POSSIBLE RISK FACTORS ASSOCIATED WITH BURN WOUND COLONIZATION IN BURN UNITS OF GAZA STRIP HOSPITALS, PALESTINE

Al Laham N.A.,* Elmanama A.A.,† Tayh G.A.‡

† Department of Medical Laboratory Sciences, Faculty of Applied Medical Sciences, Al Azhar University-Gaza, Gaza strip, Palestine
‡ Department of Medical Laboratory Sciences, Faculty of Science, Islamic University-Gaza, Gaza strip, Palestine

SUMMARY. The epidemiological pattern and risk factors of burns and burn infections varies widely in different parts of the world. This study aims to determine the epidemiologic pattern of burn injuries and possible risk factors associated with burn infections in burn units of Gaza strip hospitals. A total of 118 patients were included in the study. The data collected included: patient age and gender, the causes, site, degree, and TBSA of the burns, as well as surgical operations, length of hospital stay, and microbiological profile of samples collected from patients, the environment, and from health care staff. Pediatric and adult patients accounted for 72% and 28% respectively. 58.5% of all patients were male and 41.5% were female. The most common etiological factors in children were scalding, while in adults these were open fire and flammable liquids. The mean TBSA was 12% with a range from 1–90%. Second and third degree burns accounted for 78% and 22% respectively. The area of the body most often affected was the torso (39%), followed by the lower limb (29.7%), and upper limb (17.8%). The predominant microorganisms isolated from burn wounds were Pseudomonas aeruginosa, Enterobacter spp. and Staphylococcus spp. The study showed the highest risk groups to be children and males, and enabled us to identify possible risk factors that can help in future efforts toward prevention and minimizing nosocomial infections in burn units of Gaza strip hospitals.

Keywords: burn colonization, risk factors, burn units, Gaza hospitals, Palestine

Introduction

Burns are considered one of the most common and shocking forms of trauma. Patients with serious thermal or electrical injury necessitate immediate specialized care to minimize morbidity and mortality.¹–⁴ Electrical burns and burn injuries caused by fire, hot liquids, and contact with hot surfaces, have been recognized as a significant and major public health problem in many developing countries.⁵,⁶,⁷

Burn patients are at high risk of nosocomial infections for several reasons: the immunocompromizing effects of burns, prolonged hospital stays, and invasive diagnostic and therapeutic procedures.⁸ Furthermore, both checking and preventing infection is difficult in burn patients because of disruption to the skin barrier and the potentially heavily colonized burn unit environment by resistant microorganisms, with a high likelihood of cross contamination among patients.⁹ Burn wound infections are considered one of the most significant and potentially serious complications that ensue in the acute period following injury.¹⁰–¹¹ Burn injury is a major problem in many areas of the world, and it has been estimated that 75% of all deaths following burns are related to infection.¹²,¹³ According to data from numerous publications in different countries, the most isolated pathogens from burn patients and their environments are Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Klebsiella spp., Enterococcus spp., Coagulase negative staphylococci, Enterobacter spp., Acinetobacter spp. and Candida spp.¹³,¹⁴–²¹ Many epidemiological studies have highlighted the risks associated with burns and burn infections.²²–²⁴

To our knowledge, there are no documented reports or published data about the risk factors of burn injuries and nosocomial infections in burn units in the Gaza strip. This study was prospectively carried out at Al-Shifa and Nasser burn units, Gaza strip, Palestine to analyze the epidemiological characteristics of the burn patients, and to study the possible risk factors associated with microbial infections that occurred during hospitalization at these burn units.

* Corresponding author: Dr. Nahed Al Laham, PhD medical & molecular microbiology and immunology, Department of Medical Laboratory Sciences, Faculty of Applied Medical Sciences, Al Azhar University-Gaza, P.O. Box 1277, Gaza strip, Palestine. Tel.: + 970 5995 60533; fax: + 970 8282 3180; e-mail: dr.allaham@hotmail.com, n.lahamm@alazhar.edu.ps
Materials and Methods

Study Setting

The Gaza strip in Palestine is a narrow piece of land of 365 km² along the eastern Mediterranean coast, just 45 km long and 10 km wide. The Gaza strip is considered one of the most overpopulated areas in the world, with a population of about 1.7 million inhabitants and a population density of 4,073 per km². There are only two burn units in the two main governmental hospitals - Al-Shifa (503 beds) and Nasser (277 beds) - that serve this large population of mostly middle and low socio-economic classes. Al-Shifa’s burn unit has 10 beds, while Nasser’s has only 5 beds. An average of 289 and 30 patients per month are seen at Al-Shifa and Nasser burn units respectively; most are treated as out-patients. In 2009, there were 26 deaths in Al-Shifa burn unit, while none were recorded at Nasser because only minor burn injuries are admitted to this burn unit. Complicated cases are usually referred to Al-Shifa, or referred abroad to Egypt and other countries.27

Study design and subject

This prospective study was conducted in the Medical Laboratory Sciences Department of the Islamic University-Gaza (IUG) and Balsam Hospital Laboratory, both in Gaza, over a six month period from October 2010 to March 2011. The study was carried out in accordance with the ethical standards established in the 1964 and 1975 Declarations of Helsinki, and the modifications thereafter. The protocol of this study was approved by the Ethical Committee of the IUG. All consecutive patients admitted with burns for in-hospital treatment during this period were included in the study. There were 118 burn patients, 94 from Al-Shifa hospital and 24 from Nasser hospital. All patients (or their guardians) were cooperative and provided an informed consent for participation in this study. Burn patients were given an explanation about the purpose of the study and assurance about the confidentiality of the information that they gave.

Interview Questionnaire

A questionnaire was designed and used to collect demographic and clinical data from the burn patients. The following data were obtained from all burn cases: admission and discharge dates, age, gender, occupation, cause and mode of burn, site/organ affected, total body surface area (TBSA) distribution of burns (%), degree of burns, surgical procedures and complications. All interviews were conducted face to face by one investigator.

Type of samples and sampling procedures

Different samples were collected from both burn units (Table I). These samples were taken from burn patients, environmental elements, and health care workers (HCWs) at the burn units:

<table>
<thead>
<tr>
<th>Sample type</th>
<th>Al-Shifa hospital</th>
<th>Nasser hospital</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swabs from patients</td>
<td>94</td>
<td>24</td>
<td>118</td>
</tr>
<tr>
<td>Swabs from HCWs</td>
<td>25</td>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>Environmental samples</td>
<td>72</td>
<td>25</td>
<td>97</td>
</tr>
<tr>
<td>Total</td>
<td>191</td>
<td>52</td>
<td>243</td>
</tr>
</tbody>
</table>

HCWs: health care workers.

Surface swabs were collected from burn wounds of all patients on the fourth day of admission, after removal of dressings and topical antimicrobial agents, and cleansing of the wound surface with 70% alcohol.28 For dry wounds, the swab was moistened with sterile normal saline before swabbing. Once collected, swabs were homogenized in 4-ml sterile normal saline.29

Sterile cotton swabs moistened in sterile normal saline were used to collect environmental samples from the floors, doors, sinks, incubators, fomites, gloves and other items in the burn unit. The area of the swabbed item was approximately 10 cm².28

The fingers of 28 HCWs who agreed to participate (25 from Al-Shifa and 3 from Nasser hospital), were rubbed for 1 minute in a sterile Petri plate containing 10 ml of sterile Tryptic Soy Broth (HiMedia, India). After 24 hours incubation at 35 °C, the plate content was subcultured on Blood and MacConkey agar media (HiMedia, India).31

Microbiological methods

The swabs were inoculated onto Stuart’s transport medium, blood, and MacConkey agars (HiMedia, India), using an aseptic streaking technique. The inoculated plates were incubated aerobically at 35-37 °C for 18-24 hours.28

Bacterial identification was based on standard culture and biochemical characteristics of isolates. Gram negative bacteria were identified by standard biochemical tests, however, oxidase tests were used to differentiate P. aeruginosa from Enterobacteriaceae. Gram positive bacteria were identified with the corresponding laboratory tests, including hemolysis on blood agar, Gram staining, catalase and coagulase.32 When no growth was observed on plates after 24 hours, they were re-incubated under the same conditions for a further 24 hours before being discarded and recorded as a negative result. API systems (BioMerieux, France) were used to identify bacterial isolates at the species level.33

Statistical analysis

The data was tabulated, encoded and statistically analyzed using the Statistical Package for the Social Sciences
(SPSS) version 15 software (IBM Corporation, Somers, NY). Discrete variables were expressed as percentages. Data comparison was carried out via analysis of Pearson Chi-square and Z tests, as appropriate. The level of statistical significance was set at $P < 0.05$.

**Results**

**Description of study population**

A total of 118 consecutive patients with burn injuries, admitted for in-hospital treatment, were included and investigated in this study. There were 94 (79.7%) patients from Al-Shifa burn unit and 24 (20.3%) from Nasser burn unit.

*Table II* shows the age and gender distribution of patients during the study period. The median age of burn patients was 4.5 years, with a total range from 1 to 74 years. Pediatric patients (<15 years) accounted for 72% (85 cases) and adult patients (≥15 years) were 28% (33 cases). There were 69 (58.5%) males and 49 (41.5%) females. The gender difference, however, did not reach statistical significance ($P = 0.07$). As shown in *Table II*, scald burns resulted in 78 (66.1%) cases, whereas open fire was responsible for the rest of cases (33.9%) ($P = 0.006$). The majority (77.6%) of scald burns occurred in pediatric patients under 15 years old, while the majority (63.6%) of open fire burns occurred in adult patients. The highest percentage of burns affected the torso area (39%), followed by lower limb (29.7%), and upper limb (17.8%), while the head and neck accounted for the lowest percentage (13.6%).

The median TBSA distribution of burns was 12%, with a range of 1-90%. The 10-19% TBSA category included the highest percentage of patients (47.5%) and was found to be statistically significant in comparison to other categories. 9/118 (7.6%) patients had TBSA burns ≥30%, 78% had second degree burns, while 22% had third degree burns. 68 surgical procedures were performed on 49 patients, 20 (40.8%) patients had one operation, and 29 (59.2%) patients had more than one operation. Surgical procedures included skin grafts, escharotomies, debridement, and plastic surgery. The majority of patients (69/118, 58.4%) did not require any surgical intervention, which was significantly higher ($P > 0.0001$) than the number of patients who did.

The median hospital stay for all patients studied was 11 days, with a range of 3–60 days. 78 (66.1%) patients were discharged within 14 days ($P > 0.0001$), 25.4% were discharged after about four weeks, and 10 (8.4%) could not be discharged before 30-60 days (*Table II*).

*Table II* - Overview of patients admitted for burn injuries during the study period

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Number (%)</th>
<th>Z-score</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Al Shifa</td>
<td>94 (79.7)*</td>
<td>6.34</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Nasser</td>
<td>24 (20.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 15 years</td>
<td>85 (72)*</td>
<td>4.72</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>≥ 15 years</td>
<td>33</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>69 (58.5)</td>
<td>1.83</td>
<td>0.07</td>
</tr>
<tr>
<td>Female</td>
<td>49 (41.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cause of burn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open fire</td>
<td>40 (39.9)</td>
<td>2.75</td>
<td>0.006</td>
</tr>
<tr>
<td>Scalds</td>
<td>78 (66.1)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site of burn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head &amp; neck</td>
<td>16 (13.6)</td>
<td>0.34</td>
<td>0.73</td>
</tr>
<tr>
<td>Upper limb</td>
<td>21 (17.8)</td>
<td>1.36</td>
<td>0.17</td>
</tr>
<tr>
<td>Lower limb</td>
<td>35 (29.7)</td>
<td>2.22</td>
<td>0.03</td>
</tr>
<tr>
<td>Trunk</td>
<td>46 (39.0)*</td>
<td>1.5</td>
<td>0.13</td>
</tr>
<tr>
<td>TBSA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-9%</td>
<td>38 (32.2)</td>
<td>1.66</td>
<td>0.1</td>
</tr>
<tr>
<td>10-19%</td>
<td>56 (47.5)*</td>
<td>2.59</td>
<td>0.001</td>
</tr>
<tr>
<td>20-29%</td>
<td>15 (12.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥ 30%</td>
<td>9 (7.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>69 (58.4)*</td>
<td>3.96</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>Once</td>
<td>20 (16.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Twice or more</td>
<td>29 (24.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of hospital stay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-14 days</td>
<td>78 (66.1)*</td>
<td>4.19</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>15-29 days</td>
<td>30 (25.4)</td>
<td>5.46</td>
<td></td>
</tr>
<tr>
<td>30-44 days</td>
<td>7 (5.9)</td>
<td>5.18</td>
<td></td>
</tr>
<tr>
<td>45-60 days</td>
<td>3 (2.5)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TBSA: total body surface area; *Statistically significant at 95% confidence interval (2-tailed), $P$ value < 0.05.
Types and frequency of microbial pathogens

The most commonly isolated microorganisms from burn patients in both hospitals were *Pseudomonas* spp. 27 (50%), followed by *Enterobacter* spp. 15 (27.8%), *Staphylococcus* spp. 5 (9.3%), and *Escherichia* spp. 3 (5.6%). *Citrobacter* spp., *Acinetobacter* spp., *Klebsiella* spp., and *Candida* spp. were the least isolated (1.9%) in both hospitals (Table III).

Table III shows that in the HCWs cultures, the highest bacterial genus isolated was *Pseudomonas* spp. 10 (32.3%), followed by *Staphylococcus* spp. 9 (29%), *Klebsiella* spp. and *Escherichia* spp. 3 (9.7%). *Enterobacter* spp. and *Serratia* spp. were each isolated from 6.5% of the total positive cultures. The genus streptococci was isolated from only one HCW (3.2%) out of the total number involved. In environmental samples (72 samples), the most commonly isolated bacteria was *Pseudomonas* spp. 9 (39.1%), followed by *Staphylococcus* spp. 9 (39.1%). *Pasteurella* spp. was isolated from 2 (8.7%) samples, whereas *Enterobacter* spp., *Acinetobacter* spp., and *Klebsiella* spp. represented the lowest isolated bacteria and each of them was found in only one sample, with a percentage equal to 4.3%.

Possible risk factors associated with wound colonization in burn patients

Various possible risk factors were investigated for their role in burn wound colonization in burn units. In looking at patient age, it was noted that there were higher positive cultures 42 (49.4%) in the <15 years age group (pediatric) in contrast to 13 (39.4%) in the ≥15 years age group (adult), although this difference did not reach statistical significance (P value = 0.328) (Table IV). Males had more positive cultures (50.7%) than female patients (40.8%), but again the difference was not statistically significant (P value = 0.288). Nasser burn unit revealed statistically significant higher positive cultures 17 (68.0%) than Al-Shifa burn unit 38 (40.9%) (P value = 0.016). As regards the burn site on the body, we found the torso to be the most commonly contaminated area (56.5%) compared to other sites, but again this higher contamination did not reach statistical significance (P value = 0.302). Analyzing the results concerning burn degree, it was clear that patients with third degree burns had more positive cultures (61.5%) than patients with second degree burns (42.4%). Yet, this difference was not statistically significant (P value = 0.084).

With regard to duration of hospitalization (admission days), the groups that were hospitalized for 30-44 days and 45-60 days were found to have higher positive cultures (71.4% and 66.7% respectively) than the groups that were hospitalized for only 1-14 days and 15-29 days (41.0% and 53.3% respectively). Again this difference did not reach statistical significance. Studying the TBSA risk factor, the groups with TBSA 20-29% and ≥30% yielded higher positive cultures than the groups with TBSA 1-9% and 10-19%. Yet again, there was no statistically significant difference between the types of TBSA. Looking at the surgical procedures (such as escharotomies, debridement, and skin grafts) as a risk factor, we found that patients who were operated on had significantly higher positive cultures (60.9%) than the patients who did not require surgery (37.5%) (P value = 0.013). Finally, with regard to skin

<table>
<thead>
<tr>
<th>Isolated pathogen</th>
<th>Patient samples (%)</th>
<th>HCWs samples (%)</th>
<th>Environmental samples (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>27 (50)**</td>
<td>10 (32.3)</td>
<td>9 (39.1)</td>
<td>46 (42.6)*</td>
</tr>
<tr>
<td><em>Staphylococcus</em> spp.</td>
<td>5 (9.3)</td>
<td>9 (29.0)</td>
<td>9 (39.1)</td>
<td>23 (21.3)*</td>
</tr>
<tr>
<td><em>Enterobacter</em> spp.</td>
<td>15 (27.8)**</td>
<td>2 (6.5)</td>
<td>1 (4.3)</td>
<td>18 (16.7)*</td>
</tr>
<tr>
<td><em>Escherichia</em> coli</td>
<td>3 (5.6)</td>
<td>3 (9.7)</td>
<td>0 (0.0)</td>
<td>6 (5.6)</td>
</tr>
<tr>
<td><em>Klebsiella</em> spp.</td>
<td>1 (1.9)</td>
<td>3 (9.7)</td>
<td>1 (4.3)</td>
<td>5 (4.6)</td>
</tr>
<tr>
<td><em>Acinetobacter</em> spp.</td>
<td>1 (1.9)</td>
<td>0 (0.0)</td>
<td>1 (4.3)</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td><em>Serratia</em> spp.</td>
<td>0 (0.0)</td>
<td>2 (6.5)</td>
<td>0 (0.0)</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td><em>Pasteurella</em> spp.</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>2 (8.7)</td>
<td>2 (1.9)</td>
</tr>
<tr>
<td><em>Proteus</em> spp.</td>
<td>0 (0.0)</td>
<td>1 (3.2)</td>
<td>0 (0.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td><em>Citrobacter</em> spp.</td>
<td>1 (1.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp.</td>
<td>0 (0.0)</td>
<td>1 (3.2)</td>
<td>0 (0.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td><em>Candida</em> spp.</td>
<td>1 (1.9)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>1 (0.9)</td>
</tr>
<tr>
<td>Total</td>
<td>54 (100)</td>
<td>31 (100)</td>
<td>23 (100)</td>
<td>108 (100)</td>
</tr>
</tbody>
</table>

*HCWs: health care workers.*

*Statistically significant compared to other microbial pathogens,*

**Statistically significant compared to HCWs and environmental isolates.*
grafts as a risk factor, it was clear from Table IV that patients with skin grafts had higher positive cultures in comparison to those without skin grafts, 84.2% and 30% respectively. The difference between the two groups was statistically significant where $P$ value < 0.001.

**Discussion**

This study was carried out on 118 burn patients admitted to the burn units of Al-Shifa and Nasser hospitals, and included examination of 97 environmental samples and 29 samples collected from HCWs in the Gaza strip, Palestine. The objective was to find and analyze possible risk factors for acquiring burns and burn colonization in our area. Analysis of age and gender in our study showed that there were far more pediatric patients (72%) than adult burn patients (28%). This may be due to children having more mobility inside houses and being less aware of dangers. Most of the child patients investigated were exposed to boiling water and fire at their homes. Some houses in the Gaza strip are small, inadequate, and overcrowded, with open-plan kitchens. This finding is in agreement with some reports, and not with others where more than half of the patients were adults. Our study had more males (58.5%) than females (41.5%), which may be attributed to the fact that males in the Gaza strip are responsible for most of the duties outside the home, which increases the risks of burn accidents. This is in agreement with similar reports and in contrast to other studies in which females were more frequently victims of burns than males. As regards the site of the burn accident on the patient’s body, it was found that the highest percentage of burns affected the torso (39%), followed by lower limb (29.7%), and upper limb (17.8%), while the head and neck accounted for the lowest percentage (13.6%). This may be because the most common burn etiology was hot liquid scalds, poured on torsos and lower limbs. Our findings were in contradiction to another study, in which the highest percentage of burns occurred to the head and neck. As regards the burn etiology, we observed that hot liquid (scalds) (66.1%), followed by fire (33.9%), were the main causes of burns. This may be explained by the

---

**Table IV - Association of possible risk factors and prevalence of colonization in burn patients**

<table>
<thead>
<tr>
<th>Possible risk factor</th>
<th>Culture results</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive (%)</td>
<td>Negative (%)</td>
</tr>
<tr>
<td><strong>Patient age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 15 years</td>
<td>42 (49.4)</td>
<td>43 (50.6)</td>
</tr>
<tr>
<td>≥ 15 years</td>
<td>13 (39.4)</td>
<td>20 (60.6)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>35 (50.7)</td>
<td>34 (49.3)</td>
</tr>
<tr>
<td>Female</td>
<td>20 (40.8)</td>
<td>29 (59.2)</td>
</tr>
<tr>
<td><strong>Hospital</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al Shifa</td>
<td>38 (40.9)</td>
<td>55 (59.1)</td>
</tr>
<tr>
<td>Nasser</td>
<td>17 (68.0)*</td>
<td>8 (32.0)</td>
</tr>
<tr>
<td><strong>Burn site</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head &amp; neck</td>
<td>5 (31.3)</td>
<td>11 (68.8)</td>
</tr>
<tr>
<td>Upper limb</td>
<td>9 (42.9)</td>
<td>12 (57.1)</td>
</tr>
<tr>
<td>Lower limb</td>
<td>15 (42.9)</td>
<td>20 (57.1)</td>
</tr>
<tr>
<td>Trunk</td>
<td>26 (56.5)</td>
<td>20 (43.5)</td>
</tr>
<tr>
<td><strong>Burn degree</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second-degree burn</td>
<td>39 (42.4)</td>
<td>53 (57.6)</td>
</tr>
<tr>
<td>Third-degree burn</td>
<td>16 (61.5)</td>
<td>10 (38.5)</td>
</tr>
<tr>
<td><strong>Duration of hospitalization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-14 days</td>
<td>32 (41.0)</td>
<td>46 (59.0)</td>
</tr>
<tr>
<td>15-29 days</td>
<td>16 (53.3)</td>
<td>14 (46.7)</td>
</tr>
<tr>
<td>30-44 days</td>
<td>5 (71.4)</td>
<td>2 (28.6)</td>
</tr>
<tr>
<td>45-60 days</td>
<td>2 (66.7)</td>
<td>1 (33.3)</td>
</tr>
<tr>
<td><strong>TBSA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-9%</td>
<td>13 (34.2)</td>
<td>25 (65.8)</td>
</tr>
<tr>
<td>10-19%</td>
<td>26 (46.4)</td>
<td>30 (53.6)</td>
</tr>
<tr>
<td>20-29%</td>
<td>10 (66.7)</td>
<td>5 (33.3)</td>
</tr>
<tr>
<td>≥ 30%</td>
<td>6 (66.7)</td>
<td>3 (33.3)</td>
</tr>
<tr>
<td><strong>Surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>28 (60.9)*</td>
<td>18 (39.1)</td>
</tr>
<tr>
<td>No</td>
<td>27 (37.5)</td>
<td>45 (62.5)</td>
</tr>
<tr>
<td><strong>Skin grafting</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>16 (84.2)*</td>
<td>3 (15.8)</td>
</tr>
<tr>
<td>No</td>
<td>39 (39.4)</td>
<td>60 (60.6)</td>
</tr>
</tbody>
</table>

*TBSA: total body surface area; *Statistical significance between items of the given risk factor.
fact that hot liquids are of high importance in our homes (where women and children spend most of their time), and are most frequently used in many aspects of daily life. This finding correlates with other studies around the world.\textsuperscript{6,27,42} Moreover, flame burns were significantly the most common in adult patients, which is in agreement with other reports.\textsuperscript{1,5,10,36,44} Our study also found that nearly 80% of patients had less than 20% TBSA burn, which is lower than that found in Turkey and Iran where the extent of TBSA was 31.2% and 40% respectively.\textsuperscript{35,47} and higher than that observed in Hong Kong\textsuperscript{7} where the median burn size was 6% TBSA. We also found that almost 66% of the patients stayed less than 14 days in the hospitals. It is worth mentioning that duration of hospitalization is an important measurement of overall burn care. Factors such as severity of burn, patient’s physiologic status, nursing care and surgical practice all affect outcomes, but longer stays in hospital result in greater risk of infection. The present study found that surgeries in the form of excision and skin grafting were performed on 59.2% of the admitted patients which is higher than that found in a recent study in Egypt.\textsuperscript{49}

With regard to the type of microorganisms isolated from samples taken from the burn patients, the environment and the HCWs the overall percentage of positive cultures from both burn units was 45.8%, which is in agreement with a study from Brazil.\textsuperscript{24} In environmental samples, 76.3% were negative cultures. This may be an indicator of the cleanliness of our burn units and the use of suitable disinfectants. The present study found that \textit{P. aeruginosa} and other \textit{Pseudomonas} spp. (50%) was the highest isolated bacteria from the burn patients, followed by \textit{E. cloacae} (27.8%), \textit{Staphylococcus} spp. (9.3%), and \textit{E. coli} (5.6%). \textit{Pseudomonas} spp. was the highest bacteria isolated from environmental and HCWs samples. Our results agreed with the findings of many studies around the world, showing the most common bacteria isolated to be \textit{Pseudomonas} (USA,\textsuperscript{46} Turkey,\textsuperscript{13} India,\textsuperscript{6,14} Korea,\textsuperscript{15} Iran,\textsuperscript{7} and Nigeria\textsuperscript{2}). The remarkably high prevalence of \textit{P. aeruginosa} in the burn wards may be due to the fact that this organism thrives in a moist environment and is resistant to most antibiotics. In contrast, there was a rise in the isolation rate of \textit{Acinetobacter} species as an important cause of nosocomial infection in burn. There are a number of factors which may contribute to this increase of \textit{Acinetobacter} species, such as its presence as a normal skin commensal and its ease of spreading - due to its multidrug resistant character - in a hospital setting.\textsuperscript{16} \textit{E. cloaca} was the highest Enterobacteriacea isolated from burn patients, followed by \textit{E. coli}. This is in agreement with the results of a study conducted in China,\textsuperscript{49} and in contrast to a report from Egypt.\textsuperscript{16} The third most present bacteria isolated (9.3%) was \textit{Staphylococcus} spp., which were mostly coagulase negative \textit{Staphylococci}. This is a relatively low incidence, which is consistent with many previous reports on burn wound colonization reviewing the pathogenicity of this organism.\textsuperscript{30} Anaerobic and/or fastidiously growing bacteria were not identified in this study because the isolation of these species requires special techniques and equipment that were not available. Other microbial contaminants, such as molds, which are beyond the scope of this study, were not investigated.

Regarding possible risk factors associated with burn colonization, there was no statistically significant relationship between the cultures and ages of the burn patients. However, there were higher positive cultures (49.4%) in the pediatric group than in the adult group (39.4%). This may be attributed to the mobility of children compared to adults. The children’s general curiosity and hyperactivity in moving around the burn unit environment would also make them more prone to colonization.

There was also no significant statistical difference between the results of patient cultures and their genders. Males were found to have more positive cultures (50.7%) than females (40.8%). This could be due to the higher number of male patients (58.5%) compared to female patients (41.5%). This was not in agreement with studies from Turkey and Egypt,\textsuperscript{8,22} in which gender was identified a risk factor. A statistically significant relationship was found between hospitals and patient cultures. Nasser burn unit revealed higher positive cultures (68.0%) than Al-Shifa (40.9%). This may be because Nasser burn unit is smaller than Al-Shifa with only a single room containing five beds. The Nasser unit is narrow and crowded with patients, workers and visitors, which may lead to more direct contact, and hence more chance of contamination. Moreover, there is no special bathroom for patients in the unit and they have to use the bathrooms of other departments. In our study, no statistically significant relationship was found between degree of burn and TBSA and patient cultures. Third degree burns had more positive cultures (61.5%) compared to second degree burns (42.4%). The groups with TBSA 20-29% and ≥ 30% had the highest positive cultures. The high burn percentage and degree increase the chance of colonization by pathogenic organisms. In recent studies, a significant association has been found between increased burn size and increased incidence of pathogenic organisms.\textsuperscript{41} They also reported that the incidence of invasive-cultures increased as burn size increased. In this study, the prevalence of burn colonization was increased with lengthened hospital stays. Patients who spent more than 30 days of hospitalization had the highest positive cultures, which is in agreement with a similar study.\textsuperscript{7} The results of this study showed a statistically significant relationship between surgical procedures and increased incidence of bacterial colonization. This may be because the protocol of early escharotomy, debridement and skin grafting has simultaneously the advantage of reducing the burn...
severity and the disadvantage of increasing the chance of contamination of burns. In a study performed recently in the operating theaters of Gaza hospitals, there was a moderate percentage of contamination, which may increase the risk factors for developing surgical-site infections in operated patients, including burn patients. Finally, these findings are in agreement with a study conducted in Brazil, where they concluded that one or more surgical procedures might also allow burn patients to be colonized with potentially pathogenic microorganisms.

Conclusion and recommendations

The study showed that the highest risk groups were pediatric patients and males. The main burn etiologic was hot liquid (scalding) especially in pediatric patients, while in adult patients the etiologic agent was open fire and flammable liquids. In burn wound colonization, the type of hospital and surgical procedures could be considered as possible risk factors for burn colonization. Our study showed that positive cultures were related to various patient factors, such as age, gender, burn degree, TBSA, and duration of hospitalization. The burn wound colonization rate in Nasser hospital was higher than in Al-Shifa hospital burn unit. These findings may assist future efforts toward the prevention of infections among burn patients in the Gaza strip, and may set the foundation for establishing a prevention plan to minimize burn colonization, which can lead to nosocomial infections in burn patients.

Finally, we recommend further studies to investigate other possible risk factors associated with burns and burn infections, and to examine for the presence of anaerobic and fastidious-growing bacteria and other microbial contaminants, such as fungi.

BIBLIOGRAPHY


Conflict of interest. The authors of this paper hereby declare that they have no conflict of interest and that no funding has been involved.

This paper was accepted on 13 April 2013