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Risk Factors Associated with Wound Infection in Burned Children

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ABSTRACT

Background: Burns in children are a massive problem in Egypt. Nowadays, infections account for 51% of the overall fatalities and are the second leading cause of mortality and morbidity after burn injuries. **Aim:** to identify risk factors associated with wound infection in burned children. **Methods:** An exploratory descriptive research design was adopted for this study. At the burn and plastic surgery center of El-Mansoura University Hospitals, this study was conducted. Based on specific inclusion criteria, a purposive sample of 75 hospitalized burned children and a convenient sample of 30 nurses participated. Three main tool parts were utilized. Part I: Questionnaire Sheet: Personal information regarding burned children and personal information about nurses who care for hospitalized burned children. Part II: Health Profile Assessment Sheet covered information about a hospitalized burned child. Part III: Checklist of Observations was adapted from the Egyptian Ministry of Health's Infection Control Checklist. **Results:** The mean age of the burned children was 3.94 ±1.66 years. Two-thirds of the children were male. Pseudomonas infections cause about half of all burn infections. There was a statistically significant relationship between the nurses' practice score and the burn characteristics of burned children three days after admission to the unit. The nurses' practice scores and the length of time that children stay in hospitals were statistically related. **Conclusion:** Inadequate hand hygiene, as well as failure to wear personal protective equipment (PPE) and other contact isolation precautions, were the most important factors in wound infection transmission.

Keywords: Risk Factors; Burned Children; Infection

INTRODUCTION

A burn is an injury to the skin or other organic tissue typically caused by heat, radiation, radioactivity, electricity, friction, or contact with chemicals. According to the World Health Organization, burns are the most frequent form of injury in children that general practitioners (GPs) treat in outpatient settings. (Kawalec & Pawlas, 2022). Children are at higher risk of morbidity and death due to the immunocompromising consequences of burns, hospital stays, and diagnostic and therapeutic treatments. Although the number of patients who survive burn injuries has grown in recent years, infections continue to be the leading cause of morbidity and death following burn damage (Rosanova, Stamboulian, & Lede, 2017; Mehta &Tudor, 2022). Infection now accounts for 51% of all deaths and is the second leading cause of fatalities and serious injuries after burn injuries. In this immune-compromised population, it is well understood how important it is to prevent and monitor infections, yet there are few standard-of-care recommendations and cutting-edge methods accessible. Within the first 24 hours, sepsis and the related severe infection are still the main causes of mortality (Norbury *et al.,* 2016).

Depending on the child's age, several factors determine the cause of burn injuries. Scald injuries seem to be the most frequent type of thermal injury in children under the age of five, accounting for over 65% of cases, while fire injuries tend to happen in older children, accounting for over 56% of cases. After children are exposed to burns, they may experience significant psychological trauma and post-traumatic stress disorder (PTSD). The most common type is a thermal burn caused by hot fluids. The development of shock and suspected sepsis always requires that the wound be inspected and considered as a possible source. However, clinicians should keep in mind that in the case of minor and moderate burns, the

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burn wound itself is not the most common source of infection (Nunez *et al.*, 2017; World Health Organization, 2022).

Significance of the study

Burns are one of the leading causes of lost disability-adjusted living years in low- and intermediate-income nations. The American Burn Association noted that nearly one-third of burn injuries occur in the pediatric population. Burns caused by scalding are most frequently seen in pediatric burns related to hospitalization, specifically in subjects under 5 years of age (American Burn Association, 2021).

The Centres for Disease Control and Prevention's information indicates that hospitalized burn patients may be more susceptible to serious, perhaps fatal infections, Pseudomonas aeruginosa infections can harm patients who have burns or surgical injuries. Minor infections caused by P. aeruginosa can affect individuals everywhere, but major infections are often only encountered in healthcare (nosocomial) settings. The main cause of death in burn patients is sepsis. Sepsis in severe burns is significantly exacerbated by Pseudomonas aeruginosa. It was postulated that P. aeruginosa alters the blood's metabolism during sepsis brought on by infected burn wounds, changing certain metabolites that might be employed as biomarkers for early detection of the condition (Elmassry *et al.*, 2020).

Burns in children are a massive problem in Egypt, particularly in households with poor socioeconomic standing. These individuals frequently use kerosene stoves with no safety features and live in cramped apartments with poor cleanliness (El-Badawy & Mabrouk, 1998). Children with severe burns are also at risk for sepsis, which can arise early in the healing process because of infected burn wounds and result in organ failure and death (World Health Organization, 2022). Therefore, the present study's aim was to figure out risk factors associated with wound infection in burned children.

METHODOLOGY

Research Design

The study employed a descriptive/exploratory research design.

Sample

A purposive sample of 75 hospitalized burned children based on admission rate within 3 months in the year 2016 (this period from May to July 2016 at the plastic, reconstructive, and burn surgery center at Mansoura University Hospitals (MUH). And a convenient sample of 30 nurses was included in the study. The inclusion criteria for studying children included hospitalized burned children with wound infection, all degrees of burn, both genders, and ages 1-18 years. The exclusion criteria include children with chronic diseases and all types of blood disorders.

Data Collection Instruments

After reviewing the relevant literature, the researchers developed the following tools:

Part I: Questionnaire Sheet: It consists of two sections: personal data about burned children and personal data about nursing staff caring for hospitalized burned children.

Part II: Health Profile Assessment Sheet: covered knowledge about the hospitalized burning child, such as drug allergy, hospital stay, degree, site, percentage, and the manifestation of burn (on admission and three days after admission to the unit), and swabs from the wound for culture.

Part III: Observational Checklist: checklist for wound care, the researchers modified a checklist based on the Egyptian Ministry of Health's (MOH) infection control checklist. The checklist included 15 items such as hand washing, wearing personal protective equipment (P.P.E.), and aseptic techniques.

Validity and Reliability

The content validity of the tools was tested by three specialists in Medical Microbiology and Immunology, Pediatric Surgery, and Pediatric Nursing. The tools' reliability was tested to ensure their consistency using coefficients' alpha, which became 0.80.

Scoring System

The nurse's practice checklist for wound care of infected burned children was recorded by researchers. Each correct

step was worth one point, while each erroneous step was worth zero.The total scores were converted to 100 percent and classified as follows: less than 50% as unqualified and unsatisfactory, level 50 percent and above as qualified and satisfactory.

Procedure

The proposal was approved by the director of the Burn Unit and the Medical Microbiology and Immunology Department at the Faculty of Medicine at Mansoura University. The investigators described the main purpose and significance of the current study to the nurses and parents of the burned children. Each nurse questioned gave written consent to participate in the study. The investigators then interviewed each nurse individually; the interview lasted about 5 to 10 minutes to collect personal information on nurses. Personal information on burned children was obtained from medical records, and clinical manifestations of burn injury were reported and observed on admission and three days after hospitalization. When caring for the burned children's wounds, the nurses' performance on the observation checklist was documented. In Version 20 of the SPSS software, standard deviation, mean, and frequency were utilized as descriptive statistics. The data were coded and summarized using the mean, standard deviation, and percentage. The *p*-value cutoff was 0.05, and a *p*-value of 0.001 was deemed statistically significant.

Ethical Consideration

The ethical approval was obtained from the Research Ethics Committee in the Faculty of Nursing, Cairo-University on November 23, 2016 with reference number FWA00019803.

RESULTS

According to the personal data of the studied children, the mean age of the children was 3.94±1.66 years, and two-thirds (66.7%) of them were males. The mean weight of them was 15.05 ±1.23. Regarding the personal data of the nursing staff included in the study, they had an average of 8.77± 3.86 years of experience, with most of them (96.0%) graduating from a nursing secondary school. In terms of the training program for infection control, 50.7% of them did not attend any courses. The majority of nurse/patient ratios per shift (96%) were one nurse per 10 burnt patients per shift.

Regarding the vaccination history of the studied burned children, all of them received the mandated immunizations. In terms of past trauma history, the majority of burned children (96.5%) have no history of past trauma. Only (4%) were allergic to penicillin antibiotics, and all burned children have no history of previous surgery.

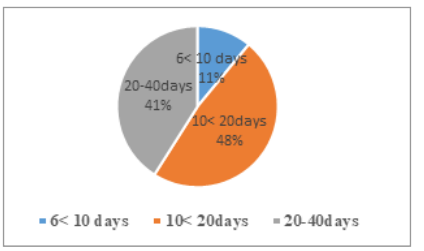

Figure 1: Hospital Stay of Burned Children

Forty-eight percent of burned children stayed in the hospital for 11-20 days, with a mean of 15.31±5.66 (Figure 1).

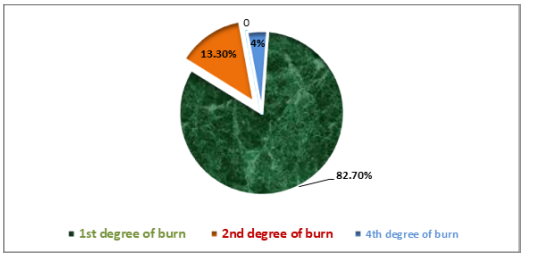

Figure 2: Degree of Burned Children

Most of the children (82.7%) suffered from first-degree burns, while a minority (4.0%) had fourth-degree burns. (Figure 2).

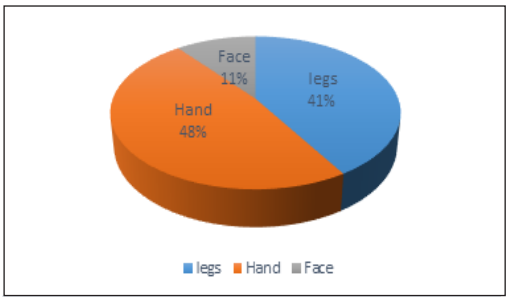

Figure 3: Burn Sites in Burned Children

Less than half (48.0%) of children had burnt their hands, while more than two fifths (41.3%) were in legs and the minority was in face (Figure 3).

Regarding percentage of burned children more than half (53.3%) of the burnt percentages were within 26%-< 35%, and the fewer were 2.7%, of them were more than 50%. Less than half (48.0%) of burned children were caused by thermal burn, followed by chemical burn (41.3%) and the minority by electrical cause.

Table 1: Wounds Cultures Results and Antibiotics for Infected Burned Children in Percentage Distribution

Items	No	%
Wounds cultures results		
Pseudomonas	34	45.3
E-Coli	16	21.3
Staphylococcus aureus	17	22.7
Klebsiella	8	10 .7
Antibiotics ordered		
Amikan	46.6	34
Sulbactam	19.2	14
Rifampin	22.7	17
Penicillin	11.5	10

Less than half (45.3%) of burnt children's wound infections were Pseudomonas followed by Staphylococcus aureus (22.7%), E-coli, (21.3%), and Kiebsiella (10.7%). Less than half of burned children (46.6%) received Amikan followed by Rifampin (Table 1).

Table 2: Children's Burn Manifestation on Admission and Three Days After Hospitalization

Manifestations of burn	On admission		Three days after hospitalization	
Presence of Pus	**No**	**%**	**No**	**%**
Yes	2	2.6	74	98.0
No	73	97.3	1	1.3
Feeling of pain or pain when pressing the burning site				
Yes	5	6.6	75	100
No	70	93.3	0	0.0
Swelling at the site of burning				
Yes	6	8	75	100
No	69	92	0	0.0
Redness in the Burning Site				
Yes	63	84	75	100
No	12	16	0	0.0
Heat in the Burning Site				
Yes	4	5.3	75	100
No	71	94.6	0	0.0
Swelling of the Wound Automatically				
Yes	3	4	75	100
No	72	96	0	0.0
Fever more than 37c				
Yes	0	·	72	96.0
No	0	0	3	4.0

Most of the studied children (84%) displayed redness at the burn site on admission, whereas all burned children (100%) manifested redness after 3 days of admission to the burn unit. The majority of burned children (98.0%) developed pus discharge after 3 days of admission, whereas the remaining smaller proportion (2.6%) had already developed pus discharge on admission (Table 2).

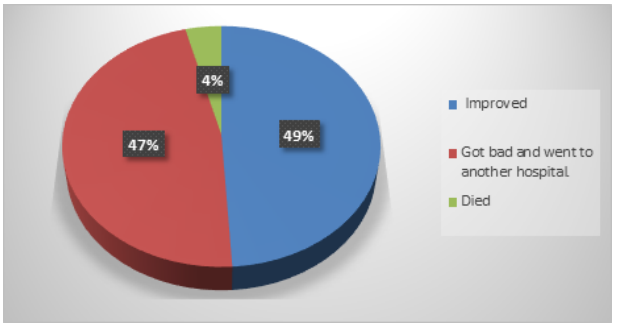

Figure 4: The Prognosis of Burned Children

Slightly less than half of the infected burned children (49.3%) improved, while more than two-fifths of the infected burned children became worse and went to another hospital, and fewer of them (4%), died (Figure 4).

In relation to Table 3, all nurses caring for burned children do not wash their hands before and after each procedure. According to P.P.E., 100% of nurses wear just sterile gloves but do not adhere to wearing a mask and gown before any contact with a burned area. There was a statistically significant difference between the overall mean score of nurses' erroneous procedures and the overall mean score of nurses' correct procedures for burning children's wound care.

Table 3: Observation Checklist of Wound Care of the Infected Burned Children in Percentage Distribution

Items	Done	%	Not done	%
Pre-performance				
1. Perform hand hygiene before starting	0	0	75	100
2. Check present dressing with non-sterile gloves.	75	100	0	0
3. Gather necessary equipment	75	100	0	0
4. Set up the setting, place the patient, alter the bed's height, and turn on the lamp.	25	33.33	50	66.66
5. Alcohol rubbing before touching the wound or any sterile equipment	0	0	75	100
Wearing Personal Protective Equipment (P.P.E)				
6. Wear sterile gloves	75	100	0	0
7. Wear Gown, mask, and overhead & Dispose gloves after every procedure	0	0	75	100
Aseptic techniques				
8. Prepare sterile field.	25	33.33	50	66.66
9. Pour cleansing solution.	75	100	0	0
10. Gently clean the wound with one -piece gauze at a time. then outer edges- top to bottom	0	0	75	100
11. Contaminated wound is cleaned with two sterile gauze and held with two sterile instruments	25	33.33	50	66.66
12. when a pus is present, and sample of pus is sent to laboratory to culture	25	33.33	50	66.66
13. The wound should be covered by placing sterile gauze	25	33.33	50	66.66
14. Dispose of all contaminated refilled in hazardous waste bin.	25	33.33	50	66.66
15. A package containing sterilizer and sterilized gauze is used for each patient separately. Hand washing after finishing.	0	0	75	100
Mean ± SD	31.66±2.1		43.33±2.9	
***p*-value**	0.02*			

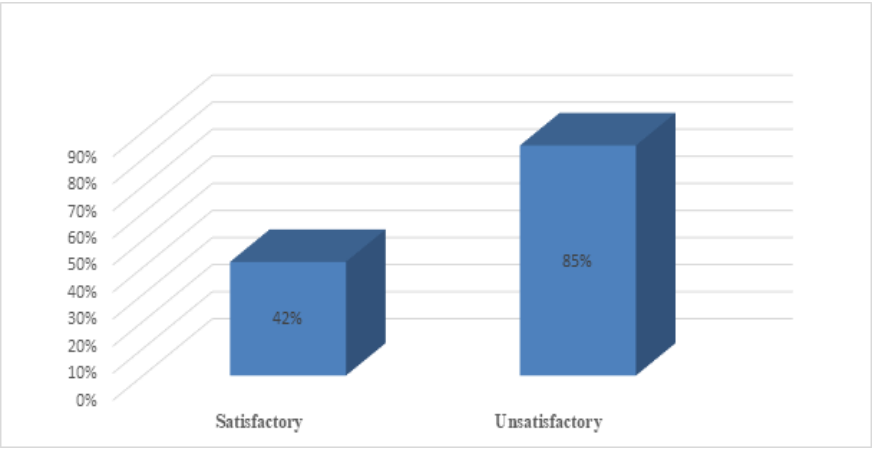

Figure 5: The Score of Nurses' Practices

The percentage of nurses who cared for the studied patients reported that only 42% had a satisfactory score, and 58% were unsatisfactory (Figure 5).

Table 4: Relationship between the Score of Nurses' Practice, Burn Child Manifestations, Hospital Stay, and Prognosis among Burned Children

Items	Nurses' Practice Score	
	Test	(*p*-value)
Burn manifestations 3 days after admission	χ^2 =1.612	0.004*
Mean of child's Hospital Stay	t =2.464	0.292
Child's Prognosis	χ^2 =75.000	<0.001*

Table (4) revealed a statistically significant relationship between the nurses' practice score and the burn characteristics of burnt children three days after admission, as well as the children's prognosis. Nevertheless, there was no significant relationship between the nurses' practice score and the hospital stay of children.

DISCUSSION

Burns are frequently referred to as one of the most damaging kinds of trauma in medicine due to their physical and emotional repercussions. In terms of the personal data of the studied burned children, their ages were in accordance with other reported studies (Kawalec & Pawlas, 2022; Coetzee, Rode, & Kahn, 2013). In our study, the male gender was predominant; nearly two-thirds of burned children were male. Aubusson (2016) reported the same finding. This finding might be attributable to the hyperactivity of male children.

Nearly 40% of the studied nurses had less than 5 years of experience. The same percentage was reported for nursing staff that had experience between 5 and 10 years. The mean years of experience of the studied nursing staff were 8.77 ± 3.86. Definitely, years of experience have a great influence on the care provided to the patient in any field, and in particular for burned children. The research finding highlighted that most nurses attended a secondary school of nursing; this result linked to the traditional dominance of secondary schools of nursing, which tended to change toward technical institutes of nursing in the last few years.

In terms of the infection control training program, nearly half of the nurses caring for burned children got infection control courses, while the other half did not. According to Fabia (2022), continuing staff education on best practices and the organization's infection control policy is essential to efficient infection control. A proactive interdisciplinary strategy to treat pediatric patients with thermal damage as well as staff education have dramatically reduced overall morbidity from thermal injury over the years.

Mohammed, Hassan, and Mohammed (2021) proposed that nurses working with children who have burn injuries

be educated about the biological changes that follow a burn, as well as critical care skills and a readiness to recognize small changes in the children's behavior and learn the subtleties of caring for burning children with painful wounds.

Regarding the hospital stay of the burned children studied, less than half of the burned children stayed in the hospital from 11-20 days, with a mean day of 15.31±5.66. Astonishingly, the outcomes of this research highlighted that there was no significant association between the nurses' practice score and the length of stay in the hospital for the studied children. This may be attributed to the relatively small sample in our study. Similar to Forson *et al.* (2017), who concluded and observed that the pattern of microorganisms' present infecting burn sites varied based on the location distribution as well as the duration of the hospitalization. Burn wound infections are a significant contributor to mortality, morbidity, and extended hospital stays in burn patients since the etiological agent is typically multidrug-resistant bacteria. In another Egyptian study, Hashish and Abdel-Karim (2017) examined "Burn Injuries among Patients Hospitalized to a Burn Unit, Suez Canal University Hospital" and discovered that 20.9% of patients who stayed in the hospital for more than a week were burned children, followed by 29.5% of patients who stayed there for 1 to 7 days.

The current results showed that only around half of burned children's wound infections were caused by Pseudomonas, followed by Staphylococcus aureus, E. coli, and Klebsiella. Similar findings were reported by others (Coetzee, Rode, & Khan, 2013; Babakir, 2017; Qureshi, 2020).

Pomeroy & Young (2015) also demonstrated that burn wound infections in children might have catastrophic implications if not recognized and treated immediately. Knowing the most common symptoms of infection and the indication of prioritizing them above other children's diseases is critical. Untreated wound infections can have a range of negative effects, from increased scarring and delayed healing to, at worst, death.

The current study's results reported that nearly half of burn sites in burned children were in hands, while more than two-fifths were in legs and the minority of burn site was in face of children. In the same context Hashish, & Abdel-Karim, (2017) indicated that the head and neck were the area's most frequently injured by burns, followed by the upper extremities, then the buttocks and genitalia.

According to the current research analysis, below 50percent of burns among children were indeed burns, with more than half of those burns falling between the percentage range of 26% to 35%. Infections with gram-negative bacteria and fungi are more common in patients with greater mean TBSA and longer hospital stays, according to Babakir, (2017). The research of Fernandez *et al.*, (2022) who found that burn wound cellulitis or erythema extended into the skin tissue close to the location of the wound and furthermore manifested by sharp pain or tenderness, inflammation or hotness at the affected site, the progression of erythema that swelling and signs of lymphadenitis extending from the affected skin area along routes of lymphatic drainage to the area, supported these findings.

Based on Ebenezer *et al.*, (2019) and Ibrahim & Bahnsawy (2021), the predominance of antibiotic resistance in burn infections necessitates the judicious use of antibiotics and strict infection control practices, such as frequent hand washing, avoiding sharing of equipment among patients, using barrier strategies, surgical removal, and closure of the wound, and using dermatologic antibiotics, improving the overall infection-related death and disability rates.

The mechanism of infection transmission may occur by touch, droplet contact, or airborne dissemination. Contemporary burn clinics include a closed border to minimize unnecessary traffic from staff and service users. Among the several environmental controls that must be properly adhered to follow contemporary infection control measures are washing hands and the usage of personal protective equipment, during interaction with the patient, all staff members must wear gowns either disposable or reusable. The isolation room's equipment must all undergo routine cleaning. (Sharma *et al.*, 2021).

The current study documented that all nurses caring for burnt children do not wash their hands before and after each procedure. And according to (P.P.E) all nurses wear just sterile gloves but do not adhere to wearing a mask and gown before any contact with a burned area. There was a statistically significant difference between the overall mean score of nurses' improper practices and the overall mean score of burn children's wound care practices. Ibrahim & Bahnsawy (2021), consistent with the current finding and concluded that handwashing and wearing full PPE are critical for

reducing the occurrence of infections in all clinical settings.

Hand washing It's crucial to wash one's hands after coming into touch with biological fluids including blood, saliva, tears, and urine to protect both the personnel and the patient. Regardless of how much or how little interaction a healthcare professional had with a patient; they should wash their hands after coming into direct contact with that patient.

Strauss, & Gillespie, (2018), stated that burns result in a sizable open hole where normal skin flora can start to invade. This can cause serious cellulitis or sepsis if left untreated. wound care is crucial for preventing infection and should be started right once.

Regarding relationships between the research variables, the present research analysis clarified that there was a highly statistically significant relationship between the nurses' practice score and prognosis among burned children. In the same context, Lachiewicz *et al.*, (2017), suggested that "improving outcomes for burn injury patients has focused extensively on infection prevention using a variety of techniques. Due to their extensive invasive procedures and extended hospital stays, children with burns are particularly vulnerable to nosocomial pathogens.

CONCLUSION

Inadequate hand hygiene, as well as failure to wear personal protective equipment (PPE) and other contact isolation precautions, were the most important factors in wound infection transmission. Burn percentage and depth are the main contributing factors to morbidity and mortality. Nurses' performance is considered a dangerous and important risk factor that can play an essential role in the spread of infection. Proper prevention and control of infection in burned children is the key to a good prognosis for burn wounds.

RECOMMENDATION

The researchers proposed the following recommendations. According to their findings:

1-Establish regular and consistent supervision and monitoring by:

- Implement a continuous education program to keep nurses in burn units up to date on the importance of handwashing.
- Providing infection control handouts to nurses when caring for burn children's infections
- Monitor and evaluate the efficiency of infection control training to verify that all nurses followed protocol and utilized PPE.

2- Use chemical and biological markers to test and ensure sterilization of all sterile equipment.

Conflict of Interest

The authors declare that they have no competing interests.

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