burns are also covered with collagen membrane till a decision is made for surgical excision and grafting. Third degree burns over 15% are primarily grafted after excision. Infected wounds are usually treated with topical Silver Sulphadiazine (Rexcin Pharmaceuticals Pvt Ltd, Himachal Pradesh, India) or Soframycin cream (Aventis Pharma Ltd, Goa, India) and semi occlusive dressings. Similarly, children with septic wounds are also treated with daily burn dressings and topical anti-microbial agents. Antibiotics are administered as per our policy for all culture positive cases. In the absence of clinical wound infection, antibiotics are withheld till culture results become known. In the case of invasive sepsis with septic shock, children are managed in the Paediatric Intensive Care Unit with Inotropes and continuous hemodynamic monitoring.

PICU Care-Management of Septic Shock in Burns[8]

Patients are usually admitted to the PICU after a variable period of hospitalization and treatment on a regular ward. As per the approved antibiotic policy, broad-spectrum antibiotics are started immediately, aimed at treating the most common organisms prevalent in our hospital. This usually includes a β-lactam/β-lactamase inhibitor (BL-BLI), such as Piperacillin / Tazobactam (Zobactin, GSK, Mumbai, India) and Vancomycin (Vancocin CP, Astra Zeneca, Bangalore, India). If the patient has been earlier exposed to BL-BLI combinations, a carbapenem substitute, such as Meropenem (Meronem, Astra Zeneca, Bangalore, India) is given. In cases of prolonged hospital stay, Colistin (Xylistin, CIPLA, India) is usually added to treat Acinetobacter Baumanii. Antifungal agents to treat Candida species, such as Amphotericin B (Amphotin, United Biotech, India) or an Echinocandin (Mycafungin, GSK, India) are also used empirically in patients who have had a prolonged hospital stay and have been exposed to multiple antibiotics. Further antimicrobial therapy is guided by the culture and sensitivity reports. Wounds are grafted only after colony counts from tissue cultures have decreased to acceptable levels.

Sometimes during therapy new micro-organisms with different sensitivity patterns may develop. Moreover, a child may occasionally deteriorate despite antibiotic therapy. This could be due to immune deficiency, burn wound reaching deeper tissues such as bones and tendons, lack of proper debridement of devitalized tissues or micro-organisms such as Staphylococcus Aureus either MRSA or methicillin sensitive forming a Biofilm. A number of Biofilms were detected among the MRSA infected group with recurrent infection 5 weeks after apparent recovery. For treatment of such cases, if the isolated micro-organism is sensitive to more than one antibiotic, the already used antibiotic may be replaced by another one.

Conclusion

Establishment of strict antibiotic policy and treatment of cases with septic shock in a PICU have improved the outcome compared to the results 10 years ago in our centre when our understanding of the different stages of sepsis was not clear and wide spectrum antibiotics were not available. In children the transition from sepsis to severe sepsis is brisk and very difficult to identify. It is critical that aggressive management of burned children is initiated whenever early signs of wound sepsis are identified. In spite of improvement in the treatment protocol, early excision and wound closure as well as availability of third generation antibiotics, we have not been able to reduce the incidence of infection, which remains the major cause of mortality among burned children admitted to our hospital.

RÉSUMÉ. Les Auteurs ont conduit une étude rétrospective dans un groupe de 273 patients pédiatriques admis à l'Unité des Brûlures Kanchi Kamakoti Childs Trust Hospital, à Chennai, en Inde, pendant les années 2004-2010. De ces enfants, 89 étaient atteints de sepsis et de choc septique dont 15 sont morts. L'observation totale des règles pour l'administration des antibiotiques, du protocole pédiatrique de l'unité de soins intensifs, et du protocole de gestion ont amélioré les résultats, en particulier en 2009 et 2010.

Mots-clés: brûlures pédiatriques, sepsis, unité pédiatrique de soins intensifs

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