

Prediction of Risk Factors for Infection Occurrence in Patients with Burn Injury

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Abstract

Burn injuries have been recognized as a significant and major public health problem in economically developing countries. Long open wound areas containing necrotic tissue make burn patients more susceptible to infection. Nosocomial infection is a recognized public health problem world-wide with an important cause of burn mortality. So, this study aimed to predict risk factors for occurrence of infection in patients with burn injury. **Research design:** Analytical cross sectional study design used the following research question: What are risk factors for occurrence of infection in patients with burn injury? **Setting:** At selected Plastic, reconstructive and Burn Surgery Center- Ain Shams University. **Sample:** A purposive sample, 100 patients of who correspond to inclusion criteria and all available nurses (n=30). **Tools for data collection:** Four tools; Tool 1: patient's interview questionnaire. Tool 2: patients with burn parameters tool. Tool 3: observational checklist of nurses' performance, Tool 4: hospital's environment observational checklist. **Result:** The results indicate that there were a relation between patients with local signs of burn wound infection and site& degree of burn, total burned surface area and increased WBCs& body temperature. Nurses' practice was poor and there were a relation between burn wound dressing and proper use of personal protective equipment& local signs of burn wound infection. **Conclusion:** risk for burn wound infection increase with age, males are more affected than females and also increased length of hospital stay increase risk for infection where 3rd degree burns were more liable for wound infection and burn wound excision considered also risk for infection. **Recommendation:** Nurses need a specific teaching guideline and training about infection control measures to be used when dealing with burned patients to minimize risk for nosocomial infection.

Keywords: prediction, risk factors, infection, patient, burn injury.

Introduction

Burn injury is the most important health problem in many countries of the world. Burns are the fourth most common type of trauma worldwide, following traffic accidents, falls, and interpersonal violence⁽¹⁾ also pointed that burn is the fifth most common cause of unintentional injury deaths in the United States. Burn is often quoted as a major health problem⁽²⁾. Despite significant improvement in burn care, thermal injury still remains a major cause for morbidity and mortality. Progress in the management of burn patients continues at a rapid pace and has led to dramatic reduction in morbidity and mortality⁽³⁾.

Nosocomial infection (NI) is an essential cause of mortality in burns. It has been estimated that 75% of all death following thermal injuries are related to infections. The rate of nosocomial infection in burn patients are higher because of various factors like nature of burn injury itself, suppressed immune system of the patient, invasive diagnostic, and therapeutic procedures, prolonged hospital stay and overcrowding in burn wards⁽⁴⁾.

Burn has been defined as loss of continuity of body surface due to coagulation and destruction of the skin and/or underlying tissues. Burn wounds occur when there is contact between tissue and an energy source, such as heat, chemicals, electrical current, or radiation incompatible cell life⁽⁵⁾.

Severity of burn injury depends on the following factors: Extent, depth, and location of burn injury, age of patient, etiologic agents involved, presence of inhalation injury and coexisting injuries or preexisting illnesses. In this point, The American Burn Association has used these parameters to establish guidelines for the classification of burn severity. This classification creates 3 categories as minor, moderate and major burn injury⁽⁶⁾.

Burn patients are at a high risk for infection as a result of the nature of the burn injury itself, the immune-compromising effects of burns, prolonged hospital stays, and intensive diagnostic and therapeutic procedures⁽⁷⁾.

There are certain groups of people who are considered to be more susceptible to infections than others (high risk groups). These groups include neonates and the elderly; those with underlying disease such as diabetics, renal failure chronic obstructive pulmonary disease, blood disorders immunosuppressed (HTV/ATDS), malignancy, and transplants; those having therapy such as immunosuppressive drugs, antineoplastic agents (chemotherapy- radiotherapy), gastric acid suppressants, anti rejection drugs, steroids and antimicrobials drugs and those having treatments and procedure being carried out, especially invasive techniques such as surgery, end tracheal tubes, central venous and arterial catheterization and intravenous therapy⁽⁸⁾.

Hospital infection is one of the socio-medicine and economic problems in developing countries. It is

associated with high prevalence of infectious disease, length of hospitalization and death of patients, a related term is nosocomial infections (NI), which refers to iatrogenic illness due to or acquired during hospital care⁽⁷⁻⁹⁾.

Nursing staff form the largest section of the multidisciplinary burn team, responsible for implementing the daily continuous care of the burn patient. Severely burned patients can be very challenging to care for, requiring intensive support physically as well as emotionally. Burn nurses require a range of skills from management of acutely unwell critical care patients on mechanical ventilation and renal support, sophisticated wound dressing techniques, to emotional support to patients and their families⁽³⁾.

Aim of the study: The aim of this study was to predict risk factors for occurrence of infection in patients with burn injury.

Significance of the study:

Burn injuries in Egypt represent a major problem as compared with heart diseases, malignancy and road accidents. Studies reveal that about 0.1% of the total population is affected by major burns. Death rate is still high, about 30%. Of the saved; 36% need later reconstruction. Domestic causes are responsible for 75% of the injuries, the rest are caused by industrial and road a report was presented to the Ministry of Public Health in 1984 showing these facts.

Burn deaths are an important public health problem in a developing country like Egypt. The purpose of this study was to record and evaluate the causes and the magnitude of the fatal burn injuries retrospectively. An analysis of autopsy records revealed 106 (2.66%) cases of burn injuries among the total autopsies done over 5 years period (2006–2010) in the mortuary of Forensic Medicine Institute, Cairo. The majority of deaths (66.1%) occurred between 11 and 50 years of age group with a preponderance of males (67%). The flame burns were seen in 96.2% of the victims. The majority of burn incidents were accidental (55.7%) in nature followed by suicidal (22.6%) and homicidal (21.7%) deaths. The percentages of burns (TBSA) over 50% were observed in most of the cases (83%). Clear signs of vitality were found in 67% of the victims. The majority of deaths occurred within a week (82%) and most of the victims died from neurogenic shock (54.7%) followed by Septicemia & pneumonia (23.5%).

Research question:

What are risk factors for occurrence of infection in patients with burn injury?

SUBJECTS AND METHODS:

Research setting and design: The study was conducted at Plastic, Reconstructive and Burn Surgery Center, Ain Shams University Hospitals which provide a wide spectrum of care at delta region. Analytical cross sectional study design was utilized to achieve the study aim.

Sample: The present study included two groups of subjects:

1st group of patients: included adult burned patients (n=100) which Calculated by using (EPI) Programs Information of Version 7. Calculating sample size at confidence level 95% and error 5%.

2nd group of staff nurses: included all available staff nurses (n=30) who accepted to participate in the study.

The patients were selected based on the following criteria:

Inclusion criteria:

Adult patients with burn injuries, who admitted immediately after burn injury, age ranging from 21-60 years, able to communicate verbally and who accepted to participate in the study.

Data collection tools: Four tools were developed by researchers to achieve the study aim:

Tool 1: Patients interview questionnaire: Consists of three parts:

Part 1: Patient's demographic data as patients age, gender, marital status, level of education, occupation, duration of burn (minutes), and length of hospital stay.

Part 2: patient's Health Relevant Data. This part used to assess patient's past history of immunosuppressive drugs (4 items; underlying disease, presence of invasive devices, body temperature and range of motion exercise).

Part 3: Signs of infection. This part used to detect any abnormalities occurred as laboratory studies (5 items: RBCs, WBCs, platelets, hemoglobin and albumin) and presence of systemic burn wound infection (5 items: sepsis. Pneumonia, blood stream infection, catheter related infection and urinary tract infection).

The response to each item is on a 2-point scale "No/or Yes" depending on how much each item applies to respondents. These are scored "0" to "1" respectively, So that a higher score reflects a greater risk in terms of each domain. The item scores of each domain are totaled by simple summation and divided by the number of its items to compute a risk score for each domain ranging between 0 and 1.

Tool II: Burn parameters tool:

This tool aimed to explore patients, susceptibility for infection occurrence as causes of burn (4 items),

degree of burn (3 items), and site of burns (8 items), extent of total body surface area burned (3 items), scene of burn injury (2 items), method of feeding used and type of dressing. The response to each item is on a 2- point scale "No/or Yes" depending on how much each item applies to respondents.

Tool III: Observational Checklist of Nurses Performance: Consists of two parts:

Part 1: Personal characteristics of study nurses as age, gender, marital status, level of education, years of experiences worked in burn unit.

Part 2: Observational checklist for nurses performance at the study setting aimed to explore nurses practice that increase risk for infection as hand washing(22 items), and proper use of personal protective equipment(35 items). Observation checklist scored on the basis of yes, no and not applicable for each activity. Yes scored (one point), no scored (zero), and not applicable omitted from the calculation.

Tool IV: Hospital Environment Observational Checklist:

This tool aimed to explore environmental factors that increase risk for infection as general environment (42 items). Linen management (3 items).waste management (27 items) and visitors, policy (3 items).Observation checklist scored on the basis of yes, no and not applicable for each activity. Yes scored (one point), no scored (zero), and not applicable omitted from the calculation.

Scoring system for tool III & IV: poor:<50% (minimum) Fair:50%-<75%(median) Good:≥ 75%(maximum)

Ethical considerations:

- Ethical approval was obtained from the Research ethical Committee of Nursing Faculty, Ain Shams University.
- Participation in the research was voluntary, confidentiality of the collected data was maintained and privacy of the study sample was assured.
- Official permission was obtained from the director of the hospital at the study setting after explanation of the purpose of the study.
- A formed consent was obtained from the respondents (patients and nurses) before their inclusion in the study.
- Nature and aim of the study was explained to each member of the participants. The data were collected throughout the assessment tools.

Methods:

- Tools of the study were developed by the researchers after reviews of related literature.
- Content validity of tools was done by 5 expertises in the field of the study that had experience in developing such instruments and the necessary modification was done.
- Tools were tested for its reliability by cronbach, s alpha to measure its internal consistency to evaluate how well the tools consistency measure what they are designed. It was (0.92) for first tool, (0.87) for second tool, (0.83) for third tool and (0.82) for fourth tool.
- A pilot study was carried out on10% of total number of sample in plastic, Reconstructive and Burn surgery center- Ain Shams University Hospital, to evaluate ambiguity, clarity and applicability of the tools and the approximate time needed for the interview. Accordingly, the necessary corrections and adjustments were done.
- All patients included in this study were interviewed individually to collect the necessary data using study tool I&tool II and medical records were reviewed regularly.
- The researchers managed to interview from two to three patients daily, laboratory investigations were taken on admission then weekly until third week and body temperature were measured daily. Also patients were assessed for local signs of burn wound infection day after day during dressing time at morning shift.
- An interview schedule was used for data collection and observed individually by the researchers using tool III.
- The researchers managed to observe from one to two nurses daily in the morning and afternoon shift using tool III where time taken to observe each nurse ranged from 15-20 minutes.
- Hospital environment was assessed using tool IV to assess general environment, linen management, waste management and visitor's policy three times through data collection period. The first assessment at the beginning of the month, the second assessment at the second month and the third assessment at the end of the third month to monitor if there is difference regarding time of observation.
- The study was started at Jan 2016 until Feb 2017; data collection covered a period of 6 months.

Statistical analysis:

Data was analyzed using SPSS (Statistical Package for Social Science) version 16.0; Descriptive statistics was done using numbers, percentages, arithmetic mean, standard deviation as well as medians. Analysis of data was conducted using: Mont Carlo exact probability, Fisher exact probability, independent samples t-test and One Way ANOVA. The P value of<0.05 indicate a significant result while, P value >0.05 indicates a non-significant result.

Results:

Table 1: Relation between local signs of burn wound infection and demographic characteristics of studied patients (n=100)

Patient demographic data	Local signs of burn wound infection				MCP
	YES		NO		
	NO	%	NO	%	
Patient age (years)					
20-	1	2.7	36	97.3	*0.001
30-	3	10.3	26	89.7	
40-	24	82.8	5	17.2	
50-60	0	0.0	5	100.0	
Gender					
Male	25	36.8	43	63.2	!*0.004
Female	3	9.4	29	90.6	
Marital status					
Single	1	4.3	22	95.5	!*0.004
Married	27	35.1	50	64.9	
Education					
Illiterate	8	61.5	5	38.5	*0.021
Read and write	8	32.0	17	68.0	
Secondary education	10	19.2	42	80.8	
Baccalaureate	2	20.0	8	80.0	
Occupation					
Working	28	35.9	50	64.1	!*0.001
Not working	0	0.0	22	100.0	
Length of hospital stay(days)					
1-	2	8.7	21	91.3	!*0.001
5-	1	1.9	51	98.1	
30-	25	100.0	0	0.0	

MCP: Mont Carlo exact probability;! *p<0.05significant Fisher exact probability

Table 1: Relation between local signs of burn wound infection and demographic characteristics of studied patients. This table illustrates that there was statistically significant difference between local signs of infection and age group, middle age group had higher percent than older adults(p=0.001). There was statistically significant difference in local signs of infection between male and female (p=0.001) and also married and single (p=0.001) A percent of patients in secondary education was significantly higher than baccalaureate education (p=0.021). Patients who work had local signs of burn wound infection higher than those who didn't work (p=0.001). For length of hospital stay, there was statistically significant differences between patients who stay more than one month and less than one in hospital(p=0.001).

Table 2: Relation between local signs of burned wound infection and patient's with burn parameters. (n=100)

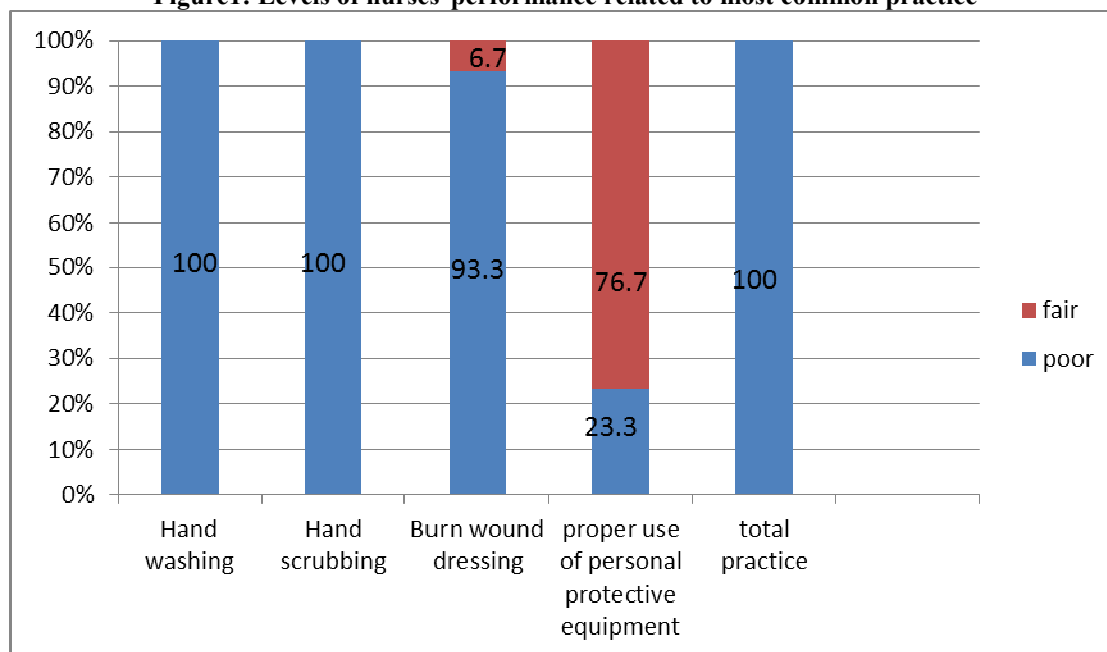
Burn parameters		Local signs of burn wound infection				MCP
		Yes		No		
		No	%	No	%	
Duration of burn (minute)	1	4	14.3	9	12.5	*0.003
	2	13	46.4	10	13.9	
	3	4	14.3	12	16.7	
	4	0	0.0	15	20.8	
	5-7	7	25.0	26	36.1	
Cause of burns	Thermal	27	96.4	69	95.8	0.806
	Electrical	1	3.6	2	2.8	
	Chemical	0	0.0	1	1.4	
Degree of burn	2nd	1	3.6	44	61.1	*0.001
	3rd	27	96.4	5	6.9	
	Both	0	0.0	23	31.9	
Head and neck burn	Yes	3	10.7	15	20.8	!0.236
	No	25	89.3	57	79.2	
Anterior trunk burn	Yes	21	75.0	22	30.6	!*0.001
	No	7	25.0	50	69.4	
Posterior trunk burn	Yes	6	21.4	11	15.3	!0.462
	No	22	78.6	61	84.7	
Right arm burn	Yes	18	64.3	36	50.0	!0.198
	No	10	35.7	36	50.0	
Left arm burn	Yes	16	57.1	27	37.5	!0.075
	No	12	42.9	45	62.5	
Right leg burn	Yes	16	57.1	30	41.7	!0.163
	No	12	42.9	42	58.3	
Left leg burn	Yes	15	53.6	29	40.3	!0.229
	No	13	46.4	43	59.7	
Genitalia burn	Yes	0	0.0	1	1.4	!0.531
	No	28	100.0	71	98.6	
Extent of total body surface area burned (%)	1-	0	0.0	8	11.1	*0.001
	10-	0	0.0	21	29.2	
	20-	0	0.0	36	50.0	
	>=30	28	100.0	7	9.7	
Scene of burn	Open	20	71.4	7	9.7	!*0.001
	Closed	8	28.6	65	90.3	
Inhalation injury	No	28	100.0	72	100.0	-
Burn wound excision	Yes	23	82.1	70	97.2	!*0.008
	No	5	17.9	2	2.8	
Escharotomy	Yes	3	10.7	4	5.6	!0.364
	No	25	89.3	68	94.4	
Type of dressing	-Closed dressing	25	89.3	68	94.4	0.389
	-Open dressing	0	0.0	1	1.4	
	-Both	3	10.7	3	4.2	
Method of feeding	oral	28	100.0	72	100.0	-

MCP: Mont Carlo exact probability Fisher exact probability! *p<0.05(significant)

Table 2: Show relation between local signs of burn wound infection and burn parameters. There were no statistically significant difference between local signs of infection and cause of burn (p=0.806). While there were statistically significant differences between patients who exposed to burning agents 2 min in duration and 4 min (p=0.003). 3rd degree of burn had a higher percentage of local signs of infection than other degree (p=0.001). Moreover local signs of burn wound infection in anterior trunk burn had a statistical significant differences than other sites of burn (p=0.001). Also local signs of burn wound infection in patients with TBSA>=30% were significantly higher than those >30% TBSA (P=0.001). Open scene of burn had higher local signs of burn wound infection than those occurred in closed scene (p=0.001). Local signs of burn wound

infection in patients who had burn wound excision were significantly higher than those who didn't have ($p=0.008$). There were no statistically significant differences between local signs of infection and both escharotomy ($p=0.364$) and type of dressing ($p=0.389$).

Figure1: Levels of nurses' performance related to most common practice



Poor: score%<50%(Minimum) Fair:%50%-<75%(Median) Good: score %≥75%(Maximum)

Figure (1): reflecting level of nurses' performance related to most common practices (n=30). Their performance regarding hand washing, scrubbing were poor(100%), while their performance concerning burn wound dressing were relatively fair(6.7%) with mean of 17.1 ± 3.0 , otherwise their performance regarding proper use of personal protective equipment were fair(76.7%) with mean of 20.5 ± 2.7

Table 3: Total observation of hospital's environment practices

Item	Minimum	Maximum	Median
General environment	27.00	28.00	27.00
Linen management	3.00	3.00	3.00
Waste management	11.00	11.00	11.00
Visitor policy	2.00	2.00	2.00

Table 3: present total observation of hospital's environment practices. Concerning the general environment, the score was ranged from twenty seven to twenty eight with an average of twenty seven out of seventy nine. As regard to linen management, the score was ranged from three to three with an average score three out of thirteen. Also, with waste management the score was ranged from eleven to eleven with an average score three out of twenty seven. The score ranged from two to two with an average score two out of thirteen with visitors' policy. Where it can carry a great risk for hospital acquired infection.

Table4: Relation between total practice of both burn wound dressing& proper use of personal protective equipment (PPE) and local signs of burn wound

Item		Practice total		t/p		
		Mean	SD			
Local signs of burn wound infection	Yes	Burn wound dressing	Poor fair	45.25 60.00	7.26 0.0	3.1 *(0.035)
		Proper use of personal protective equipment	Poor fair	42.75 46.71	11.87 6.78	0.98 (0.527)
	No	Burn wound dressing	Poor fair	49.75 71.00	11.59 0.0	2.5 *(0.042)
		Proper use of personal protective equipment	Poor fair	48.33 54.00	6.35 15.47	2.0 *(0.047)

Table 4: Show relation between practice of both burn wound dressing & proper use of personal protective equipment (PPE) and local signs of burn wound infection. There was a significant relationship between poor and fair burn wound dressing among patients with local signs of burn wound infection ($p=0.035$) and also there was no significant relationship between poor and fair proper use of personal protective equipment

among patients with local signs of burn wound infection ($p=0.527$). Concerning patients who haven't local signs of infection, a significant relationship existed between poor and fair burn wound dressing ($p=0.042$) and also a significant relationship was obvious between poor and fair proper use of personal protective equipment ($p=0.047$).

Discussion

Burn wound infections are one of the most important and potentially serious complications that occur following injury. Patients with areas of unexcised deep partial-thickness or full thickness burn wound are at risk of an invasive infection. Burn wound sepsis was predominantly due to invasive wound infection **Ghassan(2011)**⁽⁴⁾

The present study showed that, there was a significant relation between age group 40-50 years and local signs of burn wound infection. It should be pointed that such a result was observed in a previous study carried out by **Wai-sun & Ying (2001)**⁽¹⁵⁾

In respect to gender, this study shows that males are significantly prone to occurrence of burn wound infections than females. This is accordance with **Ghassan(2011)** who reported that males are more liable to burn wound infection than females⁽⁴⁾. In contradiction with similar study from **Panjeshahin & Lari (2001)** illustrate that females were the victims of burns injuries more than males⁽¹⁶⁾

Regarding to marital status, this study revealed that married patients were prone to infection greater than singles. This may be related to the fact that more than two third were in the age group between 40-50 years, and usually most males at that age are married according to culture of Egyptian society. This may indicate that marriage problems may lead to burn injury either by suicide ideas or loss of concentration when contacting with dangerous items as results of increasing work load. On the other hand, **Bayumi (2006)** found that single adults are most commonly affected with burn injury than married ones⁽¹⁷⁾.

As for education, the present study showed a significant relation between illiterate patients and wound infection. This may be related to insufficient knowledge about causes, sources of infection and how to follow aseptic technique to keep their wound clean and aseptis, This result was in the contradict with **Abdel-Hamid (2009)** who stated that no significant difference was found between levels of education and infection occurrence⁽¹⁸⁾.

Regarding occupation above one third of patient with local signs of burn wound infection was working. This may be due to the majority of patients were males. This result in the same point with **Abdel-Hamid (2009)** who found that the majority of patients with burn injury were workers⁽¹⁸⁾

This study revealed that there was a significant relation between increased length of hospital stay & burn wound infection. This may due to that infected wound need a prolonged period of recovery both in the acute and rehabilitative phases. This was in accordance with two studies **Oncul&Ulkur (2009)** and **Ghassan (2011)**^(4,7).

There was no statistical difference existed between cause of burn and local signs of burn wound infection in the present study. This may be that there are certain high risk groups are more susceptible for wound infection whatever the cause of burn. This was congruent with **Nasser&Maher(2009)** who stated that thermal injuries correlated to burn wound infection⁽¹⁹⁾.

As regard to burn degree, the present study showed a significant relation between third degree burns and wound infection. This was in accordance with **Komolafe&James (2003)** and **Oncul & Ulkur (2009)** who reported that nearly half of patients with 3rd degree burn develop burn wound infection in comparison to 2nd degree burn^(7,20).

In this study there was a significant relation between burn in anterior trunk and wound infection. This was agreed with **Ghassan(2011)** who reported that the highest percentage of burns affected in the trunk region showed burn wound infection⁽⁴⁾. In contrast with another study by **Singh&Goyal(2003)** illustrated that the highest percentage of burn happened in head and neck, followed by trunk show infection⁽²¹⁾.

The current study showed a statistically significant relation between total surface areas burned $\geq 30\%$ and wound infection where this agreed with **Legbo&Ntia(2008)** who stated that incidence of burn wound infection was low for patients with $<30\%$ TBSA burn injuries⁽²²⁾.

The current study showed statistical significant difference between burn wound excision and wound infection. This may be related to as more burn wound excision, as more suppressed immune system, invasive diagnostic and therapeutic procedure; all these factors leads to wound infection. This was in accordance with study conducted in Brazil by **Soares&Macedo(2006)**. Who concluded that one or more wound excision and debridement might also allow burn patient to be colonized with multi resistant organisms⁽²³⁾.

In relation to nurses performance of hand washing the study showed poor performance, this might be due to time limitation, workload and work pace in agreement with **Asare&Christabel(2009)** reported about the effect of work pace on non-compliance with proper hand washing⁽²⁴⁾. On the contrary, **Parmeggiani&Abbate(2010)**, in Italy demonstrated that most health care worker complied with proper hand hygiene measures⁽²⁵⁾.

The current study showed that nurses practice regarding hand scrubbing before burn wound dressing was poor. This was supported by **Creedon(2005)** who stated that hand scrubbing performance by nurses was unsatisfactory and implies a high risk for hospital acquired infection ⁽²⁶⁾.

Regarding burn dressing, nurses' performance was poor which can increase risk for burn wound infection. In accordance with **Ashry(2008)** who reported inadequate burn wound dressing in burn unit by nurses where aseptic technique are not strictly followed ⁽²⁷⁾.

Nurses' performance regarding proper use of personal protective equipment was fair in this study, it may be due to availability of supplies and nature of work. This congruent with **Flores&pevalin(2006)** who reported that proper use of personal protective barriers by nurses were poor ⁽²⁸⁾.

In the current study there was a statistical significant relationship among burn wound dressing and local signs of burn wound infection ($p=0.035$) in accordance with **Arshy(2008)** who revealed that burn wound dressing is an important risk factor for wound infection ⁽²⁷⁾. And also there was no significant relationship between proper use of personal protective equipment and local signs of burn wound infection ($p=0.527$). This result agreed with **Ghassan(2011)**, where the majority of health care workers complained to wear personal proactive equipment ⁽⁴⁾.

Conclusion

Based on finding of the current study, it can be concluded that risk for burn wound infection increase with age, males are more affected than females and also increased length of hospital stay increase risk for infection where 3rd degree burns were more liable for wound infection and burn wound excision considered also risk for infection. Furthermore nurses, performance concerning burn wound dressing and proper use of personal protective equipment play a pivotal role in nosocomial infection. Hospital environment practices as housekeeping process, waste and linen management also play an important role to minimize risk for infection.

The current study projects the following recommendations:

- Application of infection control program in burn unit.
- Nurses' compliance with infection control guidelines should be emphasized.
- The isolation care unit should be available for the infected patients and the patient with high TBSA% is essential in the prevention of hospital acquired infection.
- Nursing staff should be well trained through in service training program.

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