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Original article

A bacteriological study on burn wound infections with implementation of the available infection control measures at the Burn Unit, Tanta University Hospital

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ABSTRACT

Background: Burn wound infections represent a major health problem in hospitals as they increase the morbidity and mortality rates. The emergence of multidrug resistant (MDR) organisms in burn units has made the treatment of these infected wounds more difficult. **Methods:** We did microbiological isolation, identification, and antibiotic susceptibility testing for bacterial isolates in the burn unit and implemented infection control measures. **Results:** In our study, we isolated 50 (50%) *Stapylococcus.aureus (Staph. aureus)* isolates, 28 (28%) MDR *Pseudomonas.aeruginosa* (*P. aeruginosa)* isolates. 8 (8%) isolates were *non MDR P. aeruginosa*, 8 (8%) of the isolates were *MDR Klebsiella*, 2 (2%) were non-*MDR*, and 4(4%) were *E. coli* isolates. The percentage of MDR among *P. aeruginosa* isolates was 77.7%, and the MDR *Klebsiella* were 80 % of the *Klebsiella* isolates. **Conclusion:** The most common bacterial cause of burn wound infection in the burn unit at Tanta University Hospital was *Staph. aureus*, followed by *P. aeruginosa*. Multi drug resistant *P. aeruginosa* and MDR *Klebsiella* play a role in burn wound infections in the burn unit at Tanta University Hospital.

Introduction

Burn wounds can be classified into six separate groups based on the mechanism of injury: scalds, contact burns, fire, chemical, electrical, and radiation [1]. The most common type of burn wound is a scald [2]. There are four degrees for the burn wounds: The first-degree burn affects the epidermis; it is known as a superficial thickness burn and is clinically distinguished by erythema and the absence of blisters. The second-degree burn descends to affect the superficial dermis; it is called a superficial partial-thickness burn, and it is clinically characterized by blisters and severe pain. The third-degree burn descends to affect the deep dermis; it is called a "deep partial thickness burn," and it is presented clinically with a whiter appearance. The fourth degree burn spreads to the dermis, muscles, and bones; it is referred to as a full thickness burn and is clinically manifested as hard eschar with no sensation [3].

Colonization of the burn wound is defined as the presence of bacteria on the wound's surface but less than10^5 colony-forming units (CFU) with no evident surrounding erythema or cellulitis, although deterioration of the wound surface can be observed, while burn wound infection is defined as

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the presence of high concentrations (> 10^5 organisms/g of tissue) of bacteria in the burn wound [4].

Sources of microorganisms may be from the patient's own endogenous flora or from exogenous sources in the environment and from health care personnel. The typical burn wound is initially colonized mainly with Gram-positive organisms, which are quickly replaced by antibiotic-susceptible Gram-negative organisms, usually within a week of the burn injury. If wound closure is delayed and the patient becomes infected, requiring treatment with broad-spectrum antibiotics, these florae may be replaced by yeast, fungi, and antibiotic-resistant bacteria, so early diagnosis and proper treatment can prevent infection. Modes of transmission of bacterial wound infections include contact and droplets [5].

Gram-positive bacteria such as methicillin-resistant *Staphylococcus aureus (MRSA), Staphylococcus aureus*, beta-hemolytic *streptococci*, coagulase-negative *Staphylococci*, and vancomycin-resistant enterococci can cause bacterial burn wound infections. Gram-negative bacteria play a role in bacterial burn wound infections such as *Escherichia coli (E.coli), Klebsiella*, and *Pseudomonas aeruginosa (P. aeruginosa)* [6- 8].

Microbiological diagnosis of bacterial wound infection in burn units is very important, as early cultures should be negative or have low counts of sensitive Gram-positive organisms. If these early cultures have high counts or are positive, it suggests early contamination of the burn wound. If invasive burn wound infection is suspected, wound culture and histologic analysis can aid in the confirmation of the diagnosis; they also aid in empiric antimicrobial therapy in the burn unit. Burn wound infection with resistant organisms may be a predictor of impending invasive burn wound infection; burn wound colony counts $>10^6$ suggest a high risk of infectious complications and graft failure; and burn wound culture results may aid in the evaluation of nosocomial spread of organisms and guide infection control practice [9].

Burn wound infections are the most common infections in the burn unit; blood stream infection occurs more frequently in burn patients than in any other patient population due to hematogenous seeding of catheters, which frequently occurs in patients with colonized or infected burn wounds, and the often necessary placement of catheters near or through the wound in patients with extensive injuries; pneumonia and urinary tract infection can also occur in the burn unit [10, 11].

The occurrence of infection and sepsis on top of burns is considered an important cause of increasing mortality and morbidity in burn units. The prevention and control of infectious diseases among burned patients present a specialized problem, as the environment in burn units can become contaminated with resistant organisms [12].

Our aim in this study was to isolate and identify the causative bacteria from infected burn wounds and to implement the available infection control measures at the burn unit, aiming to decrease the rate of infections in these burn wounds.

Patients and Methods

Patients: The present study was carried out in the Medical Microbiology and Immunology Department and Burn Unit of Surgery Department, Faculty of Medicine, Tanta University, and was carried out on 100 bacterial isolates, which were isolated from patients admitted burning wards of Tanta University Hospitals during the period of the research, which was from February to august, 2022. Ethical approval for this study was provided by the ethics and research committee of the Faculty of Medicine at Tanta University. The inclusion criteria were patients suspected clinically to have burn wound infections and patients admitted to the hospital for a duration of not less than 48 hours to be one of Healthcare associated infections which defined as those infections acquired in hospital or healthcare service unit that first appear 48h or more after hospital admission. The exclusion criteria were patients admitted to the hospital for a duration less than 48 hours, patients under antibiotic therapy, and any fungal isolates.

Methods [13]:

- Burn wound swab samples were taken from the wound of each patient with the following precautions: we removed the dressing and any topical agents at first with a gauze soaked in sterile saline, we moistened the swabs with sterile saline, we swabbed an area measuring 4 cm^2 using two sterile swab sticks under complete aseptic precautions, they were labelled, and they were transported as soon as possible to the laboratory in the Medical Microbiology and Immunology Department.

- We cultured one swab on blood agar, and the second swab on MacConkey's agar, also we used mannitol salt agar culture for differentiation between *Staph.aureus* and coagulase negative *Staph*. And the colonies were identified by their morphology. Gram films, and biochemical reactions (coagulase test, oxidase test, catalase test, and sugar fermentation test). Gram stain smears were done after the culture to avoid contamination of the samples and examined microscopically.
- MRSA identification among *Staphylococcal isolates*: we used an oxacillin disc (1 µg) by the disc diffusion method, and we interpreted it as the following: a zone of inhibition of 13 mm indicated that the isolate was sensitive, and a zone of inhibition of >10 mm indicated that the isolate was resistant, i.e., we also used MRSA cefoxitin disc diffusion test: we interpreted it by using breakpoints (resistant or susceptible) of ≤19 mm/≥20 mm respectively.
- Gram negative isolates were tested against imipenem (10µg), amikacin (30 µg), ceftazidime (30 µg), ciprofloxacin (30 µg), aztreonam (30 µg), amoxicillin clavulanic acid (20\10 µg), sulfamethoxazole trimethoprim (1.25\23.75 µg), cefoxitin (30 µg), colistin (10 µg), levofloxacin (5 µg), cefotaxime (30 µg), meropenem (10 µg), and gentamicin (10 µg) , cefepime (30 µg), cefuroxime (30 µg). MDR among gram negative isolates was defined as resistance to at least one antimicrobial agent in three or even more antimicrobial classes.

Infection control measures which were implemented and followed up in the burn unit [according to CDC Recommendations [14]**]**

- Wound care: We assessed the wound at each dressing change for changes in the character, odour, or amount of wound drainage; we used a strict aseptic technique during handling the open wound and dressing materials; if the wound has necrotic materials, we used a debriding dressing .If an invasive infection was present, surgical excision of the infected wound was done, as well as suitable systemic antimicrobial therapy was given. Intravascular catheter insertion site care included non-occlusive povidone iodine dressings that were changed every 2 to 4 hours, depending on the degree of surrounding wound contamination, and catheters inserted into unburned skin whenever possible.
- Barrier technique**:** We checked the used PPE and we applied the contact precautions in the burn unit.
- We checked the application of standard precautions (hand hygiene- PPE -proper cleaning and disinfection – proper waste disposal)
- The use of antimicrobial agents: it was according to the results of culture and sensitivity. Empiric antimicrobial therapy to treat fever strongly avoided because burn patients often have fever due to the systemic inflammatory response to burn injury. Prophylactic penicillin therapy in the early post-burn period was given to paediatric patients colonized with group A beta-haemolytic *Streptococci*.

Sample size calculation

The sample size and power analysis was calculated using Epi-Info software statistical package created by World Health organization and center for Disease Control and Prevention, Atlanta, Georgia, USA version 2002. The criteria used for sample size calculation were as follows: 95% confidence limit, 86% power of the study, the sample size was found at N = 100 sites

Results

Our study was carried out on 100 bacterial isolates, they were isolated from wound surface swabs by conventional microbiological methods, and they were isolated from burn wounds suspected clinically to have infection. Our results were as follows: We isolated 50 (50%) *Staph. aureus* isolates, 28 (28%) MDR *P. aeruginosa* isolates. 8 (8%) isolates were non MDR *P. aeruginosa*, 8 (8%) isolates were MDR *Klebsiella*, 2 (2%) were non-*MDR Klebsiella* isolates, and 4(4%) were *E. coli* isolate, as shown in **figure (1)**. The MDR was detected according to the results of antibiotic sensitivity testing: 28 isolates (77.7%) out of 36 *P. aeruginosa* isolates were MDR **(Figure 2).** The percentage of MDR among *Klebsiella* isolates was 80% **(Figure 3)**. We did not detect MRSA among *Staphylococcus.aureus* isolates.

Figure 1. The percentage of the isolated bacteria during the study.

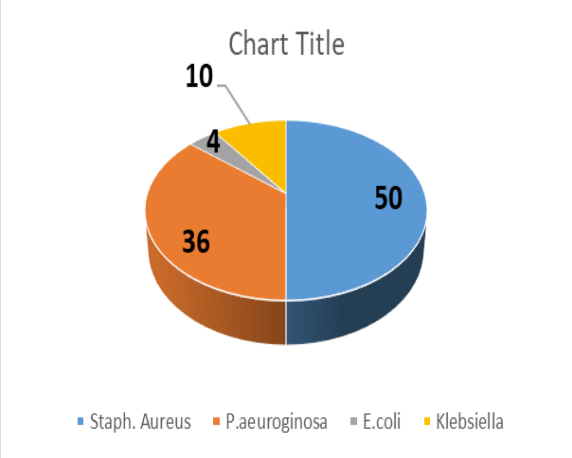


Figure 2. The percentage of the isolated *MDR P. aeruginosa* during the study.

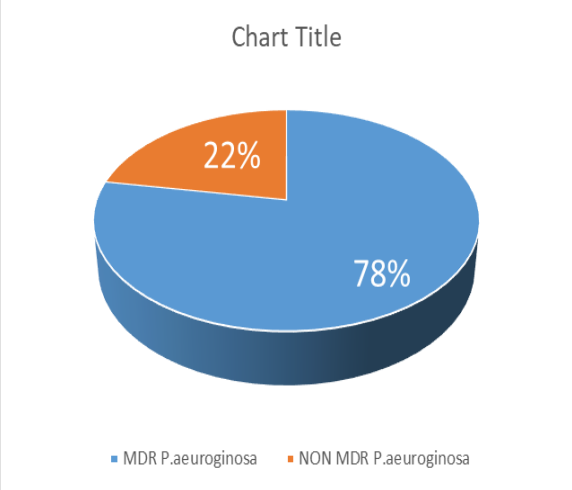
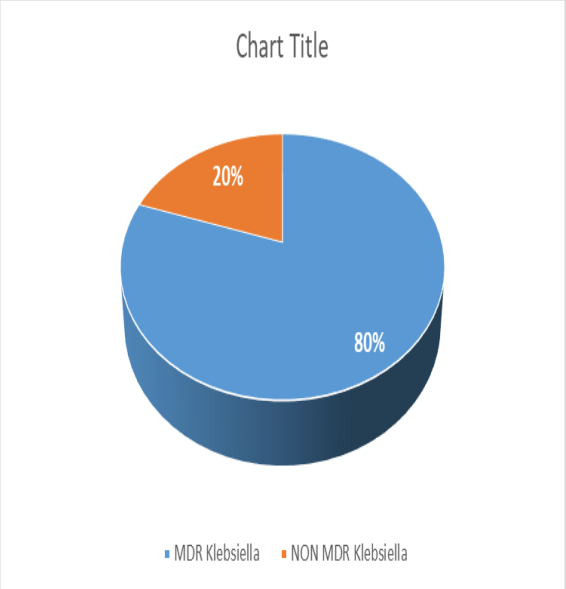


Figure 3. The percentage of the isolated *MDR Klebsiella* during the study.



Discussion

In our study, we detected that the predominant bacteria that was isolated from the infected burn wounds was *Staphylococcus aureus*, which represented 50 (50%) out of 100 isolates. This agreed with **Yin et al.** 2020 [15], who also detected that the most common isolated organism in their study from infected burn wounds was *Staphylococcus aureus* and this bacterial source is usually endogenous source.

We isolated 36 (36%) isolates of *P. aeruginosa* out of the 100 isolates studied, so it has been considered as the second most common isolated bacteria in our study. This result agreed with **Ournier et al.** 2015 [16], and **Que et al.** 2011 [17], the source of these *P. aeruginosa* was from the mattresses, the contaminated tubing used for irrigation of the patients, and the hydrotherapy of the burn patients [18].

We detected MDR *P. aeruginosa* in our study, which represented 77.7% of the isolated *P. aeruginosa*. The presence of MDR *P. aeruginosa* in burn units was also detected by **Montero et al.** 2013 [19], who detected that the most common cause of this MDR was the abuse of antimicrobials.

We detected multidrug resistance among Klebsiella isolates in our study, which was represented 80 % of the isolated Klebsiella, and Naz et al., 2015 [20] also detected multidrug resistant Klebsiella among their isolates from the infected burn wounds , also they found that , Staphylococcus aureus (33.8%) was found to be the most common bacteria isolated, followed by Pseudomonas spp. (18.46%), Acinetobacter baumanii (15.38%), Klebsiella pneumoniae (13.85%), Escherichia coli (8.46%), and Proteus mirabilis (4.42%), which were very close results to our results. We did not detect MRSA in our study; on the other hand, perween et al., 2015 [21] and Singh et al., 2017 [22] detected MRSA in their studies. Joan et al., 2004 [23] detected that the application of standard precautions together with the contact precautions were very helpful in reduction of infections at the burn units , so we implanted infection control measures aiming for reducing the rates of infections on subsequent studies at the burn units .

Conclusion

The most common bacterial cause of burn wound infection in the burn unit at Tanta University Hospital was *Staphylococcus aureus*, followed by

Pseudomonas aeurogenosa. Multi drug resistant *P. aeruginosa* and MDR *Klebsiella* play a role in burn wound infection in the burn unit at Tanta University Hospital.

Conflict of interests

The authors state that they have no competing interests.

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Compliance with ethics requirements

All procedures were carried out in accordance with the responsible committee on human experimentation's ethical standards (institutional and national).

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