The effect of delayed admission in burn centers on wound contamination and infection rates

Yanık merkezlerine gecikmiş erişimin yara kontaminasyon ve enfeksiyonuna etkisi

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AMAÇ

Uludağ Üniversitesi Tıp fakültesi yanık ünitemize yanık olayından sonra belli bir zaman geçtikten sonra geç dönemde başvuran hastalarda görülen yara enfeksiyonu oranları belirgin bir şeklide yüksek olduğu için beş yıllık bir sürede, üç yüz yirmi yanık hastası üzerinde, yanık merkezine gecikmiş erişimin yara enfeksiyonu ve kontaminasyonuna etkisinin retrospektif olarak incelenmesini amaçladık.

GEREÇ VE YÖNTEM

Yanık hastaları, orta ve ağır derecede yanıklar olmak üzere iki gruba ayrıldı. Yara enfeksiyonlarının ve yara kontaminasyonlarının sıklığı her iki grup için de hospitalizasyon süreleri ve yanık merkezine erişimdeki gecikme zamanı bakımından analiz edildi.

BULGULAR

Yanık merkezine erişimdeki gecikmenin, yara enfeksiyon ve kontaminasyon sıklığını artıran önemli bir faktör olduğu görüldü. Bu fark özellikle orta derecede yanıklı hasta grubunda daha çok belirginleşmişti.. Ağır yanıklı hasta grubunda yara enfeksiyon ve kontaminasyon sıklığının tüm başvuru zamanları için yüksek düzeyde olduğu saptanmıştır.

SONUÇ

Orta derecede yanıklı hastalarda, yanık olayından en az yetmiş sekiz saat geçtikten sonra yanık merkezine erişmiş olanlara, sistemik antibiyotik profilaksisi başlanması tartışmaya açılmalıdır. Ağır yanıklı tüm hastalarda başvuru zamanından bağımsız olarak yara kontaminasyon ve enfeksiyon sıklığı yüksek bulunmuştur. Bu nedenle, bu gurup hastalarda da antibiyotik profilaksisi, her ne kadar normal deri florası için zararlı olsa da, tartışmaya açılmalıdır.

Anahtar sözcükler: Yara enfeksiyonu, yara kontaminasyonu, antibiyotik profilaksisi, yanık.

BACKGROUND

Since wound infection rates in patients with delayed admission seemed to be significantly higher, a retrospective study of bacteriology in 320 burn patients, over a 5-year period was carried out in order to analyze the relation between delayed admission and wound infection rates in our Burn unit of Uludağ University, Faculty of Medicine..

METHODS

The patients were separated into moderate or major burn groups according to burn severity. Wound infection and contamination frequencies were analyzed according to time-delay between burn injury and hospitalization time.

RESULTS

Delayed admission was found to be an important factor that causes an increase in wound infection and contamination frequency. This increase was significant especially among patients with moderate burn wounds. In patients with severe burns, wound infection and contamination frequencies were found to be higher for all admission time points.

CONCLUSION

Systemic antibiotic prophylaxis should be discussed in patients with moderate burns whose admission-delay is more than 78 hours. Wound infection and contamination rates were high in patients with major burns independent of the admission time. Therefore, systemic antibiotic prophylaxis should also be discussed in this group of patients, although it results in elimination of the normal skin flora.

Key words: Wound infection, wound contamination, antibiotic prophylaxis, burn

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Infection is the most common cause of mortality following burn injury [1,2,3,4], and sepsis is more likely to be seen in burn wounds when compared to all other forms of trauma due to an alteration in immune responses and breach of skin continuity. [5] Any complication may easily result in death in an immunsupressed burn patient with multiple system problems. In many of the previous clinical studies, it was demonstrated that the most common complication that contributed to death in burn patients was sepsis, which results from invasive common wound infections. [6,7] All these findings imply the necessity that burn patients, who are more susceptible to wound infections should be decontaminated and every effort should be made to decrease the probability of infection.

Antibiotic prophylaxis means the use of antibiotics for preventing the setting in of an infection or suppressing an acquired infection before it becomes clinically manifest. The goal of preventing an infection is the adequate treatment against all organisms, which have infectious potentials. Therefore, the most encountered microorganisms cultured from the burn wound and commonly used antibiotics should be analyzed in order to determine the validity of any antibiotic use.

It can be difficult to develop a rational antibiotic policy for burn units. Antibiotic selection is usually the concern of the individual unit which takes its prevalent pathogens into consideration and recommendations from one unit may not be applicable for another.

Since normal bacterial flora is believed to play a protective role as it prevents colonization of antibiotic resistant microorganisms, routine use of systemic antibiotic prophylaxis against possible wound infections is another handicap in burn patients. Instead of antibiotherapy, early debridement and skin coverage of the burn wound have been accepted as the most effective approach in keeping the burn wound out of infection. [8]

However, in many countries those are not well-organized in patient transportation and do not have enough number of burn care units, burn patients still subject to inappropriate wound care until they are hospitalized in a burn care unit, and based upon this fact, it is sometimes impossible to perform early debridement and skin coverage in these patients prior to the development of a wound infection that can easily convert to a systemic infection. Therefore, a question arises; what should our policy be against wound infections in patients, who could not initially admit to a burn care unit soon after the burn injury? This retrospective clinical study was carried out in order to analyze the relation between delayed admission and wound contamination and/or infection rates in burn patients with an aim to discuss the problem, determine the high risk group for wound infection and modify our policy in antibiotherapy in the burn unit.

MATERIAL AND METHODS

Three hundred and twenty burn patients admitted to the burn unit of Uludağ University Hospital between the years 1998 and 2003 were included in this retrospective study. The Lund & Bowder chart was used to establish the extent of burn injury. [9] Patients were categorized as minor, moderate and major burn groups using "The Burn Classification & Triage ." [3] Accordingly, moderate burns were defined as second degree burns between 15% and 25% of total body surface area (TBSA) or third degree burns between 3% and 10% of TBSA. Major burns were accepted as second degree burns greater than 25% of TBSA, and third degree burns over 10% of TBSA. Minor burns were not included. All data was collected from patient records and unclear data was excluded.

Culture swabs from the burn wounds were taken at the time of admission and subsequently on a twice a week basis. The culture swabs were taken from different sites of burn wounds. Burn wounds were accepted as contaminated, when the presence of bacteria was demonstrated and there was not any sign of a wound infection. The wounds were classified as infected if there were some clinical changes at the burn wound site as listed in table 1, [10] and in the presen-

Table 1. Local signs of wound infection.

• Deepening of the burn injury
• Brown, black or violaceous discoloration
• Rapid separation of eschar
• Green pigmentation of the subcutaneous fat
• Edema and/or red discoloration of normal skin surrounding the burn wound
• Spread of subcutaneous edema

Table 2. Frequencies of wound contamination and wound infection in moderate burn patients according to time delay before the admission.

Admission time (hours)	0-6h	7-12h	13-18h	19-24h	25-30h	31-36h	37-42h	43-48h	49-54h	55-60h	61-66h	67-72h	73-78h	79-84h	85-90h*	91-96h	More than 4 days
Number of patients	90	24	2	2	11	7	4	2	6	0	2	4	2	2	0	4	20
Frequency of contaminated wounds	24	5	1	0	4	2	0	0	4	0	2	4	2	2	0	3	14
Frequency of infected wounds	13	3	0	0	2	0	0	0	3	0	2	3	2	2	0	2	13

Table 3. Frequencies of wound contamination and wound infection in major burn patients according to time delay before the admission.

Admission time (hours)	0-6h	7-12h	13-18h	19-24h	25-30h	31-36h	37-42h	43-48h	49-54h	55-60h	61-66h	67-72h	73-78h	79-84h	85-90h	91-96h	More than 4 days
Number of patients	26	32	4	3	4	2	4	4	6	4	5	4	6	4	2	2	26
Frequency of contaminated wounds	24	32	4	3	4	2	4	4	5	3	3	4	5	3	2	2	25
Frequency of infected wounds	22	30	3	3	3	2	3	4	4	3	2	3	5	3	2	2	25

Table 4. Distribution of contamination and infection rates in both groups according to admission times.

	Contamination rates	Infection rates
Moderate burns		
A	26,5%	13,2%
B	60%	50%
C	73,1%	65,4%
Major burns		
A	97,2%	88,7%
B	84,8%	72,7%
C	94,1%	94,1%
Total burns		
A	50,7%	39,1%
B	75,5%	64,2%
C	85%	81,7%

ce of bacteria confirmed with susceptibility tests. All data about infections was recorded daily.

Systemic antibiotic prophylaxis was not routinely used at our burn unit provided that there were deep dermal wounds secondary to fasciotomy or escharatomy. Additionally, systemic antibiotics were administered according to positive culture results and clinical assessment under the supervision of a microbiology and infectious disease consultant.

In this study, the patients were initially divided into two groups as moderate or major burn groups according to burn severity. Then, wound contamination and wound infection frequencies were analyzed in both groups as they were distributed according to time-delay between the onset of burn injury and hospitalization in the burn unit. Distribution of the patients and wound contamination and infection frequencies in both groups according to delay in admission time divided into intervals of six hours are listed in table 2 and 3. Secondly, both groups were divided again into three subgroups in relation with the admission time as A (admissions before 36 hours), B (admissions between 36 and 78 hours) and C (admissions after 78 hours) in order to obtain adequate sample size within each group. These subgroups were also compared to each other in terms of contamination and infection rates (Table 4). Additionally, common isolates from burn wounds (Table 5) and the antibiotics generally used for systemic antibiotherapy in some patients mentioned above were documented (Table 6).

Statistical analyses

Pearson chi-square test, Fisher's exact test and Mantel-Haenszel chi-square test were applied for data obtained from patient records including admission time, burn sizes and wound culture results by using SPSS 10.0 for Microsoft" Windows software.

RESULTS

A total of 196 patients (61.2% of total) had at least one positive swab culture and 164 of them (51.2% of total) also had clinically manifest wound

Table 5. List of microorganisms detected in swab cultures.

Microorganisms	Frequency of isolates
Pseudomonas aeruginosa	64
Staphylococcus aureus	31
Coagulase negative Staph.	23
Alfa hemolytic Streptococcus	0
Beta hemolytic Streptococcus	1
Enterococcus faecalis	0
Acinetobacter	17
Escherichia coli	8
Enterobacter	12
Klebsiella	11
Candida	2

Table 6. Antibiotics used and number of courses during the antimicrobial therapy.

Antibiotics	Number of courses
Ampicillin/sulbactam	171
Gentamycin	97
Cefuroxim	69
Ciprofloxacin	56
Clindamycin	43
Vancomycin	35
Ceftazidine	32
Imipenem	27
Metronidazol	12
Cephotaxime	9
Fluconazole	8
Trimethoprim	5
Piperacillin	4

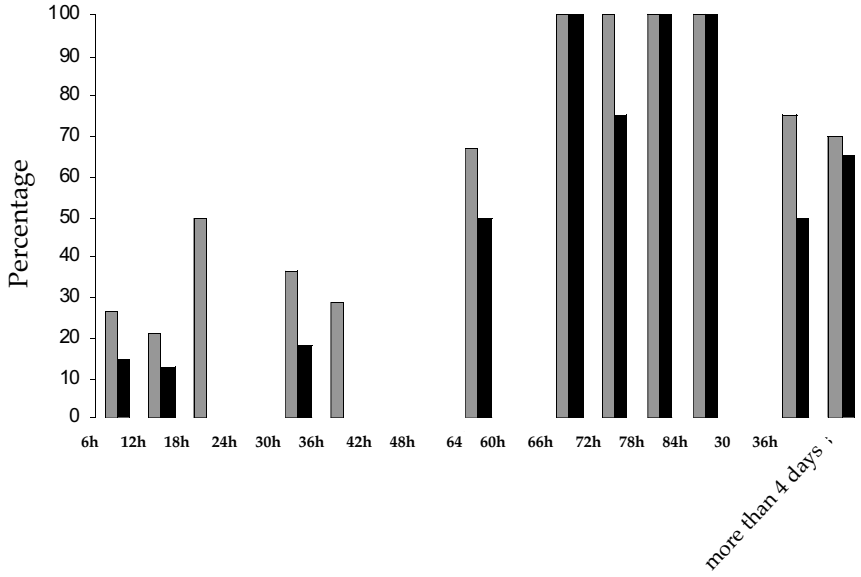

Table 7. Wound contamination *(gray column)* and wound infection *(black column)* rates in relation with the admission time in the moderate burn group.

infection out of 320 admissions. When evaluated totally, time delay before admission seems to be an effective factor for an increase in the frequency of wound contamination (linear by linear association 27.346, *p*=0.000) and wound infection (linear by linear association 37.568, *p*=0.000) among the groups A, B and C. Additionally, as expected, contamination rate seen in the major burn group (93%) was higher than that of the moderate burn group (31.8%) and the difference was statistically significant (Pearson chi-square 106.183, *p*=0.000). The same result was obtained for the infection rates (Pearson chi-square 118.844, *p*=0.000). In other words, early admission to a fully equipped burn unit soon after the injury and limited extent and degree of burn injury decreased the risk of wound contamination and infection.

In the moderate burn patients group, there were 182 patients and in the major burn patients group there were 138 patients. In the moderate burn group, contamination and infection rates of more than fifty percent were seen after a delay for 48 hours, when the admission time intervals were arranged in periods of six hours (Table 7). Statistically, it was calculated that both wound contamination and wound infection rates increased depending on the increase in delay times in the subgroups A, B, C and the differences between these subgroups were significant (linear by linear association 24.708, p=0.000 for contamination and linear by linear association 38.394, p=0.000 for infection), and rates of contamination and infection were more than fifty percent, when the delay before the admission to the burn unit exceeded 78 hours. However, in the major burn group, there was not any difference in contamination and infection rates correlated with the time of admission both graphically (Table 8) and statistically (linear by linear association 0,043, *p*>0.050)), and frequencies of contamination and infection for each time period were extremely high compared to those of the moderate burn group and the difference was statistically significant (Mantel-Haenszel chi-square 12.327, *p*=0.000 and 22.478, *p*=0.000, respectively). For the moderate burn group, early admission seemed to be a protective measure against wound contamination (odds ratio 0.25 (95%CI, 0.11-0.57) and infection risk (odds ratio 0.17 (95%CI, 0.07-0.38).

The mean delay time between burn injury and hospitalization in the burn unit for the patients with contaminated wound was 54.3 hours (range 3-192 hours), it was 54.9 hours (range 4-192 hours) for the patients with infected wounds and it was 12.7 hours (range 1-89 hours) for the patients without wound contamination or infection.

The most common microorganism cultured from infected burn wounds was *Pseudomonas aeruginosa* (38%, n=64), and it was followed by *Staphy-*

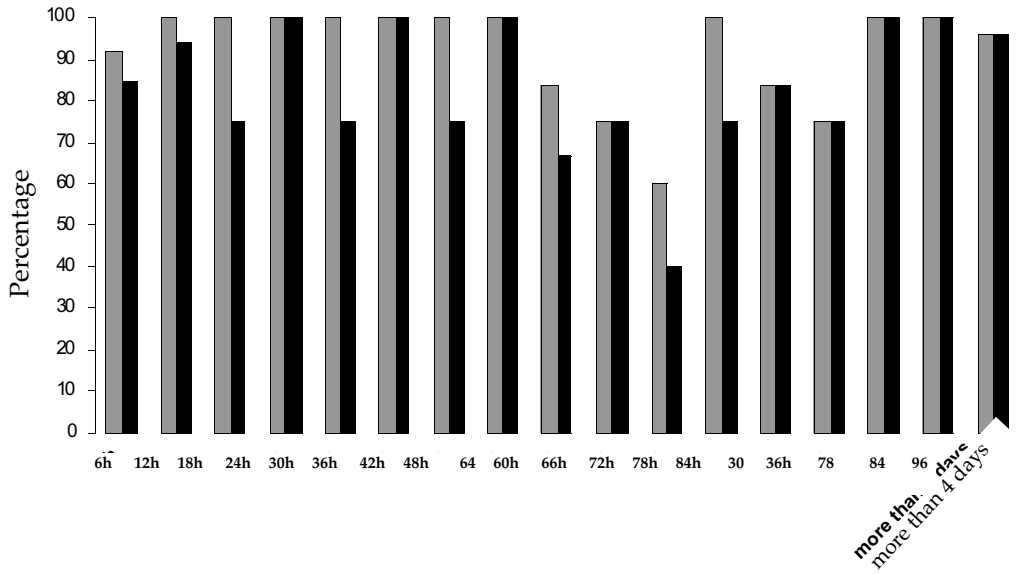

Table 8. Wound contamination (gray column) and wound infection (black column) rates in relation with the admission time in the major burn group.

lococcus aureus (18.3%, *n*=31) and coagulase negative staphylococci (13.6%, *n*=23) (Table 5).

Systemic antibiotherapy was used in certain situations mentioned before and also on suspicion of a systemic infection, which was confirmed by positive culture results. Antibiotics were used in 197 patients out of 320 (61.5%) during the hospitalization period. The antibiotherapy was administered in 568 courses and the median duration of courses was 9 days in a range of 0 to 31 days. Durations of courses were consultated with microbiology and infectious disease consultant. The most frequently used antimicrobials were ampicillin/sulbactam (*n*=171), gentamycin (*n*=97), and cefuroxime (*n*=69). The antibiotic courses are shown in Table 6.

DISCUSSION

Since, infections are shown to be the major cause of death among burn patients after the initial dehydrated state and wound infection may easily convert to a systemic infection in case of a depressed host defense, all of the possible preventive measures against wound infection in burn patients should be discussed. Depending on high wound infection rates seen in patients those admitted to our burn unit after a delay in our region, this retrospective study was carried out to evaluate high risk groups for wound contamination and/or infection in means of delay-times between the injury and the admission to the burn unit.

Negative effects of delayed admission have been reported in means of the relationship between arrival-delay and mortality before, and critical time limit for an increase in mortality was found to be 2 [11] and 4 hours. [12] But, in the present study, the relationship between admission-delay and the risk of wound contamination and infection in burn patients was studied, and approximately 78 hour delay was found to be the critical time limit that caused an increase in the rate of wound contaminations and wound infections in the moderate burn patients. However, in the major burn group, there was not any statistically significant difference neither in wound contamination nor in wound infection rates in relation with the delay time (Fisher's exact test, $p>0.05$). The incidence of wound contamination and infection were found to be extremely high regardless of admission times. This result was confirmed with a positive correlation between burn size and post burn infections. Major burn group patients had higher incidences of wound contaminati-

ons and wound infections in the post burn period. Similar results were obtained by Sheridan et al., in their analysis of 16 children with serious burns who had arrived to the burn unit 5 to 44 days (mean 16.3 days) after the injury, and found higher risks of bacteremia, renal dysfunction and wound sepsis when compared with concurrently managed control group of patients admitted to the burn unit within 24 hours of injury. [13]

In our country, inadequate social care facilities, problems and difficulties in transportation of burn patients from peripheral health care units to referral burn centers are factors which cause a delay in the time of arrival to the burn units. These patients are initially taken under care in different health institutions or hospitals that are not experienced about burn care. Although all necessary protective measures are taken into consideration in these facilities, isolation of burn patients from contaminating factors seems to remain as a difficult problem. Moreover, burn patients are probably exposed to different resistant microorganisms in these institutions which probably increase wound infection rates in patients with delayed admission in addition to infections caused by the patient's own bacterial flora.

Another group of patients in the delayed admission group initially try to treat their wounds by some plant extracts, toothpaste, olive oil, etc. The use of those materials relies mostly on historical and anecdotal evidence and might result in wound contamination and/or infection.

Shortening the time to admission is of great importance in this regard, but it necessitates education of the people and amelioration of the infrastructure. Therefore, the only weapon remained against pathogen microorganisms is antimicrobial therapy. Since antibiotherapy is the most important application for an optimal care in burn treatment in our region, it is necessary to determine the need for a systemic antibiotherapy and type of antibiotic to be used.

In the present study, gram-negative bacilli were the mostly encountered agent obtained from wound cultures and Pseudomonas was the most common microorganism identified, followed by Staphylococcus aureus as has been reported in many previous studies. [14,15,16,17,18,20] Although Pseudomonas aeruginosa and Staph. aureus were the most common microorganisms cultured from wound infections in our burn unit; ampicillin/sulbactam was the most frequently used antibiotic in systemic antibiotherapy. So it seems conflicting because, *Pseudomonas aeruginosa* is not susceptible to penicillin and it is well-known that many strains of *Staph. aureus* are b-lactamase positive. The reason for this discordance lies under the rationale for antibiotic prophylaxis and treatment. Antibiotic prophylaxis is mostly used against sensitive opportunistic flora that normally present on the skin of the patient, and the antibiotics usually used for prophylaxis are effective in eradicating opportunistic bacteria which may become pathogenic immediately after the integrity of skin is disrupted. There is no need for broad-spectrum antibiotics in this regard. Furthermore, it is necessary to balance effective antimicrobial treatment long enough to produce a beneficial effect but not sustained unnecessarily to develop opportunistic or resistant organisms. [21] Hence, most of the wound infections are treated with local antibiotherapy with ointments, such as silver sulphadiazine (Silverdin®) until any sign of systemic infection becomes manifest. This is usually enough for eradication.

In the present study, low proliferation rates of penicillin susceptible strains obtained in the swab cultures might be the result of elimination due to prophylactic penicillin use in the risk groups. This may explain the discordance between the pre-dominancy of pseudomonas in the culture results and the kind of antibiotics used for systemic antibiotherapy. Another fact to explain this discordance is that broad spectrum antibiotics which may act against Pseudomonas and Staph. aureus are usually kept as a final and definitive treatment alternative.

Prophylactic antibiotic administration is accepted as useless or even harmful in burn patients [21,22,23] and early debridement and skin coverage is the method of choice in modern treatment of a burn wound. [8] This is true in well-organized societies, but the value and validity of prophylactic antibiotherapy in burn patients in developing countries are sometimes underestimated.

Consequently, admission-delay, as well as the burn severity was found to be an important factor that contributed to higher incidences of wound contamination and wound infection in our region. Admission-delay alone was found to be an impor-

tant factor only for the moderate burn group. It was concluded that systemic antibiotic prophylaxis with an appropriate antibiotic should be considered in the moderate burn patients whose admission-delay is more than 78 hours due to higher rates of wound contamination and wound infection (> 50%) in this group. Since the corresponding incidence rates are extremely high for each time period in the major burn group, prophylactic antibiotherapy is useless in that it will not make any difference in clinical outcomes, and in addition it will enhance the development of resistant strains.

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