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Multi-drug resistant gram negative bacteria colonization and infection in burned children: Lessons learned from a 20-year experience

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ABSTRACT

Objectives: Our objective is to highlight the growing problem of multi-drug resistant gram negative bacterial (MDRGNB) species in burn units and demonstrate strategies for successful management.

Methods: Using a concurrent data collection, a 20-year experience with MDRGNB in a pediatric burn unit was reviewed.

Results: 220 (6.5%) of 3,359 children admitted for management of acute burns or open wounds had MDRGNB recovered. The children had an average age of 8.8 ± 0.3 years and average burn size of 42.9 ± 22.8 percent. The incidence of MDRGNB increased over the 20 years of the study from 2.5% of admissions in the first decade to 8.6% in the second. 90% (198) were found colonized with MDRGNB on admission on transfer from other facilities. MDRGNB sepsis (blood recovery) occurred in 80 (36.4%), MDRGNB invasive wound infection in 46 (20.9%), MDRGNB pneumonia in 19 (8.6%), and MDRGNB UTI in 46 (20.9%) of the children. There were 14 (6.4%) fatalities, the cause of death being MDRGNB sepsis in all 14 children. However the large majority of the children 206 (93.6%) survived despite their MDRGNB infection.

Conclusions: MDRGNB may be transferred into burn units during transfers of patients with complex wounds and can be the cause of life threatening infections. The number of children arriving with MDRGNB organisms has steadily increased over time. MDRGNB infected patients can be successfully managed with wound excision and closure supported by topical mafenide acetate and administration of the limited antibiotics to which the organisms are sensitive, particularly Colistin. Strict infection control practices will limit cross infection with these difficult organisms.

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1. Introduction

Multi-drug resistant gram negative bacteria (MDRGNB) are rapidly emerging as a major public health problem [1]. Interestingly, the increased mortality associated with infections caused by these organisms may be primarily related to initial poor antibiotic choice (where there are choices) rather than innate increased virulence [2]. The emergence of multi-drug resistant gram negative bacteria (MDRGNB) species is of particular concern in burns, where

sepsis remains the leading cause of death and the risk of cross contamination is high [3]. Our regional pediatric burn practice has seen a steady increase in the numbers of children presenting with large burns colonized with MDRGNB over the past 20 years. We have evolved strategies for addressing these wounds and for preventing cross-colonization following principles established for addressing and containing the increasing MRSA isolates seen in the 1990's [4]. The objective of this paper is to share this experience, lessons learned, and effective management strategies.

2. Methods

A twenty year experience with MDRGNB colonization and infection in children with burns was reviewed. All subjects were inpatients at the Boston Shriners burn unit. Multiple drug resistance was defined as resistance to three or more antimicrobial classes

Abbreviations: MDRGNB, Multiple Drug Resistant Gram Negative Bacteria; TBSA, Body Surface Area.

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of drugs. Pan drug resistance was defined as resistance to all antimicrobial classes with the exception of Colistin. Infections were defined using the Centers for Disease Control definitions. Blood stream infection diagnosis required recovery of an organism on blood culture. Pneumonia diagnosis required radiographic change, purulent sputum, and fever. Urinary tract infection required recovery of more than 10,000 colony forming units on a catheter specimen. Wound infection diagnosis was clinical and required change in wound appearance, fever, purulent drainage (quantitative cultures were not done). Colonization of wounds was defined as organism recovery on swab culture without a diagnosis of wound infection. Standard universal precautions and contact isolation were rigorously applied in all cases to minimize cross-colonization. Cross-colonization was defined by recovery of an MDRGNB species in any culture from a child who arrived without the organism on cultures taken within 72 h of admission, providing the organism was of a similar species with a similar antibiotic resistance pattern of an organism in another child in the unit. The general treatment philosophy during this 2-decade period was consistent. Deep burns were excised whenever possible during the first week of care. Most excised wounds were immediately closed with autograft. If autograft was not adequate, temporary closure with allograft was common pending healing of limited donor sites. Mechanical ventilation was used when needed during periods of respiratory failure. Data was collected concurrently by the infection control coordinator on all patients. This included patient demographic and burn data, MDRGNB origin, colonization and infection, length of stay, and mortality. Descriptive statistics were applied to the patient data.

3. Results

From January 1994 through December 2013, there were 3,359 children admitted for management of acute burns or open wounds to a regional pediatric burn unit. Two hundred twenty (220) of these children (6.5%) had MDRGNB recovered from wounds, sputum, urine, or blood during their hospitalization (Table 1). The incidence of MDRGNB increased over the twenty years of the study from 2.5% of admissions in the first 10 years to 8.6% in the second 10 years. These children had an average age of 8.8 ± 5.3 years. The average burn size was 42.9 ± 22.8 percent of the body surface, with full thickness burn of 37.7 ± 23.1 percent. One hundred ninety-eight (198) of 3,359 (5.9%) of the patients were colonized with MDRGNB on admission (Fig. 1), of which 184 (93%) had been admitted after significant treatment delay from outside the continental United States. These 198 children were transferred to Boston Shriners a median of 19 days after injury. It was during this time that the organisms were presumably acquired.

Table 1
Patient characteristics.

Characteristic	Value	S.D.	Range
Age (years)	8.8	± 5.3	1 month–23 years
Male (Number)	121 (55%)	–	–
Burn Injury (% TBSA)	42.9	22.8	1.5–98
Third Degree (%TBSA)	37.7	23.1	0–96
Length of Stay (days)	57.7	43.8	2–273
Inhalation injury (Number)	75 (34.1%)	–	–
Etiology of Burn injury*:	–	–	–
Flame	145 (71.1%)	–	–
Scald	30 (14.7%)	–	–
Electrical	29 (14.2%)	–	–
Patients from outside continental U.S.	193 (87.7%)	–	–
Lived	206 (93.6%)	–	–

*For the 204 patients with burn injury.

Origin of MDRGNB Organisms

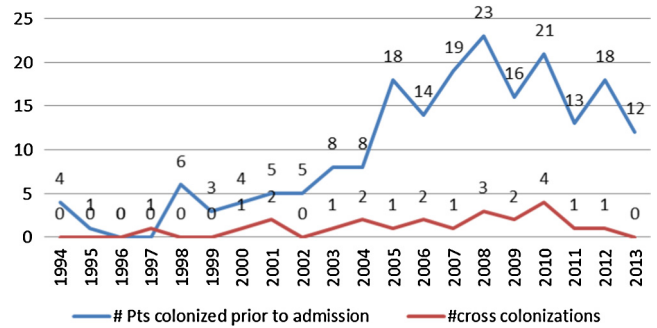


Fig. 1. MDRGNB recovery and potential cross-transmission over time.

Table 2
Organism characteristics.

Organism	Total # Resistant	# PAN Resistant (%)
<i>A. baumannii</i>	127	41(32.3)
<i>P. aeruginosa</i>	117	35 (29.9)
<i>K. pneumoniae</i>	84	2 (2.4)
<i>E. cloacae</i>	28	1 (3.6)
<i>S. maltophilia</i>	24	1 (4.2)
<i>E. coli</i>	24	0 (0.0)

*2 also resistant to Colistin.

MDRGNB sepsis (blood recovery) occurred in 80 (36.4%), MDRGNB invasive wound infection occurred in 46 (20.9%), MDRGNB pneumonia in 19 (8.6%), and MDRGNB urinary tract infection in 46 (20.9%) of the children. Recovered MDRGNB species included *P. aeruginosa*, *A. baumannii*, *S. maltophilia*, *K. pneumoniae*, *E. cloacae*, and *E. coli* (Table 2). Topical treatment included silver nitrate and mafenide acetate. Wound closure proceeded in these children despite MDRGNB colonization or infection, supported by topical mafenide acetate and use of the limited antibiotics to which the organism was susceptible, generally Colistin. Strict infection control measures were practiced to minimize the occurrence of cross colonization which included contact isolation on admission for all patients who had been an inpatient prior to arrival at our hospital and admission surveillance culturing of all patients. There were 14 (6.4%) fatalities, the cause of death being MDRGNB sepsis in all 14 children, all having MDRGNB in blood cultures. However the large majority of the children 206 (93.6%) survived despite their MDRGNB infection.

4. Discussion

MDRGNB are increasingly common recoveries in hospital settings and are associated with a significant cost burden [5]. MDRGNB recovery has steadily increased over time, possibly related to the more widespread use of broad-spectrum antibiotics [6]. In our experience, MDRGNB are more common in burn patients admitted from other units after long delays, during which necrotic material is not promptly excised and broad-spectrum antibiotics are used liberally to combat sepsis related to unexcised wounds [7]. The occurrence of MDRGNB issue can be expected to increase in frequency and to occur in less severe medical and surgical conditions than burns. If the spread of MDRGNB follows the pattern of resistant gram positives seen in the 1990's and early 2000's, community acquisition of these organisms can be expected to occur in addition to nosocomial acquisition [8].

Management of MDRGNB requires anticipation, early appropriate surgical wound care, early empiric antibiotic coverage with

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